NEC NARASARAOPETA ENGINEERING COLLEGE (AUTONOMOUS)

PROCEEDINGS

4th INTERNATIONAL CONFERENCE

EMERGING TRENDS IN MECHANICAL ENGINEERING AND INDUSTRIAL AUTOMATION

NEC-ICETMEIA-2K24

19th & 20th April, 2024

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Proceedingsof

International Conference on
Emerging Trends in Mechanical Engineering and Industrial Automation
NEC-ICETMEIA- 2K24

19th – 20th April 2024

Chief Editors

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It's my privilege to thank the Keynote Speakers, Invited Speakers and Chairpersons of various technical sessions for their support in organizing the event. My sincere thanks to all the individual members of the Scientific Advisory Committee and Organizing Committee for their constructive ideas while designing the Conference Program. My special thanks to **Mr. R.S. Pushyanth Kumar,** Design Engineer, CLAAS KGaA mbH, Germany and **Mr. Nagarjuna Ravella,** Automation Engineer, Accenture GmbH, Hamburg, Germany for sparing their valuable time. I thank all the participants who submitted the scientific and technical papers for sharing their ideas.

NEC-ICETMEIA 2K24 conference would have been impossible without the support of academic institutions and industrial organizations both in terms of manpower and ideas. This support is greatly acknowledged. I thank my management **Sri M.V.Koteswara Rao** Garu, Chairman and **Sri M. Ramesh Babu** Garu Secretary for their kind support and encouragement for the conference.

My heartfelt thanks to my colleagues and all my research team members whose efforts and hard work in organizing and managing the conference are gratefully acknowledged. I thank Co-Conveners and Organizing Committee forrenderingtheirsupporttotheconference.

I sincerely thank M/S Spectrum Publications Hyderabad for bringing out the Souvenir and Pre Conference Proceedings well in time.

Finally, I thank all the people and institutions who are directly and indirectly involved in organizing the Conference.

I thank one and all

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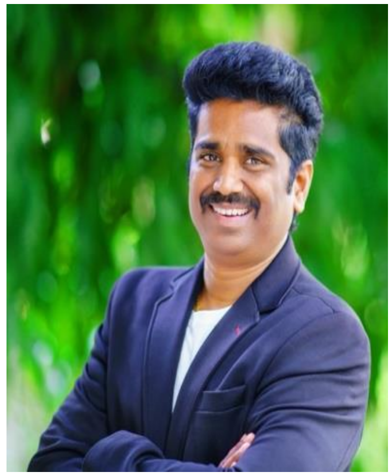
PREFACE

International Conference on "Emerging Trends in Mechanical Engineering and Industrial Automation" **NEC-ICETMEIA-2K24** provides an excellent international forum for sharing knowledge and results in theory, methodology and applications impacts and challenges of Mechanical Engineering. The purpose of this conference is to bring together the mechanical engineering community to explore, disseminate and strengthen initiatives in new directions under the broad areas of Manufacturing, Thermal Sciences, Mechanical Design, Robotics, Mechatronics and Industrial Automation.

The objective of this conference is to create an international conglomeration of scientists, engineers and institutional experts. This forum serves as platform where people can share information about latest diverse technological advancements, innovations and achievements in the areas of Mechanical Engineering and allied fields of Engineering. Further it would also facilitate the discussion that centers on the developments and challenges in the fields of design, manufacturing, thermal, robotics, mechatronics fields of Engineering. The focus of this conference is to provide technical platform that encourages the scientific research and educational activities that would cater the needs of both society and the industry. Most importantly, NEC-ICEMEIA-2K24 is invested in the advancement of a common man's life by utilizing the theory and practice of mechanical engineering and allied streams of Engineering. The conference includes Keynote addresses and guest lectures by eminent speakers around the globe who would deliberate the recent trends and challenges in the fields of Mechanical Engineering and Industrial Automation.

Message from Vice Chairman



I am glad to know that Department of Mechanical Engineering of Narasaraopeta Engineering College is organizing "International Conference on Emerging Trends in Mechanical Engineering and Industrial Automation [NEC-ICETMEIA2K24]. I hope this e-conference can congregate academicians, industry personnel and research scholars to share their findings and insights about innovations in Mechanical Engineering. The theme of the conference emphasizes on key aspects of Manufacturing, Thermal Sciences, Mechanical Design, Robotics, Mechatronics and Industrial Automation. I hope this initiative by Department of Mechanical Engineering will pave way to exceptional deliberations and other activities to enhance the power of knowledge and ideology in the field of engineering.

I wish the organizers great success for the conference.

Mr.M.S.Chakravarthi
Vice Chairman
NEC-Group

Message from Principal

I am glad to know that the Department of Mechanical Engineering of Narasaraopeta Engineering College organizing an International Virtual Conference on "Emerging Trends in Mechanical Engineering and Industrial Automation [NEC-ICETMEIA2K24] during 19th& 20th of April 2024. The unprecedented ongoing pandemic situation prevailing all over the globe has driven the professionals to continue their research and knowledge dissemination virtually. I believe that such virtual conferences will be one of the finest opportunities for academicians, scientists, professionals, students and researchers from all over the globe to share and express their views, discuss the practical challenges and possible solutions in Science & Engineering fields.

The theme of the conference emphasizes the necessity of engineering innovation Mechanical Engineering in these difficult times all over the globe. I hope the scientific deliberations, discussions and other activities that happen during the conference will enrich the participants and definitely leave new milestones.

I wish the organizers the very best for the success of the Conference

Dr. M. Sreenivasa Kumar
Principal
Narasaraopeta Engineering College

Message from Vice Principal

It gives immense pleasure to write a message for the International Conference on "Emerging Trends in Mechanical Engineering and Industrial Automation [NEC-ICETMEIA2K24] organized by Department of Mechanical Engineering, Narasaraopeta Engineering College (Autonomous) during 19th& 20th of April 2024. There are truly amazing innovations and breakthrough nowadays in the selected fields of Mechanical Engineering. I expect the present International Conference will explore students and research scholars to focus much on the field of Mechanical Engineering and Industrial Automation. I have gone through some of the abstracts and could see its rich qualitative academic content. I am also able to envisage its great potential to discuss and learn some new innovations in the fields of Mechanical Engineering.

It is important to inculcate an attitude towards research in the minds of younger generation and this conference would be a stepping stone towards this attainment in the field of Mechanical Engineering.

I wish the conference a great success. I am sure the conference is a grand scientific extravaganza and great feast for the student community.

Dr. D. Suneel
Vice Principal
Narasaraopeta Engineering College

Message from Head of the Department

I am very much delighted in welcoming the delegates for the 2 day virtual international conference on "Emerging Trends in Mechanical Engineering and Industrial Automation [NEC-ICETMEIA2K24]. The pursuit for knowledge has been from the beginning of time but knowledge only becomes valuable when it is disseminated and applied to benefit of humankind. The prime focus of this conference is to bring together academicians, researchers and industry professional to join hands in finding the scope, challenges and opportunities and solutions that are encountered in the fields of Mechanical Engineering. Our technical sessions are rich and varied in the domains of Machine Design, Production Engineering, Thermal Engineering and Automation. As a conference Convener, I know that the success of the conference depends ultimately on the many people who have worked with us in planning and organizing both the technical program and virtual technical deliberations. In particular, we thank the review and advisory committee for their wise advice and brilliant suggestion on organizing the technical program; the Program Committee for their thorough and timely reviewing of the papers and publishing them in a conference proceeding. It is envisaged that the intellectual discourse will result in future collaborations between Universities, research institutions and industry globally towards the recent technological developments of Mechanical Engineering, during this pandemic situation.

Dr. B. Venkata Siva
Head, Department of ME
Narasaraopeta Engineering College

LIST OF FULL LENGTH PAPERS SELECTED FOR PROCEEDINGS

International Conference on Emerging Trends in Mechanical Engineering and Industrial Automation

NEC-ICETMEIA- 2K24

Leakage detection by using PLC in Oil and Gas Industries

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Abstract - **Leakage detection in oil and gas industries is paramount for ensuring safety, environmental protection, and operational efficiency. This abstract presents a novel approach utilizing Programmable Logic Controllers (PLCs) for leakage detection. PLCs offer real-time monitoring and control capabilities, making them ideal for detecting leaks promptly. The proposed system integrates sensors strategically placed along pipelines and storage facilities to detect anomalies in pressure, flow rate, and temperature, indicative of potential leaks. Upon detection, the PLC triggers immediate responses such as shutting down valves or activating alarm systems to mitigate risks. This paper discusses the design, implementation, and performance evaluation of the PLC-based leakage detection system, highlighting its reliability, efficiency, and cost-effectiveness. Case studies and experimental results demonstrate the effectiveness of the proposed approach in enhancing safety and minimizing environmental impact in oil and gas operations.**

I. INTRODUCTION

PLCs (Programmable Logic Controllers) are essential components in the oil and gas sector, assisting in the automation and optimization of production operations. Because of the high risk and complexity of oil and gas operations, the use of PLCs has become increasingly important in order to assure safe, efficient, and cost-effective operations. PLCs are utilized in a variety of industrial applications, from monitoring and controlling equipment and processes to data logging and analysis. They offer real-time process monitoring and control, decreasing the need for manual intervention and increasing safety. Furthermore, by recognizing possible problems and streamlining manufacturing processes, PLCs can assist in minimizing maintenance and operational expenses. As a result, PLCs are becoming increasingly popular in the oil and gas industry, with many organizations recognizing their worth in improving efficiency and production.

Pressure switches play a pivotal role in leakage detection systems by continuously monitoring pressure levels within pipelines and storage tanks. When a deviation from the predefined threshold occurs, the pressure switch sends a signal to the PLC, triggering a series of predetermined actions.

Solenoid valves, controlled by the PLC, act as gatekeepers, regulating the flow of fluids within the system. In the event of a detected leak, the PLC can command solenoid valves to shut off the flow, isolating the affected section and preventing further leakage.

Indicators and push buttons provide essential feedback and manual override capabilities to operators. Indicators display system status, alerting personnel to potential issues or alarms, while push buttons allow for manual intervention in emergency situations, such as initiating shutdown procedures.

By integrating these components with PLCs, oil and gas companies can establish robust leakage detection systems that offer rapid response capabilities, minimize environmental impact, and ensure compliance with regulatory standards. This integrated approach not only enhances safety and operational efficiency but also demonstrates a commitment to responsible resource management and environmental stewardship in the oil and gas industry.

II. PROBLEM IDENTIFICATION

Challenges in PLC-based leakage detection systems for oil and gas industries include false alarms disrupting operations, sensor reliability for accurate leak detection, and integration issues with existing infrastructure. Regular maintenance is crucial for diagnosing and resolving system issues promptly, while cyber security threats require robust protection measures. Harsh environmental conditions may impact PLC performance, necessitating careful equipment selection. Proper personnel training is vital, especially in remote locations, for effective system operation and maintenance. Continuous monitoring and testing are essential to ensure system readiness, and collaboration with experts can provide valuable insights for optimizing performance.

III. METHODOLOGY

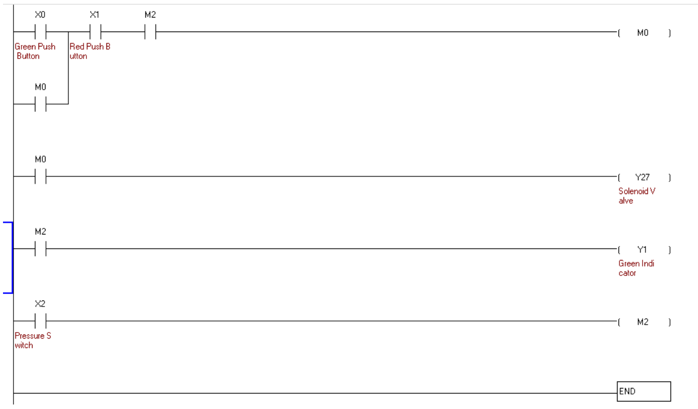

Figure-1: Block diagram and the Design.

IV. MATERIALS

There are five types of Materials that are usually produced.

- Pressure Switch
- Solenoid Valve
- Green Indicator
- Reed, Green Push Buttons
- Air Compressor

V. MODELING

Green Push Button has two connection one end connect to X0 and another end connect to Red Push Button .Red Push Button has two connection one end connect to X1 and another end joint the two wires by using double lug (green end & 24 volts) is connect to another end. Pressure Switch is has two connection one side is connect to X2 and another end is connect to 24 volts. Solenoid valve is two connection one end is connect to Y0 and another end is connect to power supply. Green Indicator has two connection one end is connect to Y1 and another end is connect to 0 volts common. Pressure Switch is placed on Air compressor. Air compressor outlet valve we connect the pneumatic hose pipe that can inside diameter is 4 mm and outside 6mm using the couple is attached to Air compressor. Another hose pipe is connect to couple for solenoid valve have inlet 8 mm we have to use couple 6mm to 8mm to connect hose pipe to solenoid valve. Solenoid valve outlet valve 8 mm and we fixed Hose pipe and couple to 8 mm valve to 6mm hose pipe.

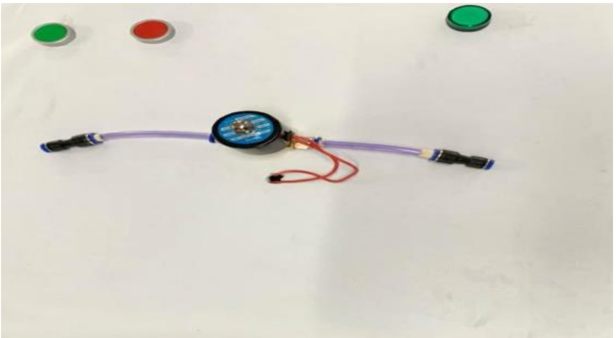

Figure-2: Leakage detection setup

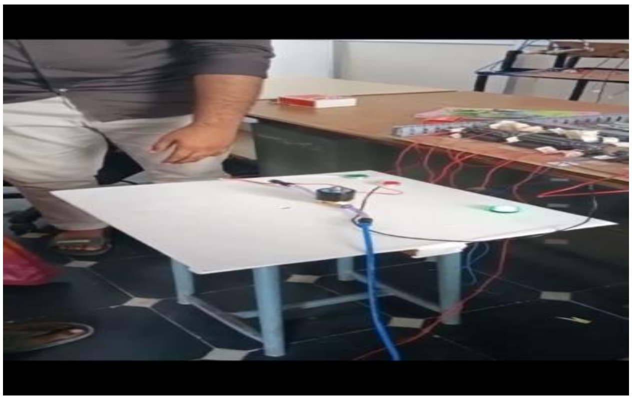

Figure-3: Leakage detection setup connected to PLC board

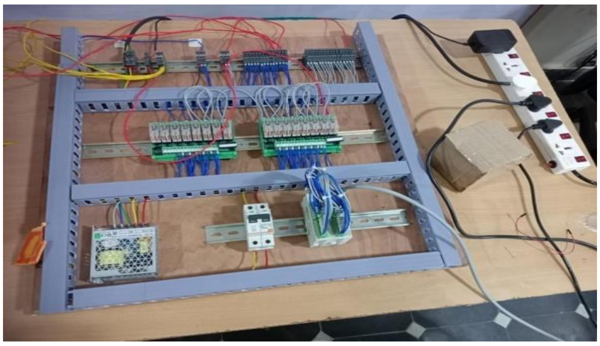

Figure-4:Arrangement of PLC board.

VI. ANALYSIS

A. Data Processing

In the real time monitoring of leakage detection within the oil and gas industries, data processing stands as a pivotal component of Programmable Logic Controller (PLC) systems. These PLC-based systems are engineered to swiftly process incoming sensor data, enabling real-time analysis to promptly identify deviations from expected operational parameters. Through intricate algorithms, the PLCs assess the incoming data stream, comparing it against predefined thresholds or historical patterns indicative of normal operation. This analytical prowess allows the PLCs to discern potential leaks or abnormalities, triggering timely alerts or automated response actions to mitigate risks promptly. Furthermore, data processing extends beyond mere anomaly detection, encompassing tasks such as adaptive learning, where PLCs utilize machine learning techniques to refine detection algorithms over time, thereby enhancing accuracy and reducing false alarms.

B. Algorithm Development.

Algorithm development within PLC-based leakage detection systems is a meticulous process aimed at maximizing the accuracy and efficiency of leak detection. Engineers meticulously craft algorithms that analyze incoming sensor data in real-time, leveraging statistical methods, pattern recognition techniques, and historical data to differentiate between normal operating conditions and potential leaks. These algorithms are fine-tuned to establish thresholds for various parameters, ensuring that deviations beyond acceptable limits prompt immediate action. Through iterative refinement, algorithm developers strive to minimize false alarms while maximizing the system's sensitivity to genuine anomalies. Moreover, advanced PLC systems may incorporate adaptive learning algorithms, which continuously adjust detection parameters based on evolving operational patterns, further enhancing the system's responsiveness and reliability. This iterative process of algorithm development is essential for ensuring that PLC-based leakage detection systems can swiftly and accurately identify leaks, mitigating risks and minimizing downtime.

C. Real Time Analysis.

Real-time data analysis in PLC-based leakage detection systems is fundamental for prompt identification of potential leaks. Through instantaneous processing of sensor data, PLCs swiftly assess parameters such as pressure, flow rates, and temperature, enabling rapid detection of abnormalities. These systems employ sophisticated algorithms to compare incoming data against predefined thresholds or historical patterns, instantly recognizing deviations indicative of a leak. By analyzing data in real-time, PLCs can trigger immediate alerts or response actions, facilitating timely intervention to mitigate risks. Furthermore, real-time analysis enables PLCs to adapt dynamically to changing operational conditions, ensuring continuous monitoring and proactive detection of leaks. This agile approach enhances safety and minimizes environmental impact by reducing the time between detection and response, thereby safeguarding oil and gas facilities against potential hazards.

Figure-5: PLC Processer

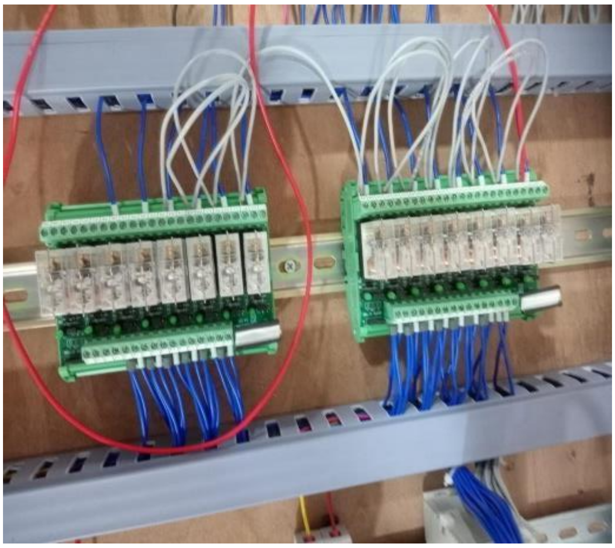

Figure-6: Relay switches

VII. CONCLUSION & FUTURE SCOPE

The implementation of a leakage detection system in oil and gas industries using Programmable Logic Controllers (PLCs) with real-time analysis offers significant benefits in terms of safety, environmental protection, and operational efficiency. Through swift leak detection enabled by PLCs, coupled with continuous monitoring and immediate response capabilities, companies can mitigate risks associated with leaks, reduce environmental impact, enhance safety, and improve operational productivity. Overall, PLC-based leakage detection systems represent a vital component of risk management strategies within the oil and gas industry, safeguarding both the environment and the integrity of critical infrastructure. Moreover, the adoption of PLC-based leakage detection systems underscores a commitment to innovation and technological advancement in the oil and gas industry. By embracing automation and leveraging PLC technology, companies can modernize their infrastructure, improve operational efficiency, and stay competitive in a rapidly evolving market landscape. As such, PLC-based leakage detection systems represent not only a practical solution to mitigate risks but also a strategic investment in the long-term viability and sustainability of the oil and gas industry.

A. Future Scope

In the future, leakage detection systems in oil and gas industries using Programmable Logic Controllers (PLCs) with real-time analysis will see advancements in sensor technologies, artificial intelligence integration, predictive maintenance capabilities, cyber security measures, and integration with IoT and cloud technologies. These developments aim to enhance accuracy, reliability, scalability, and sustainability of PLC-based systems, ensuring proactive risk management, regulatory compliance, and operational excellence in the oil and gas sector.

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Performance analysis on 4 stroke Internal Combustion engine with EGR by using mahuva oil blends

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***Abstract*: As a renewable and alternative fuel for compression ignition engines, biodiesel instead of diesel has been increasingly fuelled. In the recent 10 years many researchers investigated the effects on engine performances and emissions which are the harmful in diesel engine. Around the world researched are devoted to reduce such emissions with different ways like fuel modification, combustion chamber design and treating the exhaust gas, etc., In this connection the hunt for the suitable alternative fuels for diesel engine initiated. The paper focused on effective utilization of fuel blend in DI diesel engine operating at different exhaust gas recirculation. In this work an effort was made to compare the performance characteristics of the diesel engine fuelled with pure diesel, pure Mahuva biodiesel and the blend of diesel-biodiesel-ethanol (ternary fuel blends). It was observed that the performance of the diesel engine with ternary fuel blends is as par with pure diesel. The experiments were conducted on single cylinder direct injection diesel engine at constant speed 1500 rpm. The engine was run without EGR, and 5% EGR. The blends are considered that with 5%, 10% of blend for EGR and without EGR. The results obtained were compared with that of pure diesel fuel.**

***KEYWORDS:** IC engine, mahuva oil, EGR, Blends, Performance and emission analysis*

I. INTRODUCTION

Fossil fuel consumption is steadily rising in industrial as well as in transportation sector as a result of population growth in addition to improvements in the standard of living. The continually depleting resources of fossil fuel and the highly toxic emissions which are produced due to these fuels have largely hastened the need for alternate fuels for internal combustion (IC) engines. Several fuels have been tried for running internal combustion engines. These include straight vegetable oil, biodiesel, alcohol, natural gas and hydrogen. Hydrogen has been found to have several properties which are essential for a green alternate fuel to be used in IC engines. Its high auto ignition temperature and low ignition energy coupled with its various other combustive properties help in enhancing engine performance. The high diffusivity of hydrogen which is about four times that of gasoline improves the mixing process of fuel and air. As the burning velocity rises the actual indicator diagram is nearer to the ideal diagram and the thermodynamic efficiency increases.

II. BROAD CLASSIFICATION OF BIOFUELS

Classification based on Generation (Suc-classification of the secondary biofuels) According to this classification, the biofuels have been kept in four groups based on the source materials. They are: first generation, second generation, third generation and fourth biofuels.

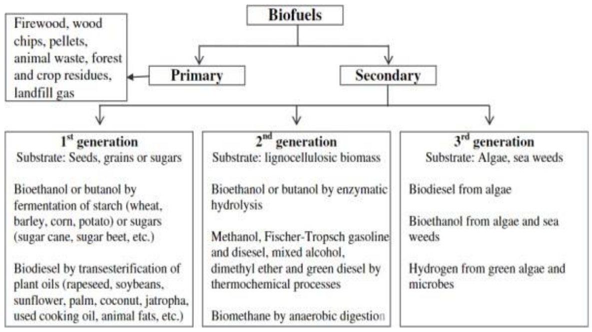

Figure-1: Broad classification of biofuels

III. EXPERIMENTAL SETUP AND METHODOLOGY

A. Production of Mahuva oil

Mahua oil is extracted from mahua seed by mechanical expeller. First the dry fruits were collected in a drum, and the kernels were separated. Later the kernels were dried and then fed into the oil extraction machine. The oil obtained by pressing is collected in a drum. Then filtration is done to remove the unwanted particles left in the extruded oil in order to obtain the pure vegetable oil.

The oils obtained from expeller were used for biodiesel production. Degumming process was carried out for Neem and Polanga oil to nullify the gum effect.. Then the oils were analysed for determination of their acid values by titrating against a known strength of KOH solution.

The methods adopted for degumming were treating the crude mahua oil first with immobilized phospholipase and then extracting the phospholipase-treated crude oil with pure water. 1% phosphoric acid was added to 1200 ml of crude neem/polanga oil. The mixture was heated and stirred at 900C. Then the mixture underwent settling for 24 hours resulting in gum free mahua oil


Figure-2: mahuva oil from seeds

It is semi-evergreen herbage indigenous to IndiaMahua oil has around 20% FFAs and has a yield of 181,000 metric tons per year in India

Figure-3 .Life cycle analysis of mahua oil biodiesel

The unprocessed yet filtered rawmahua oil is greenish yellow in color. The fatty acid profile determines the quality and effectiveness of fats and oils. According to the fatty acid profile of mahua oil, the main fatty acids are palmitic acid, stearic acid, oleic acid, and linoleic acid. Table 2 indicated mahua oil contains a high concentration of saturated along with mono-unsaturated fatty acids.

Oils and fats can be processed into bio-diesel in at least four ways transesterification, dilution, micro-emulsions, and pyrolysis. The standard method is transesterification. It is a chemical process that forms fatty acid alkyl esters and glycerine, which is catalyzed by oil or fat and an alcohol

B. Exhaust gas recirculation

Diesel engines have inherently high thermal efficiencies, resulting from their high compression ratio and fuel lean operation. The high compression ratio produces the high temperatures required to achieve auto-ignition, and the resulting high expansion ratio makes the engine discharge less thermal energy in the exhaust. The extra oxygen in the cylinders is necessary to facilitate complete combustion and to compensate for non-homogeneity in the fuel distribution. However, high flame temperatures predominate because locally stoichiometric air–fuel ratios prevail in such heterogeneous combustion processes. Consequently, Diesel engine combustion generates large amounts of NOx because of the high flame temperature in the presence of abundant oxygen and nitrogen

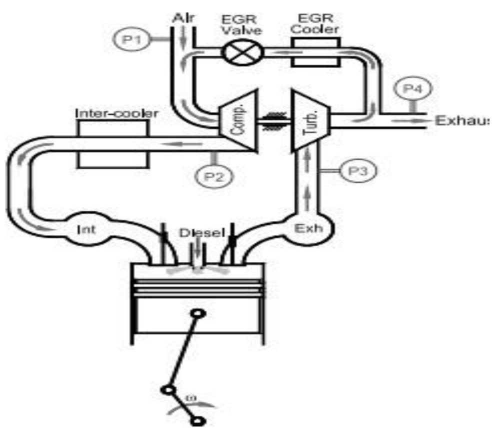

Figure-4:Exhaust gas recirculation

C. Different Types Of Blends

The different types of blended bio fuels used in these projects are

1. B0 : 100% PURE DIESEL
2. B5 : 5% MAHUVA OIL &95% DIESEL
3. B10 : 10% MAHUVA OIL& 90% DIESEL
4. B15 : 15% MAHUVA OIL & 85% DIESEL

TABLE 1: PROPERTIES OF BLENDS

S.No	Blend	Viscosity(Stokes)	CV (Kj/kg)	Flash Point(⁰C)	Fire Point(⁰C)	Density 45 ⁰C (Kg/m³)
1	B0	2.65	46000	55	61	640
2	B5	2.98	45125	69	74	655
3	B10	3.45	44150	71	76	671
4	B15	4.12	43750	83	88	684
5	MAHUVA OIL	27.63	37450	212	227	915

3.3 Test rig specification

TABLE 2 : SPECIFICATIONS OF THE ENGINE AND THE DYNAMOMETER

Description	Specifications
Engine	
Make	Mahindra and Mahindra
Engine Capacity (cc)	625
Type	Automotive (Multi-speed)
Compression Ratio	18:1
Power	9 HP @ 3000 rpm
Torque	30 NM @ 1800 rpm
Dynamometer	
Maker	Technomech
Type	Eddy current
Max. Power (in BHP)	10
Load measurement method	Strain Gauge
Cooling	Water

Figure 5: 4 stroke 1- cylinder diesel engine WITH EGR

IV. RESULTS AND ANALYSIS

4.1 Performance Parameters

A. EGR Vs Break Power at Torque of 24Nm

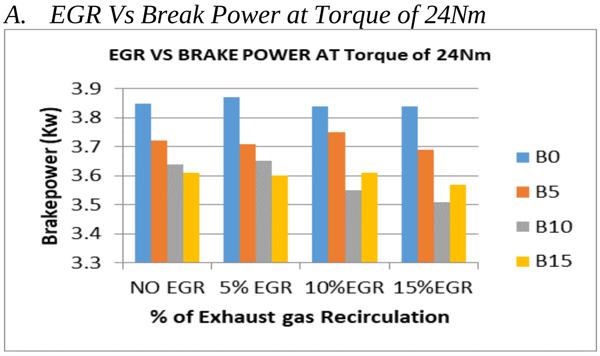

Figure-6: variation of brake power with EGR

B. EGR Vs Brake Thermal Efficiency at Torque of 24Nm

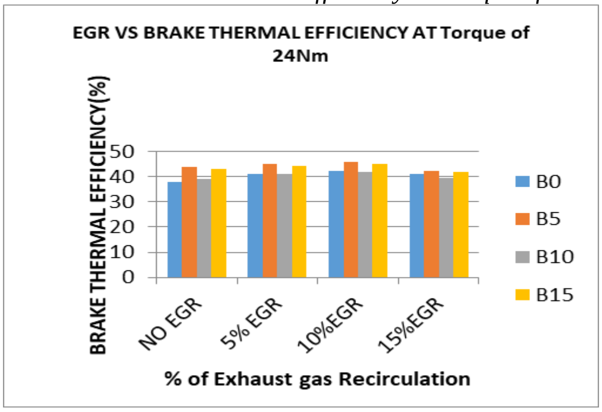

Figure-7: variation of BTE with EGR

C. EGR VS Exhaust Gas Temperature at Torque of 24Nm

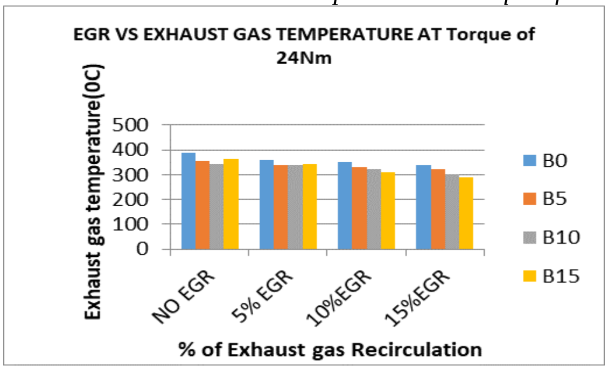

Figure-8: variation of EGT with EGR

D. EGR VS Brake Specific fuel consumption (Kg/Kw Hr) at Torque of 24Nm

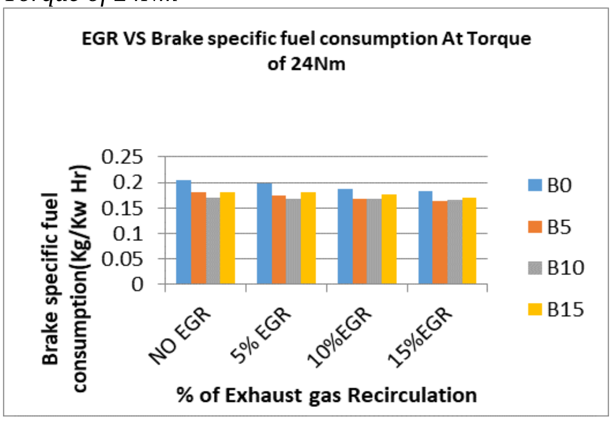

Figure-9: variation of BSFC with EGR

E. EGR VS Brake mean effective pressure (bar) AT Torque of 24Nm

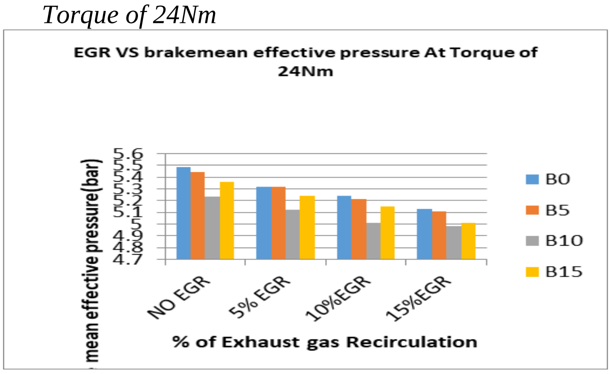

Figure-10: variation of BMEP with EGR

F. EGR Vs Volumetric efficiency (%) at Torque of 24Nm

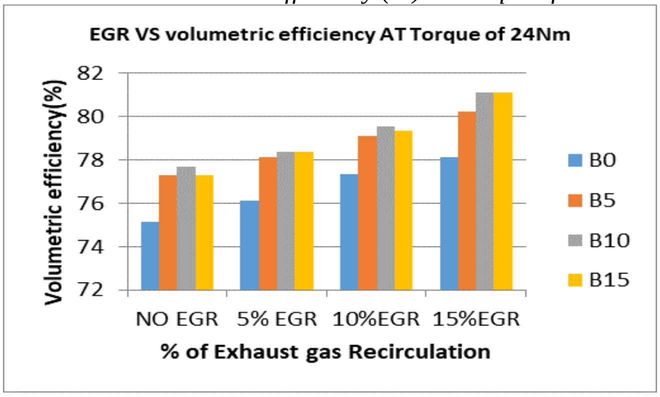

Figure-11: variation of Volumetric Efficiency with EGR

4.2 EMISSION ANALYSIS

A. EGR Vs Hydrocarbon at Torque of 24Nm

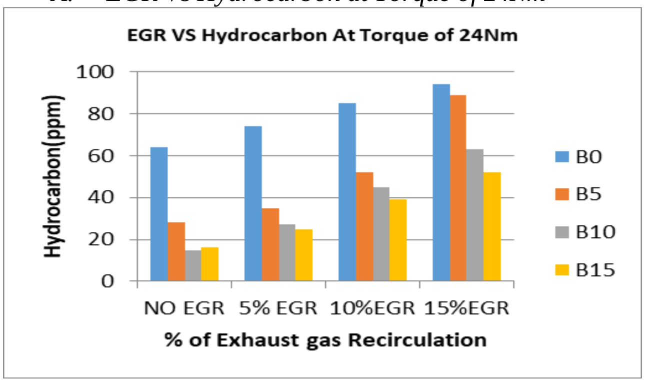

Figure-12: variation of HC with EGR

B. EGR VS NITROGEN OXIDE EMISSION (ppm) at Torque of 24Nm

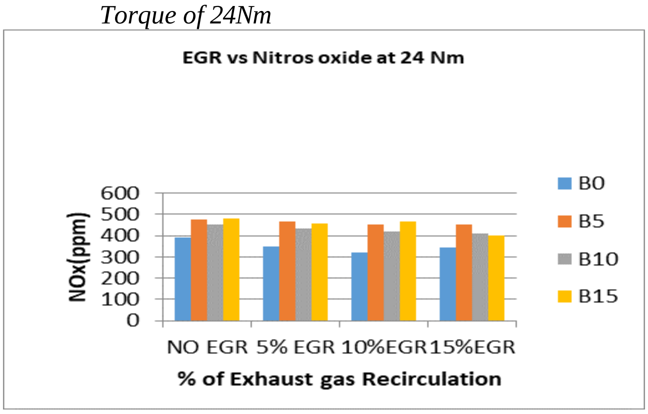

Figure-13: variation of NOx with EGR

C. EGR Vs CARBON DI OXIDE (%) at Torque of 24Nm

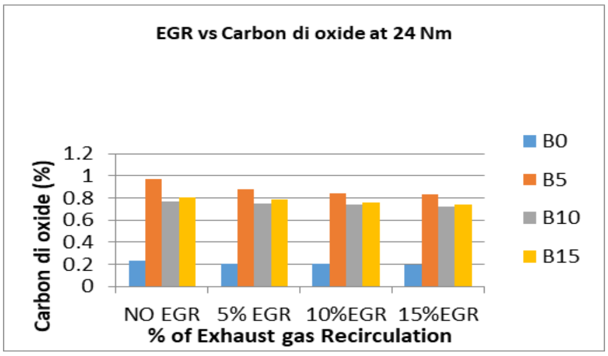

Figure-14: variation of CO2 with EGR

D. EGR VS CARBON MONOXIDE (%) at Torque of 24Nm

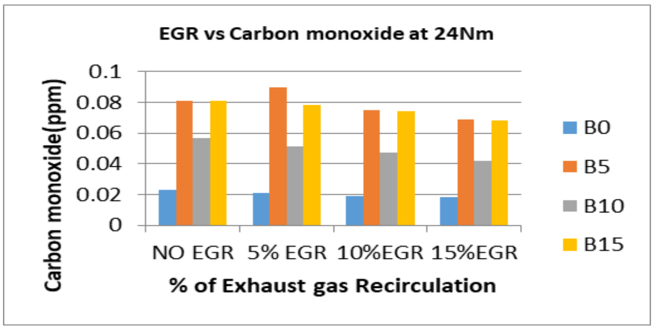

Figure-15: variation of CO with EGR

V. CONCLUSION

The experimental results shown in this paper that engine performance and emissions of all blends where run on the diesel engine and compared with standard diesel fuel

1. Smooth working of engine is observed with mahua oil by blending with diesel without any modifications.
2. Percentage increase in mahua oil increases the viscosity of diesel.
3. Increase in percentage of mahua oil changes the properties of blends.
4. Slight increase in brake thermal efficiency and decrease in specific fuel consumption is observed in the case of mahua oil compared to that of diesel at different EGR.
5. Mahua oil and its blends can be used directly without any major engine modification. NOx for various EGR rates.
6. CO for various EGR rates.. The brake thermal efficiency decreases with a corresponding increase in the percentage of Mahua oil blend.
7. Maximum torque of 24 Nm and 10% Mahua oil blend is found to be optimum condition considering the SFC and BT efficiency.
8. NOx emissions are higher for Mahua oil and its blends. As the percentage of blend increases, the NOx emission rates are also higher. Three EGR flow rates are used to reduce the NOx emissions. 10% EGR flow rate is found to be optimum for the 10% Mahua oil blend 24Nm considering the emission of NOx and BT efficiency.

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Thermal Analysis of Engine Cylinder with Fins by using ANSYS Workbench

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Abstract: **The Engine cylinder is one of the major automobile component, which is subjected to high temperature variations and thermal stresses. In order to cool the cylinder, fins are provided on the surface of the cylinder to increase the rate of Heat transfer. By doing thermal analysis on the engine cylinder and fins around it, It is helpful to know the heat dissipation rate and Temperature Distribution inside the cylinder. We know that, By increasing the surface area we can increase the heat dissipation rate, so designing such a large complex engine is very difficult. The main aim of the present project is to analyse the thermal properties like Directional Heat Flux, Total Heat Flux and Temperature Distribution by varying Geometry(Circular, Rectangular),material(Aluminium Alloy, Magnesium Alloy) and thickness of Fin (3mm,2mm) of an approximately square cylinder model prepared in SOLIDWORKS-2013 which is imported into ANSYS WORKBENCH-2016 for Transient Thermal analysis with an Average Internal Temperature and Stagnant Air-Simplified case as Cooling medium on Outer surface with reasonable Film Transfer Coefficient as Boundary Conditions.**

Keywords: Dissipation, Thermal conductivity, Film transfer coefficient, Internal Temperature, Stagnant Air-Simplified case, Boundary Conditions, SOLIDWORKS- 2013, ANSYS WORKBWNCH-2016.

I. INTRODUCTION

A. Engine Cylinder and Combustion Chamber:

We know that in case of Internal Combustion engines, combustion of air and fuel takes place inside the engine cylinder and hot gases are generated. The temperature of gases will be around 2300-2500°C. This is a very high temperature and may result into burning of oil film between the moving parts and may result in seizing or welding of same that is chances of piston seizure, chances of piston ring, compression ring, oil ring etc. can be affected. Excess temperature can also damage the cylinder material. So this temperature must be reduced to about 150-200°C at which the engine will work most efficiently. Too much cooling is also not desirable since it reduces the thermal efficiency. So, the object of cooling system is to keep the engine running at its most efficient operating temperature. It is to be noted that the engine is quite inefficient when it is cold and hence the cooling system is designed in such a way that it prevents cooling when the engine is warming up and till it attains to maximum efficient operating temperature, then it starts cooling.

To avoid overheating, and the consequent ill effects, the heat transferred to an engine component (after a certain level) must be removed as quickly as possible and be conveyed to the atmosphere. It will be proper to say the cooling system as a temperature regulation system. It should be remembered that abstraction of heat from the working medium by way of cooling the engine components is a direct thermodynamic loss.

The rate of heat transfer depends upon the wind velocity, geometry of engine surface, external surface area and the ambient temperature. In this work analysis is done on engine block fins considering temperature inside by means of conduction and convection, air velocity is not consider in this work. Motorbikes engines are normally designed for operating at a particular atmosphere temperature, however cooling beyond optimum limit is also not considered because it can reduce overall efficiency. Thus it may be observed that only sufficient cooling is desirable.

Air-cooled engines generally use individual cases for the cylinders to facilitate cooling. Inline motorcycle engines are an exception, having two-, three-, four-, or even six-cylinder air-cooled units in a common block. Water-cooled engines with only a few cylinders may also use individual cylinder cases, though this makes the cooling system more complex. The Ducati motorcycle company, which for years used air-cooled motors with individual cylinder cases, retained the basic design of their V-twin engine while adapting it to water-cooling.

B. Natural Air Cooling:

In normal cause, larger parts of an engine remain exposed to the atmospheric air. When the vehicles run, the air at certain relative velocity impinges upon the engine, and sweeps away its heat. The heat carried-away by the air is due to natural convection, therefore this method is known as Natural air-cooling. Engines mounted on 2-wheelers are mostly cooled by natural air. As the heat dissipation is a function of frontal cross-sectional area of the engine, therefore there exists a need to enlarge this area. An engine with enlarge area will becomes bulky and in turn will also reduce the power by weight ratio. Hence, as an alternative arrangement, fins are constructed to enhance the frontal cross-sectional area of the engine. Fins (or ribs) are sharp projections provided on the surfaces of cylinder block and cylinder head. They increase the outer contact area between a cylinder and the air. Fins are, generally, casted integrally with the cylinder. They may also be mounted on the cylinder.

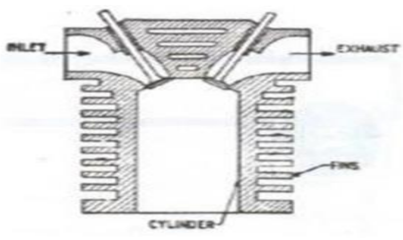

Figure-1.1 Natural air cooling

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C. Fins:

A Fin is a surface that extends from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, radiation of an object determines the amount of heat it transfers. Increasing the temperature difference between the object and the environment, increasing the convection heat transfer coefficient, or increasing the surface area of the object increases the Heat transfer. Sometimes it is not economical or it is not feasible to change the first two options. Adding a fin to the object, however, increases the surface area and can sometimes be economical solution to heat transfer problems. Circumferential fins around the cylinder of a motor cycle engine and fins attached to condenser tubes of a refrigerator are a few familiar examples.

Figure-1.2 Automobile Fin

The temperature distribution within an SI engine is extremely important for proper engine operation to maximize the thermal efficiency of an engine; it has to be operated at specific thermal condition. This condition is controlled by cooling process of fins that tends to remove the heat that is highly critical in keeping an engine and engine lubricant from thermal failure and thermal effects. Actually Fins are provided because, they provide a channel for cooling the engine whenever it gets hot. Fins doesn't let the engine to burn out. The fins provided on the engine cylinder depends on the capacity of the engine. Higher the capacity of the engine, more number of fins provided on the surface of the engine block.

Figure-1.3 Malossi air-cooled cylinder for two-stroke scooters.The exhaust port is visible to the right.

Figure-1,4 Air-cooled boxer engine on a 1954 BMW

motorcycle

Fin terminology and types:

Fin base,

- Fin tip,
- Straight fin,
- Variable cross-sectional area fin,
- *Spine* or a pin fin,
- *Annular* or cylindrical

D. THERMAL ANALYSIS:

Thermal analysis is a branch of materials science where the properties of materials are studied as they change with temperature. Several methods are commonly used – these are distinguished from one another by the property which is measured:

- Dielectric thermal analysis (DEA): dielectric permittivity and loss factor
- Thermal Analysis (DTA): temperature difference versus temperature or time
- Differential Scanning Calorimetry (DSC): heat flow changes versus temperature or time
- Dilatometry (DIL): volume changes with temperature change
- Dynamic Mechanical Analysis (DMA or DMTA) : measures storage modulus (stiffness) and loss modulus (damping) versus temperature, time and frequency
- Evolved Gas Analysis (EGA) : analysis of gases evolved during heating of a material, usually decomposition products
- Laser flash analysis (LFA): thermal diffusivity and thermal conductivity
- Thermo gravimetric Analysis (TGA): mass change versus temperature or time
- Thermo mechanical analysis (TMA): dimensional changes versus temperature or time
- Thermo-optical analysis (TOA): optical properties
- Derivatography: A complex method in thermal analysis

Thermal analysis calculates the temperature and heat transfer within and between components in your design and its environment. This is an important consideration of design, as many products and material have temperature dependent properties. Product safety is also a consideration—if a product or component gets too hot, you may have to design a guard over it.

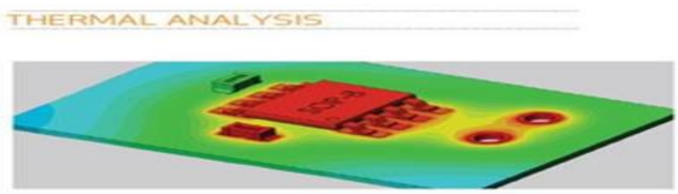

Figure-1.5 Thermal analysis

The heat flow through the components can be in a steady state (where the heat flow does not change over time) or transient in nature. The thermal analogy of a linear static analysis is a steady-state thermal analysis, while a dynamic structural analysis is analogous to a transient thermal analysis.

Heat transfer problems can be solved using structural and fluid flow analysis methods:

- In a thermal structural analysis, the effect of the moving air or a moving liquid is approximated by a series of boundary conditions or loads.
- In a thermal fluid analysis, the effect of the air or a liquid is calculated, increasing the run time but also increasing to overall solution accuracy.

E. Transient Thermal Analysis:

The ANSYS/ Multi physics, ANSYS / Mechanical, ANSYS/Thermal, and analysis determines temperatures and other thermal quantities that vary over time. Engineers commonly use temperatures that a transient thermal analysis calculates as input to structural analyses for thermal stress evaluations. Many heat transfer applications- heat treatment problems, nozzles, engine blocks, piping systems, pressure vessels, etc.-involve transient thermal analyses.

A transient thermal analysis follows basically the same procedures as a steady-state thermal analysis. The main difference is that most applied loads in a transient analysis are functions of time. To specify time-dependent loads, you first divide the load-versus-time curve into load steps. Each "corner" on the load-time curve can be one load step, as shown in the following sketches.

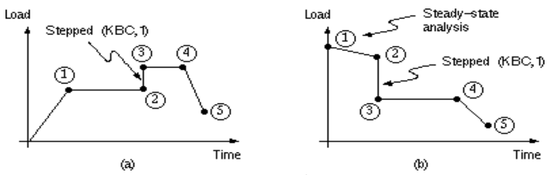

Figure-1.6 Examples of load-versus-time curves

For each load step, you need to specify both load values and time values, along with other load step options such as stepped or ramped loads, automatic time stepping, etc. You then write each load step to a file and solve all load steps together. To get a better understanding of how load and time stepping work, see the example casting analysis scenario in this chapter

II. LITERATURE SURVEY

Fernando Allan [1] simulated the heat transfer from cylinder to air of a two-stroke internal combustion finned engine. The cylinder body, cylinder head (both provided with fins), and piston have been numerically analyzed and optimized in order to minimize engine dimensions.

G. Babe and M. Lava Kumar [2] analyzed the thermal properties by varying geometry, material and thickness of cylinder fins.

Ajay Paul et.al. [3] Carried out Numerical Simulations to determine heat transfer characteristics of different fin parameters namely, number of fins, fin thickness at varying air velocities.

Phani Raja Rao et.al [4] analyzed the thermal properties by varying geometry, material and thickness of cylinder fins

Young Researchers, Central Tehran Branch, Islamic Azad University, Tehran, Iran [5] has stated that heat transfer in a straight fin with a step change in thickness and variable thermal conductivity which is losing heat by convection to its surroundings is developed.

III. METHODOLOGY

The main aim this project is to increase the heat dissipation rate of the given square engine cylinder and to analyze distribution of different properties like Temperature, Total heat flux and Directional heat flux by varying the material used for the cylinder, Geometry of the Cylinder and Linear Dimensions.

There are two ways to increase the rate of Heat transfer for dissipation of Heat from the Cylinder walls

- Increasing the Surface Heat transfer coefficient(h value),
- Increasing the Outer surface area of the Component (Cylinder) which is in contact with the ambient atmospheric air.

A.Increasing the surface heat transfer coefficient:

To increase the Surface Heat transfer coefficient, The flowing fluid which flows with a Natural frequency and To which Heat is transferring need to flow with higher velocity so that value of Surface Heat transfer coefficient may increase. Because heat transfer coefficient is directly proportional to the velocity of fluid flowing. But it requires Artificial means like Installation of Pump or Blower to force which we call it as Forced convection.

One another means is that the existing material can be replaced by another material which have higher value of heat transfer coefficient than that of previous one. But we cannot give any assurance to the Economy of the product because the cost of material may increase or sometimes the replaced material cannot serve as good as the first one concern with another properties of the Ideal material required. For Example the requirement is that material for an x-component should be ductile in nature and need to have higher heat transfer coefficient

Take material-1 which is purely ductile in nature but it’s value of heat transfer coefficient is moderate and let us consider that the material-2 is having good heat transfer coefficient value but not ductile in nature may be harder n brittle in nature. For cases like these we go for alloys different materials to satisfy the needs of both structural and thermal requirements.

Hence maximum effort need to be put to produce alloys which is not economical and time consuming. That’s why the alternate method called fins extended surfaces is followed by Industrialists, Designers etc.

B.Increasing the Surface area of the given Component:

In the study of heat transfer, fins are surfaces that extend from an object to increase the rate of heat transfer to or from the environment by increasing convection. The amount of conduction, convection, or radiation of an object determines the amount of heat it transfers. Increasing the temperature gradient between the object and the environment increasing the surface area of the object increases the heat transfer. Sometimes it is not feasible or economical to change the first option. Thus, adding a fin to an object, increases the surface area and can sometimes be an economical solution to heat dissipation. This process is more Economical and convenient to use when compared with the first method of increasing the value heat transfer coefficient

Figure-3.1: Heat sinks

C. Few Reasons that Illustrating Importance of usage of fins:

1. K" should be as high as possible, (copper, aluminium, iron). Aluminium is preferred: low cost and weight, resistance to corrosion.
2. p/A_c should be as high as possible. (Thin plate fins and slender pin fins)
3. Most effective in applications where h is low. (Use of fins justified if when the medium is gas and heat transfer is by natural convection).

a. Fins Approach:

An important consideration is the selection of the proper *fin length L. I*ncreasing the length of the fin beyond a certain value cannot be justified unless the added benefits outweigh the added cost.

The efficiency of most fins used in practice is above 90 percent

Temperature distribution and heat loss for fins of uniform cross section

Case	Tip Condition ($x = L$)	Temperature Distribution θ/θ_b	Fin Heat Transfer Rate q_f
A	Convection heat transfer: $h\theta(L) = -k\,d\theta/dx\vert_{x=L}$	$\dfrac{\cosh m(L-x) + (h/mk)\sinh m(L-x)}{\cosh mL + (h/mk)\sinh mL}$	$M\dfrac{\sinh mL + (h/mk)\cosh mL}{\cosh mL + (h/mk)\sinh mL}$
B	Adiabatic $d\theta/dx\vert_{x=L} = 0$	$\dfrac{\cosh m(L-x)}{\cosh mL}$	$M \tanh mL$
C	Prescribed temperature: $\theta(L) = \theta_L$	$\dfrac{(\theta_L/\theta_b)\sinh mx + \sinh m(L-x)}{\sinh mL}$	$M\dfrac{(\cosh mL - \theta_L/\theta_b)}{\sinh mL}$
D	Infinite fin ($L \rightarrow \infty$): $\theta(L) = 0$	e^{-mx}	M

$\theta \equiv T - T_\infty$ $\quad m^2 \equiv hP/kA_c$

$\theta_b = \theta(0) = T_b - T_\infty$ $\quad M \equiv \sqrt{hPkA_c}\,\theta_b$

Table-1

b. Problem Definition:

In the present Project investigation on thermal issues on automobile fins were carried out. Investigation yields the temperature behaviour and Total Heat flux and Directional heat flux of the Cylinder fins due to high temperature in the combustion chamber. ANSYS WORKBENCH-2016 is utilized for analysis. The analysis is done for different models of almost a square engine and a comparison is thus established between them by changing geometry and Fin thickness

c. The ANSYS Workbench Interface:

The ANSYS Workbench interface consists primarily of a Toolbox region, the Project Schematic, the Toolbar, and the Menu bar. Depending on the analysis type and/or application or workspace, you may also see other windows, tables, charts, etc. One way to work in ANSYS Workbench is to drag an item such as a component or analysis system from the Toolbox to the Project Schematic or to double-click on an item to initiate the default action. You can also use the context menus, accessible from a right-mouse click, for additional options. You will view your analysis systems -- the components that make up your analysis -- in the Project Schematic, including all connections and links between the systems. The individual applications in which you work will display separately from the ANSYS Workbench GUI, but the results of the actions you take in the applications may be reflected in the Project Schematic.

d. Toolbox:

The ANSYS Workbench Toolbox presents the types of data that you can add to your project. The Toolbox is context-sensitive; as you select different items in the Project Schematic or other workspaces, the contents of the Toolbox may change to reflect the components and actions available to you. When working in other workspaces, such as Engineering Data or Parameters, you can return to the Project Workspace by clicking the Return to Project button on the Toolbar.

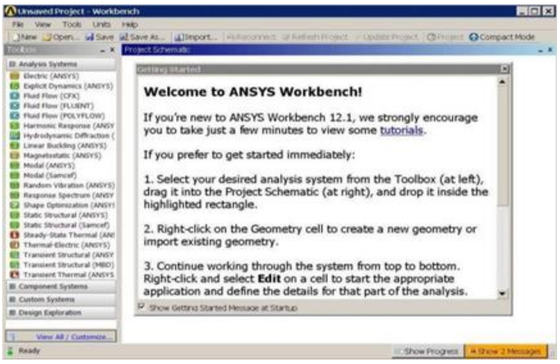

Figure-3.2 ANSYS WORKBENCH TOOL BOX

As we Discussed earlier there are two main types of thermal analysis normally used they are:

1. Steady state thermal analysis,
2. Transient thermal analysis.

1. Steady state thermal analysis:

A Steady state thermal analysis calculates the effect of steady thermal load on a system or component, analyst were also doing the steady state analysis before performing the transient analysis. We can use this analysis to determine temperature, thermal gradient, heat flow rates and heat flux in an object that do not vary with time.

A Steady state thermal analysis may be either linear with constant material properties or nonlinear with material properties that depend on temperature. Transient thermal analysis:

A transient thermal analysis follows basically the same procedures as a steady-state thermal analysis. The main difference is that most applied loads in a transient analysis are functions of time. To specify time-dependent loads, you first divide the load-versus-time curve into load steps. Each "corner" on the load-time curve can be one load step, as shown in the following sketches.

From the definition of both Steady state thermal analysis and Transient thermal analysis, it is observed that individually both analysis have their own advantage in their respective fields of application but the present scenario is to analyze the variation of properties either linear or non- linear with respect to time.

So, Transient thermal analysis is chosen for thermal analysis of the four models developed in SOLIDWORKS- 2013 for a square engine. By changing the Material (Magnesium alloy, Aluminium alloy), Geometry (Circular, Rectangular) and Fin thickness (2mm, 3mm) analysis is done and their effect on the time taken for reaching the steady state is plotted on a graph of time verses a property and the different properties analyzed are as discussed above Temperature, Directional heat flux, Total heat flux.

Assumptions for analysis:

- The temperature of the surrounding air do not change significantly.
- Constant heat transfer coefficient is considered at the air side.
- The heat generation is neglected.
- Loads are constant.
- Most of physical properties are constant

IV. DESIGN DETAILS

A. Modelling of Cylinder Fin:

Cylinder along with fin was modelled in SOLIDWORKS-2013. The dimensions of the cylinder along with fin were taken for a square engine whose stroke ratio is unity. Fins with different geometries (circular and rectangular) were modelled using SOLIDWORKS-2013.

B. ***Procedure to draw the rectangular and cylindrical fins in SOLIDWORKS-2013***:

i. Observe and Understand the given model's top and font views clearly and their dimensions,
ii. Adjust the Unit system in SOLIDWORKS as SI- system,
iii. Go to Sketch,
iv. Select the front view from the given views,
v. First draw the Centre line assumed distance by using line command,
vi. Then draw one side of front view with assumed dimensions
vii. By using the smart dimension command adjust the fin length, groove length, upwards projection of cylinder and Projection distance from center line which is the diameter of the fin flank in case of circular fins and for rectangular fins take it as the diagonal length of the fin flank.
viii. For both cases the internal and external diameter of the cylinder are fixed,
ix. Then by using revolute command revolute the drawn section,
x. In case of circular fins, The fin model is ready but in case of rectangular fins we need to perform extrude cut in downward direction by using the extrude cut option and film cut need to performed to remove the excess projections of rectangular shape.
xi. Both circular and rectangular cylindrical fins are available now and their respective dimensions need to be changed as per the given data by changing the fin thickness.

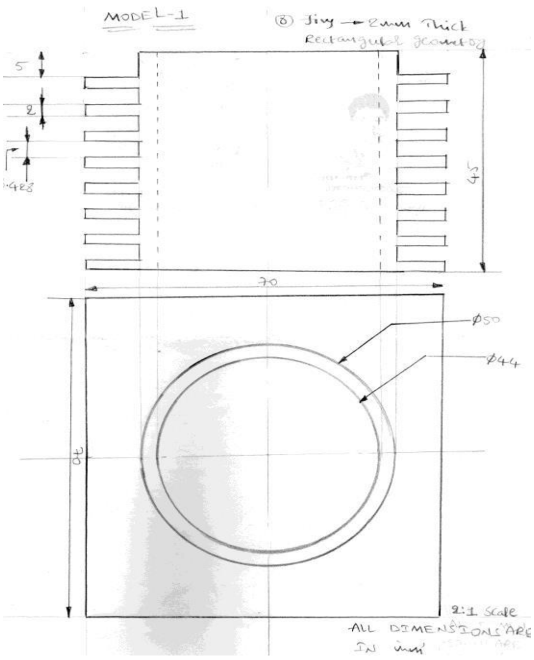

Figure-4.1 MODEL-1

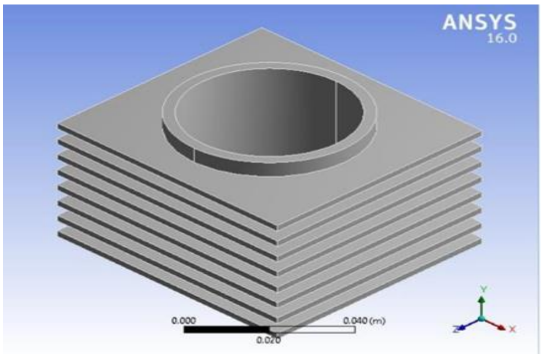

Fig-4.2.Rectangular fins of 2mm thickness

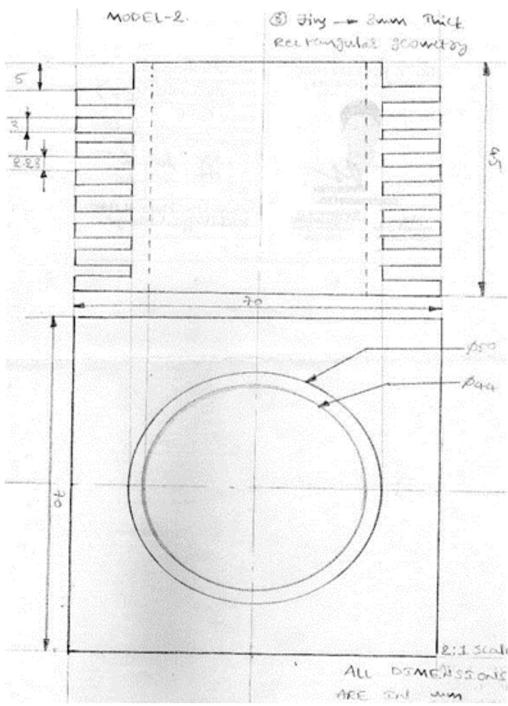

Figure-4.3 MODEL-2

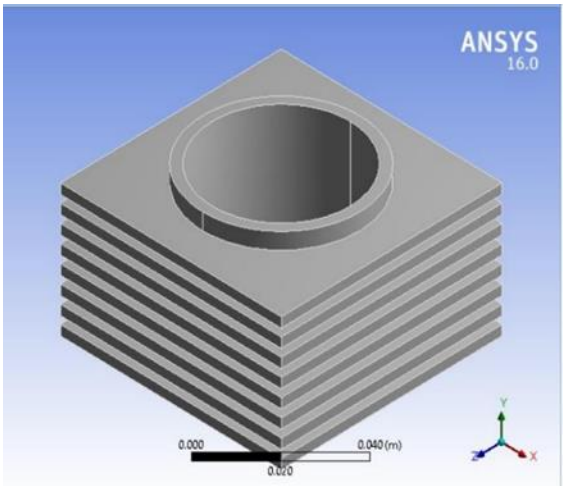

Figure-4.4.Rectangular fins of 3mm thickness Fig. Rectangular cylindrical fin

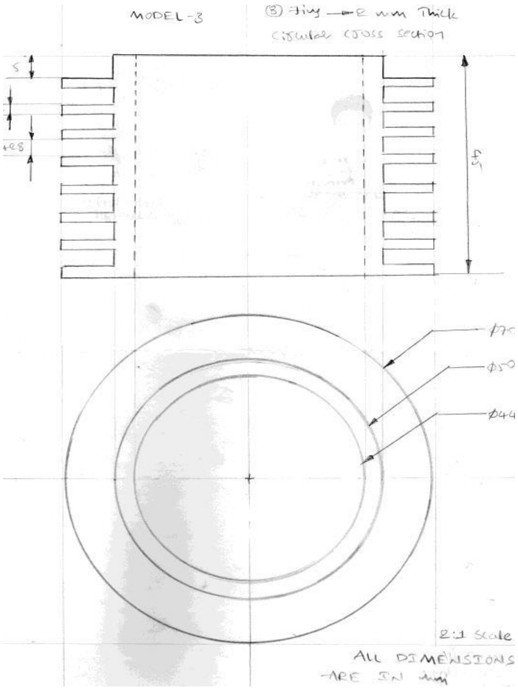

Figure-4.5 MODEL-3

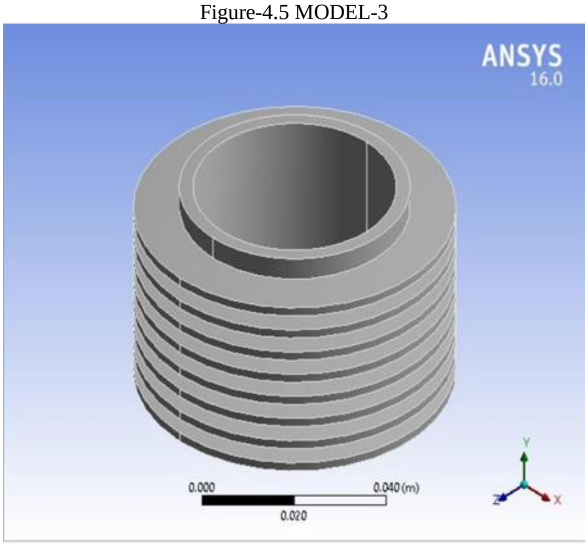

Figure-4.6.Circular fins of 2mm thickness

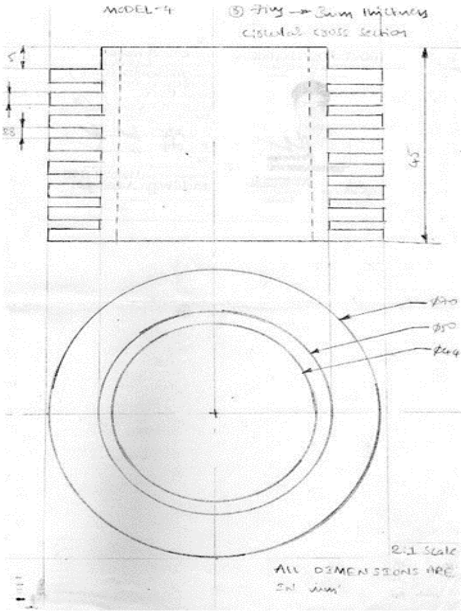

Figure-4.7 MODEL-4

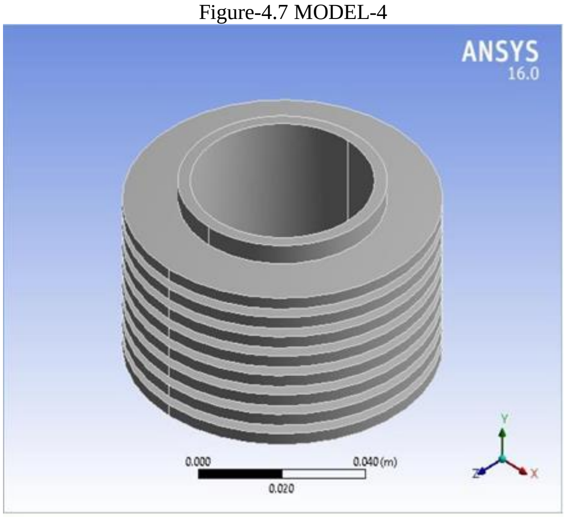

Figure-4.8.Circular fins of 3mm thickness Fig. Circular cylinder fin

V. EXPERIMENTAL DETAILS

A. The Boundary Conditions are:

Table: 5.1-Input Parameters

Sl. No.	Loads	Units	Value
1	Inlet temperature	K	1073
2	Film coefficient	$W/m^2 K$	5
3	Ambient temperature	K	303
4	Material		Aluminum Alloy, Magnesium Alloy

B. Material Data:

Aluminum Alloy:

Table: 5.2-Aluminium Alloy Constants

Density	2770 kg m^-3
Coefficient of Thermal Expansion	2.3e-005 C^-1
Specific Heat	75 J kg^-1 C^-1

Magnesium Alloy:

Table: 5.3-Magnesium Alloy Constants

Density	1800 kg m^-3
Coefficient of Thermal Expansion	2.6e-005 C^-1
Specific Heat	1024 J kg^-1 C^-1
Thermal Conductivity	156 W m^-1 C^-1
Resistivity	7.7e-007 ohm m

VI. RESULTS AND DISCUSSION

A model of cylinder with fins mounted on it is used for analysis in the present project. This is imported into ANSYS workbench environment and boundary conditions were applied as mentioned above. Analysis is carried out for different geometry of fins (circular and rectangular) with various thicknesses and materials. The results are shown below,

MODEL-1

Type : **rectangular**

Material: **Aluminium alloy**

Fin thickness: **2mm**

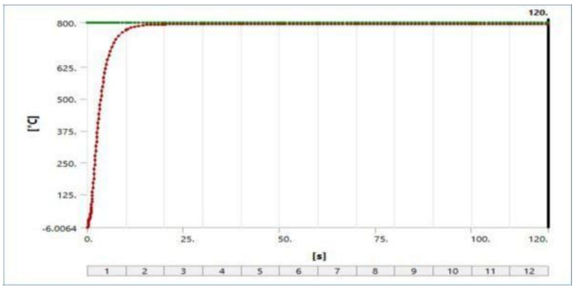

Figure 6.1: Time verses Temperature graph of Model-1

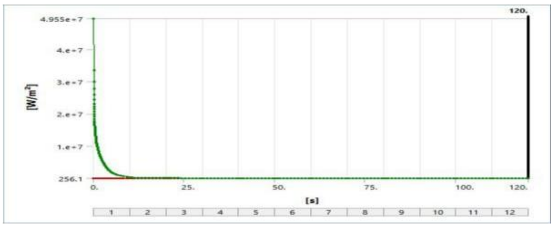

Figure 6.2: Time verses Total heat flux graph of Model-1

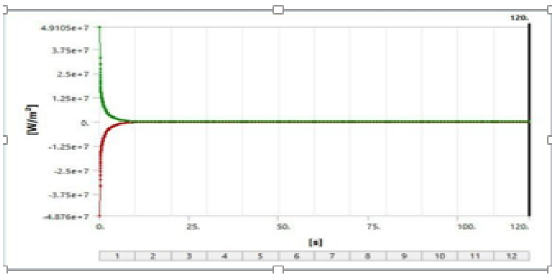

Figure 6.3: Time verses Directional heat flux graph of Model-1

Table 6.1: Results of Model-1

RESULTS			
Minimum	793.71°C	2321.3 W/m²	-69934 W/m²
Maximum	800. °C	82965 W/m²	70639 W/m²
Minimum Value Over Time			
Minimum	-6.0064°C	256.1 W/m²	-4.876e+007W/m²
Maximum	793.71°C	9370.9 W/m²	-69934 W/m²
Maximum Value Over Time			
Minimum	800. °C	82965 W/m²	70639 W/m²
Maximum	800. °C	4.955e+007 W/m²	4.9105e+007 W/m²

MODEL-2

Type : rectangular fin

Material : magnesium alloy

Fin thickness : 2mm

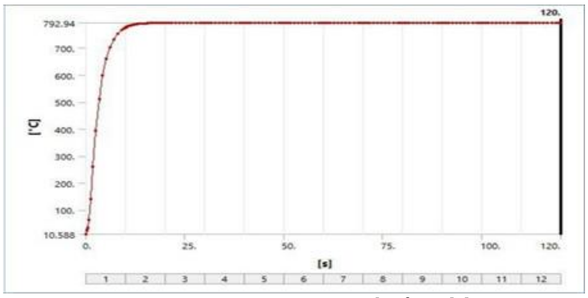

Figure 6.4: Time verses Temperature graph of Model-2

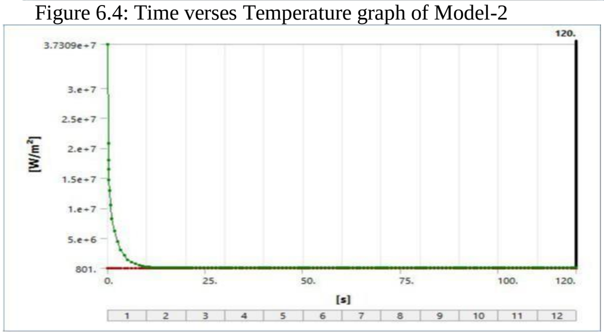

Figure 6.5: Time verses Total heat flux graph of Model-2

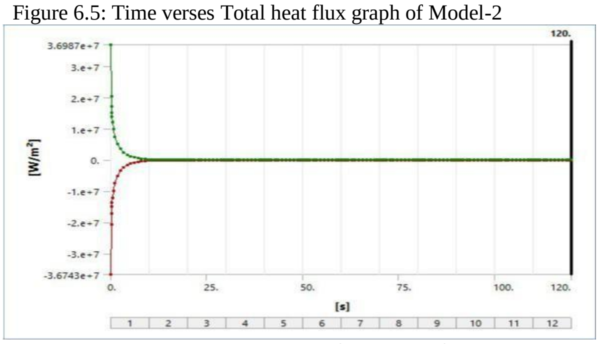

Figure 6.6: Time verses Directional heat flux graph of Model- 2

Table 6.2: Results of Model-2

Results			
Minimum	795.33 °C	2328.6 W/m²	-49044 W/m²
Maximum	800. °C	63273 W/m²	48177 W/m²
Minimum Value Over Time			
Minimum	-2.875 °C	555.52 W/m²	-5.0515e+007W/m²
Maximum	795.33 °C	9891.5 W/m²	-49044 W/m²
Maximum Value Over Time			
Minimum	800. °C	63273 W/m²	48177 W/m²
Maximum	800. °C	5.1579e+007 W/m²	5.1357e+007 W/m²

MODEL-3

Type : rectangular fin

Material : aluminium alloy

Fin thickness : 3mm

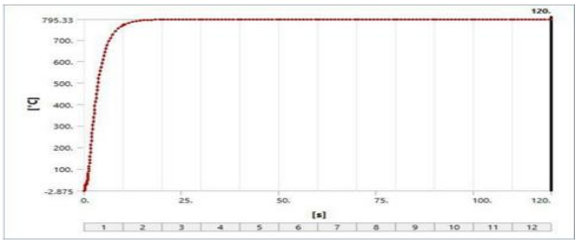

Figure -6.7: Time verses Temperature graph of Model-3

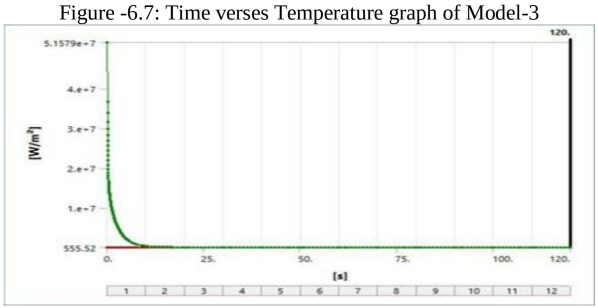

Figure-6.8: Time verses Total heat flux graph of Model-3

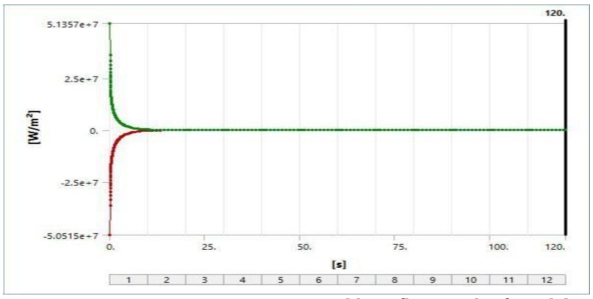

Figure-6.9: Time verses Directional heat flux graph of Model- 3

Table 6.3: Results of Model-3

RESULTS			
Minimum	795.33°C	2328.6 W/m²	-49044 W/m²
Maximum	800 °C	63273 W/m²	48177 W/m²
Minimum Value Over Time			
Minimum	-2.875 °C	555.52 W/m²	-5.0515e+007 W/m²
Maximum	795.33 °C	9891.5 W/m²	-49044 W/m²
Maximum Value Over Time			
Minimum	800 °C	63273 W/m²	48177 W/m²
Maximum	800 °C	5.1579e+007 W/m²	5.1357e+007 W/m²

MODEL-4
Type : rectangular
Material : magnesium alloy
Fin thickness : 3mm

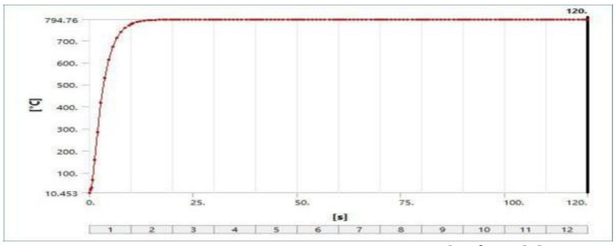

Figure 6.10: Time verses Temperature graph of Model-4

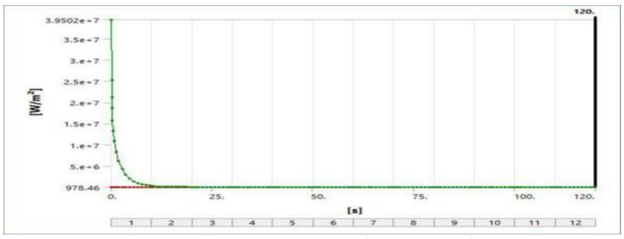

Figure-6.11: Time verses Total heat flux graph of Model-4

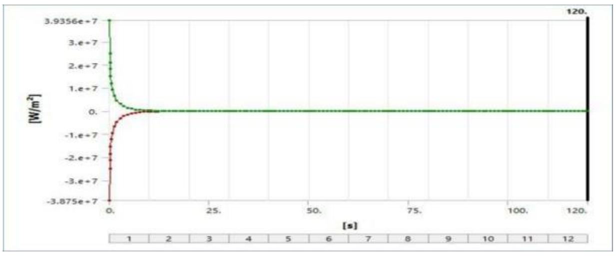

Figure-6.12: Time verses Directional heat flux graph of Model-4

Table 6.4: Results of Model-4

RESULTS			
Minimum	795.33 °C	2328.6 W/m²	-49044 W/m²
Maximum	800 °C	63273 W/m²	48177 W/m²
Minimum Value Over Time			
Minimum	-2.875 °C	555.52 W/m²	-5.0515e+007 W/m²
Maximum	795.33 °C	9891.5 W/m²	-49044 W/m²
Maximum Value Over Time			
Minimum	800 °C	63273 W/m²	48177 W/m²
Maximum	800 °C	5.1579e+007 W/m²	5.1357e+007 W/m²

MODEL-5
Type : circular
Material : aluminium alloy
Fin thickness : 2mm

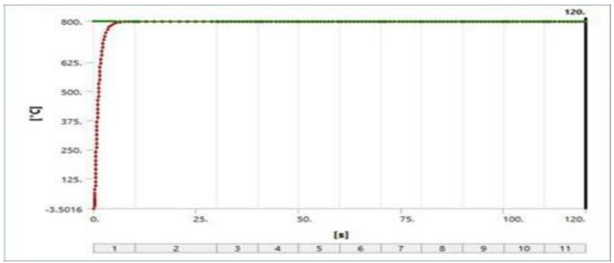

Figure-6.13: Time verses Temperature graph of Model-5

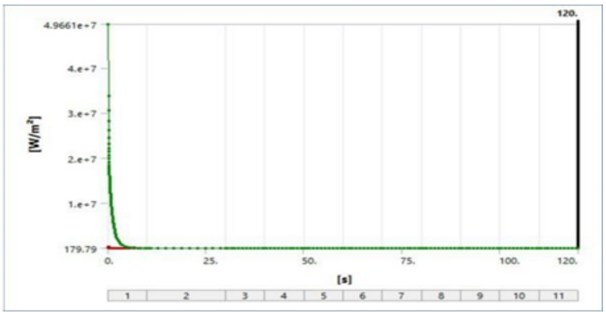

Figure 6.14: Time verses Total heat flux graph of Model-5

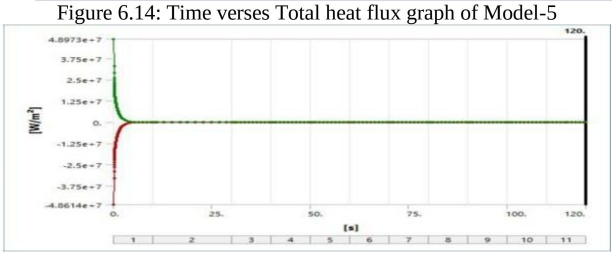

Figure-6.15: Time verses Directional heat flux graph of Model-5

Table 6.5: Results of Model-5

Results			
Minimum	797.84°C	1649.7 W/m²	-46844 W/m²
Maximum	800 °C	49178 W/m²	45732 W/m²
Minimum Value Over Time			
Minimum	-3.5016 °C	179.79 W/m²	-4.8614e+007 W/m²
Maximum	797.84 °C	4.1861e+005 W/m²	-46844 W/m²
Maximum Value Over Time			
Minimum	800 °C	49178 W/m²	45732 W/m²
Maximum	800 °C	4.9661e+007 W/m²	4.8973e+007 W/m²

MODEL-6
Type : circular
Material : magnesium alloy
Fin thickness : 2mm

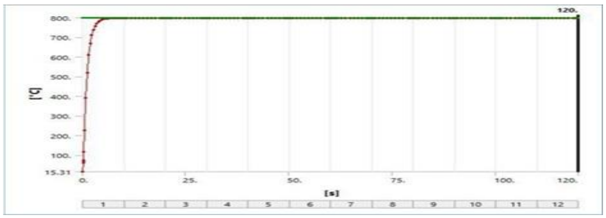

Figure-6.16: Time verses Temperature graph of Model-6

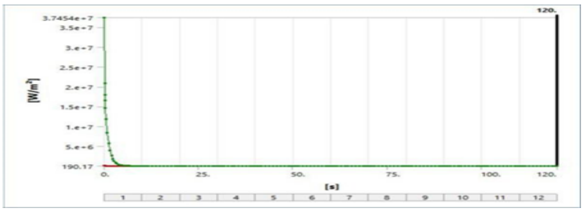

Figure-6.17: Time verses Total heat flux graph of Model-6

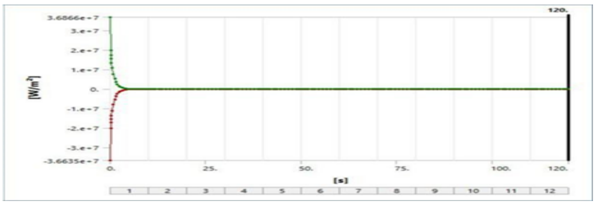

Figure-6.18: Time verses Directional heat flux graph of Model-6

Table 6.6: Results of Model-6

Results			
Minimum	797.58 °C	1648.7 W/m²	-46831 W/m²
Maximum	800 °C	49164 W/m²	45720 W/m²
Minimum Value Over Time			
Minimum	15.31 °C	190.17 W/m²	-3.6635e+007 W/
Maximum	797.58 °C	1.9031e+005 W/m²	-46831 W/m²
Maximum Value Over Time			
Minimum	800 °C	49164 W/m²	45720 W/m²
Maximum	800 °C	3.7454e+007 W/m²	3.6866e+007 W/

MODEL-7
Type : circular
Material : aluminium alloy
Fin thickness : 3mm

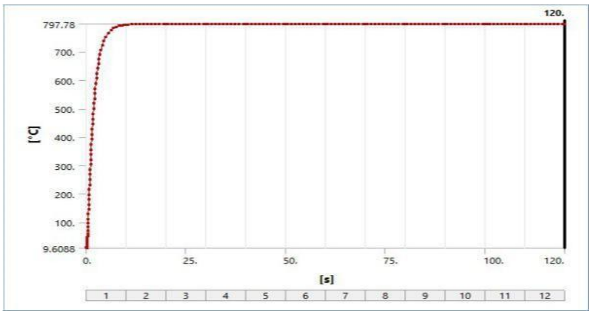

Figure-6.19: Time verses Temperature graph of Model-7

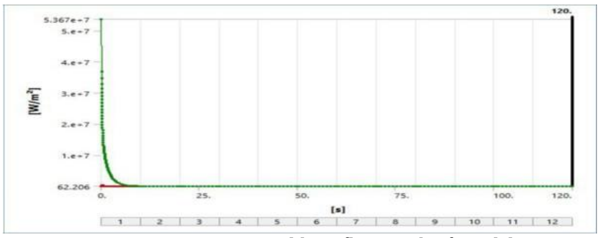

Figure-6.20: Time verses Total heat flux graph of Model-7

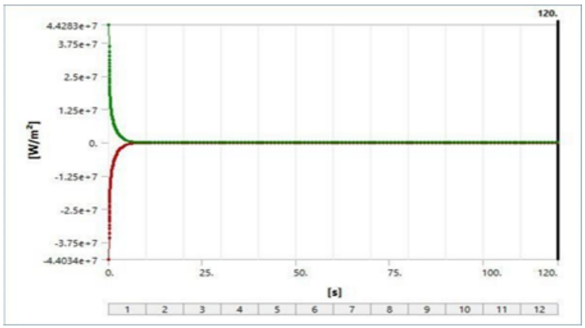

Figure-6.21: Time verses Directional heat flux graph of Model-7

Table 6.7: Results of Model-7

Results			
Minimum	797.78 °C	2361.9 W/m²	-36746 W/m²
Maximum	800 °C	36888 W/m²	36592 W/m²
Minimum Value Over Time			
Minimum	9.6088 °C	62.206 W/m²	-4.4034e+007 W/m²
Maximum	797.78 °C	4.2114e+005 W/m²	-36746 W/m²
Maximum Value Over Time			
Minimum	800 °C	36888 W/m²	36592 W/m²
Maximum	800 °C	5.367e+007 W/m²	4.4283e+007 W/m²

MODEL-8
Type : circular
Material : magnesium
Fin thickness : 3mm

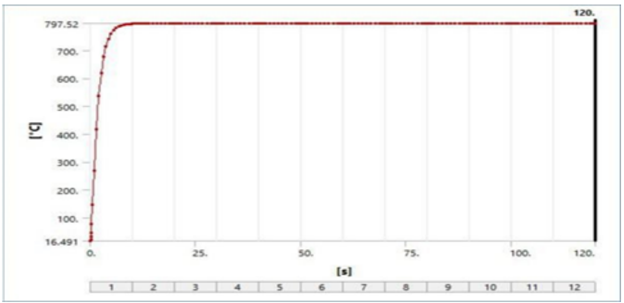

Figure-6.22: Time verses Temperature graph of Model-8

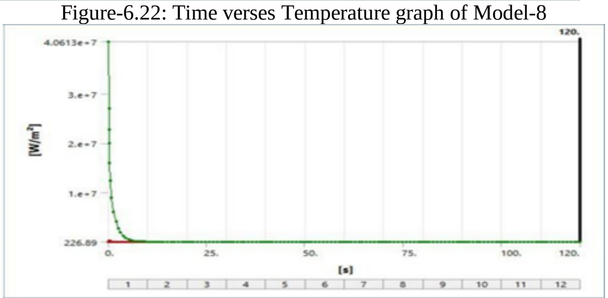

Figure-6.23: Time verses Total heat flux graph of Model-8

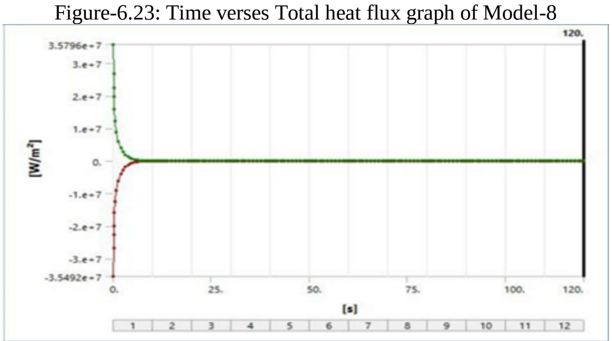

Figure-6.24: Time verses Directional heat flux graph of Model-8

Table 6.8: Results of Model-8

Results			
Minimum	797.52 °C	2360.8 W/m²	-36737 W/m²
Maximum	800 °C	36879 W/m²	36582 W/m²
Minimum Value Over Time			
Minimum	16.491 °C	226.89 W/m²	-3.5492e+007 W/m²
Maximum	797.52 °C	3.291e+005 W/m²	-36737 W/m²
Maximum Value Over Time			
Minimum	800 °C	36879 W/m²	36582 W/m²
Maximum	800 °C	4.0613e+007 W/m²	3.5796e+007 W/m²

A. Discussion:

a. Temperature Distribution:

From the above results, We can observe that the 5th model which is made of aluminium alloy with 2mm thick circular shaped circumferential fins can attain maximum temperature of 797.84°C.Which is also maximum amongst all the other model's values of maximum temperature and the time taken to attain this steady state is 14.8 seconds.

But on the other hand model-6 which is made of magnesium alloy with same features of 2mm thick and circular in geometry giving tight competition to the model-5.Whose attained value of maximum temperature is less when compared with model-5, which is 797.58 °C but to attain that temperature it took very less time amongst all the other models which is 10.9 seconds.

Rate of change of temperature is high for Model-8 which is made of Magnesium alloy with 3mm thick circular circumferential fins.

Hence, Both Attained value of Maximum Temperature and Temperature change with respect to time are high in Fins of Circular Geometry.

b. Total Heat flux:

When it is matter of total heat flux conducted by the cylinder the variation observed is as follows:

The model-1 which is made of aluminium alloy with 2mm rectangular circumferential fins conducts more total heat flux when compared with all the other models.

When material is the point of interest, aluminium alloy conducts more total heat flux because model-2 which is made of magnesium alloy with same features as model-1 except material change conducting less total heat flux.

And one another observation is that Total Heat flux conducted by a material increases with increase in amount of material. That's why its value is high in rectangular geometry then the circular geometry and it also decreases with increase in fin thickness

c. Directional Heat flux:

In case of Directional Heat flux all the results are similar to Total Heat flux. The Directional heat flux conducted by the material increases with increase in amount of material but decreases with increase in fin thickness and it is high in rectangular geometry when compared with circular geometry.

Aluminium alloy fin conducts more directional heat than that of magnesium alloy fin with the same geometry and fin thickness

In the negative radial direction opposite to the positive direction same effects are applicable.

VII. CONCLUSION

In present work, a cylinder fin body is modelled by using SOLIDWORKS-2013 and Transient thermal analysis is done by using ANSYS WORKBENCH-2016. These fins are used for air cooling systems for two wheelers. In present study, Aluminium alloy is compared with Magnesium alloy. The various parameters (i.e., geometry and thickness of the fin) are considered, by reducing the thickness and also by changing the shape of the fin to circular shape from the conventional geometry i.e. rectangular, the weight of the fin body reduces there by increasing the heat transfer rate and efficiency of the fin.

The results shows, By using circular fin with material Aluminium Alloy is better since heat transfer rate of the fin is more. By using circular fins the weight of the fin body reduces compared to existing rectangular engine cylinder fin.

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DESIGN AND FABRICATION OF 3D PRINTED PLANE TURBINE MECHANISM

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Abstract— **This study delves into the transformative impact of additive manufacturing on traditional manufacturing methods, focusing on the design and production of a lightweight, durable turbine mechanism using 3D printing. Employing fusion360 software, a meticulously detailed digital model is crafted, optimizing its geometry for both aerodynamic efficiency and mechanical resilience. Special emphasis is placed on designing turbine blades to maximize lift and thrust while minimizing drag. The fabrication process utilizes either selective laser sintering or fused deposition modeling, with materials chosen for their ability to withstand high temperatures and mechanical stresses. Rigorous testing, including wind tunnel experiments and computational fluid dynamics simulations, evaluates the turbine's performance under various conditions. Additionally, the integration of an Arduino-based environmental monitoring and control system, featuring a DHT11 sensor for real-time temperature feedback, offers a compact and energy-efficient solution for temperature regulation and monitoring in diverse environments.**

I. INTRODUCTION

In this project we are going to describe the concept on 3D printing and designing the Plane turbine in FUSION 360 software and print the model using Ultimaker 3d printer.

3D Printing is a process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of a material. It brings a digital object (its FUSION 360 representation) into its physical form by adding layer by layer of materials.

There are several different techniques to 3D Print an object. We will go in further details later in the next chapters. 3D Printing brings two fundamental innovations: the manipulation of objects in their digital format and the manufacturing of new shapes by addition of material.

3d printing is a tool that allows people to create new things, limited only by imagination. 3D printing reduce time to get the first version of a product and emancipate many constraints that are not possible with traditional production methods.

3D Printing also known as additive manufacturing has been quoted in the Financial Times and by other sources as potentially being larger than the Internet. Some believe this is true. Many others urge that this is part of the extraordinary hype that exists around this very exciting technology area. So, what really is 3D printing, who generally uses 3D printers and what for. The term 3D printing covers a host of processes and technologies that offer a full spectrum of capabilities for the production of parts and products in different materials.

Technology has affected recent human history probably more than any other field. Think of a light bulb, steam engine or, more latterly, cars and aero planes, not to mention the rise and rise of the World Wide Web

3D printing, also known as additive manufacturing, is a method of creating a three-dimensional object layer-by-layer using a computer created design. 3D printing is an additive process whereby layers of material are built up to create a 3D part.

Additive Manufacturing is the formalized term for what used to be called Rapid Prototyping and what is popularly called 3D Printing. The term Rapid Prototyping (or RP) is used in a variety of industries to describe a process for rapidly creating a system or part representation before final release or commercialization. In other words, the

Emphasis is on creating something quickly, and that the output is a prototype or basis model from which further models and eventually the final product will be derived. Management consultants and software engineers both also use the term Rapid Prototyping to describe a process of developing business and software solutions in a piecewise fashion that allows clients and other stakeholders to test ideas and provide feedback during the development process. In a product development context, the term Rapid Prototyping was used widely to describe technologies which created physical prototypes directly from digital model data. This text is about these latter technologies, first developed for prototyping but now used for many more purposes.

Technology has affected recent human history probably more than any other field. Think of a light bulb, steam engine or, more latterly, cars and aero planes, not to mention the rise and rise of the World Wide Web. These technologies have made our lives better in many ways, opened up new avenues and possibilities, but usually it 3 takes time, sometimes even decades, before the truly disruptive nature of the technology becomes apparent.

In recent years, 3D printing has gone beyond being an industrial prototyping and manufacturing process as the technology has become more accessible to small companies and even individuals. Once the domain of huge, multi-national corporations due to the scale and economics of owning a 3D printer, smaller (less capable) 3D printers can now be acquired for under $1000.

This has opened up the technology to a much wider audience, and as the exponential adoption rate continues apace on all fronts, more and more systems, materials, applications, services and ancillaries are emerging.

The earliest 3D printing technologies first became visible in the late 1980's, at which time they were called Rapid Prototyping (RP) technologies. This is because the processes were originally conceived as a fast and more cost-effective method for creating prototypes for product development within industry. As an interesting aside, the very first patent application for RP technology was filed by a Dr Kodama, in Japan, in May 1980. Unfortunately for Dr Kodama, the full patent specification was subsequently not filed before the one-year deadline after the application, which is particularly disastrous considering that he was a patent lawyer! In real terms, however, the origins of 3D printing can be traced back to 1986, when the first patent was issued for stereolithography apparatus (SLA).

Figure 1: 3D Printing Technology

II. MATERIALS

A. PLA

A crowd favourite in our 3D printing materials guide is PLA, which can, under certain commercially attainable conditions, biodegrade. (You're not going to be able to compost it at home.)

First and foremost, Polylactic Acid (PLA) is easy to print with. It has a low printing temperature, doesn't need a heated bed (although it helps), and doesn't warp as easily. Another benefit of using PLA is that it doesn't give off an off-putting odour during printing (unlike ABS). Moreover, it is a suitable 3D printing material for single-use food contact. However, PLA is less durable than ABS or PETG and susceptible to heat. So, for any type of engineering part, you'll be better off with the latter.

B. ABS

Remember the quality of Lego bricks? Then you can relate to why Acrylonitrile butadiene styrene (ABS) is one of the most popular 3D printing materials to date. Made from petroleum, ABS is commonly used in injection moulding and is found in many household items, such as those rock-hard Lego bricks, phone cases, or bicycle helmets – due to its durability, robustness, and temperature resistance.

While it plays a major role in commercial applications such as rapid prototyping, in hobbyist 3D printing, ABS is less popular. This is due to it being slightly more difficult to print – it's prone to warping without an enclosed and heated build chamber.

Nonetheless, ABS makes a good general-purpose 3D printer filament for DIY projects. Examples include high-wear toys, tool handles, automotive trim components, and electrical enclosures.

C. PVA

Polyvinyl alcohol (PVA) is soluble in water, and that's exactly what commercial applications take advantage of. Popular uses include packaging for dishwasher detergent "pods" or bags full of fishing bait. (Throw the bag in water and watch it dissolve, releasing the bait.) For 3D printing, PVA, like HIPS, is engineered for use as a soluble support material, primarily when paired with another 3D printer filament in a dual extrusion 3D printer. The advantage of using PVA over HIPS is that it can support more materials than just ABS.

D. Nylon

Nylon, a branch of synthetic polymers, is a tough and durable material originally seen in textiles. The technical name for the material is polyamide (PA), while the common name is "nylon" (despite some still associating it with stockings). The material stands out for its toughness and its resistance to high temperatures and impacts. It also has a very low coefficient of friction, making it the ideal 3D printing material for parts that require good tensile and mechanical strength.

E. Wood Composite

Wood 3D printer filament is typically a PLA infused with wood fibre. Wood 3D filament is another composite, typically PLA infused with wood fibre. There are many wood-PLA 3D printer filaments available today. These include the more standard wood varieties, such as pine, birch, cedar, ebony, and willow. But the range also extends to fewer common types, like bamboo, cherry, coconut, cork, and olive.mobile robots that perform different kinds of work over everyday activities in many areas such as industry, manufacturing, production lines, or health, etc. are very commonly usedto improve our life.

Figure 2: Materials of 3D printing

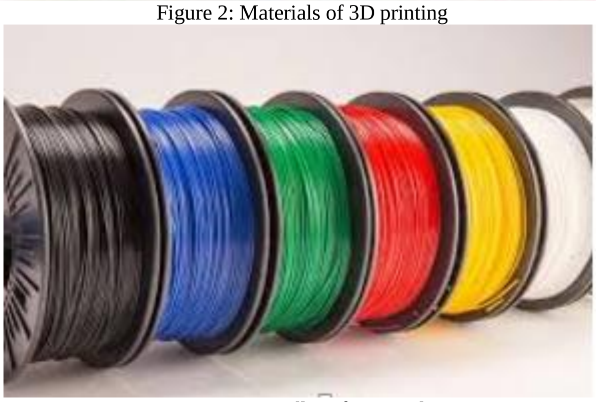
Figure 3: Bundles of Materials

III. MODELLING OF A JET ENGINE PROPULSION

The modeling of a jet engine propulsion system in Fusion 360 software involves a meticulous approach to designing each component with precision and accuracy. Beginning with the geometric modeling of the engine's various elements, such as the inlet, compressor, combustion chamber, turbine, and nozzle, engineers utilize Fusion 360's advanced CAD tools to create detailed 3D representations.

In Fusion 360, designers can leverage parametric modeling techniques to easily modify and refine the geometry of each component, ensuring optimal performance and functionality. The software's intuitive interface allows for seamless integration of complex shapes and features, facilitating the creation of intricate engine parts.

Once the geometric models are complete, engineers can simulate airflow through the engine using Fusion 360's simulation capabilities. By analyzing factors such as pressure distribution, velocity profiles, and temperature gradients, designers can assess the aerodynamic performance of the engine and identify areas for optimization.

Additionally, Fusion 360 provides tools for simulating combustion processes within the engine, allowing engineers to analyze fuel injection, mixing, and combustion efficiency. This enables them to fine-tune the design to achieve optimal combustion performance and minimize emissions.

Furthermore, Fusion 360's integrated CAM (Computer-Aided Manufacturing) functionality enables engineers to generate toolpaths for machining engine components, ensuring accurate and efficient manufacturing.

Overall, modeling a jet engine propulsion system in Fusion 360 software empowers engineers to design and optimize complex aerospace systems with confidence, streamlining the development process and ultimately leading to more efficient and reliable propulsion solutions.

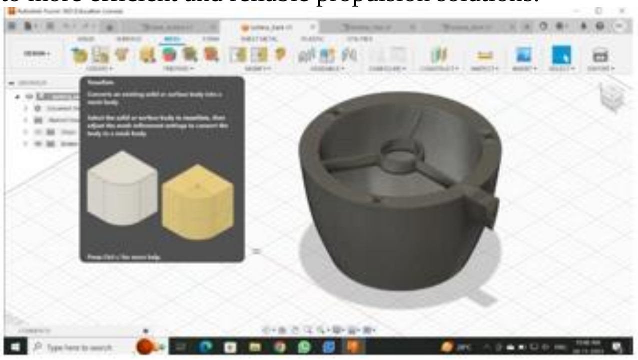

Figure 4: Body Casing

Figure 5: propeller

IV. FABRICATION OF JET ENGINE PROPULSION

Fabricating a jet engine propulsion system using a 3D printing machine and Cura software involves several critical steps to ensure precision, durability, and performance.

Firstly, engineers begin by converting the detailed digital model of the propulsion system, previously designed in Fusion 360, into a format compatible with Cura software. This may involve exporting the model in a suitable file format such as STL or OBJ.

Next, within Cura software, engineers carefully configure the printing parameters such as layer height, infill density, print speed, and support structures based on the material being used and the desired mechanical properties of the components. For jet engine parts, high-strength materials like heat-resistant thermoplastics or composite filaments are typically preferred to withstand the extreme conditions within the engine.

After configuring the printing parameters, engineers import the digital model into Cura and position it on the build platform. They may also use Cura's slicing features to optimize the toolpaths for efficient printing and minimize printing time.

Once everything is set up, the digital model is sliced into thin layers, and the 3D printing machine begins fabricating the components layer by layer according to the specified parameters. Depending on the size and complexity of the parts, printing may take several hours or even days.

Throughout the printing process, engineers monitor the quality of the prints and make any necessary adjustments to ensure accuracy and reliability. Post-processing steps such as removing support structures, sanding, and surface finishing may also be performed to achieve the desired final appearance and functionality of the components.

Once all components are printed and post-processed, they are assembled to form the complete jet engine propulsion system. Engineers may conduct additional testing and evaluation to verify performance and make any final adjustments if needed.

Overall, the fabrication of a jet engine propulsion system using a 3D printing machine and Cura software enables engineers to produce complex, customized components with precision and efficiency, advancing the development of innovative aerospace technologies.

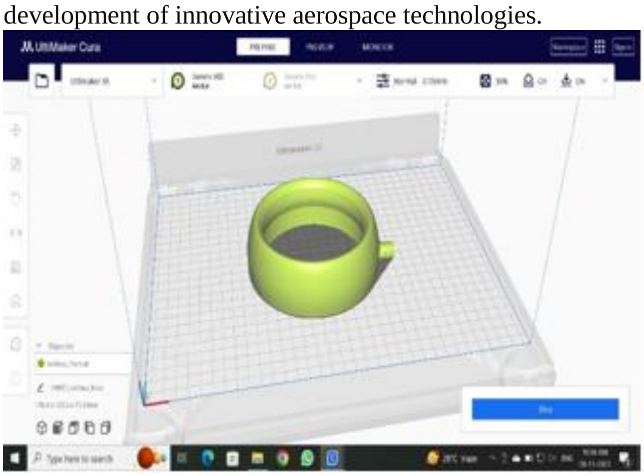

Figure 6: Layers

V. ELECTRONICS USED IN PROJECT

A. ARDUINO UNO

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010. The Arduino UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The UNO board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer release.

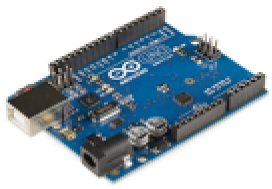

Figure 7: Arduino UNO

B. LCD DISPLAY

LCDs are compact displays that show 16 characters on 2 lines. Each character is formed by a 5x7 pixel matrix. They are widely used for text-based information in electronics, robotics, and embedded systems. Operated at 4.7-5.3V, they interface with microcontrollers.This 16x2 lcd display has the outline size of 80.0 x 36.0 mm and VA size of 66.0 x 16.0 mm and the maximum thickness is 13.2 mm. WH1602W 16x2 LCD Displays are built-in controller ST7066 or equivalent. It is optional for + 5.0 V or + 3.0 V power supply.

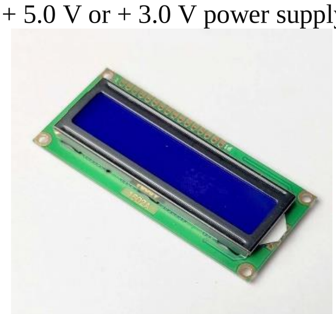

Figure 8: LCD Display

C. LCD ADAPTER MODULE

This LCD I2C adapter module is designed to fit directly below the standard 16x2 LCD display. Then through this module, the LCD can communicate through I2C protocol which requires only 2 pins from the controller side and then uses the PCF8574 IC to receive data from I2C and display them on the LCD screen.

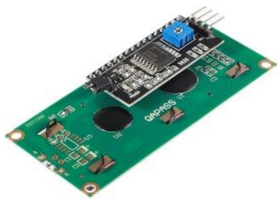

Figure 9: LCD Adapter Module

D. DHT11 TEMPERATURE SENSOR

The DHT11 is a basic, ultra low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data.

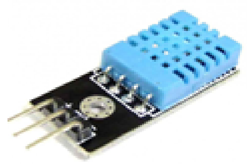

Figure 10: DHT11 Temperature Sensor

E. 18650 LI-ION BATTERY

An 18650 battery is a type of lithium-ion rechargeable battery. The numbers "18650" refer to the battery's dimensions: it is 18mm in diameter and 65mm in length. 18650 batteries are commonly used in electronic devices such as laptops and flashlights, as well as in electric vehicles and other high-power applications.

Figure 11: 18650 LI-ION Battery

F. RS-555 DC MOTOR

Description. RS-555 motor operates at DC 12V and maximum current up to 4A. This is a multipurpose brushed motor. It is used in many applications like a portable drill for PCBs, DIY projects, etc.

Figure 12: RS-555 DC Motor

VI. SOFTWARE DEVELOPMENT

To develop this software, we must install the software Arduino 1.8.13 and there we must write the program and compile it. Here in the code, we are given the wi-fi device name ARC BATCH: -B4, now our robot car will operate only for the device named ARC BATCH: -B4. If we want to change the device name, then we must change the name in code and dump or update it then compile. Now we can operate the machine with the changed name.

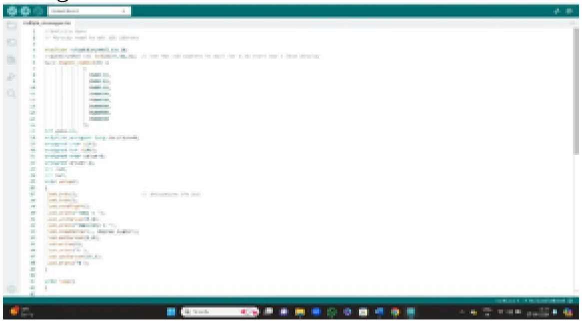

Figure 13: Program

A. ASSEMBLY

Figure 14: Assembly

VII. CONCLUSION

Though 3D printing is still a growing technology, it already has many benefits and drawbacks. While many people agree that this technology could change the world, there are also those who believe it could have extreme consequences if it is not researched and tested thoroughly. For now, it is something that has to be further looked into in order to fully understand its extents whether good or bad

With the help of FUSION 360, design of Plane Turbine mechanism is developed including few sub-assemblies and fabrication of right-hand components lime fingers, pins palm is completed by using 3D printing machine. 3D printing technology is the most advanced manufacturing process which is trending now a day which help in printing component at high speed and reduces production cost.

Moreover, the incorporation of electronics such as the Arduino Uno, 16*2 LCD Display, LCD adapter module, and DHT11 Temperature sensor, alongside the 18650 Li-ion Battery and RS-555 DC Motor, demonstrates the convergence of hardware and software for enhanced functionality and control within the plane turbine mechanism.

Moving forward, continued research and testing will be essential to fully comprehend the extent of 3D printing's impact on manufacturing and its potential consequences. As technology evolves, the convergence of 3D printing with electronics integration offers promising avenues for innovation and advancement in various industries, including aerospace engineering.

In essence, while acknowledging the benefits and drawbacks of 3D printing, this project underscores the importance of ongoing exploration and evaluation to harness its full potential while mitigating any potential risks.

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AUTOMATIC HVAC SYSTEM SCREEN DEVELOPMENT USING SCADA

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Abstract:
Remote monitoring and screen control of industrial processes is the need of today's automation industry. The project is focused on control of layout temperature in industrial building automation and control activities. Within industrial buildings, heating and cooling air conditioning systems (HVAC) must be well controlled. The main purpose of this work is to study and design an automated system of efficient HVAC control for energy saving in industrial buildings.

SCADA (Supervisory Control and Data Acquisition) system is useful in monitoring, screen controlling and accessing the performance of remotely situated systems by acquiring and controlling the physical parameters such as temperature, screen control etc. This project describes the design and development of Scada for temperature control system. On the other hand, Industrial Automation tools provide many acquisitions system in the process.

Develop regulate the operation of the HVAC system, chiller unit, and water filling unit based on setpoints, feedback loops, and predefined logic. This may include temperature control, pressure control, flow control, etc. Implement trending and historical data analysis tools to visualize the performance of the HVAC system, chiller unit, and water filling unit over time. Enable remote access to the SCADA system for operators to monitor and control the HVAC system, chiller unit, and water filling unit from centralized location. Ensure secure communication and access control mechanics.

I. INTRODUCTION

A. Heating, ventilation, and air conditioning:

Heating, Ventilation, and Air Conditioning (HVAC) is a technology and system that plays a fundamental role in providing thermal comfort, acceptable indoor air quality, and environmental control in buildings and industrial environments. The main goal of HVAC systems is to create a comfortable and healthy indoor environment for occupants, while also ensuring the efficiency and sustainability of energy usage. Here's a brief introduction to the key components and functions of HVAC.

SCADA (Supervisory control and data acquisition) is a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes. It also covers sensors and other devices, such as programmable logic controllers, which interface with process plant or machinery.

B. AUTOMATION IN SCADA:

Supervisory Control and Data Acquisition (SCADA) is a combination of hardware and software used for industrial automation.

C. SCADA automation allows users to:

Supervise and control industrial processes both locally and remotely Acquire, process, and record data.

Interact with local machinery through HMIs (Human Machine Interfaces) and PLCs (Programmable Logic Controllers) to communicate with the SCADA system. SCADA systems allow companies to make smarter decisions, improve efficiency, and minimize downtime. SCADA is used across a variety of industries and is commonly found in manufacturing, automation, oil and gas, and wastewater applications.

D. SCADA software:

- AVEVA has a long history and unbeatable track record in delivering SCADA software solutions to organizations large and small. We offer a winning strategy for meeting complex and evolving automation requirements, as well as solutions for more straightforward operations.
- It's almost impossible to predict your long-term technology requirements in this era of constant innovation and rapid change.
- High Performance
- Our SCADA software is reliable, flexible and high performance, and has been helping industries around the world for decades.
- Trusted Solutions
- Our SCADA software is highly secure, scalable and offers real-time supervisory control.
- It's trusted to manage critical infrastructures around the world

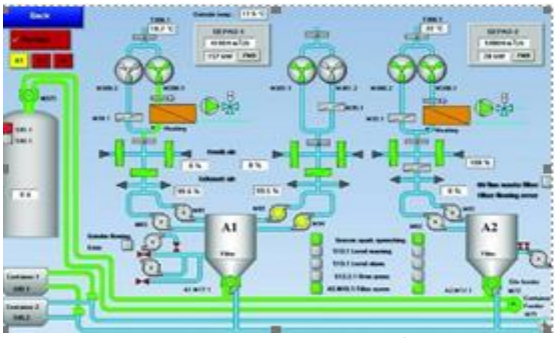

Figure.1.1: SCADA Software

II. LITERATURE SURVEY

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III. DEVELOPMENT OF SCADA

Several advancements have occurred in SCADA (Supervisory Control and Data Acquisition) systems as they pertain to HVAC (Heating, Ventilation, and Air Conditioning) systems. Here are some notable developments:

A. Integration with Building Management Systems (BMS):

SCADA systems have become more tightly integrated with BMS platforms, allowing for comprehensive building automation and management. Integration enables centralized control and monitoring of not just HVAC systems, but also other building systems such as lighting, security, and access control.

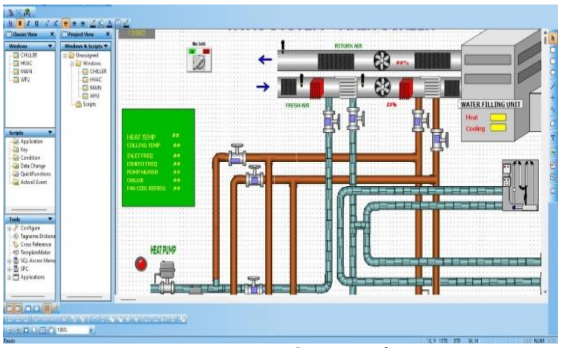

Figure.3.1: Development of SCADA

B. SCADA INTERFACE DESIGN

1) HVAC SYSTEM MAIN SCREEN

Developing the main screen for an automatic HVAC system using SCADA involves designing a user-friendly interface that provides operators with essential information about the HVAC system's status and enables them to monitor and control its operation efficiently. Here's a general outline of how you might approach screen development:

2) Layout Design:

Begin by designing the layout of the main screen, considering factors such as screen resolution, aspect ratio, and user accessibility.

Arrange components logically, grouping related information and controls together for easy navigation.

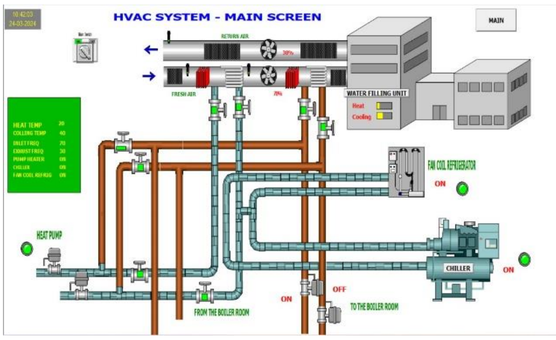

Figure.3.2: HVAC screen in on position System

3) Overview:

Include an overview section displaying key parameters such as current temperatures, humidity levels, set points, and equipment statuses. Utilize graphical elements like gauges, thermometers, and icons to represent system components and their states.

4) Alarms and Alerts:

Dedicate a section to display active alarms and alerts, highlighting critical issues that require immediate attention.

Provide visual and auditory cues for alarms, with options to acknowledge and clear them as needed.

5) Energy Management:

Integrate energy monitoring and reporting features to track energy consumption and identify opportunities for optimization.

Display real-time energy usage metrics and historical consumption data to promote energy efficient operation.

Ensure consistency in navigation design and labeling to enhance usability and reduce operator errors.

6) User Authentication and Security:

Implement user authentication mechanisms to restrict access to authorized personnel and protect sensitive system settings.

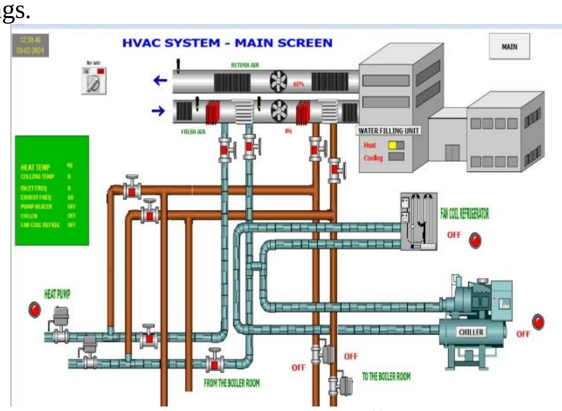

Figure.3.3 HVAC screen in off position

7) Customization and Flexibility:

Provide options for customization to accommodate different user preferences and system configurations.

Allow users to personalize the layout, colors, and widgets based on their specific monitoring and control needs.

8) Testing and Iteration:

Conduct thorough testing and validation of the main screen design to ensure its functionality, responsiveness, and reliability.

Gather feedback from operators and stakeholders and iterate on the design based on usability testing results and user input.

C. SYMBOL FACTORY:

Symbol Factory is a collection of graphical symbols and icons commonly used in SCADA (Supervisory Control and Data Acquisition) systems for creating intuitive and visually appealing user interfaces. When developing HVAC system screens using SCADA with Symbol Factory, you can leverage a wide range of pre-designed symbols to represent various components, equipment, and parameters within the HVAC system. Here's how you can utilize Symbol Factory in HVAC system screen development.

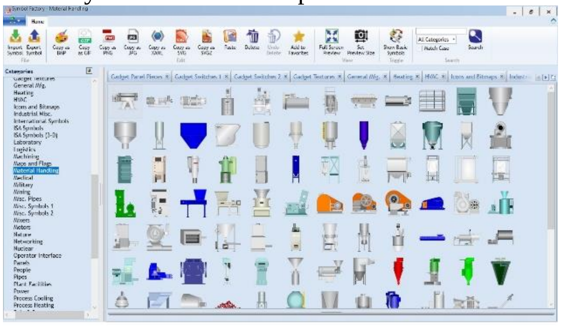

Figure.3.4: Symbol Factory and Material handling

D. WIZARD SELECTION:

Implementing a wizard selection interface in an HVAC system screen using SCADA can greatly enhance user experience by guiding operators through complex tasks or processes step by step. Here's how you can design and implement a wizard selection interface. Identify Use Cases: Determine the scenarios in which operators may need guidance or step-by-step assistance in the HVAC system. This could include setting up new equipment, configuring parameters, troubleshooting, or performing maintenance tasks.

Breakdown Tasks: Divide the tasks or processes into logical steps that can be presented sequentially in the wizard interface. Each step should focus on a specific aspect of the task, making it easier for operators to follow along.

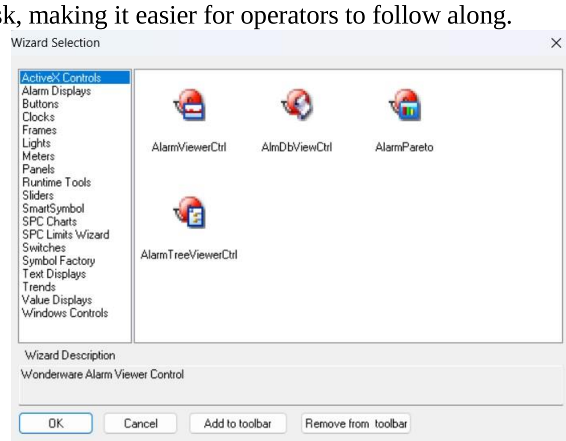

Figure.3.5: Wizard Selection

E. SCRIPT FOR HVAC SCREEN:

St = 0;
H = 0; HV = 0; p = 0; PH = 0;
FCR = 0;
C = 0;
INF = 0;
EF = 60;
HT = 45; C=0;

St: This tag represents the start signal for the system. "=0" indicates that the system is currently not started or activated.

H: The "H" tag signifies the status of the water filling unit. "=0" means that the water filling unit is currently inactive or not running.

HV: This tag indicates the status of the valve within the system. "=0" suggests that the valve is currently closed or not allowing the flow of fluids.

p: Represents the status of the fan in the system. "=0" implies that the fan is currently turned off or not operational.

PH: Denotes the status of the heat pump. "=0" signifies that the heat pump is currently inactive or not providing heating or cooling.

FCR: Indicates the status of the fan refrigeration coil. "=0" suggests that the fan refrigeration coil is currently inactive or not in use.

C: Represents the status of the chiller unit. "=0" means that the chiller unit is currently inactive or not running.

INF: This tag represents the value of the inlet frequency, which determines the frequency of incoming air or fluid. "=0" implies that there is no incoming flow or frequency.

EF: Denotes the value of the exhaust frequency, specifying the frequency of outgoing air or fluid. "=0" indicates that there is currently no outgoing flow or frequency.

HT: Represents the value of the heat temperature within the system. "=0" suggests that the temperature is currently at a baseline or inactive state.

F. CHILLER UNIT:

A chiller is a machine that removes heat from a liquid coolant via a vapor-compression, absorption refrigeration, or absorption refrigeration cycles. This liquid can then be circulated through a heat exchanger to cool equipment, or another process stream (such as air or process water). As a necessary by-product, refrigeration creates waste heat that must be exhausted to ambience, or for greater efficiency, recovered for heating purposes.

Chilled water is used to cool and dehumidify air in mid- to large-size commercial, industrial, and institutional facilities. Water cooled chillers can be liquid-cooled (through cooling towers), air-cooled, or evaporatively cooled. Water or liquid-cooled systems can provide efficiency and environmental impact advantages over air-cooled systems. A liquid (glycol based) chiller with an air-cooled condenser on the rooftop of a medium size commercial building. A liquid (glycol based) chiller with an air cooled condenser on the rooftop of a medium size commercial building.

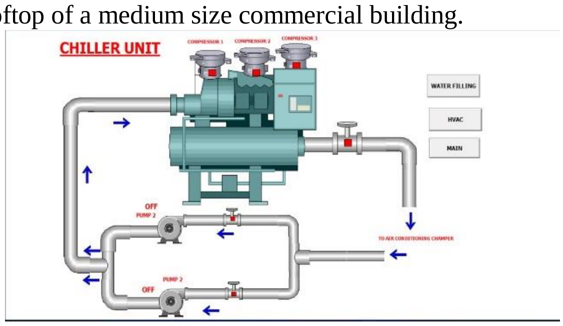

Figure.3.6: Chiller Unit

G. SCRIPT FOR CHILLER UNIT:

V1 = 0; v2=0; v3=0; v4=0; v5=0; v6=0; v7=0;

V1: Represents a slider control, typically used for adjusting a parameter or setting.

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"=0" indicates that the slider is currently set to its minimum value or position, suggesting that it may not be actively controlling any parameter at the moment.

V2: Represents the status of compressor 1, which is likely a component in a system such as an air conditioning or refrigeration system.

"=0" suggests that compressor 1 is currently turned off or inactive, meaning it is not compressing any fluid.

V3: Represents the status of compressor 2, which could be another compressor unit in the same system or a different system altogether.

"=0" indicates that compressor 2 is currently turned off or inactive, meaning it is not compressing any fluid.

V4: Represents the status of compressor 3, similar to the previous compressors.

"=0" suggests that compressor 3 is currently turned off or inactive, meaning it is not compressing any fluid.

V5: Represents the status of the output valve, which controls the flow of fluid or gas out of a system.

"=0" indicates that the output valve is closed or inactive, meaning there is no flow of fluid or gas through it.

V6: Represents the status of the exhaust valve, which controls the release of exhaust gases or fluids from the system.

"=0" suggests that the exhaust valve is closed or inactive, meaning there is no release of exhaust gases or fluids.

V7: Represents the status of the exhaust pump, which could be a pump responsible for removing exhaust gases or fluids from the system.

"=0" indicates that the exhaust pump is currently turned off or inactive, meaning it is not actively removing exhaust gases or fluids.

H. WATER FILLING UNIT

The Water Filling Unit Screen is a dedicated interface designed within the SCADA system for monitoring and controlling the water filling unit in an HVAC system. This screen provides real-time visualization of water levels and offers options for controlling the valves responsible for water flow.

Figure.3.7: Water filling unit

Overall, the water filling unit plays a critical role in maintaining the proper functioning and efficiency of an HVAC system by ensuring that the system has an adequate supply of water at the correct pressure levels. Proper installation, maintenance, and monitoring of the water filling unit.

I. SCRIPT FOR WATERFILING UNIT:

```
IF St == 0 THEN
  H = 0;
ENDIF;
IF St == 1 THEN
  H = H + 2;
ENDIF;
IF H == 100 THEN
  H = 0;
ENDIF;
```

St: Represents the start signal for the system. It controls the overall operation of the water filling unit.

H: Indicates the status of the water filling unit. It represents the amount of water filled in the unit.

ENDIF: Denotes the end of a conditional statement block.

Explanation of each condition:

IF St == 0 THEN

If the start signal is equal to 0 (indicating the system is not started), the water filling unit status (H) is set to 0, indicating no water filling.

IF St == 1 THEN

If the start signal is equal to 1 (indicating the system is started), the water filling unit status (H) increases by 2, representing water filling.

IF H == 100 THEN

If the water filling unit status (H) reaches 100 (indicating it's filled to the maximum), the status is reset to 0, ready for the next cycle of filling.

Overall, this script controls the operation of the water filling unit based on the start signal and ensures that the unit operates within its specified range, resetting it when necessary.

IV. CONCLUSION

The integration of Heating, Ventilation, and Air Conditioning (HVAC) systems with Supervisory Control and Data Acquisition (SCADA) technology marks a significant advancement in the field of building automation and control. Through this project, we have explored the capabilities of SCADA to enhance the performance, efficiency, and management of HVAC systems in various environments including residential, commercial, and industrial buildings.

One of the key outcomes of this project is the development of a user-friendly SCADA interface tailored specifically for monitoring and controlling HVAC parameters. This interface provides users with centralized access to critical system data, enabling them to make informed decisions and adjustments in real-time. By visualizing temperature, humidity, airflow, and system status in a comprehensible manner, the SCADA interface empowers users to optimize HVAC performance and maintain comfortable indoor environments.

V. FURTUR SCOPE

The future scope of HVAC (Heating, Ventilation, and Air Conditioning) lies in advanced energy-efficient systems that integrate smart technologies for optimal performance and environmental sustainability. SCADA (Supervisory Control and Data Acquisition) systems are poised to evolve with advancements in IoT (Internet of Things) and AI (Artificial Intelligence), enabling real-time monitoring, predictive maintenance, and enhanced control of HVAC systems. Integration of SCADA with HVAC will facilitate smarter decision making, improved energy management, and greater resilience in building automation. Overall, the convergence of HVAC and SCADA technologies holds promise for more efficient, sustainable, and intelligent building operations in the future.

Furthermore, as climate change concerns grow, there will be increasing emphasis on HVAC systems that can adapt to changing environmental conditions and prioritize energy conservation. SCADA's role in providing comprehensive data analytics and remote-control capabilities will be essential for optimizing HVAC performance and reducing overall carbon footprint in buildings.

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ANALYSIS OF WING LOCATION ON AERODYNAMICS PERFORMANCE OF AIRPLANE

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***Abstract*—The study focuses on investigating the impact of wing location on the aerodynamic performance of an airplane, employing computational analysis through XFLR5 software. The positioning of wings plays a crucial role in determining the aircraft's efficiency, stability, and overall flight characteristics. Utilizing XFLR5, a powerful tool for airfoil and wing analysis, the research involves simulating various wing configurations and their effects on lift, drag, and overall aerodynamic behavior.**

The methodology involves systematically altering the wing location and assessing key aerodynamic parameters. By analyzing lift-to-drag ratios, stall characteristics, and other performance indicators, the study aims to optimize wing placement for enhanced flight performance. XFLR5 allows for the visualization of aerodynamic forces and moments, providing valuable insights into the intricate relationship between wing location and aircraft dynamics.

The outcomes of this research have significant implications for aircraft design and engineering, potentially leading to advancements in fuel efficiency, maneuverability, and overall flight safety. Understanding how wing location influences aerodynamic performance is vital for optimizing aircraft design and achieving superior flight characteristics.

I. INTRODUCTION

XFLR5 is a powerful and versatile software tool used in aerodynamics and aircraft design. It stands out for its capability to analyze and simulate various aspects of aerodynamic behavior, including wings, airfoils, and wing locations. Let's delve into each of these components to understand their significance in aerodynamics and how XFLR5 plays a role in analyzing them.

A. Wings

In aerodynamics, wings are crucial components of an aircraft that generate lift when the aircraft is in motion. Wings come in various shapes and sizes, each designed to achieve specific aerodynamic goals.

- XFLR5 allows engineers and designers to analyze the performance of different wing designs by simulating airflow over them. This analysis includes lift, drag, stall characteristics, and overall aerodynamic efficiency.

B. Airfoils

- Airfoils are the cross-sectional shapes of wings or other aerodynamic surfaces. They play a fundamental role in determining the aerodynamic properties of an aircraft, such as lift and drag.
- XFLR5 provides tools to analyze and compare different airfoil profiles. Engineers can simulate airflow around airfoils to understand their performance under various conditions, such as different angles of attack or Reynolds numbers.

C. Wing

- The position and configuration of wings on an aircraft significantly impact its stability, control, and overall aerodynamic behavior. Wing location refers to where the wings are mounted on the fuselage or body of the aircraft.
- XFLR5 allows designers to study the effects of changing wing locations on aerodynamic performance. This analysis helps optimize the placement of wings to achieve desired flight characteristics, such as stability, manoeuvrability, and fuel efficiency.

XFLR5's capabilities extend beyond individual components like wings, airfoils, and wing locations. It can also perform complex analyses such as predicting aircraft performance, stability derivatives, and even simulating entire aircraft designs. By leveraging XFLR5, engineers and designers can make informed decisions during the aircraft design process, leading to more efficient and effective aircraft configurations..

II. LITERATURE REVIEW

The Study of wing location and its impact on the aerodynamic performance of airplanes is a multifaceted field that has garnered extensive attention from researchers and engineers.

The positioning of wing relative to the fuselage plays a pivotal role in determining crucial aerodynamic factors such as lift, drag, stability, and manoeuvrability. Research by torenbeek and Wittenberg (2009) has explored the effects of wing sweep, emphasizing how the sweep angle influences lift and drag distribution. Phllips (2013) and Raymer (2012) have delved into the intricate aerodynamic interactions at the wing-fuselage junction, shedding light on drag and lift characteristics.

III. DESIGN AND ANALYSIS OF AIRFOIL

A. AIRFOIL AND TYPES OF AIRFOIL:-

Airfoils, also known as aerofoils, are the cross-sectional shapes of wings, blades, or other surface designed to provide lift when moving through a fluid, such as air. There are various types of airfoils, each with unique characteristics suited for specific applications. Here are some common types of airfoils:

1. Symmetrical Airfoil.
2. Asymmetrical Airfoil or Cambered Airfoil
3. Clark Y Airfoil
4. NACA Airfoil, Etc.

B. DESIGNING OF AIRFOIL

Make sure you have XFLR5 installed on your computer. You can download it from the official website. After installation open the software click o the file option and click create new project and name as new project. After that click the module option and click on direct foil design. Click on foil in that click on NACA foils. Enter the any 4 digit number that is one foil here we take NACA0012, NACA0025, NACA2412 and N10 foils. This is the process to design the Airfoil.

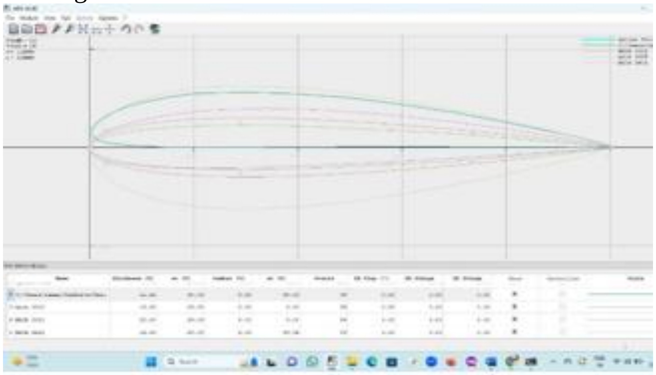

Figure-3.1: The figure shows Different types of Airfoil designed in XFLR5 software

C. ANALYSIS OF AIRFOIL:

After designing of airfoil click on module after click on XFoil Direct Analysis. After that click on each airfoil which we designed after that click on analysis after that click on define an analysis Reynolds number will automatically defined or you calculate the Reynolds number enter the number and click on ok after that click on analyze. Then you will get one foil analysis after click ok another foil repeat the same process. After that select another repeat the same process do all foils like this then we will get a graphs as shown in below figure. That figure shows the comparison between the foils or analysis of the foils.

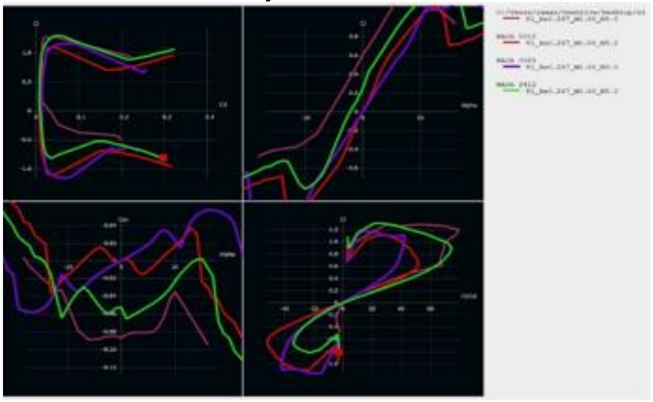

Figure-3.2: The figure shows different Airfoil Analysis in XFLR5 Software

IV. DESIGN AND ANALYSIS OF WING LOCATIONS

It appears that there might be a small type in your question, and you might be referring to "wing locations." Wing locations is also known as wing Configuration. If you mean the placement or positioning of wings on an aircraft, I can provide information on different wing configurations and their applications:

1) High-Wing Configuration
2) Mid-Wing Configuration
3) Low-Wing Configuration

A. DESIGN OF WING LOCATIONS

After designing of airfoils go to modulus and click on Wing and Plane Design. Click on the plane option enter plane name as high wing and untick the Elevator and Fin and tick the body option later go to main wing and click define option. Arrange chord 2 columns are equal and offset also 2 columns are equal Then we get the rectangular wing. Click on the save button. Keep X= -0.040 and Z= 0.020 and click on save.

Similarly Mid wing and long wing also follow the same process. For mid wing Keep X= -0.040 and Z= 0.000. For low wing Keep X= -0.040 and Z= -0.035.

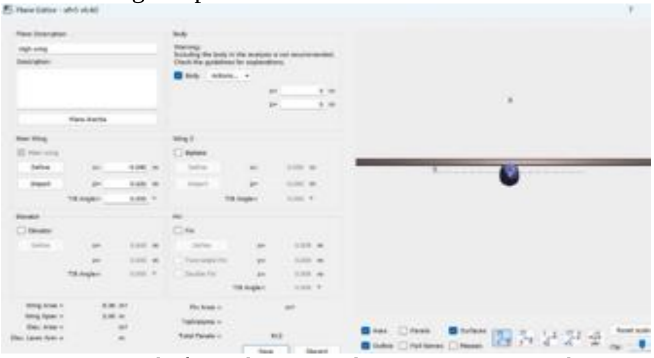

Figure-4.1: In the figure shows wing above Y- Axis means High wing configuration

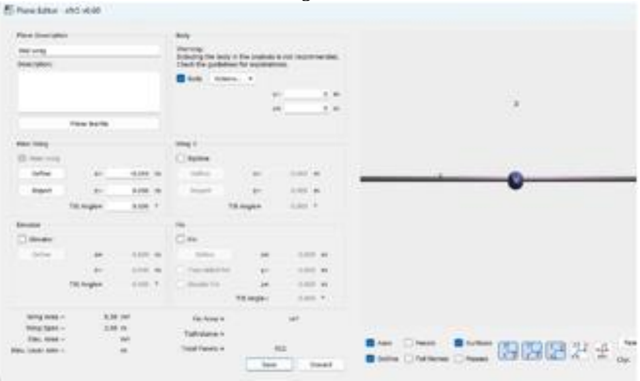

Figure-4.2: In the figure shows wing on Y- Axis means Mid wing configuration

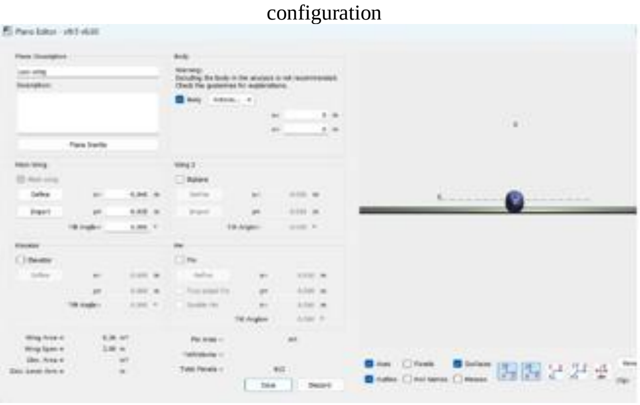

Figure-4.3: In the figure shows wing below Y- Axis means Low wing configuration

V. TESTING METHODS

Testing Methods are used to test the Aircraft models, Wing location variations etc.

When conducting a study on the effects of wing location on the aerodynamic performance of an airplane, it's essential to follow a systematic approach. Here's a general outline of testing methods you might consider:

1. Clearly define the objectives of your study. What specific aspects of aerodynamic performance are you investigating?
2. Choose a specific airplane model or design for your study. Ensure that it represents a realistic and relevant scenario.
3. Determine different wing locations to test. This may include variations in wing sweep, dihedral, anhedral, and span.
4. Ensure that changes in wing location are incremental and systematic.
5. Ensure the scale model of the aircraft is accurate and representative.

This all are check well while doing the testing of wing locations and aircraft models. Our project on wing locations so we have some testing methods.

Studying the effects of wing location on the aerodynamic performance of an airplane involves a combination of theoretical analysis, computational simulations, and experimental testing. Here are some testing methods that you can consider:

1. Wind Tunnel Testing.
2. Computational Fluid Dynamics (CFD).
3. Flight Testing.
4. Pressure Measurement Techniques.
5. Force and Moment Measurements.
6. Model Scalling. Etc.,

VI. EXPERIMENTAL PROCEDURE

Our aim is to find the lift and drag at Different wing locations. To find the lift and drag the below procedure we have to follow:

1. Open xflr5 > Module > Direct foil design.
2. Foil > NACA Foil > Enter digit 0012 > ok > ok.
3. Foil > NACA Foil > Enter digit 0025 > ok > ok.
4. Foil > NACA Foil > Enter digit 2412 > ok > ok.
5. Open file > Select n10 > open.
6. Click on Module > select Xfoil Direct analysis.
7. Click on n10 > Analysis > Define an analysis > ok > Analyze.
8. Click on NACA0012 > Analysis > Define an analysis > ok > Analyze.
9. Click on NACA0025 > Analysis > Define an analysis > ok > Analyze.
10. Click on NACA2412 > Analysis > Define an analysis > ok > Analyze.
11. Click on Module > select Wing and Plain design.
12. Plain > Define a new plane > name as Mid wing > Untick the Elevator and Fin > Tick the Body > In main wing click define > select any foil in 1st row > select the same foil in 2nd row same as 1st row.
13. Change the wing shape by using the offset and chord > suppose we are taking rectangular wing > keep the row 1 and row 2 offset are equal and row 1 and row 2 chord are equal and click on save option > save.
14. Click on high wing > Analysis > define an Analysis > Analysis > untick the viscous > save > Analyze.
15. Plain > Define a new plane > name as High wing > Untick the Elevator and Fin > Tick the Body > In main wing click define > select any foil in 1st row > select the same foil in 2nd row same as 1st row.
16. Change the wing shape to rectangle > save > in main wing keep X = -0.040 and Z = 0.020 > save > ok.
17. Click on High wing > Analysis > Define an Analysis > Analysis > untick the viscous > save > Analyze.
18. Plain > Define a new plane > name as Low wing > Untick the Elevator and Fin > Tick the Body > In main wing click define > select any foil in 1st row > select the same foil in 2nd row same as 1st row.
19. Change the wing shape to rectangle > save > in main wing keep X = -0.040 and Z = -0.035 > save > ok.
20. Click on Low wing > Analysis > Define an Analysis > Analysis > Untick the viscous > save > Analyze.
21. After analyze we get graphs compare that graphs and wing at which location the lift is more.
22. Repeat the same process for Swept Back Wing and Delta Wing and also compare their graphs.

VII. EXPERIMENTAL PROCEDURE

We done a report on different types of wings in different types of locations that report images are given below.

A. Rectangular Wing:

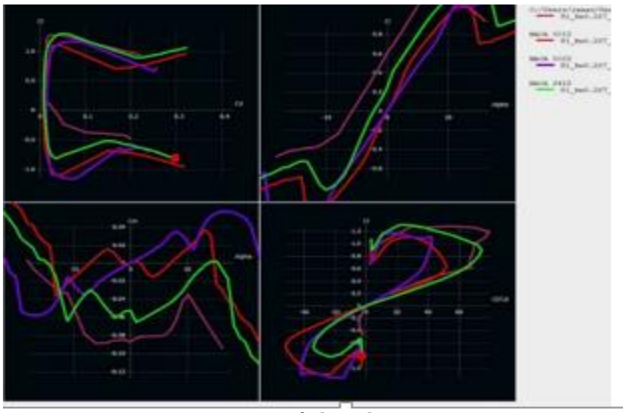

Figure-7.1 Airfoil Analysis

Airfoil analysis focuses on studying the aerodynamic properties of wing or blade shapes. It involves analyzing geometry, lift and drag coefficients, angle of attack effects, flow characteristics, and using simulations/testing to optimize designs for aircraft performance. This process is crucial for enhancing aerodynamic performance and ensuring the effectiveness of aircraft wings and propeller blades.

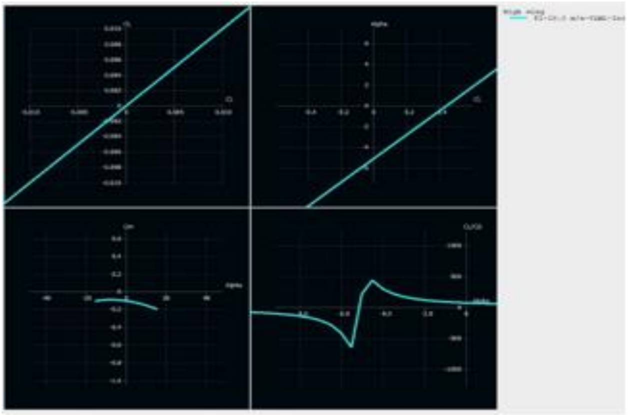

Figure-7.2: The figure shows High-Wing Configuration in Rectangular Wing

A high wing configuration with a rectangular wing offers stability, increased payload capacity, better visibility for passengers, shorter landing gear requirements, and easier maintenance access. This design is commonly chosen for its balanced advantages, making it suitable for various aircraft types like commercial airliners, cargo planes, and general aviation aircraft.

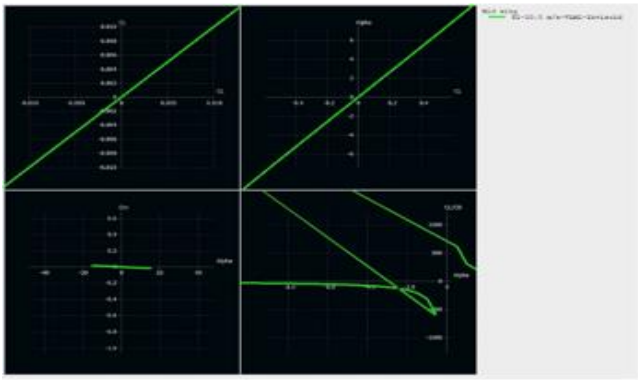

Figure-7.3: The figure shows Mid -Wing Configuration in Rectangular Wing

A mid-wing configuration with a rectangular wing strikes a balance between aerodynamic performance and structural considerations. It offers good stability, payload flexibility, and aerodynamic efficiency across various flight conditions, making it a popular choice for modern aircraft in commercial, business, and military applications.

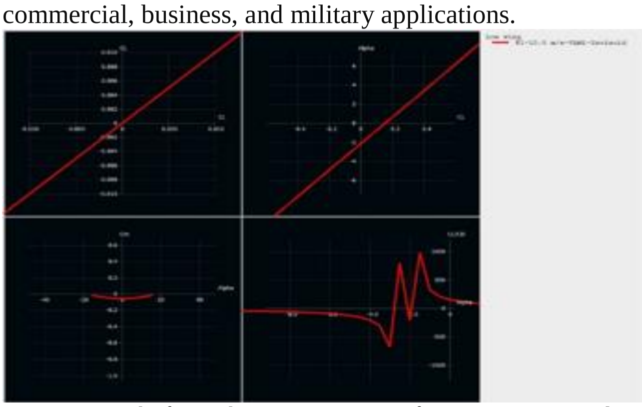

Figure-7.4: The figure shows Low-Wing Configuration in Rectangular Wing

In a low wing configuration with a rectangular wing, the wings are attached closer to the bottom of the fuselage. This design offers good aerodynamic efficiency, stability, and improved ground visibility for pilots during takeoff and landing. It requires robust wing-to-fuselage attachments and has specific ground handling considerations.

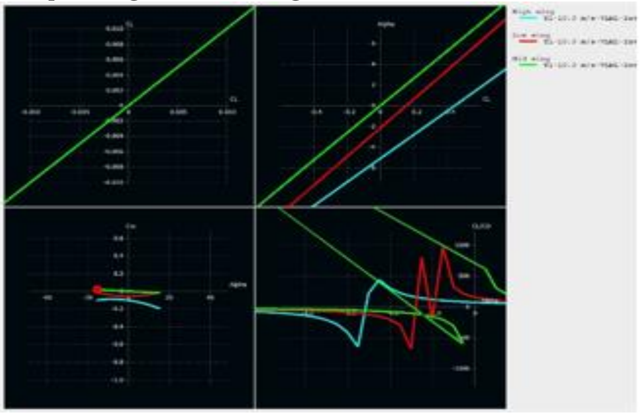

Figure-7.5: The figure shows Comparison between High, Mid, Low Wing Configuration in Rectangular Wing

B. Result Values:

Case-1: Rectangular Wing.

	Hing wing Configuration	Mid wing Configuration	Low wing Configuration
X-Axis (Lift)	6	1.8	2.6
Y-Axis (Drag)	3.8	2	1.8

We will check the above table at High wing configuration we will get more Lift with less Drag

VIII.CONCLUSION

The study of wing location in relation to the aerodynamic performance of an airplane is a critical and complex aspect of aircraft design. The position of the wings significantly influences the overall aerodynamic characteristics, affecting key parameters such as lift, drag, stability, and maneuverability. Through systematic investigation and analysis, researchers and engineers can gain valuable insights into the optimal wing placement for different types of aircraft and missions.

The findings of such studies contribute to the enhancement of aircraft efficiency, safety, and performance. By understanding how wing location impacts aerodynamics, designers can make informed decisions to achieve a balance between lift and drag, ensuring optimal fuel efficiency and maneuvering capabilities. Additionally, considerations for stability and control become crucial elements in determining the most suitable wing position for specific applications.

As technology advances and computational tools improve, researchers can conduct more sophisticated simulations and experiments, leading to further refinements in aircraft design. The continuous exploration of wing location's impact on aerodynamic performance is vital for the ongoing development of innovative and efficient aircraft, contributing to the evolution of aviation and aeronautical engineering.

By our Analysis we will get more lift in rectangular wing at High wing configuration lift is 6 and drag is 3.8.

By our Analysis we will get more lift in swept back wing at Low wing configuration lift is 1 and drag is 0.8.

By our Analysis we will get more lift in delta wing at Mid wing configuration lift is 1 and drag is 0.6.

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AUTOMATIC COLOUR CODE SENSING PUNCHING MACHINE CONTROLLED BY PLC

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***Abstract*— This project presents the design and implementation of an automatic color code sensing punching machine controlled by Programmable Logic Controller (PLC). The system aims to streamline the punching process by accurately detecting color codes on work pieces and executing punching operations accordingly. By integrating color sensing technology with PLC control, the machine offers precise and efficient operation in industrial environments. This paper discusses the methodology, hardware setup, and programming logic employed to achieve seamless automation. The proposed system showcases the potential of PLCs in enhancing productivity and accuracy in manufacturing processes, paving the way for advanced automation solutions in various industries.**

Keywords— Allen Bradley PLC, DC motor, IR Proximity sensor, Relay, inductive proximity sensor, capacitive proximity sensor

I. INTRODUCTION

In industrial automation, advanced technologies have transformed manufacturing processes, enhancing efficiency and reliability. The Automatic Color Code Sensing Punching Machine, employing Programmable Logic Controller (PLC) technology, exemplifies this innovation. It automates punching operations, offering manufacturers an efficient solution.

A. OBJECTIVES:

Automation: Develop a system capable of autonomously detecting color-coded materials and executing punching operations.

Precision: Achieve precise punching accuracy through color sensing technology and PLC control.

Efficiency: Enhance production efficiency by reducing setup time and minimizing waste.

Flexibility: Design a system accommodating various materials and punching patterns.

Cost-effectiveness: Reduce labor costs and improve resource utilization.

User-friendliness: Develop a user-friendly interface for seamless integration.

Scalability: Design adaptable to varying production demands.

Integration: Ensure seamless integration with existing manufacturing processes.

Compliance: Ensure compliance with industry standards and safety regulations.

B. PROBLEM STATEMENT: Manual Intervention: Manual or semi-automated punching operations incur labor costs and reduce throughput.

Inaccuracy: Human-operated machines may result in errors, leading to product defects.

Limited Flexibility: Conventional systems struggle with diverse materials and punching patterns.

Low Efficiency: Manual processes are slower and less efficient than automation.

Quality Control Issues: Manual processes may lead to inconsistencies and lower product quality.

Scalability Challenges: Manual processes hinder quick response to market changes follow.

II. PLC SYSTEM

A programmable logic controller (PLC), also known as a programmable controller, is a computer-like device utilized to control equipment in industrial facilities. PLCs are real-time controllers with cyclic behavior. They are digitally operating electronic devices that utilize programmable memory for internal storage of instructions for executing specific functions, such as logic sequencing, timing, counting, and control through digital or analog input/output modules.

The PLC operates in several steps. Initially, it scans the inputs to the controller and creates a representation of the input status in its memory. Subsequently, the software stored in the controller's memory is processed, considering the input memory representation. This processing results in an image of the outputs. In the final step, this output image is mapped to the actual outputs.

A. I/O Interfaces:

An I/O module is a plug-in assembly containing circuitry that facilitates communication between a PLC and field devices. These devices may transmit and/or receive digital and/or analog signals.

B. Programming Languages:

1) Graphical Languages:

i. Ladder Diagram (LD): Utilizes a standardized set of ladder programming symbols to implement control functions.

ii. Function Block Diagram (FBD): A graphical language enabling the user to program components so that they resemble wired electric circuits.

iii. Sequential Function Chart (SFC): A graphical language providing a diagrammatic representation of control sequences in software.

2) Text-Based Languages:

1. Instruction List: A low-level language similar to machine language.

2. Structured Text: A high-level language allowing structured programming, enabling complex tasks to be broken down into smaller ones, or utilizing assembly language with microprocessors.

III. METHODOLOGY

The methodology involves developing an automated sorting system using a PLC and a color sensor to distinguish between green and red boxes on a conveyor belt. Initially, the system design is outlined, identifying necessary components such as the PLC, color sensor, and pneumatic actuators. The PLC is then programmed to interpret color sensor data, triggering the appropriate actuator to divert boxes based on their color. Mechanical assembly integrates these components into a functional system. Testing ensures accurate color detection and reliable sorting, with adjustments made as needed. User-friendly interfaces and documentation are provided for seamless operation and maintenance. Through systematic implementation and refinement, the system achieves efficient and precise sorting of green and red boxes, enhancing industrial automation processes.

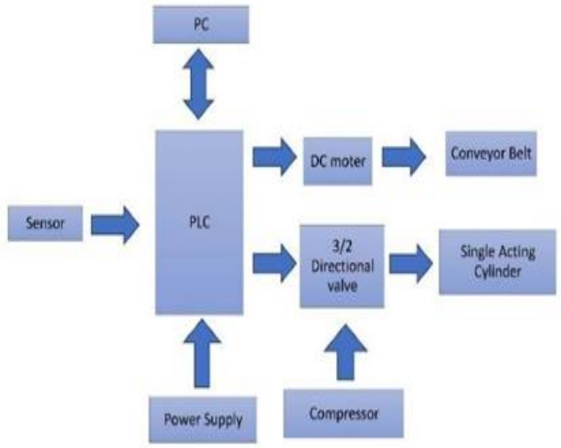


Fig 3.1 process

IV. HARDWARE CONFIGURATION

The hardware components are connected and configured according to the system design, with sensors interfaced to the PLC's input modules, actuators connected to its output modules, and other devices integrated as necessary. The PLC program is developed using Delta software to control the operation of the system, including color sensing, punching, and conveyor movement, based on input from sensors and user commands. Through proper configuration and integration, the hardware components work together seamlessly to achieve the desired functionality of the automatic color code sensing punching machine.

A. SENSOR:

The hardware configuration for the automatic color code sensing punching machine also includes an inductive proximity sensor. This type of sensor is used to detect the presence of metallic objects, such as the material passing through the conveyor belt. The inductive proximity sensor emits an electromagnetic field and detects changes in that field caused by the presence of metallic objects within its sensing range.

B. DC MOTOR:

DC motors utilize a magnetic field to exert mechanical force on a current-carrying conductor. They are commonly used in industrial applications such as conveyor belts and elevators for material handling.

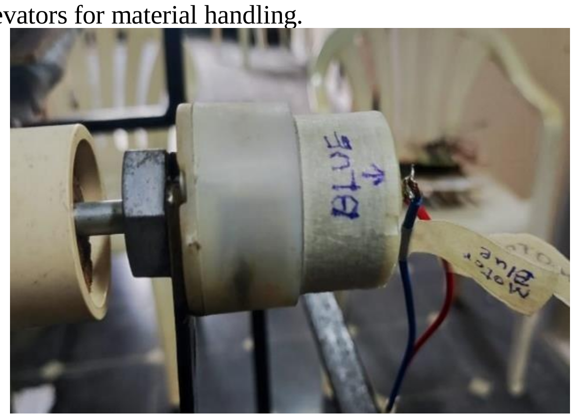


Fig 4.1 DC motor

C. RELAY:

Relays act as switches to manually close or open circuits, connecting and disconnecting two circuits. They come in various types, including electromechanical and solid-state.

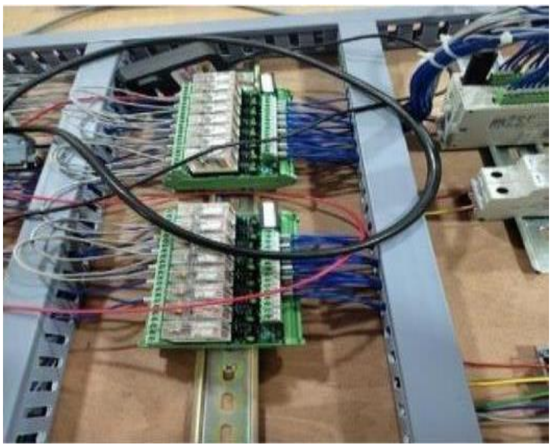


Fig 4.2 Relay

D. PUSH BUTTONS HARDWARE:

Connect the push buttons to the PLC: attach one wire from each button to a different input on the PLC, and connect the other wire of each button to a common ground or power source. When you press a button, it completes the circuit and sends a signal to the PLC, allowing it to respond accordingly—for example, starting or stopping the machine.

Fig 4.3 Green and Red push buttons

E. GREEN INDICATOR CONNECTION:

Link the green indicator to the PLC: connect one wire to an output on the PLC and the other wire to a power source. When the PLC activates the output, the indicator lights up, giving a visual cue—for instance, showing that the machine is ready to run. This simple setup lets operators easily interact with and understand the machine's status.

Fig 4.4 Green Indicator

F. 3/2 DIRECTIONAL VALVE:

A 3/2 directional valve in pneumatics is a basic component used to control the direction of airflow in pneumatic systems. It consists of three ports and two positions. The ports include an inlet for compressed air (usually labeled as P), an outlet for directing air to the pneumatic device (often labeled as A), and an exhaust port (usually labeled as R). In one position, the valve allows airflow from the inlet to the outlet, enabling the pneumatic device to extend or move in one direction. In the other position, it blocks airflow to the outlet and allows the air in the pneumatic device to exhaust through the exhaust port, causing the device to retract or return to its original position. This type of valve is commonly used in various pneumatic applications for controlling the movement of cylinders or other pneumatic actuators.

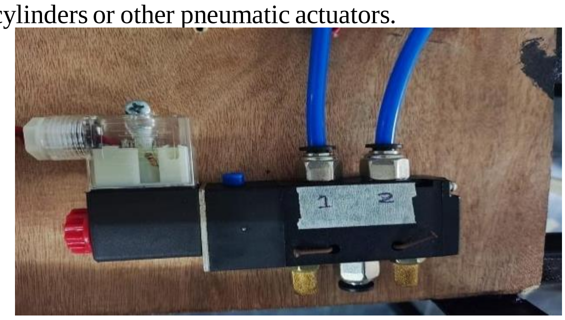


Fig 4.5 3/2 Directional valve

G. SINGLE ACTING CYLINDER:

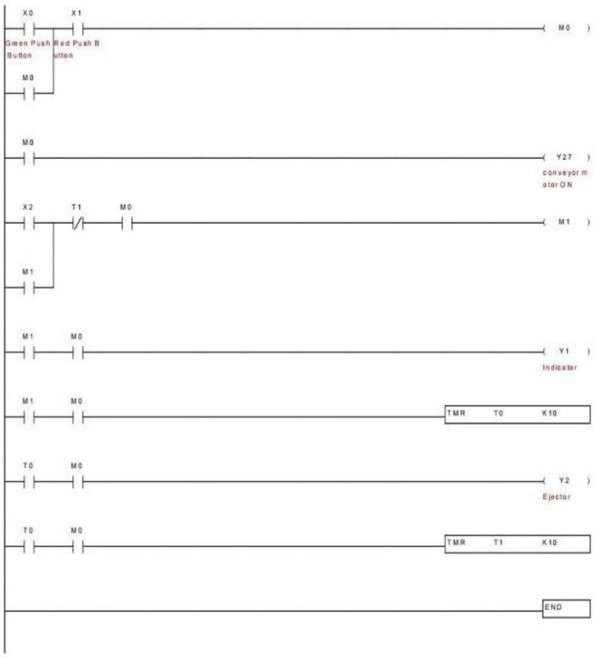
A single-acting cylinder is a type of pneumatic or hydraulic cylinder that operates using fluid pressure to perform work in only one direction. It consists of a cylinder barrel, piston, and a single port for fluid entry or exit. When fluid is pressurized and enters the cylinder, it pushes the piston in one direction, executing mechanical work. This design simplifies the cylinder mechanism and makes it more cost-effective compared to double-acting cylinders, which can exert force in both directions. Single-acting cylinders find common use in applications where work is only required in one direction, such as lifting, pushing, or clamping operations.

Fig 4.6 Single acting cylinder

V. PROPOSED METHOD AND SIMULATION

It is activated when the green push button (X0) is pressed. When X0 becomes active (pressed), it energizes M0, turning it on. and included as a safety measure to ensure that M0 is turned off when the red push button (X1) is pressed. When X1 becomes active (pressed), it de-energizes M0, turning it off. When green push button is pressed then conveyor motor ON, whenever sensor sensed red color then the green indicator lights ON and after one second single acting cylinder turns on with the help of 3/2 directional valve and a second after the punch single acting cylinder comes to actual position. The process continues until the red push button is pressed.

SIMULATION: Ladder diagram is used to execute the above proposed system.



VI. RESULT

The ladder diagram outlines the systematic operation of an automatic color code sensing punching machine, focusing on efficiently identifying and separating red-colored boxes from a conveyor belt. By continuously checking for material presence and activating the color sensor, the system accurately detects the color of each object passing through. Upon identifying a red box, the punching mechanism specific to red boxes is triggered, facilitating their separation from the conveyor. The diagram also incorporates checks for user input and system status, ensuring responsiveness to operator commands and maintaining safety protocols throughout the process. Overall, the ladder diagram provides a structured approach to automate the sorting process, enhancing efficiency and productivity while prioritizing operational control and safety.

The result of executing the ladder diagram is the reliable and automated separation of red-colored boxes, enhancing the efficiency and productivity of the punching machine while ensuring operational safety and control.

Fig 4.7 Sensor detect

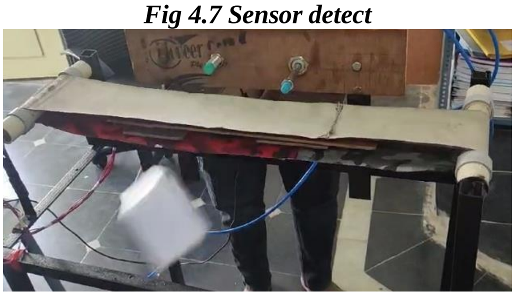


Fig4.8 Punching

VII. CONCLUSION

The ladder diagram presents a clear and structured approach to the operation of an automatic color code sensing punching machine, specifically designed to efficiently separate red-colored boxes from a conveyor belt. Through systematic checks for material presence, color detection, and responsive action based on the identified color, the system ensures reliable and accurate sorting while maintaining operational safety and control. By incorporating user input and system status monitoring, the diagram demonstrates a comprehensive approach to automation, prioritizing efficiency, productivity, and safety in industrial processes. Overall, the ladder diagram serves as a valuable tool for designing, implementing, and optimizing automated sorting systems, contributing to streamlined operations and enhanced performance in manufacturing and logistics environments.

VIII. FUTURE SCOPE

The automatic color code sensing punching machine, as depicted in the ladder diagram, offers a structured approach to efficiently sort red-colored boxes from a conveyor belt. Its systematic checks for material presence, color detection, and responsive action ensure reliable sorting while prioritizing operational safety. Future advancements could include integrating machine learning for improved color recognition and exploring advanced sensor technologies for enhanced adaptability. Additionally, opportunities for automation expansion beyond color-based sorting and integration of robotics present promising avenues for further optimization and increased versatility in industrial automation processes.

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DESIGN AND FABRICATION OF AUTOMATIC PNEUMATIC CLUTCH AND BRAKING SYSTEM

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Abstract— **Pneumatics operation technology now-a - days widely used in all kind work related with compressed air. The knowledge from timber work to robot technology it is used with so advanced and also with automation. It is therefore very essential and important for any technicians or engineers to get a better knowledge of pneumatic system, air operated valves and others. The compressed air from the compressor pass through medium and to the cylinder by a pipe line fabrication. To achieve maximum work done of pneumatic system, it is of importance that pressure drop between generation and consumption of compressed air is kept minimum.**

This project is to develop a control system along with an effective electronic controlled automotive braking and clutch method is called "Automatic pneumatic clutch and braking system". Pneumatic Brake and clutches operated though sensors which with IR transmitter and Receiver unit, Control Unit, and Pneumatic breaking system.

The IR sensor is to find the resisting area and obstacle. If there is any resisting in the passage, the IR sensor senses the proximity and obstacle and giving the control signal to the breaking and clutch system. The pneumatic breaking and clutch system is used to break the vehicle and clutch to shift the gear system.

I. INTRODUCTION

To reduce the speed of the vehicle or to stop **brake** is a common device. This mechanical tool reducing the speed or stopping the movement of an object. By using friction between two contacting surfaces by pressing together, then convert the kinetic to static condition with elevation of some heat. Here one method of energy conversion is employed in this project is Eddy current Eddy current brake is a break used in magnetic fields to change dynamic energy into electric current in the brake unit, which is applied with better efficiency and low power consumption.

Break applying in a very high speed vehicle such as race car or jet aero plane or parachute with gravitational force, Breaks are mainly applied to rotating parts, but it may also be in other forms as the surface of a moving fluid (water or air). In this project eddy current is used to make effective action of break in rotating wheel.

II. WORKING PRINCIPLE

The infrared rays reflected, if any prevention is there in the path. "IR receiver" receives the signal of infra-red rays reflection from the IR transmitter unit which transmits the Infra-Red rays.
The control circuit will get control signal from IR rays which reflects from IR receiver circuit. Solenoid valve will get activation from control circuit. When the solenoid valve is functioned to activate, the compressed air flows to the Double Acting Pneumatic Cylinder. Then the air pressed the pneumatic cylinder to move the piston rod.
The breaking arrangement will function when the piston moves forward and break the wheel slowly or rapidly by moving of piston . "Flow control valve" will vary the breaking speed by adjusting the valve.
In this project, the breaking arrangement is in a wheel as a model. The compressed air from the compressor flow through the hose tube to the flow control valve. The flow control valve is connected to the solenoid valve which control the entire system.

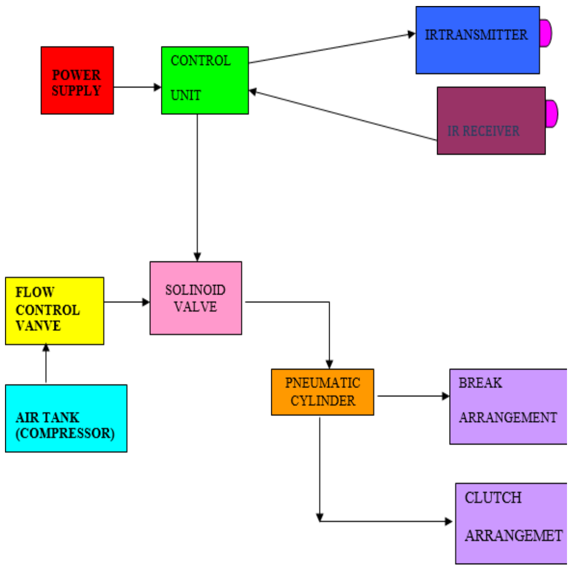

Fig 2.1: Working diagram

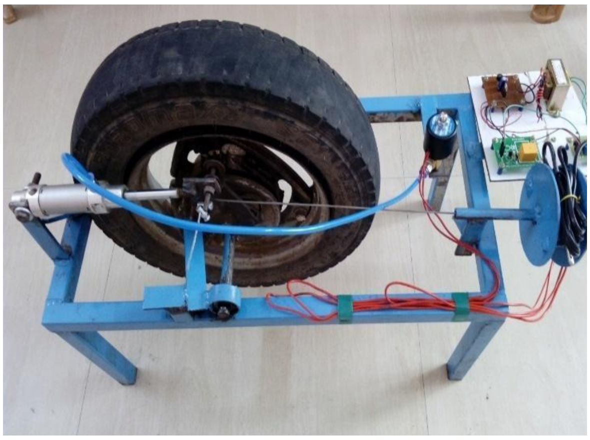

Fig 2.2: Prototype

III. ADVANTAGES

- Comparatively cost is less.
- Free from maintenance.
- Power consumption is very low.
- Assembly is very simple.
- Installation cost is less.
- Less time and more benefit.

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DESIGN AND FEA ANALYSIS OF STEAM BOILER AT DIFFERENT FLOW CONDITIONS

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***Abstract*— A steam boiler is a closed vessel that heats water or another fluid under pressure and then releases steam for use in different heating applications. Thermal design and analysis, design for production, physical dimensions, and cost are the most important factors to consider when designing a boiler for a specific application.**

The steam flow in a steam boiler is modelled in this thesis using CATIA parametric design software. The focus of the thesis will be on thermal and CFD study of various input velocities (10, 25, 35, and 45 m/s).

The heat transfer coefficient, heat transfer rate, mass flow rate, and pressure drop were determined using CFD analysis in this thesis. Thermal analysis to estimate temperature distribution and heat flux for diverse materials such as EN 31 steel, stainless steel 316L, and copper in steam boiler models.

CATIA was used to construct the 3D model, while ANSYS was used to do the analysis.

***Keywords*— CFD analysis, CATIA, ANSYS and velocities.**

I. INTRODUCTION

A Boiler (otherwise called a steam evaporator) is a shut vessel wherein liquid (regularly water) is warmed. The liquid doesn't really bubble. The warmed or disintegrated liquid leaves the evaporator for use in different cycles or warming applications, like cooking, water or focal warming, or kettle based power age. Boilers (or all the more explicitly steam boilers) are a fundamental piece of nuclear energy stations.

A. Working Principle of Boiler

The fundamental working guideline of evaporator is extremely basic and straightforward. The heater is basically a shut vessel inside which water is put away. Fuel (for the most part coal) is singed in a heater and hot gasses are delivered. These hot gasses interact with water vessel where the hotness of these hot gases move to the water and thusly steam is delivered in the kettle.
Then, at that point, this steam is funnelled to the turbine of nuclear energy station. There are various sorts of evaporator used for various purposes like running a creation unit, disinfecting some region, cleaning hardware, to heat up the environmental elements and so forth

B. Steam Boiler Efficiency

The level of all out heat sent out by outlet steam in the complete hotness provided by the fuel (coal) is called steam heater proficiency. It incorporates with warm proficiency, ignition productivity and fuel to steam effectiveness. Steam heater effectiveness relies on the size of kettle utilized. A run of the mill productivity of steam evaporator is 80% to 88%. As a matter of fact there are a few misfortunes happen like inadequate burning, emanating misfortune happens from steam kettle encompassing divider, faulty ignition gas and so forth Subsequently, proficiency of steam evaporator gives this outcome.

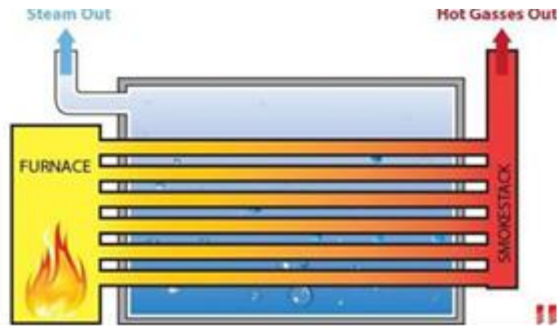


Fig1.1: Steam Boiler

II. LITERATURE SURVEY

Zhongyi Su at.al.[1] completed the contextual investigation on the waste energy usage in enterprises at China. He has completed the examination on the different modern cycles and discovering colossal information for utilized of natural waste again in the businesses. The finish of the review shows that reusing the expected squanders for the creation is attainable. Liang-Chen Wang,et.al.[2]carried out the investigation on the reusability of the energy from the fumes gas calciner for creation of carbon. In this concentrate on the investigation of exhaust is done or creation of carbon with utilized of calciner. The current review intends to foster this technique and a burning model. To show the rightness of the strategy and the model, in view of the information gathered from the functioning calciners, the energy use proportion of a calciner with force of 1250 kW is examined.

Rakesh Jain et.al. [3] Carried out the presentation improvement of a heater through squander heat recuperation from a cooling unit. In this concentrate on the hotness from the cooling unit of the heater is utilized for warming the feed water in kettle. The consequences of the review presumed that productivity of Boiler will increment from 76.33% to 76.53%.

Satish K. Maurya, [4] completed the work on the insightful review on the waste hotness recuperation Combined Ejector and Vapor Compression Refrigeration System. The critical benefit of the consolidated plant is the Financial and affordable perspectives likewise legitimize the hotness recuperation as in the majority of the cases as in a large portion of the cases returns in term of reserve funds are a lot more noteworthy than the speculation costs.

R. Loganathan et.al. [5] Carried out the waste hotness recuperation steam generator in wipe iron plant. The waste hotness in plant is used gas cooler. The aftereffects of the review presumed that around yearly reserve funds will come around 198.79 lakhs which is more than the evaporator cost surmised 180 lakhs.

A. Problem description

The goal of this undertaking is to make a 3D model of the steam heater and study the CFD and warm conduct of the steam evaporator by playing out the limited component analysis.3D demonstrating programming (Favourable to Engineer) was utilized for planning and examination programming (ANSYS) was utilized for CFD and warm investigation.

III. METHODOLOGY

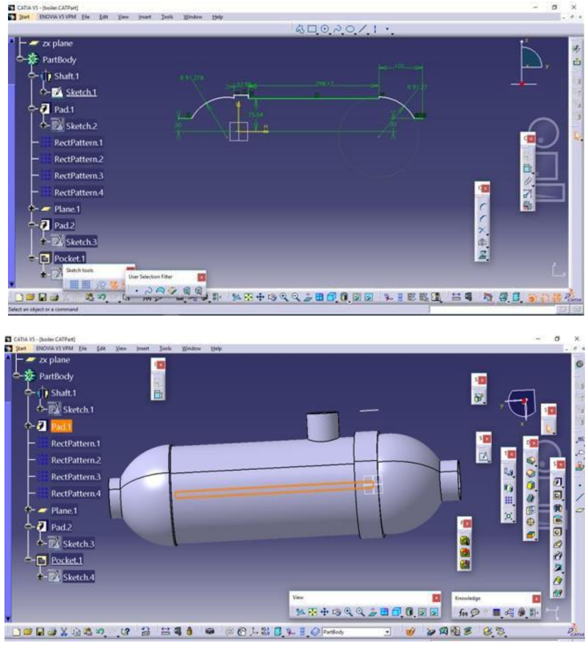
The technique continued in the task is as per the following:

- Make a 3D model of the steam Boiler gathering utilizing parametric programming supportive of designer.
- Convert the surface model into Para strong document and import the model into ANSYS to do examination.
- Perform warm examination on the steam Boiler gathering for warm loads.
- Perform CFD investigation on the current model of the surface steam heater for Velocity bay to discover the mass stream rate, heat move rate, pressure drop.

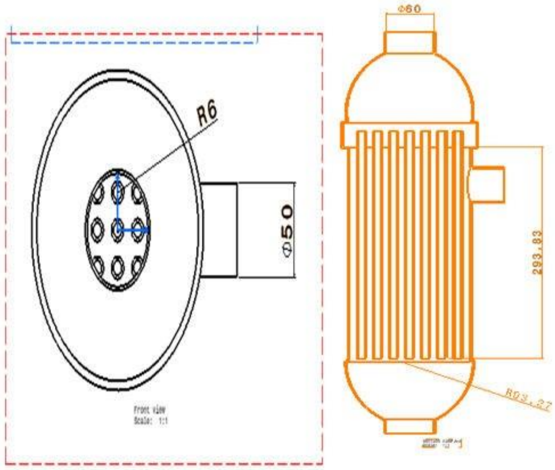
IV. MODELING AND ANALYSIS

Computer-aided design (CAD) is the use of computer systems (or workstations) to help in the creation, alteration, investigation, or upgrade of a structure. PC supported structure writing computer programs is used to grow the productivity of the organizer, improve the idea of arrangement, improve correspondences through documentation, and to make a database for amassing. PC helped configuration yield is normally as electronic records for print, machining, or other gathering assignments. The term CADD (for Computer Aided Design and Drafting) is moreover used. CATIA is a condensing for Computer Aided Three-dimensional Interactive Application. It is one of the fundamental 3D programming used by relationship in different organizations stretching out from flight, vehicle to purchaser things. CATIA is a multi-organize 3D programming suite made by Systems, including CAD, CAM similarly as CAE. Dassault is a French structure mammoth dynamic in the field of flying, 3D structure, 3D progressed bogus ups, and thing lifecycle the officials (PLM) programming.

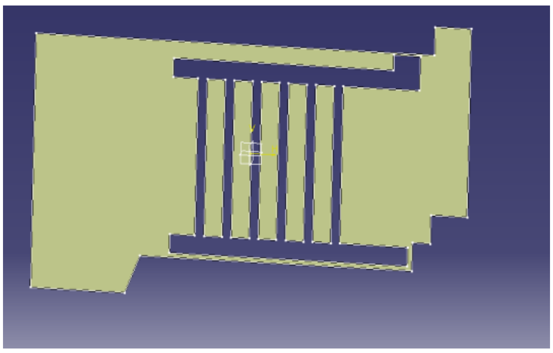
A. 3D Model of steam boiler



B. 2D model of steam boiler



C. Surface model of boiler



FEM/FEA helps in evaluating complicated structures in a system during the planning stage. The strength and design of the model can be

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improved with the help of computers and FEA which justifies the cost of the analysis. FEA has prominently increased the design of the structures that were built many years ago.

D. CFD

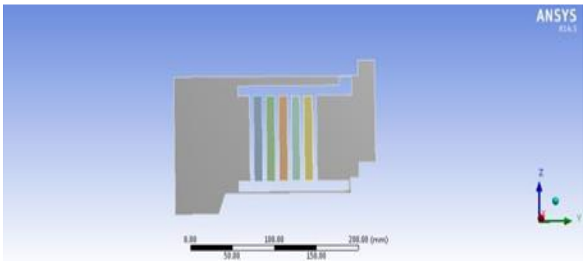
Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows.

V. CFD ANALYSIS OF STEAM BOILER

A. Geometry

Steam boiler is built in the ANSYS workbench design module. It is a counter-flow Steam boiler. First, the fluid flow (fluent) module from the workbench is selected. The design modeler opens as a new window as the geometry is double clicked.

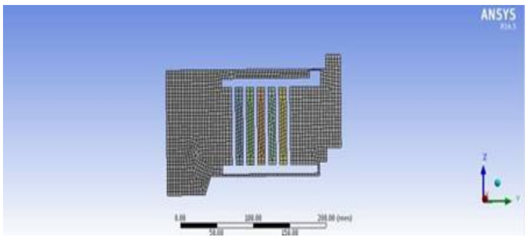
B. Imported model

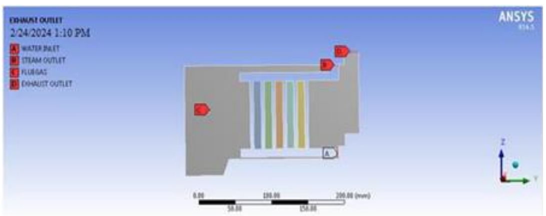


C. Meshing

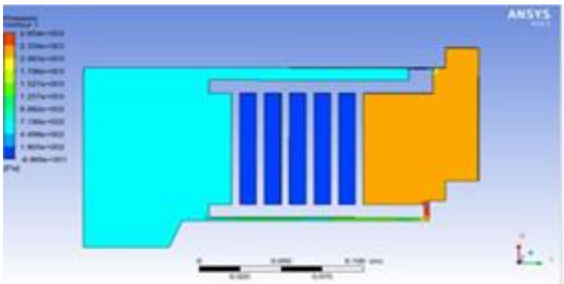
The model is designed with the help of CATIA and then import on ANSYS for Meshing and analysis. The analysis by CFD is used in order to calculating pressure profile and temperature distribution. For meshing, the fluid ring is divided into two connected volumes. Then all thickness edges are meshed with 360 intervals. A tetrahedral structure mesh is used. So the total number of nodes and elements is 6576 and 3344.Steam boiler model after Meshing

Inlet velocity-4.8 m/s

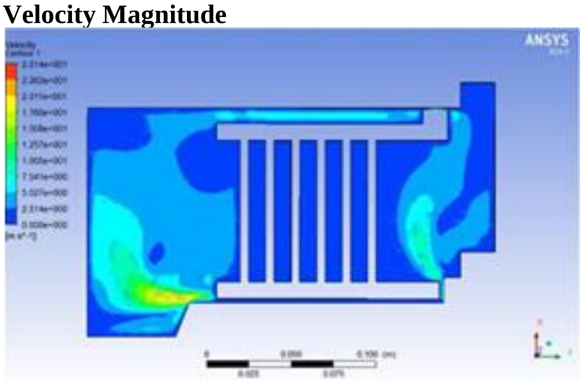




Static Pressure



Velocity Magnitude



Mass flow rate

Mass Flow Rate	(kg/s)
interior-fluegas	23.602331
interior-split.2_	0
steam_outlet	-0.47910237
wall-fluegas	0
wall-split.2_	0
water_inlet	0.67500001
Net	0.19589764

Heat transfer rate

Total Heat Transfer Rate	(w)
steam_outlet	-143318.86
wall-fluegas	0
wall-split.2_	-0.0010746096
water_inlet	224623.13
Net	81304.265

VI. THERMAL ANALYSIS OF STEAM BOILER

Used Materials steel, copper, brass & stainlesssteel

A. Copper material for tube

EN 31 Steel, brass & stainless steel 316L for boilercasing

B. Copper material properties

Thermal conductivity = 385w/m-k
Specific heat = 0.385j/g^{0}C
Density = 0.00000776kg/mm^3

C. Steel material properties

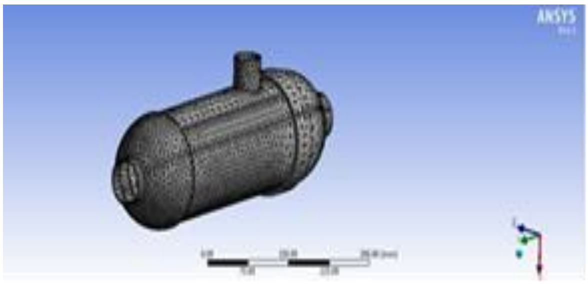
Thermal conductivity = 93.0w/m-k
Specific heat = 0.669j/g^{0}C
Density = 0.0000075kg/mm^3

Stainless Steel material properties

Thermal conductivity = 34.3w/m-k
Specific heat = 0.620j/g^{0}C
Density = 0.00000901kg/mm^3

Imported Model

A. Meshed model

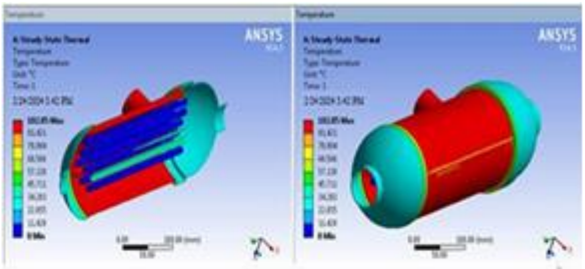


Finite element analysis or FEA representing a real project as a “mesh” a series of small, regularly shaped tetrahedron connected elements, as shown in the above fig.And then setting up and solving huge arrays of simultaneous equations. The finer the mesh, the more accurate the results but more computing power is required.

B. Boundary Conditions

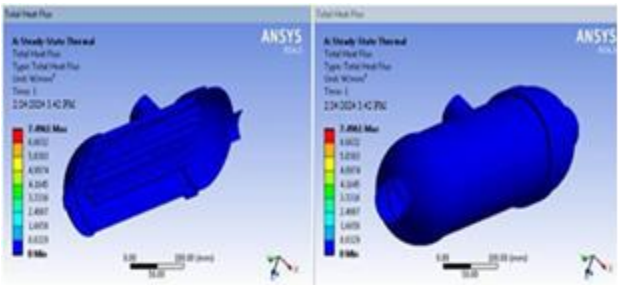
MATERIAL- STEEL FOR BOILER CASING, COPPER FOR TUBES

Temperature

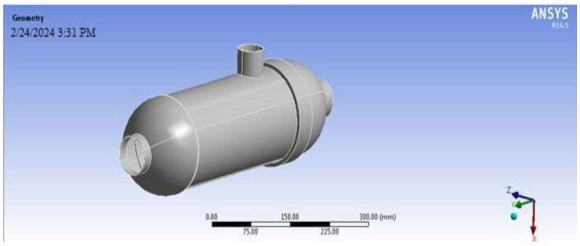


According to the contour plot, the temperature distribution maximum temperature at tubes because the steam passing inside of the tube. So we are applying the temperature inside of the tube and applying the convection except inside the tubes. Then the maximum temperature at tubes and minimum temperature at steam boiler casing.

Heat flux



According to the contour plot, the maximum heat flux at inside the tubes because the steam passing inside of



the tube. So we are applying the temperature inside of the tube and applying the convection except inside the tubes. Then the maximum heat flux at inside the tubes and minimum heat flux at steam boiler casing and outside of the tubes.

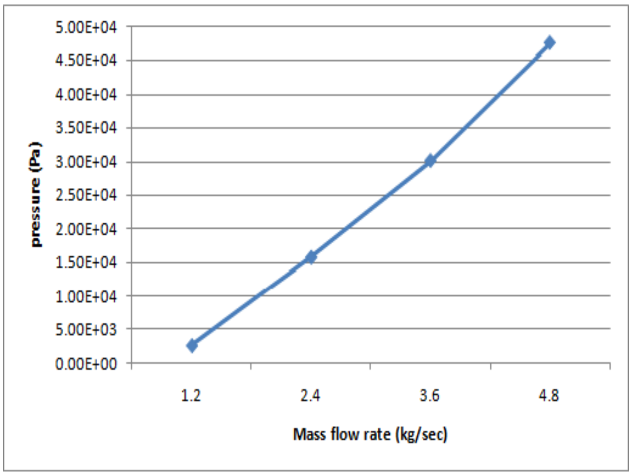
According to the above contour plot, the maximum heat flux is 7.496 w/mm^2 and minimum heat flux is 0.8329 w/mm^2.

VII. RESULT TABLES

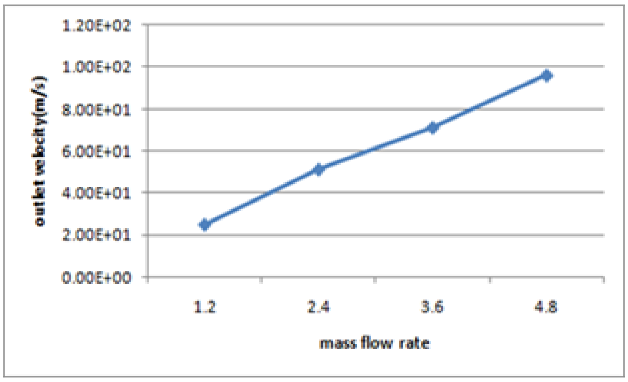
Velocity (m/s)	Pressure (Pa)	Velocity (m/s)	Massflow rate (kg/s)	Heat transfer Rate(W)
1.2	2.60e+	2.51e	0.04368	21681.53
	03	+01		2
2.4	1.58e+	5.14e	0.11344	52773.63
	04	+01		2
3.6	3.02e+	7.13e	0.15603	9596.454
	04	+01		
4.8	4.76e+	9.62e	0.19589	81304.16
	04	+01		5

Thermal Analysis Result Table

Materials	Temperature (°C)	Heat flux
Mild steel	102.85	7.4961
Stainless steel 316L	103.04	19.821
Copper	103.17	49.672

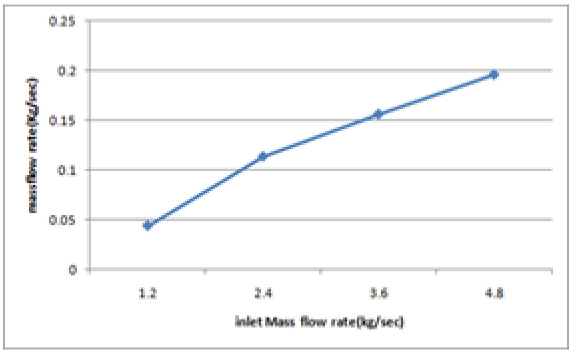


A plot between maximum pressure and velocities by FEA approach is shown in above fig. From the plot the variation of maximum static pressure is observed. Maximum static pressure increases with increases in velocities.

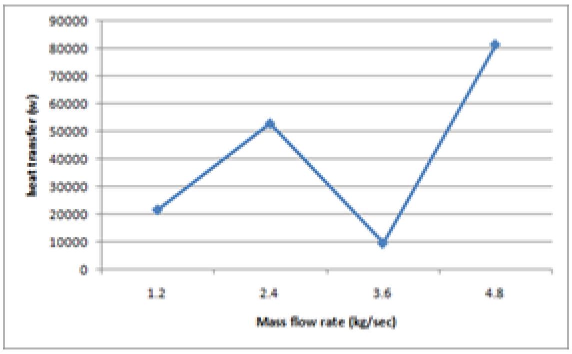


A plot between maximum velocity and velocities by FEA approach is shown in above fig. From the plot the variation of maximum static velocity is observed. Maximum velocity increases with increases in velocities.

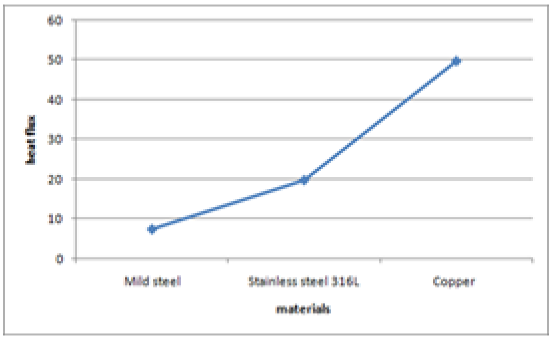
Mass Flow Rate Plot



A plot between maximum mass flow rate and velocities by FEA approach is shown in above fig. From the plot the variation of maximum mass flow rate is observed. Maximum mass flow rate increases with increases in velocities.



A plot between maximum heat transfer rate and velocities by FEA approach is shown in above fig. From the plot the variation of maximum heat transfer rate is observed. Maximum heat transfer rate increases with increases in velocities.



A plot between maximum heat flux and velocities by FEA approach is shown in above fig. From the plot the variation of maximum heat flux is observed. Maximum heat flux increases with increases in velocities. Heat flux value is decreases steel than stainless steel &copper.

VIII.CONCLUSION

In this thesis, the steam boiler is modelled using CATIA design software. The thesis will focus on thermal and CFD analysis with different velocities (10, 25, 35& 45m/s). Thermal analysis done for the steam boiler by steel, stainless steel& copper.

By observing the CFD analysis the pressure drop, velocity, heat transfer coefficient, mass flow rate & heat transfer rate increases by increasing the inlet velocities.

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COMPARATIVE STUDY OF S1223RTL AIRFOILS WITH NACA0012 AIRFOIL

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Abstract— **Analysis on the airfoil profile is carried out to find the values of coefficient of lift (CL) and coefficient of drag (CD) at different values of angle of attack and also aerodynamic forces acting up on an airfoil. In this work to perform analysis two airfoils are taken via NACA0012 and a bio inspired airfoil S1223RTL is taken from the albatross the earth's largest sea bird. XFLR5 is an analysis tool for airfoils, wings and planes operating at low Reynolds number. Xfoil's is direct and inverse analysis capabilities software. This study presents a comparative analysis between the standard NACA 0012 and the modified S1223RTL airfoils, focusing on aerodynamic performance under varying Reynolds numbers. Utilizing computational fluid dynamics (CFD) simulations the aerodynamic characteristics of both airfoils were evaluated across a range of angles of attack and Reynolds numbers at low-speed flight conditions. The results have highlighted significant differences in lift, drag, and stall behavior between the two airfoil designs. While the NACA 0012 exhibits symmetrical performance and predictable aerodynamic behavior, the S1223RTL demonstrated enhanced lift generation and reduced drag, particularly at lower Reynolds numbers.**

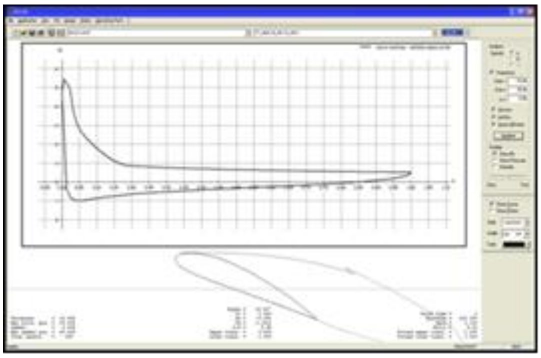
I. INTRODUCTION

An air foil is a streamlined shape designed to produce lift as it moves through a fluid, typically air. It's a crucial component of aircraft wings, propeller blades, and turbine blades. The shape of an air foil is characterized by its cross-sectional profile, which includes characteristics like curvature, thickness, and camber. NACA (National Advisory Committee for Aeronautics) air foils are a series of air foil shapes developed by the NACA in the early to mid-20th century. These air foils are identified by a numerical designation that describes their shape. The NACA 0012, for example, indicates an air foil with 0% camber, 0% nose radius, and 12% thickness-to-chord ratio. S1223RTL is a specific type of air foil designed by the University of Illinois at Urbana-Champaign. It belongs to the Eppler air foil series and is optimized for low Reynolds number flow, which is typical for small-scale aircraft like drones or model airplanes. The "S" likely stands for Selig, one of the researchers involved in its development. The numbers denote specific characteristics of the air foil, such as thickness, camber, and other design parameters.

II. SOFTWARE REQUIRED

XFLR5 is an analysis tool for airfoils, wings and planes operating at low Reynolds Numbers. It includes: XFoil's Direct and Inverse analysis capabilities. Wing design and analysis capabilities based on the Lifting Line Theory, on the Vortex Lattice Method, and on a 3D Panel Method.

Xfoil is probably the best known of the above codes. It dates back to 1986 and was written by Dr. Mark Drela, an aerodynamics professor at the Massachusetts Institute of Technology. It uses a high-order panel method and a fully-coupled viscous/inviscid interaction method to evaluate drag, boundary layer transition and separation. Xfoil is widely used in the aircraft industry and generally speaking is a reliable tool, although, in the view of this author, it suffers from a poor user interface when compared to many other codes. The user of modern computer operating systems is averse to the unfriendly interfaces of the bygone MS-DOS era. This has been solved in a program called XFLR5 [18], developed by Mr. André Deperrois, which makes Xfoil analyses much easier to perform (see Figure)



Xfoil allows the user to perform viscous and inviscid analysis of existing airfoils. The user can specify where a laminar boundary layer transitions into a turbulent one, or have the program predict the movement of the transition point with AOA. The viscous analysis can be used to predict Cl, Cd, and Cm to just beyond Clmax, and uses Karman-Tsien compressibility correction at high subsonic airspeeds (see Section 8.3.6). The program allows the user to simulate control surface deflection by specifying hinge point and deflection angle.

Method Used in Xflr5

- XFOIL 2D airfoil analysis with 3D wing analysis based on the Lifting Line Theory (LLT).
- Vortex Lattice Method (VLM).
- 3D Panel Method

III. METHODOLOGY

- Foil Design
- XFoil Direct Analysis
- Wing And Plane Design

CALCULATION

Reynolds Number Calculation for NACA 0012 & S1223RTL Air foil.

Reynolds number (R) = ρ V L /μ
Were
The density of the fluid (ρ) = 1.245 kg/m3
The dynamic viscosity of the fluid (μ) = 1.460 kg/ms
The characteristics length, the chord width of an air foil (L) = 1 m
V = Velocity of the fluid

Here Reynolds change is depended on velocity of air foil is taken in range between 25-45 m\s. the velocities are 25, 30, 35 & 40 m\s.

R = ρ V l \ μ
= (1.245×25×1) \ (1.460×10-5) = 2131849.31506
= (1.245×30×1) \ (1.460×10-5) = 2558219.17808
= (1.245×35×1) \ (1.460×10-5) = 2984589.04109
= (1.245×40×1) \ (1.460×10-5) = 3410958.90410

IV. RESULTS

Direct Foil Analysis

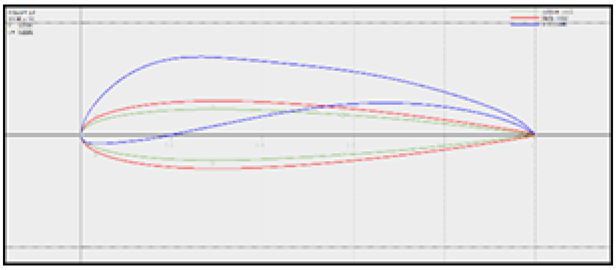


Fig: 2D Airfoil of NACA 0012 and S1223RTL

We can observe from the figure 5.1 i.e., 2-Dimensional representation of NACA 0012 and S1223RTL Xfoil Direct Analysis. We note that the foil as Observed that red line indicates NACA 0012, blue line indicates S1223RTL Air foil. For NACA 0012 there is no chamber i.e., zero camber is present and lift produced is also zero, S1223RTL has Positive camber at zero angle.

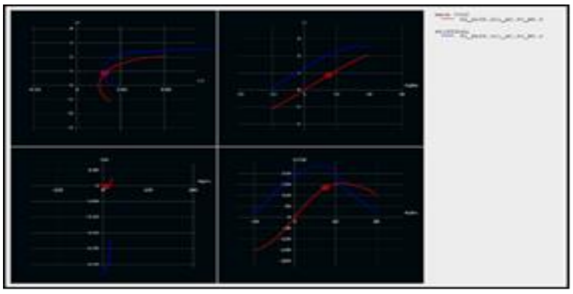


Fig: Graph of C_L, C_D & Angle of attack

The 4 graphs represent coefficient of lift, coefficient of drag and Angle of attack relation of NACA 0012 and S1223RTL.

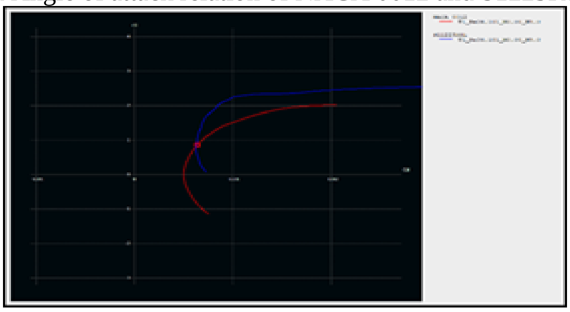


Fig: C_L vs C_D

The lift and drag of a NACA 0012 symmetric air foil is compared with the S1223RTL, lift and drag of air foil is depended on the angle of attack (α). Here the taken angle of attack is in the range of -10⁰ to 20⁰. It is observed that lift and drag of S1223RTL air foil is higher than NACA 0012. The red graph indicates with the help of drag polar theory, we can see that the distance at the edge of graph towards the cl graph is long which indicates the uncambered section. The drag curve or drag polar is the relationship between the drag on an aircraft and other variables, such as lift, coefficient of lift, angle of attack or speed. Blue graph which producing lift & drag from 00 to positive sign.

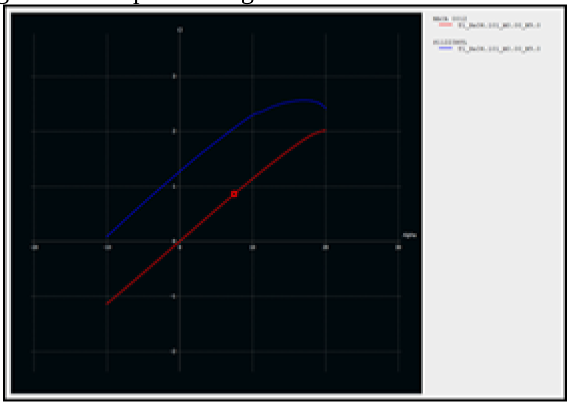


Fig: C_L Vs Alpha

Lift of an airfoil is mainly based on angle of attack; coefficient of lift is directly to angle of attack. From the above graph red line indicates NACA 0012 airfoil and blue lines indicates S1223RTL airfoil. NACA 0012 produce 0 lift at α=0, producing of lift is above 00 (upward lift is produced between 0 to 200 angle of attack) and when α is negative it produces lift but in opposite direction and 2.015 CL value with 40 m\s air flow. In NACA 0012 CL is gradually increases with angle of attack(α). S1223RTL has high lift coefficient ratio as compared to NACA foil, by the graph S1223RTL produces 1.265 when α=0. At the end a curve denotes slight fall in the coefficient of lift.

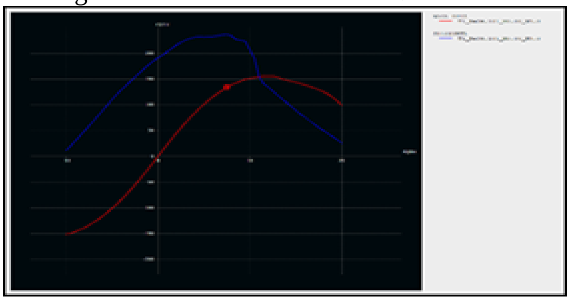


Fig: C_L/C_D Vs Alpha

The NACA 0012 and the S1223RTL are two different types of airfoils, which are the cross-sectional shapes of the wings of aircrafts. The NACA 0012 is a symmetric airfoil, meaning that its upper and lower surfaces are identical. The S1223RTL is a cambered airfoil, meaning that its lower surface is convex and its upper surface is concave. The camber of an airfoil affects its lift and drag characteristics, which are also dependent on the angle of attack, which is the angle between the airfoil's chord line and the direction of the airflow.

The lift and drag coefficients of an airfoil are dimensionless numbers that measure the amount of lift and drag forces per unit area and per unit dynamic pressure. The lift coefficient (CL) is proportional to the angle of attack (α) up to a certain point, called the stall angle, beyond which the lift coefficient decreases sharply due to flow separation. The drag coefficient (CD) is composed of two components: the parasitic drag, which is due to skin friction and form drag, and the induced drag, which is due to the generation of lift and the formation of wingtip vortices. The parasitic drag increases with the square of the airspeed, while the induced drag decreases with the square of the airspeed.

Wing Design

NACA 0012 Airfoil

The NACA 0012 airfoil stands as a fundamental element in aerodynamic research, particularly when Analysis under low Reynolds numbers and airflow velocities ranging between 25 to 40 m\s. This symmetrical airfoil shape, characterized by its 12% thickness-to-chord ratio, is subjected to a comprehensive analysis spanning a wide range of angles of attack, from -10 to 20 degrees.

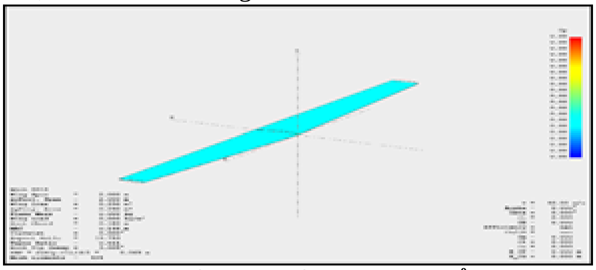


Fig: Lift & Drag of NACA 0012 at 0^0

Wing design of NACA 0012 at α = 0 it produces 0 lift & drag. At this angle, the airflow over the upper surface and lower surface of the airfoil is symmetric, resulting in no lift.

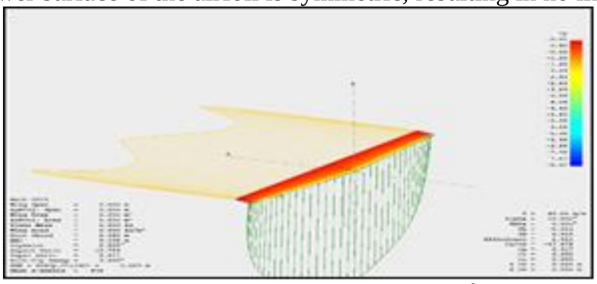


Fig: Lift & Drag of NACA 0012 at -10^0

Green lines represent coefficient of lift and orange lines Induced drag, CL produced by NACA 0012 at -100 is -0.919 and cd= 0.019. at α=-10 Cp of airfoil is high as it shown in figure.

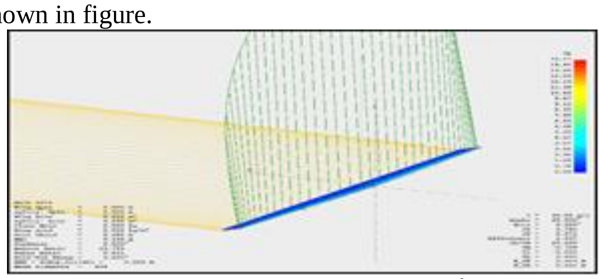


Fig: Lift & Drag NACA 0012 at 20^0

After 0 to 200 Angle of attack upward CL is produced, in NACA 0012 CL is gradually increases with angle of attack(α). Pressure (Cp) to surface of airfoil is range of 0.03-1.54.

S1223RTL Airfoil

The albatross is the largest seabird in the world, with a wingspan ranging from 6.5 to 11 feet (2 to 3.5 meters). The albatross can fly for long distances and durations without flapping its wings, using a technique called dynamic soaring. Dynamic soaring is a flying technique where a glider, either a bird or a machine, extracts its propulsive energy from non-uniform horizontal winds such as those found over the oceans. Albatrosses, the archetypal dynamic soarers, have been recorded to travel 5000 km per week while relying on wind energy alone.

The basic mechanism of dynamic soaring is as follows:

The albatross dives downwind into the boundary layer, where the wind speed is lower, and gains speed due to gravity. The albatross turns across the wind and flies upwind, gaining altitude and losing speed. The albatross climbs above the boundary layer, where the wind speed is higher, and gains speed due to the wind gradient. The albatross turns downwind and flies with the wind, losing altitude and gaining speed. The albatross repeats the cycle, gaining more energy than it loses in each loop. By using dynamic soaring, the albatross can achieve high speeds and gliding ratios, and minimize the metabolic cost of flight. The albatross also uses slope soaring, which is another technique that exploits the vertical component of the wind over waves or terrain, to gain additional lift and energy. The albatross is well adapted for soaring flight, with long and narrow wings that reduce drag and increase lift, and a locking mechanism in the shoulder joint that allows the wings to be held outstretched without muscle effort.

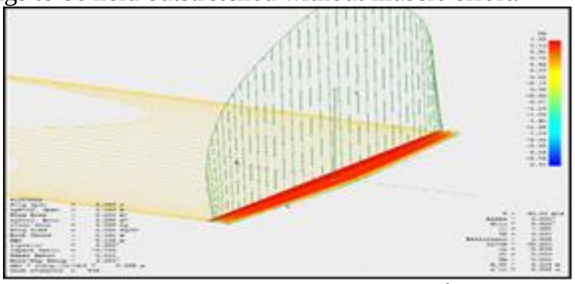


Fig: Lift & Drag of S1223RTL at 0^0

When the S1223RTL airfoil operates at an angle of attack (α)=0, the aerodynamic forces acting upon it are characterized by a balanced distribution of lift and drag. At this neutral position, airflow over the airfoil's surface is symmetrical, resulting in minimum lift produced. However, despite the absence of lift, the airfoil still experiences some drag due to skin friction and pressure differences between the upper and lower surfaces, the values of CL and CD are 1.088 & 0.28 respectively.

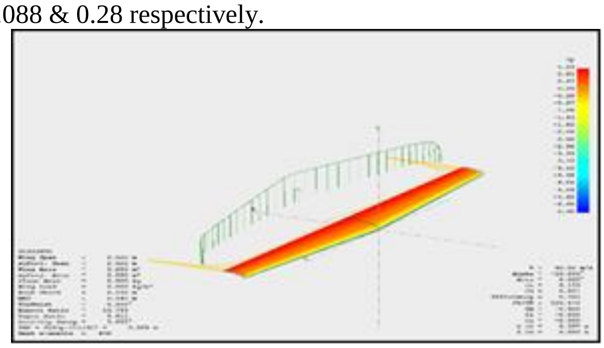


Fig: Lift & Drag of S1223RTL at -10^0

When the S1223RTL airfoil operates at an angle of attack (α)= -100, the aerodynamic forces acting upon it are characteristics undergo a change compared to the neutral position. In negative angle of attack, it generates small amount of lift. Air pressure (Cp) applied on surface on the foil is more.

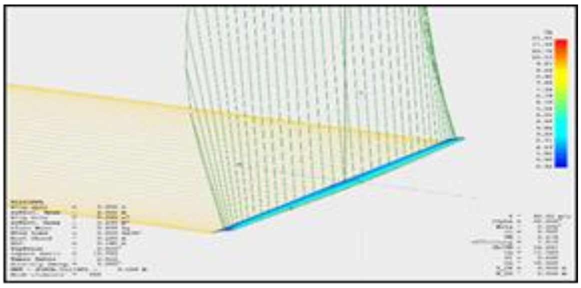


Fig: Lift & Drag S1223RTL at 20

Positive angle of attack produces high CL & CD and pressure applied is minimum.

By analysis the maximum CL produced by the Airfoil's in four cases are given below.

Diff. Reynolds no.	Angle of attack (α)		Co-efficient of Lift (C_L)	
	NACA 0012	S1223RTL	NACA 0012	S1223RTL
2.13185e+06	17	16.5	1.582	2.519
2.55822e+06	18	15	1.602	2.514
2.98459e+06	18	15	1.651	2.513
3.4101e+07	20	17	2.015	2.557

V. CONCLUSION

In this comparative analysis of the Standard NACA 0012 and S1223RTL airfoils conducted using XFLR5 Software and varying Reynolds number, several key findings have emerged. Firstly, the aerodynamic performance of both airfoils was evaluated across a range of Reynolds number characteristic of low-speed flight condition. The results indicate distinct difference in the Lift and Drag behaviour of two airfoil designs. The S1223RTL airfoil demonstrated superior performance compared to Standard NACA 0012 airfoil in terms of lift generation and drag reduction. The project mainly aims to investigate the Coefficient of Lift and Coefficient of Drag characteristics of NACA 0012 and S1223RTL airfoil across a range of angle of attack (α) between -10 to 20 degrees in the speed limits are 25, 30, 35 & 40. Due speed limits are taken from the albatross bird (French and British researchers working in the sub-Antarctic recorded a grey-headed albatross flying an average 78.9 mph i.e., 127 km/h (35.2778 m/s) during a foraging trip.) The NACA 0012 airfoil is one of the most widely used airfoils in the aerospace industry due to its high lift-to-drag ratio and low drag coefficient, due symmetrical profile CL & CD are gradually increasing. Equal and same lift is generated during its positive and negative Angle of attack, at point α =0=CL≠CD. The S1223RTLairfoil is a modified airfoil design that exhibits specific characteristics, due to its airfoil shape albatross wing provides high lift. S1223RTL can generate minimum lift at 0 angle of attack, the drag parameter is gradually increasing as increase in angle of attack. However, it is important to note that the specific performance characteristics observed may vary depending on factors such as angle of attack, airfoil geometry, and Reynolds number range. Further studies incorporating additional parameters and refined analysis techniques could provide deeper insights into the comparative performance of these airfoils.

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[7] J. Gordon Leishman, D.Sc. (Eng.), Ph.D., F.R.Ae.S. Distinguished Professor of Aerospace Engineering, ERAU, Daytona Beach, FL. Professor Emeritus of Aerospace Engineering, University of Maryland, College Park, MD. Introduction to Aerospace Flight Vehicles.

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Performance of A Finned-Tube Evaporator Optimized for Different Mixed Refrigerants on System Efficiency

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Abstract— **An air conditioner (AC) in a room or a vehicle works by gathering hot air from a given space, handling it inside itself with the assistance of a refrigerant and a lot of coils and afterward discharging cool air into a similar space where the hot air had initially been gathered. An evaporator is use in an air-conditioning system or refrigeration system to allow a compressed cooling chemical, such as Freon or R-134A, to evaporate from liquid to gas while enthralling heat in the process. It is also use to remove water or other liquids from mixtures.**

In this project, The isotropic mixture of R134A & R160 we are taken, R134A As a base fluid mixing with R160 with concentrations of 0%, 20%, 40%, 60%, 80% and 100% and it is used in a Refrigeration unit with different flow rates by fixing the other input parameters such as a pressure and temperatures are constant in evaporator.

The fin tube evaporator is modeled in 3D modeling software CATIA. The fins considered are rectangular fin, Hexagonal Fin and circular fin. The mass flow rate and heat transfer rate are analyzed by using CFD technique in ANSYS software. Thermal analysis conducted on evaporator with different materials such as aluminum alloy 7475, copper and brass.

Key words---CFD, Thermal, CATIA, Fin, aluminum alloy 7475.

I. INTRODUCTION

An evaporator is a device that is used to transfer a chemical substance from its liquid state to its gaseous state (vapor). The liquid is evaporated, or vaporised, into a gas form of the desired component in this procedure. In a closed compressor-driven liquid coolant circulation system, an evaporator is a sort of radiator coil. This is alluded to as a cooling framework (A/C) or refrigeration framework since it permits a packed cooling compound, for example, R-

22 (Freon) or R-410A, to vanish/disintegrate from fluid to gas inside the framework while engrossing warmth from the encased cooled region, like a cooler or indoor rooms. This works in the shut A/C or refrigeration framework with a condenser radiator curl that trades the warmth from the coolant, for instance, into the general climate An alternate sort of evaporator can be utilized to warm and conceivably heat up an item that contains a fluid all together for the fluid to dissipate. Water or different fluids can be eliminated from fluid based blends utilizing the right system. Vanishing is ordinarily used to think fluid food sources like soup or to spread the word about concentrated milk as "dense milk," which is made by dissipating water from milk. The motivation behind vanishing in the fixation cycle is to dissipate most of the water from an answer containing the ideal item.

A. *Finned Evaporators*

Finned evaporators are uncovered cylinder evaporators that have been covered with balances. It is important that there is acceptable contact between the curl and the blades for balances to be viable. Balances are bound straightforwardly to the loop's surface in specific conditions, and blades are just positioned over the outside of cylinders or curls in others. Finned evaporators are found in basically a wide range of forced air systems, including window, split, bundled, and focal cooling. The cooling coi in this framework is a finned evaporator's. The warmed air is cooled by going through a finned evaporator. Inward balances are added to the tubing to work on the productivity of warmth move from the evaporator. These blades are made by delivering fluctuated inward cross area structures while tubing is being produced.

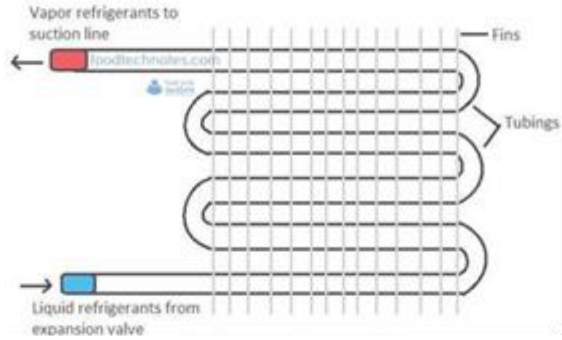


Fig 1: finned tube evaporator

B. *Refrigerants*

R134a Refrigerant is a normal refrigerant that is utilized in an assortment of cooling applications and comes in blue chambers. R134a has little ozone exhaustion potential and has a low nursery impact because of its characteristics as a HFC (hydro fluorocarbon) refrigerant. R134a is a phenomenal substitute for R12, which has been utilized in an assortment of uses.

1) *Properties*

Density = 1326.6 kg/m3
Specific heat = 1043.0 j/kg/k
Thermal conductivity = 0.0042 w/m-k
Viscosity = 0.000279 kg/m-s

R-410C is a refrigerant comprised of a combination of hydro fluorocarbons. It's a combination of difluoromethane (R-32), pentafluoroethane (R-125), and 1,1,1,2-tetrafluoroethane with azeotropic properties (R-134a). Difluoromethane is utilized to give heat limit, though pentafluoroethane is utilized to reduce combustibility and tetrafluoroethane is utilized to bring down pressure. Consumed orange is the shade of R-410C chambers.

R22a could be a substitution for R22, perhaps the most predominant hydrocarbon refrigerants available, despite the fact that it should be eliminated because of ozone layer concerns. The EPA, then again, offers a rundown of naturally reasonable options on its site, and it firmly goes against the utilization of R22a.

II. LITERATURE SURVEY

Mota-Babiloni et al. [1] and UNEP [2] HFC refrigerants were listed among the chemicals that contribute to global warming. Consequently, a treaty was signed by the United Nation members to limit

The use of HFCs and phase out HFCs by developed countries in 2020 and completely phase out HFCs in 2030 worldwide. Currently, the use of HFCs in domestic VCRS has been phased out completely in Europe. Since then, an effort has been geared towards the use of natural refrigerants in the refrigeration system. Hydrocarbon refrigerants have been adopted as of the refrigerants and Isobutene (R600a) is one of them. Numerous researchers have made effort to replace and improve the performance of hydrocarbon refrigerant in VCRS

Agrawal et al. [3], Kasaeian et al. [4] and Oyedepo et al. [5] they all concluded that hydrocarbon refrigerants can serve as substitutes to R12 and 134a in vapour compression system. The energy demand associated with refrigeration systems has made researchers think about new technology to enhance the energy efficiency of the refrigeration system Di Battista and Cipollone [6] through the introduction of nanotechnology. The two popular methods of introducing nanoparticles in refrigeration systems: one is by dispersing it in the base refrigerant while the other is by dispersing the nanoparticles in the base lubricant, this result into nanolubricant which eventually mix with the refrigerant in refrigeration system in operation. The application of nanotechnology in refrigeration systems is new and has started gaining attention.

Rasheed et al. [7]. Graphene is capable of reducing friction energy consumption and also have good anti- wear properties when being used either as additives in lubricants Gupta et al. [8] and Mao et al. Zhao et al. [9]. The use of graphene nanoparticles as additives in the lubricant is gaining swift attention from researchers. However, the properties of nanoparticles that affect the performance refrigerant in refrigeration system depend on chemical and physical properties such as nanoparticles size, shape and concentration of the nanoparticles in the base lubricant. Some researchers have reported on the use of nanoparticles as additives in lubricating oil.

A. METHODOLOGY

- Go over the review of the literature.
- Using CATIA parametric software, construct a 3D model of the evaporator.
- R134A, R22A, and R410C are among the fluids available.
- Calculate thermal loads using CFD and thermal analysis on the evaporator assembly.

B. PROBLEM DESCRIPTION

This project's goal is to create a 3D model of the evaporator and use finite element analysis to investigate the evaporator's CFD and thermal behaviour. Designing was done with CATIA 3D modelling software, while CFD and thermal analysis were done with ANSYS analysis software.

III. MODELING AND ANALYSIS

The utilization of program to make an item or an article is known as PC supported plan (CAD). The utilization of program and innovation to design, sort out, and control the exercises of an assembling plant is known as PC supported assembling (CAM). PC Aided Engineering (CAE) is the utilization of program to tackle designing issues and look at CAD- made items. PC Aided Three-dimensional Interactive Application (CATIA) is an abbreviation for Computer Aided Three-dimensional Interactive Application. It is a mainstream 3D demonstrating program utilized by organizations in an assortment of enterprises, including aviation, cars, and buyer products. Dassault Systems' CATIA is a multi-stage 3D programming suite that incorporates CAD, CAM, and reproduction.

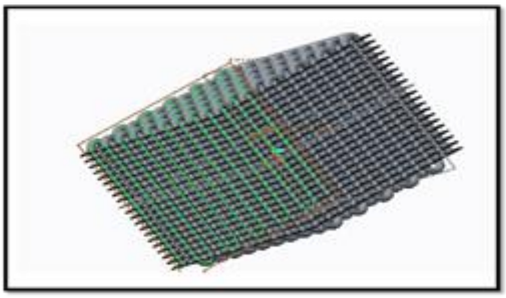
A. ANSYS

ANSYS is a limited component examination (FEA) programming suite that might be utilized for an assortment of utilizations. Limited Element Analysis (FEA) is a mathematical methodology for separating an enormous framework into little (client characterized) parts called components. The product makes a careful clarification of how the framework capacities in general by executing conditions that direct the conduct of different components and settling them by and large.

The impacts of consistent warm loads on a framework or segment are determined utilizing consistent state warm investigations. Prior to playing out a transient warm investigation, clients often play out a consistent state study to help make gauge conditions. A consistent state study can likewise be utilized as the last phase of a transient warm investigation, after all transient impacts have died down. Temperatures, warm slopes, heat stream rates, and warmth transitions in a thing initiated by warm loads that don't shift over the long run can be determined utilizing ANSYS.

Computational liquid elements (CFD) is a part of liquid mechanics that settles and investigations issues including liquid streams utilizing mathematical techniques and calculations. The calculations important to demonstrate the collaboration of fluids and gases with surfaces characterized by limit conditions are performed on PCs. Better arrangements are conceivable with high velocity supercomputers. Momentum research is yielding programming that expands the precision and speed of troublesome reproduction situations like transonic or violent streams. The underlying trial approval of such programming is done in an air stream, with full-scale testing giving a definitive affirmation.

B. 3d Model of Evaporator



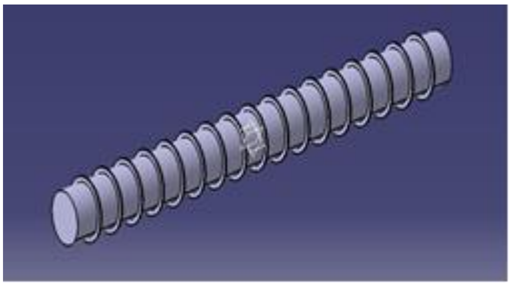


Fig: 2 Evaporator circular finned tube

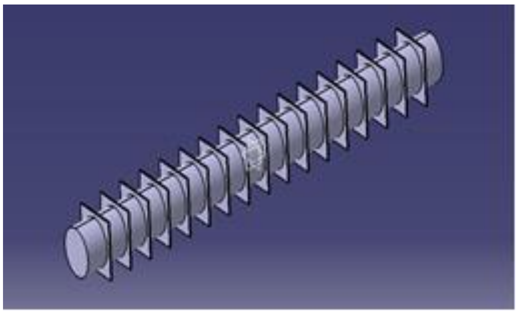


Fig: 3 Rectangular finned tube evaporator

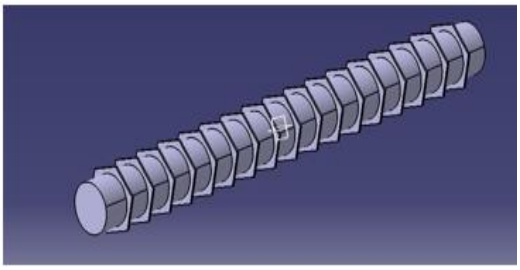


Fig:4 3d Model of hexagonal Finned Tube Evaporator

IV. RESULTS AND DISCUSSION

A. CFD Analysis of Finned Tube Evaporator

Case 1-Circular Fins

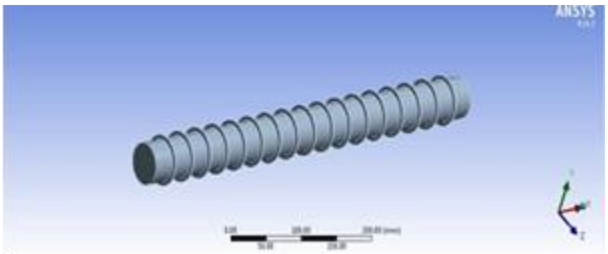


Fig 4: imported model

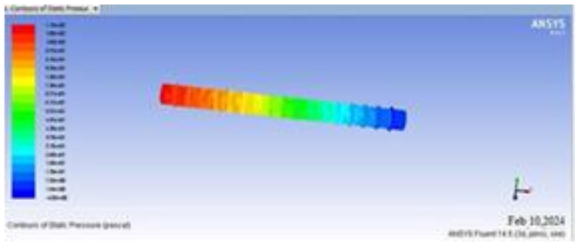


Fig 5: pressure counters

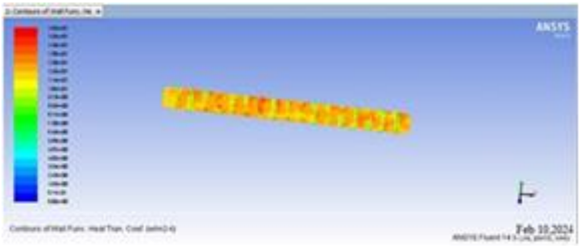


Fig 6: Heat Transfer Coefficient

Mass Flow Rate

Mass Flow Rate	(kg/s)
inlet	1.5000006
interior-partbody	-0.65700382
outlet	-1.4979161
wall-partbody	0
Net	0.0020844936

Case 2-Rectangular Fins

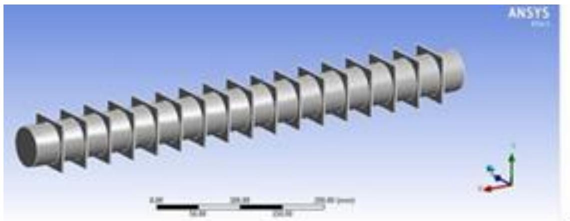


Fig 7: imported model

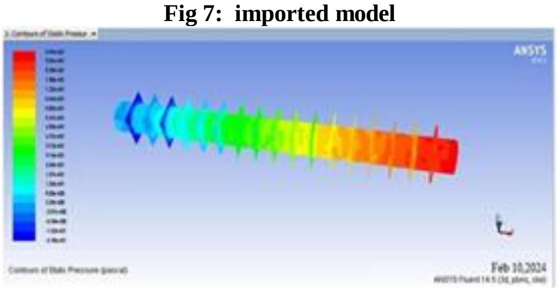


Fig 8: pressure counters

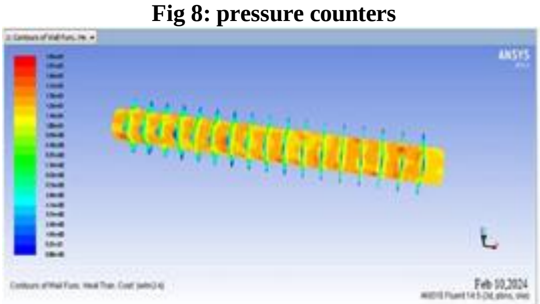


Fig 9: Heat Transfer Coefficient
Mass Flow Rate

```
        Mass Flow Rate                 (kg/s)
-------------------- --------------------
                 inlet              1.5000005
  interior-partbody              2.9729486
                outlet             -1.4968315
        wall-partbody                      0
-------------------- --------------------
                   Net        0.0031689405
```

B. THERMAL ANALYSIS OF FINNED TUBE EVAPORATOR

Case 1-Circular Fins

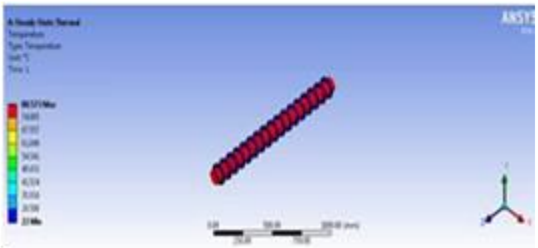


Fig: 10 Temperature

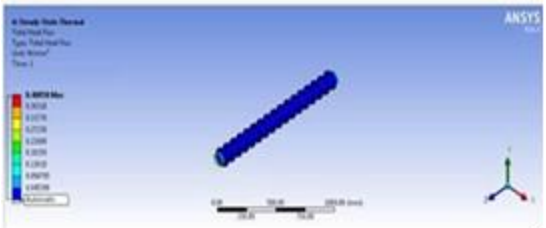


Fig: 11 Heat flux

Case 2-Rectangular Fins

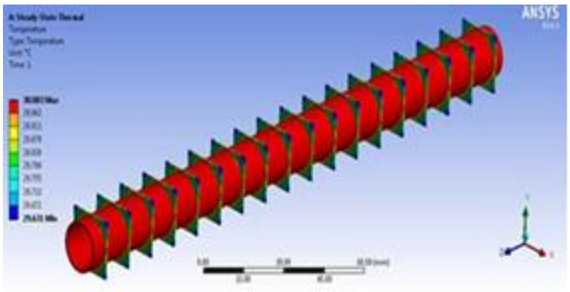


Fig :12 Temperature

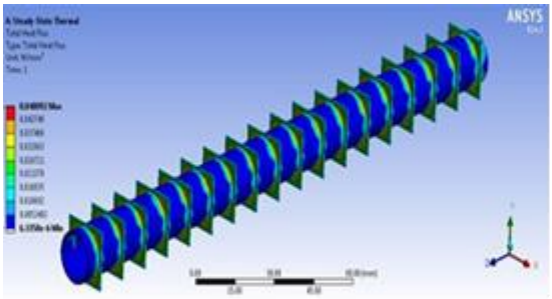


Fig :13 Heat flux

C. RESULT TABELS

Table 1: CFD analysis results

Fin geometry	Fluid volume fraction (%)	Pressure (Pa)	Velocity (m/s)	Heat transfer coefficient $(w/mm^2- k)$	Mass flow rate	Heat transfer rate(w)
Rectangular	0.2	9.56e+01	7.33e-01	1.65e+02	0.003168	127.98
	0.4	9.58e+01	7.63e-01	2.56e+01	0.003268	155.50
	0.6	9.68e+01	7.96e-01	2.91e+01	0.002834	113.98
	0.8	1.02e+01	8.31e-01	3.42e+01	0.0017054	68.49
Circular	0.2	1.15e+02	7.36e-01	1.62e+01	0.0020844	84.30
	0.4	1.20e+02	7.61e-01	2.46e+01	0.0021493	105.52
	0.6	1.30e+02	7.99e-01	2.94e+01	0.0022530	90.718
	0.8	1.40e+02	8.36e-01	3.47e+01	0.0017814	71.492
Hexagonal	0.2	1.01e+02	7.30e-01	1.60e+01	0.0021239	85.785
	0.4	1.47e+02	7.62e-01	6.63e+01	0.0023427	115.00
	0.6	1.53e+02	7.90e-01	8.10e+01	0.0024602	98.972
	0.8	1.56e+02	8.26e-01	9.60e+00	0.0022699	91.101

Table 2: Thermal analysis results

Fin geometry	Materials	Temperature (°C)	Heat flux (W/mm^2)
Rectangular	Aluminum alloy 7475	20.803	1.0193
	Copper	14.412	1.9435
	Brass	21.428	0.8404
Circular	Aluminum alloy 7475	5.62	0.98626
	Copper	8.0818	1.531
	Brass	9.002	0.8424
Hexagonal	Aluminum alloy 7475	15.162	0.971
	Copper	2.382	1.676
	Brass	17.459	0.824

V. CONCLUSION

CFD analysis is done by varying the volume fractions as a 0.2, 0.4, 0.6 and 0.8% of R 160 fluid and base fluid as R134a at different fin geometries (circular, rectangular and hexagonal).CFD and thermal analysis is done in ANSYS.

By observing the CFD analysis results, heat transfer coefficient increases the increasing the volume fraction of fluid and heat transfer rate, mass flow rate is more for rectangular fin at 0.4 % volume fraction.

By observing the thermal analysis results, the heat flux is more for copper material at rectangular fin than circular and hexagonal fins.

So we can conclude that aluminum is the better material for fin tube evaporator because light weight than brass and copper.

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Design And Analysis of Reactor Pressure Vessel Using Composite Material at Different Positions

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Abstract—**The Reactor pressure vessels are commonly used for hold gases or liquids at a pressure substantially different from the ambient pressure and temperature in nuclear power plant and gas plants. They are widely used in various industries such as petrochemical, oil and gas, chemical, and food processing industries and chemical laboratory applications. At present the outer shells of the pressure vessels are commonly made of metals like carbon steels and aluminum alloys. The payload performance, speed, operating range depends upon the weight. The lower the weight is give the better performance, one way is reducing the weight, and it is by reducing the weight of the shell structure. The composite materials improves the performance of the vessel and offers a significant amount of material savings. The stacking sequence is very crucial to the strength of the composite material. This Project involves various objective functions such as stiffness, buckling load and Weight at each level of optimization. In this present work composite pressure vessels are made of carbon fiber reinforced aluminum matrix composite. Usually composite pressure vessels are designed for minimum mass under strength constraints. A graphical analysis is presented to find optimum fiber orientation for given layer thicknesses. In the present work, an analytical model is developed for the Prediction of the minimum buckling load with/ without stiffener composite shell placed at continuous angle ply laminas of (00, 150, 900) for investigation. Design involves parameters such as maximum safe operating pressure and temperature, safety factor, corrosion allowance and minimum design temperature. Comparisons are made with the finite element model done by 3-D finite element analysis is built using ANSYS-15.0 version software into consideration, for static and buckling analysis on the pressure vessel.**

Keywords—Reactor pressure vessel, CATIA, ANSYS, carbon fiber reinforced aluminum matrix composite and Stainless Steel composite material.

Determination of Mechanical Properties of Al4032 with Reinforcement SiC Fabricated through Stir Casting

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*Abstract***— The present work is focused on determination of mechanical properties of aluminum alloy Al4032-Silicon carbide (sic) metal matrix composites fabricated through stir casting method. Using this method, varied weight percentage 1%, 2%, 3% and 4% of Sic particles are successfully introduced in the aluminum 4032 alloy to produce castings through stir casting. The mechanical properties of the composites were determined and are increased with increase in the percentage of reinforcement. The micro structure revels that the uniform dispersion of SiC particles in the aluminum alloy matrix.**

I. Introduction

Aluminium based metal matrix composites have evoked a keen interest in recent times for potential applications in marines, aerospace and automotive industries owing to their superior strength to weight ratio, good wear and corrosion resistance. Composite materials are having their desirable properties, which include high specific stiffness, low density, controlled co efficient of thermal expansion, high specific strength, and superior dimensional stability at elevated temperatures. As the dispersed phase is compared to matrix phase it is stronger. So it is called as reinforcement phase. In this work the various aspects of the wear behaviour of MMC's have been investigated. Metal Matrix Composites (MMCs) have resistant with the ceramic particulates and tender to the significant performance advantages over pure metals and alloys. MMC's are adapt with the best properties of the two components, such as ductility and toughness of the matrix. Generally aluminium alloys are having low density and good adaptability, good corrosion resistance and high thermal and electrical conductivity. The objective of the present study is to investigate the wear behaviour of al 4032 reinforced with SiC.

II. LITERATURE REVIEW

Deepak Kumar and Pradeep K [1] presents the aluminum-silicon alloys used in automotive applications with focus on investigation of the morphological and mechanical behavior of the metal matrix composites formed. The silicon carbide

reinforced aluminium alloy (Al-4032) metal matrix composites have been produced through the stir casting technique. Four different compositions, i.e. 0, 3, 6 and 9% (by weight) silicon carbide. In general, all the mechanical properties, the tensile strength, hardness, and impact strength have been observed to improve with the reinforcement over the base metal. These properties have also been found to improve with increase in the weight percentage of the reinforcement. Pardeep Saini and Pradeep K Singh Mer [2] present work reports the impact of silicon carbide (SiC) reinforcement on the physical, microstructural, and mechanical characteristics of Al-4032/SiC composites with 4, 6, 8% of SiC fabricated through bottom pouring stir casting set-up. The mechanical properties have also been measured according to American society for testing and materials (ASTM) standards. The UTS, microhardness, and impact toughness of the AMC samples have been found to improve significantly owing to the addition of ceramic particles. Himanshu Kala and K.K.S [3] focus on aluminum matrix composite due their high strength to weight ratio, low cost and high wear resistance are widely manufactured and used in structural applications along with aerospace and automobile industry. Also, a simple and cost effective method for manufacturing of the composites is very essential for expanding their application. Reinforcements like particulate alumina, silicon carbide, graphite, fly ash etc can easily be incorporated in the melt using cheap and widely available stir casting method. Deepak Kumar and Pradeep k [4] focus of this research is on investigation of the effect on tribological behavior (wear properties) of silicon carbide (SiC) reinforced Al-4032 based metal matrix composite. In this study, silicon carbide particles were reinforced at 6% by weight to the aluminium alloy (Al-4032) matrix to form composite using the bottom pouring stir casting technique. Wear analysis has been attempted on the pin on disc setup, using the metal matrix composite. Taguchi's optimization approach has been adopted for design of experiments. "Smaller-the-better" criteria has been considered as objective 12 model to investigate the wear resistance of the MMC. The optimization of the operating parameters and Analysis of Variance (ANOVA). From the ANOVA study, it is observed that the applied load and rotational time of disc have the significant effect on the tribological behavior. Avinash Gudimetla, S Sambu Prasad, and D Lingaraju [5] aimed at developing a new Metal Matrix Composite (MMC). The MMC were manufactured using stir casting technique. The tribological behavior of Al 4032 was compared with the as cast MMC of varying reinforcements of Si and Si B. Three compositions of reinforcements i.e., 1%, 3% and 5% for each of Si and Si B were considered for investigation of wear rate. The effect of varying loads on the wear rate was studied by measuring the changes in thickness per unit time, by conducting experiments on pin-on-disc apparatus. The wear behavior of Al MMC sliding against hardened stainless-steel disc was compared with conventional Al 4032. It was observed that the wear resistance of the composite was increased in comparison with Al 4032, under identical test conditions and is better for composite made of Si B with 3%wt reinforcement at all the considered loads. There was a decrease in wear and corresponding to the load respectively, when compared with base material S. Dinesh Kumar, M. Ravichandran, and M. Meignanamoorthy [6] describes.the physical and mechanical properties that can be acquired with aluminium metal matrix has developing demand in aircraft, automotive and other industries. More in recent times, particulate reinforced MMCs have concerned significant attention are preferable due to their low cost, constant properties, and characteristic isotropic properties. The potential of these materials is mostly reliant on choosing the correct combination of reinforcing materials since most of the processing parameters are related with the reinforcing particulates. Deepak Kumar, Pardeep Saini, and Pradeep K. Singh [7] focus on the pattern of metal matrix composites can be enhanced by integrating the concept of hybrid metal matrix composite to produce newer engineering materials with improved properties. The morphological and mechanical characteristics of Al-4032/SiC/GP hybrid composites have been investigated. The aluminium alloy (Al-4032) based hybrid composites have been fabricated through the bottom pouring stir casting set up, by reinforcing the silicon carbide (SiC) and granite powder ceramic particles as the reinforcement material at various fraction level i.e. 0, 3, 6, 9 weight% in equal proportion. The microstructural 13 characterization of the hybrid composite samples has been carried out using optical microscope, SEM and XRD. The study reveals that the reinforcement hybrid particles are almost uniformly distributed throughout the matrix phase. N.V. Rangasamy, M. Rajkumar and S. Senthil [8] focus on the EDM machining process is done on Al 4032 with Zrb2&Tib2 in-situ composite. The Mechanical properties of composite are gained high strength and hardness. Tauchi and ANOVA method is used to find optimal process parameter in EDM process. Pradeep Saini and Pradeep K. Singh [9] presents the wear characteristics of the aluminium alloy (Al-4032) matrix-based hybrid composites (AMHCs) has been investigated through the pin-on-disc tribometer. The AMHCs have been fabricated through the bottom pouring vacuum stir casting set up, using the mixture of silicon carbide (SiC) and granite marble powder ceramic particles in equal proportion. The mass loss has been considered as the response parameter and 'Smaller-the-Better' criteria has been adopted as the objective model in the study. The optimization of the control parameters i.e., composition, normal load, sliding time and sliding speed has been produced using main effect of means and Analysis of Variance methods. It is observed that all four control parameters have considerable influence on the wear characteristics of the AMHCs. The wear resistance of the AMHCs increases with increase in the amount of reinforcement up to 6%. Pradeep Saini and Pradeep K [10] he disposal of waste granite marble powder (GMP) causes environmental problems. The present work reports the impact of waste GMP as a reinforcement to produce composites. The Al-4032/GMP composites with 0%, 4%, 6%, and 8% (by weight) GMP have been fabricated through stir casting. A maximum 0.63% increase in theoretical density while a maximum 5.65% decrease in experimental density has been recorded for 8% reinforcement. The microstructure of the as-cast samples has been analyzed using an optical microscope, x-ray diffraction, and scanning electron microscope equipped with energy-dispersive x-ray spectroscopy. Other properties, such as ultimate tensile strength, micro-hardness, and impact strength of the composites, were enhanced from 69.4 MPa to 115 MPa, 131.4 HV to 174.1 HV, and 22.4 J to 32 J, respectively, because of the addition of GMP particles. Among all, the Al-4032/6%GMP composite appears to possess the best combination of all mechanical properties.

III. EXPERIMENTAL WORK

A. Materials

In this study, Al 4032 with density 2.69 g/cm3 is used as Matrix material. It is one of the most popular in its series. Chemical composition of Aluminium alloy is given in the below tabular form.

B. Reinforcement Material

Silicon carbide is also known as carbondium which contains silicon and carbon. Grains of the silicon carbide can be bonded together by sintering to form very hard ceramics which are used in wide applications required high endurance, such as car brakes, car clutches and ceramics plates.

C. Preparation of Samples of Composites

silicon carbide on an average of 38 microns is preheated upto a temperature of 2000c. Stir casting is a liquid metallurgical method of composite material fabrication, in which a dispersed phase like ceramic particles, short fibers etc. is mixed with molten metal by means of a stirrer attached to it.

Fig1.Al-4032(Pure)

Fig2. Silicon Carbide

TABLE I. CHEMICAL COMPOSITION OF AL-4032

Material	Si	Fe	Mn	Cu	Ag	Ni	Al
Percentages	21.42	0.22	0.04	0.67	0.10	0.82	76.73

Fig.3 Bottom Type Stir Casting Machine

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TABLE II. VARIOUS COMBINATIONS OF CASTINGS

Casting	Al4032	Silicon Carbide
1	100%	-
2	99%	1%
3	98%	2%
4	97%	3%
5	96%	4%

Fig.4 Universal Testing Machine

IV. RESULTS AND DISCUSSIONS

A. Compression Test

Compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. It is used to analyse the compressibility of the materials. The compressive load is applied on the specimen and the resistance of the specimen to deform is called compressive strength of the materials.
Specimens are confined according to ASTM standards. The length to diameter ratio (L/D) of the specimens is taken as 26mm and 13mm respectively. They are placed under UTM in which two forces acts in opposite direction which means compressing. After compressing, the values are tabulated and compared in the following graph.

TABLE III. COMPRESSION STRENGTH OF AL4032-SIC

Casting	Composites	Compressive strength (MPa)
1	Al 4032 (Pure)	153.278
2	Al 4032+SiC (1%)	200.704
3	Al 4032+SiC (2%)	200.553
4	Al 4032+SiC (3%)	306.781
5	Al 4032+SiC (4%)	391.915

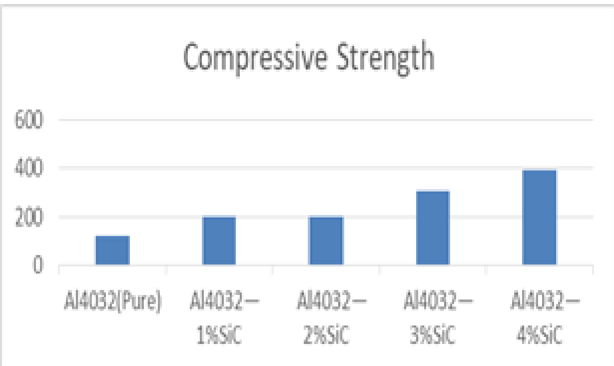

Fig.5 Compressive Strength graph of Al4032-SiC composites

B. Tensile Test

Tensile strength is the capacity of a material or structure to withstands while being stretched or pulled before breaking. It is used to analyze tensile nature of the materials. The tensile load is applied on the specimen and the resistance of the specimen to deform is called tensile strength of the materials.

Specimens are confined according to ASTM standards. The length of the specimens is taken as 200mm and width 20mm respectively. They are placed under UTM in which two forces acts in opposite direction which means Stretching. After Stretching, the values are tabulated and compared in the following graph.

TABLE IV. TENSILE VALUES OF AL4032-SIC

Casting	Composites	Tensile Strength (Mpa)
C1	Al4032(pure)	77.350
C2	Al4032 + SiC (1%)	82.585
C3	Al4032 + SiC (2%)	94.532
C4	Al4032 + SiC (3%)	106.462
C5	Al4032 + SiC (4%)	134.769

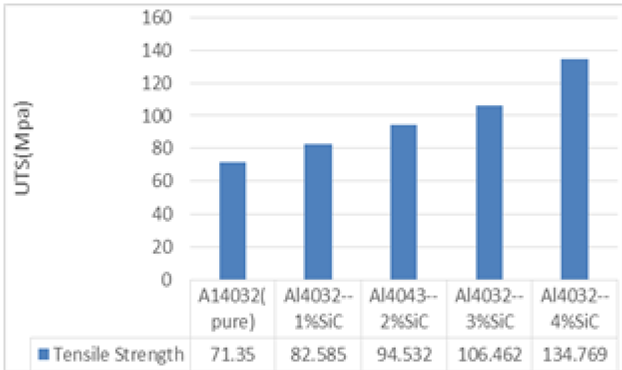

Fig.6 Tensile Strength graph of Al4032-SiC Composites

C. Micro Hardness

The hardness of a material can be determined by Vickers's hardness test. In Vickers's hardness test, diamond indentation is used to determine the hardness. Vickers's test determines the hardness by the measurement of the depth of penetration of an indenter under load more than compared to the penetration made by a preload. There are different scales, denoted by a single letter, that use different loads or indenters.

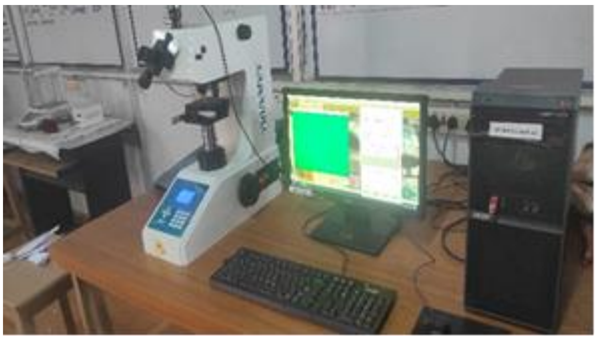

Fig7. Vicker's Hardness Testing Machine

The hardness of the Al4032 alloy and composites was determined with Vickers Micro Hardness Tester

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(LECOAT700 Micro hardness Tester). The dimension of each specimen for hardness testing was 10x10mm and each specimen was grinded and polished to obtain a flat smooth surface. During the testing, a load of 500gm. was applied for 10s on the specimen through square based diamond indenter and the hardness readings taken in a standard manner.

TABLE V. MICROHARDNESS VALUES OF AL4032-SIC

Casting	Composition	Micro Hardness Value (HRV)
1	Al4032(pure)	57.80
2	Al4032 +SiC (1%)	60.18
3	Al4032 +SiC (2%)	65.73
4	Al4032 +SiC (3%)	81.55
5	Al4032+SiC (4%)	117.6

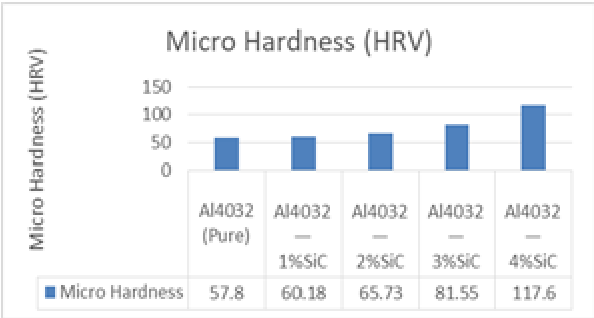

Fig.9 Microhardness graph of Al4032-SiC Composites

D. Inverted Metallurgical Microscope

The metallurgical microscope micro structure of a metal matrix composite is observed by using Trinocular metallurgical microscope. The micro structure of various metal matrix composites.

Fig7.Inverted Metallurgical Microscope

E. Microstructures of composites

Fig.8 Al4032(Pure)

Fig.9 Al4032+1% SiC

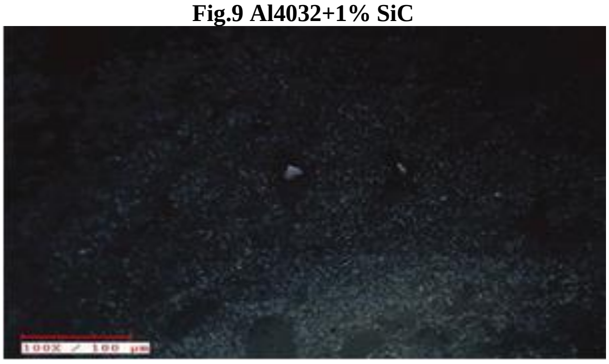

Fig.10 Al4032+2% SiC

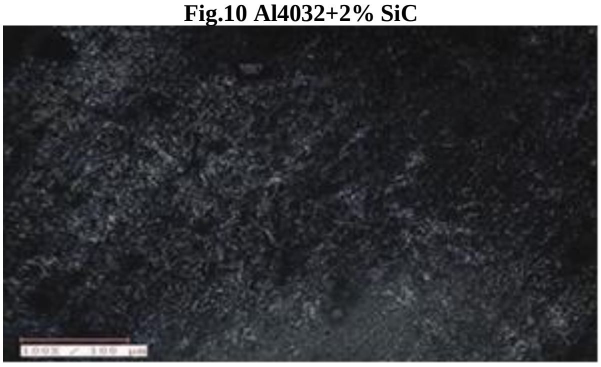

Fig.11 Al4032+3%SiC

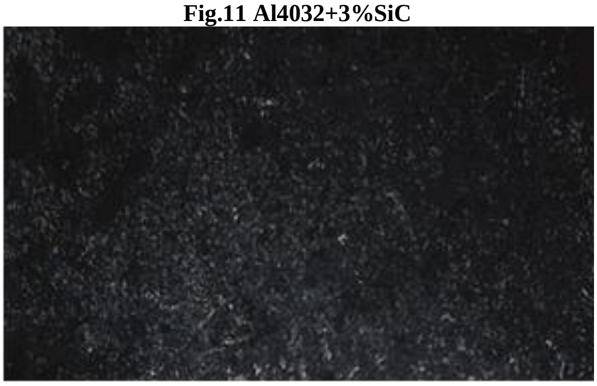

Fig12.Al4032+4%SiC

CONCLUSION

A. The combination of Al4032 as base material and reinforced material Silicon Carbide with different proportions as 1%,2%,3% and 4%. fabrication through stir casting process.

B. The distribution of reinforcement material is fully distributed in base material as composition increases.

C. The mechanical properties like tensile, compression, microhardness was increased with increase in the proportions of SiC.

D. The combination of Al4032 as base material and 4% SiC as reinforcement has the best mechanical characteristics.
E. The results depicted in above tables were within the acceptable range and hence can be used for predicting the results of unknown data of Al4032-SiC reinforced composites.

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WI-FI CONTROLLED CAR

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Abstract

This project introduces a Wi-Fi-controlled car system designed for remote operation using a smartphone or computer. The primary objective is to enable users to navigate the car wirelessly through a dedicated mobile application or web interface. The car is equipped with a microcontroller that communicates with a Wi-Fi module, establishing a connection with the user's device.

The mobile application provides an intuitive interface for real-time control, allowing users to drive the car, adjust speed, and steer with ease. Additionally, the system incorporates live video streaming from an onboard camera, enhancing user experience and enabling remote navigation even in inaccessible areas.

The implementation involves Arduino-based hardware and relevant programming for both the microcontroller and the user interface. The Wi-Fi-controlled car serves as a versatile and accessible platform for educational purposes, research, and entertainment, showcasing the potential of wireless communication in robotics and IOT applications

I.INTRODUCTION

Designing a Wi-Fi-controlled wireless car is the main motto of this project. Wi-fi technology used has an average range of 10 m, due to which the car cannot travel a binger distance. So, Bluetooth-controlled automated cars have a limited range of issues. This limitation has been solved by using a Wi-Fi Module with a better range and wireless connectivity. Another key point behind developing the project is the use of Android Applications rather than traditional hardware controllers, which effectively reduces cost. The wireless car is controlled via a smartphone which is connected to the Wi-Fi module. This Android application has been developed with the required software tools (Android Studio) and it works as a controller that controls the movement of the car. Node MUC has been used as a microcontroller to drive this project.

Node MCU board provides ease in terms of hardware interfacing and the coding is done using Arduino software In the last decade, with the development of technology, sensors used with electronic devices have been used in many areas to facilitate life. Sensors are devices that convert energy forms into electrical energy. The sensors serve as a bridge connecting the environment and various electronic devices. The environment can be any physical environment such as military areas, or airports. factories, hospitals, shopping malls, and electronic devices can be smartphones, robots, tablets, or smart clocks. These devices have a wide range of applications to control, protect, image, and identification in the industrial process. Today, there are hundreds of types of sensors produced by the development of technology such as heat, pressure, and obstacle recognizer. human detecting. Sensors were used for lighting purposes in the past, but now they are used to make life easier. Thanks to technology in the field of electronics, incredibly fast developments are experienced. In this respect, it is possible to develop an invention or a new application every day and make life easier.

A robot is an electromechanical machine that is controlled by computer program to perform various operations. Industrial robots have designed to reduce human effort and time to improve productivity and to reduce manufacturing cost. Today human-machine interaction is moving away from mouse and pen and becoming much more pervasive and much more compatible with the physical world. Android app can control the robot motion from a longdistance using Bluetooth communication to interface controller and android. Microcontroller unit can be interfaced to the Bluetooth module though protocol and code is written in embedded C language.

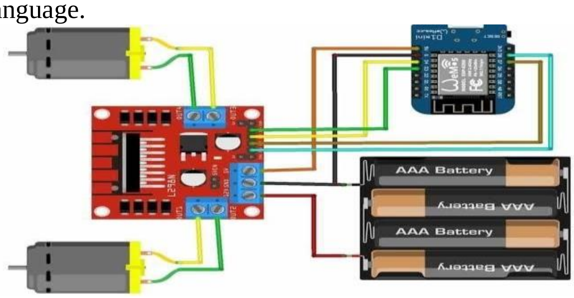

Fig:1.1: Wi-Fi-controlled wireless car

A smartphone is a mobile phone built on a mobile computing platform, with more advanced computing ability and connectivity than a feature phone. Smartphones are a more affordable and efficient hand-held devices which can be used to support collaborative activities in a community. It is a result of a huge advancement in mobile phones technology. Humans are anxiously working on finding new ways of interacting with machines. However, a major breakthrough was observed when gestures were used for this interaction. A gesture is a form of nonverbal communication in which visible bodily actions communicate particular messages. It comprises of sound, light variation or any type of body movement. Based upon the type of gestures, they have been captured via Acoustic (sound), Tactile (touch), Optical (light), Bionic and Motion Technologies through still camera, data glove, Bluetooth, infrared beams etc.

II. LITERATURE REVIEW

The purpose of the project is to carry the load at Starting to require a location with controlling the mobile. The application of the prototype car is maximum weight is carried 3kg and it is used in hazardous situations of the area i.e., for example for military weapons transfer, any fire accidents. etc.

The designing methodology of the system has two major portions: software design and hardware design. hardware is designed by arranging microcontrollers whereas software design includes programming that is written and uploaded to the microcontroller.

Node MCU (Node Microcontroller Unit) is the central coordinator. This microcontroller has built-in support for Wi-Fi connectivity which allows it to send and receive data from the mobile application via an internet server. It reads data and sends them to mobile applications and receives commands from mobile applications to control the robot. It then drives the robotic directions. Mobile application- Node MCU CAR is the simple software used to control the robotic directions.

Internet server-mobile application in smartphones and Node MCU communicates by using Wi-Fi. Bidirectional transfer of data between Node MCU and mobile app occurs through this server.

The idea of robots taking up jobs previously done by humans may feel dystopian but scientists believe machines can free up human hospital medical staff while limiting the spread of the virus. "Robots can play a vital role during the present pandemic as they can minimise human intervention at all levels, starting from patient examination to patient care and drug delivery mechanism,".

The designing methodology of the system has two major portions: software design and hardware design. hardware is designed by arranging microcontroller whereas software design includes programming that is written and uploaded in the microcontroller.

Dipak Aphale, Vikas Kusekar "PLC Based Pick and Place Robot with 4 DOF" The pick and place robot is one of the technologies in manufacturing industry and designed to perform various functions. The system is very important to eliminate human errors and to get more precise work. It can also save the cost in long term and help to solve problems and tasks that cannot be done such as on high temperature area, narrow area and very heavy load thing. This project is a basic development and modification for that type of robot where it uses the peripheral interface Programmable Logic Control (PLC) as the robot brain to control all of the robot movement. The rotation of tills robot is 360 degree (clockwise) and -360 degree (counter clockwise). The electromagnetic gripper will move horizontally to pick up and hold the object from one place to another place. This robot is used to pick and place the object only in their specifications (up to 300mm horizontal and 300mm vertically). The benefit of this project is the robot can pick the object using electromagnetic gripper which is simple in construction and also cost effective.

S Premkumar, Vikas Kusekar "Design and Implementation of multi handling Pick and Place Robotic Arm" Robot manipulator is an essential motion subsystem component of robotic system for positioning, orientating object so that robot can perform useful task The main aim of our work is to collaborate the gripper mechanism and vacuum sucker mechanism working in a single pick and place robotic arm. This robot can be self-operational in controlling, stating with simple tasks such as gripping, sucking, lifting, placing and releasing in a single robotic arm. The main focus of our work is to design the robotic arm for the above-mentioned purpose. Robotic arm consists of revolute joints that allowed angular movement between adjacent joint. Three double acting cylinders were used to actuate the arm of the robot. Robot manipulators are designed to execute required movements. By using this collaborated mechanism, the success rate of pick and place robots are increased.

III. TYPES OF ROBOT MODULES

3.1. Bluetooth Controlled Robot

In this project, I will show you how to design and develop a Bluetooth Controlled Robot using Arduino, HC-05 Bluetooth Module and L298N Motor Driver Module. On the other end of the Bluetooth Communication, I will be using a Smart Phone and a simple Android App to control the Robotic Car. Wireless Bluetooth Controlled Robot Car Using Arduino. The robotic car can be controlled wirelessly via a Smartphone. The smartphone has an Android app through which the user can send commands directly to Robot. The robot can move forward, backward, left and right and can also be stopped.

The Arduino's Bluetooth controlled robot car is interfaced with a Bluetooth module HC05 or HC-06. We can give specific voice commands to the robot through an Android app installed on the phone. At the receiving side, a Bluetooth transceiver module receives the commands and forwards them to the Arduino and thus the robotic car is controlled.

Fig.3.1 Arduino UNO

The Arduino Wireless Voice Controlled Robot consists of a transmitter and a receiver section. The transmitter end consists of Smartphone Bluetooth and the Android app installed on it. Similarly, the Receiver section has Arduino board as a processor, HC-05 Bluetooth Module as a wireless communication module, L293D for driving motors and pair of DC geared as a part for moving robot.

3.2. Wi-Fi Controlled Robot using ESP8266 and Arduino:

If you have followed our "Wi-Fi Controlled LED using ESP8266 and Arduino" project, then you can easily understand the concept of the Wi-Fi Controlled Robot.

The ESP8266 Module is responsible for connecting to the Wi-Fi Network and acting as a server. Coming to the client, a simple HTML page is created and the browser which opens this web page acts as a client

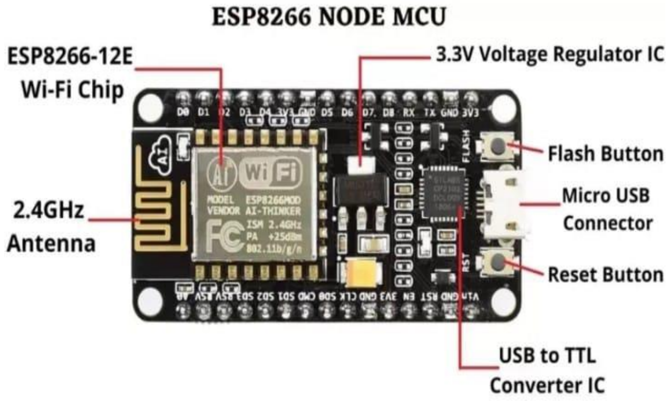

Fig3.2. Wi-Fi module

Whenever you click on the web page, corresponding information will be transmitted to the Server (ESP8266). This information is further received by Arduino, and it controls the motors of the robot.

3.3. Wi-fi Controlled Robot Car using Node MCU:

Robotic evolution starts with some basic ideas. It minimizes the human efforts, and it can be deployed in a lot of fields like military, surveillance applications, Industrial Pick and Place Robots latest Humanoid robots are developed in the modern world. Now a day's robotic cars are developed using Wireless

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technology. Wireless technology in Robotics starts with Bluetooth, WI-FI, and Zigbee Communication. Based on the Requirement and Application they deployed the communication in Projects. And we have numerous android Applications in the Play store to control a robot car. Blynk is a Popular App used in this Project it has a lot of features like buttons, gauges, Sliders, and Plotting Features also. By using Wi-Fi technology, we can connect a greater number of Robotic Cars to control it very useful for surveillance applications. Now a day's Indoor localization Technologies are developed in that case also we can deploy this type of Wi-Fi controlled Robotic Car.

Now a day the advancement in technology various new designed smart makes use of Wi-Fi robot for various applications. Mostly wi-fi network was using home security purposes. The various applications are done by robot car like doing different works on the command ex- switching on the lights when the robot is given the command by the Wi-Fi enabled device. The car was controlled by the wi-fi network in the Blynk android application. The wi-fi robot car can be easily moved from one place to another place by using the command in the Blynk application. We can make the car do the various task using wi-fi network technologies.

IV.COMPONENTS

These are the main important components used:

- Node MCU (esp82 66-12e v1.0) Wi-fi Board
- L298N Motor Driver Module
- DC geared motor
- Wheels
- Caster ball wheel
- Micro USB cable
- 14.8v rechargeable battery Li-Po battery
- Jumper wires (female to a female)
- 2-wheel car chassis kit

i.L298N MOTOR DRIVER:

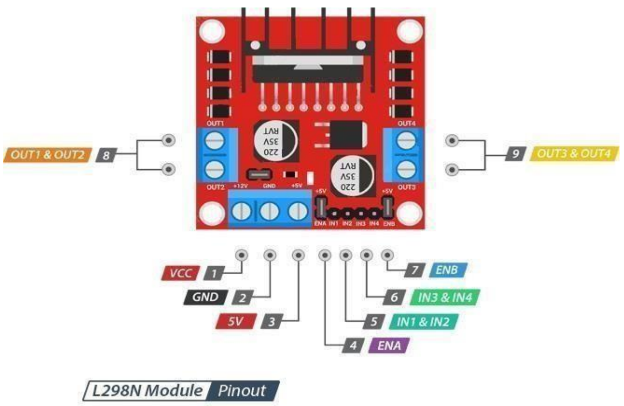

Fig:4.1: L298N Motor Driver

This L298N Motor Driver Module is a high-power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply I s less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator, and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and a separate 5V should be given through the SV terminal to power the internal circuitry.

ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

Features & Specifications of L298N Motor Driver IC:

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

ii. DC GEARED MOTOR:

Fig4.2: DC Geared motors

DC Motor 300RPM &12Volts geared motors are generally simple DC motors with a gearbox attached to them. This can be used in allterrain robots and a variety of robotic applications. These motors have a 3 mm threaded drill hole in the middle of the shaft thus making it simple to connect it to the wheels or any other mechanical assembly.

300 RPM 12V DC geared motors are widely used for robotics applications. Very easy to use and available in standard size.

Specifications and Features: -

RPM	- 500.
Operating Voltage	- 12V DC
Gearbox	- Attached Plastic (spur)Gearbox
Shaft diameter	- 6mm with internal hole
Torque	- 2 kg-cm

iii.WHEELS:

Two wheels plus a caster or four wheels are the most common combinations for wheeled robots.

Fig 4.3: Wheels

Both combinations of wheels can turn in place and are known as a differential drive for the two-wheel version, while the four wheels must be driven independently to turn in place.

iv. MICRO USB CABLE:

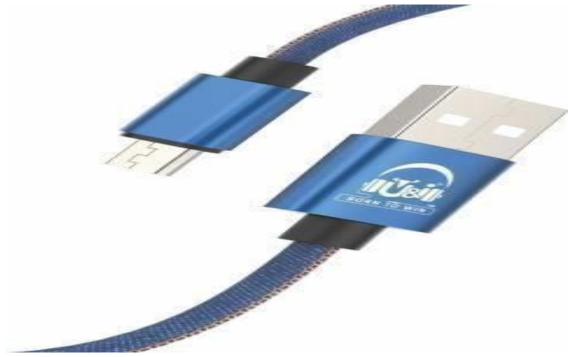

Fig 4.4: Micro USB cable

Micro USB is a miniaturized version of the Universal Serial Bus (USB) interface developed for connecting compact and mobile devices such as smartphones, Mp3 players, GPS devices, photo printers and digital cameras. Micro USB connectors exist or have existed in three forms: microA, microB, and micro-USB 3.

We used it for supply and upload code to node MCU.

v. 14.8V BATTERY:

A lithium-ion battery or Li-ion battery is a type of rechargeable battery composed of cells in which lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge and back when charging. Li-ion cells use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. Li-ion batteries have a high energy density, no memory effect, and low selfdischarge. Cells can be manufactured to prioritize either energy or power density. They can however be a safety hazard since they contain flammable electrolytes and if damaged or incorrectly charged can lead to explosions and fires.

Fig4.5: 14.8V Battery

Features:

- Metal Jacket Body
- Good Built Quality and hence Leakproof
- Easy to install and Replace
- Corrosion-free Connector Point for long-term use
- 0% Mercury and Cadmium. Environment-friendly
- 14.8 Volts Battery capacity 2500 MAH

JUMPER WIRE:

Features:

Current : 4-20 mA
Voltage :12 V
Rated Pressure : 25 Kpa
Pitch :2.54 mm

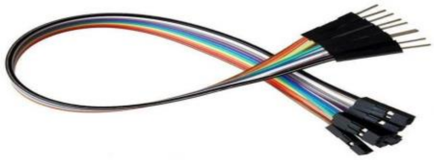

Fig 4.6: Jumper wire

A jump wire is an electrical wire, or group of them in a cable, with a connector or pins at each end (orsometimes without them simply "tinned"), which is normally used tinterconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.

Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

IV-WHEEL CAR CHASSIS KIT:

Robot Metal Chassis for 2 Motors Wheels is easy to mount the motors on the place by using a normal motor mount nut. It can either be used in differential configuration (2 rear wheels + 1 front caster wheel). The body contains perforated holes for easy mounting of various size circuit boards and other mechanical components.

This Chassis board is widely used as a mechanical frame structure for mobile robots. It is the backbone of the robot, where we arrange and connect everything like motors, sensors, and wheels. It gives you the base to build our robot and allows you to place your components according to the requirements.

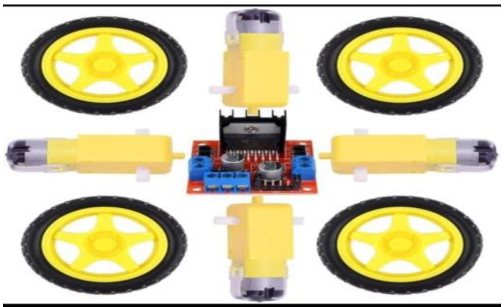

Fig4.7.: 4-wheel car chassis kit

Features:

Many perforated holes have been given for easy attachment of the development board and sensors

The Centre Shaft gear motor and side shaft gear motor can be used for this chassis.

Specifications:

Dimensions in mm	- 115*105*45
Weight(gm)	- 200
Colour	- red
Sheet thickness	- 1.5mm
Motor fitting hole thickness	- 13.75mm

IV-a :FABRICATION OF APP CONTROL ROBOT

Wifi module for the system, which can be used as either master or slave. Generally our master will be smartphone and slave will be Bluetooth module Bluetooth module will give the commands given by smartphone to the microcontroller. Microcontroller will act as the brain of the robot. The motor movement will he decided by the microcontroller. In this system we will using microcontroller named Arduino Uno which microcontroller chip. The microcontroller will be programmed with the help of the Embedded C programming Arduino has its own programming environment through which the microcontroller can be purpose we will be using a DC motor purpose we will be using a DC motor t will generate high amount of power and torque which will be sufficient to drive a human being. A motor driver will be used to control the DC motor will we connected to the microcontroller and the Bluetooth module will be connected to the same. In this proposed system we will be using any rechargeable battery to supply power to the electronic components of the system. Mainly the microcontroller and DC motor will be in need of power supply. The model represents a general idea how our robot will look like and it is interfacing with the android smartphone.

All of the above-mentioned components. will be mounted on the skateboard. And act mentioned in the system architecture the working will be processed.

Motor driver is used to control DC motor. The microcontroller is the Brain of the robot. and is used to connect the smartphone through the Bluetooth module. The motor belt driver is used to connect the wheels of the skateboard and the de motor through driving cog. The entire electronic component except the motor and belt will be kept in electronic component case.

In the operating system of the smart mobile phone android, we develop a remotecontrol program. The program connected with wi-fi to communicate with the robot. Wireless control is the most important basic need of all people. Wireless networkcontrolled robots use wi-fi modules.

Arduino blue control android application will transmit commands using wi-fi to the car so that it can move in the required direction like moving forward, reverse, turning left, turning right, and stop.

LOAD CARRYING ROBOT

The wi-Fi-controlled robot is used to carry the load at Starting to require a location with controlling with the mobile. The application of the prototype car is maximum weight is carried 3kg and it is used in hazardous situations of the area i.e., for example for military weapons transfer, any fire accidents. etc.

BLOCK DIAGRAM OF PROJECT :

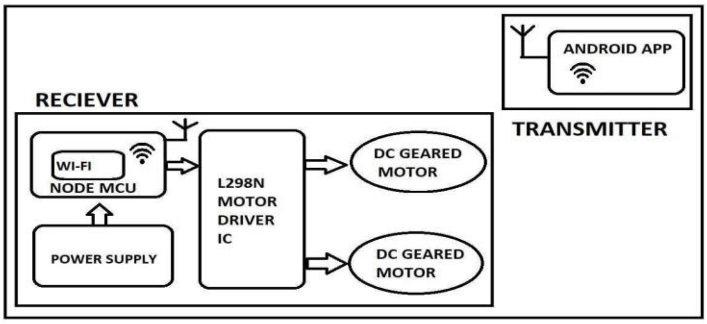

Fig4.8 : Block diagram

Here is a block diagram, we have two sections one is the transmitter section and the receiver section. In the receiver section Node MCU is connected to two L298N motor drivers where one is connected to two dc geared motors. The power supply is also given to Node MCU. On the transmitter side, we have a simple android app.

V.IMPLEMENTATION PROCESS BUILDING:

Preparation of chassis:

Preparation of chassis for mounting of motor drive and Node MCU which are to drive according to the commands loaded in MCU.

Fig:5.1. Preparation of chassis

Fitting of IOT'S:

Placing the Motor driver, Node MCU and battery on the chassis with glue and c ertain tapes.After fitting allrequired parts inspecting that there are fixed at right positons according to the rough draft and blue print.

Fig5.2:. Fitting of IOT'S

Wiring:

Making necessary connection between motor drive and Node MCU according to Program was loaded to Output terminal of MCU

Fig5.3: Making connection

Assemble:

Attaching the wheels to motor drive for moment and making certain setup to carry load.

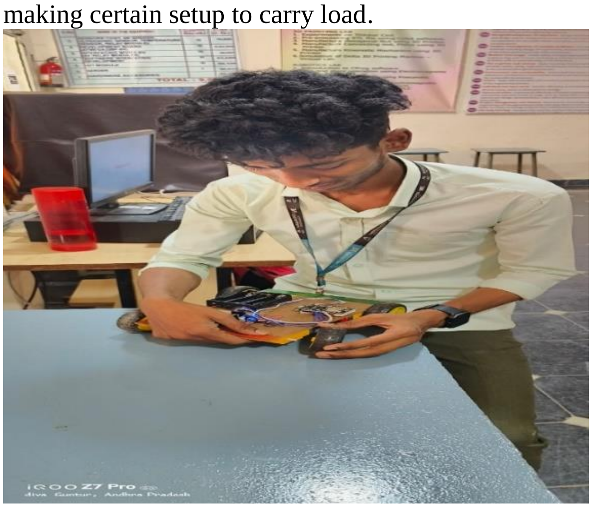

Fig5.4: Assembly

Programming: Preparation of code to move the robot according to our commands like to move forward & backward and also to turn right.

SOFTWARE DEVELOPMENT :

To develop this software, we must install the software Arduino 1.8.13 and there we must write the program and compile it. Here in the code, we are given the wi-fi device name ARC BATCH: -B4, now our robot car will operate only for the device named ARC BATCH: B4. If we want to change the device name, then we must change the name in code and dump or update it then compile. Now we can operate the machine with the changed name.

using Arduino is an application based on popular open-source technology Android and Arduino. The aim of the project was to create an Arduino integrated robot that has to be controlled through an application that runs on the android operating system. The project has been completed with success with the maximum satisfaction. Provisions are created to upgrade the code. The applying has been tested with live information and has provided a health result. Hence the code has proven to figure hasty. The system created met its objectives, by being straightforward to use, implement. Further modules may be simply other once necessary. The code is developed with standard approach. All modules within the system are tested with all the valid information for everything work with success.

Wireless control is one of the most important basic needs for all the people all over the world. But unfortunately, the technology is not fully utilized due to a huge amount of data and communication overheads. Generally, many of the wireless-controlled robots use RF modules. But our project. for robotic control make use of Android mobile phone which is very cheap and easily available. The available control commands are more than RF modules. For this purpose, the android mobile user has to install a designed application on her/his mobile.

VI: FUTURE SCOPE WORK :

Multiple sensors can be added in the robot.

Size and shape of the Robot can be modified according to the requirement. We can also mount the web camera in our robot, which can be used in various field such as spying, or for military uses.

It is rapidly growing field, as continue to research design and build new robots that serve various practical purposes, whether domestically, commercially, militarily. However, there's still lots of scope for future improvement and add-ons in practicality.

A wireless camera is mounted on the robot vehicle for spying and surveillance purpose even in night time by using infrared lighting. Future modifications can be made to perform different tasks with precise control such as:

Robot Mounted with camera.

A headset, with a full-colour display

A mission control centre .

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DESIGN AND FABRICATION OF LINEACTUATOR BY USING 3D PRINTER

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***ABSTRACT*-A linear actuator is an actuator that creates linear motion (i.e., in a straight line), in contrast to the circular motion of aconventional electric motor. Linear actuators aroused in machine tools and industrial machinery, computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor. Linear electricactuators and generators (LEAGs) are electromagnetic devices which develop directly short-travel progressive (or oscillatory) linear motion. Machine tool sliding tables, pen recorders and free piston power machines are typical industrial applications for LEAGs.**

3D printing technology enables the design and testing linear. Actuator is a component of a machine that produces force, torque or displacement. Usually in a controlled way, when an electrical, pneumatic or Hydraulic input is supplied to it in a system (is called Linear actuating).the control signal is relatively low energy and may be electric voltage or currentpneumatic. It is a form of automation or automatic control. The Displacement achieved is commonly linear or rotational, as exemplified by linear motors and rotary motors. Rotary motors and is more natural for small machine making large displacement. By means of a lead screw, rotary motion can be adapted to function as a linear actuator.

I.INTRODUCTION

ADDITIVE MANUFACTURING

Additive Manufacturing is the formalized term for what used to be called Rapid Prototyping and what is popularly called 3D Printing. The term Rapid Prototyping (or RP) is used in a variety of industries to describe a process for rapidly creating a system or part representation before final release or commercialization. In other words, the emphasis is on creating something quickly, and that the output is a prototype or basis model from which further models and eventually the final product will be derived. Management consultants and software engineers both also use

the term Rapid Prototyping to describe a process of developing business and software solutions in a piecewise fashion that allows clients and other stakeholders to test ideas and provide feedback during the development process.

II.PROBLEM IDENTIFICATION

The earliest 3D printing technologies first became visible inthe late 1980's, at which time they were called Rapid Proto typing (RP) technologies. This is because the processes were originally conceived as a fast and more cost-effective method for creating prototypes for product development within industry. As an interesting aside, the very first patentapplication for RP technology was filed by a Dr Kodama, inJapan, in May 1980. Unfortunately for Dr Kodama, the full patent specification was subsequently not filed before the one year deadline after the application, which is particularlydisastrous considering that he was a patent lawyer! In real terms, however, the origins of 3D printing can be traced.

III.MATERIALS

The CAD design and the final 3D-printed linear actuator.

Table:2.1: PLA Properties of materials

S. No	Properties	Metric	units
1	Yield strength	1.85e7 - 5.1e7	pa
2	Tensile strength	2.76e7 - 5.52e7	pa
3	Elongation	0.015 - 1	% strain
4	Hardness (Vickers)	5.49e7 - 1.5e8	pa
5	Fracture Toughness	1.19e6 - 4.29e6	Pa/m^0.5
6	Young's Modulus	1.19e9 - 2.9e9	pa
7	Max Service Temperature	61.9 - 76.9	°C
8	Specific Heat Capability	1.39e3 - 1.92e3	J/kg °C
9	Thermal Expansion Coefficient	8.46e-5 - 2.34e-4	strain/°C

The final actuator design had a weight of 0.34 kg, a bore diameter and a stroke length.

The pneumatic cylinder consisted of four main components: (1) a 3D-printed cylinder body; (2) two 3D-printed sensor carriers, positioned around the cylinder to retain the position sensors; (3) a metal piston rod with a 3D-printed piston head; and (4) a 3D-printed end cap with bushingsA linear actuator is an actuator that creates linear motion (i.e., in a straight line), in contrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer.

Table:2.1: PLA materials

S.NO	Part name	Time Taking to print	QTY of Material
1	Gearbox	9hours	26g
2	Gearlock	4hours	8g
3	Gearteeth	4 hours	8g
4	Body	11hour	28g
5	piston	3 hours	5g
6	support	4 hours	7g
	Total	**35 Hours**	**82g**

III.MODELING

Peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor. With this handy gadget, you can turn rotary motion into linear motion with ease! Using some skateboard bearings, machine screws, and 3D. Some mechanical linear actuators only pull, such as hoists, chain drive and belt drives. Others only push (such as a cam actuator). Pneumatic and hydraulic cylinders,or lead screws can be designed to generate force in both directions.

Mechanical actuators typically convert rotary motion of a control knob or handle into linear displacement via screws and/or gears to which the knob or handle is attached. A jackscrew or car jack is a familiar mechanical actuator. Another family of actuators are based on the segmented spindle. Rotation of the jack handle is converted mechanically into the linear motion of the jack head. Mechanical actuators are also frequently used in the field of lasers and optics to manipulate the position of linear stages,rotary stages, mirror mounts, goniometers and other positioning instruments. For accurate and repeatable positioning, index marks may be used on control knobs. Some actuators include an encoder and digital position readout. These are similar to the adjustment knobs used on micrometers except their purpose is position adjustment rather than position measurement.

printed parts, the machine comes together in no time and can be used for all kinds of machines or robots.This mechanism is bases on number 92, "Ordinary Crank Motion". This is going to be along project, so if you've got a specific mechanism you'd like me to make.

METHODOLOGY:

Step 1: Initially the components to be prepares are drawn using FUSION 360 software
by using sketcher tool.

Step 2: Once the component is drawn as per required dimensions then the file is saved as
STL file in FUSION 360software

Step 3: After completion of above procedure, STL file is loaded into Cura software.

Step 4: Once the STL file is loaded, required parameters are set in Cura software that is
material used, layer thickness, infill density, infill shapes, fan speed, nozzle temperature,
bed temperature, extrusion temperature, supports required all are selected and modified
as per the requirement.

Step 5: After selection of the above parameters slicing is done by using slice option.

Step 6: Once slicing is done STL file is converted into G codes which is readable by 3D
printer.

Step 7: G-code file is loaded in 3D printer by using pen drive and printing is done.

Step 8: Assembly of Printed Components.

WORKBENCHES IN FUSION 360**:**

- Design
- Generative design.
- Render.
- Animation.
- Simulation.
- Manufacture.
- Drawing.

Gear box:

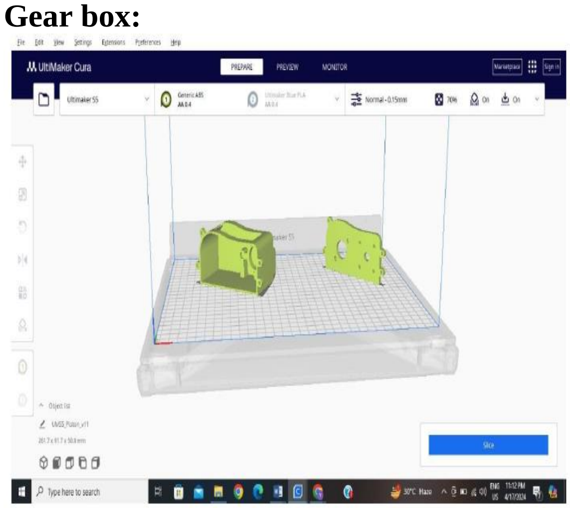

Figure 3.1: Gear box

The above Figure shows the Gear box file. Design in a FUSION 360 and saved in the .prtformat because if any changes or modifications required to the lithography) format thisformat is used for the 3D printers and next transfers into cura software. Cura converts .stl file into machine understandable file above component .prt file is editable and after again saved in the .stl (stereo) i.e. a G code in. ufp format.

Bearing housing:

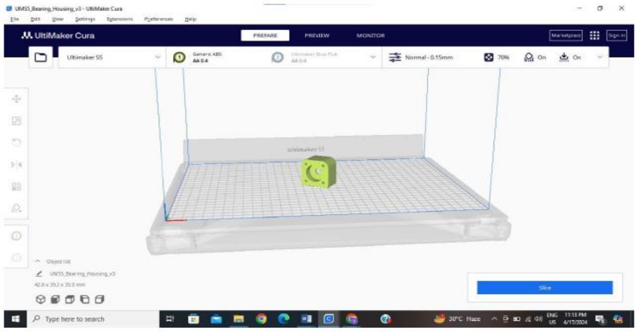

Figure 3.2.: Bearing Housing

The above Figure shows the Bearing housing file. Design in a FUSION 360 and saved
in the.prt format because if any changes or modifications required to the above
component .prt file is editable and after again saved in the .stl (sterolithography) format
this format is used for the 3D printers and next transfers into cura software. Cura converts
.stl file intomachine understandable file i.e. a G code in. up format.

The above Figure shows the Gear box lock file. Design in a FUSION 360 and saved in
the.prt format because if any changes or modifications required to the above component
.prt file is editable and after again saved in the .stl (sterolithography) format this format
is used for the 3D printers and next transfers into cura software. Curaconverts .stl file into
machine understandable file i.e. a G code in. ufp format.

PISTON:

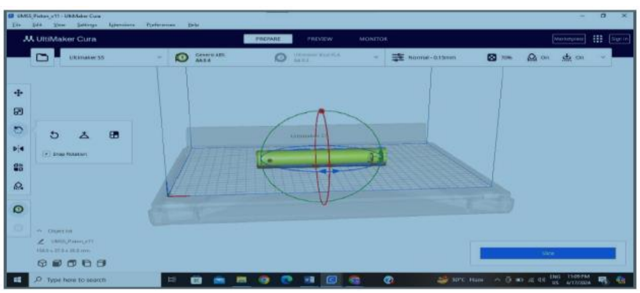

Figure 3.3.: Piston

The above Figure shows the piston file. Design in a FUSION 360 and saved in the.prt format because if any changes or modifications required to the above component .prt file is editable and after again saved in the .stl (sterolithography) format this format is used for the 3D printers and next transfers into cura software. Cura converts .stl file into machine understandable file i.e. a G code in. up format.

IV. PROCESSING FUSION 360 MODEL USING CURA SOFTWARE

STL file prepared in FUAION 360 software and loaded into a Cura software which is a free print preparation software for the ultimate 3D printers. Slicing is done using this software. After slicing the file is save in G codes format and with is used as input for 3D printer for printing of the components. Each and every parameter required is modified as per the requirement in Cura software.

Table.4.1 parameters of model

s.no	Part name	Time taking toprint	Qty of material	colours
1	Gear box	9 hours	26g	green
2	Gear lock	4 hours	8g	green
3	Gear teeth	4 hours	8g	green
4	Body	11 hours	28g	green
5	piston	3 hours	5g	green
6	support	4 hours	7g	green
	Total	**35 hours**	**82g**	

Gearbox and Gear Lock and Gearing:

Table.4.2: Gearbox and Gear Lock and Gearing

	fast	normal	fine	Extra fine
Quality Layer height	0.4mm	0.15mm	0.1mm	0.06mm
Walls Wall thickness	0.8mm	0.8mm	0.8mm	0.8mm
Wall count line	2	2	2	2
Top/bottom				
Top/bottom thickness	0.8mm	1.0mm	1.0mm	1.0mm
Top thickness	0.8mm	1.0mm	1.0mm	1.0mm
Top layer	4	7	10	7
Bottom thickness	0.8mm	1.0mm	1.0mm	1.0mm
Bottom layer	4	7	10	7
In fill				
Infill density	15%	20%	20%	20%
Infill pattern	triangles	triangles	triangles	triangles
material				
Printing temperature	205◦c	200◦c	200◦c	195◦c
Build plate temperature	60◦c	60◦c	60◦c	60◦c
Speed				
Print speed	70mm/sec	70mm/sec	70mm/sec	70mm/sec
Time				
Estimated time	1hr 08 min	3hr 47min	2hr 45min	2hrs 10min
Material consumption	12g 1.45m	13g 1.65m	13g 1.64m	10g 1.22m

Table 4.3:Piston

	fast	normal	fine	Extra fine
Quality Layer height	0.2mm	0.15mm	0.1mm	0.03mm
Walls Wall thickness	0.8mm	0.8mm	0.8mm	0.8mm
Wall count line	2	2	2	2
		Top/bottom		
Top/bottom thickness	0.8mm	1.0mm	1.0mm	0.9mm
Top thickness	0.8mm	1.0mm	1.0mm	0.9mm
Top layer	4	7	10	3
Bottom thickness	0.8mm	1.0mm	1.0mm	0.9mm
Bottom layer	4	7	10	3
		In fill		
Infill density	15%	20%	20%	15%
Infill pattern	triangles	triangles	triangles	triangles
material				
Printing temperature	205•c	200•c	200•c	210•c
Build plate temperature	60•c	60•c	60•c	60•c
		Speed		
Print speed	70mm/sec	70mm/sec	70mm/sec	70mm/sec
Time				
Estimated time	1hr 08 min	1hr 47min	2hr 45min	56min
Material consumption	11g 1.45m	13g 1.65m	13g 1.64m	12g 1.33m

V. RESULTS AND DISCUSSION

A linear actuator is an actuator that creates linear motion, incontrast to the circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor.

As enthusiasts explore personalized motion systems, the future holds promise for more tailored solutions at a reduced cost, thanks to the accessibility of 3D printing and other off-the-shelf technologies.

The fabrication of linear motion using 3D printing is a fascinating field that intersects mechanical engineering, additive manufacturing, and precision control. Let's delve into the key aspects and conclusions related to this topic: Linear Actuators and Motion Systems in 3D Printing: Electric Linear Actuators: These critical components play a pivotal role in 3D printers. They enable precise movement of various parts, including the printing head. By providing axial movement with high precision, linear actuators ensure smooth and accurate motion during the printing process.

Belt Drives: Attached to a rotating motor, belt drives move printing components to their designated positions in 3D space. They are cost-effective, well-suited for long distances, and integrate seamlessly with the machine structure. However, regular inspections are necessary to maintain precision.

Screws: In high-precision areas, screws (such as ball screws or lead screws) are used. These systems feature rotary motors and linear spindles. While ball screws offer superior precision, lead screws are less efficient but still effective. A power loss can jam a screw system, unlike belt drives.

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Preparation and Characterization Aluminium Bronze Alloy

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***Abstract*— A Binary Alloy (Aluminum-Brone) is prepared with Aluminium as a base metal. An Al alloy has been prepared in a view to enhance strength, ductility and effective transfer load. Al binary alloy is prepared 0%, 11%,42%,50%, weight fractions. The Mechanical behaviour of alloy is studied in terms of hardness, tensile and compression. An increment of 20% hardness has been observed for 10% of reinforced alloy. Increased reinforcement enhanced the Mechanical properties such as yield strength and tensile strength.**

Keywords—Binary Alloy, hardness, tensile, compression, Al matrix.

I.INTRODUCTION

Alloy is a homogeneous mixture of two or more metals or a metal and a nonmetal in a fixed proportion by mass in their molten states. Alloying is a great way to improve the properties of a metal. alloy properties are frequently quite different from the properties of their individual components. When compared to pure metals, alloys frequently have higher strength and hardness. Red gold is an example of an alloy, which is created by combining copper and gold. Another important gold alloy is white gold, which is createdby combining silver and gold.

The process of alloying involves melting the constituent metals together and then allowing them to solidify. By controlling the proportions and types of elements added, engineers can be the alloy's properties to meet specific requirements.

Alloys offer numerous advantages over pure metals, including improved strength, hardness, ductility, and resistance to corrosion and wear. They have revolutionized industries and enabled the development of advanced technologies by providing materials with tailored properties suited to a wide range of applications.

II.EXPERIMENTAL DETAILS

2.1.1 Matrix

In the present investigation Aluminium was used as a matrixmaterial. The main application of Aluminium is in aircraft industry in producing numerous elements in the construction of aircrafts, and to make intricate shapes and patterns of aircraft industry. Aluminium is most widely used due its light weight, thermal conductivity, wear resistance, density, machinability, work ability and can be rolled, forged and extruded easily. Individually aluminium shows poor stiffness and tribological properties. Hence if the Aluminium matrix is combined with other elements, required properties can be obtained. follows. Al-99.77; Cu- 0.005; Fe-0.095; Mg-0.005; Mn-0.011;Si-0.083; Ni-0.015; Zn-0.013.

2.1.2 Reinforcement

The bronze is used as reinforcement in this project due to its high strength and stiffness applications includes its excellent corrosive resistance, and its joining, polishing and finishing characteristics. The presence of Aluminium makes bronze extremely resistance to many kinds of moisture such as heat exchangers and condensers.

2.1 Preparation of Alloy

The alloy Al-bronze preparation starts by melting pure Aluminium placed in clay graphite crucible kept at electric resistance heating furnace at 700C. After Aluminium melts at 700C, the furnace temperature increased to 950C. At this temperature bronze of weighed quantity is added and waited for 1 hour. To ensure the bronze dissolution, the melt is thoroughly mixed with a graphite tube. After melting was completed, the slag was removed which forms on the surface. After the melt was poured into the 20 pre heated mould. These ingots are homogenized by keeping them in heat treatment furnace at 100C for 24hours.

Fig 2.1: Electric furnace

Fig 2: 2 finger die

2.2 Hardnestest

The Vickers hardness test is a widely used method for measuring the hardness of materials, particularly metals, ceramics, and some polymers

Hardness test were carried on Vickers hardness test by taking 0.5kg load for dwell period of 10s. Hardness value was finalized by taking average of six reading for each.

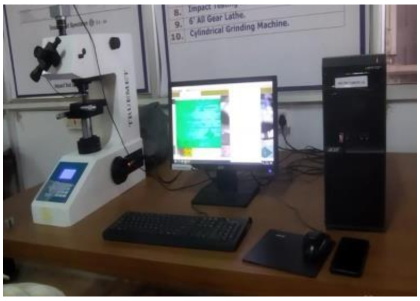

Fig 2. 3: Vickers hardness equipment

2.3 Characterization of Alloy

2.3.1 Tensile test

The tensile was performed on universal testing machine. Tensile test, otherwise known as strain test, exposes the specimen to a controlled strain until the scientific investigation of the materials fails. The results from the experiments are often used to select material applications, quality control and for see how the material will respond under different loads. Tensile strength of composites at room temperature was determined using computerized Universal test machine (400KN).

Fig 4:Tensile test

Fig:2.4. Compression test

The compression tests were performed by using computer operated universal testing machine (Model: MECHC.S/UTE40) the specimens are in between the lower table and upper cross head of U.T.M in such a way that the grains of the specimen are perpendicular to the direction of application of load the sample axis symmetrically. The compression tests were conducted on alloys with steady cross head speed. The loads and displacements were recorded and stored continuously in data logging system. the samples were taken with dimensions 15x20mm length. The samples were undergone 0%, 11%,42% & 50% weight fractions in height reduction.

Fig 5: Compression test

III.Results and Discussions

3.1 Hardness Studies

Hardness of the extruded alloy is high when compared to as cast alloy for the tested materials. The figure 6 graph also indicates hardness increased with increase in percentage of reinforcement. Figure 7 show the comparison of hardness between rule of mixture and measured values with respect to reinforcement. the effect of reinforcement content on hardness of the alloy.

S.NO	Percentage of Reinforcement	Hardness Value
1	0	95
2	11	153
3	42	205
4	50	282

Table 3.1: Hardness strength values

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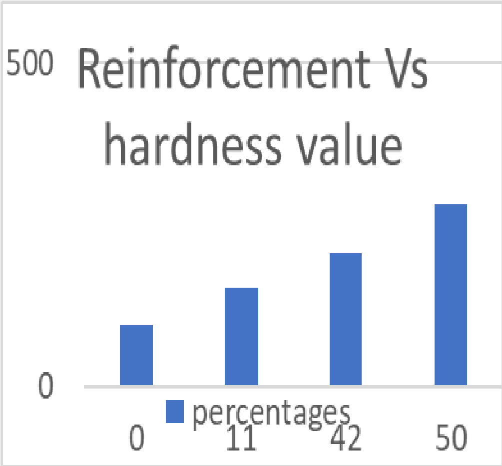

Fig 6:varaiations of hardness strength

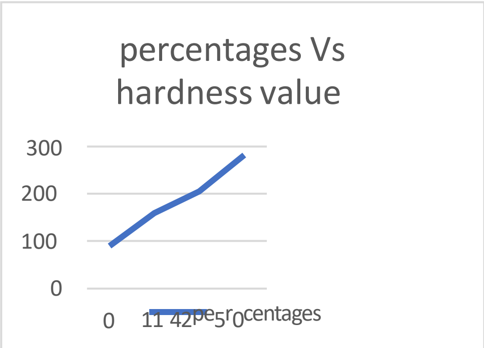

Fig 7: percentages Vs hardness value

3.2 Tensile studies:

The figure 8 graph represents the tensile behaviour of Al matrix and extruded alloy. The alloy with 11%,42% and 50% reinforcement shows better ultimate tensile strength compared to base Al matrix which is shown in figure 9.. The

% elongation is influenced by particle size & weight fraction of reinforcement. increase in weight percentage of reinforcement. Ultimate strength was increase but elongationpercentage had increased.

S. No	Percentageofreinforcement	Ultimatetensile strength(N/mm^2)
1	0	346
2	11	347
3	42	349
4	50	352

Table 2: tensile strength values

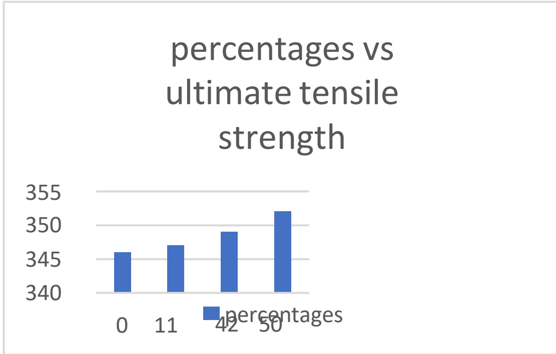

Fig 8:varaiations of tensile strength

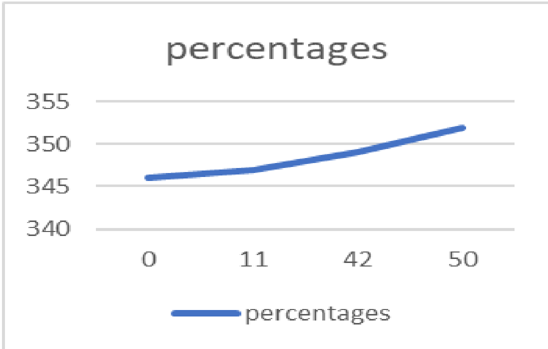

Fig 9:percentages Vs tensile strength

3.3 Compression studies:

The compression strength of Al matrix and mixture alloy of reinforcement shows better compression strength decreases and 50% of reinforcement was certainly decrease and breaks the alloy by compressive load. the figure 11graph represents the variations of compression strength decreases. Figure 12 represents the percentages Vs compressionstrength.

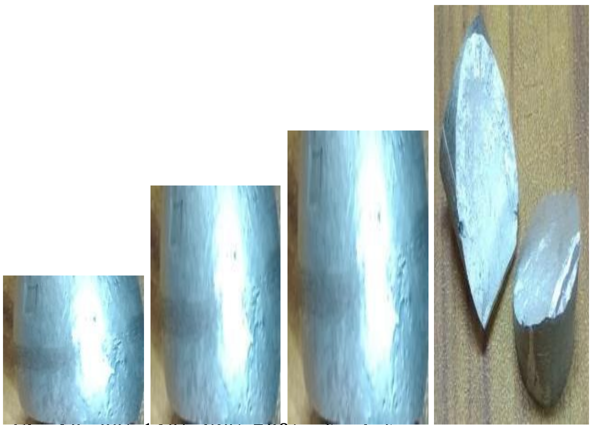

Fig 10: 0%,11%,42%,50% of reinforcement aftercompression test

S. No	Percentage o freinforcement	Compression strength (N/mm^2)
1	0	472
2	11	478
3	42	366
4	50	250

Table 3:compression strength values

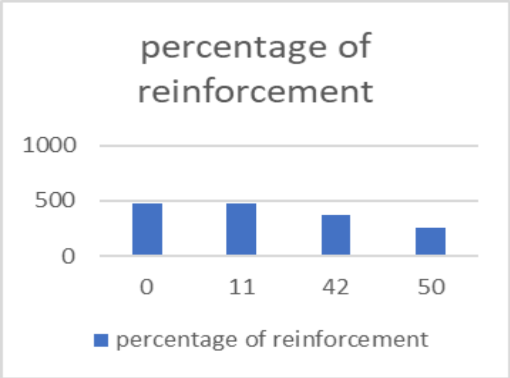

Fig 11:varaiations of compression strength

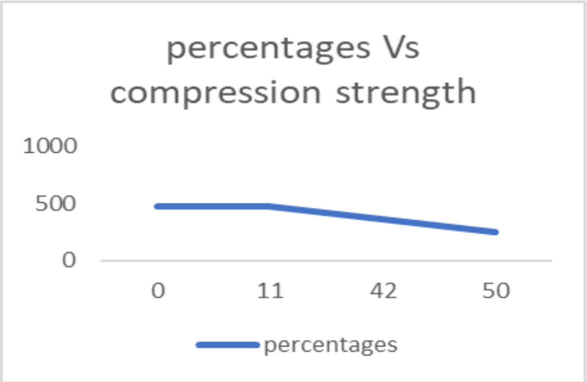

Fig 12:percentages Vs compression Strength

IV.CONCLUSION

In the present study the aim is to prepare Alloy with help of Manufacturing process and its characterization. For this pure Al is selected as matrix phase while bronze particles (11,42and50 wt. %) act as reinforcement with help of manufacturing process. We had successfully manufactured alloy and the following results were observed.

- The extruded alloy shows 50% high hardness compared to as alloy. Measured values of hardness are more than rule of mixture values due to increase in dislocation density and reduction in grain size.
- The 50% reinforcement alloy shows better ultimate ensile strength compared to other 11% reinforced alloy and base material due to the effective load distribution from matrix to the reinforced particles.
- The 50% reinforcement alloy shows the decrease of compressive strength compare to other 42% reinforced alloy and base material .it decrease due to high reinforcement in base material.

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Production And Characterization Of Ternary Alloy (Al-Cu-Mg) With Different Weight Fractons

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Abstract— **A new ternary alloy is prepared (Aluminum-Copper-magnesium) with aluminum as base material. An Al alloy has been prepared in a view to optimize strength, ductility and productive transfer of load. Ternary alloy is prepared Al, Al-20Cu-10Mg, Al-10Cu-10Mg, Al-5Cu-10Mg, Al-25Cu-5Mg, Al-25Cu-10Mg, Al-25Cu-15Mg weight fractions. the preparation method involves melting and casting the alloy in controlled conditions to optimize the Mechanical behavior of alloy is studied in terms of hardness, tensile and compression. An increment of 20% hardness has been observed for 10% of reinforced alloy. rise reinforcement improved the Mechanical properties such as yield strength and tensile strength. this comprehensive characterization into the relationship between following parameters.**

Key words: Tensile, Compression, Hardness, Ductility

I. INTRODUCTION

Ternary alloys stand at the forefront of innovation in mechanical engineering, offering a compelling fusion of three elemental components meticulously tailored to meet stringent performance criteria. These alloys, finely tuned for specific mechanical properties, serve as cornerstone materials in the design and fabrication of high-stress components, machinery, and structural elements. Through precise manipulation of composition, ternary alloys empower engineers to optimize strength, ductility, and corrosion resistance, ushering in a new era of efficiency and reliability in mechanical systems. "The Al-Cu-Mg ternary alloy represents a remarkable synergy of aluminum, copper, and magnesium, meticulously blended to harness a spectrum of mechanical properties crucial in aerospace, automotive, and structural applications. Known for its exceptional strength-to-weight ratio, corrosion resistance, and formability, this alloy stands as a cornerstone material in modern engineering. From aircraft fuselages to high-performance automotive components, the Al-Cu-Mg ternary alloy continues to redefine the boundaries of strength, durability, and specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) ease of use when formatting individual papers, (2) automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) conformity of style throughout a conference proceedings. versatility in materials science."

II. METHODOLOGY

A. *Plan of work*

For the Preparation of Ternary alloy the following materials are Matrix is Aluminum and Reinforcement materials are copper and magnesium.

B. *Casting process*

First melt aluminium in muffle furnace after melting of Al after that add copper and then increase temperature, after that melting of Cu, add magnesium wait for few minutes pour in to die after solidification we required specimen.

III. PROPOSED CHARACTERIZATION FOR PREPARED MATERIALS

Tensile
Compression
hardness

A. Tensile Test

Tensile strength refers to the load that a material with a particular cross-sectional area can withstand when loaded in tension under specified conditions. For example, a weight hanging on the end of a metal cable creates a tensile load in the cable. As more weight is continually added to the end of the cable, it will begin to stretch until it begins to permanently deform, or "yield," to the load. reaches its yield point which means that any more weight will cause the cable to permanently deform. If even more weights are added, the cable will eventually begin to neck down at one focal point and break. The various points of failure can be measured as stress which is defined as the force per unit area. The tensile strength results of the Al-Cu-Mg alloys of reinforcements Al-20Cu-10Mg, Al-10Cu-10Mg, Al-25Cu-10Mg as shown in figure. It is observed that ultimate tensile strength is increased by decreasing the percentage of copper in the alloy. This is due to better interfacial bonding between the matrix and reinforcement which transverses and distributes the load from the matrix to the reinforcement. Therefore, the reinforcements tends to bear the entire load that has acted upon the matrix. The addition of copper in the matrix induces less strength to matrix alloy by offering less resistance to tensile stresses.

B. *Compression Test*

- Compression tests are used to determine a material's behavior under applied crushing loads, and are typically conducted by applying compressive pressure to a test specimen using platens or specialized fixtures on a universal testing machine

C. *Hardness Test*

A Measure of the resistance to localized plastic deformation, such as an indentation (over an area) or a scratch (linear), induced mechanically either by pressing or abrasion. Hardness test were carried on Vickers hardness test by taking 0.5 kg load. Hardness value was finalized by taking average of three reading for each sample.

IV. TABLES AND FIGURES

Table I. Hardness Test Values

SI	Percentage of composition	LOAD (In	Penetration Time	Hardness Value (In

N o		Gram)	(In Secs)	Microns)
1	Al-5Cu-10Mg	500	10	153.12
2	Al-10Cu-10Mg	500	10	238.43
3	Al-20Cu-10Mg	500	10	294.04

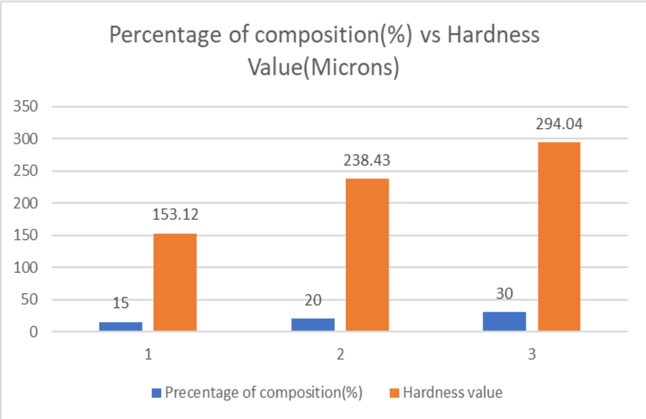

Fig I. Graph for Hardness values of desired compositions

Table II. Hardness Test Values

S No.	Percentage of composition	LOAD (In Grams)	Penetration Time (In Secs)	Hardness Value (In Microns)
1	Al-25Cu-15Mg	500	10	306.03
2	Al-25Cu-10Mg	500	10	317.63
3	Al-25Cu-5Mg	500	10	328.52

The above table shows hardness values. the hardness values are increasing in increase of copper. Al-20Cu-10Mg have more hardness. Here Magnesium is constant.

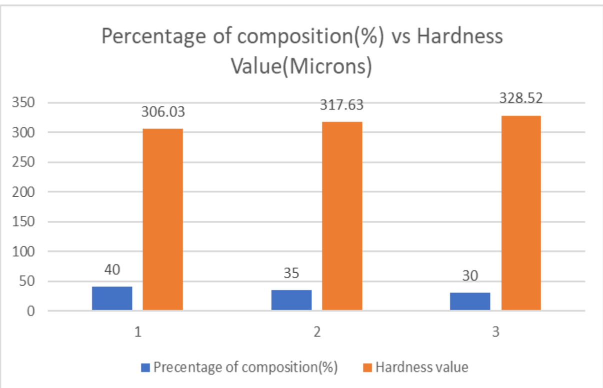

Fig II. Graph for Hardness values of desired compositions

The above table shows hardness values when copper is constant and Magnesium is varying. The hardness values are decreased due to increase of magnesium.

Table III. Tensile Test Values

SI No.	Percentage of Composition	Original Gauge Length (mm)	Final Gauge Length(mm)	Ult. Tensile Strength (N/mm2)
1	Al-20Cu-10Mg	100	200	90.36
2	Al-10Cu-10Mg	100	200	151.9
3	Al-5Cu-10Mg	100	200	277.9
4	Al-25Cu-5Mg	100	200	71.62

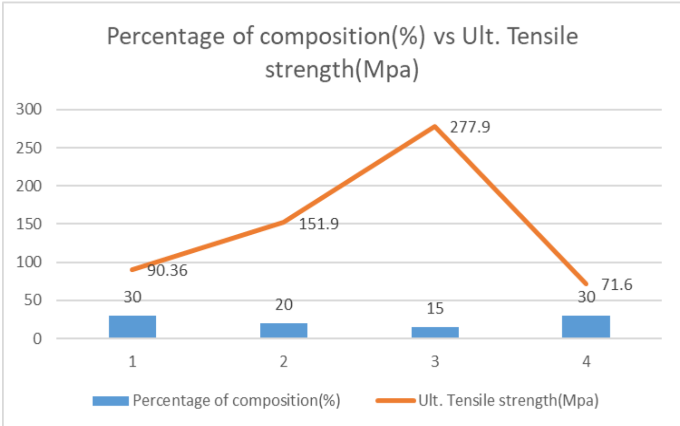

Fig III. Graph for Tensile values of desired compositions

The above table shows that ultimate tensile strength values decrease. When copper percentage increase the ultimate tensile strength is decrease.

Table IV. Compression Test Values

SI No.	Percentage of Composition	Ult. Compressive Strength(N/mm2)
1	Al-5Cu-10Mg	218.09
2	Al-10Cu-10Mg	593.49
3	Al-20Cu-10Mg	896.23

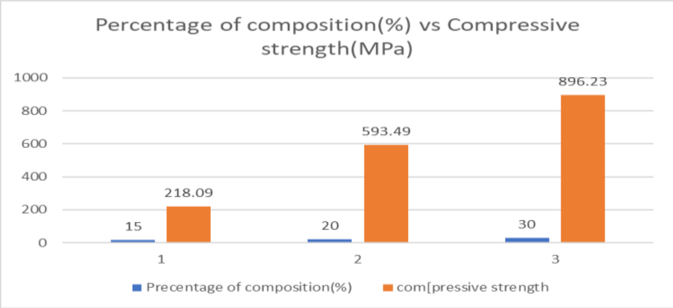

Fig IV. Graph for Compression Test Values of desired proportions

The above table shows the compressive strength values decrease of copper percentage decreasing and magnesium is constant.

Table V. Compression Test Values

SI No.	Percentage of Composition	Ult. Compressive Strength(N/mm2)
1	Al-25Cu-5Mg	231.89
2	Al-25Cu-10Mg	301.16
3	Al-25Cu-15Mg	45.15

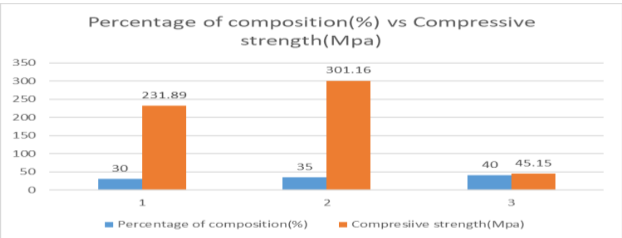

Fig V. Graph for Compression Test Values of desired proportions

The above table shows the compressive strength values increased and decreased according to the composition of magnesium and when copper is constant. The compressive strength is maximum when the composition is Al-25Cu-10Mg.

V Conclusions

The ternary alloy composed of Aluminium, Copper and Magnesium presents a unique combination of properties. This ternary alloy can achieve super strength, corrosion resistance, and lightweight characteristics compared to its individual constituent metals.

In Vickers Hardness Test the hardness of the alloy increases with increase in Cu and decrease in Mg. The maximum hardness attained at Al-25Cu-5Mg.

The tensile strength of the alloy increases with reinforcement content compared with the matrix. The maximum tensile strength attained at Al-5Cu-10Mg.

When copper(%) is increased and magnesium (%) is decreased(Al-25Cu-5Mg) the ultimate tensile strength is decreased.

The compressive strength of the alloy decrease with increase in reinforcement content. The maximum compressive strength attained at Al-20Cu-10Mg.

The compressive strength of the alloy (Al-25Cu-15Mg) is decreased due to the increase of Mg. Increase of Mg (%) increases brittleness of alloy increases.

VI Acknowledgment

The authors would like to thank Seshadri Rao Gudlavalleru Engineering College, Krishna District, Andhra Pradesh, for their support and encouragement throughout this research project. Special thanks to all the faculty members and col- leagues who provided valuable insights and feedback that contributed to the success of this endeavor.

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FABRICATION OF PNUEMATIC ARM HAMMER AND NAIL PULLER

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Abstract- **The Pneumatic Arm Hammer and Nail Puller represents a significant advancement in construction and wood working tools. By integrating the functionality of hammering and nail pulling into an efficient and user-friendly pneumatic system. This innovative device leverages compressed air to deliver powerful, precise hammering strokes for driving nails into a variety of materials with minimal effort and maximal accuracy. Simultaneously, it incorporates a robust nail pulling mechanism that effortlessly extracts nails from any material without causing damage. The present work explores the design principles, mechanical operation and practical applications of the Pneumatic Arm Hammer and Nail Puller, demonstrating its superiority over traditional manual tools in terms of speed, efficiency and ease of use. The system uses a pneumatic actuator powered by compressed air supply. The cylinder is attached with a hammering head to ensure hammering on the surface. The hammering head is also integrated with a nail puller which provides nail pulling operation. The experimentation carried on pulling and hammering different types of nails like common nails, box nails, finish nails etc. having different sizes. The minimum force required to pull the nails is 50lbf and the maximum force is approximately 150lbf. The maximum and minimum forces vary based on the size of the nails.**

I. INTRODUCTION

A traditional nail puller has a pair of hinged jaws which grip nails in order to pull them out. The burp jaws allow the tool to be hit into the wood, or wall with either its handle or a separate hammer. The jaws then grip the nail before being pivoted over to remove it. When using a nail puller be aware that causing damage in the surface. Some nail pullers will cause a lot of damage to the material the nail is being pulled from, while others have been designed to minimize this damage. Traditional nail pullers aim to minimize damage to the wood or wall but they are all likely to leave some surface damage and are not intended to be used for fine finishing work. For removing finishing nails, with minimum damage to the surface, it is usually recommended to pull them from the back of the wood with a plier tool. Jawed nail puller, traditional nail puller, nail remover, removing a flushed nail,
antique nail puller. The basic design of this nail puller has not changed much in well over a hundred years, and antique versions of the tool are still available to buy. There are many types of nails, brads and tacks, which can come in various sizes, shapes and styles, depending on their uses. Because of this huge range of nail types, you will find there are several types of nail puller, or remover, and they can be referred to with names, nail lifter, detailer, nail claw and cat's paw are all common names used for nail removers, and they are often interchangeable.

Once the function of the valve has been determined, look at the required flow capacity. The usual first step is to use the air cylinder bore, stroke and cycle rate to determine a flow rate in standard cubic feet per minute (SCFM). Many valve suppliers will list a flow rate at a particular inlet pressure and pressure drop. Others will list this value as a factor CVSs, which has no units. For a more thorough explanation, check out our Interactive CVS Calculator here. Oversized valves often cost more and will use more air.

II. PROBLEM IDENTIFICATION

The introduction of the Pneumatic Arm Hammer and Nail Puller marks a significant advancement in construction and woodworking technology. This innovative tool combines the functionalities of a hammer and nail puller, leveraging pneumatic power for enhanced efficiency and precision. Traditional hammering and nail-pulling techniques often entail physical strain and lack finesse, prompting the need for a more sophisticated solution. The Pneumatic Arm Hammer and Nail Puller address these challenges by integrating powerful pneumatic strikes and effortless nail extraction, promising to revolutionize the way tasks are approached in these industries.

III. METHODOLOGY

The methodology for developing the Pneumatic Arm Hammer and Nail Puller involves initial research on existing pneumatic tools and traditional hammering and nail-pulling techniques. Following this, design concepts are generated with a focus on ergonomics and efficiency. Prototypes are then created using CAD software and 3D printing technology, and subsequently
tested for functionality and durability. Feedback from testing is used to refine the design iteratively. Finally, the integration of pneumatic technology is executed, and the performance of the final prototype is evaluated for effectiveness and user satisfaction. A nail puller mechanism is fixed to the pneumatic arm. The claw or pincer is positioned around the nail's head. The pneumatic arm then provides the necessary force to grip and pull.

IV.PARTS

- Pneumatic Cylinder DNC 32x50-S, pressure 0.5-1 MPa
- Hammer Head of Metal
- Nail Puller
- Spring
- Dampers
- Arm Attachments
- Supporting Frame
- Base Frame
- Controlling Circuitry
- Operation Button
- LED's
- Mounts and Joints
- Screws and Bolts

V. MODELING

Fins improve heat transfer in two ways. One way is by creating turbulent flow through fin geometry, which reduces the thermal resistance (the inverse of the heat transfer coefficient) through the nearly stagnant film that forms when fluid flows parallel to a solid surface. A second way is by increasing the fin density, which increases the heat transfer area that encounters the fluid. Fin geometries and densities that create turbulent flow and improve performance also increase pressure drop, which is a critical requirement in most high-performance applications. The optimum fin geometry and fin density combination is then a compromise of performance, pressure drop, weight, and size. A figure-of-merit comparison based on performance, pressure drop, weight, and size among common fin types is described in "Air Cooled Compact Heat Exchanger Design for Electronics Cooling." Aside from fin geometry, parameters such as thickness, height, pitch, and spacing can also be altered to improve performance. Typically, fin thicknesses vary from 0.004 in (0.1 mm) to 0.012 in (0.3 mm), heights vary from 0.035 in (0.89 mm) to 0.6 in (15.24 mm), and densities vary from 8 to 30 FPI (Fins per Inch).

VI.ANALYSIS

- Pneumatic System Design
- The design of the pneumatic system includes a compressed air chamber, control valves, and actuators, ensuring optimal performance and reliability.
- Hammering Mechanism
- The hammering mechanism is designed to deliver rapid and powerful blows, incorporating features such as adjustable power settings and impact control for versatile use.
- Nail Pulling Mechanism
- The nail puller features a secure gripping mechanism designed to clamp onto various nail sizes and types, with a user-friendly activation mechanism for efficient nail removal.
- Material Selection
- Durability
- Materials such as high-strength steel and durable plastics are selected to ensure the tool's longevity and withstand the high forces and pressures exerted during operation.
- Weight Consideration
- Selecting lightweight yet robust materials contributes to the tool's overall ergonomics, reducing operator fatigue and enhancing usability.
- Design Validation and Testing
- Prototype Testing
- A functional prototype is developed to validate the design, incorporating features such as pressure sensors, force gauges, and safety mechanisms to assess performance and reliability.

VII.RESULTS AND DISCUSSION

Experimentation Conducted on Nails Hammered

Table 4.1 Represents Experimentation Conducted on different types of nails having different sizes and the force required to hammer nails**.**

S. No	Types of Nails	Size (Inches)	Force (lbf)
1	Common Nails	2	100-150
2	Duplex Nails	2	110-160
3	Casing Nails	2	100-150
4	Box Nails	2	90-130
5	Roofing Nails	1.75	100-140
6	Sinker Nails	3	120-170

Table 4.1. Experimental values on nail Hammered

Experimentation Conducted on Nails Pulled

Table 4.2 Represents Experimentation Conducted on different types of nails having different sizes and the force required to pull nails

S. No	Types of Nails	Size (Inches)	Force (lbf)
1	Common Nails	2	100-150
2	Finish Nails	2	80-120
3	Brad Nails	1	50-80
4	Galvanised Nails	2	100-150
5	Box Nails	2	90-130

Table 4.2. Experimental values on nail pulled

When categorizing nails based on their application, particularly focusing on whether they are intended to be hammered into materials or designed for ease of removal (pulled), we can summarize the key characteristics and uses of each type as follows. The main distinction between these two categories lies in their intended permanence and ease of removal. Nails designed to be hammered are generally for more permanent constructions and offer a variety of shapes and sizes to suit different materials and uses. Those intended to be pulled offer solutions for temporary constructions or situations where adjustments might be necessary, featuring design elements that facilitate easier removal. Each type of nail serves a unique purpose in construction and woodworking, emphasizing the importance of selecting the right nail for the specific task at hand. This consideration of future needs and potential adjustments underscores the importance of selecting the right type of nail for the task at hand, balancing between the need for permanence and the flexibility for change.

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VIII.CONCLUSION & FUTURESCOPE

The Pneumatic Arm Hammer and Nail Puller stands as a landmark innovation in the realm of construction and woodworking tools, epitomizing the fusion of efficiency, precision, and user centric design by leveraging pneumatic technology to streamline the traditionally laborious processes of hammering and nail pulling, the device not only enhances productivity but also significantly reduces the physical strain on users, marking a leap forward in occupational health and safety within its application environments .The positive reception and performance feedback from field tests underscore its potential to redefine industry standards and practices. The experimentation carried on pulling and hammering different types of nails like common nails, box nails, finish nails etc having different sizes. The minimum force required to pull the nails is 50lbf and the maximum force is approximately 150lbf. The maximum and minimum forces vary based on the size of the nails.

Future enhancements will focus on further optimizing its energy efficiency, adapting the device for a wider range of materials, and integrating smart technology for precision control and monitoring. The Pneumatic Arm Hammer and Nail Puller has set a new benchmark, but the quest for improvement and adaptation to emerging construction challenges continues. As such, it invites ongoing research, development, and collaboration across disciplines to fully realize its potential and spearhead the next generation of construction tools.

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ANALYSIS OF ULTRASONIC TESTING ON HOT ROLLED MILD STEEL PLATE

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***ABSTRACT*-Product quality has always been one of the most important aspects of manufacturing operation. In present global economy and competition, continuous improvement in quality has become a major priority for various industrialized countries including India. In this percept Non-destructive evaluation is a wide and interdisciplinary field used to detect and verify the quality of products.**

By using various Non-Destructive Evaluation Techniques internal defects are tested in such a manner that product integrity and surface texture remains unchanged. In the present study, a test specimen of Hot Rolled Mild Steel Plate is taken to identify the discontinuities like Lamination defects, Inclusions, edge cuttings, cracks, rolling mark's etc., by Ultrasonic Flaw Detector using Straight Beam Probe.

Key words: Non-Destructive testing; NDT methods; Ultrasonic testing

I. INTRODUCTION

Importance of NDT-NDT plays an important role in the quality control of a product. It is used during all the stages of manufacturing of a product. It is used to monitor the quality of the:

(a) Raw materials which are used in the construction of the product.
(b) Fabrication processes which are used to manufacture the product.
(c) Finished product before it is put into service.

Use of NDT during all stages of manufacturing results in the following benefits:

(a) Increases the safety and reliability of the product during operation.
(b) Decreases the cost of the product by reducing scrap and conserving materials, labor and energy.
(c) It enhances the reputation of the manufacturer as producer of quality goods.

All of the above factors boost the sales of the product which bring more economical benefits to the manufacturer .NDT is also used widely for routine or periodic determination of quality of the plants and Structures during This not only increases the safety of operation but also eliminates any forced shut down of the plants.

II.TYPES OF NDT METHODS

The methods of NDT range from the simple to the complicated. Visual inspection is the simplest of all. Surface imperfections invisible to the eye may be revealed by penetrant or magnetic methods. If really serious surface defects are found, there is often little point in proceeding to more complicated examinations of the interior by ultrasonic or radiography. NDT methods may be divided into groups for the purposes of these notes: conventional and nonconventional.

Visual Testing (VT)

Often overlooked in any listing of NDT methods, visual inspection is one of the most common and most powerful means of non-destructive testing. Visual testing requires adequate illumination of the test surface and proper eye-sight of the tester. To be most effective visual inspection does however, merit special attention because it requires training (knowledge of product and process, anticipated service conditions, acceptance criteria, record keeping, for example) and it has its own range of equipment and instrumentation. It is also a fact that all defects found by other NDT methods ultimately must be substantiated by visual inspection. Visual testing can be classified as direct visual testing, remote visual testing and translucent visual testing. The most common NDT methods MT and PT are indeed simply scientific ways of enhancing the indication to make it more visible. Often the equipment needed is simple Figure.

Liquid Penetrant Testing

Liquid penetrate testing is one of the oldest and simplest NDT methods where its earliest versions (using kerosene and oil mixture) date back to the 19th century. This method is used to reveal surface discontinuities by bleed out of a colored or fluorescent dye from the flaw. The technique is based on the ability of a liquid to be drawn into a "clean" surface discontinuity by capillary action. After a period of time called the "dwell time", excess surface penetrant is removed and a developer applied. This acts as a blotter that draws the penetrant from the discontinuity to reveal its presence.

It improves the detestability of a flaw due to the high level of contrast between the indication and the background which helps to make the indication more easily seen (such as a red indication on a white background for visible penetrant or a penetrant that glows under ultraviolet light for fluorescent penetrant.

Liquid penetrant testing is one of the most widely used NDT methods. Its popularity can be attributed to two main factors: its relative ease of use and its flexibility. It can be used to inspect almost any material provided that its surface is not extremely rough or porous. Materials that are commonly inspected using this method include, metals, glass, many ceramic materials, rubber and plastics. However, liquid penetrant testing can only be used to inspect for flaws that break the surface of the sample (such as surface cracks, porosity, laps, seams, lack of fusion, etc.

Steps In Penetration Testing:

Pre-Cleaning

Applying Penetrant

Dwell Time

Removable Of Excess Penetrant

Applying Developer

Developing Time

Interpretation

Post Cleaning

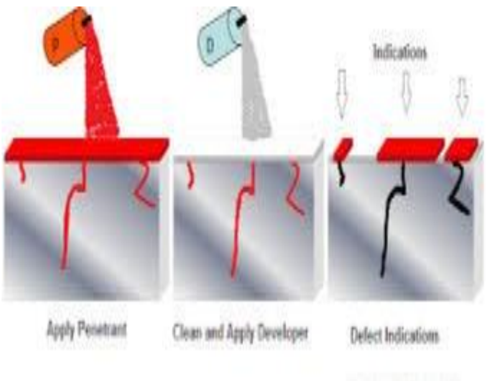


Fig 1: Liquid Penetration Test

Magnetic Particle Testing (MPT)

Magnetic particle testing is one of the most widely utilized NDT methods since it is fast and relatively easy to apply and part surface preparation is not as critical as it is for some other methods. This method uses magnetic fields and small magnetic particles to detect flaws in components. The only requirement from an inspect ability standpoint is that the component being inspected must be made of a ferromagnetic material such as iron, nickel, cobalt, or some of their alloys.

The method is used to inspect a variety of product forms including castings, forgings, and weldments. Many different industries use magnetic particle inspection such as structural steel, automotive, petrochemical, power generation, and aerospace industries. Underwater inspection is another area where magnetic particle inspection may be used to test items such as offshore structures and underwater pipelines. Basic principle "Magnetic Flux Leakage".

Steps In MPT

Pre-Cleaning
Demagnetization (If required)
Applying White Contrast

Applying Magnetic Medium
Interpretation
De Magnetization
Post Cleaning

Fig 2: Permanent Magnet

Ultrasonic Testing

Ultrasonic Testing (UT) uses high frequency sound waves (typically in the range between 05 and 15 MHz) to conduct examinations and make measurements. Besides its wide use in engineering applications (such as flaw detection/evaluation, dimensional measurements, material characterization, etc.), ultrasonic are also used in the medical field (such as sonography, therapeutic ultrasound, etc.).

In general, ultrasonic testing is based on the capture and quantification of either the reflected waves (pulse-echo) or the transmitted waves (through-transmission). Each of the two types is used in certain applications, but generally, pulse echo systems.

Fig 3: Specimen Scanning

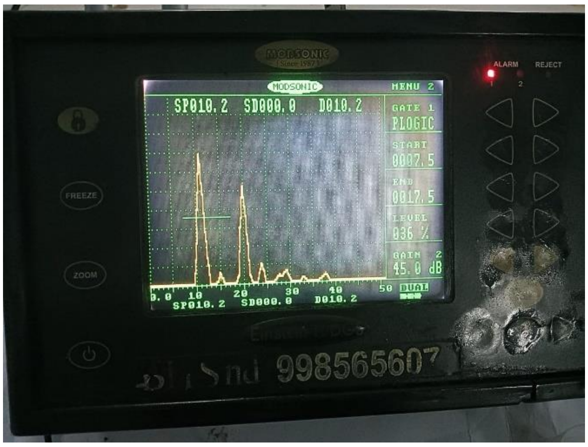


Fig 4: Defect Indication

Basic principle "Acoustic Impedance Mismatch"

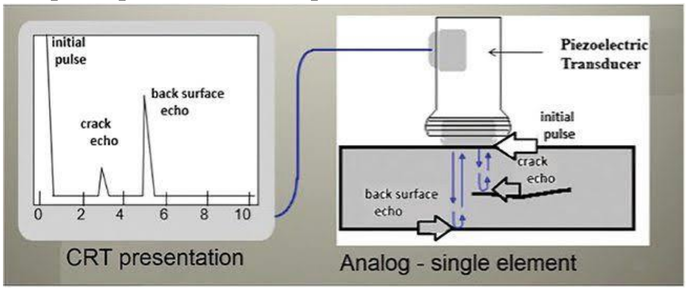


Fig 5: Ultrasonic Testing

A typical pulse-echo UT inspection system consists of several functional units, such as the pulser/receiver, transducer, and a display device. A pulser/receiver is an electronic device that can produce high voltage electrical pulses. Driven by the pulser, the transducer generates high frequency ultrasonic energy. The sound energy is introduced and propagates through the materials in the form of waves. When there is a discontinuity (such as a crack) in the wave path, part of the energy will be reflected back from the flaw surface.

The reflected wave signal is transformed into an electrical signal by the transducer and is displayed on a screen. Knowing the velocity of the waves, travel time can be directly related to the distance that the signal travelled. From the signal, information about the reflector location, size, orientation and other features can sometimes be gained.

Radiographic Testing

Radiography is used in a very wide range of applications including medicine engineering, forensics, security, etc. In NDT, radiography is one of the most important and widely used methods. Radiographic testing (RT) offers a number of advantages over other NDT methods, however, one of its major disadvantages is the health risk associated with the radiation.

In general, RT is method of inspecting materials for hidden flaws by using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials. The intensity of the radiation that penetrates and passes through the material is either captured by radiation sensitive film (Film Radiography) or by a planer array of radiation sensitive sensors (Real-time Radiography). Film radiography is the oldest approach, yet it is still the most widely used in NDT.

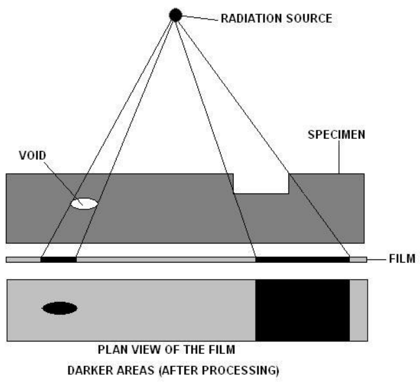


Fig 6: Radiographic Scanning

III.INTRODUCTION TO ULTRASONIC TESTING

Ultrasonic examination is a non-destructive method in which beams of high-frequency sound waves are introduced into materials for the detection of surface and subsurface flaws in the material. The sound waves travel through the material with some attendant loss of energy (attenuation) and are reflected at interfaces. The reflected beam is displayed and then analyzed to define the presence and location of flaws or discontinuities.

The degree of reflection depends largely on the physical state of the materials forming the interface and to a lesser extent on the specific physical properties of the material. For example, sound waves are almost completely reflected at metal/gas interfaces. Partial reflection occurs at metal/liquid or metal/solid interfaces, with the specific percentage of reflected energy depending mainly on the ratios of certain properties of the material on opposing sides of the interface.

Cracks, laminations, shrinkage cavities, bursts, flakes, pores, and other discontinuities that produce reflective interfaces can be easily detected. Inclusions and other in homogeneities can also be detected by causing partial reflection or scattering of the ultrasonic waves or by producing some other detectable effect on the ultrasonic waves. Most ultrasonic inspection instruments detect flaws by monitoring one or more of the following:

- Reflection of sound from interfaces consisting of material boundaries or discontinuities within the metal itself
- Time of transit of a sound wave through the test piece from the entrance point at the transducer to the exit point at the transducer.
- Attenuation of sound waves by absorption and scattering within the test piece.
- Features in the spectral response for either a transmitted or a reflected signal.

Most ultrasonic inspection is done at frequencies between 0.1 and 25 MHz-well above the range of human hearing, which is about 20 Hz to 20 kHz. Ultrasonic waves are mechanical vibrations; the amplitudes of vibrations in metal parts being ultrasonically inspected impose stresses well below the elastic limit, thus preventing permanent effects on the parts. Many of the characteristics described in this article for ultrasonic waves. especially in the section "General Characteristics of Ultrasonic Waves," also apply to audible sound waves and to wave motion in general.

Ultrasonic inspection is one of the most widely used methods of non-destructive inspection. Its primary application in the inspection of metals is the detection and characterization of internal flaws, it is also used to detect surface flaws, to define bond characteristics, to measure the thickness and extent of corrosion, and (much less frequently) to determine physical properties, structure, grain size, and elastic constants.

Basic Equipment

Most ultrasonic inspection systems include the following basic equipment:

- An electronic signal generator that produces bursts of alternating voltage (a negative spike or a square wave) when electronically triggered.
- A transducer (probe or search unit) that emits a beam of ultrasonic waves when bursts of alternating voltage are applied to it.
- A couplet to transfer energy in the beam of ultrasonic waves to the test piece.
- A couplet to transfer the output of ultrasonic waves (acoustic energy) from the test piece to the transducer.
- A transducer (can be the same as the transducer initiating the sound or it can be a separate one) to accept and convert the output of ultrasonic waves from the test piece to corresponding bursts of alternating voltage. In most systems, a single transducer alternately acts as sender and receiver.
- An electronic device to amplify and, if necessary, demodulate or otherwise modify the signals from the transducer.
- A display or indicating device to characterize or record the output from the test piece. The display device may be a CRT, sometimes referred to as an oscilloscope: a chart or strip recorder, a marker, indicator, or alarm device; or a computer printout.
- An electronic clock, or timer, to control the operation of the various components of the system, to serve as a primary reference point, and to provide coordination for the entire system.

Circuits

Electronic Equipment

Although the electronic equipment used for ultrasonic inspection can vary greatly in detail among equipment manufacturers, all general-purpose units consist of a power supply, a pulser circuit, a search unit, a receiver-amplifier circuit, an oscilloscope, and an electronic clock.

Many systems also include electronic equipment for signal conditioning, gating, automatic interpretation, and integration with a mechanical or electronic scanning system. Moreover, advances in microprocessor technology have extended the data acquisition and signal-processing capabilities of ultrasonic inspection systems.

Power Supply

Circuits that supply current for all functions of the instrument constitute the power supply, which is usually energized by conventional 115-V or 230-V alternating current. There are, however, many types and sizes of portable instruments for which the power is supplied by batteries contained in the unit.

Pulser Circuit

When electronically triggered, the pulser circuit generates a burst of alternating voltage The principal frequency of this burst, its duration, the profile of the envelope of the burst, and the burst repetition rate may be either fixed or adjustable, depending on the flexibility of the unit.

Search Units

The transducer is the basic part of any search unit. A sending transducer is one to which the voltage burst is applied, and it mechanically vibrates in response to the applied voltage. When appropriately coupled to an elastic medium, the transducer thus serves to launch ultrasonic waves into the material being inspected.

A receiving transducer converts the ultrasonic waves that impinge on it into a corresponding alternating voltage. In the pitch-catch mode, the transmitting and receiving transducers are separate units; in the pulse-echo mode, a single transducer alternately serves both functions. The various types of search units are discussed later in this article.

Control Systems

Even though the nomenclature used by different instrument manufacturers may vary, certain controls are required for the basic functions of any ultrasonic instrument. These functions include power supply, clock, pulser, receiver-amplifier, and display. In most cases, the entire electronic assembly, including the controls, is contained in one instrument. A typical pulse-echo instrument is shown in Fig.

Fig 7: Flaw Detector

The power supply is usually controlled by switches and fuses. Time delays can be incorporated into the system to protect circuit elements during warm-up. The pulses of ultrasonic energy transmitted into the test piece are adjusted by controls for pulse-repetition rate, pulse length, and pulse tuning. A selector for a range of operating frequencies is usually labelled "frequency," with the available frequencies given in megahertz.

For single-transducer inspection, transmitting and receiving circuits are connected to one jack, which is connected to a single transducer. For double-transducer inspection, such as through transmission or pitch-catch inspection, a T (transmit) jack is provided to permit connecting one transducer for use as a transmitter, and an R (receive) jack is provided for the use of another Tran shaver for receiving only. A selector switch (test switch) for through (pitch catch) or normal (pulse echo) transmission is provided for control of the T and R jacks.

Gain controls for the receiver amplifier circuit usually consist of fine and coarse- sensitivity selectors or one control marked "sensitivity." For a clean video display, with low-level electronic noise eliminated, a reject control can be provided.

The display (oscilloscope) controls are usually screwdriver adjusted, with the exception of the scale illumination and power on/off. After initial setup and collaboration, the screwdriver-adjusted controls seldom require additional adjustment. The controls and their functions for the display unit usually consist of the following:

- Controls for vertical position of the display on the oscilloscope screen.
- Controls for horizontal position of display on the oscilloscope screen.
- Controls for brightness of display.
- Control for adjusting focus of trace on the oscilloscope screen.
- Controls to correct for distortion or astigmatism that may be introduced as the electron beam sweeps across the oscilloscope screen.
- A control that varies the level of illumination for a measuring grid usually incorporated in the transparent faceplate covering the oscilloscope screen.
- Timing controls, which usually consist of sweep-delay and sweep-rate controls, to provide coarse and fine adjustments to suit the material and thickness of the test piece. The sweep-delay control is also used to position the sound entry point on the left side of the display screen, with a back reflection or multiples of back reflections visible on the right side of the screen.
- On/off switch

IV.PIEZOELECTRIC ELEMENT

Transducer Elements

The generation and detection of ultrasonic waves for inspection are accomplished by means of a transducer element acting through a couplet. The transducer element is contained within a device most often referred to as a search unit (or sometimes as a probe). Piezoelectric elements are the most commonly used transducer in ultrasonic inspection, although EMA transducers and magnetostriction transducers are also used.

Piezoelectric Transducers

Piezoelectricity is pressure-induced electricity, this property is characteristic of certain naturally occurring crystalline compounds and some man-made materials. As the name piezoelectric implies, an electrical charge is developed by the crystal when pressure is applied to it. Conversely, when an electrical field is applied, the crystal mechanically deforms (changes shape). Piezoelectric crystals exhibit various deformation modes; thickness expansion is the principal mode used in transducers for ultrasonic inspection. The most common types of piezoelectric materials used for ultrasonic search units are quartz, lithium sulphate, and polarized ceramics such as barium titanate, lead zirconated titanate, and lead meta niobate.

Quartz Crystals

These were initially the only piezoelectric elements used in commercial ultrasonic transducers. Properties of the transducers depended largely on the direction along which the crystals were cut to make the active transducer elements.

Principal advantages of quartz-crystal transducer elements are electrical and thermal stability, insolubility in most liquids, high mechanical strength, wear resistance, excellent uniformity, and resistance to aging.

A limitation of quartz is its comparatively low electromechanical conversion efficiency, which results in low loop gain for the system.

Lithium Sulphate

The principal advantages of lithium sulphate transducer elements are ease of obtaining optimum acoustic damping for best resolution, optimum receiving characteristics, intermediate conversion efficiency, and negligible mode interaction. The main disadvantages of lithium sulphate elements are fragility and a maximum service temperature of about 75 °C (165 °F).

Polarized Ceramics

Generally, have high electromechanical conversion efficiency, which results in high loop gain and good search-unit sensitivity. Lead zirconated titanate is mechanically rugged, has a good tolerance to moderately elevated temperature, and does not lose polarization with age. It does have a high piezoelectric response in the radial mode, which sometimes limits its usefulness.

Barium titanate is also mechanically rugged and has a high radial-mode response. However, its efficiency changes with temperature, and it tends to depolarize with age. which makes barium titanate less suitable for some applications than lead zirconated titanate. Lead meta niobate exhibits low mechanical damping and good tolerance to temperature. Its principal limitation is a high dielectric constant, which results in a transducer element with a high electrical capacitance.

Selection of a piezoelectric transducer for a given application is done on the basis of size (active area) of the piezoelectric element, characteristic frequency, frequency bandwidth, and type (construction) of search unit. Descriptions of various types of search units with piezoelectric elements are given in the section "Search Units" in this article. Different piezoelectric materials exhibit different electrical-impedance characteristics. In many cases, tuning coils or impedance-matching transformers are installed in the search- unit housing to render a better impedance match to certain types of electronic instrumentation. It is important to match impedances when selecting a search unit for a particular instrument.

Both the amount of sound energy transmitted into the material being inspected (radiated power) and beam divergence are directly related to the size (active area) of the transducer element.

Thus, it is sometimes advisable to use a larger search unit to obtain greater depth of penetration or greater sound beam area.

Each transducer has a characteristic resonant frequency at which ultrasonic waves are most effectively generated and received. This resonant frequency is determined mainly by the material and thickness of the active element. Any transducer responds efficiently at frequencies in a band cantered on the resonant frequency.

The extent of this band, known as bandwidth, is determined chiefly by the damping characteristics of the backing material that is in contact with the rear face of the piezoelectric element.

Straight-beam contact-type units

Manufacturing-induced flaws: -
Billets: inclusions, stringers, pipe
Forgings: inclusions, cracks, segregations, seams, flakes,
Pipe Rolled Products: laminations, inclusions, tears, seams, racks
Castings: slag, porosity, cold shuts, tears, shrinkage cracks, inclusions
Service-induced flaws: -
Fatigue cracks, corrosion, erosion, stress-corrosion cracks

Angle-beam contact-type units

Manufacturing - Induced flaws: -
Forgings: cracks, seams, laps
Rolled products: tears, seams, cracks, cupping
Welds: slag inclusions, porosity, incomplete fusion, incomplete penetration, drop through, suck back, cracks in filler metal and base metal Tubing and pipe: circumferential and longitudinal cracks
Service-induced flaws: -
Fatigue cracks, stress-corrosion cracks
Dual-element contact-type units
Manufacturing-induced flaws: -
Plate and sheet: thickness measurements, lamination detection
Tubing and pipe:
Service-induced flaws: -
Wall thinning, corrosion, erosion, stress-corrosion cracks

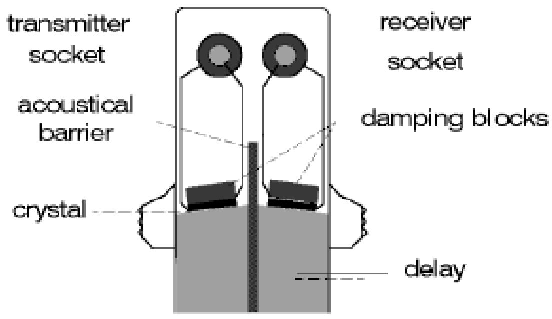


Fig 8: Nomenclature of Angular Probe

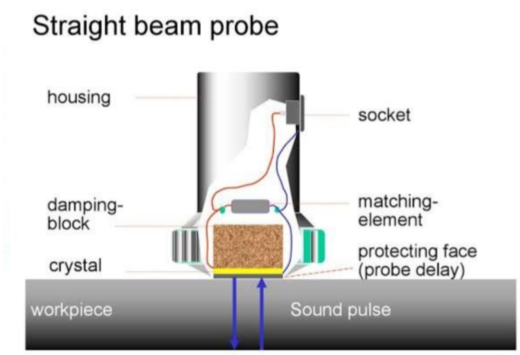


Fig 9: Nomenclature of Straight Probe

Contact-Type Units

Although contact-type search units can sometimes be adapted to automatic scanning. they are usually hand held and manually scanned in direct contact with the surface of a test piece. A thin layer of an appropriate couplet is almost always required for obtaining transmission of sound energy across the interface between the search unit and the entry surface.

V.ANGLE BEAM PROBE (SHEARWAVE)

Angle-Beam Units

The construction of an angle-beam contact-type search unit. A plastic wedge between the piezoelectric element and the contact surface establishes a fixed angle of incidence for the search unit. The plastic wedge must be designed to reduce or eliminate internal reflections within the wedge that could result in undesired false echoes.

Angle-beam search units are used for the inspection of sheet or plate, pipe welds or tubing, and test pieces having shapes that prevent access for straight beam. Angle-beam search units can be used to produce shear waves or combined shear and longitudinal waves, depending on the wedge angle and test piece material.

There is a single value of wedge angle that will produce the desired beam direction and wave type in any given test piece. A search unit having the appropriate wedge angle is selected for each specific application.

The surface wave search unit is an angle-beam unit insofar as it uses a wedge to position the crystal at an angle to the surface of the test piece. It generates surface waves by mode conversion as described in the section "Critical Angles" in This article. The wedge angle is chosen so that the shear wave refraction angle is 90" and the wave resulting from mode conversion travels along the surface.

Couplet

Air is a poor transmitter of sound waves at megahertz frequencies, and the impedance mismatch between air and most solids is great enough that even a very thin layer of air will severely retard the transmission of sound waves from the transducer to the test piece. To perform satisfactory contact inspection with piezoelectric transducers, it is necessary to eliminate air between the transducer and the test piece by the use of a couplet.

Couplet normally used for contact inspection include water, oils, glycerin, petroleum greases, silicone grease, wallpaper paste, and various commercial paste like substances. Certain soft rubbers that transmit sound waves may be used where adequate coupling can be achieved by applying hand pressure to the search unit.

The following should be considered in selecting a couplet:

- Surface finish of test piece.
- Temperature of test surface Possibility of chemical reactions between test surface and couplet.
- Cleaning requirements (some couplets are difficult to remove)

Water is a suitable couplet for use on a relatively smooth surface; however, a wetting agent should be added. It is sometimes appropriate to add glycerin to increase viscosity. however, glycerin tends to induce corrosion in aluminum and therefore is not recommended in aerospace applications.

Heavy oil or grease should be used on hot or vertical surfaces or on rough surfaces where irregularities need to be filled.

Heavy oil, grease, or wallpaper paste may not be good choices when water will suffice, because these substances are more difficult to remove. Wallpaper paste, like some proprietary couplet, will harden and may flake off if allowed to stand exposed to air When dry and hard, wallpaper paste can be easily removed by blasting or wire brushing Oil or grease often must be removed with solvents.

Couplet used in contact inspection should be applied as a uniform, thin coating to obtain uniform and consistent inspection results. The necessity for a couplet is one of the drawbacks of ultrasonic inspection and may be a limitation, such as with high-temperature surfaces. When the size and shape of the part being inspected permit, immersion inspection is often done. This practice satisfies the requirement for uniform coupling.

VI.ADVANTAGES AND DISADVANTAGES

The principal advantages of ultrasonic inspection as compared to other methods for non-destructive inspection of metal parts are:

- Superior penetrating power, which allows the detection of flaws deep in the part. Ultrasonic inspection is done routinely to thicknesses of a few meters on many types of parts and to thicknesses of about 6 m (20 ft.) in the axial inspection of parts such as long steel shafts or rotor forgings.
- High sensitivity, permitting the detection of extremely small flaws.
- Greater accuracy than other non-destructive methods in determining the position of internal flaws, estimating their size, and characterizing their orientation, shape, and nature.
- Only one surface needs to be accessible.
- Operation is electronic, which provides almost instantaneous indications of flaws. This makes the method suitable for immediate interpretation, automation, rapid scanning, in-line production monitoring, and process control. With most systems, a permanent t record of inspection results can be made for future reference.
- Volumetric scanning ability, enabling the inspection of a volume of metal extending from front surface to back surface of apart.
- Non-hazardous to operations or to nearby personnel and has no effect on equipment and materials in the vicinity.
- Provides an output that can be processed digitally by a computer to characterize defects and to determine material properties.

The disadvantages of ultrasonic inspection include the following:

- Manual operation requires careful attention by experienced technicians.
- Extensive technical knowledge is required for the development of inspection procedures.
- Parts that are rough, irregular in shape, very small or thin, or not homogeneous are difficult to inspect.
- Discontinuities that are present in a shallow layer immediately beneath the surface may not be detectable.

Applicability

The ultrasonic inspection of metals is principally conducted for the detection of discontinuities. This method can be used to detect internal flaws in most engineering metals and alloys. Bonds produced by welding, brazing, soldering, and adhesive bonding can also be ultrasonically inspected. In-line techniques have been developed for monitoring and classifying material as acceptable, salvageable, or scrap and for process control. Both line-powered and battery-operated commercial equipment is available, permitting inspection in shop, laboratory, warehouse, or field.

Ultrasonic inspection is used for quality control and materials inspection in all major industries. This includes electrical and electronic component manufacturing; production of metallic and composite materials; and fabrication of structures such as airframes, piping and pressure vessels, ships, bridges, motor vehicles, machinery, and jet engines. In-service ultrasonic inspection for preventive maintenance is used for detecting the impending failure of railroad-rolling-stock axles, press columns, earthmoving equipment, mill rolls, mining equipment, nuclear systems, and other machines and components.

Some of the major types of equipment that are ultrasonically inspected for the presence of flaws are:

- Mill components: Rolls, shafts, drives, and press columns.
- Power equipment: Turbine forgings, generator rotors, pressure piping, weldments, pressure vessels, nuclear fuel elements, and other reactor components.
- Jet engine parts: Turbine and compressor forgings, and gear blanks.
- Aircraft components: Forging stock, frame sections, and honeycomb sandwich assemblies.
- Machinery materials: Die blocks, tool steels, and drill pipe.
- Railroad parts: Axles, wheels, track, and welded rail.
- Automotive parts: Forgings, ductile castings, and brazed and/or welded components.

VII. EQUIPMENT USED

PROBES: T-R/DUAL PROBE

Frequency of probe is 5MHZ

Transmitter-receiver probe with contact diameter 10mm.

Piezoelectric material probes are used, because a piezoelectric material has the ability to produce ultrasonic sounds and satisfies re visibility property.

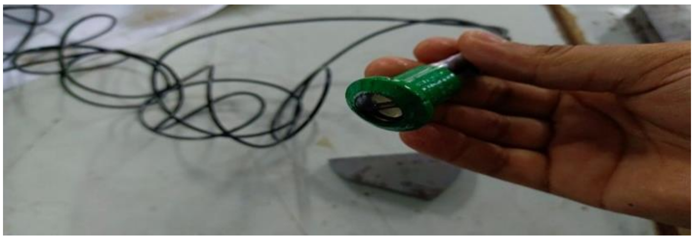


Fig 10: Dual Probe

Machine: ULTRASONIC FLAW DETECTOR (UFD)

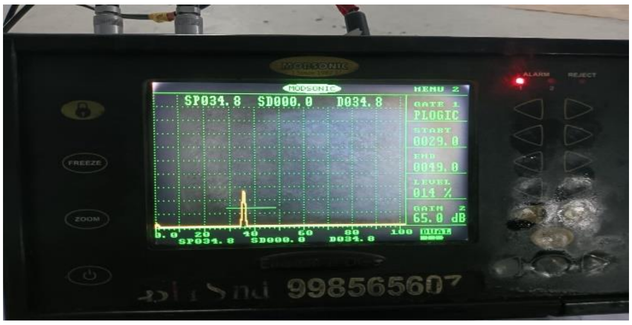


Fig 11: Flaw Detector

PROBE: DUAL /T-R PROBE

MODEL: EINSTIN-DGS

MAKE: MODOSONIC

Velocity: dual probe produces LONGITUDINAL WAVES with velocity 5920 m/s.

Size up Method: Equalization method is selected for marking defected areas in work specimen. Defects are marked between two echoes" (defect indicating echo and final echo) at equal amplitude levels.

Reference Curve Used For Analyzing The Intensity Of Defect: DAC curve is draw by using FBH Block (FLAT BOTTOM HOLE).

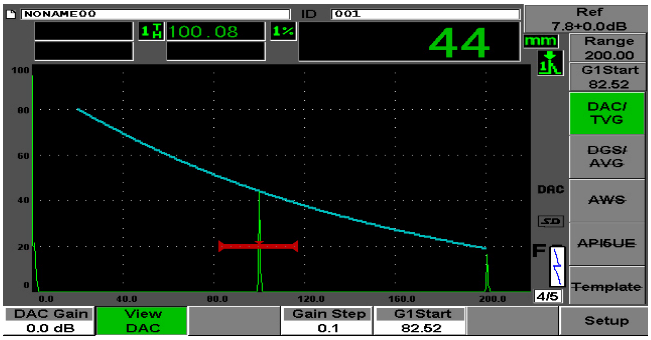


Fig 12: DAC Curve

Standard Blocks Used:

Below shown Figure is FBH Block-flat bottom hole is used for calibration process.

VI block-universal block

Fig 13: V1 Block

Work specimen:

This below shown picture is work piece of test conducted.

Fig 14: Work Specimen

VIII.TESTING PROCEDURE

Experimental procedure tests performed on lamination scanning with the knowledge of ultrasonic testing explained in above chapters, the sample of mild steel plate has been tested for identifying defects like lack of fusion, porosity, cracks, lamination defects... etc. has been observed

Procedure Steps

- **Calibration**
- **Drawing DAC Curve**
- **Lamination Scanning**

Calibration

IIW blocks are mainly used to calibrate instruments prior to contact inspection using an angle-beam search unit, these blocks are also useful for.

- Checking the performance of both angle-beam and straight-beam search units.
- Determining the sound beam exit point of an angle-beam search unit.
- Determining refracted angle produced.
- Calibrating sound path distance.
- Evaluating instrument performance.

The material from which a block is prepared is specified by the IIW as killed, open hearth or electric furnace, low-carbon steel in the normalized condition and with a grain size of McQuaid-Ehn No. 8. All IIW standard reference blocks are of the same size and shape, official IIW blocks are dimensioned in the metric system of units One of the standard English-unit designs is given.

Linearity

Calibration in terms of metal distance or reflector depth assumes a linear oscilloscope sweep for the instrument, which can be checked using a straight-beam search unit. The search unit is placed on either surface C or D to obtain multiple echoes from the 25 mm (1 in) thickness. These echo indications will be aligned with evenly spaced grid lines or scale marks if the time base is linear. Linearity within ±1% (or less) of the full- scale value of thickness is usually obtainable.

Fig 15: Linearity checking

Resolution

A straight-beam search unit, as well as the instrument, can be checked for back- surface resolution by placing the search unit on surface A and reflecting the beam from the bottom of the 2 mm (0.080 in.) wide notch and from surfaces B and E on either side of it. With proper resolution, the indications from these three surfaces should be clearly separated and not overlapped so as to appear as one broad, jagged indication. Because resolution is affected by test conditions and by characteristics of the search unit and instrument amplifier, this degree of resolution sometimes may not be obtained.

Fig 16: Resolution checking

Sensitivity

The relative sensitivity of an angle-beam search unit in combination with a given instrument can be defined by placing the unit on either surface A or B and reflecting the beam from the side of the 1.5 mm (0.060 in.) die hole. The position of the search unit is adjusted until the echo from the hole is maximum, then the gain of the instrument is adjusted to give the desired indication height.

When no back reflection is expected, the sensitivity of a straight-beam system is defined by placing the search unit on either surface B or F in line with the 1.5 mm (0.060 in) die hole. The position of the search unit is adjusted until the echo from the side of the hole is maximum, then the gain of the instrument is adjusted to give the desired indication height.

When a back reflection is expected, a plastic insert can be used in the 50 mm (2 in.) die hole to gage the sensitivity of a straight-beam system. The plastic material and insert thickness are specified to have the absorption characteristics of 50 mm (2 in.) of steel. With this calibration, the search unit is placed on the side of the insert facing surface C. and the number of echoes and the height of the last echo indication are noted.

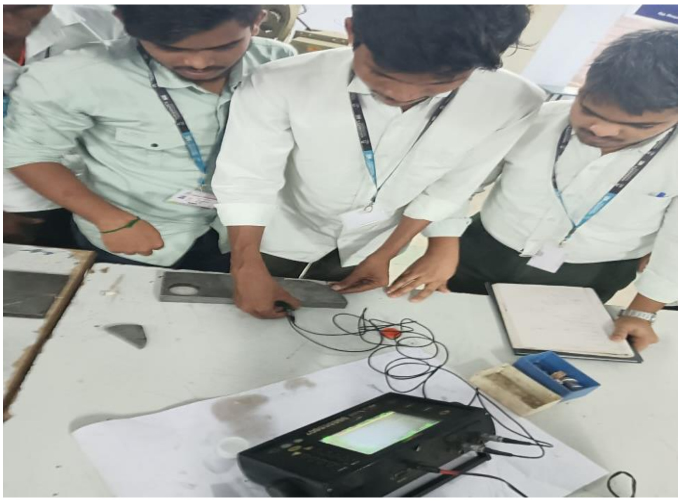


Fig 17: Sensitivity checking

Range Setting

Range for a search-unit and instrument system for straight-beam inspection can be set for various distances by use of the IIW block. From surface F to the 2.0 mm (0.080 in) wide notch is 200 mm (8 in.), from surface A to surface B is 100 mm (4 in), from surface E to surface A is 91.4 mm (3.60 in.), and from surface C to surface D is 25 mm (1 in.).

Range: Range =2*thickness of specimen

=2*20

=40mm

Lamination Checking in Rolled Plate

Laminations are an imperfection in a steel or alloy, resulting from blisters, seams, foreign material, and/or scratches on an ingot or billet that are not repaired during the rolling process

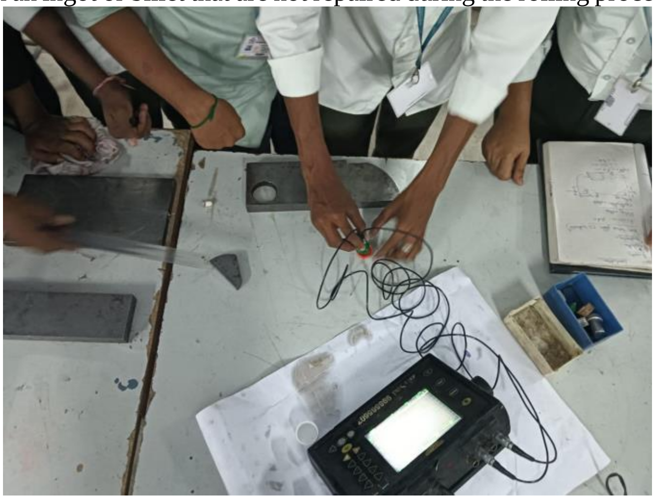


Fig 18: Lubrication of prob

Laminations can be;

- A rolled in lap on the surface of the metal, invisible when the product ships, but which opens up upon further work machining or rolling.
- An imperfection that opens up during bending.

Inclusions, if they are dense enough, will impede machining. They may affect weld ability of a product. Internal laminations would be considered a defect if they violate ultrasonic testing (UT) or eddy current testing requirements for the product, although, as noted previously, they are difficult to detect with common NDT.

Fig 19: Lamination Checking

If measured values are mismatched with standard block values, then adjust zero in flaw detector to standard block values. After adjusting zero draw DAC (DISTANCE AMPLITUDE CORRECTION CURVE).

Then proceed scanning on work piece under inspection and detect defects by observing echoes in flaw detector.

Table:8.1: Types of Flow Laminations

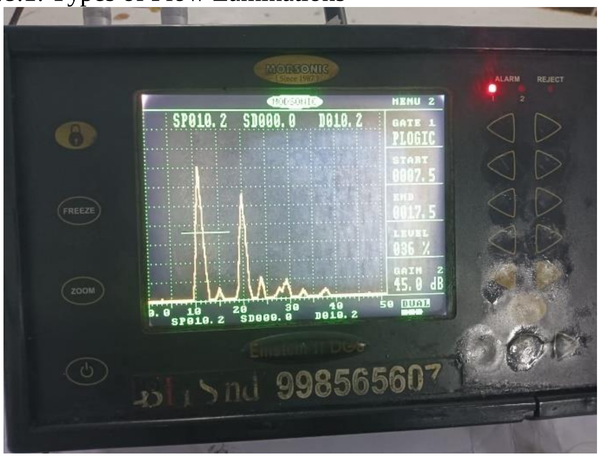


Fig 20: Identifying defects on flow detector

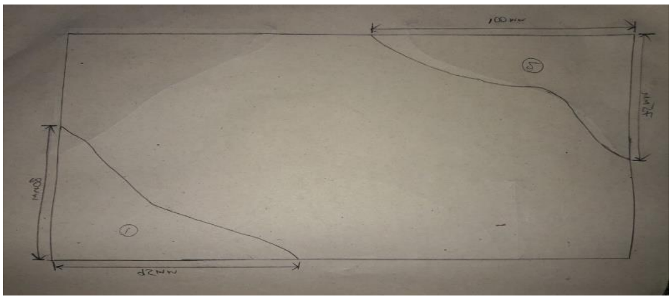
IX.PLATE SCANNING REPORT

Table:9.1: Specimen data

SPECIMEN REFERANCE NUMBER	**MI-16-01-LAM-653**
SPECIMEN LENGTH & THICKNESS	**300MM & 20MM**
CALIBRATION RANGE	**100**
EQUIPMENT USED	**ULTRASONIC FLAW DETECTOR**
REFERANCE REFLECTOR TYPE/ SIZE	**FBH/ 6MM DIA**
TRANSDUSER USED & ANGLES	**T-R/ DUAL PROB &0 DEGREE**
REFERANCE GAIN SETTING	**53.5MM**
COUPLANT USED	**LUBRICATING OIL**
DEFECT SIZING METHOD FOLLOW	**EQUILLIZATION METHOD**

Reflector Location Sketch 1:

In this sample material we identified two defected regions. The below figure shows the defected areas, which are marked as 1 and 2. The size of the defected areas are marked at two opposite corners.



S.NO	FLAW TYPE	FLAW LENGTH(MM)	FLAW WIDTH(MM)	FLAW DEPTH(MM)
1	LAMINATION	95	80	8.4
2	LAMINATION	100	75	8.6

Fig 21: Measuring size of defects

Reflector Location Sketch 2:

In this sample material we identified three defected regions. The below figure shows the defected areas, which are marked as 1,2 and 3. The size of the defected areas are marked at two opposite corners and south middle end.

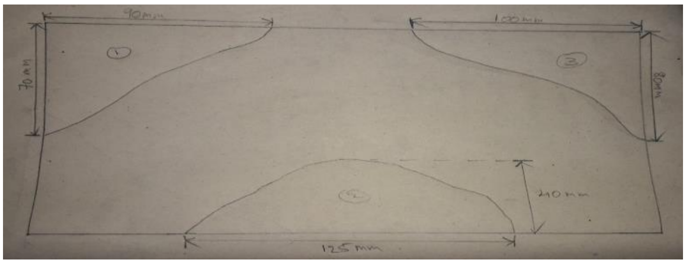


Table:8.2: Types of Flow Variables

S.NO	FLAW TYPE	FLAW LENGTH(MM)	FLAW WIDTH(MM)	FLAW DEPTH(MM)
1	LAMINATION	90	70	9.6
2	LAMINATION	125	40	12.2
3	LAMINATION	100	80	9.6

X.CONCLUSION

This project aims at introducing inspection and various testing methods to understand its purpose and importance in industries especially in fabrication industries.

After studying various non-destructive inspections and testing techniques, their applications, advantages and limitations, it can be concluded that it is a very important tool for the modern industries. we selected ULTRASONIC TESTING TECHNIQUE for detecting LAMINATION defects in MILD STEEL PLATE by using DUAL PROBE. this technique is further used for detecting defects like cracks. porosity etc., in WELDED JOINTS by using ANGULAR PROBE.

By using this technique, we can easily detect the defects and its location. Following specimens are examined and defected areas are found, which are displayed in scanning report.

S. No	Specimen metal	Specimen number	Defects observed
1	Mild Steel	MI-16-01-LAM-653	8. (lamination)
2	Mild Steel	MI-16-03-LAM-654	9. (lamination)

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INFLUENCE OF GAMMA RADIATION ON THERMOPLASTIC POLYMERIC MATERIALS

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Abstract:
Gamma radiation has been used widely in a variety of industrial applications, including sterilisation and material modification. Its impacts on thermoplastic polymeric materials, in particular, have received a lot of interest since they are used in various of industries, including healthcare, packaging, and aerospace. This approach is a great way to change the physical, chemical, thermal, surface, and structural properties of diverse thermoplastics. Gamma radiation-induced grafting and crosslinking are highly efficient, ecologically benign, simple to use, and painstakingly regulated techniques for improving the characteristics of polymeric materials. This review aims to thoroughly investigate the effects of gamma radiation on thermoplastic polymeric materials, with an emphasis on structural changes, mechanical characteristics, and degradation processes. The article discusses many aspects that influence thermoplastic radiation reaction, such as dosage, irradiation environment, and material composition. Furthermore, the role of nanofillers and radiation shielding in preventing radiation-induced degradation is investigated. The article also discusses current advances in radiation processing methods that improve the performance and durability of thermoplastic polymers. Understanding the complicated interplay between gamma radiation and thermoplastic materials is critical for improving their performance in radiation-rich settings and realising their full potential in a extensive range of applications.
Keywords: Gamma radiation; crosslinking, polymer modification, induced grafting mechanical properties.

I. Introduction:

Gamma radiation, a form of electromagnetic radiation, has long been utilized in a myriad of industrial applications ranging from sterilization to material modification. Within the realm of material science, one area that has garnered significant interest is its effects on thermoplastic polymeric materials. For over three decades, scientists have been exploring the effects of subjecting polymers to high-energy radiation like gamma and electron beam radiation, aiming for crosslinking, grafting, and compatibilization purposes [1-3]. Polymeric molecules treated with radiation have become crucial in the worldwide market across diverse applications [4]. Over the past thirty years, radiation-treated polymeric compounds, including functionalized polymers, polymer blends, and composites, have found extensive utilization in sectors such as automotive, construction, aerospace, nuclear, defence, electrical, electronics, and high-temperature applications [3, 5, 6]. Gamma rays, a type of ionising radiation, are used to modify a wide range of industrial polymers, including thermoplastics such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), Nylon-6, Nylon-66 [6-8]. Gamma radiation ionises the polymeric chain, which causes chain crosslinking and scission via a free radical process. The extent of crosslinking is influenced by factors such as polymer structure, morphology, controlled dose and duration of gamma radiation exposure, and the characteristics of the radiation source [9, 10]. Typically, the process of radiation-induced ionization occurs in two stages. Initially, covalent bonds are broken, leading to the formation of free radicals. Subsequently, these radicals instigate chemical interactions between molecules at varying concentrations [11-14]. Gamma radiation exposure has emerged as a widely utilized method for altering the structure, inducing polymerization, grafting, sterilization, and crosslinking of diverse thermoplastics [13,15].

Mehtap Sirin [16] investigated how radiation influences blends of polypropylene and polyethylene with varying weight ratios. S.K. Raghuvanshi et.al investigated the effects of gamma irradiation on the optical characteristics of the ultra-high-molecular-weight polyethylene (UHMWPE) polymer [17]. Siddhartha et.al explored the impact of gamma radiation on the structural and optical characteristics of both untreated Polyethylene Terephthalate (PET) polymer and PET polymer subjected to gamma irradiation doses ranging from 0 to 2000 kGy [18]. Doaa El-Malawy [19] studied the effects of γ-ray irradiation on the physical and chemical properties of thin polymeric sheets made of poly methyl methacrylate (PMMA) containing varying concentrations of nano CdO (0.3–1.8 wt. %). Carlos González Niño [20] analyzed viscosity changes in both virgin and recycled polymers following exposure to different radiation levels. This article aims to delve into the intricate relationship between gamma radiation and thermoplastic polymeric materials, providing a comprehensive review of the current understanding and recent advances in this field.

II. Enhancement of properties through gamma radiation (γ-R) modification.

Gamma radiation arises as electromagnetic radiation is released when an unstable atomic nucleus sheds energy. Characterized by high proton energy, this radiation boasts numerous practical applications owing to its performance attributes. In gamma irradiation, both chain crosslinking and chain scission occur simultaneously within the polymer matrix. Polymers subjected to controlled doses of gamma radiation (1–10 kGy) display resilience to high-energy gamma radiation and elevated temperatures while retaining fundamental properties [12, 21, 22]. Exposure of polymer products to high-energy ionizing radiation and temperature for specific durations ensures their reliability and performance under designated operational conditions. Gamma radiation-treated polymer blends and composites are resistant to high-energy radiation and higher temperatures while maintaining mechanical, thermal, thermomechanical, physiochemical, and environmental qualities [23]. Figure 1 shows the effect of gamma radiation on several polymer processes.

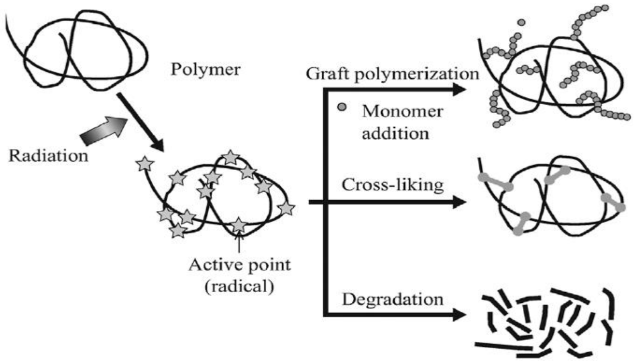

Fig.1 The impact of high-dose gamma radiation on polymers in different manners (Tamada and Maekawa, 2010).

Gamma radiation alteration leads to advancements in various polymeric systems, including thermoplastics, elastomers, thermoplastic elastomer blends, and nano-composites.

Enhancing mechanical, thermal, morphological, and environmental properties in thermoplastic-elastomer and elastomer-elastomer blends relies on achieving an optimal degree of compatibility.

Enhanced mechanical, thermal, and chemical resistance properties through crosslinking.

Maintain physical form, mechanical, thermal, and environmental characteristics during high-energy radiation exposure. High-temperature resistance without altering color, physical shape, or dimensional stability.

Development of hydrogels for medical and healthcare applications.

Albano et al. studied the mechanical and thermal characteristics of polypropylene (PP) composites including sisal and wood fibres with gamma radiation at a dosage rate of 4.8 kGy/h at room temperature. Gamma radiation irreversibly alters the thermal and mechanical characteristics of polymers. These changes might be induced by chain scission, crosslinking, high-energy irradiation, the breakage of specific covalent bonds, or the release of active free radicals [24-26]. Ashhab et al. investigated the influence of gamma radiation on cellulose acetate polymer and discovered that the duration of radiation exposure affects chain scission and intrinsic characteristics of cellulose acetate at different radiation doses [27].

III. Degradation Mechanisms

Degradation mechanisms induced by gamma radiation can vary depending on the specific polymer and irradiation conditions. However, some common degradation processes include chain scission, crosslinking, and formation of free radicals.

Chain Scission: Gamma radiation can break polymer chains, leading to a decrease in molecular weight and potentially causing a reduction in mechanical properties. [3,4]

Crosslinking: Radiation-induced crosslinking involves the formation of covalent bonds between polymer chains, which can increase molecular weight and improve mechanical properties. However, excessive crosslinking may lead to embrittlement [12].

Formation of Free Radicals: Gamma radiation can generate free radicals within the polymer matrix, which may initiate further chemical reactions, including oxidation and degradation [3].

Chemical Alterations: Irradiation can result in chemical modifications such as bond cleavage, rearrangement, and formation of new functional groups, which can influence the polymer's properties and stability [25, 26]

Morphological Changes: Gamma radiation may induce morphological alterations in polymers, affecting crystallinity, morphology, and phase structure, which in turn impact mechanical and thermal properties [25,27].

These degradation mechanisms can have significant implications for the performance and durability of polymers exposed to gamma radiation.

IV. Structural Changes and Mechanical Properties.

Upon exposure to gamma radiation, thermoplastic polymers undergo structural modifications at the molecular level. Cross-linking, chain scission, and the formation of free radicals are common phenomena observed. These structural changes often manifest in alterations to mechanical properties such as tensile strength, elongation at break, and impact resistance. Understanding these changes is essential for predicting the performance of thermoplastic materials in radiation-rich environments. Irradiation enhanced the interactions between CNTs/montmorillonite and facilitated better dispersion of nanofillers within the matrix. This resulted in an overall increase in mechanical characteristics, thermomechanical properties, thermal conductivity, and electrical conductivity, particularly in samples exposed to the ideal gamma radiation absorbed dosage of 150 kGy. However, beyond this threshold, increasing the radiation dose resulted in a decline in sample properties. Fig.2 shows the mechanical properties of the thermoplastic polymer with and without gamma radiation [28]. A similar pattern was seen in the investigation of SF-UP composites with various quantities of MWCNT. Gamma irradiation improves the interfacial adhesion between SF and the UP matrix, as seen by SEM micrographs. This innovation improved the SF-UP composite's static and dynamic mechanical characteristics. Mechanical characteristics deteriorated as radiation intensity increased [29].

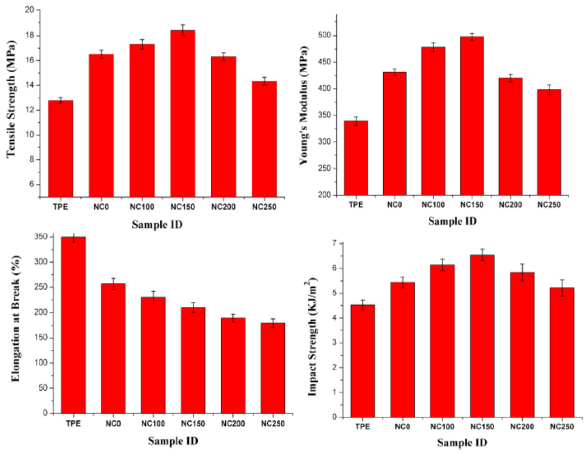

Fig.2.The mechanical characteristics of TPE and TPE/CNTs/DK4 nanocomposites about the absorbed dosage.

V. Mitigation Strategies

Efforts to mitigate the detrimental effects of gamma radiation on thermoplastic polymers have led to the development of various strategies. Incorporating additives such as antioxidants, UV stabilizers, and radiation shielding [23] materials [22] can help enhance the radiation resistance of thermoplastic materials. Furthermore, advancements in radiation processing techniques, such as controlled irradiation and dose optimization [30], offer promising avenues for improving the performance and durability of thermoplastic polymers in radiation-prone environments.

VI. Future Directions

As research in this field continues to advance, there is a growing emphasis on exploring novel materials and innovative approaches to further enhance the radiation resistance of thermoplastic polymeric materials. Collaboration among academics, industry stakeholders, and regulatory agencies is critical for accelerating innovation and guaranteeing the safe and effective use of thermoplastic materials in radiation-intensive applications.

VII. Conclusions

This study emphasises the significant impact of gamma irradiation on the enhancement, modification, and degradation of characteristics in a variety of polymeric systems, including individual polymers, and composites. Gamma radiation processing has benefits over chemical procedures since it does not require any reaction additives, can be used at a wide temperature range, and allows for regulated grafting and crosslinking. Gamma radiation-modified polymers offer a wide range of applications in high-end industries including automotive, Film packaging, electrical insulation, hydrogel production, tissue engineering, medical device sterilisation, and biomedical and radioactive applications.

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WORKING OF BUTTON OPERATED ELECTROMAGNETIC GEAR SHIFTING FOR TWO-WHEELER

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ABSTRACT
This study presents the development of an indigenous automatic gear shifting system for motorcycles, aiming to enhance rider convenience and control. While conventional motorcycles rely on manual gear shifting, this system introduces an additional electromechanical component to enable automatic gear changes. By retaining the option for manual shifting, the system offers flexibility and compatibility with any two-wheeler ranging from 50cc to 200cc. Key components include electromagnetic coils coupled to the gear lever, which are activated by buttons to facilitate gear shifts. This low-cost solution promises to revolutionize motorcycle transmission technology, providing riders with a seamless and adaptable riding experience.

Key words: - Gear Shift, Two Wheeler, Electromagnetic Coil, Gear lever, Button , etc.

I. INTRODUCTION

The exploration into the implementation of a buttonoperated electro-magnetic gear shifting system for automobiles constitutes the principal objective of this comprehensive study. In the automotive landscape, particularly in regions like India where motorcycles are widely prevalent, the conventional manual gear shifting systems have long been the norm. However, this paper delves into the development of an indigenous automatic gear shifting system tailored specifically for standard motorcycles. Unlike conventional approaches that require manual intervention, this innovative system integrates an additional electromechanical apparatus into the vehicle, enabling seamless gear shifting operations. This augmentation ensures that while the manual mechanical gear shifting system remains intact, riders are also provided with the option of automatic gear shifting, thereby offering enhanced flexibility and control. Notably, the system's cost-effectiveness renders it accessible across a wide spectrum of motorcycles, ranging from 50cc to 200cc, contributing to its versatility and widespread applicability.

At the heart of this gear shifting innovation lies a sophisticated control apparatus, meticulously designed to synchronize the rotational output of the internal combustion engine with the drive wheels via an automatic transmission and a load device. During gear shifting-up manoeuvres, the load device plays a pivotal role, adjusting the load applied to modulate the rotational speed of the engine's output shaft, thereby facilitating smooth transitions between gear ratios. Central to the operational efficacy of this system are the two electromagnetic coils strategically coupled to the gear rod. These coils, activated by user-friendly buttons, serve as the catalysts for initiating gear changes, further enhancing the system's user-centric design and operational efficiency.

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Furthermore, in the ever-evolving automotive industry, characterized by escalating demands for performance, quality, and cost-effectiveness, the need for innovative solutions to streamline gear shifting mechanisms has become paramount. Particularly for small cars catering to individuals with special needs, the imperative for intuitive and efficient gear shifting systems is underscored, given the complexities of navigating challenging driving scenarios. Herein lies the promise of the automatic gear shifting mechanism—an advancement poised to alleviate the burdens associated with manual gear shifting, thereby enhancing safety, reducing human effort, and mitigating maintenance costs.

While the transition from manual to automatic gear shifting holds immense promise, it is not without its challenges. The precise control of generated torque and ensuring the widespread availability of electromagnetic actuators remain key areas of concern. Nonetheless, the system's potential to instil confidence in drivers and its adaptability to diverse driving environments underscore its significance as a transformative innovation in the realm of automotive technology. Through a thorough exploration of its design, operation, and potential applications, this study endeavours to shed light on the transformative capabilities of the button-operated electro-magnetic gear shifting system, paving the way for enhanced driving experiences and safer roadways.

II. CONSTRUCTION

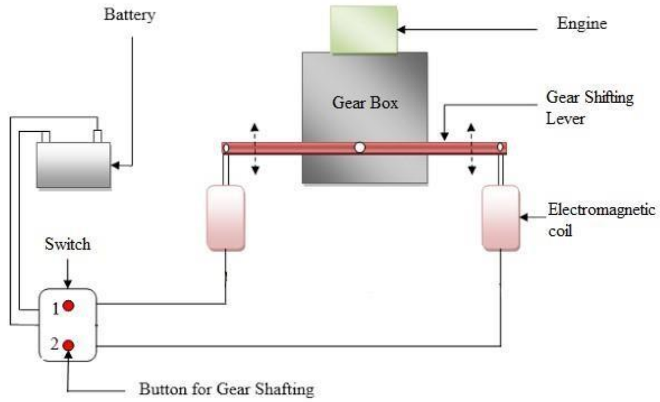

Fig- 2.1 Model of Button operated gear shifting system.

The various parts/ components used in the construction of button operated electro-magnetic gear shifting system are:

1. Electromagnetic solenoid.
2. Gear shifting switch.
3. Gear shifting lever.
4. Battery.

1. Electro-magnetic solenoid

It is attached to gear shifting lever. The electromagnetic solenoid serves as a crucial component in the button-operated electro-magnetic gear shifting system, facilitating the movement of the gear shifting lever.

2. Gear shifting switch.

It is attached to electro-magnetic solenoid. The gear shifting switch serves as the interface between the rider and the electro-magnetic solenoid, enabling seamless gear shifting operations.

3. Gear shifting lever.

It is attached to engine. The gear shifting lever is the mechanical interface between the transmission system of the motorcycle and the electro-magnetic solenoid.

4. Battery

It is attached to the gear shifting switch panel.

The parts/components attached as battery is attached to the gear shifting switch panel and gear shifting switch is attached to the electro-magnetic solenoid and electromagnetic solenoid is attached to the gear shifting lever and gear shifting lever is attach to the engine. In this system control switch is used instead of the gear lever in vehicle and the electro-magnetic solenoid is attached to the gear lever to operate lever. Electro-magnetic solenoid is switch operated by electric power supply from battery of vehicle and switch that can be engaging or disengaging the gear. There are two buttons for operating the gear shifting lever. First button for neutral the gear or down the gear. Second button for up the gear.

By meticulously constructing each component of the button-operated electro-magnetic gear shifting system, riders can enjoy enhanced convenience and control over their motorcycle's transmission, leading to a smoother and more enjoyable riding experience.

III. WORKING

The operational methodology of the button-operated electro-magnetic gear shifting system involves the strategic placement of two electro-magnetic coils onto the gear shaft, each serving a distinct purpose in facilitating gear shifts. One coil is dedicated to shifting gears in an upward direction, while the other is tasked with initiating downward gear shifts. These coils operate in response to the vehicle's speed, effectively transforming the system into an automatically button-operated electro-magnetic gear changer tailored specifically for two-wheelers.

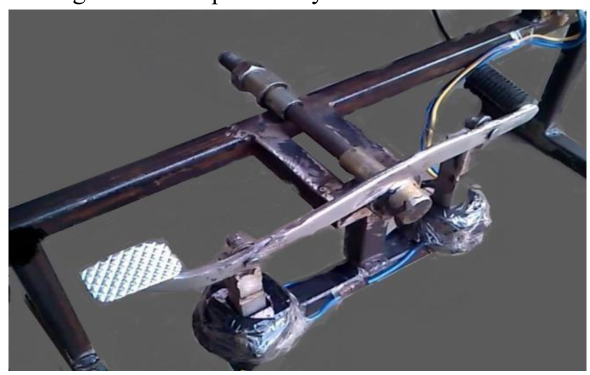

Fig-3.1 Working Model of Button operated gear shifting system.

In practice, the system functions by interfacing with an automatic gear change control apparatus installed within the automobile. This apparatus establishes a connection between the rotational output of the internal combustion engine and the drive wheels, alongside a load device. During gear shifting-up sequences, the load device is strategically manipulated to either increase the applied load or connect it to the engine's output rotation shaft via a selectively connecting device. This adjustment serves to modulate the rotational speed of the engine's output shaft, thereby facilitating smooth transitions between gear ratios.

While the concept of a fully automatic gear shifting system exists, its prohibitive cost renders it inaccessible to middle-class individuals. In contrast, the semi-automatic gear system presents a viable alternative, offering comparable functionality at a significantly reduced cost. In semi-automatic gear shifting scenarios, electronic switches positioned on the bike's handlebar enable riders to manipulate gear shifts conveniently. Two switches are provided, allowing users to navigate between gears seamlessly, thereby enhancing the overall riding experience.

3.1 Working Principle of Electro-magnetic Solenoid

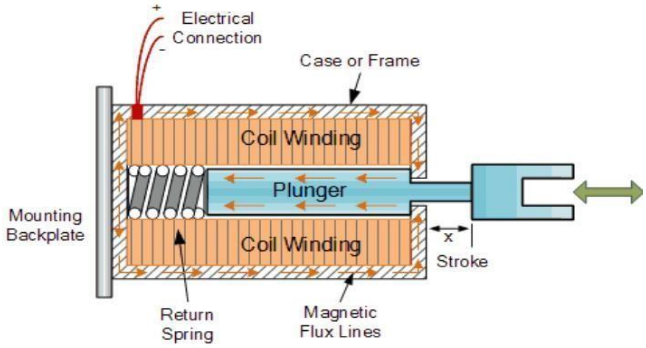

Fig-3.2 Cross sectional view of an electro-magnetic solenoid

the operational principle of solenoids underscores their role as electromechanical devices, adept at converting electrical energy into linear mechanical motion for controlling various systems, whether electrical, pneumatic, or hydraulic. At its core, a solenoid comprises an electromagnetically inductive coil wound around a movable armature or plunger. The coil's configuration allows the armature to move linearly in and out of its centre, thereby altering the coil's inductance. This movement of the plunger generates mechanical force, which serves to activate the associated control mechanism. Operationally, a solenoid is initiated by applying an excitation voltage to its electrical terminals, which initiates current buildup within the solenoid winding. This current flow generates a magnetic flux that traverses through the solenoid's housing, plunger, and any air gaps present, effectively forming a magnetic circuit. The resulting magnetic field, particularly within the main air gap, exerts an attractive force on the plunger, compelling it to move inward towards the solenoid's housing. In essence, the functioning of a solenoid can be delineated into two primary systems: the electromagnet system and the mechanical system. The electromagnet system is responsible for converting the applied voltage into magnetizing current, thereby generating the requisite electromagnetic force to initiate plunger movement. Concurrently, the mechanical system, comprising the plunger and return spring, facilitates the linear movement induced by the electromagnetic force, thereby enabling precise control over the solenoid's operational behaviour.

IV. ADVANTAGE's

- Easy to control the gear shifting.
- Cheaper compared to the other alternatives.
- Maintenance is easy.
- Occupy lesser space compared to the other alternatives.
- Less fatigue to driver.
- Noiseless gear shifting.
- No shocks or jerky while driving.

V. DISADVANTAGE's

- Higher initial cost compared to traditional manual gear shifting systems.
- Elevated power consumption leading to potential battery drain and reduced lifespan.

VI. CONCLUSION

The versatility of this system renders it seamlessly adaptable to motorcycles readily available in the Indian market, requiring no significant modifications for integration. Motorcycle manufacturers stand to benefit from the system's compatibility, as it can be effortlessly incorporated into existing vehicle designs without necessitating internal modifications to the gear system. By offering this cost-effective solution, companies can enhance their product offerings and potentially boost sales by introducing these innovative features to consumers. Moreover, the implementation of this system holds promise for improving fuel economy and extending the lifespan of vehicle components, further underscoring its significance in the realm of automotive technology.

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DECARBONISATION OF INTERNAL COMBUSTION ENGINE

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ABSTARCT: Automobiles became quite common in human life. After certain period of time, every automobile need to undergo servicing to avoid problems like engine failure, etc. Similarly Decarbonisation is one of the servicing process used to clean carbon deposits inside the combustion chamber (which forms during combustion process). These carbon deposits formed during combustion process may adverse effect such that engine performance gets slow down which may causes engine life degradation. Decarbonisation can be done mostly in two ways either mechanically or by using chemical solvents. In this project our work focusses on the study of how decarbonisation can be done without dismantling the engine. We tested and compared the vehicle parameters before and after the decarbonisation process.

KEYWORDS:
Carbonisation, Decarbonisation, Energizer, Hydroxy gas (HHO).

1. INTRODUCTION:

In internal combustion engine, heat generation takes place by combustion of fuel (petrol/diesel). As the fuel burns completely, the engine work will be more efficient. This combustion process takes place in combustion chamber of an I. C engine (either two stroke engine or four stroke engine). I. C engine i.e., internal combustion engine converts this fuel energy into mechanical energy which is required to run the automobiles.

In this project, our work was carried out on hero glamour bike.

1.1. Engine specifications:

Engine Type	Air cooled 4 stroke
Displacement	125 cc
Max Torque	10.4 Nm @ 6000 rpm
No. of Cylinders	1
Cooling System	Air Cooled
Valve Per Cylinder	2
Starting	Kick and Self Start
Fuel Supply	Fuel Injection
Clutch	Wet Multi-plate
Gear Box	5 Speed
Bore	52.4 mm
Stroke	57.8 mm
Compression Ratio	9.9:1
Emission Type	bs6-2.

1.2. Carbonisation:

When automobile covers a distance over 30,000 km to 70,000km, a layer of carbon deposit forms inside the cylinder (combustion chamber). Formation of this carbon layer is called carbonisation. Carbonisation of an I. C causes some effects such as

- Reduction of work efficiency.
- High fuel consumption
- Engine life degradation etc.

This carbonisation can be determined by the following factors. They are:

- Reduce in mileage
- Black smoke
- Sound of the engine while running

1.3. Decarbonisation:

Removal of carbon deposits that are left over after combustion from the combustion chamber is known as decarbonisation. It is of two types

- Physical/mechanical
- Chemical

Physical decarbonisation can be done by dismantling the engine, whereas chemical decarbonisation can be done with very less effort compared to physical.

2. LITERATURE SURVEY:

Authors	Outcomes	Drawbacks
Roger cracknell	Decarbonisation of mobility	Hazards due to risk of thermal runaway and combustible gas release
George mallouppas	Decarbonisation in shipping industry	Only 3% contribution to greenhouse gas(GHG) emissions

3. PROBLEM STATEMENT

3.1. Protecting life span of an engine in complete combustion causes decrease in efficiency of the engine. So this process helps in maintaining engine at better condition.

3.2. Environmental conditions Decarbonisation helps in reducing the carbon and other pollutants percentage in exhaust gases, which causes pollution.

3.3. Better economicalcondition:

Compared to mechanical decarbonisation Chemical decarbonisation requires less cost, time and effort.

4. MOTIVATION AND OBJECTIVES

Motivation

Decarbonisation in internal combustion engine mainly aims to decrease the greenhouse gas emissions and conflict climate change, by lowering carbon dioxide (CO_2) gases from vehicles. we can control the impacts of global warming and reduce air pollution, which leads to healthier environment.

Objectives

i. To increase efficiency of an old engine.
ii. To decrease the unburned carbon content in internal combustion engine.
iii. To maintain optimal engine function

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5. METHODOLOGY

Starting the project based on collected literature

⇩

Identifying the required components of decarbonisation such as Energizer, syringe, Hydroxy gas machine etc.

⇩

Performing decarbonisation process

⇩

Performing inspection and testing the Internal combustion engine

⇩

Comparing the results before and after Decarbonisation process

6. COMPONENTS AND MATERIALS

1. Energizer:
In this project we used acetone as energizer. This removes carbon deposit layer by breaking them into small pieces.

2. Syringe:
Syringe is used to inject the energizer into the fuel tank of an internal combustion engine. Its max capacity is 60ml. For bikes - 15ml to 20ml
For cars - 30ml to 60ml
Based on cc of an engine and distance covered by the automobile.

Hydroxy gas machine: This machine discharges hydroxy gas in a certain flow rate based on the size (CC) of the engine through a hose/pipe into the air inlet valve of an internal combustion engine.

7. WORKING PROCEDURE

- Checking whether the engine is weak or not. By observing the exhaust gas properties like colour (black/white) and engine sound.

(To make this process fuel should be maintained at 20% of its capacity)

- Injecting Energizer into the fuel tank using 60ml capacity syringe.
- Put the hose of the hydroxy gas machine into the air inlet valve of internal combustion engine of an automobile.
- Adjust the parameters/controls of the hydroxyl gas producing machine based on the requirements.
- Switch on the bike/car engine and then accelerate it for 15 to 20 sec for every 2 min interval of time.
- This process is carried out for 15 to 30 min based on type of engine, cc of an engine, distance travelled and other parameters.

(After completing this process, fuel tank should be emptied before it undergoes refilling)

8.MERITS & DEMERITS

Merits:

- Pickup speed increases
- Mileage increases
- Black smoke reduces
- Requires less money, time and effort compared to mechanical decarbonisation.

Demerits:

- Some chemical agents used for decarbonisation can be harmful to the environment.
- Some chemical solvents may corrode the engine if they are not used properly.

9.APPLICATIONS This process is used for all types of automobiles (internal combustion engines) such as cars, bikes, scooters, etc.

10.CONCLUSION

Hence, our intension is to clean or remove the unwanted wastes like carbon deposits through an effective technique i.e., chemical decarbonisation which removes the carbon deposits internally and effectively by cleaning agents or chemical solvents. It also leads to improved performance and fuel efficiency of the internal combustion engine.

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DEFECT DETECTION ON WELDED JOINTS USING ULTRASONIC TESTING

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ABSTRACT

Product quality has always been one of the most important aspects of manufacturing operation. In present global economy and competition, continuous improvement in quality has become a major priority for various industrialized countries including India. In this percept Non-destructive evaluation is a wide and interdisciplinary field used to detect and verify the quality of products.By using various Non-Destructive Evaluation Techniques internal defects are tested in such a manner that product integrity and surface texture remains unchanged. In the present study, a test specimen of Hot Rolled Mild Steel Plate is taken to identify the discontinuities like welding defects, Inclusions, edge cuttings, cracks, etc., by Ultrasonic Flaw Detector using INCLINED BEAM PROBE. Key words: Non-Destructive testing; NDT methods; Ultrasonic testing

I. INTRODUCTION

Importance of NDT

NDT plays an important role in the quality control of a product. It is used during all the stages of manufacturing of a product. It is used to monitor the quality of the:

(a) Raw materials which are used in the construction of the product.

(b) Fabrication processes which are used to manufacture the product.

(c) Finished product before it is put into service.

Use of NDT during all stages of manufacturing results in the following benefits:

(a) Increases the safety and reliability of the product during operation.

(b) Decreases the cost of the product by reducing scrap and conserving materials, labor and energy.

(c) It enhances the reputation of the manufacturer as producer of quality goods.

All of the above factors boost the sales of the product which bring more economical benefits to the manufacturer.

NDT is also used widely for routine or periodic determination of quality of the plants and Structures during service. This not only increases the safety of operation but also eliminates any forced shut down of the plants.

II. TYPES OF NDT METHODS

The methods of NDT range from the simple to the complicated. Visual inspection is the simplest of all. Surface imperfections invisible to the eye may be revealed by penetrant or magnetic methods. If really serious surface defects are found, there is often little point in proceeding to more complicated examinations of the interior by ultrasonic or radiography. NDT methods may be divided into group for the purposes of these notes: conventional and nonconventional.

Visual Testing (VT)

Often overlooked in any listing of NDT methods, visual inspection is one of the most common and most powerful means of non-destructive testing. Visual testing requires adequate illumination of the test surface and proper eye-sight of the tester. To be most effective visual inspection does however, merit special attention because it requires training (knowledge of product and process, anticipated service conditions, acceptance criteria, record keeping, for example) and it has its own range of equipment and instrumentation. It is also a fact that all defects found by other NDT methods ultimately must be substantiated by visual inspection. Visual testing can be classified as direct visual testing, remote visual testing and translucent visual testing. The most common NDT methods MT and PT are indeed simply scientific ways of enhancing the indication to make it more visible. Often the equipment needed is simple Figure.

Liquid Penetrant Testing

Liquid penetrate testing is one of the oldest and simplest NDT methods where its earliest versions (using kerosene and oil mixture) date back to the 19th century. This method is used to reveal surface discontinuities by bleed out of a colored or fluorescent dye from the flaw. The technique is based on the ability of a liquid to be drawn into a "clean" surface discontinuity by capillary action. After a period of time called the "dwell time", excess surface penetrant is removed and a developer applied. This acts as a blotter that draws the penetrant from the discontinuity to reveal its presence.

It improves the detestability of a flaw due to the high level of contrast between the indication and the background which helps to make the indication more easily seen (such as a red indication on a white background for visible penetrant or a penetrant that glows under ultraviolet light for fluorescent penetrant.

Liquid penetrant testing is one of the most widely used NDT methods. Its popularity can be attributed to two main factors:

its relative ease of use and its flexibility. It can be used to inspect almost any material provided that its surface is not extremely rough or porous. Materials that are commonly inspected using this method include, metals, glass, many ceramic materials, rubber and plastics. However, liquid penetrant testing can only be used to inspect for flaws that

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break the surface of the sample (such as surface cracks, porosity, laps, seams, lack of fusion, etc.

Steps In Penetration Testing
Pre-Cleaning
Applying Penetrant
Dwell Time
Removable Of Excess Penetrant
Applying Developer
Developing Time
Interpretation
Post Cleaning

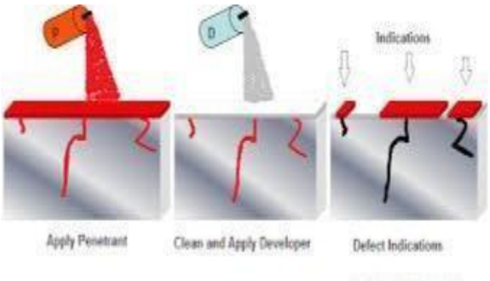

Fig 1: Liquid Penetration Test

Magnetic Particle Testing (MPT)

Magnetic particle testing is one of the most widely utilized NDT methods since it is fast and relatively easy to apply and part surface preparation is not as critical as it is for some other methods. This method uses magnetic fields and small magnetic particles to detect flaws in components. The only requirement from an inspect ability standpoint is that the component being inspected must be made of a ferromagnetic material such as iron, nickel, cobalt, or some of their alloys.

The method is used to inspect a variety of product forms including castings, forgings, and weldments. Many different industries use magnetic particle inspection such as structural steel, automotive, petrochemical, power generation, and aerospace industries. Underwater inspection is another area where magnetic particle inspection may be used to test items such as offshore structures and underwater pipelines. Basic principle "Magnetic Flux Leakage".

Steps In MPT
Pre-Cleaning
Demagnetization (If required)
Applying White Contrast
Magnetizing The Material
Applying Magnetic Medium
Interpretation
De Magnetization
Post Cleaning

Fig 2: Permanent Magnet

Ultrasonic Testing

Ultrasonic Testing (UT) uses high frequency sound waves (typically in the range between 05 and 15 MHz) to conduct examinations and make measurements. Besides its wide use in engineering applications (such as flaw detection/evaluation, dimensional measurements, material characterization, etc.), ultrasonic are also used in the medical field (such as sonography, therapeutic ultrasound, etc.).

In general, ultrasonic testing is based on the capture and quantification of either the reflected waves (pulse-echo) or the transmitted waves (through-transmission). Each of the two types is used in certain applications, but generally, pulse echo systems.

Fig 3: Specimen Scanning

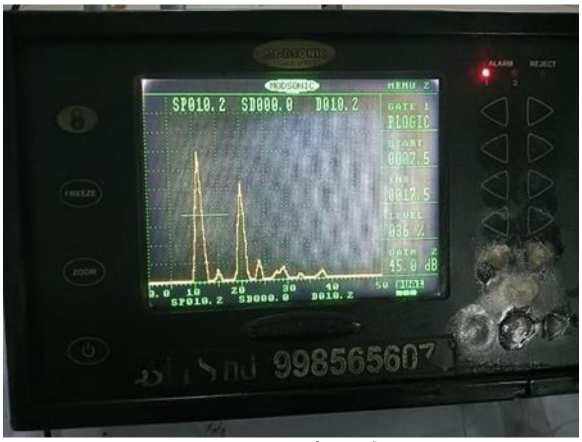

Fig 4: Defect Indication

Basic principle "Acoustic Impedance Mismatch"

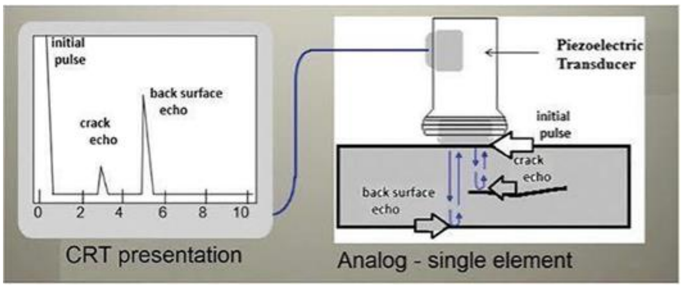

Fig 5: Ultrasonic Testing

A typical pulse-echo UT inspection system consists of several functional units, such as the pulser/receiver, transducer, and a display device. A pulser/receiver is an electronic device that can produce high voltage electrical pulses. Driven by the pulser, the transducer generates high frequency ultrasonic energy. The sound energy is introduced and propagates through the materials in the form of waves. When there is a discontinuity (such as a crack) in the wave path, part of the energy will be reflected back from the flaw surface.

The reflected wave signal is transformed into an electrical signal by the transducer and is displayed on a screen. Knowing the velocity of the waves, travel time can be directly related to the distance that the signal travelled. From the signal, information about the reflector location, size, orientation and other features can sometimes be gained.

Radiographic Testing

Radiography is used in a very wide range of applications including medicine engineering, forensics, security, etc. In NDT, radiography is one of the most important and widely used methods. Radiographic testing (RT) offers a number of advantages over other NDT methods, however, one of its major disadvantages is the health risk associated with the radiation.

In general, RT is method of inspecting materials for hidden flaws by using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials. The intensity of the radiation that penetrates and passes through the material is either captured by radiation sensitive film (Film Radiography) or by a planer array of radiation sensitive sensors (Real-time Radiography). Film radiography is the oldest approach, yet it is still the most widely used in NDT.

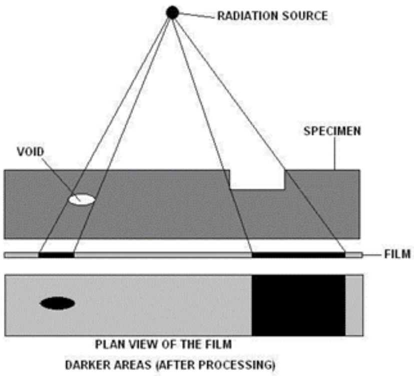

Fig 6: Radiographic Scanning

III. INTRODUCTION TO ULTRASONIC TESTING

Ultrasonic examination is a non-destructive method in which beams of high-frequency sound waves are introduced into materials for the detection of surface and subsurface flaws in the material. The sound waves travel through the material with some attendant loss of energy (attenuation) and are reflected at interfaces. The reflected beam is displayed and then analyzed to define the presence and location of flaws or discontinuities.

The degree of reflection depends largely on the physical state of the materials forming the interface and to a lesser extent on the specific physical properties of the material. For example, sound waves are almost completely reflected at metal/gas interfaces. Partial reflection occurs at metal/liquid or metal/solid interfaces, with the specific percentage of reflected energy depending mainly on the ratios of certain properties of the material on opposing sides of the interface.

Cracks, laminations, shrinkage cavities, bursts, flakes, pores, and other discontinuities that produce reflective interfaces can be easily detected. Inclusions and other in homogeneities can also be detected by causing partial reflection or scattering of the ultrasonic waves or by producing some other detectable effect on the ultrasonic waves. Most ultrasonic inspection instruments detect flaws by monitoring one or more of the following:

- Reflection of sound from interfaces consisting of material boundaries or discontinuities within the metal itself
- Time of transit of a sound wave through the test piece from the entrance point at the transducer to the exit point at the transducer.
- Attenuation of sound waves by absorption and scattering within the test piece.
- Features in the spectral response for either a transmitted ora reflected signal.

Most ultrasonic inspection is done at frequencies between 0.1 and 25 MHz-well above the range of human hearing, which is about 20 Hz to 20 kHz. Ultrasonic waves are mechanical vibrations; the amplitudes of vibrations in metal parts being ultrasonically inspected impose stresses well below the elastic limit, thus preventing permanent effects on the parts. Many of the characteristics described in this article for ultrasonic waves. especially in the section "General Characteristics of Ultrasonic Waves," also apply to audible sound waves and to wave motion in general.

Ultrasonic inspection is one of the most widely used methods of non-destructive inspection. Its primary application in the inspection of metals is the detection and characterization of internal flaws, it is also used to detect surface flaws, to define bond characteristics, to measure the thickness and extent of corrosion, and (much less frequently) to determine physical properties, structure, grain size, and elastic constants.

Basic Equipment

Most ultrasonic inspection systems include the following basic equipment:

•An electronic signal generator that produces bursts of alternating voltage (a negative spike or a square wave) when electronically triggered.

•A transducer (probe or search unit) that emits a beam of ultrasonic waves when bursts of alternating voltage are applied to it.

•A couplet to transfer energy in the beam of ultrasonic waves to the test piece.

•A couplet to transfer the output of ultrasonic waves (acoustic energy) from the test piece to the transducer.

•A transducer (can be the same as the transducer initiating the sound or it can be a separate one) to accept and convert the output of ultrasonic waves from the test piece to corresponding bursts of alternating voltage. In most systems, a single transducer alternately acts as sender and receiver.

•An electronic device to amplify and, if necessary, demodulate or otherwise modify the signals from the transducer.

•A display or indicating device to characterize or record the output from the test piece. The display device may be a CRT, sometimes referred to as an oscilloscope: a chart or strip recorder, a marker, indicator, or alarm device; or a computer printout.

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•An electronic clock, or timer, to control the operation of the various components of the system, to serve as a primary reference point, and to provide coordination for the entire system.

CIRCUITS

Electronic Equipment:

Although the electronic equipment used for ultrasonic inspection can vary greatly in detail among equipment manufacturers, all general-purpose units consist of a power supply, a pulser circuit, a search unit, a receiver-amplifier circuit, an oscilloscope, and an electronic clock.

Many systems also include electronic equipment for signal conditioning, gating, automatic interpretation, and integration with a mechanical or electronic scanning system. Moreover, advances in microprocessor technology have extended the data acquisition and signal-processing capabilities of ultrasonic inspection systems.

Power Supply:

Circuits that supply current for all functions of the instrument constitute the power supply, which is usually energized by conventional 115-V or 230-V alternating current. There are, however, many types and sizes of portable instruments for which the power is supplied by batteries contained in the unit.

Pulser Circuit:

When electronically triggered, the pulser circuit generates a burst of alternating voltage The principal frequency of this burst, its duration, the profile of the envelope of the burst, and the burst repetition rate may be either fixed or adjustable, depending on the flexibility of the unit.

Search Units:

The transducer is the basic part of any search unit. A sending transducer is one to which the voltage burst is applied, and it mechanically vibrates in response to the applied voltage. When appropriately coupled to an elastic medium, the transducer thus serves to launch ultrasonic waves into the material being inspected.

A receiving transducer converts the ultrasonic waves that impinge on it into a corresponding alternating voltage. In the pitch-catch mode, the transmitting and receiving transducers are separate units; in the pulse-echo mode, a single transducer alternately serves both functions. The various types of search units are discussed later in this article.

Control Systems:

Even though the nomenclature used by different instrument manufacturers may vary, certain controls are required for the basic functions of any ultrasonic instrument. These functions include power supply, clock, pulser, receiver-amplifier, and display. In most cases, the entire electronic assembly, including the controls, is contained in one instrument. A typical pulse-echo instrument is shown in Fig.

Fig 7: Flaw Detector

The power supply is usually controlled by switches and fuses. Time delays can be incorporated into the system to protect circuit elements during warm-up. The pulses of ultrasonic energy transmitted into the test piece are adjusted by controls for pulse-repetition rate, pulse length, and pulse tuning. A selector for a range of operating frequencies is usually labelled "frequency," with the available frequencies given in megahertz.

For single-transducer inspection, transmitting and receiving circuits are connected to one jack, which is connected to a single transducer. For double-transducer inspection, such as through transmission or pitch-catch inspection, a T (transmit) jack is provided to permit connecting one transducer for use as a transmitter, and an R (receive) jack is provided for the use of another Tran shaver for receiving only. A selector switch (test switch) for through (pitch catch) or normal (pulse echo) transmission is provided for control of the T and R jacks.

Gain controls for the receiver amplifier circuit usually consist of fine and coarse- sensitivity selectors or one control marked "sensitivity." For a clean video display, with low-level electronic noise eliminated, a reject control can be provided.

The display (oscilloscope) controls are usually screwdriver adjusted, with the exception of the scale illumination and power on/off. After initial setup and collaboration, the screwdriver-adjusted controls seldom require additional adjustment. The controls and their functions for the display unit usually consist of the following:

•Controls for vertical position of the display on the Principal advantages of quartz-crystal transducer elements are oscilloscope screen.

•Controls for horizontal position of display on the oscilloscope screen.

•Controls for brightness of display.

•Control for adjusting focus of trace on the oscilloscope screen.

•Controls to correct for distortion or astigmatism that may be introduced as the electron beam sweeps across the oscilloscope screen.

•A control that varies the level of illumination for a measuring grid usually incorporated in the transparent faceplate covering the oscilloscope screen.

•Timing controls, which usually consist of sweep- delay and sweep-rate controls, to provide coarse and fine adjustments to suit the material and thickness of the test piece. The sweep-delay control is also used to position the sound entry point on the left side of the display screen, with a back reflection or multiples of back reflections visible on the right side of the screen.

•On/off switch

IV. PIEZOELECTRIC ELEMENT

Transducer Elements:

The generation and detection of ultrasonic waves for inspection are accomplished by means of a transducer element acting through a couplet. The transducer element is contained within a device most often referred to as a search unit (or sometimes as a probe). Piezoelectric elements are the most commonly used transducer in ultrasonic inspection, although EMA transducers and magnetostriction transducers are also used.

Piezoelectric Transducers:

Piezoelectricity is pressure-induced electricity, this property is characteristic of certain naturally occurring crystalline compounds and some man-made materials. As the name piezoelectric implies, an electrical charge is developed by the crystal when pressure is applied to it. Conversely, when an electrical field is applied, the crystal mechanically deforms (changes shape). Piezoelectric crystals exhibit various deformation modes; thickness expansion is the principal mode used in transducers for ultrasonic inspection. The most common types of piezoelectric materials used for ultrasonic search units are quartz, lithium sulphate, and polarized ceramics such as barium titanate, lead zirconated titanate, and lead meta niobate.

Quartz Crystals:

These were initially the only piezoelectric elements used in commercial ultrasonic transducers. Properties of the transducers depended largely on the direction along which the crystals were cut to make the active transducer elements.
electrical and thermal stability, insolubility in most liquids, high mechanical strength, wear resistance, excellent uniformity, and resistance to aging.

A limitation of quartz is its comparatively low electromechanical conversion efficiency, which results in low loop gain for the system.

Lithium Sulphate:

The principal advantages of lithium sulphate transducer elements are ease of obtaining optimum acoustic damping for best resolution, optimum receiving characteristics, intermediate conversion efficiency, and negligible mode interaction. The main disadvantages of lithium sulphate elements are fragility and a maximum service temperature of about 75 °C (165 °F).

Polarized Ceramics:

Generally, have high electromechanical conversion efficiency, which results in high loop gain and good search-unit sensitivity. Lead zirconated titanate is mechanically rugged, has a good tolerance to moderately elevated temperature, and does not lose polarization with age. It does have a high piezoelectric response in the radial mode, which sometimes limits its usefulness.

Barium titanate is also mechanically rugged and has a high radial-mode response. However, its efficiency changes with temperature, and it tends to depolarize with age. which makes barium titanate less suitable for some applications than lead zirconated titanate. Lead meta niobate exhibits low mechanical damping and good tolerance to temperature. Its principal limitation is a high dielectric constant, which results in a transducer element with a high electrical capacitance.

Selection of a piezoelectric transducer for a given application is done on the basis of size (active area) of the piezoelectric element, characteristic frequency, frequency bandwidth, and type (construction) of search unit. Descriptions of various types of search units with piezoelectric elements are given in the section "Search Units" in this article. Different piezoelectric materials exhibit different electrical-impedance characteristics. In many cases, tuning coils or impedance- matching transformers are installed in the search- unit housing to render a better impedance match to certain types of electronic instrumentation. It is important to match impedances when selecting a search unit for a particular instrument.

Both the amount of sound energy transmitted into the material being inspected (radiated power) and beam divergence are directly related to the size (active area) of the transducer element.

Thus, it is sometimes advisable to use a larger search unit to obtain greater depth of penetration or greater sound beam area. Each transducer has a characteristic resonant frequency at which ultrasonic waves are most effectively generated and received. This resonant frequency is determined mainly by the material and thickness of the active element. Any transducer responds efficiently at frequencies in a band cantered on the resonant frequency.

The extent of this band, known as bandwidth, is determined chiefly by the damping characteristics of the backing material that is in contact with the rear face of the piezoelectric element.

Straight-beam contact-type units:

Manufacturing-induced flaws:-

Billets: inclusions, stringers, pipe

Forgings: inclusions, cracks, segregations, seams, flakes,

Pipe Rolled Products: laminations, inclusions, tears, seams, racks

Castings: slag, porosity, cold shuts, tears, shrinkage cracks, inclusions

Service-induced flaws:-

Fatigue cracks, corrosion, erosion, stress-corrosion cracks

Angle-beam contact-type units:-

Manufacturing - Induced flaws:- Forgings: cracks, seams, laps

Rolled products: tears, seams, cracks, cupping

Welds: slag inclusions, porosity, incomplete fusion, incomplete penetration, drop through, suck back, cracks in filler metal and base metal Tubing and pipe: circumferential and longitudinal cracks

Service-induced flaws:-

Fatigue cracks, stress-corrosion cracks Dual-element **contact-type units Manufacturing-induced flaws:-**

Plate and sheet: thickness measurements, lamination detection

Tubing and pipe:

Service-induced flaws: -

Wall thinning, corrosion, erosion, stress-corrosion cracks

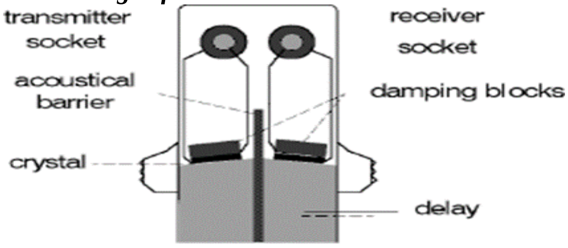

Fig 8: Nomenclature of Angular Probe

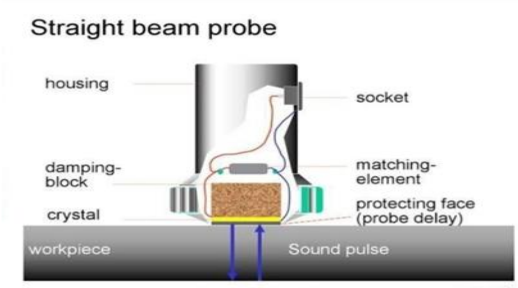

Fig 9: Nomenclature of Straight Probe

Contact-Type Units:

Although contact-type search units can sometimes be adapted to automatic scanning. they are usually hand held and manually scanned in direct contact with the surface of a test piece. A thin layer of an appropriate couplet is almost always required for obtaining transmission of sound energy across the interface between the search unit and the entry surface.

V. ANGLE BEAM PROBE (SHEARWAVE)

Angle-Beam Units:

The construction of an angle-beam contact-type search unit. A plastic wedge between the piezoelectric element and the contact surface establishes a fixed angle of incidence for the search unit. The plastic wedge must be designed to reduce or eliminate internal reflections within the wedge that could result in undesired false echoes.

Angle-beam search units are used for the inspection of sheet or plate, pipe welds or tubing, and test pieces having shapes that prevent access for straight beam. Angle-beam search units can be used to produce shear waves or combined shear and longitudinal waves, depending on the wedge angle and test piece material.

There is a single value of wedge angle that will produce the desired beam direction and wave type in any given test piece. A search unit having the appropriate wedge angle is selected for each specific application.

The surface wave search unit is an angle-beam unit insofar as it uses a wedge to position the crystal at an angle to the surface of the test piece. It generates surface waves by mode conversion as described in the section "Critical Angles" in This article. The wedge angle is chosen so that the shear wave refraction angle is 90" and the wave resulting from mode conversion travels along the surface.

Couplet:

Air is a poor transmitter of sound waves at megahertz frequencies, and the impedance mismatch between air and most solids is great enough that even a very thin layer of air will severely retard the transmission of sound waves from the transducer to the test piece. To perform satisfactory contact inspection with piezoelectric transducers, it is necessary to eliminate air between the transducer and the test piece by the use of a couplet.

Couplet normally used for contact inspection include water, oils, glycerin, petroleum greases, silicone grease, wallpaper paste, and various commercial paste like substances. Certain soft rubbers that transmit sound waves may be used where adequate coupling can be achieved by applying hand pressure to the search unit.

The following should be considered in selecting a couplet:

- Surface finish of test piece.
- Temperature of test surface Possibility of chemical reactions between test surface and couplet.
- Cleaning requirements (some couplets are difficult to remove)

Water is a suitable couplet for use on a relatively smooth surface; however, a wetting agent should be added. It is sometimes appropriate to add glycerin to increase viscosity. however, glycerin tends to induce corrosion in aluminum and therefore is not recommended in aerospace applications.

Heavy oil or grease should be used on hot or vertical surfaces or on rough surfaces where irregularities need to be filled.

Heavy oil, grease, or wallpaper paste may not be good choices when water will suffice, because these substances are more difficult to remove. Wallpaper paste, like some proprietary couplet, will harden and may flake off if allowed to stand exposed to air When dry and hard, wallpaper paste can be easily removed by blasting or wire brushing Oil or grease often must be removed with solvents.

Couplet used in contact inspection should be applied as a uniform, thin coating to obtain uniform and consistent inspection results. The necessity for a couplet is one of the drawbacks of ultrasonic inspection and may be a limitation, such as with high-temperature surfaces. When the size and shape of the part being inspected permit, immersion inspection is often done. This practice satisfies the requirement for uniform coupling.

VI. ADVANTAGES AND DISADVANTAGES

The principal advantages of ultrasonic inspection as compared to other methods for non-destructive inspection of metal parts are:

•Superior penetrating power, which allows the detection of flaws deep in the part. Ultrasonic inspection is done routinely to thicknesses of a few meters on many types of parts and to thicknesses of about 6 m (20 ft.) in the axial inspection of parts such as long steel shafts or rotor forgings.

•High sensitivity, permitting the detection of extremely small flaws.

•Greater accuracy than other non-destructive methods in determining the position of internal flaws, estimating their size, and characterizing their orientation, shape, and nature.

•Only one surface needs to be accessible.

•Operation is electronic, which provides almost instantaneous indications of flaws. This makes the method suitable for immediate interpretation, automation, rapid scanning, in-line production monitoring, and process control. With most systems, a permanent t record of inspection results can be made for future reference.

•Volumetric scanning ability, enabling the inspection of a volume of metal extending from front surface to back surface of apart.

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•Non-hazardous to operations or to nearby personnel and has no effect on equipment and materials in the vicinity.
•Provides an output that can be processed digitally by a computer to characterize defects and to determine material properties.

The disadvantages of ultrasonic inspection include the following:

•Manual operation requires careful attention by experienced technicians.
•Extensive technical knowledge is required for the development of inspection procedures.
•Parts that are rough, irregular in shape, very small or thin, or not homogeneous are difficult to inspect.
•Discontinuities that are present in a shallow layer immediately beneath the surface may not be detectable.

Applicability:

The ultrasonic inspection of metals is principally conducted for the detection of discontinuities. This method can be used to detect internal flaws in most engineering metals and alloys. Bonds produced by welding, brazing, soldering, and adhesive bonding can also be ultrasonically inspected. In-line techniques have been developed for monitoring and classifying material as acceptable, salvageable, or scrap and for process control. Both line-powered and battery-operated commercial equipment is available, permitting inspection in shop, laboratory, warehouse, or field.

Ultrasonic inspection is used for quality control and materials inspection in all major industries. This includes electrical and electronic component manufacturing; production of metallic and composite materials; and fabrication of structures such as airframes, piping and pressure vessels, ships, bridges, motor vehicles, machinery, and jet engines. In-service ultrasonic inspection for preventive maintenance is used for detecting the impending failure of railroad-rolling-stock axles, press columns, earthmoving equipment, mill rolls, mining equipment, nuclear systems, and other machines and components.

Some of the major types of equipment that are ultrasonically inspected for the presence of flaws are:

•Mill components: Rolls, shafts, drives, and press columns.
•Power equipment: Turbine forgings, generator rotors, pressure piping, weldments, pressure vessels, nuclear fuel elements, and other reactor components.
•Jet engine parts: Turbine and compressor forgings, and gear blanks.
•Aircraft components: Forging stock, frame sections, and honeycomb sandwich assemblies.
•Machinery materials: Die blocks, tool steels, and drill pipe.
•Railroad parts: Axles, wheels, track, and welded rail.
•Automotive parts: Forgings, ductile castings, and brazed and/or welded components.

VII. EQUIPMENT USED

PROBES: T-R/DUAL PROBE
Frequency of probe is 5MHZ
Transmitter-receiver probe with contact diameter 10mm.
Piezoelectric material probes are used, because a piezoelectric material has the ability to produce ultrasonic sounds and satisfies re visibility property.

Fig 10: Single Probe

Machine: ULTRASONIC FLAW DETECTOR (UFD)

Fig 11: Flaw Detector

PROBE: DUAL /T-R PROBE MODEL: EINSTIN-DGS
MAKE: MODOSONIC
Velocity: dual probe produces LONGITUDINAL WAVES with velocity 5920 m/s.
Size up Method: Equalization method is selected for marking defected areas in work specimen. Defects are marked between two echoes" (defect indicating echo and final echo) at equal amplitude levels.

Reference Curve Used For Analyzing The Intensity Of Defect: DAC curve is draw by using FBH Block (FLAT BOTTOM HOLE).

Fig 12: DAC Curve

Standard Blocks Used:

Below shown Figure is FBH Block-flat bottom hole is used for calibration process.

VI block-universal block

Fig 13: V1 Block

Work specimen:

This below shown picture is work piece of test conducted.

Fig 14: Work Specimen

VIII. TESTING PROCEDURE

Experimental procedure tests performed on lamination scanning with the knowledge of ultrasonic testing explained in above chapters, the sample of mild steel plate has been tested for identifying defects like lack of fusion, porosity, cracks, lamination defects... etc. has been observed.

Procedure Steps

- Calibration
- Drawing DAC Curve
- Testing on welded joints

Calibration

IIW blocks are mainly used to calibrate instruments prior to contact inspection using an angle-beam search unit, these blocks are also useful for.

•Checking the performance of both angle-beam and straight-beam search units.

•Determining the sound beam exit point of an angle-beam search unit.

•Determining refracted angle produced.

•Calibrating sound path distance.

•Evaluating instrument performance.

The material from which a block is prepared is specified by the IIW as killed, open hearth or electric furnace, low-carbon steel in the normalized condition and with a grain size of McQuaid-Ehn No. 8. All IIW standard reference blocks are of the same size and shape, official IIW blocks are dimensioned in the metric system of units One of the standard English-unit designs is given.

Linearity

Calibration in terms of metal distance or reflector depth assumes a linear oscilloscope sweep for the instrument, which can be checked using a straight-beam search unit. The search unit is placed on either surface C or D to obtain multiple echoes from the 25 mm (1 in) thickness. These echo indications will be aligned with evenly spaced grid lines or scale marks if the time base is linear. Linearity within ±1% (or less) of the full- scale value of thickness is usually obtainable.

Fig 15: Linearity checking

Resolution

A straight-beam search unit, as well as the instrument, can be checked for back- surface resolution by placing the search unit on surface A and reflecting the beam from the bottom of the 2 mm (0.080 in.) wide notch and from surfaces B and E on either side of it. With proper resolution, the indications from these three surfaces should be clearly separated and not overlapped so as to appear as one broad, jagged indication. Because resolution is affected by test conditions and by characteristics of the search unit and instrument amplifier, this degree of resolution sometimes may not be obtained.

Fig 16: Resolution checking

Sensitivity

The relative sensitivity of an angle-beam search unit in combination with a given instrument can be defined by placing the unit on either surface A or B and reflecting the beam from the side of the 1.5 mm (0.060 in.) die hole. The position of the search unit is adjusted until the echo from the hole is maximum, then the gain of the instrument is adjusted to give the desired indication height.

When no back reflection is expected, the sensitivity of a straight-beam system is defined by placing the search unit on either surface B or F in line with the 1.5 mm (0.060 in) die hole. The position of the search unit is adjusted until the echo from the side of the hole is maximum, then the gain of the instrument is adjusted to give the desired indication height.

When a back reflection is expected, a plastic insert can be used in the 50 mm (2 in.) die hole to gage the sensitivity of a straight-beam system. The plastic material and insert thickness are specified to have the absorption characteristics of 50 mm (2 in.) of steel. With this calibration, the search unit is placed on the side of the insert facing surface C. and the number of echoes and the height of the last echo indication are noted.

Fig 17: Sensitivity checking

Range Setting

Range for a search-unit and instrument system for straight-beam inspection can be set for various distances by use of the IIW block. From surface F to the 2.0 mm (0.080 in) wide notch is 200 mm (8 in.), from surface A to surface B is 100 mm (4 in), from surface E to surface A is 91.4 mm (3.60 in.), and from surface C to surface D is 25 mm (1 in.).

Range: Range =2*thickness of specimen
=2*20
=40mm

Lamination Checking in Rolled Plate

Laminations are an imperfection in a steel or alloy, resulting from blisters, seams, foreign material, and/or scratches on an ingot or billet that are not repaired during the rolling process.

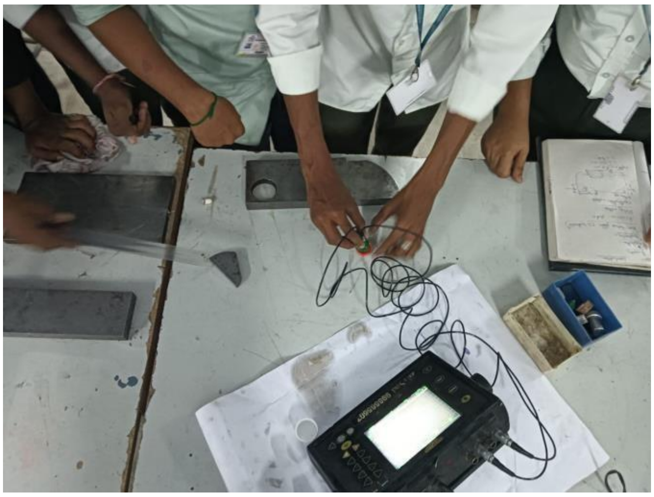


Fig 18: Lubrication of probe

Laminations can be:

•A rolled in lap on the surface of the metal, invisible when the product ships, but which opens up upon further work machining or rolling.

•An imperfection that opens up during bending.

Inclusions, if they are dense enough, will impede machining. They may affect weld ability of a product. Internal laminations would be considered a defect if they violate ultrasonic testing (UT) or eddy current testing requirements for the product, although, as noted previously, they are difficult to detect with common NDT.

Fig 19: Lamination Checking

If measured values are mismatched with standard block values, then adjust zero in flaw detector to standard block values. After adjusting zero draw DAC (DISTANCE AMPLITUDE CORRECTION CURVE).

Then proceed scanning on work piece under inspection and detect defects by observing echoes in flaw detector.

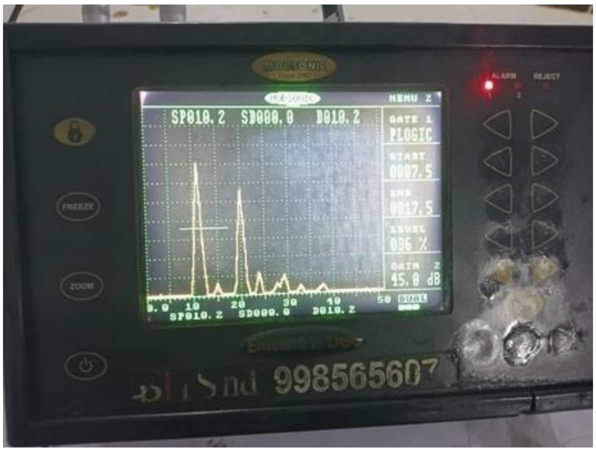


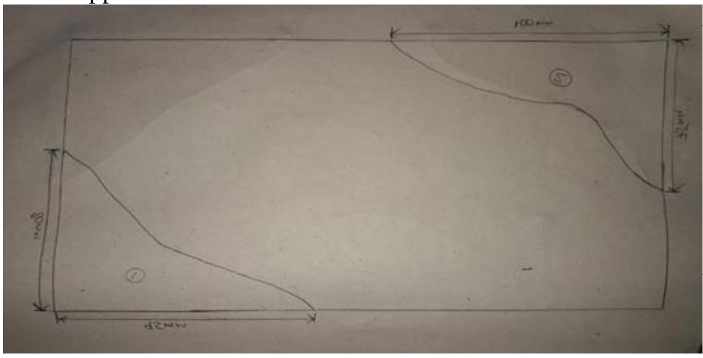
Fig 20: Identifying defects on flow detector

IX. PLATE SCANNING REPORT

SPECIMEN REFERANCE NUMBER	MI-16-01-HSV-156
SPECIMEN LENGTH & THICKNESS	300MM & 20MM
CALIBRATION RANGE	300
EQUIPMENT USED	ULTRASONIC FLAW DETECTOR
REFERANCE REFLECTOR TYPE/ SIZE	SDH BLOCK/3MM DIAMETER
TRANSDUSER USED & ANGLES	0 DEG, 45 DEG, 60 DEGRESS&70 DEGRESS
REFERANCE GAIN SETTING	69.5MM
COUPLANT USED	LUBRICATING OIL
DEFECT SIZING METHOD FOLLOW	EQUILLIZATION METHOD

Reflector Location Sketch 1:

In this sample material we identified two defected regions. The below figure shows the defected areas, which are marked as 1 and 2. The size of the defected areas are marked at two opposite corners.

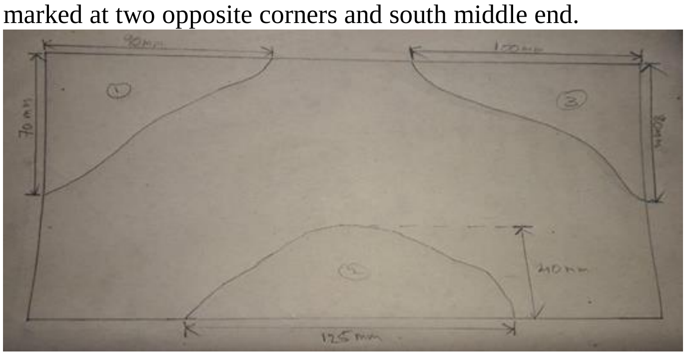


S.NO	FLAW TYPE	FLAW LENGTH(MM)	FLAW WIDTH(MM)	FLAW DEPTH(MM)
1	FUSION	24	52	4.2
2	ROOT CRACK	26	170	16.5

Fig 21: Measuring size of defects

Reflector Location Sketch 2:

In this sample material we identified three defected regions. The below figure shows the defected areas, which are marked as 1,2 and 3. The size of the defected areas are marked at two opposite corners and south middle end.



S. NO	FLAW TYPE	FLAW LENGTH(MM)	FLAW WIDTH(MM)	FLAW DEPTH(MM)
1	LACK OF FUSION-1	20	42	13.2
2	SLAG	18	200	15.8
3	LACK OF FUSION-2	18	110	6.8

X. CONCLUSION

This project aims at introducing inspection and various testing methods to understand its purpose and importance in industries especially in fabrication industries.

After studying various non-destructive inspections and testing techniques, their applications, advantages and limitations, it can be concluded that it is a very important tool for the modern industries. we selected ULTRASONIC TESTING TECHNIQUE for detecting WELDING defects in MILD STEEL PLATE by using DUAL PROBE. this technique is further used for detecting defects like cracks. porosity etc., in WELDED JOINTS by using INCLINED BEAM PROBE.

By using this technique, we can easily detect the defects and its location. Following specimens are examined and defected areas are found, which are displayed in scanning report.

S. No	Specimen metal	Specimen number	Defects observed
1	Mild Steel	MI-16-01-LAM-653	10. (lamination)
2	Mild Steel	MI-16-03-LAM-654	11. (lamination)

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WORKING ON FOOTSTEP POWER GENERATION USING PIEZO ELECTRIC EFFECT

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Abstract
In our energy-hungry world, finding renewable sources is key. This study looks at turning human movement into power using piezoelectric sensors. The idea is to collect and store energy from walking, especially in busy places. It explains how piezoelectric sensors can turn pressure into electricity effectively. This technology could be a big help in making sustainable energy, by using our movement more wisely. The study talks about how the sensors are set up, how the energy is stored, and why this is good for the environment.
Key words: piezoelectric buzzer, battery,voltage regulator.

INTRODUCTION

In response to the escalating global demand for electricity, there is an urgent imperative to seek sustainable energy solutions

Among the array of innovative approaches, the harnessing of human locomotion energy through footstep power generation systems has emerged as a promising avenue.This strategy capitalizes on the fascinating principle of piezoelectricity, wherein mechanical stressapplied to certain materials generates electrical charge. Such a concept not only presents are newable energy source but also holds the potential to revolutionize urban energy landscapes.The core of footstep power generation lies in the deployment of piezoelectric sensors strategically placed beneath surfaces commonly traversed by pedestrians, such as pavements, floors, or even integrated within footwear. As individuals walk, run, or engage in any form of locomotion, the pressure exerted on the ground is effectively converted into electrical energy by these embedded sensors. This seamless integration of piezoelectric technology with everyday urban infrastructure offers a promising solution for sustainable energy generation.

Moreover, the significance of footstep power generation extends beyond mere electricity production; it embodies a paradigm shift towards more efficient and environmentally friendly energy practices. Particularly in densely populated regions like India and China, where foot traffic is abundant, the implementation of such systems holds immense potential. By capitalizing on the kinetic energy generated by human movement, these regions can not only alleviate the strain on conventional energy sources but also foster sustainable living practices. Furthermore, the choice of piezoelectric materials plays a pivotal role in optimizing the efficiency and viability of footstep power generation systems. Researchers have been exploring various materials with enhanced piezoelectric properties, aiming to maximize energy conversion efficiency while ensuring durability and cost-effectiveness. Advances in material science continue to drive innovation in this field, promising further improvements in the performance and applicability of footstep power generation technology. In essence, footstep power generation using piezoelectric sensors represents more than just a novel approach to energy harvesting; it embodies a fundamental shift towards sustainable urban development. By harnessing the latent energy present in human locomotion, these systems offer a compelling solution to the pressing energy challenges of our time. This paper delves into the efficiency, significance, and potential of footstep power generation, highlighting its role in shaping a more sustainable and resilient future for urban environments worldwide.

CONSTRUCTION

The various parts/ components used in the construction of footstep power generation using piezo electric effect.

- Piezoelectric sensors
- Voltage boosters
- Voltage regulator
- PIC microcontroller
- Battery
- LCD display
- Light Dependent Resistor (LDR)
- Buzzer
- Mobile charging socket
- Pull-down resistor

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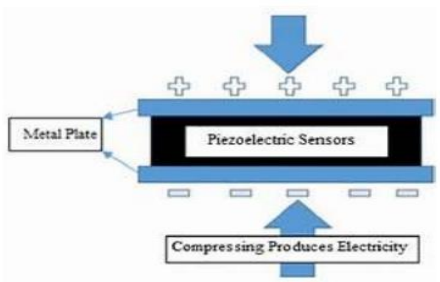
Piezoelectric sensors:
These sensors convert mechanical energy (from footsteps) into electrical energy through the piezoelectric effect.
Voltage boosters:
Two voltage boosters are used to increase the voltage.
PIC microcontroller:
Controls the operation of the system. It receives input from the sensors, manages the charging of the battery, and controls the display on the LCD screen
Battery:
Stores the generated electrical energy for later use. It acts as a buffer to ensure continuous power supply, even when footsteps are not actively generating Electricity.
Buzzer: Provides an audible alert when the battery voltage falls below the required level for charging the microcontroller. It serves as a warning mechanism to notify users of potential issues with the system.
Pull-down resistor: Used to maintain constant voltage range for the required device.
Connection and workflow of Components:

- Footsteps exert pressure on the piezoelectric sensors, generating electrical energy.
- The output from the sensors is fed into the voltage boosters to increase the voltage to the desired range (9-12V).
- The regulated voltage from the voltage regulator is stored in the battery.
- The microcontroller manages the system operation, including monitoring battery
- voltage, controlling charging, and interfacing with the LCD display.
- The LCD display shows the amount of charge stored in the battery.
- The LDR detects ambient light levels, indicating when the generated power is being used to light a streetlight.
- The buzzer provides an alert if the battery voltage falls below the required level for charging the microcontroller. .
- The mobile charging socket allows users to charge their devices using the generated power,
- regulated by the pull-down resistor to maintain a 5V output.
- ➢This system utilizes mechanical energy from footsteps to generate electricity, making it suitable for various applications in schools, colleges, theaters, shopping complexes, temples, etc. However, it's essential to note that the mechanical moving parts may increase the cost of implementation.

Working:



Footstep power generation systems utilizing piezoelectric sensors work by converting mechanical energy from footsteps into electrical energy. These systems are typically installed beneath flooring or on staircases, where they can be compressed by the weight of a person walking. When pressure is applied to the piezoelectric sensors, they deform slightly, generating a voltage across their electrodes due to the piezoelectric effect. This voltage is then collected and conditioned using a voltage booster to increase it to a usable level, typically between 9-12V. A voltage regulator ensures that the output voltage remains stable, and the energy is stored in a battery for later use. The stored energy can be used to power various applications, such as lighting or charging electronic devices. Overall, footstep power generation using piezoelectric sensors offers a sustainable and efficient way to harness the energy from human movement in high-traffic areas**.**

Circuit diagram :

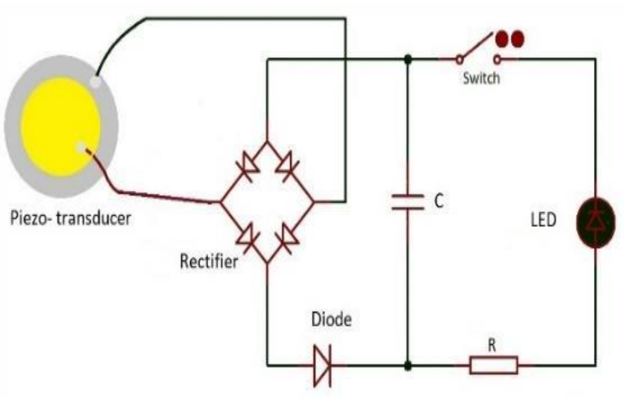


Fig: Circuit diagram of footstep generator

FUTURE SCOPE
The future of piezoelectric energy harvesting looks bright, especially in busy places like China and Japan, where there's a lot of movement in places like train stations and malls. Using piezoelectric crystals in these areas could create a lot of electricity from people walking, which is great for the environment.
Also, putting these crystals in everyday things like shoes could change how we charge our phones and
gadgets. This new way of making electricity from our daily activities is convenient and eco-friendly. As technology gets better, we'll likely see more of these systems using renewable resources, helping us move towards a greener future.

A. Advantages
1) Power generation is simply walking on step
2) No need fuel input
3) There is a non-conventional system
4) No moving parts long service life
5) Compact yet highly sensitivity
6) Self generating no external power required

Fig: Working of Piezoelectric Sensor

B. **Disadvantages**

1) Only applicable for the particular place
2) Initial cost of the arrangement is high
3) Output affected by temperature variations
4) Crystal is prone to crack if over stressed

CONCLUSION:

The projects propose innovative methods for generating electrical power from footstep using piezoelectric energy harvesting, highlighting the importance of non-conventional energy sources in densely populated countries like India and China. They emphasize converting mechanical energy into electrical energy using piezoelectric sensors, aiming to harness waste energy from human locomotion. The practical implementation of these systems could serve as viable alternatives for power supply and help conserve energy in areas with high foot traffic, such as roads, railway stations, and footpaths.

REFERENCE

1.FOOTSTEP POWER GENERATION USING PIEZOELECTRIC PLATE Kunal Soni*1,
Nikhil Jha*2, Jai Padamwar*3, Devanand Bhonsle*4, Tanu Rizvi*5 *1,2,3Students,
Department Of Electrical Engineering, Shri Shankaracharya Technical Campus, Junwani,
Bhilai 490020, Chhattisgarh, India. *4,5Assistant Professor, Department Of Electrical
Engineering, Shri Shankaracharya Technical Campus, Junwani, Bhilai 490020, Chhattisgarh,
India.
2.Footstep Power Generation Using Piezoelectric Sensor Adeel Ali1, Usama Khan1, Md.
Omair Ahmad1, Asfia Aziz1, Neha1, {adeel.ali.2222@gmail.com} 1School of Engineering
Science and Technology (SEST) Jamia Hamdard New Delhi, India
3. Footstep Power Generation Using Piezoelectric Sensor Namrata.J. Helonde1, Punam Suryawanshi2, Ankita Bhagwatkar3, Arun Wagh4, Pradhnya Vetal5 1Professor, Department of Electrical Engineering, S.I.T.R.C, Savitribai Phule Pune University, Nashik, India 2, 3, 4, 5Student, Department of Electrical Engineering, S.I.T.R.C, Savitribai Phule Pune University, Nashik, India
4. [1] https://www.nanomotion.com/piezo-ceramic-motor-technology/piezoelectric-effect/
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PERFORMANCE OF DI DIESEL ENGINE BASED ONJATROPHA OIL METHYL, ETHYL ESTER & ITS BLENDS

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ABSTRACT: Biodiesel is an alternative to conventional diesel fuel made from renewable resources, such as non-edible vegetable oils. The oil from seeds (e.g., Jatropha and Pongamia.) can be converted to a fuel commonly referred to as “Biodiesel.” No engine modifications are required to use biodiesel in place of petroleum-based diesel. Biodiesel can be mixed with petroleum –based diesel in any proportion. This interest is based on a number of properties of biodiesel including the fact that is produced from a renewable domestic source its biodegradability, and its potential to reduce exhaust emissions. The climate change is presently an important element of energy use and development. Biodiesel is considered “climate neutral” because all of the carbon dioxide released during consumption had been sequestered out of the atmosphere during crop growth. The use of biodiesel resulted in lower emissions of unburned hydrocarbons, carbon monoxide, and particulate matter. also increased catalytic converter efficiency in reducing particulate emissions. Chemical characterization also revealed lower levels of some toxic and reactive hydrocarbons species when biodiesel fuels were used. Petroleum prices approaching record highs and they will deplete within few decades , it is clear that more can be done to utilize domestic non-edible oils while enhancing our energy security. The economic benefits include support to the agriculture sector, tremendous employment opportunities in plantation and processing. Jatropha and pongamia are known just crude plants which grow on eroded soils and require a hot climate and hardly any water to survive. These are the strong reasons, enforcing the development of biodiesel plants. In this project, fuel quality biodiesels produced from jatropha oil using methanol and ethanol were tested as pure and blends B10, B20, B30 with petroleum based diesel fuel (PBDF) in a direct injection (DI) diesel engine running at six different engine loads (500,750,1000,1250,1500,2000). The results showed that the brake specific consumptions (BSFC) of ester fuels were higher than those of diesel. The BSFC of ethyl ester biodiesel was slightly lower as compared wit methyl ester biodiesel. The thermal efficiencies of the ester fuels were higher those of petrol based diesel fuels. Ethyl ester biodiesel had slightly better thermal efficiency than methyl ester biodiesel. Ethyl ester had slightly better mechanical efficiency than methyl ester biodesel.

Keywords: Jatropha oil, Methyl ester, Ethyl ester, Petroleum based diesel fuels(PBDF).

IMPROVEMENT OF MECHANICAL PROPERTIES OF ALUMINIUM –BORON CARBIDE COMPOSITES

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ABSTRACT:
Materials technology and Engineering design field requires advanced engineering materials with high end mechanical, electrical and magnetic properties. To suit the requirements of engineering industries, the ceramic particles like Al_2O_3, BORON are mostly reinforced with Aluminum metal matrix for their improved mechanical properties like hardness, toughness, and low wear rate. Recent researches show that, boron carbide reinforced Al metal matrix composites has attractive properties like good tensile strength, high hardness and low density than Al- BORON composites in this thesis, to develop lightweight Aluminum - Boron carbide composites and evaluate the mechanical properties with effect of addition of calcium carbide particles Objective ofthis research is to fabricate and testing the mechanical properties of Aluminum metal matrix composites with Boron Carbide at different volume proportions. Mechanical properties like tensile strength, impact strength and hardness of newly developed metal matrix composites is improved significantly by incorporating boron carbide particles.

Keywords: *Aluminum - Boron carbide composites, metal matrix composites, Stir Casting*

I. INTRODUCTION:

A composite is a structural material that consists of two or more constituents that are combined at a microscopic level and are not soluble in each other in which one constituent is called the reinforcing phase and the other in which the reinforcement is embedded is called the matrix phase. Reinforcement provides strength and rigidity, helping to support structural load.

Characteristics of Composites:

High strength to weight ratio: Fiber composites are extremely strong for their weight. By refining the laminate many characteristics can be enhanced. Stiffness should not be confused with strength.

Light weight: A standard fiber glass laminate has a specific gravity in the region of 1.5, compared to alloy of 2.7 or steel of When you then start looking at carbon laminates, strength can be many times that of steel, but only a fraction of weight.

Translucency: Polyester resins are widely used to manufacture translucent moulding and sheets. Light transmission of up to 85% can be achieved

Low Thermal conductivity: Fiberglass Developments has been involved in the development and production of specialized meat containers which maintain prime cuts of chilled meat at the correct temperature for Export markets. They are manufacturesusing the RTM process, with special reinforcing and foam inserts.

Advantages of Composite Materials

- Tensile strength of the composite is four to six times greater than that of steel or aluminum.
- Improved torsional stiffness and impact properties.
- Higher fatigue endurance limit.
- Lower embedded energy compared to other structural metallic materials like steel, aluminum etc.

Composites are less noisy while in operation and provide lower vibration transmission than metals.

II. LITERATURE REVIEW:

[1] B.Stalin, S.Arivukkarasan (2015) Mechanical investigation of Aluminum alloy (AA) LM 6, B4C (boron carbide) and TiO2 metal matrix composites. Aluminum is the matrix metal having properties like light weight, high strength and ease of machinability. Boron carbide which has excellent hardness and fracturetoughness is added as reinforcements with TiO2.It has been inferred that the tensile strength of sample 1 is marginally higher than other two samples because of its Aluminum content. But, the sample 3 has higher tensile strength (157.1 MPa) than sample 2 (148.48 MPa).

[2] **Dr.B.StalinC.Murugan (2016**) the fabrication of 5,10,15 wt % of Boron carbide reinforced with Aluminum alloy LM4 metal matrix composite by using liquid stir casting technique was performed and fabricated under ASTM standard B557M for finding its tensile strength, Hardness and Impact tests were carried out and compared with the base metal and its metallographic structure of its each proportion. In this evaluation Aluminum Metal Matrix Composites of Lm4-B4C were fabricated in three different proportions like Lm4 reinforced with different Wt% of boron carbide with its value of density, hardness, tensile, impact tests showed that improved its mechanical behavior and characters. Percentage of Elongation, density values were decreased by increasing the percentageof reinforcement.

[3] **Saikeerthi.S.P, Vijayaramnath.B (2014**)Metal matrix composite (MMC) focuses primarily on improved specific strength, high temperature and wear resistance application From the collected literature it is found that, metal matrix composites are under serious consideration as potential candidate materials and it is mainly used to replace conventional materials in aerospace and automotive applications. So, the MMC are highly used in automotive and space applications. And the Aluminum Matrix Composite is a material with two constituent parts, one being a metal, and other being reinforcement.

[4] **AifWakeel, 2mustafa Saleem(2017)**the aluminum metal matrix composite fabricated through different powder metallurgy process. This MMC's has wide applicationin aerospace, automobile, sports and industrial appliances due to their high strength to weight ratio, high temperature, better corrosion and wear resistance.This study will reveal the effect of different reinforcement in an aluminum matrix composite and review the technique that different researcher used to fabricating and estimating different mechanical and tribological properties.

III. PREPARATION OF SPECIMENS:

Casting process is a simplest and cost effective liquid state fabricating method of metal matrix composites, in which a distributed phase (ceramic particulates) is mixed with a molten matrix by means of mechanical stirring which ensures a more uniform distribution of the reinforcing particles. In this process, 6061 Aluminum alloy was superheated to 800°C and then the temperature is lowered gradually below the liquids temperature to keep the matrix material in the semi-solid state. At this temperature, the preheated boron carbide with different volume proportions of (10 % B_4C, 15 % B_4C, 20 % B_4C, 25 % B_4C) average size of 45 µm & 100 µm respectively were introduced into the slurry and mixed using a graphite stirrer.

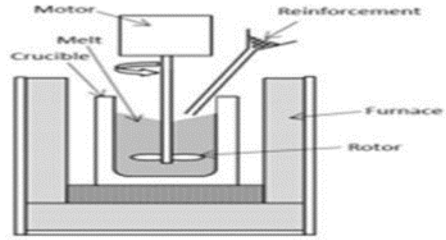


Fig: Line diagram of Stir Casting

Table: Properties of Boron carbide & **Al-6061**

Physical properties	Boron carbide	Al-6061
	Metric	Metric
Density	2.50 g/cc	2.69 g/cc
Mechanical properties	Metric	Metric
Young's modulus	450-475 Gpa	68.7 Gpa
Poisson's ratio	0.18-0.21	0.32

Matrix material:

Aluminum Alloy is greatly influence the engineering industrial applications Where most necessary areas of stress. And which can be accommodating thin sections and can able to cast varying cross sections. Cast alloy can also heat treated to improve the mechanical properties and also LM4 has the high static loads are anticipated and creep extinction at the elevated highertemperature.

Machining process for doumble shape: The shape of the machined surface is determined by the contour of the cutting edges on the broach, particularly the shape of final cutting teeth. Broaching is a highly productive method of machining. Advantages include good surface finish, close tolerances, and the variety of possible machined surface shapes, some of them can be produced only by broaching. Owing to the complicated geometry of the broach, tooling is expensive. Broaching is a typical mass production operation. Broaching canbe used for machining of various integrate shapes which cannot be otherwise machined with other operations. Some of the typical examples of shapes produced by internal broaching are: Productivity improvement to ten times or even more is not uncommon, as the metal removal rate by broaching is vastly greater. Roughing, semi finishing and finishing of the component is done just in one pass by broaching, and this pass is generally accomplished in seconds.

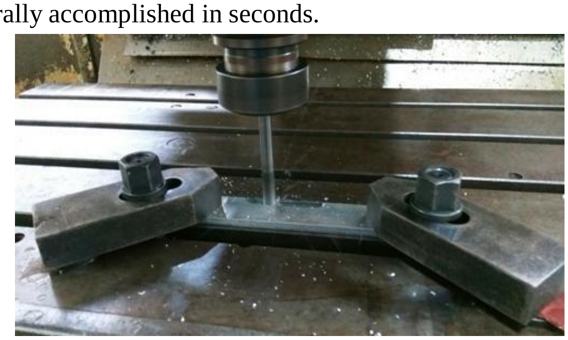


Figure: doumble shape machining process

Tensile Test:

Tensile testing, also known as tension testing is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under normal forces. Properties that are directly measured via a tensile test are ultimate tensile strength, maximum elongation and reduction in area. From these measurements the following properties can also be determined: Young's modulus, Poisson's ratio, yield strength, and strain - hardening characteristics. Uniaxial tensile testing is the most commonly used for obtaining the mechanical characteristics of isotropic materials.

Figure: Tensile test machine

Hardness Test:

Hardness is a characteristic of a material, not a fundamental physical property. It is defined as the resistance to indentation, and it is determined by measuring the permanent depth of the indentation.The Brinell hardness test method as used to determine Brinell hardness is defined in ASTM E10. Most commonly it is used to test materials that have a structure that is too coarse or thathave a surface that is too rough to be tested using another test method, e.g., castings and forgings.The Rockwell hardness test method, as defined in ASTM E-18, is the most commonly used hardness test method. You should obtain a copy of this standard, read and understand the standard completelybefore attempting a Rockwell test.

Figure: Hardness Test machine

Impact Test:

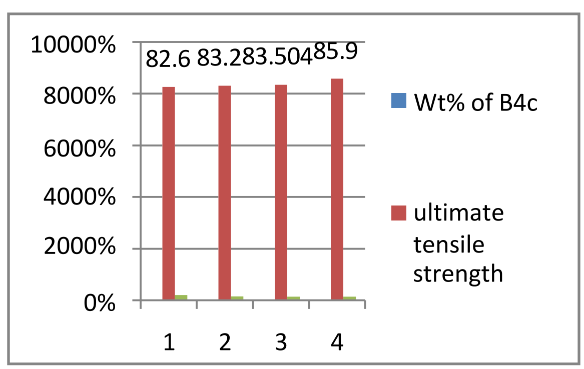
The impact test, also known as the Charpy V-notch test, is a standardized high strain- rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's notch toughness and acts as a tool to study temperature-dependent ductile-brittle transition. It is widely applied in industry, since it is easy toprepare and conduct and results can be obtained quickly and cheaply. A disadvantage is that some results are only comparative.the technical contributions and standardization efforts by Charpy. The test was pivotal in understanding the fracture problems of ships utilized in many industries for testing materials, for example the construction of pressure vessels and bridges to determine how storms will affect the materials used.

Figure: Impact Test

IV. RESULTS AND DISCUSSIONS:

Table 4.1 Tensile Strength Results:

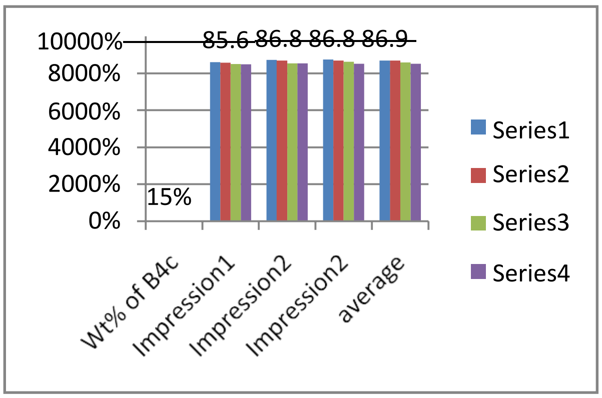
Wt% of B4c	Tensile Strength	Hardness value / absorbed energy
10%	82.7	2
15%	83.3	1.5
20%	83.501	1.42
25%	85.8	1.42



Graph: Effect of Wt% of boron carbide ontensile strength

Table 4.2 Hardness test results

Wt % of B4c	Impression1	Impression2	Impression2	average
10 %	86.2	87.1	87.2	86.73
15 %	85.7	86.7	86.7	86.8
20 %	85	85.2	86.3	85.86
25 %	84.8	85.2	85.3	85.2



Graph: Effect of Wt% of boron carbide onBHN value.

V. CONCLUSIONS:

This experimental evolution of Aluminum and Boron Carbide composites leads to the following conclusions:

- Production of Al-Boron Carbide composite was completedsuccessfully.
- From mechanical investigation, there is increase in the tensile strength and BHN value with the increase in wt% of B_4C.
- There is decrease in the absorbed impact energy with increase in wt% of B_4C. This phenomenon may bedue to the increased.

FUTURE SCOPE OF RESEARCH:

There is a wide scope for future scholars to explore this area of research. The research results may be used in designing of mechanical components against vibrations which are,

- Propeller blades.
- Cutting tools.
- Cylinder liners.
- Aerospace applications

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DESIGN AND FABRICATION OF MULTI MODE ROBOTIC CAR

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ABSTRACT: This paper introduces a multi-mode robotic car designed to offer diverse control options and obstacle avoidance capabilities. The robotic car operates in three primary modes: manual, gesture, and voice control, catering to users' preferences and interaction styles. In "manual control mode", users can remotely control the robotic car via Bluetooth using mobile devices or computers. Commands such as forward, backward, left, and right are transmitted wirelessly to an Arduino microcontroller, facilitating precise movement control. "Gesture control mode" enhances user interaction by allowing gestures to steer the car. A servo-controlled ultrasonic sensor detects hand movements, translating them into corresponding directional commands. For instance, moving the hand left or right can steer the car accordingly, while vertical gestures control forward and backward motion. "Voice control mode" enables hands-free operation, providing convenience and accessibility. Utilizing voice recognition technology, the robotic car interprets spoken commands such as "forward," "backward," "left," and "right." This mode enhances user experience by eliminating the need for manual input devices. Furthermore, the robotic car is equipped with "obstacle avoidance" capability, ensuring safe navigation in dynamic environments. It utilizes sensor feedback from an ultrasonic sensor and an infrared (IR) sensor to detect obstacles in its path. When an obstacle is detected, the car autonomously adjusts its course to avoid collisions, prioritizing safety during operation. Overall, the multi-mode robotic car's versatility and adaptability make it suitable for various applications, ranging from entertainment to practical tasks requiring precise control and obstacle avoidance. By offering multiple control options and safety features, this robotic car represents a significant advancement in robotic technology, catering to diverse user needs and preferences.

1. INTRODUCTION

This project embarks on a journey to contribute to this evolving landscape by focusing on the design and fabrication of a multi-mode robotic car that integrates manual, gesture, voice, and obstacle avoidance control mechanisms. The primary objective of this project is to "design and fabricate a robotic car capable of multi-mode control", enabling interaction through different input modalities. By "integrating manual, gesture, voice, and obstacle avoidance control mechanisms", the robotic car aims to provide users with a comprehensive and intuitive means of controlling its movements and navigating its environment.

To achieve this objective, the project leverages a combination of hardware and software components, including an Arduino microcontroller as the central processing unit, DC motors for propulsion, a servo motor for directional control, and a range of sensors for perception and feedback. These components work in harmony to enable multi-mode control and obstacle avoidance functionality, offering users a seamless and immersive robotic experience.

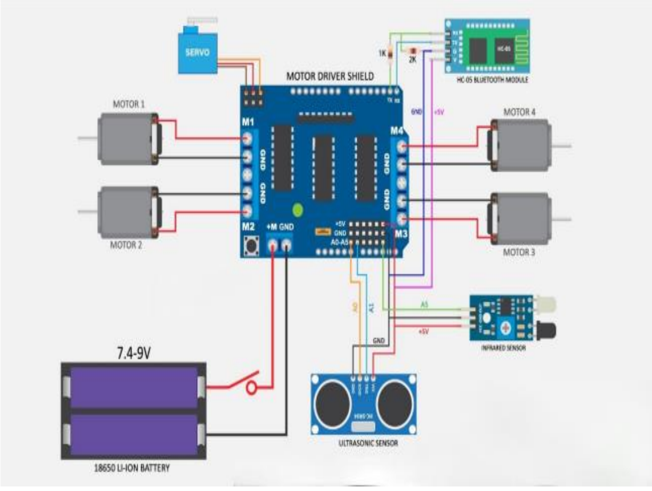

Figure 1.1: Basic Connections

In essence, this project represents a step forward in the advancement of robotic systems capable of intelligent and interactive interaction. By harnessing the power of multi-mode control and obstacle avoidance, the robotic car offers a glimpse into the future of robotics technology, where versatility, adaptability, and innovation converge to redefine the boundaries of human-robot interaction.

2. INTRODUCTION OF EMBEDDED C PROGRAMMING

Before going into the details of Embedded C Programming Language and basics of Embedded C Program, we will first talk about the C Programming Language.

The C Programming Language, developed by Dennis Ritchie in the late 60's and early 70's, is the most popular and widely used programming language.

The C Programming Language provided low level memory access using an uncomplicated compiler (a software that converts programs to machine code) and achieved efficient mapping to machine instructions.

The C Programming Language became so popular that it is used in a wide range of applications ranging from Embedded Systems to Super Computers.

Embedded C Programming Language, which is widely used in the development of Embedded Systems, is an extension of C Program Language. The Embedded C Programming Language uses the same syntax and semantics of the C Programming Language like main function, declaration of datatypes, defining variables, loops, functions, statements, etc. The extension in Embedded C from standard C Programming Language include I/O Hardware. Addressing, fixed point arithmetic operations, accessing address spaces, etc.

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Keywords in Embedded C:

A Keyword is a special word with a special meaning to the compiler (a C Compiler for example, is a software that is used to convert program written in C to Machine Code). For example, if we take the Keil's Cx51 Compiler (a popular C Compiler for 8051 based Microcontrollers) the following are some of the keywords:

- **bit**
- **sbit**
- **sfr**
- **small**
- **large**

Data Types in Embedded C:

Data Types in C Programming Language (or any programming language for that matter) help us declaring variables in the program. There are many data types in C Programming Language like signed int, unsigned int, signed char, unsigned char, float, double, etc. In addition to these there few more data types in Embedded C. The following are the extra data types in Embedded C associated with the Keil's Cx51 Compiler.

- **bit**
- **sbit**
- **sfr**
- **sfr16**

Factors for Selecting the Programming Language:

The following are few factors that are to be considered while selecting the Programming Language for the development of Embedded Systems.

- **Size:** The memory that the program occupies is very important as Embedded Processors like Microcontrollers have a very limited amount of ROM (Program Memory).
- **Speed**: The programs must be very fast i.e., they must run as fast as possible. The hardware should not be slowed down due to a slow running software.
- **Portability:** The same program can be compiled for different processors.
- Ease of Implementation.
- Ease of Maintenance.
- Readability.

Earlier Embedded Systems were developed mainly using Assembly Language. Even though Assembly Language is closest to the actual machine code instructions and produces small size hex files, the lack of portability and high number of resources (time and manpower) spent on developing the code, made the Assembly Language difficult to work with.

There are other high-level programming languages that offered the above-mentioned features, but none were close to C Programming Language. Some of the benefits of using Embedded C as the main Programming Language:

- Significantly easy to write code in C.
- Consumes less time when compared to Assembly.
- Maintenance of code (modifications and updates) is very simple.
- Make use of library functions to reduce the complexity of the main code.
- You can easily port the code to other architecture with very little modification.

COMPONENTS:

This are the main important components used:

- Arduino UNO
- L293D Motor Driver Shield..
- Bluetooth module HC05
- DC Motor.
- Wheels.
- Micro USB cable.
- Rechargeable battery Li-Po battery.
- Jumper wires (female to a female).
- 4-wheel car chassis Board.
- Ultrasonic Sensor
- IR Sensor
- Servo Motor

3. FABRICATION OF MULTI-MODE ROBOTIC CAR

The fabrication process of the multi-mode robotic car involves several steps to assemble, integrate, and program the various components for versatile functionality. Beginning with the chassis assembly, the project progresses through mounting components, wiring and connections, programming the Arduino Uno microcontroller, testing and calibration, and finalization. The chassis serves as the foundation for the robotic car, providing structural support for mounting components such as DC motors, motor driver board, Arduino Uno, sensors, and modules. Once assembled, components are securely mounted onto the chassis, ensuring accessibility and proper alignment for wiring and connections. Wiring and connections are meticulously established, ensuring correct polarity and proper insulation to prevent short circuits or loose connections

Programming the Arduino Uno microcontroller is a critical step, as it dictates the functionality and behavior of the robotic car. The Arduino sketch (code) is written to implement manual, gesture, voice, and obstacle avoidance control modes, utilizing libraries and algorithms to interface with sensors, motors, and communication modules. Testing and calibration are essential to ensure the proper operation of the robotic car. Each control mode is thoroughly tested, verifying functionality and making necessary adjustments to the code or wiring as needed. The obstacle avoidance capability is rigorously tested by placing obstacles in the car's path and observing its response, fine-tuning sensor thresholds and parameters for optimal performance. Finalization involves securing all components and wiring to prevent damage or malfunction during operation. Double-checking the mounting of components and tightening screws or bolts ensures stability and durability. A final functionality test confirms that the robotic car operates as intended in various scenarios, culminating in documentation and presentation of the project's findings. Once the robotic car is assembled and programmed, thorough testing and calibration are conducted to ensure its proper operation. Each control mode is tested extensively to verify functionality, and any necessary adjustments are made to the code or wiring to optimize performance. The obstacle avoidance capability undergoes rigorous testing by introducing obstacles in the car's path and observing its response, fine-tuning sensor thresholds and parameters for optimal performance.

The finalization stage involves securing all components and wiring to prevent damage or malfunction during operation. Components are double-checked for proper mounting, and screws or bolts are tightened to ensure stability and durability. A final functionality test confirms that the robotic car operates as intended in various scenarios, culminating in the documentation and presentation of the project's findings. In addition to the onboard controls, the robotic car is equipped with an Android remote control application. This application communicates with the car via Bluetooth, allowing users to wirelessly control its movements. The Arduino Blue Control Android application enables users to transmit Commands such as moving forward, reverse, turning left, By following this comprehensive fabrication process, the Design and Fabrication of Multi-Mode Robotic Car ensures a robust and versatile platform for exploring the exciting world of robotics.

WORKING MODES:

The multi-mode robotic car operates in three primary modes: manual, gesture, and voice with obstacle avoidance.

1. **Manual Control**:

The robotic car can be controlled remotely via Bluetooth using a mobile device or computer. Commands such as forward, backward. left, and right are transmitted wirelessly to the Arduino microcontroller, which controls the movement of the car accordingly.

2. **Gesture Control:**

Gesture control allows users to interact with the robotic car through hand gestures detected by a servo-controlled ultrasonic sensor. For example, moving the hand left or right can steer the car in the corresponding direction, while moving the hand up or down can control forward and backward motion

3. **Voice Control:**

The robotic car accepts voice commands from the user, enabling hands-free operation. Voice recognition technology interprets spoken commands such as "forward," "backward," "left," and "right," translating them into actions for the robotic car to execute.

Obstacle avoidance mode utilizes sensor feedback from an ultrasonic sensor and an infrared (IR) sensor to detect obstacles in the car's path. When an obstacle is detected, the car autonomously adjusts its course to avoid collisions, ensuring safe navigation in dynamic environments.

BLOCK DIAGRAM OF PROJECT:

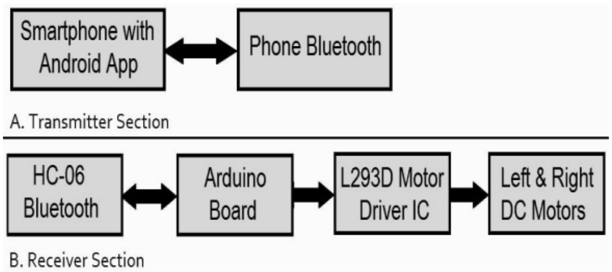

Figure 3.2: Block Diagram

Here is a block diagram, we have two sections one is the transmitter section and the receiver section. In the receiver section is connected to two L293D motor drivers where one is connected to two dc geared motors. The power supply is also given to Arduino Board. On the transmitter side, we have a simple android app through which we connect Bluetooth and use mobile internal microphone by that we give commands to it.

SOFTWARE DEVELOPMENT:

To develop this software, we must install the software Arduino 1.8.13 and there we must write the program and compile it. Here in the code, we are given the Bluetooth device name HC05, now our robot car will operate only for the device named HC05. If we want to change the device name, then we must change the name in code and dump or update it then compile. Now we can operate the machine with the changed name.

Figure 3.3a: Program

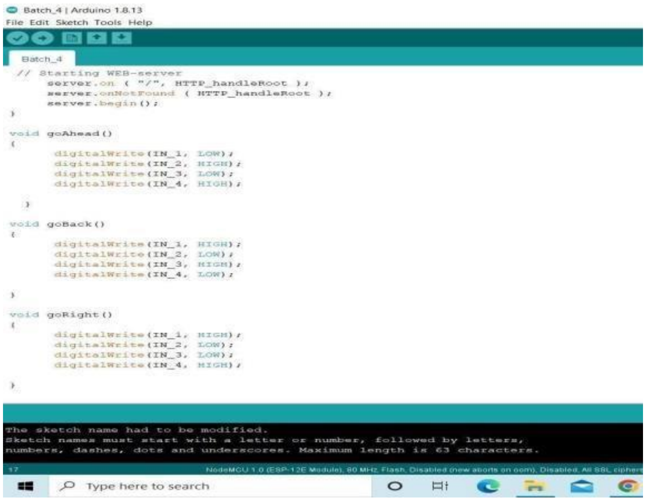

Figure 3.3b: Program

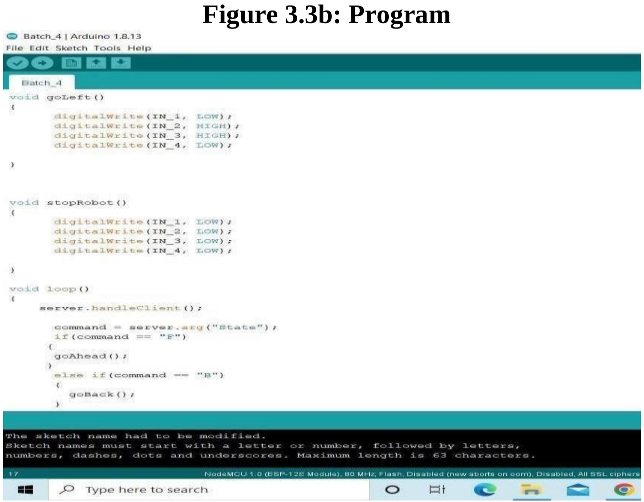

Figure 3.3c: Program

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APP INSTALLATION:

Step.1. Install this app (SriTu Hobby) on your mobile.

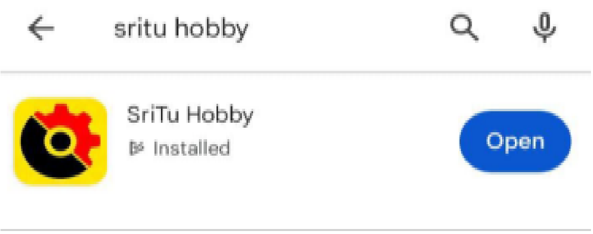

Figure 3.4: Node MCU

Step.2 Open the app, then you can find.

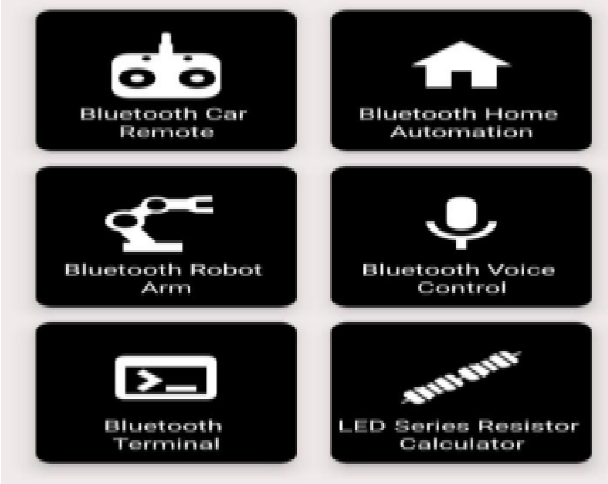

Figure 3.5: Image showing inside the app

Now, you can see the manual remote control. Then, touch the gear wheel icon in the upper right corner and find the name of your Bluetooth module. To do so, touch the "Find Device" button.

Figure 3.6: Find Devices

Next, select the name of your Bluetooth module. Then, it will be connected. Now, you can control your car using this remote. Also, if you want to change the remote mode, just click the arrow icon in the upper left corner and select the mode.

Figure 3.7: Manual Control

The above arrow marks indicate the directions in which we can move the robot car in different directions. Console page consist of 5 buttons named as LEFT, RIGHT, FORWARD, BACKWARD & STOP. On pressing these buttons one can move the robot in the specified direction, for example on pressing Right the app will send an R output to the controller which 37 will then process the signal and give the input to motor driver. While pressing the stop button the robot will stop its movements

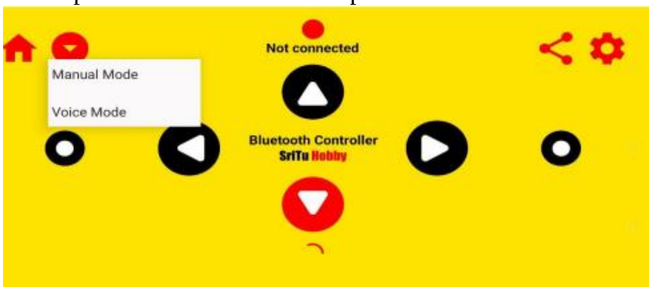

Figure 3.8: Gesture Control

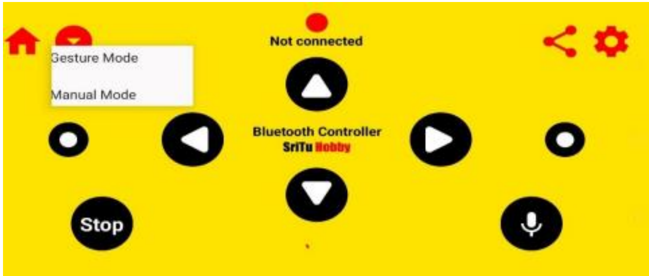

Figure 3.9: Voice Control

CIRCUIT DIAGRAM:

Node MCU is connected to L298N motor driver where it is connected to two dc geared motors. Power supply bis also given to Node MCU. In IN1 transmitter side we have a simple android app.

- Connect the pin of the L298n motor driver module to the D1 pin of the Node MCU board.
- Connect the IN2 pin of the L298n motor driver module to the D2 pin of the Node MCU board.
- Connect the IN3 pin of the L298n motor driver module to the D3 pin of the Node MCU board.
- Connect the IN4 pin of the L298n motor driver module to the D4 pin of the Node MCU board
- Connect the GND pin of the L298n motor driver module to the GND pin of the Node MCU board.
- Connect VCC pin of L298n motor driver module to Vin pin of Node MCU board.

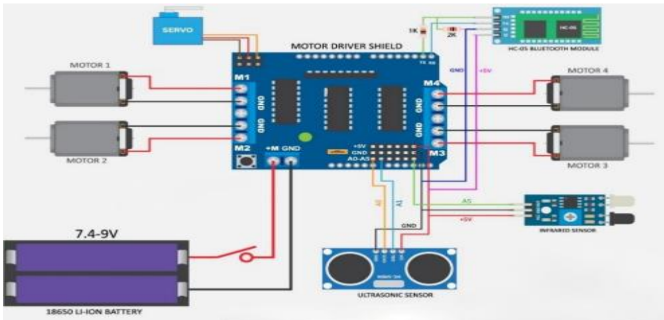

Figure 3.10: circuit diagram

1. DC Motors (M1, M2, M3, M4) connections:

M1: Connect to Output 1 of the motor driver.
M2: Connect to Output 2 of the motor driver.
M3: Connect to Output 3 of the motor driver.
M4: Connect to Output 4 of the motor driver.

2. Servo Motor connections:

Signal (SIG): Connect to Digital Pin 10 of the Arduino.
VCC: Connect to 5V output of the Arduino.
GND: Connect to GND (Ground) pin of the Arduino.

3. Infrared (IR) Sensor connections:

VCC: Connect to 5V output of the Arduino.
GND: Connect to GND (Ground) pin of the Arduino.
OUT: Connect to Analog Pin 5 of the Arduino.

4. Ultrasonic Sensor connections:

I VCC: Connect to 5V output of the Arduino.
GND: Connect to GND (Ground) pin of the Arduino.
TRIGGER: Connect to Analog Pin I of the Arduino.
ECHO: Connect to Analog Pin 0 of the Arduino.

5. Bluetooth Module connections:

VCC: Connect to 5V output of the Arduino.
GND: Connect to GND (Ground) pin of the Arduino.
TX: Connect to Digital Pin 0 (RX) of the Arduino.
RX: Connect to Digital Pin 1 (TX) of the Arduino

4. WORK EXPERIENCE AND FINAL PROJECT:

Figure 4.1: Final project

5. CONCLUSION

The Design and fabrication of the multi-mode robotic car represent a significant advancement in the field of robotics, showcasing the integration of diverse control mechanisms and sensor feedback to enable versatile and intuitive operation. Through this project, we have demonstrated the feasibility of creating a robotic system capable of responding to manual, gesture, and voice commands while navigating its environment autonomously using obstacle avoidance techniques. The Multi-Mode Robotic Car project integrates manual, gesture, and voice control modes for versatile operation. “Manual control” via Bluetooth allows remote manipulation using commands like forward, backward, left, and right.” Gesture control” utilizes a servo-controlled ultrasonic sensor to interpret hand gestures for steering and motion. “Voice control” enables handsfree operation with voice recognition technology understanding commands for directional movement. Additionally, “obstacle avoidance” mode employs ultrasonic and infrared sensors to autonomously adjust the car's path, ensuring safe navigation in dynamic environments.

The multi-mode robotic car offers a wide range of practical applications across various domains, including surveillance and security, search and rescue operations, exploration, assistive technology, education, entertainment, and industrial automation. Its adaptability and versatility make it suitable for addressing real-world challenges and enhancing efficiency, safety, and convenience in diverse environments.

One of the key strengths of the robotic car lies in its ability to seamlessly transition between different control modes based on user input and environmental conditions. Whether controlled manually via Bluetooth, through hand gestures detected by the ultrasonic sensor, or by voice commands recognized by the integrated module, the robotic car offers users a flexible and intuitive means of interaction.

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OPTIMIZATION OF WEAR BEHAVIOUR OF AL 6082/ B_4C/ MOS_2 HYBRID METAL MATRIX COMPOSITE

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Abstract: Metal Matrix Composite Al6082, Aluminum Metal Matrix Composites (MMCs) are preferred over traditional materials in various applications because of their superior enhanced properties. In this investigation Al6082 alloy is used as matrix material and with optimization of Boran carbide of 3 Wt% and 3 wt% MOS_2 composites. The hybrid composites were fabricated by Stir Casting Method. Based on controlling variables including load, speed, and distance, ANOVA was used to analyze how the most significant variables affected the WR. The software MINITAB was used to evaluate the results.

Keywords: Hybrid metal matrix composite mixture, stir casting, Wear rate, ANOVA and Taguchi method.

1. INTRODUCTION

Aluminum (Al) is the mostly abundant element on the earth and it became a strong competitor for all the Engineering applications by the end of the 19th century. One of the most potential characteristics is its versatility. Aluminum alloys and its composites are extensively used in structural applications, as materials in transportation (automobiles and aerospace), and engine components (cylinder block). Thus it becomes all the more vital to study the tribological characteristics of Aluminum alloys and its composite materials.

The main objective of this paper is to optimize the wear resistance of the material.

Metal Matrix Composite Al6082, Aluminum Metal Matrix Composites (MMCs) are preferred over traditional materials in various applications because of their superior enhanced properties. In this investigation Al6082 alloy is used as matrix material and with optimization of Boran carbide and MOS2 composites. The hybrid composites were fabricated by Stir Casting Method. MMCs synthesized from aluminum alloy have excellent mechanical properties largely owing to the use of ceramic abrasive grit like Boron carbide and molybdenum disulphide. Composites like these are strong and lightweight while also having good wear resistance and weight reduction properties, which makes them an excellent structural material. These types of applications spark metal matrix composite wear behavior research. Composites can be made using a variety of methods, but the most common is powder metallurgy, stir casting. Boran carbide is the second hardest material known. Its abrasive properties make it ideal for tools used in cutting and grinding operations. Tests for wear are carried out by altering sliding speed and applied load. Due to the wide range of materials studied, it was found that as the size of the abrasive particle increases, the wear rates increase but decrease as a percentage of the total volume increases.

The wear performance of an Al-B4C-MOS2 alloy fortified with B4C particles was analysed. Alloy wear resistance was significantly improved by mixing in a small amount of Boron Carbide (B4C). Using the same methodology, investigated how people choose to dress. When interpreting sliding distance speed, wear rates rise. Particle reinforcement has been considered by most researchers, while reinforcement has been used by others. The material's wear behavior was studied by who used an Al alloy with a whisker content of 15% by volume of boron carbide. As counter material, a steel ball was used to perform the wear tests on an oscillating wear tester. The Al-B4C composite outperformed the aluminum alloy in order to wear resistance, according to the results of the tests. The same team of researchers used Al-B4C-MOS2 composite in another wear study.

2. WEAR TEST APPARATUS

The experiment was performed on wear test setup (TR-201) under dry condition as shown in Figure 1 with following specifications:

Manufacturer	**: Ducom Ltd., Chennai**
Load range	**: up to 120 N**
Disc Speed	**: 100-2000 rpm**
Wear track diameter	**: 10-120 mm**
Specimen pin diameter	**: 10-12 mm**
Pin length	**: 25-30 mm**

Figure 1.1: Wear Test (Pin on Disc Tribometer)

Specimen placed in pin holder and kept at right angle to the disk (is made of EN31 steel) provides sliding action. The experiment was performed at different levels with track diameter of 70 mm and selected input parameters were load, speed, and distance. At each experiment, the steel disk was cleaned with acetone solution. The output results of wear WR (μm) was noted from experiment.

3. TAGUCHI METHOD

In this method, DOE was depending upon the input factors. In this statistical investigation, Taguchi L9 (3^3) OA was selected. Taguchi calculated S/N ratio for each experimental setting. The higher S/N ratio determines the level of process parameters that should be used. In present investigation, the input parameters are load, speed (136 rpm, 273 rpm and 409 rpm), and distance (150 m, 300 m and 450 m) have been selected and set at three levels. Finally, the optimum parameter setting was designed by ANOVA with help of MINITAB software.

4. RESULTS AND DISCUSSIONS

Design of experiment (DOE) was conducted at three levels with nine experiments. S/N ratio plot, and residual plot were drawn using MINITAB software, from this results estimate the most influencing parameters on WR. The results of specimens and S/N ratios were shown in Table 1.

Table 4.1: Experimental Results and S/N ratios

Load	Speed	Distance	Wear Rate	SNRA1
15	136	150	61	-35.7066
15	273	300	72	-37.1466
15	409	450	89	-38.9878
25	136	300	75	-37.5012
25	273	450	68	-36.6502
25	409	150	123	-41.7981
35	136	450	237	-47.4950
35	273	150	128	-42.1442
35	409	300	157	-43.9180

4.1 TAGUCHI ANALYSIS

Table1 indicates S/N ratio of the response table at smaller is better for the WR. Figure 1 represents the S/N ratio plot of WR. From this graph observed that the highest values are the optimum process parameter setting. Finally, concluded that the load (45 N), speed (136 rpm) and distance (450 mm) has have been the maximum for mean of S/N ratio, therefore the predicted optimum process parameter setup for obtaining low WR using taguchi method is L3-S1-D3.

Figure 1.2: Mean S/N Ratio of Wear Rate

4.2 ANOVA ANALYSIS

This method used to analyze the outcomes of experiments. It was conducted for level of confidence at 95%. ANOVA investigated order of influencing parameters on WR. The results of WR listed in Table 2.

Degree of freedom (DF) was obtained by number of levels minus one, here total considering three factors at three levels.

Table 4.2: Response Table for WR

Level	Load	Speed	Distance
1	-37.28	-40.23	-39.88
2	-38.65	-38.65	-39.52
3	-44.52	-41.57	-41.04
Delta	7.24	2.92	1.52
Rank	1	2	3

Table 4.3: ANOVA for WR

Source	DF	Adj SS	Adj MS	P-Val.
Regression	3	16123.7	5374.6	0.156
Load	1	15000.0	15000.0	0.040
Speed	1	3.0	3.0	0.970
Distance	1	1120.7	1120.7	0.487
Error	5	9937.9	1987.6	
Total	8	26061.6		

4.3 MODELING

In the current study, the linear regression analysis was done using Minitab for create the predictive equations. The dependent variable is WR and it has a function of load, velocity, and distance respectively. The linear regression equation was as shown in the equation for WR of hybrid composite.

The developed models were checked by using R^2 value. Usually, it varies from zero to 100%. If this value is close to 100%, it gives a good fit between the variables. From the regression analysis, concluded that R^2 for WR has better.

REGRESSION EQUATION

Wear Rate = -38.7+ 5.00 Load- 0.005 Speed + 0.091 Distance

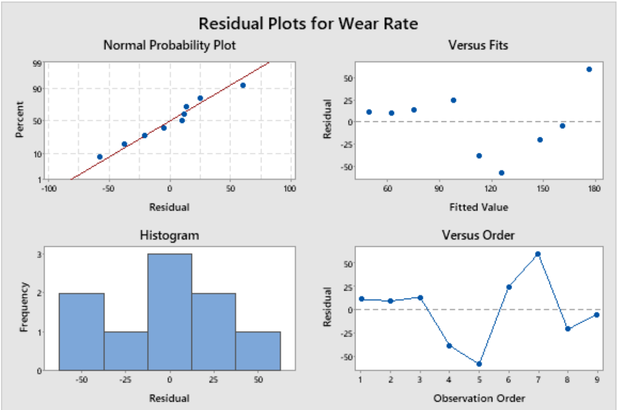

Figure 1.2 Residual plots for WR

The importance of the coefficients in the projected model was examined using the residual plot; if it is straight, the errors are normally occurred and distributed Figure shows the residual plots, noticed that the residuals shown around the straight line, which gives the developed model was appreciable.

5. CONCLUSIONS

- Taguchi method determined that the optimum combination for obtaining low WR was found as load 45 N, speed 136 rpm, and distance 450 m (L3-S1-D3).
- According to the ANOVA results, the load has the great impact on WR.
- The linear regression equation was developed for WR and it was checked with R^2 value. Hence the developed model was good fit for WR.
- From the above investigation, concluded that the load (45 N) has the most influencing parameter on WR.

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INVESTIGATION OF MECHANICAL PROPERTIES OF AL6082/SILICON DIOXIDE/GRAPHENE REINFORCED HYBRID METAL MATRIX COMPOSITES

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Abstract: The present investigation is to evaluate the effect of the Silicon Dioxide (SiO_2) and grapheme Nanoparticles on the mechanical properties of hybrid composites. Methods: In the current study, silicon Dioxide (SiO_2) and grapheme Nanoparticles are used as reinforcement, while Al6082 alloy served as the matrix material. Using the stir casting method, Al6082-SiO_2-Gr hybrid composites were developed with composition of Gr 3 wt % and SiO_2 3 wt%. The hardness, tensile Strength (UTS), and compressive strength of the fabricated hybrid composites were analyzed.

Keywords: Al6082, Hybrid composite, stir casting.

1. INTRODUCTION

The investigations into the fabrication and mechanical properties of composite materials have yielded but no definitive results, and more research is needed to determine the optimal matrix and reinforcing material composition. As a result, fabrication, microstructural assessment, and mechanical characteristics of Al6082/SiO_2/Graphene reinforced hybrid composites have been attempted. The fabrication, microstructure analysis, and mechanical characteristics of stir-cast Al6082/SiO_2/Graphene reinforced hybrid composites are the key areas of attention in the current work.The SiO_2 particles enhance the hardness properties, whereas the graphene particles improve the Tensile and Compressive Properties. By these functional properties of the material were more important, for its victorious applications in automotive and aerospace industries.

2. MATERIALS AND METHODS

The Al6082's elemental composition was the reinforcement materials are SiO_2 and GrNano particles. Al6082 was selected as the matrix alloy. The elemental composition of Al6082: Si-1.22%, Mg-1.05%, Cu-0.92%, Mn-0.88%, Fe-0.40%, Al-Rest.

The manufacturing process of hybrid composites carried out by an experimental setup shown in Figure1. Using an induction furnace, stir casting at a frequency of 600 Hz and a power of 175 kW is possible. We used aluminium composites or element mixtures that had been put in a graphite crucible that was melting at 700°C.We used eight grams of chromium, thirty-two grams of manganese, and forty grams of magnesium as base metals in the mixture of aluminium, now used SiO2 reinforcements at 3%, and graphene reinforcements at 3%. Study the mechanical properties of material composite. In order to strengthen the bond, we heated the SiO2 and graphene powders beforehand. After that, we used the eddy current method to add powders to the base metal in stir casting, which stirs depending on frequency at a speed of 1500 to 3000 rpm. Following the completion of the base metal (Al 6082) powder mixing. We filled a cast iron (CI) die with molten metal, creating a specimen with a 20 mm diameter and 150 mm length. 710°C is the pouring temperature. We raise it by 10°C to prevent solidification. The metal is formed and solidified after being poured into the die.

Figure 2.1: Photograph of Stir Casting Furnace

3. RESULTS AND DISCUSSION

As SiO2 and graphene are reinforced in the composite, the hardness result of the material was improved as compared with base alloy. The specimen hardness has increased by 2.45%.

A modification in the volume ratio of SiO_2 and Graphene Nanoparticles increases the UTS and YS of composites. In Nanoparticles reinforced with metal matrix composites. The Ultimate Tensile Strength and Yield Strength of the specimen containing 3% SiO2 and 3% graphene are enhanced by 8%. 3% SiO2 exhibits great strength overall, owing to the uniform distribution of reinforcement nanoparticles.

The compression results of the composite was enhanced due to the reinforcement of SiO_2 and Graphene Nanoparticles in composites. The specimen with a compressive strength of 704.05 MPa has 3% SiO2 and 3% graphene in it. In comparison to the base alloy, the specimen containing 3% SiO2 and 3% graphene has improved in strength overall.

4. CONCLUSIONS

Al6082-SiO_2-Graphene hybrid composite has been successfully fabricated by the stir casting method. The hardness, tensile, compressive properties, and microstructure analysis of hybrid composites were evaluated. The results of the present investigation can be summarized as follows:

- Composites exhibit improved mechanical properties when graphene content is increased while SiO2 ratio remains constant. Thus, a specimen with 3% graphene and 3% SiO_2 showed 26% higher Ultimate Tensile Strength and Yield Strength than specimens with other compositions.
- Significant increases in compressive strength are obtained by incorporating 3% SiO_2 and 3% graphene exhibited the highest Compressive strength and overall improvement over the first composite.
- When SiO2 and graphene nanoparticles are added, specimen with 3% SiO_2 and 3% Graphene has hardness increases significantly by 13.7%.
- Finally, the proposed Al6082 hybrid metal matrix composite of 3wt%SiO_2 and 3 wt % Graphene showed better results.

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DEVELOPING OF MATERIAL SEGREGATION SYSTEM BY USING PLC

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Abstract: The project describes the scrap material segregation using automation system. This can be used to segregate waste in industries and domestic level. The advantage of scrap disposal reduce manufacturing cost and to minimize the raw material wastage. This paper proposes the separation of metal and nonmetal waste into respective bins; different sensors are incorporated for detecting the material along conveyor belt. Program is developed by Programmable logic controller (PLC).

Keyword: Allen Bradley PLC, DC motor, IR Proximity sensor, Relay, inductive proximity sensor, capacitive proximity sensor

I. INTRODUCTION

Automation plays an increasingly essential role in the international economic system. One of the critical software of automation in segregate the metal and nonmetal for domestic and commercial use because the charge of scrap technology continually main at the back of the price of scrap disposal. Segregation machine are better overall performance environmental, uncooked fabric wastage minimizes this outcomes is primary advantage of lowering the producing cost of cloth. Even though there are large scales industrial waste segregators present, it's far always much better to segregate the waste at the supply itself. The benefits of doing so are that a higher excellent of the fabric is retained for recycling which means that more cost may be recovered from the waste.

The occupational chance for waste workers is decreased. Also, the segregated waste can be at once dispatched to the recycling and processing plant rather than sending it to the segregation plant then to the recycling plant. In this PLC used as automation gadget due to the fact it's far value powerful, very bendy, lessen complexity, area green. The PLC represents one of these regular controllers and it can be used for special applications and, through application is mounted in its reminiscence. Automation method is quicker, cleanser and does now not affect the ecosystem.

The largest benefit of automation is that it saves exertions; it also used to save power and materials and to improve great, accuracy and precision.

The most important advantages of automation are:-

- Increased throughput or productiveness Increased consistency of output.
- Improved robustness (consistency), of processes or product.
- Reduced direct human hard work prices And fees.

2. OBJECTIVES

The Material Segregation by using PLC project aims to revolutionize material segregation processes by leveraging automation and precision. The primary objectives are to develop a fully automated system capable of autonomously detecting materials and executing segregation operations without human intervention. Precision is crucial, achieved through integrating material sensing technology with PLC-based control, ensuring accurate segregation at designated locations on the material surface. The project also prioritizes efficiency by reducing setup time, minimizing material waste, and increasing throughput compared to manual processes. Flexibility is key, with a focus on designing a system that can accommodate various material types, sizes, and punching patterns. Cost-effectiveness is a core goal, aiming to reduce labor costs, improve product quality, and optimize resource utilization through automation and advanced control algorithms. Additionally, user- friendliness is emphasized, with the development of a user-friendly interface enabling operators to monitor system performance and adjust parameters effectively. Scalability is considered to accommodate varying production demands without significant modifications or downtime. Integration with existing manufacturing processes and equipment is crucial for seamless operation and compliance with industry standards and safety regulations. Ultimately, the project seeks to enhance productivity, accuracy, and safety in material segregation processes while reducing costs and improving overall efficiency in manufacturing environments.

3. PROBLEM STATEMENT

Manual intervention in segregation operations leads to increased labor costs and reduced throughput, as constant human oversight is required for setup, operation, and quality control. Human-operated punching machines are prone to errors in alignment, resulting in inaccuracies in punch positioning and dimensions, leading to product defects and waste. Conventional punching systems lack the flexibility to accommodate diverse material types, sizes, and segregation patterns, limiting their applicability to a wide range of manufacturing requirements. Manual punching processes are slower and less efficient than automated systems, leading to longer production cycles, increased lead times, and higher operational costs. Additionally, manual processes are susceptible to inconsistencies and variations in punch quality, resulting in lower product quality and increased rework or scrap rates. Manual processes are also challenging to scale or adapt to changing production demands, hindering manufacturers' ability to respond quickly to market changes and customer requirements.

4. PLC SYSTEM

A programmable logic controller (PLC), also known as a programmable controller, is a computer-like device utilized to control equipment in industrial facilities. PLCs are real-time controllers with cyclic behavior. They are digitally operating electronic devices that utilize programmable memory for internal storage of instructions for executing specific functions, such as logic sequencing, timing, counting, and control through digital or analog input/output modules.

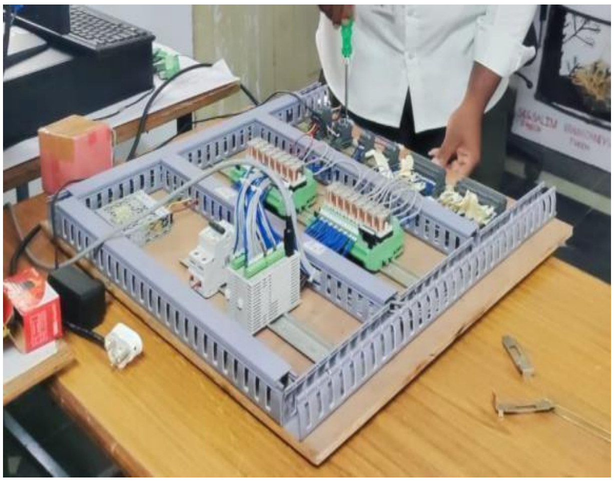

Figure 4.1: PLC System

The PLC operates in several steps. Initially, it scans the inputs to the controller and creates a representation of the input status in its memory. Subsequently, the software stored in the controller's memory is processed, considering the input memory representation. This processing results in an image of the outputs. In the final step, this output image is mapped to the actual outputs.

I/O Interfaces:
An I/O module is a plug-in assembly containing circuitry that facilitates communication between a PLC and field devices. These devices may transmit and/or receive digital and/or analog signals.

Programming Languages & Graphical Languages:

i. Ladder Diagram (LD): Utilizes a standardized set of ladder programming symbols to implement control functions.
ii. Function Block Diagram (FBD): A graphical language enabling the user to program components so that they resemble wired electric circuits.
iii. Sequential Function Chart (SFC): A graphical language providing a diagrammatic representation of control sequences in software.

Text-Based Languages:

1. Instruction List: A low-level language similar to machine language.
2. Structured Text: A high-level language allowing structured programming, enabling complex tasks to be broken down into smaller ones, or utilizing assembly language with microprocessors.

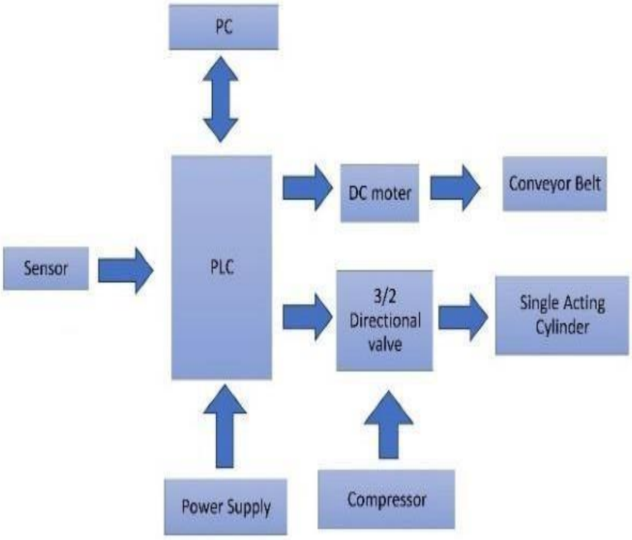

Figure 4.1: PLC Process

5. METHODOLOGY

The methodology involves developing an automated sorting system using a PLC and a material sensor to distinguish between green and red boxes on a conveyor belt. Initially, the system design is outlined, identifying necessary components such as the PLC, material sensor, and pneumatic actuators. The PLC is then programmed to interpret material sensor data, triggering the appropriate actuator to divert boxes based on their material. Mechanical assembly integrates these components into a functional system. Testing ensures accurate material detection and reliable sorting, with adjustments made as needed. User-friendly interfaces and documentation are provided for seamless operation and maintenance. Through systematic implementation and refinement, the system achieves efficient and precise sorting of green and red boxes, enhancing industrial automation processes.

6. HARDWARE CONFIGURATION

The hardware components are connected and configured according to the system design, with sensors interfaced to the PLC's input modules, actuators connected to its output modules, and other devices integrated as necessary. The PLC program is developed using Delta software to control the operation of the system, including material sensing, punching, and conveyor movement, based on input from sensors and user commands. Through proper configuration and integration, the hardware components work together seamlessly to achieve the desired functionality of the automatic material segregation sensing punching machine.

6.1 SENSOR:

The hardware configuration for the automatic material segregation sensing punching machine also includes an inductive proximity sensor. This type of sensor is used to detect the presence of metallic objects, such as the material passing through the conveyor belt. The inductive proximity sensor emits an electromagnetic field and detects changes in that field caused by the presence of metallic objects within its sensing range.

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6.2 DC MOTOR:

DC motors utilize a magnetic field to exert mechanical force on a current-carrying conductor. They are commonly used in industrial applications such as conveyor belts and elevators for material handling.

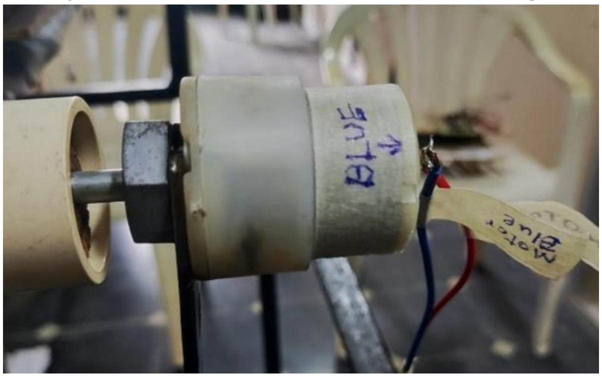

Figure 6.1: DC Motor

6.3 RELAY:

Relays act as switches to manually close or open circuits, connecting and disconnecting two circuits. They come in various types, including electromechanical and solid-state.

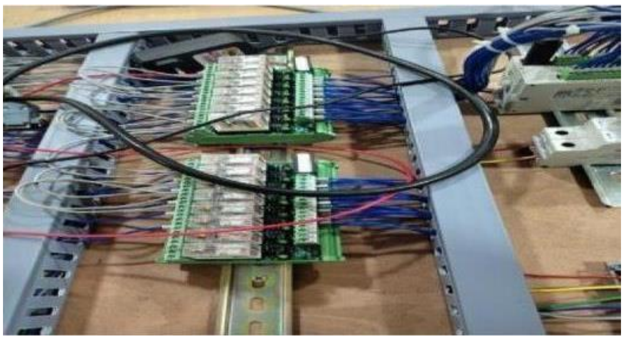

Figure 6.2: Relay

6.4 PUSH BUTTONS HARDWARE:

Connect the push buttons to the PLC: attach one wire from each button to a different input on the PLC, and connect the other wire of each button to a common ground or power source. When you press a button, it completes the circuit and sends a signal to the PLC, allowing it to respond accordingly—for example, starting or stopping the machine.

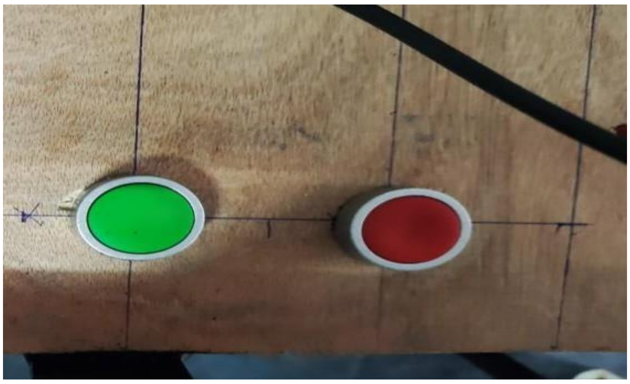

Figure 6.3: Green and Red push buttons

6.5 GREEN INDICATOR CONNECTION:

Link the green indicator to the PLC: connect one wire to an output on the PLC and the other wire to a power source. When the PLC activates the output, the indicator lights up, giving a visual cue—for instance, showing that . the machine is ready to run.

Figure 6.4: Green Indicator

6.6 3/2 DIRECTIONAL VALVE:

A 3/2 directional valve in pneumatics is a basic component used to control the direction of airflow in pneumatic systems. It consists of three ports and two positions. The ports include an inlet for compressed air (usually labeled as P), an outlet for directing air to the pneumatic device (often labeled as A), and an exhaust port (usually labeled as R). In one position, the valve allows airflow from the inlet to the outlet, enabling the pneumatic device to extend or move in one direction. In the other position, it blocks airflow to the outlet and allows the air in the pneumatic device to exhaust through the exhaust port, causing the device to retract or return to its original position. This type of valve is commonly used in various pneumatic applications for controlling the movement of cylinders or other pneumatic actuators.

Figure 6.5: 3/2 Directional valve

6.7 Single acting cylinder:

A single-acting cylinder is a type of pneumatic or hydraulic cylinder that operates using fluid pressure to perform work in only one direction. It consists of a cylinder barrel, piston, and a single port for fluid entry or exit. When fluid is pressurized and enters the cylinder, it pushes the piston in one direction, executing mechanical

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work. However, the return stroke typically relies on an external force, such as a spring or gravity, rather than fluid pressure. This design simplifies the cylinder mechanism and makes it more cost-effective compared to double-acting cylinders, which can exert force in both directions. Single-acting cylinders find common use in applications where work is only required in one direction, such as lifting, pushing, or clamping operations.

Figure 6.6: Single Acting Cylinder

7. PROPOSED METHOD AND SIMULATION

It is activated when the green push button (X0) is pressed. When X0 becomes active (pressed), it energizes M0, turning it on. and included as a safety measure to ensure that M0 is turned off when the red push button (X1) is pressed. When X1 becomes active (pressed), it de-energizes M0, turning it off. When green push button is pressed then conveyor motor ON, whenever sensor sensed red colour then the green indicator lights ON and after one second single acting cylinder turns on with the help of 3/2 directional valve and a second after the punch single acting cylinder comes to actual position. The process continues until the red push button is pressed.

SIMULATION: Ladder diagram is used to execute the above proposed system.

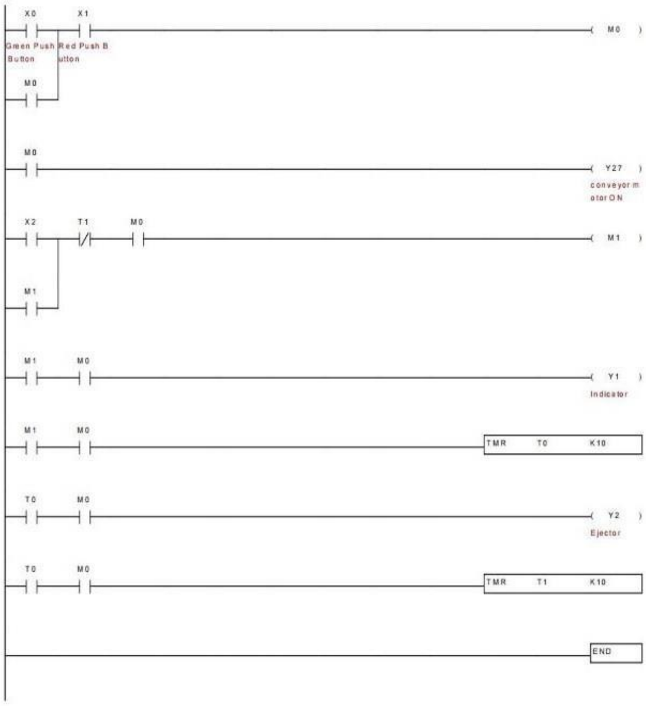

Figure 7.1: Ladder Diagram

8. RESULT

The ladder diagram outlines the systematic operation of an automatic material segregation sensing punching machine, focusing on efficiently identifying and separating red-materialed boxes from a conveyor belt. By continuously checking for material presence and activating the material sensor, the system accurately detects the material of each object passing through. Upon identifying a red box, the punching mechanism specific to red boxes is triggered, facilitating their separation from the conveyor. The diagram also incorporates checks for user input and system status, ensuring responsiveness to operator commands and maintaining safety protocols throughout the process. Overall, the ladder diagram provides a structured approach to automate the sorting process, enhancing efficiency and productivity while prioritizing operational control and safety.

The result of executing the ladder diagram is the reliable and automated separation of red-materialed boxes, enhancing the efficiency and productivity of the punching machine while ensuring operational safety and control.

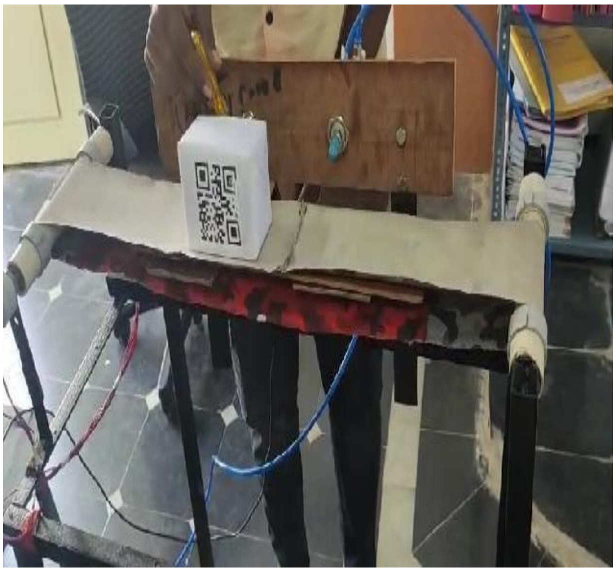

Figure 8.1: Sensor Detect

Figure 8.2: Punching

9. CONCLUSION

The project progressed with arranging all components according to the ladder diagram, essential for the material segregation process. A conveyor setup was assembled to facilitate the execution of the program, enabling the movement of materials through the system. The setup was constructed using appropriate models to ensure functionality and efficiency. Connections were meticulously made to all components as outlined in the connection diagram, with clear indicators provided for easy identification and integration with the PLC board. The ladder diagram was programmed into a PC to initiate and control the material segregation process. Specific parameters such as a 10-second time interval between material ejections and a sensor range of 3mm were incorporated into the ladder diagram to optimize system performance. The completed composition of the ladder diagram enables the automated material segregation process, making it suitable for implementation in various manufacturing environments, including multinational corporations, with minimal reliance on manpower.

9.1 FUTURE SCOPE

The future scope for prototype development integrated with PLC technology offers exciting prospects for innovation across industries. By combining PLCs with advanced sensors and actuators, prototypes can become more sophisticated and adaptable, optimizing processes and enhancing efficiency. The rise of Industry 4.0 and the IIoT is driving increased adoption of PLC-based prototypes in smart manufacturing, enabling real-time data analysis and decision-making for improved productivity and quality. Moreover, PLC-based prototypes extend beyond manufacturing to applications like smart buildings and healthcare, offering advanced automation and monitoring capabilities. Simplified programming interfaces and support for emerging technologies like AI and machine learning further enhance the potential for future developments in PLC-based prototype design.

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FABRICATION OF STAMPING MECHANISM

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Abstract— To achieve perfect stamping, it's essential to have a flat surface, ensure proper ink coverage, and apply uniform pressure. We propose an automated stamping machine using the Scotch yoke mechanism for precision. This mechanism converts rotary motion into precise reciprocating motion, facilitating controlled stamping on paper. The machine features a specialized feed roller with a friction grip for paper feed. Prior to design, determine motor speed, yoke ratio, and feed roller grip calculations. Components like the slotted yoke, rotating crank, and a 12V motor are carefully selected for integration. Through meticulous design and research, the stamping machine integrates the Scotch yoke mechanism seamlessly. The result is a reliable and efficient stamping machine that enhances automated stamping technology. This advancement offers a cost-effective solution for industries requiring high-quality stamping.46.05 hours and material consumption of 434 grams. Powered by a single 6V electric motor with a speed reducer, it utilizes 4AA batteries, jumper cables, and a paperclip for assembly. Once assembled, the mechanism achieves successful walking movement.

I. INTRODUCTION

To achieve perfect stamping, it's essential to have a flat surface, ensure proper ink coverage, and apply uniform pressure. We propose an automated stamping machine using the Scotch yoke mechanism for precision. This mechanism converts rotary motion into precise reciprocating motion, facilitating controlled stamping on paper.

The machine features a specialized feed roller with a friction grip for paper feed. Prior to design, calculations determine motor speed, yoke ratio, and feed roller grip. Components like the slotted yoke, rotating crank, and a 12V motor are carefully selected for integration.Through meticulous design and research, the stamping machine integrates the Scotch yoke mechanism seamlessly. The result is a reliable and efficient stamping machine that enhances automated stamping technology. This advancement offers a cost-effective solution for industries requiring high-quality stamping.Mechanical stamping for paper is a process where pressure is applied to create imprints, designs, or text using ink on paper surfaces. This method is crucial in industries like printing, packaging, stationery, and publishing for branding, labelling, and decoration. Our specialized Mechanical Stamping Process uses the Scotch yoke mechanism tailored for printing stamps on paper. This precision-driven approach applies controlled pressure to produce distinct imprints, meeting various printing and labelling needs.The Scotch yoke mechanism integration ensures precise and consistent motion vital for stamping, ensuring uniformity and accuracy in imprints. This mechanical linkage, powered by a dedicated 12V motor, efficiently transforms rotary motion into reciprocating motion, ensuring smooth and reliable stamping movements.

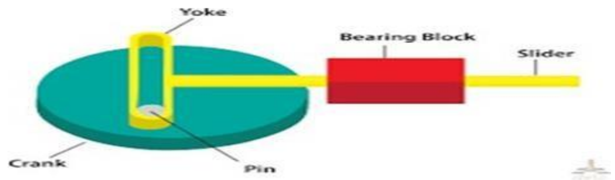

Figure: 1.1 Scotch Yoke Mechanism

The above figure: 1.1 shows the machine features a specialized feed roller with a friction grip for paper feed. Prior to design, calculations determine motor speed, yoke ratio, and feed roller grip. Components like thand research, the stamping machine integrates the Scotch yoke mechanism seamless the stamping machine features two main mechanisms: the Scotch yoke for converting rotary to reciprocating motion and a feed roller mechanism adapted from printer feeding systems. The Scotch yoke, also known as a slotted link mechanism, directly couples a sliding yoke to a rotating part via a slot and pin arrangement, converting linear to rotational motion. This mechanism produces a sine wave motion of constant amplitude and frequency with constant rotational speed.

II. LITERATURE REVIEW

Patel,[1] A., & Gupta, S. (2024) Optimization of Scotch Yoke Mechanism Parameters for Automated Stamping Machines. Robotics and Automation Engineering. Patel and Gupta's research investigates the optimization of Scotch yoke mechanism parameters for automated stamping machines. They delve into intricate analyses of factors such as stroke length, angular velocity, and linkage geometry to enhance the efficiency and accuracy of stamping operations.
Smith,[2] J., & Johnson, R. (2023)Automation in Metal Stamping Processes: A Comprehensive Review. Journal of Manufacturing Technology. Smith and Johnson offer a comprehensive review of automation applications in metal stamping processes. Their research encompasses an in-depth analysis of various automation technologies, including robotic arms, servo presses, and computer numerical control (CNC) systems. By examining case studies and industry best practices, they provide valuable insights into the benefits and challenges associated with automating metal stamping operations.
Patel,[3] S., & Singh, M. (2023) Materials Selection Criteria for Fabricating Stamping Machine Components: A Comparative Study. Materials Research Express. Patel and Singh conduct a comparative study of materials selection criteria for fabricating stamping machine components. Their research involves evaluating the mechanical properties, durability, and cost- effectiveness of different materials, including metals, polymers, and composites functionality.
Wang,[4] X., & Li, Q. (2021). Materials Selection and Fabrication Techniques for Stamping Machine Components. Materials Science and Engineering: A. Wang and Li delve

into the intricate process of materials selection and fabrication techniques for stamping machine components.

Gupta,[5] R., & Sharma, P. (2020). Feed Roller Mechanisms: Design and Optimization Techniques for Stamping Machines. International Journal of Manufacturing Engineering. Gupta and Sharma's research focuses on the design and optimization of feed roller mechanisms for stamping machines.

Brown,[6] D., & Wilson, E. (2019). Integration of Automation Technologies in Stamping Processes: Challenges and Opportunities. Journal of Automation and Robotics. Brown and Wilson delve deeper into the integration of automation technologies in stamping processes, examining the specific challenges and opportunities encountered by manufacturers.

Chen, Y., & Zhang, L. (2017). Automated Stamping Systems: Design, Development, and Applications. International Journal of Advanced Manufacturing Technology. Chen and Zhang focus on the design, development, and practical applications of automated stamping systems across various industries. They explore the integration of advanced robotics, machine vision, and adaptive control algorithms to enhance the efficiency, flexibility, and reliability of stamping operations.

III. DESIGN OF STAMPING MECHANISM

Figure 3.1 Fusion 360

Fusion 360 is a parametric, feature-based solid modeling tool that uses numeric and geometric parameters to define shapes and assemblies. Design intent guides the model's behavior during updates; for instance, a hole specified at a can's top surface remains there regardless of changes. Features are the basic building blocks, either shape-based like holes or slots, created from sketches and extrusions, or operation-based like fillets and chamfers applied directly to parts.

Building a model in Fusion 360 consists of three steps. The first step is called part Drawing and usually starts with 2D sketch. The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and locations of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity and concentricity. The parametric nature of Fusion 360 means that the dimensions and relations drive the geometry, not the other way around

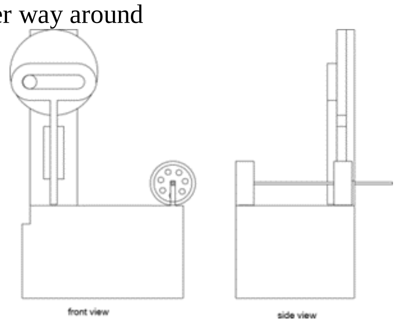

Figure3.3 Scotch Yoke feeding mechanism

The above Figure:3.3 shows the whole scotch yoke is made up of wood (plywood).The yoke which moves up and down. The pin is placed eccentrically on the crank. So that a yoke is held by an pin. A small bolt were using here, which is used to connect the shaft and roller. The required wood pieces are cut in their shaped and then fixed.

IV. DESIGN CALCULATIONS

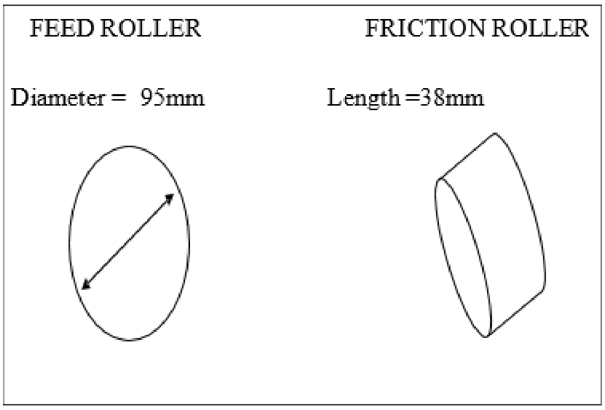

Figure: 4.1 Specification of Rollers

Number of rollers used =2

Grip =5mm

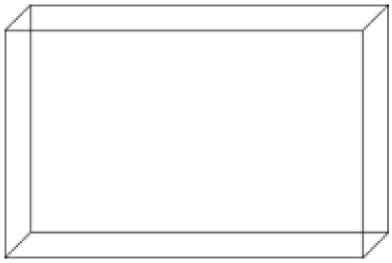

Figure:4.2 Frame

FRAME SPECIFICATION:

Material used = plywood Length = 330mm

Height = 200mm

Thickness = 15mm

Width = 255mm

SPRING SPECIFICATION:

Height = 140m

Thickness = 3mm

Number of coils = 8

Diameter = 40mm

SCOTCH YOKE SPECIFICATIONS:

Width = 255mm

Fly wheel diameter =185mm

Yoke length = 225mm

Pin diameter = 30mm

MOTOR SPECIFICATIONS:

Speed = 20rpm

Voltage = 5V

V. FABRICATION OF STAMPING MACHINE

A. STEP 1:-FABRICATION OF BED

To fabricate the stamping machine bed, a 3*3 feet plywood was marked and cut. The following carpentry tools were used:

1. Tape Measure: A flexible ruler with linear measurement markings.

2. Hacksaw: A fine-toothed saw for cutting metals, wood, and plastics. The blade can cut on push or pull stroke.
3. Try Square: Used for measuring and marking right angles in woodworking or metalworking.
4. Hammer: Delivers blows to objects for driving nails, fitting parts, forging, or breaking objects.
5. Drill: Equipped with a drill bit for boring holes in various materials.

B. STEP 2:- FABRICATION OF FEEDING MECHANISM

The next step in prototype fabrication is developing the feed mechanism for paper insertion into the stamping area. The shaft, made of mild steel, was machined using a conventional center lathe to the required diameter. This feed mechanism will accommodate various paper sizes and thicknesses for versatile stamping applications. High-quality rollers, bearings, and grippers will ensure smooth and consistent paper feeding.

Figure: 5.1 Feeding Mechanism

Centre Lathe: Also known as an Engine lathe, it operates with automatic feed for cutting tools. It uses a motor-driven spindle attached to a multi-step design for flat belt attachment. Different spindle speeds are achieved by adjusting the belt on different step cones. Carbide cutting tools are used due to their high machining speed tolerance, reducing machining times and increasing production efficiency.

Turning: It involves removing metal from the external surface of cylindrical work pieces. Straight turning was used where the cutting tool is fixed in the chuck and fed perpendicular to the work piece. Horizontal feed is applied along the work piece length, while vertical feed is given in small steps until the desired shaft diameter is achieved.

C. STEP 3:- FABRICATION OF SCOTCH YOKE

Figure:5.2 Scotch Yoke

The whole scotch yoke is made up of wood (plywood).The yoke which moves up and down. The pin is placed eccentrically on the crank. So that a yoke is held by an pin. A small bolt were using here, which is used to connect the shaft and roller. The required wood pieces are cut in their shaped and then fixed. The pin fitted eccentrically on the crank by using small bolt. The length of yoke and the crank are as per the design calculation.

The scotch yoke is constructed from plywood. The yoke moves up and down, held by a pin placed eccentrically on the crank. A small bolt connects the shaft and roller. Wooden pieces are cut and shaped according to design calculations, with the pin mounted eccentrically using a bolt. The lengths of the yoke and crank are determined by design calculations.

D. STEP 4:-ASSEMBLY

Figure:5.3 Assembly

The final step is the assembly of the Scotch yoke and feed mechanisms to the stamping machine's wooden base, followed by motor integration. Both mechanisms and their components are meticulously mounted and secured to the base using appropriate fastening methods to ensure stability and alignment. This alignment is vital for consistent and precise stamping operations.

Next, 12V motors are integrated with the Scotch yoke and feed mechanisms. Motors are strategically positioned and fixed to the base, aligning them with the moving parts of the mechanisms. Couplings or adapters are used to create a secure connection between the motors and mechanisms, ensuring smooth power transmission

After motor integration, comprehensive testing is conducted to validate functionality and synchronization. This includes checking the movement of the Scotch yoke and feed mechanism in response to motor operation and assessing the overall performance of the stamping machine prototype.

Thorough testing ensures the seamless coordination between motors and mechanisms. Any required adjustments or fine-tuning are made to optimize system operation. This guarantees efficient and precise stamping on paper surfaces, confirming the stamping machine's reliability and effectiveness.

E. MATERIALS USED IN THE DESIGN OF STAMPING MACHINE

Plywood consists of thin wood sheets glued together, producing a durable and sturdy material. Using professional adhesive enhances its resistance to cracks, shrinking, and warping. Cross-graining reduces wood splitting, expansion, and provides dimensional stability. The odd number of layers balances the sheet, minimizing warping. Plywood's alternating grain makes it difficult to bend perpendicular to the surface ply's grain direction.

Mechanical properties of plywood depend on factors like wood species, adhesive type, and product density. Specific Gravity measures density ratio to a reference substance. Modulus of Elasticity gauges a substance's resistance to bending. Shear Modulus indicates resistance to shear stress causing member deflection. Modulus of Rupture measures a specimen's strength, unlike Elasticity Modulus. Compressive Yield Strength is the maximum load a body can bear before failure, divided by its area.

1) Specific Gravity: Specific gravity is the ratio of the density of a substance to the density (mass of the same unit volume) of a reference substance.

2) Elastic Properties

Modulus of Elasticity: Bending modulus of elasticity is a measure of the resistance of substance.

3) Shear Modulus: Shear modulus is also called as modulus of rigidity, indicates the resistance to deflection of a member caused by shear stresses. Shear stress is different from tension or compressive stress in that it tends to make one side of a member slip past the other side of a member adjacent to it.

4) Strength Properties

Modulus of Rupture: Modulus of rupture, frequently abbreviated as MOR, it is a measure of a specimen's strength, unlike the modulus of elasticity, which measure the wood's deflection, but not its ultimate strength.

5) Compressive Yield Strength: Compressive strength is defined as the maximum compressive load body can bear prior to failure, divided by its cross sectional area.

6) Shear strength: Shear strength is the maximum shear load a body can withstand before failure occurs divided by its cross sectional area.

VI. CONCLUSION

In conclusion, our project successfully designed, developed, and fabricated an automated stamping machine using the Scotch yoke mechanism. Through extensive research and engineering, we've created a robust system for precise stamping on paper surfaces. The Scotch yoke mechanism proved strategic, providing reliable motion conversion essential for stamping. Its incorporation ensured smooth, accurate reciprocating motion, resulting in high-quality stamped imprints.

The design phase considered factors like motor speed, yoke ratio, and roller grip coverage. Thorough calculations optimized these parameters, enhancing machine performance. Fabrication was executed with precision, leading to the successful assembly of the stamping machine. Integration of components like the slotted yoke, rotating crank, and 12V motor was seamless, ensuring reliability.

Our project signifies a notable advancement in stamping technology, offering a cost-effective solution for automation. The Scotch yoke mechanism, combined with innovative design, has potential to revolutionize stamping across industries.

Moving forward, our automated stamping machine promises to enhance efficiency, productivity, and quality in manufacturing processes requiring precise stamping.

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Design and Fabrication of Dexterity of a Human Hand by Using 3D Printing

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***Abstract*— The dexterity of a human hand scope extends beyond basic manipulation, incorporating features a prosthetic hand finger and wrist movement. Through EMG sensor users can input commands, by electronic muscle movement signal commands that gives robotic arm to grasp and lift items with a high degree of accuracy. The Electromyography sensors records the movement and transmits to robotic hand. This project focuses on the design and fabrication of a human like robotic arm utilizing 3D printed components, resistors, servomotors, Electro Myo Graphy (EMG) sensor, batteries, Arduino microcontroller, and jumper cables. The primary objective is to create an innovative and cost-effective solution for achieving lifelike movements, resembling the dexterity of a human arm. The robotic arm is constructed using 3D-printed material called ABS, ensuring a lightweight and customizable structure. Servomotors are strategically integrated to mimic the joint movements of the human arm, enabling precise and coordinated motions. The Arduino microcontroller serves as the central processing unit, executing a programmed sequence of movements to control the arm's articulation.**

Keywords- ABS, Servomotors, Arduino, 3DPrinter, EMG, Designing, Fabrication & Microcontroller.

I. INTRODUCTION

Additive Manufacturing is the formalized term for what used to be called Rapid Prototyping and what is popularly called 3D Printing. The term Rapid Prototyping (RP) is used in a variety of industries to describe a process for rapidly creating a system or part representation before final release or commercialization.

The basic principle of this technology is that a model, initially generated using a three dimensional Computer Aided Design (3D CAD) system, can be fabricated directly without the need for process planning. Although this is not in reality as simple as it first sounds, additive manufacturing technology significantly simplifies the process of producing complex 3D objects directly from CAD data.

The key to how additive manufacturing works is that parts are made by adding material in layers; each layer is a thin cross-section of the part derived from the original CAD data. Obviously in the physical world, each layer must have a finite thickness to it, and so the resulting part will be an approximation of the original data, as illustrated by Figure. The thinner each layer is, the closer the final part will be to the original.

1) Material selection:

This might seem an odd thing to decide first. Most of the time however it is immediately clear what material the part should be made of.

- It can be imposed by the industry or individual customer.
- The environment in which the part will live: mechanical loads, chemical environment, temperatures, expected life-span, etc.

2) Additive Manufacturing-process selection

- First of all, it should be decided if AM is the best solution. Most parts can be produced in traditional ways, better and cheaper. There should always be a good reason to turn to AM. (Time can also be a reason.)
- Secondly, the specific AM-technology needs to be selected. This choice is depending on the material as well as the geometry of the part (overall size, detail size, accuracy requirements, etc.). Some designs are even better adapted to the specifications of the chosen process.
- Thirdly, the process parameters need to be determined.

3) The design

(CAD-file) needs to be pre-processed and made ready for printing. Necessary provisions need to be made to ensure a good fit as specific printing processes have different tolerances.

4) The printing itself

This is pretty obvious. During the printing, the process is monitored through a wide variety of sensors and cameras. The readings of these sensors are logged and can provide already quality information about the part. This part of the process will be handled and described separately.

5) The part needs to be taken from the machine

This can include a cooling down phase and removal of excessive powder and/or support structures. . On some technologies extra baths, UV curing or additional baking is required to give the parts their final strength.

6) Post-processing steps

This again depends on the previous steps. The possibilities here are endless. They can range from basic sanding over painting, coating, post-milling, polishing to even HIP (Hot Isostatic Pressing) and WIP (Warm Isostatic Pressing).

A. Introduction to Prosthetic Hand

The prosthetic hand is an artificial device which is designed for the people with upper limb amputations to come up with some functions of the natural hands. The number of amputees in the developing countries is significantly greater than in developed countries due to minimum medical facilities and the popularity of illnesses that have been cured in the developed world. Loss of upper limbs has many circumstances not only in the sense of physically but also in social and psychological department.

In this project the upper extremity amputation is considered. The number of amputation in developing countries are significantly higher than in western countries. Reasons for it is of lack either medical knowledge, equipment or medicine for sicknesses that are defeated in developed countries.

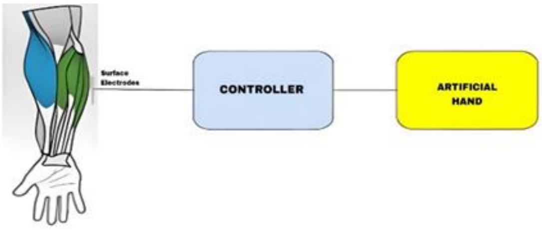

Figure 1: Myoelectric Hand

B. BACKGROUND RESEARCH

Electromyography (EMG from now on) is a well-known diagnostic tool for detecting muscle disorders from motor unit activation potentials. In its non-invasive (surface) version it has also been used since the Sixties to enable amputees control one or two degrees-of-freedom (DOFs) of active upper limb prostheses. Its commercial/clinical applications include, e.g., Otto Bock's Sensor Hand Speed the Motion Control Hand and the Utah Arm and more recently, Touch Bionics' I-LIMB with 5 active and one passive DOF. In some of these cases, force/torque are also controlled

The low-cost prosthetic hand developed for this project consists of four primary components:

- A 3D-printed electromechanical hand,
- An EMG interface,
- A microcontroller capable of real-time signal processing,
- A stable embedded control system.

C. PROSTHETIC HAND OVERVIEW

The 3D-printed hand prototype was modelled, printed and assembled for less than ₹10000. The hand contains over 30 components, including 15 unique printed components. It is actuated with high-torque hobby servos that are controlled by pulse width modulated (PWM) signals regulated by the microcontroller, an Arduino Due. Figure 1 shows a basic overview of the hand's electronic control system.

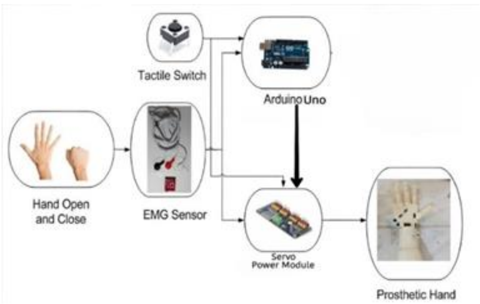

Figure 2: Top Level Overview of the Electronic Control System for the Prosthetic Prototype

D. EMG SIGNAL

EMG stands for electromyography. It is the study of electrical signals in a muscle. It is often referred to as myoelectric activity. Muscle tissue conducts electrical potential similar way to the nerve cells. The name given to these signals is muscle action potential. The muscle is composed of bundles of specializes cells capable of relaxation and contraction. The main function of these cells is to produce motion, moving substance within body, providing stabilization and generating heat. The three muscle tissue types can be identified on basis of structure, contractile properties and control mechanisms; these are called skeletal muscle, smooth muscle and cardiac muscle. The study of EMG signal is applied to skeletal muscle group.

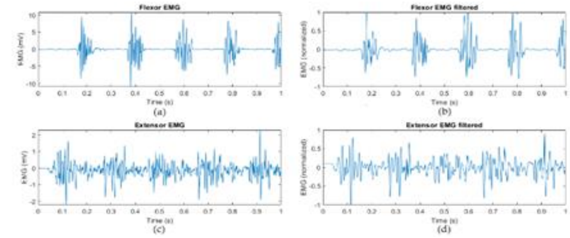

Figure 3: Serial Plotter of EMG Signal

The EMG signal amplitude range is 0-10 mV before amplification and main dominant energy is in a rage from 0-500 Hz. The EMG signal acquires noise while propagating through different tissue. Electrical noise that affects EMG signal is categorized into: Inherent noise in electronic equipment, ambient noise, motion artefact and inherent instability of signal.

II. LITERATURE REVIEW

A prosthetic hand is an artificial prototype which is designed for disabled people who lose their hands through trauma or congenitally. A desired prosthetic hand should have similar features and functions to real human hand. Based on the performance of prosthetic hands, they can be divided into four kinds:

- Cosmetic hand
- Body-powered hand
- Electromyography (EMG) prosthetic hand
- Anthropomorphic prosthetic hand with EMG control.

During the last decade, some multi-Doff (degree of freedom) prosthetic hands with similar functions to real human hand have been developed by some research institutions.

The design and fabrication process of a prosthetic hand with enhanced dexterity achieved through 3D printing by Smith, J., Johnson, A., & Williams, B. (2019). The study focuses on optimizing the hand's range of motion and grasp strength while maintaining affordability and accessibility through the use of 3D printing technology. [2]

Development and evaluation of a multi-fingered prosthetic hand fabricated using 3D printing techniques by Chen, L., Zhang, J., & Wang, W. (2018). The study focuses on enhancing the hand's dexterity and adaptability to various tasks through the integration of novel actuation mechanisms and biomimetic design principles. [3]

Design and fabrication process of a functional prosthetic hand using 3D printing technology by Gupta, S., Sharma, A., & Singh, S (2021). The study explores different approaches to enhancing the hand's dexterity, including tendon-driven actuation systems, under actuated mechanisms, and advanced sensor integration for improved feedback control. [4]

 ISBN: 978-93-91420-93-2

Smart materials in the construction of prosthetic hands by Patel, D., & Kumar, N (2022). It highlights how materials like shape-memory alloys and responsive polymers can be integrated into 3D printed structures to enhance the functionality and adaptability of prosthetic hands, thus improving their dexterity and responsiveness to environmental stimuli. [5]

Integration of various sensor technologies into 3D printed prosthetic hands by Morales, A., Rodriguez, F., & Garcia, L (2021). The study discusses the types of sensors that can be embedded within the prosthetic structure to provide tactile feedback, pressure detection, and temperature sensitivity, thereby offering a more natural experience for users. [6]

As noted by The Economist in 2013, the phenomenon of 3D printing has been rapidly scaling up, indicating its increasing adoption and potential impact. Excel (2010) elaborates on this trend, discussing the rise of am and its implications for engineering and production processes. This sentiment is echoed in a learning course on additive manufacturing offered by tmg-muenchen.de, underlining the growing interest and educational initiatives surrounding this technology. [7]

The implementation of 3D printing has not only attracted attention in industry but also in academic circles. Lam et al. (2019) examine the impact of 3D printing implementation on stock returns from a contingent dynamic capabilities perspective, highlighting the complex dynamics involved in integrating this technology into business 4 operations. Furthermore, explainedideas.com provides comprehensive insights into 3D printing, offering readers a comprehensive understanding of its various aspects. [8]

Statistics on the most used 3D printing technologies, as reported by Statista, shed light on the prevalent methods and techniques driving the additive manufacturing landscape. Meanwhile, the International Organization for Standardization (ISO) and the American Society for Testing and Materials (ASTM) jointly established standards for additive manufacturing, as outlined in ISO/ASTM 52900:2015, emphasizing the importance of standardization in this rapidly evolving field. [9]

However, it's crucial to note that additive manufacturing and 3D printing are not synonymous, as highlighted by Zelinski (2017). This distinction underscores the nuances within the realm of AM technologies. [10]

In summary, the evolution of 3D printing has sparked significant interest and research, with implications reaching across industries, academia, and standards organizations.

As we delve deeper into this technology, it becomes increasingly evident that its impact will continue to shape the future of manufacturing and innovation.

III. MODELLING OF A PROSTHETIC HAND

Autodesk Fusion 360 combines CAD, CAM, CAE and PCB into a single, integrated cloud software platform. It includes all the tools that you need to go from design to manufacturing, seamlessly. With Fusion 360, you'll be able to: Explore design iterations with easy to use 3D modelling tools.

- Industrial designers
- Mechanical engineers
- Electrical engineers
- Machinists
- Hobbyists
- Start-ups

A. ARDUINO SUPPORT

To design an Arduino support in Autodesk Fusion 360, start by measuring your Arduino board and planning extra space for clearance and mounting holes. In Fusion 360, sketch the outline and mounting holes, then extrude this sketch to create a 3D model, adjusting the height as needed. Round off edges with the Fillet tool for safety, and incorporate design features like clips or slots to secure the board and manage cables. Ensure your design accounts for manufacturing tolerances, especially for 3D printing (add 0.2 to 0.5 mm clearance). Finally, export your model as an STL for 3D printing. Prototyping is recommended to refine fit before the final production, and material choice (like PLA for ease or ABS/PETG for strength) should match your project requirements.

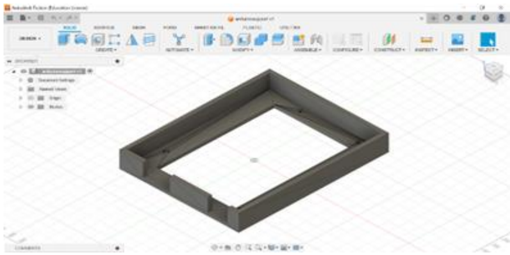

Figure 4: Arduino support

B. FINGERS

The below Figure shows the Auriculaire3 (Fingers) file. Design in a FUSION 360 and saved in the .prt format because if any changes or modifications required to the lithography) format this format is used for the 3D printers and next transfers into Cura software. Cura converts .stl file into machine understandable file above component .prt file is editable and after again saved in the .stl (stereo) i.e. a G code in. ufp format.

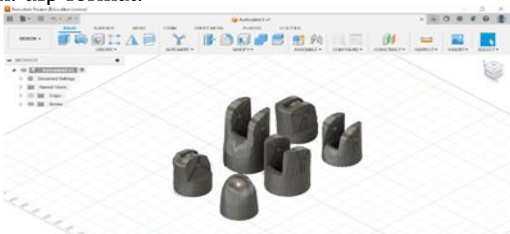

Figure 5: Fingers

C. ROB CABLE FRONT

To design Rob Cable Front in Fusion 360, first define its function and constraints, then sketch and model the component with cable paths and features using tools like Extrude and Sweep. Refine the design for durability and compatibility, validate it with Fusion 360's analysis tools, and prepare for 3D printing. After printing, test fit and iterate based on functionality and integration with the robotic system, emphasizing efficient cable management.

ISBN: 978-93-91420-93-2

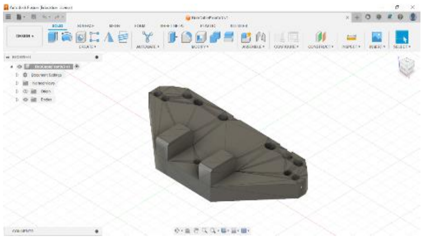

Figure 6: Rob Cable Front

D. ROB SERVO MOTOR

To design Rob Servo Bed in Fusion 360, sketch its outline with dimensions and extrude to form a 3D object. Add features like servo mounting holes, apply fillets or chamfers for smooth edges, and review the design for functionality and aesthetics. Adjustments can be made as necessary before saving the design in Fusion 360 format for further editing or exportation.

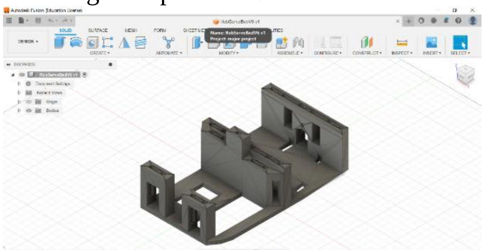

Figure 7: Rob Servo Bed

IV. SLICING & 3D PRINTING

After converting the designed file into the STL file the next process is to create the G code then the file is imported the STL file into slicing software like Cura. The slicing software will convert the information from the STL file into a G code, which is a specific code containing exact instructions for the printer.

A. PREPROCESS OF 3D PRINTING

There are three basic stages to preparing files for 3D printing.

B. MODELLING

This is carried out in any 3D modelling application such as Tinker cad or Sketch Up, which are just two of many example applications. These applications have their own file format and these enable you to open, edit, save, and export those 3D printer files from the application.

C. 3D FILE EXPORT

Once you have created your model, it then needs to be exported as either an STL, OBJ, or UMF file. These are the file formats that are recognized by Cura. They differ from the file formats that are native to the 3D modelling applications as they just hold the final geometry and not the individual primitives and editable content. Still, you can change the size of the 3D model, but not the geometry.

D. SLICING FILE EXPORT

The STL or OBJ file can then be imported into the Cura software where it is sliced and output as G-Code. This G-Code is just a text document (in essence) with a list of commands for the 3D printer to read and follow such as hot-end temperature, move to the left this much, right that much

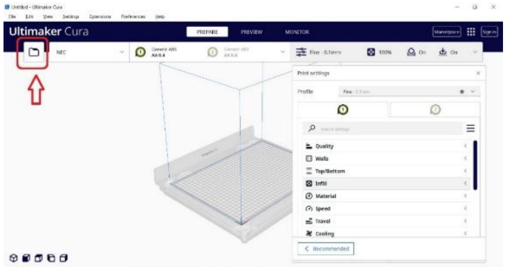

Figure 8: Inserting of designed product to slicing software

Once you have set up Cura for your printer, it’s time to import a model into the Cura software. To import a model, you can either click on the floating folder icon on the left or select File > Open File(s) from the top menu. Select an STL, OBJ, or 3MF file from your computer and Cura will import it.

Table-1: Preferred print setting

S.No	Setting Name	Preferred Setting	Preferred Value
1	Profile	Fine	(0.1mm)
2	Quality	Layer height	0.1mm
3	Walls	Wall thickness	0.8mm
		Wall count	2
		Horizontal expansion	-0.01mm
4	Top/Bottom	Top thickness	1.2mm
		Top layers	12
		Bottom thickness	1.2mm
		Bottom layers	12
5	Infill	Infill density	40%
		Infill pattern	Cubic
6	Material	Printing temperature	240^0C
		Build plate temperature	85^0C
7	Speed	Print Speed	65 mm/sec
8	Travel	Enable retraction	Yes
		Z Hop when retracted	No
9	Cooling	Enable print cooling	Yes
		Fan speed	100%
10	Support	Generate support	Enable
		Support placement	Everywhere
		Support overhang angle	60.0^0
		Support horizontal expansion	0 mm
11	Build plate adhesion	Enable prime blob	Yes
		Build plate adhesion type	Brim

After entering the preferred settings in the right down corner you will see slice press on it and slice the component file and give the file to the 3d printing

E. 3DPRINTING

A Cura 3D Printer builds its parts in discrete slices called layers. As discussed in our 3D printing software overview a 3D printing slicer takes an STL file, divides it into layers, then calculates and creates a tool path for each layer. At the beginning of each layer, the print bed is set at a given height and the gantry motion system moves the print head along the tool path as the extrusion system deposits material.

V. 3D PRINTER OF COMPONENTS

A. STEPS INVOLVED

The steps involved for 3d printing of every component is same. The Procedure is explained step by step below:

Step 1: Once the modelling is done then STL file is loaded into cura software and slicing is done. After completion of the above process the G code file loaded in to 3D printer by using SD card or Pen drive.

Step 2: In order to print the component filament is loaded into the machine (ABS filament is used).

Step 3: Initially bed is prepared by cleaning it with alcohol-based solvent.

Step 4: After cleaning bed is preheated to 85^0C temperature.

Step 5: Before printing the component, glue stick is applied because of avoiding the warping.

Step 6: Once the above procedure is done select the G code file from the SD card by using select option.

Step 7: Each and every parameter setting is visible on the machine screen. Check for any errors and parameters and do modifications if necessary.

Step 8: After checking the parameters printing is started by giving start option in the machine.

Step 9: After completion of the component wait for at least 30 minutes in order to remove the component from the machine bed.

Step 10: Post processing is done to the components by removing of excess material and component supports.

The components which been 3D printed were listed here along with their time and how much material is required for the components.

Table-4: Components printed using 3D printer

S.No	Part Name	Time Duration	Material (g)
1	Arduino support	1 hr 51 mins	8
2	Auriculaire finger	2 hr 23 mins	10
3	Bolt entretoise	3 hr 38 mins	15
4	Cable Holder Wrist	1 hr 24 mins	6
5	Cover finger	3 hr 12 mins	13
6	Index finger	3 hr 25 mins	13
7	Majeure	4 hrs	15
8	Ring finger	3 hr 4 mins	11
9	Rob Cable Back	1 hr 40 mins	8
10	Rob Cable front	3 hr 9 mins	17
11	Rob cap	5 hr 33 mins	31
12	Rob part- 1	7 hr 45 mins	50
13	Rob part- 2	6 hr 12 mins	38
14	Rob Ring	3 hr 11 mins	14
15	Rob servo bed	8 hr 2 mins	53
16	RotaWrist-1	3hr 8 mins	46
17	RotaWrist-2	2 hr 59 mins	22
18	RotaWrist-3	1 hr 37 mins	13
19	Servo pulleys	2 hr 28 mins	10
20	Thumb finger	2 hr 23 mins	27
21	Top surface-1	5 hr 4 mins	52
22	Top surface -2	5 hr 37 mins	60
23	Wrist gear	2 hr 36 mins	10
24	Wrist large	7 hr 11 mins	68
25	Wrist small	3 hr 11 mins	29

These are the components which were printed on the 3d printing machine

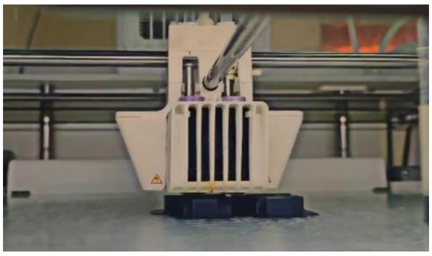

Figure 9: Components Printing

Figure 10 : printed parts of prosthetic hand

The took 3 days 22 hours 43 minutes to 3D print all the required components and the material consumed to print the components of this project is 639 grams. In Ultimaker Cura slicing software, arrangement of components were done in the effective way to reduce the time and material wastage.

VI. ASSEMBLY OF PROSTHETIC HAND

All the components printed for the hand assembly first we see the assembly of the 3d printed parts and after that we will go with electronic components. To assemble all the parts first we need to stick all the separated parts with the help of a glue.

- Each finger is divided in to six parts to increase movement of the fingers and it also improves the structure of the finger. The main reason to print like this is to decrease the wastage of filament because the filament which is used is expensive.
- Separate all the fingers and put it in a different bags, Do this procedure carefully or else you will find it to tell apart. After that do the surface finishing of fingers where they are going to mate the reason for that is unfinished component has tolerance gap and it produce friction that restricts the movement of fingers to prevent it we are giving surface finish the components.

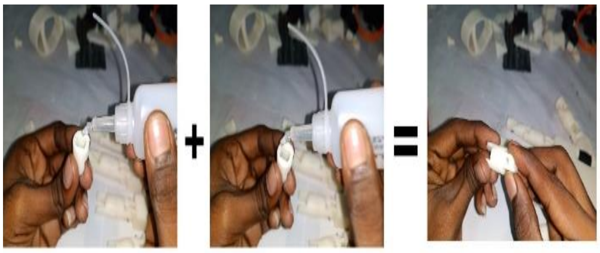

Figure 11 Sticking of Finger Parts

- Do the same processes of gluing to all the fingers and place it aside
- Now Put the 2.85mm filament in to the key holes of the fingers as shown in the figure 11 and glue it at the edges. So, that it didn't fell apart while moving like joints of fingers movement. Do the same procedure to all the joints of the fingers as shown in figure 12

Figure 12 making it into joints

Figure 13 Assembled view of fingers

- Take the wrist small part 1 and place it in the wrist large part upper position as sown in the figure 13a again take the wrist small part 2 and place it beside the wrist part 1 as shown in the figure 13b.

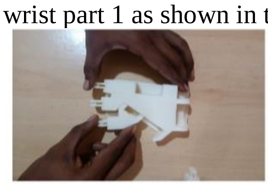

Figure 14a Assembled wrist small part 1 **Figure 14b Assemble of wrist small part 2**

- After that place the place bolt in the lower part of the palm and tighten it with Allen key as shown in figure to restrict the movement.

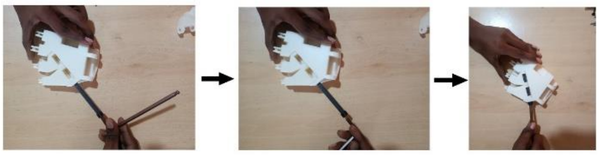

Figure 15 Bolt fitting

- Next step is to join the fingers to the palm of the hand

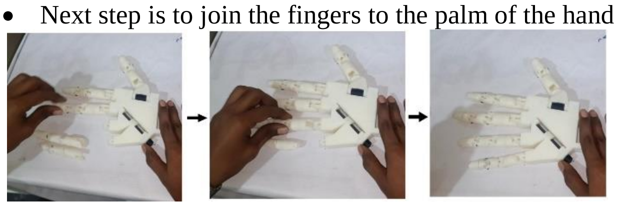

Figure 16 Fingers Assembled to palm

- Next step is take the upper and lower cover casings and glue it together as shown in the figure

Figure 17 Joining the Upper and Lower Cover Casings

- And the next step us to attach the Servo Bed to the cover casing and fasten it with screws as shown in figure 16

Figure 18 Fixing the Servo bed

- Next step is attach the servo pulleys with servo motor holders and fasten it together after that fix the servo motors in the servo bed.

Figure 19 Fixing servo pulleys to the servomotors

- Attach the Rota Wrist to the wrist and then to then attach the small gear and cable supporter to the servo motor located at the wrist

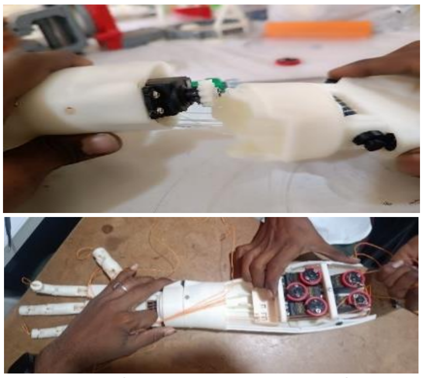

Figure 20 Gear fixing at Servo motor & fishing wire

- Insert the fishing wire in all of the five fingers and test them weather the string are tight or not, is the fingers are properly moving or not and is there any clumsiness in the movement.
- If everything is ok then pass the strings through the wrist gear
- And after that attach the string to the strings holder located at wrist servo motor
- Then pass the string through the Rob part2 which is under the wrist servo motor there are ten hole in that part see carefully and set the strings in the right direction without tangling the string.
- And finally attach the string to the servomotors at servo bed and test it weather they are properly working.

VII. ELECTRONICS COMPONENTS USED

A. ELECTRONIC COMPONENTS

All the components require for this project are

1) EMG Sensor
2) Mg995 Servo Motor
3) Jumper Cables
4) Fishing Wire
5) Arduino UNO
6) Battery
7) IC7805
8) Screws

B. EMG SENSOR

EMG is also known as Electromyography sensor measures muscle response or electrical activity in response to a nerve's stimulation of the muscle. The test is used to help detect neuromuscular abnormalities. During the test, one or more small needles (also called electrodes) are inserted through the skin into the muscle. Muscle tissue does not normally produce electrical signals during rest. When an electrode is inserted, a brief period of activity can be seen on the oscilloscope, but after that, no signal should be present.

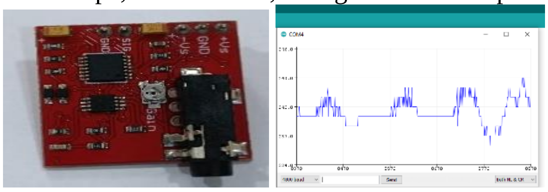

Figure 21: EMG (Electro-Myo-Graphy) Sensor & Signals

C. MG995 SERVO MOTOR

MG995 Metal Gear Servo Motor is a high-speed standard servo can rotate approximately 180 degrees (60 in each direction) used for airplane, helicopter, RC-cars and many RC model. Provides 10kg/cm at 4.8V, and 12kgcm at 6V.

It is a Digital Servo Motor which receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces.

Figure 22: Mg995 Servo Motor

D. JUMPER CABLES

Jumper Cables are used to temporarily connect sources like arduino to motors and sensors. The jumper cables are three types first one is Male to Male second one is Male to Female and the third one is Female to Female.

Figure 23: jumper Cables

E. FISHING WIRE

Generally fishing wire s is used to catch fishes. It is designed and engineered to be strong more abrasion resistant and more durable than ever before. For instance, many fishing lines have a core made from multiple layers of halcyon, a powerful synthetic material that offers superior strength and sensitivity.it is in this project as movement from the fingers.

Figure 24: Fishing wire

F. ARDUINO UNO R3

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, and Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output.

Figure 25: Arduino UNO R3

G. 9V BATTERY

The nine-volt battery, or 9-volt battery, is an electric battery that supplies a nominal voltage of 9 volts. Actual voltage measures 7.2 to 9.6 volts, depending on battery chemistry. Batteries of various sizes and capacities are manufactured; a very common size is known as PP3, introduced for early transistor radios

H. IC7805

The LM7805 voltage regulator operates by comparing the output voltage with an internal reference voltage and adjusting the pass transistor accordingly. Its primary function is to regulate the voltage supplied to electronic devices, ensuring they receive a stable and constant +5V DC power source.

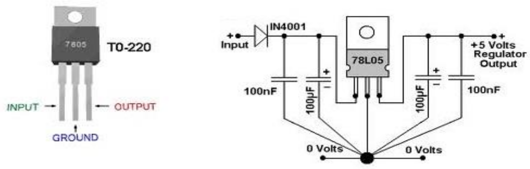

Figure 26: IC 7805

I. SCREWS

A screw is an externally helical threaded fastener capable of being tightened or released by a twisting force (torque) to the head.

VIII. ARDUINO CODING

The arduino integrated development environment - or arduino software (ide) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. Here is a sample code

```
#include <Servo.h>
Servo servo1; // Create object for Servo motor 1
Servo servo2; // Create object for Servo motor 2
Servo servo3; // Create object for Servo motor 3
Servo servo4; // Create object for Servo motor 4
```

```
Servo servo5; // Create object for Servo motor 5
int position = 0;  // Variable to store the position
void setup()
{
servo1.attach(3); // Set PWM pin 3 for Servo motor 1
servo2.attach(4); // Set PWM pin 5 for Servo motor 2
servo3.attach(5); // Set PWM pin 5 for Servo motor 3
servo4.attach(6); // Set PWM pin 5 for Servo motor 4
servo5.attach(7); // Set PWM pin 5 for Servo motor 5
}
void loop()
{
// Rotating Servo motor 1 in Anti clockwise from 0
degree to 180 degree
for (position = 0; position <= 180; position++)
{
servo1.write(position); // Set position of Servo
motor 1
delay(10);
}
```

A. CODE EXPLANATION

This Arduino code utilizes the Adafruit_PWMServo Driver library to control multiple servos connected to an Adafruit PWM Servo Driver board. The setup function initializes serial communication with EMG senor and to the servo driver, setting the PWM frequency to 90Hz. In the loop function, a for-loop gradually increases the pulse length sent to the servo from SERVOMIN to SERVOMAX, causing it to move in one direction. After a delay, another for loop decreases the pulse length, moving the servo in the opposite direction. The code then increments the servonum variable to move to the next servo, looping back to the first servo once all servos have been cycled through. This code effectively sweeps each servo connected to the PWM driver through its range of motion repeatedly.

IX. CONCLUSION

This project focuses on the design and fabrication of a human like robotic arm utilizing 3D printed components, resistors, servomotors, electromyography sensor, batteries, Arduino microcontroller, and jumper cables. The primary objective is to create an innovative and cost-effective solution for achieving lifelike movements, resembling the dexterity of a human arm.

It concludes the development of the EMG-controlled dexterity human hand, featuring customized components, 3D printing technology and EMG sensor integration with servo motors representing a significant advancement in the field of prosthetics devices. This innovative design not only offers users greater customization and functionality but also enhances their ability to interact with their environment more naturally. By combining cutting-edge technology with user centered design principles, this robotic hand has the potential to significantly improve the quality of life for those in need, fostering greater independence and self-expression.

Furthermore the project can be developed into upgrading the sensors it can increase the sensibility muscle movement and give more accurate values or it can also be implemented into a full hand by attaching muscle sensing sensor at arm joint. There is a more good scope to use AI & ML technologies and research and development for the robotic hand. There is a lot of chances of creating lower limbs which as act as substitute for their loosen parts

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DESIGN AND IMPLEMENTATION OF A FUZZY LOGIC CONTROLLER FOR INTEGRATING HYBRID DISTRIBUTED GENERATION SYSTEMS WITH DC MICROGRIDS: A MATLAB APPROACH

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Abstract: This paper presents the design and implementation of a fuzzy logic controller (FLC) aimed at optimizing the integration of hybrid distributed generation (DG) systems with direct current (DC) microgrids. As renewable energy sources and distributed generation become increasingly prevalent, managing their integration effectively is crucial for enhancing system reliability and efficiency. The proposed fuzzy logic controller facilitates the smooth operation of hybrid DG systems, which typically consist of multiple renewable energy sources, by dynamically adjusting control parameters based on real-time system states. Utilizing MATLAB and its Simulink environment, we developed and simulated the FLC to evaluate its performance in various operational scenarios including variable load conditions and fluctuating generation capacities. Our results demonstrate that the FLC effectively maintains system stability and improves power sharing between the connected sources, thereby optimizing the overall performance of the DC microgrid. The controller also adapts to changes in load demands and generation without requiring manual recalibration. This research contributes to the field by providing a robust control strategy that can be implemented in similar microgrid configurations, paving the way for more adaptive and resilient energy systems in the context of increasing renewable integration.

Keywords: Microgrid, RES, FLC, DGS, optimization

OPTIMIZING ENERGY EFFICIENCY THROUGH ADVANCED DEMAND SIDE MANAGEMENT STRATEGIES IN THE E-ENERGY LANDSCAPE

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Abstract: This research paper investigates the application of advanced Demand Side Management (DSM) strategies within the e-Energy framework, utilizing MATLAB to enhance energy efficiency in electrical networks. The growing emphasis on sustainable energy consumption necessitates the development of sophisticated tools that can dynamically adjust energy usage in response to supply variability and consumer demand patterns. In this study, we explore a comprehensive DSM strategy that includes peak shaving, load shifting, and real-time pricing models, implemented via MATLAB simulations to analyze their effectiveness in reducing energy costs and peak load. Our approach incorporates predictive algorithms and real-time data processing to facilitate intelligent decision-making at the consumer level, promoting a more efficient use of resources. By integrating these DSM strategies into the MATLAB environment, we provide a versatile and powerful tool for energy researchers and utility managers to simulate various scenarios and their potential impacts on both energy consumption and utility economics. The results highlight the potential of these DSM strategies to significantly enhance energy efficiency, demonstrating notable reductions in peak demand and overall energy expenditure. This research not only contributes to the theoretical understanding of DSM in the e-Energy sector but also offers practical insights and tools for its implementation, thereby supporting the transition towards more sustainable energy systems.

Keywords: DSM, Sustainable energy, e-Energy system, Optimization, Predictive algorithm

AN EXPERIMENTAL STUDY ON R134a VAPOUR COMPRESSION REFRIGERATION SYSTEM WITH A DIFFUSER AT VAPOUR LINE

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Abstract: Nowadays, refrigeration systems find extensive applications in both industrial and domestic sectors. The majority of household refrigerators operate on a vapor compression system, utilizing an expansion valve to lower the pressure of liquid refrigerant before delivering it to the evaporator. However, the leakage of commonly used hydro fluorocarbon refrigerants from refrigerators poses significant environmental concerns such as global warming and ozone depletion. The aim of this research is to improve the Coefficient of Performance (COP) of the Vapor Compression Refrigeration (VCR) cycle. Enhancing the COP of the VCR cycle involves either decreasing compressor work or augmenting the refrigerating effect. In the VCR cycle, the compressor's function is to raise the refrigerant pressure. However, high-velocity refrigerant exiting the compressor can cause condenser splashing, leading to erosion. Converting this kinetic energy into pressure energy can be achieved by employing a diffuser. The system's performance is evaluated by practically implementing the VCR cycle with diffuser utilization. Experimental findings show that the COP of the basic VCR is 6.83. With the inclusion of diffuser 1, the COP rises to 7.73, while for diffuser 2, it reaches 7.81, and with both diffusers, it reaches 8.44. Consequently, diffuser 1 demonstrates a 13.18% performance enhancement, diffuser 2 shows a 14.32% improvement, and when both diffusers are combined, and the enhancement is 23.876%, compared to the simple vapor compression refrigeration cycle.
Keywords: VCR system, Diffuser, COP and Refrigeration effect.

1. INTRODUCTION

Refrigeration theory focuses on understanding the characteristics of working fluids, known as refrigerants, and the energy dynamics involved in cooling processes. It serves as the fundamental framework for the operation of mechanical refrigeration systems. In nature, heat naturally flows from regions of higher temperature to those of lower temperature without any external intervention. However, achieving the reverse process—transferring heat from a colder area to a warmer one—requires specialized equipment known as refrigerators. These devices operate based on the principles of the reversed Carnot cycle theory, facilitating the transfer of heat against its natural direction.

G. Naga Raju et al. [1] investigated the impact of diffusers placed at the compressor inlet and condenser inlet. They observed that placing a diffuser at the compressor inlet led to an approximate 6% increase in COP, primarily attributed to reduced compressor work. Conversely, when a diffuser was positioned at the condenser inlet, COP increased by approximately 3%, mainly due to enhanced refrigerating effect. L. Kairouani, M. Elakhdar, E. Nehdi, and N. Bouaziz [2] introduced an enhanced cooling cycle for a traditional multi-evaporators simple compression system by incorporating an ejector for vapor recompression. The upgraded refrigeration cycle integrates multiple evaporators operating at distinct pressure and temperature levels. They developed a one-dimensional mathematical model of the ejector based on flow and thermodynamic equations, utilizing the constant-area ejector flow model. Theoretical analysis indicates that the COP of this innovative cycle surpasses that of the conventional system.

In another development aimed at improving the coefficient of performance, F. W. Yu and K. T. Chan [3] discussed the utilization of direct evaporative coolers to enhance the energy efficiency of air-cooled condensers. These evaporative coolers are installed in front of air-cooled condensers to pre-cool outdoor air prior to its entry into the condenser. Predictive results suggest that employing the evaporative cooler leads to an augmentation in the refrigeration effect**.** Enhancing vapor compression refrigeration systems through the implementation of sub-cooling and a diffuser at the inlet of the condenser. In this setup, the diffuser is installed at the inlet of the condenser. In the rapidly evolving landscape of modern technology, the demand for energy-efficient solutions is ever-increasing. Air conditioning and refrigeration systems play a significant role in this scenario, directly impacting energy consumption. This study primarily centers on assessing the performance of a vapor compression refrigeration (VCR) system utilizing R134a, employing various techniques to enhance its efficiency [4].

The primary focus lies on evaluating the coefficient of performance (COP) of the system. Through experimental investigations on the VCR system with and without a diffuser, the performance metrics of the compressor, evaporator temperature, and COP are scrutinized. The findings indicate that employing a diffuser leads to improved system performance compared to operating without one. In a vapor compression refrigeration system, the condenser plays a crucial role in extracting heat from high-pressure vapor refrigerant, converting it into high-pressure liquid refrigerant. The refrigerant circulates within the coils of the condenser, while a cooling fluid flows over these coils. Typically, domestic vapor compression refrigeration systems utilize air-

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cooled condensers, which can be either naturally or forced air-cooled. Heat transfer occurs from the refrigerant to the cooling fluid during this process. Subsequently, the high-pressure liquid-refrigerant-passes through an-expansion device to achieve-low-pressure refrigerant, which then flows through the evaporator. Within the evaporator, the liquid refrigerant absorbs latent heat, transitioning into vapor refrigerant, which is then returned to the compressor. The compressor elevates the pressure and temperature of the vapor refrigerant before discharging it into the condenser, completing the refrigeration cycle [5-7].

Adityaswaroop1 and S.C. Roy conducted a study titled "Enhancing COP of a Refrigerator through Diffuser Implementation" published in the International Journal of Advanced Research in Science and Engineering, Volume 6. The aim of this project is to demonstrate that the installation of a diffuser between the condenser and the evaporator can lead to an increase in the coefficient of performance (COP) of the vapor compression refrigeration system. In this study, experiments were conducted on a vapor compression refrigeration system operating with a diffuser at the vapor line. Two variable diffuser divergent angles, namely 15° and 17°, were investigated. The system was tested both with and without the diffuser, and its performance was evaluated in terms of refrigeration system efficiency, compressor work, and coefficient of performance.

2. EQUIPMENT SETUP DETAILS

The design of diffuser main concentrated on rise the temperature & pressure of the working refrigerant, it depends on the divergence angle in this work, it connected between the compressor outlet and condenser inlet. The cross sectional area of the diffuser gradually increases. Observe the diffuser models are on Fig. 2.1 and Fig. 2.2.

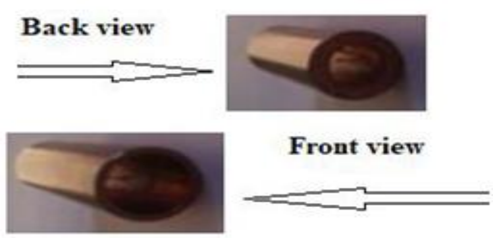


Figure 2.1: Diffuser

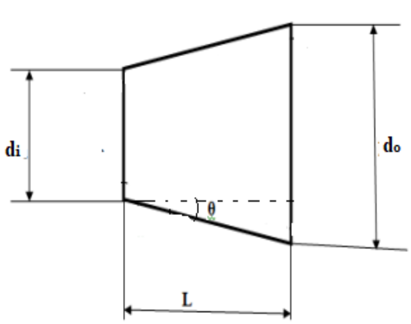


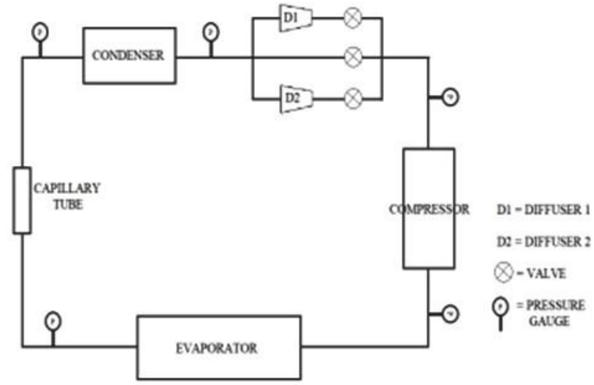
Figure 2.2: Diffuser line diagram

$$Tan\ \theta = \frac{outler\ diameter - inlet\ diameter}{2l}$$

do =outlet diameter di = inlet diameter

l= length of the diffuser ϴ= divergent angle

The fabrication of vapour compression refrigeration system compressor, condenser, expansion and evaporator in series, the diffuser connected between compressor outlet and condenser inlet a separate line created between them on Fig. 2.3 a & b Hermetically sealed reciprocating compressor used.



The degree of temperature of the working system at different points identified by using k Type temperature sensor.

Figure 2.3: (a) Experimental setup layout

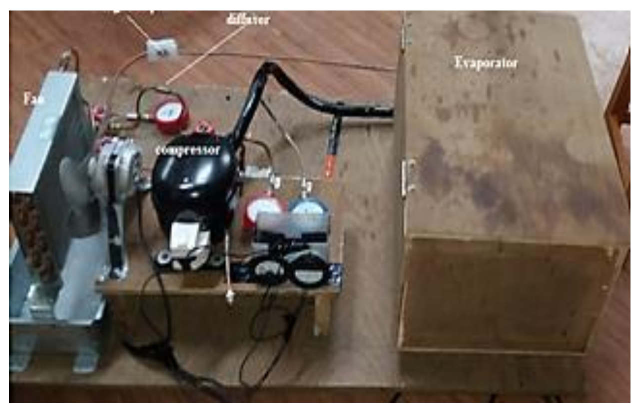


Figure 2.3: (b) Experiment setup fabrication model

- Temperature &Pressure mentioned by T and P respectively with point.
- Evaporator Outlet/ Compressor Inlet Temperature and Pressure (T1 & P1)
- Compressor Outlet/Diffuser Inlet Temperature and Pressure (T2 & P2)
- Diffuser Outlet& Condenser Inlet Temperature and Pressure (T2 ' & P2 ')
- Condenser Outlet &Capillary Tube Inlet Temperature and Pressure (T3 & P3)

- Capillary Outlet & Evaporator Inlet Temperature and Pressure (T4 & P4)

3. EXPERIMENT RESULTS

Case-1: Experiments conducted without diffuser and Diffuser 1 (angle 15°)

Table 1: Without and with Diffuser 1(angle 15°)

System	Without Diffuser	Diffuser 1
P1	75	76
P2	395	395
P2’	390	397
P3	355	360
P4	87	88
T1	14.4	14.6
T2	90.2	88.3
T2’	88.1	90.1
T3	33.1	31.1
T	13.7	12.9

Case-2: Experiments conducted without diffuser and Diffuser 2 (angle 17°)

Table 2: Without and with Diffuser 2(angle 17°)

System	Without Diffuser	Diffuser 2
P1	75	78
P2	395	395
P2’	390	395
P3	355	365
P4	87	90
T1	14.4	14.2
T2	90.2	88.9
T2’	88.1	89.1
T3	33.1	30.9
T	13.7	12

Case-3: Experiments conducted without and with diffuser (combiner (15°& 17°)

Table 3: Without and with Diffuser 1&2 (angle 15°& 17°)

System	Without Diffuser	Diffuser 1&2
P1	75	78
P2	395	375
P2’	390	390
P3	355	355
P4	87	90
T1	14.4	14.9
T2	90.2	88
T2’	88.1	89.8
T3	33.1	30.9
T	13.7	12.8

3.a Refrigeration Effect :

Table 4: The refrigeration effect

Type	Refrigerating Effect (KJ/Kg)
Without Diffuser	196
Diffuser 1	202
Diffuser 2	203
Diffuser 1&2	203

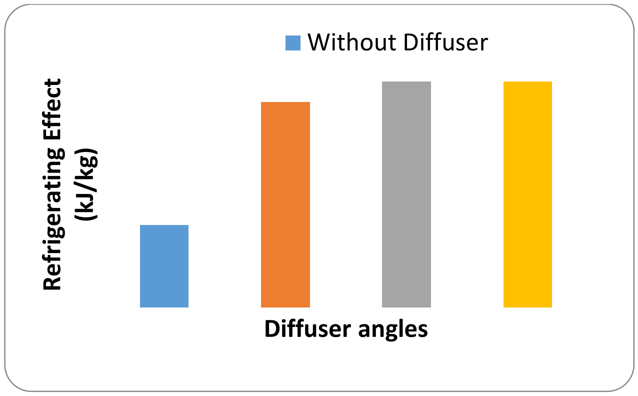


Figure 3.1: The Refrigerant effect without and with diffuser

The above figure 3.1. Shows the refrigeration effect is increased when comparing the vapor compression refrigeration system with and without a diffuser. The primary function of the diffuser is to reduce the velocity of the flow exiting the impeller, leading to an increase in pressure. Utilizing a combined effect of diffusers set at 15° and 17° in the operating conditions of the vapor line improves the system's performance

3.b Compressor work:

Table 5. Compressor work

Type	Compressor Work (KJ/Kg)
Without Diffuser	29
Diffuser 1	26
Diffuser 2	26
Diffuser 1&2	24

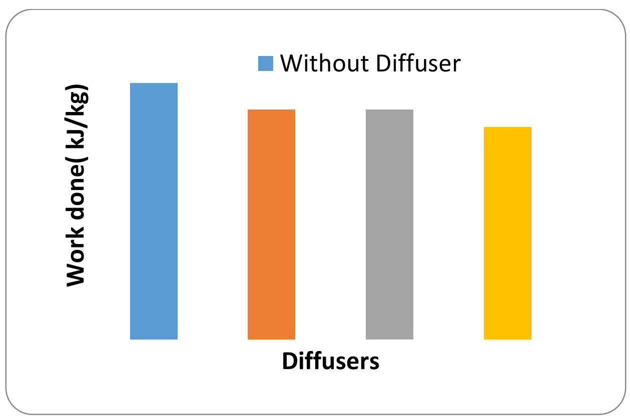


Figure 3.2: The compressor work without and with diffuser

The compressor work in a vapor compression system significantly influences its overall efficiency and performance. When the compressor operates, it compresses the refrigerant vapor, increasing its pressure and temperature. This process requires energy input, which is provided in the form of mechanical work. From fig 5. The compressor work is decreased by using the diffusers, the diffuser angle 15º the compressor work is low compare to the other diffusers.

3.c. Coefficient of Performance:

Table 6: Coefficient of performance

Type	COP
Without Diffuser	6.83
Diffuser 1	7.73
Diffuser 2	7.81
Diffuser 1&2	8.46

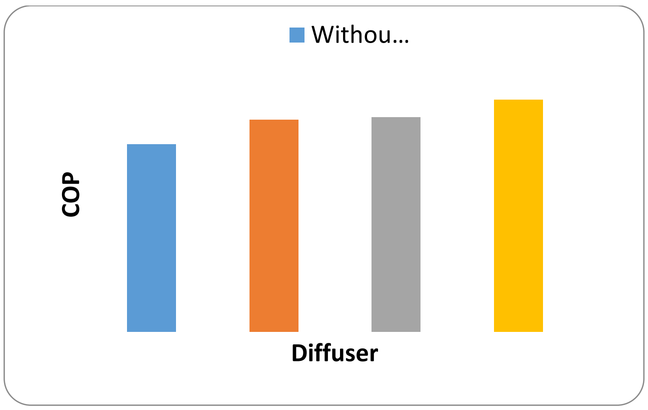


Figure 3.3: The COP with and without diffuser angles

The diffuser helps in reducing the velocity of the refrigerant flow leaving the compressor, thereby increasing the pressure. This reduction in velocity results in less energy loss due to friction and turbulence, leading to improved efficiency, fig 6. shows the COP of the system is increased with diffuser , the maximum values is obtained combined effect of diffusers (15º&17º).

4. CONCLUSION

An experimental analysis, the performance of a vapor compression refrigeration system using a diffuser at the vapour line that of a simple vapor compression refrigeration cycle. Diffuser 2(angle 15º) exhibits superior performance compared to Diffuser angle (17º), which has a 15^0-degree divergence angle. Furthermore, utilizing both diffusers results in the highest performance improvement compared to both diffusers individually and the simple vapor compression refrigeration cycle.

The experimental data reveals the following coefficient of performance (COP) values: 6.83 for the simple VCR, 7.73 for VCR with Diffuser 1, 7.81 for VCR with Diffuser 2, and 8.44 for VCR with both diffusers. Consequently, the performance improvement percentages are as follows: 13.17% for Diffuser 1, 14.34% for Diffuser 2, and 23.86% for both diffusers compared to the simple vapor compression refrigeration cycle.

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Recent Advances in the Thermal Barrier Coatings for Extreme Environments

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Abstract—**Thermal barrier coatings (TBCs) are gaining tremendous research interest for protecting aircraft turbine blades, power plants, and other applications from high-temperature exposure. This opinion spotlights on those recent progresses that have directed to the use of TBCs for component life addition and, lately, as an essential part of advanced components design for high temperatures and related harsh environments, such as applications in the nuclear industries. Development of this coatings has been driven by results obtained from laboratory and industrial testing, corroborated by engine and gas-turbine testing and related high-temperature application experience. Factors that have led to the choice of current high-tech advanced coating fabrication methods–such as plasma spray deposition (PSP), electron-beam physical vapor deposition (EB-PVD), and electrophoretically fabricated thermal barrier coatings, have also been highlighted in current coating research and development. Here, we provide a short review on the present status of TBCs, their latest advances in fabrication and performance, drawbacks associated with them, as well as recommendations for their futuristic use in harsh high-temperature environments**

I. INTRODUCTION

Efficient thermal-resistive coatings are crucial to improve thermo mechanical performance and service life of materials in the area of high-temperature, corrosive, harsh environments for example, those seen in gas turbine engines and thermal and nuclear power plants [1,2]. Thermal barrier coatings (TBCs) are protective coatings applied to the surface of hot metallic components in turbines and reactors [3]. TBCs are composite systems combining metallic and ceramic materials to increase a component's performance under highly demanding thermal cycling and surroundings [4]. In conjunction with metals, ceramic materials enhance thermal- insulation and thermal-expansion compliance of TBCs. The potential for thermal barrier materials is highly dependent on their fabrication methods and targeted application. Here, in this review, the recent advanced in the fabrication and application as well as draw- backs associated with thermal barrier coatings are captured

II. THERMAL BARRIER COATINGS (TBCS) AND RECENT ADVANCES

Electron-beam physical vapour deposition, and plasma sprayings are two recognized fabrication techniques, however, newer coating methods, such as electrophoretic coating method, and advanced thermal spraying processes, including plasma-spray physical vapour deposition (PS-PVD) are not fully developed and showing interesting advanced properties [5–8]. There are three key factors which typically studied in developing efficient TBC coating meth- ods—namely, thermal conductivity, reproducibility, and strain tolerance.

New advanced reactor design strategies, and their development provide the necessity for the use of TBCs towards more-extreme harsh environmental conditions, for example, very high temperatures under highly corrosive and neutron irradiation environments. To develop TBCs that can achieve appropriate lifetimes under the demand of these extreme operating conditions and new environments, advances in manufacturing techniques, new coatings materials and thermal barrier coating design should be studied. Diversity of environments and performance needs further add to increases in interest in TBCs. Alongside with the evolving performance necessities, new specified coating functions are desirable to achieve required design performance in every application. An example of new material design is corrosion resistance in yttria stabilized zirconia (YSZ), a ceramic with a low thermal- expansion coefficient [9]. A thin coating of YSZ can be applied as a TBC to turbine blades to improve heat insulation and enhance temperature performance of turbine engines. Furthermore, an engineered-bond coating between the substrate and the YSZ coating shields the substrate from the oxidation environment and offers better adhesion between the substrate and the ceramic coating. Typically, an alloy like MCrAlY is used as a metallic bond coating, where M symbolizes Ni, Co, or their mixtures. The concepts for developing new material for designing TBCs should have lower thermal conductivity and display improved temperature stability than the existing 7–8 wt% YSZ [10]. Furthermore, multilayer systems with different functions are also under consideration. These include functionally graded materials (FGMs), materials with spatially dependent microstructure or composition [11,12]. FGMs, comprising layers for chemical insulation with an intermediate conventional partially stabilized zirconia layer and a new-material top layer, or structures graded in chemical composition have been used in various high-temperature applications such as aircraft turbine blades, power plants, etc [11].

Reducing thermal conductivity throughout the coating material can increase a module's operating-temperature window without degradation, thus increasing overall efficiency. Increased porosity in a material has been shown to reduce overall thermal conductivity [12]. Porous FGM has been used to beating the mismatch in stress concentrations and thermal expansion coefficients in TBCs [13]. TBCs graded in porosity towards the surface can decrease thermal conductivity, improve thermal shock resistance, and reduce residual stress through the coatings, providing improved temperature gradients in coatings and improved inlet temperatures in applications such as gas turbines [9]. One of the challenges in design of TBCs for high-temperature nuclear components is spallation of the top coating under harsh thermal cycling conditions. In order to inhibit spallation and increase the thermo mechanical performance of the TBC, FGM ceramic coatings can be fabricated [14]. FGM, in combination with advanced manufacturing technologies present promising new capabilities to further improve thermo mechanical and extreme-environment performance of TBCs [9,11,14].

The prospect for advancement in barrier coatings is fairly high, and a range of new manufacturing routes, and particularly, advanced manufacturing technology (AMT) [15–17] can improve the success rate and choices for future applications. These new manufacturing techniques and science-based material synthesis methods can lead to manufacture of improved, more resilient, and useful coatings [18–24]. Thermal barrier coatings can provide an insulation result for short and long-term problems in the inter- nal combustion, gas turbine, energy generation and storage, nuclear industries, and other coatings related applications [25–30].

III. Conclusion and recommendation

Application of thermal barrier coatings on modules such as high-pressure turbine blades, and combustors is uncompromisingly growing in commercial and military related applications. This tendency will certainly continue owing to TBCs shielding capability, which allows higher working temperatures and reduces the cost of cooling systems, thus refining overall component efficiency. Energy-generation sectors, like turbine engines and reactors, are also progressively using thermal barrier coatings, and industries like nuclear and defense are accepting this coating method quickly. TBCs are also planned to be used on modules fabricated by ceramic–matrix composites and metal–metal and metal-ceramic frameworks. With the appropriate modification of FGM and TBC fabrication processes and parameters, an opposite TBC, graded in porosity and functional composition, can be designed, and established, and this will increase thermal resistance and whole coating performance for applications in extreme environments.

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Fabrication of Solar Powered Seed Sprayer

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***Abstract*— The aim of the project is to design and develop a solar powered seed sprayer. The seed sewing machine is a mullite functional key component of agricultural field. The various technique used in India for seed sowing and fertilizer placement are manual, ox and tractor operator. The manual and ox operator technique are time consuming and productivity is low. Tractor is running on fossil fuel which emits carbon dioxide and other pollution every second and cannot be used of small agriculture lands. This evident has led to widespread air, water and noise pollution and most importantly has led to a realistic energy crisis in the near future, in order to make the development of our farmer as well as nation sustainable and cause less harm to our environment. Now the approach of this project is to develop the seed sowing machine which is to minimize the working cost and the time for seed sowing and grass cutting as well as operate on clean energy. In this machine solar panel is used to capture solar energy and then it is converted into electrical energy which in turn is used to charge 12V battery, which then gives the necessary power to a shunt wound DC motor. This power is then transmitted to the DC motor to drive the wheels. And to further reduction of labor dependency.**

Keywords— Solar panel, Lead acid battery, Blower Fan, DC Motors.

I. INTRODUCTION

Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. The government of India appointed a commission to assess the feasibility of increasing the crop productivity under prevailing Indian ecological conditions.

In order to develop the standard of living of small farmers we should make the machines with low cost. Then only small farmers can implement the recent modern machines for farming purposes. The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and spacing, cover the seeds with soil and provide proper compaction over the seed.

Our proposed "Solar seed sprayer machine" is used to sowing seed easily. In this project an attempt has been made to provide the low-cost sowing machine and also it reduces the human effort. Seed sowing machine is a device which helps in the sowing of seeds in a desired position hence assisting the farmers in saving time and money. The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. The paper discusses different aspects of seed sowing machine which will be helpful for the agriculture industry to move towards mechanization.

II. LITERATURE REVIEW

Mahesh R. Pundkar [1] stated that the seed sowing machine is a key component of agriculture field. high precision pneumatic planters have been developed for many verities of crops, for a wide range of seed sizes, resulting to uniform seeds distribution along the travel path. in seed spacing. M.A. Asoodar [2] another agricultural researcher determined the effects of different seeding technique and machines and also different rates of oilseed rape application on seeding emergence plant establishment and final grain yield.

Roshan V Marode et al., [3] in the traditional method, the rate of seed sowing is more but the total operating time is more and the labor cost is much more. Today's aim is to go towards the rising of all sectors as well as the agricultural sector. New techniques have to be implemented to achieve future demands by the famers, which will not affect the soil but crop production will be increased. R. Joshua V. Vasu and P. Vincent [4] are discussed the "Energy-demand" is the major problem for India. Finding solutions, to meet these demands is a difficult challenge for Social Scientist and Engineers. This paper deals how a 'Power' which is already in use and works with fossil fuel can be converted into a solar operated machine.

III. METHODOLOGY

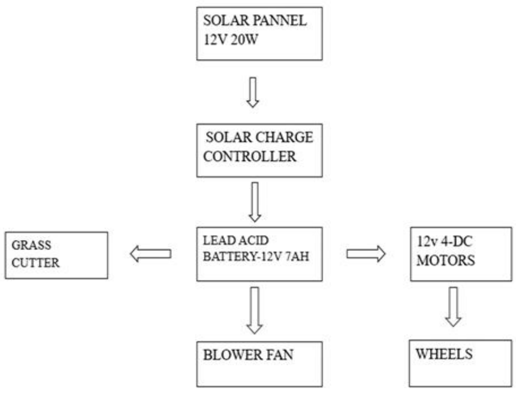

Figure 1 Methodology

IV. PROPOSED SYSTEM

The proposed system incorporates several key features in this machine a solar panel is used to consume solar energy and this energy is converted into electrical energy. The electrical energy is stored inside a 12V battery of capacity 7 Amp Hour, with the help PWM solar charge controller. The power from the battery is sent to DC motors, grass cutter and blower. Due to the centrifugal force generated by high-speed dc motor the grass cutting is done. Seeds passes from the convergent nozzle of the hopper. The seeds are sown on to the soil by means of high-pressure air which is produced by blower fan.

Figure 2 Solar powered seed sprayer

The basic objective of sowing operation is to put the seeds in rows, to maintain seed to seed spacing the recommended row to row spacing, seed rate, seed to seed spacing and depth of seed placement can vary from crop to crop and for different agro-climatic conditions to achieve optimum yields. Wheels of the machine are rotated by means of the dc motors connected at four corners of the machine. Various fabrication processes involve cutting and welding of mild steel and cutting of galvanised iron sheet, cutting of mild steel bar, cutting and welding used in cutter, bolting of DC motor, clamping of batteries and solar panel, wiring and clamping of seed Sower and adjuster etc.

V. ASSEMBLY PROCESS

In this project many components are used they are solar panel, solar charge controller, lead acid battery, DC Motor, wheels, funnel, blower fan, frame-chassis and some other basic mountings. In the beginning a chassis is made up of cast iron and galvanised iron sheet (GI) by the welding process with the dimensions 50cm length, 38cm width and 2.5 cm thickness.

Figure 3 chassis

Once the chassis gets done 4-DC motors are fixed four sides of the chassis along with the wheels for forward and backward moment. A frame is welded to the chassis inclined with a height of 40cm from the chassis which is made for the solar panel mounting.

Next a supporting rectangular bar is welded in between chassis and frame for mountings like hopper and servo motor. Now the 12V 20W solar panel is mounted on the frame inclinedly. After fixing the solar panel the solar charge controller and lead acid battery are placed rigidly on the chassis with screws, nuts and bolts. Now the connections are given to the solar panel, solar charge controller and lead acid battery as per the positive negative terminals. A high-speed motor with cutting blades is placed Infront of the frame for the grass cutting. The blower fan is supported with the help of screws on chassis for sowing the seeds coming from the hopper. A hopper is fixed to the vertical rod for storing the seed.

VI. COMPARISION TABLE

WITH SOLAR SEED SPRAYER	WITHOUT SOLAR SEED SPRAYER
1.Required manpower is very less & labour cost nearly 300 rupees	1.Required manpower is high & Labour cost is nearly 900 rupees
3.It takes nearly 3 hours' time and can-do multiple operations	3.It takes 2 hours' time but can't do multiple operations
4.Machine maintenance is required and skilled labour is required	4.No machine maintenance is required and skilled labour not required
5.Spraying of seeds can be done in proper manner	5.Spraying of seeds can be done in improper /random manner
6.Proper plantation can achieve	6.Proper plantation may not be achieved

VII. CONCLUSION AND FUTURE SCOPE

A. Conclusion

A solar powered seed sprayer is multi-functional project designed for small farmers to improve their productivity. In this machine a common seed storage place is introduced to reduce the cost of the machine. The drawbacks in the existing sowing machine are rectified successfully in our machine. It will be more use full for small farmers and the agriculture society. Thus, solar operated automatic sowing machine will help the farmers of those remote areas of country where fuel is not available easily.

B. Future scope

Addition of multi hoppers can be attached side by side for sowing large farm. Multi hoppers can be fixed at the corners for simultaneous operation which reduces time taking for sowing the seeds per large farming land or for small farming land.

Water dripping unit can be included in seed sowing machine. If the system can attach to the solar vehicle this will be very time efficient as well as effort less work will do by the farmer with accurate and efficient way.

The seed drilling is a modern method of sowing seeds. Replacing of seed drilling equipment in the place of grass cutter can increase the rate of productivity by means of sowing the seeds at required depth and row to row spacing.

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CFD ANALYSIS OF MASS FRACTION OF REFRIGERANT LEAK INTO THE PASSENGER COMPARTMENT THROUGH THE HVAC UNIT

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Abstract: To predict and control the total amount of mass fraction of refrigerant leak into the passenger compartment through the HVAC unit with panel mode of operation. As preliminary assessment the problem is solved using the CFD solver in steady state. The quality of air passing through the ventilation system is of great importance when designing and developing climate systems for the automotive industry. There are clear benefits both concerning the climate comfort in the compartment and cost efficiency in the development process, if the owing an early stage can be estimated and analyzed virtually. This project is a part of the development work of a computational method to be used for flow rate prediction of the climate system in the automotive industry. And also to consider this analysis is preliminary to identified the correct selection of refrigerant for evaporator which will cause the least global warming. The new method consists of guidelines for setting up a numerical model of the climate system and directives on how to carry out the refrigerant flow rate computations. The climate system refers to the complete internal system for transporting refrigerant through the vehicle compartment. Since the amount of refrigerant mixing with air transported through the system and also a minor investigation of the solutions mesh dependency and the dependency towards choice of turbulence. In order to evaluate the method the refrigerant mass flow through at outlets with the computational model. The CFD simulations of the system modeled as turbulence model and with the fan at maximum operating speed showed promising results and exceeded the measurements completely reliable. Instead of a slight, the CFD results would probably under predict the flow without the leakage since the measured values would most likely be significantly larger. Even though the results appear to correspond to the measured values some further validations are suggested. There are some uncertainties connected to the measurements both considering leakage and mesh resolution. Some effort may also be reserved to ensure an unambiguously.

Reverse Engineering Technique and its application using 3D Printing

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Abstract:This study Investigates the "What is Reverse Engineering Technique and How its applications are useful for 3D printing"Reverse engineering is a technique that involves deconstructing a product or system to understand its components and functionality. When paired with 3D printing, it serves as a powerful method for replicating and improving existing designs. This synergy allows for the creation of digital models from physical objects, which can then be modified, optimized, and reproduced with precision and efficiency

I.INTRODUCTION

The fundamental principle of reverse engineering is to learn how a system works by examining it from the outside in, without the benefit of its original blueprints. It's like figuring out how a complex machine ticks by disassembling it and analysing its Here's a breakdown of what reverse engineering entails:

1. **Understand the Function:** The very first step is to grasp the system's intended purpose. What problem does it solve, or what task does it perform? This involves understanding the desired outcome or functionality delivered by the system.
2. **Deconstruct the System:** Once you have a basic understanding of the function, you can start dismantling (virtually or physically) the system into its constituent parts. This could involve breaking down a physical object like a gadget into its components, analysing the code modules in a software program, or identifying the steps involved in a complex process.
3. **Analyse the Components:** After dissecting the system, meticulously examine each individual component to understand its specific purpose and how it interacts with other parts. This might involve studying the functionality of each part in a machine, analysing the logic behind different sections of code in software, or understanding the decision points within a process.

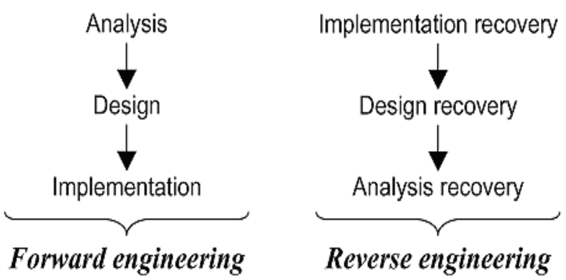


Fig1.1:Differences of Forward & Reverse Engineering

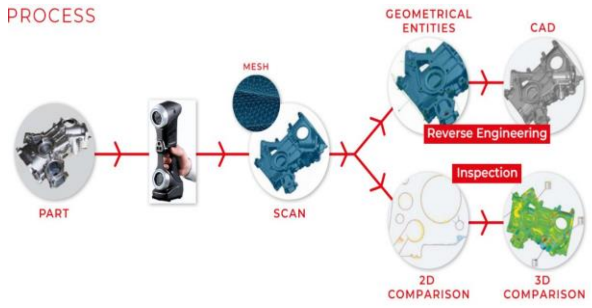


Fig1.2:Processes of Reverse Engineering

II. TECHNIQUES OF REVERSE ENGINEERING

The toolbox of a reverse engineer is filled with various techniques depending on the target being investigated. Here's a glimpse into some of the common methods used for reverse engineering.

Physical Objects:

- **Disassembly and Analysis:** This is the most straightforward technique. The object is meticulously taken apart, and each component is examined to understand its function, material properties, and how it interacts with other parts.
- **3D Scanning and Reconstruction:** Advanced technologies like 3D scanners and computer-aided design (CAD) software can be used to create a digital model of the physical object. This digital replica can then be analysed and manipulated to understand the design intent and functionality.

Software Programs:

- **De-compilation:** This involves converting compiled code (machine code) back into a more human-readable form (assembly language or even a higher-level programming language). While imperfect, de-compilation can provide insights into the program's logic and functionality.
- **Static Analysis:** Specialized tools can analyse the code without actually running the program. This can reveal information about the program's structure, variables, functions, and potential vulnerabilities.
- **Dynamic Analysis:** Involves running the program and monitoring its behaviour. This can be helpful in understanding how the code interacts with the system resources, data flow, and execution patterns.

General Techniques:

- **Documentation Review:** If available, any user manuals, design documents, or API references can be immensely valuable in understanding the system's intended function and components.

- **Experimentation:** This can involve testing the system's inputs and observing the outputs to infer its behaviour and functionality. It's particularly useful when combined with other techniques.
- **Knowledge and Experience:** Leveraging existing knowledge about similar systems or technologies can significantly aid in understanding the target system through educated guesses and informed analysis.

Remember:

- The specific techniques used will vary depending on the complexity of the system and the resources available.
- Ethical considerations are crucial. Always comply with intellectual property laws and use these techniques for legitimate purposes.

Techniques for Acquiring Data:

- **Physical Measurement:** This involves manually measuring an existing object with Cali-per, rulers, or specialized measuring tools. While effective for simple objects, it can be time-consuming and inaccurate for complex geometries.
- **3D Scanning:** This technique utilizes a 3D scanner to capture the precise geometry of an object. The scanner projects light (laser, structured light) on the object's surface and creates a digital 3D model based on the captured data. 3D scanners offer high accuracy and can handle intricate shapes.
- **Photogrammetry:** This method involves taking multiple photographs of an object from different angles. Specialized software then analyses these photos and creates a 3D model by reconstructing the object's geometry from the 2D images. Photogrammetry is a cost-effective option but might have lower accuracy compared to 3D scanning.

Process of Applying Reverse Engineering to 3D Printing:

1. **Object Selection:** Choose the physical object you want to replicate or modify for 3D printing.
2. **Data Acquisition:** Use one of the techniques mentioned above (physical measurement, 3D scanning, or photogrammetry) to capture the object's 3D data.
3. **Data Processing:** The acquired data might need processing and cleaning in specialized software to remove noise, fill in missing information (for photogrammetry), and prepare it for 3D printing. This may involve mesh editing, smoothing, and potential redesign for printability.
4. **3D Modelling:** The processed data is then converted into a 3D model usable for 3D printing software. This model often requires adjustments for printability, such as adding support structures for overhangs and ensuring wall thicknesses meet the 3D printer's capabilities.
5. **3D Printing:** The final 3D model is then sliced into thin layers and prepared for printing on the 3D printer. The choice of 3D printing material and printing parameters will depend on the desired outcome (strength, detail, etc.).
6. **Post-Processing:** Depending on the printing process and material, the printed part might require post-processing steps like support structure removal, sanding, smoothing, or painting.

III. ADVANTAGES, DISADVANTAGES & APPLICATIONS OF REVERSE ENGINEERING

Reverse engineering offers a multitude of advantages across various fields. Here are some of the key benefits:

- **Problem-solving and Improvement:** By understanding the inner workings of a system, engineers can troubleshoot problems, identify areas for improvement, and develop innovative solutions. This is particularly valuable for legacy systems where original documentation might be unavailable.
- **Innovation:** Studying existing designs serves as a springboard for creating new and improved products. Reverse engineering can fuel creative thinking and inspire the development of better solutions based on existing concepts.
- **Learning and Education:** It's a fantastic way to gain knowledge about different technologies, design principles, and manufacturing processes. By dissecting a system, you can acquire a deeper understanding of how similar systems work.
- **Security Analysis:** By reverse engineering a system, security experts can identify potential weaknesses that could be exploited by attackers. This knowledge can be used to patch vulnerabilities and improve the overall security of the system.
- **Interoperability:** In a world filled with diverse technologies, reverse engineering can help ensure that different systems can work together seamlessly. By understanding the communication protocols and data formats used by a system, engineers can develop compatible components or create bridges between otherwise incompatible systems.
- **Cost Savings:** Reverse engineering can be a cost-effective approach to product development. By understanding how an existing product works, companies can avoid reinventing the wheel and focus their resources on innovation and improvement.
- **Digital Archiving:** For older or outdated systems, reverse engineering can be used to create digital documentation of their design and functionality. This digital archive can be invaluable for future reference, maintenance, or historical preservation.

DISADVANTAGES OF REVERSE ENGINEERING

While reverse engineering offers a range of benefits, it's not without its drawbacks

Legal Issues: A major concern is intellectual property (IP) infringement. Reverse engineering can be a legal grey area, especially if it leads to copying a protected design or functionality without permission. It's crucial to understand and comply with patent, copyright, and trade secret laws to avoid legal repercussions.

- **Ethical Concerns:** Some argue that reverse engineering is unethical because it involves taking apart someone else's work without their permission. There's a debate about the balance between the right to learn and understand existing systems and the protection of innovation and investment.
- **Limited Scope:** Reverse engineering typically focuses on understanding the existing functionality of a system. It might not provide insights into the design rationale, manufacturing processes, or future development plans. This can limit the applicability of the knowledge gained through reverse engineering.
- **Time-Consuming Process:** Disassembling, analysing, and understanding a complex system can be a very time-consuming process. This can be a significant drawback for projects with tight deadlines or limited resources.

- **Incomplete Information:** The information obtained through reverse engineering might be incomplete, especially for complex systems with intricate details or proprietary components. This can lead to misunderstandings or inaccurate reproductions of the original system.
- **Quality Concerns:** Even with a complete understanding of a system's design, replicating it perfectly can be challenging. Factors like material selection, manufacturing tolerances, and undocumented processes can lead to a replica with inferior quality or performance compared to the original.
- **Security Risks:** In the context of software reverse engineering, exposing the inner workings of a system can potentially reveal security vulnerabilities. Malicious actors could exploit this knowledge to launch attacks or bypass security measures.

APPLICATIONS

Reverse engineering techniques have a surprisingly broad range of applications across many different fields. Here are some key areas where you'll find reverse engineering being used:

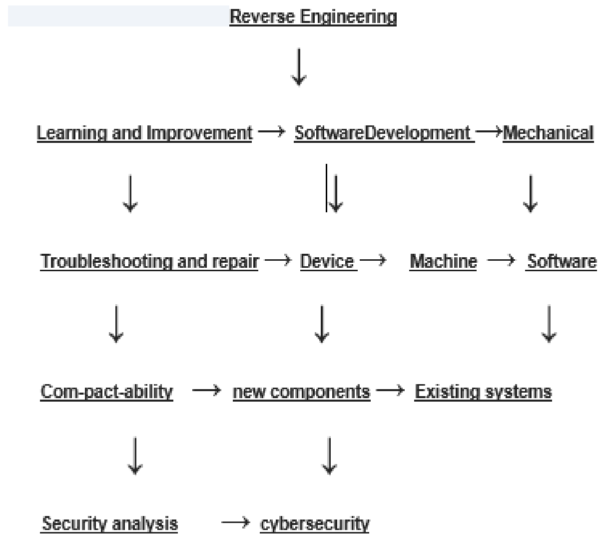
Manufacturing:

- **Product Improvement:** Manufacturers often use reverse engineering to analyse competitor's products. This unveils details about design choices, material selection, and overall functionality. By understanding these aspects, they can develop improved versions of their own products with enhanced features or better performance.
- **Repair and Maintenance:** For complex machinery and equipment, reverse engineering helps decipher their inner workings. This knowledge empowers technicians to diagnose problems, identify compatible replacement parts, and perform repairs more efficiently, especially for legacy equipment lacking original documentation.
- **Quality Control:** Reverse engineering can be used to analyse a manufactured product and compare it to the original design specifications. This helps identify any deviations or inconsistencies in the manufacturing process, ensuring quality control and adherence to design standards.
- **Understanding Existing Code:** When dealing with legacy codebases or integrating with third-party software, reverse engineering can be a valuable tool. It helps developers grasp the functionality and data flow within the existing code, enabling smoother integration and reducing development time.
- **Security Analysis:** Security experts heavily rely on reverse engineering to identify potential vulnerabilities in software that could be exploited by attackers. This knowledge is crucial for developers to patch these vulnerabilities and improve the overall security of the software they create.
- **Interoperability:** In a world where countless software programs need to work together, reverse engineering helps bridge the gap. By understanding the communication protocols and data formats used by different software, developers can create interfaces or bridges that enable seamless interaction between them.

Other Applications:

- **Video Game Design:** Video game designers sometimes leverage reverse engineering to understand the mechanics and level design of popular games. This knowledge can inspire new ideas and gameplay elements for their own games.
- **Medical Devices:** By reverse engineering existing medical devices, researchers can gain valuable insights into their functionality and design principles. This knowledge can pave the way for the development of new and improved medical devices that enhance patient care.
- **Archaeology and Forensics:** Reverse engineering can be applied to analyse artifacts and understand their construction techniques or functionality. This can provide valuable insights into historical practices and aid in forensic investigations to analyse objects or materials left behind at a crime scene.

3.1:Flow Diagram of Reverse Engineering



IV: CONCLUSIONS:

In conclusion, the integration of reverse engineering techniques with 3D printing technology represents a significant advancement in the field of manufacturing and design. This combination has revolutionized the way we approach product development, customization, and innovation. Here are the key takeaways:

- **Innovation and Design Freedom**: Reverse engineering and 3D printing together provide unparalleled freedom in design and innovation, allowing for the recreation and improvement of existing products with ease and precision[1].
- **Cost-Effectiveness**: The process is cost-effective, reducing the need for expensive tooling and materials, and enabling rapid prototyping and production at a fraction of the traditional costs[1].
- **Customization and Personalization**: It offers the ability to customize and personalize products to meet specific needs, which is particularly beneficial in medical, automotive, and aerospace industries[1].
- **Preservation of Legacy Parts**: This approach is invaluable for preserving legacy parts and machinery, ensuring that even out-of-production components can be replicated and kept in service[1].
- **Enhanced Learning and Understanding**: Reverse engineering serves as an educational tool, enhancing the understanding of complex products and systems by dissecting and studying them in detail[1].
- **Sustainability**: By optimizing the use of materials and reducing waste, reverse engineering and 3D printing contribute to more sustainable manufacturing practices[1].
- **Speed and Agility**: The speed at which prototypes can be produced and tested allows for greater agility in product development and a faster time-to-market for new innovations.

- **Quality Improvement**: The detailed analysis possible with reverse engineering leads to quality improvements, as flaws can be identified and corrected before production[1].
- **Competitive Advantage**: Companies that adopt these technologies can gain a competitive edge by quickly adapting to market changes and customer needs[1].
- **Digital Archiving**: The creation of digital archives of physical objects ensures that designs are preserved for future reference and use.

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Reverse Engineering Technique and its application using 3D Printing

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Professor & Diploma Dean, Department of Mechanical Engineering[1], KHIT, Department of Mechanical Engineering[2-5], KHIT, Guntur Andhra Pradesh, India.

Abstract:This study Investigates the "What is Reverse Engineering Technique and How its applications are useful for 3D printing"Reverse engineering is a technique that involves deconstructing a product or system to understand its components and functionality. When paired with 3D printing, it serves as a powerful method for replicating and improving existing designs. This synergy allows for the creation of digital models from physical objects, which can then be modified, optimized, and reproduced with precision and efficiency

I.INTRODUCTION

The fundamental principle of reverse engineering is to learn how a system works by examining it from the outside in, without the benefit of its original blueprints. It's like figuring out how a complex machine ticks by disassembling it and analysing its Here's a breakdown of what reverse engineering entails:

1. **Understand the Function:** The very first step is to grasp the system's intended purpose. What problem does it solve, or what task does it perform? This involves understanding the desired outcome or functionality delivered by the system.
2. **Deconstruct the System:** Once you have a basic understanding of the function, you can start dismantling (virtually or physically) the system into its constituent parts. This could involve breaking down a physical object like a gadget into its components, analysing the code modules in a software program, or identifying the steps involved in a complex process.
3. **Analyse the Components:** After dissecting the system, meticulously examine each individual component to understand its specific purpose and how it interacts with other parts. This might involve studying the functionality of each part in a machine, analysing the logic behind different sections of code in software, or understanding the decision points within a process.

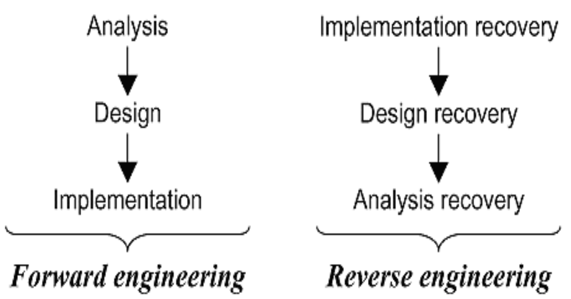


Fig1.1:Differences of Forward & Reverse Engineering

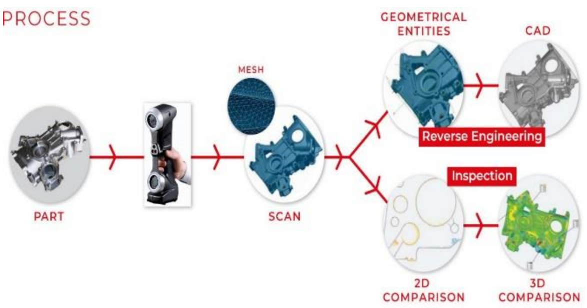


Fig1.2: Processes of Reverse Engineering

II. TECHNIQUES OF REVERSE ENGINEERING

The toolbox of a reverse engineer is filled with various techniques depending on the target being investigated. Here's a glimpse into some of the common methods used for reverse engineering.

Physical Objects:

- **Disassembly and Analysis:** This is the most straightforward technique. The object is meticulously taken apart, and each component is examined to understand its function, material properties, and how it interacts with other parts.
- **3D Scanning and Reconstruction:** Advanced technologies like 3D scanners and computer-aided design (CAD) software can be used to create a digital model of the physical object. This digital replica can then be analysed and manipulated to understand the design intent and functionality.

Software Programs:

- **De-compilation:** This involves converting compiled code (machine code) back into a more human-readable form (assembly language or even a higher-level programming language). While imperfect, de-compilation can provide insights into the program's logic and functionality.
- **Static Analysis:** Specialized tools can analyse the code without actually running the program. This can reveal information about the program's structure, variables, functions, and potential vulnerabilities.
- **Dynamic Analysis:** Involves running the program and monitoring its behaviour. This can be helpful in understanding how the code interacts with the system resources, data flow, and execution patterns.

General Techniques:

- **Documentation Review:** If available, any user manuals, design documents, or API references can be immensely valuable in understanding the system's intended function and components.
- **Experimentation:** This can involve testing the system's inputs and observing the outputs to infer its behaviour and functionality. It's particularly useful when combined with other techniques.

- **Knowledge and Experience:** Leveraging existing knowledge about similar systems or technologies can significantly aid in understanding the target system through educated guesses and informed analysis.

Remember:

- The specific techniques used will vary depending on the complexity of the system and the resources available.
- Ethical considerations are crucial. Always comply with intellectual property laws and use these techniques for legitimate purposes.

Techniques for Acquiring Data:

- **Physical Measurement:** This involves manually measuring an existing object with Cali-per, rulers, or specialized measuring tools. While effective for simple objects, it can be time-consuming and inaccurate for complex geometries.
- **3D Scanning:** This technique utilizes a 3D scanner to capture the precise geometry of an object. The scanner projects light (laser, structured light) on the object's surface and creates a digital 3D model based on the captured data. 3D scanners offer high accuracy and can handle intricate shapes.
- **Photogrammetry:** This method involves taking multiple photographs of an object from different angles. Specialized software then analyses these photos and creates a 3D model by reconstructing the object's geometry from the 2D images. Photogrammetry is a cost-effective option but might have lower accuracy compared to 3D scanning.

Process of Applying Reverse Engineering to 3D Printing:

1. **Object Selection:** Choose the physical object you want to replicate or modify for 3D printing.
2. **Data Acquisition:** Use one of the techniques mentioned above (physical measurement, 3D scanning, or photogrammetry) to capture the object's 3D data.
3. **Data Processing:** The acquired data might need processing and cleaning in specialized software to remove noise, fill in missing information (for photogrammetry), and prepare it for 3D printing. This may involve mesh editing, smoothing, and potential redesign for printability.
4. **3D Modelling:** The processed data is then converted into a 3D model usable for 3D printing software. This model often requires adjustments for printability, such as adding support structures for overhangs and ensuring wall thicknesses meet the 3D printer's capabilities.
5. **3D Printing:** The final 3D model is then sliced into thin layers and prepared for printing on the 3D printer. The choice of 3D printing material and printing parameters will depend on the desired outcome (strength, detail, etc.).
6. **Post-Processing:** Depending on the printing process and material, the printed part might require post-processing steps like support structure removal, sanding, smoothing, or painting.

III. ADVANTAGES, DISADVANTAGES & APPLICATIONS OF REVERSE ENGINEERING

Reverse engineering offers a multitude of advantages across various fields. Here are some of the key benefits:

- **Problem-solving and Improvement:** By understanding the inner workings of a system, engineers can troubleshoot problems, identify areas for improvement, and develop innovative solutions. This is particularly valuable for legacy systems where original documentation might be unavailable.
- **Innovation:** Studying existing designs serves as a springboard for creating new and improved products. Reverse engineering can fuel creative thinking and inspire the development of better solutions based on existing concepts.
- **Learning and Education:** It's a fantastic way to gain knowledge about different technologies, design principles, and manufacturing processes. By dissecting a system, you can acquire a deeper understanding of how similar systems work.
- **Security Analysis:** By reverse engineering a system, security experts can identify potential weaknesses that could be exploited by attackers. This knowledge can be used to patch vulnerabilities and improve the overall security of the system.
- **Interoperability:** In a world filled with diverse technologies, reverse engineering can help ensure that different systems can work together seamlessly. By understanding the communication protocols and data formats used by a system, engineers can develop compatible components or create bridges between otherwise incompatible systems.
- **Cost Savings:** Reverse engineering can be a cost-effective approach to product development. By understanding how an existing product works, companies can avoid reinventing the wheel and focus their resources on innovation and improvement.
- **Digital Archiving:** For older or outdated systems, reverse engineering can be used to create digital documentation of their design and functionality. This digital archive can be invaluable for future reference, maintenance, or historical preservation.

DISADVANTAGES OF REVERSE ENGINEERING

While reverse engineering offers a range of benefits, it's not without its drawbacks

Legal Issues: A major concern is intellectual property (IP) infringement. Reverse engineering can be a legal grey area, especially if it leads to copying a protected design or functionality without permission. It's crucial to understand and comply with patent, copyright, and trade secret laws to avoid legal repercussions.

- **Ethical Concerns:** Some argue that reverse engineering is unethical because it involves taking apart someone else's work without their permission. There's a debate about the balance between the right to learn and understand existing systems and the protection of innovation and investment.
- **Limited Scope:** Reverse engineering typically focuses on understanding the existing functionality of a system. It might not provide insights into the design rationale, manufacturing processes, or future development plans. This can limit the applicability of the knowledge gained through reverse engineering.

- **Time-Consuming Process:** Disassembling, analysing, and understanding a complex system can be a very time-consuming process. This can be a significant drawback for projects with tight deadlines or limited resources.
- **Incomplete Information:** The information obtained through reverse engineering might be incomplete, especially for complex systems with intricate details or proprietary components. This can lead to misunderstandings or inaccurate reproductions of the original system.
- **Quality Concerns:** Even with a complete understanding of a system's design, replicating it perfectly can be challenging. Factors like material selection, manufacturing tolerances, and undocumented processes can lead to a replica with inferior quality or performance compared to the original.
- **Security Risks:** In the context of software reverse engineering, exposing the inner workings of a system can potentially reveal security vulnerabilities. Malicious actors could exploit this knowledge to launch attacks or bypass security measures.

APPLICATIONS

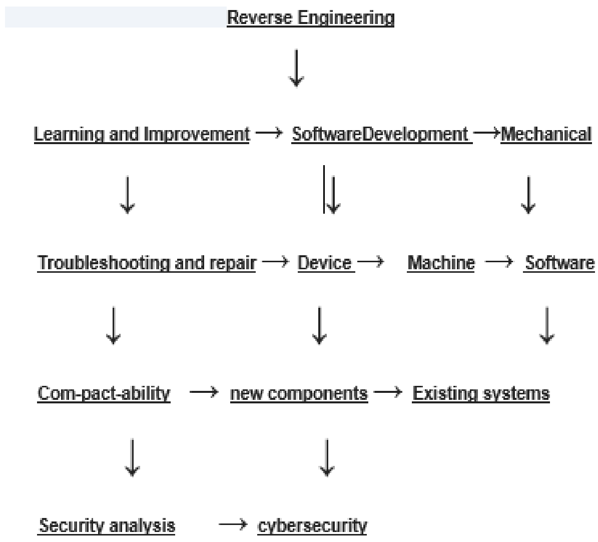
Reverse engineering techniques have a surprisingly broad range of applications across many different fields. Here are some key areas where you'll find reverse engineering being used

Manufacturing:

- **Product Improvement:** Manufacturers often use reverse engineering to analyse competitor's products. This unveils details about design choices, material selection, and overall functionality. By understanding these aspects, they can develop improved versions of their own products with enhanced features or better performance.
- **Repair and Maintenance:** For complex machinery and equipment, reverse engineering helps decipher their inner workings. This knowledge empowers technicians to diagnose problems, identify compatible replacement parts, and perform repairs more efficiently, especially for legacy equipment lacking original documentation.
- **Quality Control:** Reverse engineering can be used to analyse a manufactured product and compare it to the original design specifications. This helps identify any deviations or inconsistencies in the manufacturing process, ensuring quality control and adherence to design standards.
- **Understanding Existing Code:** When dealing with legacy codebases or integrating with third-party software, reverse engineering can be a valuable tool. It helps developers grasp the functionality and data flow within the existing code, enabling smoother integration and reducing development time.
- **Security Analysis:** Security experts heavily rely on reverse engineering to identify potential vulnerabilities in software that could be exploited by attackers. This knowledge is crucial for developers to patch these vulnerabilities and improve the overall security of the software they create.
- **Interoperability:** In a world where countless software programs need to work together, reverse engineering helps bridge the gap. By understanding the communication protocols and data formats used by different software, developers can create interfaces or bridges that enable seamless interaction between them.

Other Applications:

- **Video Game Design:** Video game designers sometimes leverage reverse engineering to understand the mechanics and level design of popular games. This knowledge can inspire new ideas and gameplay elements for their own games.
- **Medical Devices:** By reverse engineering existing medical devices, researchers can gain valuable insights into their functionality and design principles. This knowledge can pave the way for the development of new and improved medical devices that enhance patient care.
- **Archaeology and Forensics:** Reverse engineering can be applied to analyse artifacts and understand their construction techniques or functionality. This can provide valuable insights into historical practices and aid in forensic investigations to analyse objects or materials left behind at a crime scene.



3.1: Flow Diagram of Reverse Engineering

IV: CONCLUSIONS:

In conclusion, the integration of reverse engineering techniques with 3D printing technology represents a significant advancement in the field of manufacturing and design. This combination has revolutionized the way we approach product development, customization, and innovation. Here are the key takeaways:

- **Innovation and Design Freedom**: Reverse engineering and 3D printing together provide unparalleled freedom in design and innovation, allowing for the recreation and improvement of existing products with ease and precision[1].
- **Cost-Effectiveness**: The process is cost-effective, reducing the need for expensive tooling and materials, and enabling rapid prototyping and production at a fraction of the traditional costs[1].
- **Customization and Personalization**: It offers the ability to customize and personalize products to meet specific needs, which is particularly beneficial in medical, automotive, and aerospace industries[1].

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- **Preservation of Legacy Parts**: This approach is invaluable for preserving legacy parts and machinery, ensuring that even out-of-production components can be replicated and kept in service[1].
- **Enhanced Learning and Understanding**: Reverse engineering serves as an educational tool, enhancing the understanding of complex products and systems by dissecting and studying them in detail[1].
- **Sustainability**: By optimizing the use of materials and reducing waste, reverse engineering and 3D printing contribute to more sustainable manufacturing practices[1].
- **Speed and Agility**: The speed at which prototypes can be produced and tested allows for greater agility in product development and a faster time-to-market for new innovations.
- **Quality Improvement**: The detailed analysis possible with reverse engineering leads to quality improvements, as flaws can be identified and corrected before production[1].
- **Competitive Advantage**: Companies that adopt these technologies can gain a competitive edge by quickly adapting to market changes and customer needs[1].
- **Digital Archiving**: The creation of digital archives of physical objects ensures that designs are preserved for future reference and use.

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DESIGN OF PRESS TOOL USING CAM AND FOLLOWER MECHANISM

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***Abstract* - Press Tool is a manufacturing tool used to manufacture sheet metal components. Generally, Press Tool is used in hydraulic, pneumatic, and mechanical presses to produce the sheet metal components in large volumes.**

In this press tool is designed for POWER SCREW SUPPORT BRACKET (component) of CAR SCISSOR JACK and DIE plate of the press tool is analyzed using CAD software's.

The primary goal of this project is to provide a mechanized press tool using the CAM mechanism. In this a CAM mechanism is installed on top of the press tool, where cam profile decides when the blanking or punching operations is done and in the dwell time sheet metal is penetrated in the press tool. This will be a cost – effective solution which requires only one mechanism.

Keywords – Press Tool, CAM & FOLLOWER, CAD.

A.INTRODUCTION:

One of the most interesting aspects of press tool is using CAM & FOLLOWER mechanism and its installation. Because press tools are already present in industries used for various sheet metal operations. This means these can be used in a wide range of applications.

Furthermore, press tools use hydraulic and mechanical mechanisms and for this require fluid medium for hydraulic and human intervention. But using this CAM & FOLLOWER mechanism these requirements are reduced. Only a cam of definite one is required, and this can be driven by drive mechanism.

As of today, industries use traditional technology Press Tool which are very high cost, weight of the machine is high, takes time to load material and requires a skilled operator in which safety is less. High vibrations and more noise, so to reduce these parameters a new innovative idea using CAM mechanism is created. It can also be done using various mechanisms.

This Press Tool is designed using CAM and Traditional Press Tool. This doesn't require any hydraulic fluid or mechanical drives to produce force and shear to fracture the raw material. Only a suitable CAM and FOLLOWER mechanism is used. And another parameter is the material of the CAM and how to produce force from that CAM is important.

It can also be easily automated. The CAM system is on the top of the assembly of the press tool so that due to profile of cam the top assembly moves in which the punch is assembled, the forward stroke penetrating through raw material and due to spring force, the top assembly return back to TDC.

B.PROBLEM IDENTIFICATION:

The press tool is manufactured with large quantity of metals to withstand the forces or load acting on the press and due to this noise is more. To drive a press tool either hydraulic cylinders or mechanical forces are required. So to optimize these parameters a new concept of installing CAM & FOLLOWER Mechanism in combination of Traditional Press tool is designed which can reduce cost and no medium is required and also easy to operate.

C METHODOLOGY:

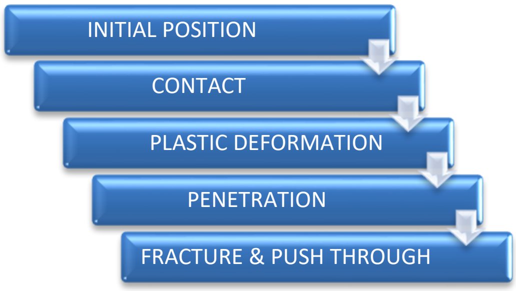

Figure.3: Flow chart of Punching/shearing theory

D WORKING:

The press tool (commonly known as die/ dies) is an assembly of die, punch, punch plate, punch backplate, stripper plate, etc. to produce sheet metal components/ stamped parts from the flat metal sheet. Metal forming is one of the manufacturing processes which are almost chipless. These operations are mainly carried out with the help of presses and press tools. These operations include deformation of metal work pieces to the desired size and size by applying pressure or force. Presses and press tools facilitate mass production work. These are considered the fastest and most efficient way to form sheet metal into finished products. In this Press Tool there are two assemblies:

a. TOP ASSEMBLY
b. BOTTOM ASSEMBLY.

In this TOP ASSEMBLY contains components like

1. CAM & FOLLOWER Mechanism.
2. PRESS RAM
3. TDC-TOP DEAD CENTRE
4. PUNCH
5. TOP PLATE.

Figure:4(A) PRESS TO

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In Bottom Assembly contains components like:

1. BDC
2. BOLSTER PLATE
3. DIE

E COMPONENTS OF PRESS TOOL:

Ram (Slide): Moving Component of the press which transfers the mechanical or hydraulic force from the Flywheel /hydraulic system to the Press tool for sheet metal stamping.

Shank: The shank is used as a part for installing the top die in the slide of the press machine.

Punch Holder (Upper Shoe): This is the upper part of the die set which contains guidepost pushing. The whole upper section (generally contains Punch, punch plate) of the die set is mounted on the upper shoe.

Die Holder (Lower Shoe): This is the lower part of the die set which contains guidepost. The whole lower section (Generally contain die, stripper) of the die set is mounted on the upper shoe.

Back up Plate: Backup plate is placed so that the intensity of pressure does not become excessive on the punch holder. It is also called Punch backplate and Pressure Plate.

Punch Plate: The function of the punch plate is to hold punch in its proper relative position. The punch plate fits closely over the body of the punch. It is also called Punch Retainer.

Punch: This is the main component of die assembly, which is directly or indirectly moved by press ram or slide. Punch and die act together to make a stamped part.

Bed: The bed is the lower part of the press frame that serves as a table to which a bolster plate is mounted.

Bolster Plate: This is a thick plate secured to the bed which is used for supporting & locating the die set.

Die: Die is a female part of the die block/press tool for producing the given job work in a press. Die and punch work together to make the desired shape product.

Stripper: A stripper is used to strip the metal strip from a punch or die.

Guidepost & Guidepost bushing: This two-component of the press tool guide the die set to maintain the alignment during the operation. Properly lubricated, and positioned, they improve tool operation and contribute to producing quality products. This is also called a pillar die set.

Shut Height: The distance between the top of the bed and bottom of the slide, with its stroke down and adjustment up.

Stroke: The distance of Ram movement from its up position to its down position. It is generally constant for mechanical presses but variable for hydraulic presses.

The Press Tool uses a ram which reciprocates from TDC to BDC, then. For the rotation of CAM, the follower which is attached to the Top Assembly of the Press Tool moves downward. A punch is attached to the top assembly and simultaneously raw material strip is forced into the press there by Punching or Shearing operation on the raw material strip.

DIFFERENT TYPES OF CAM PROFILES

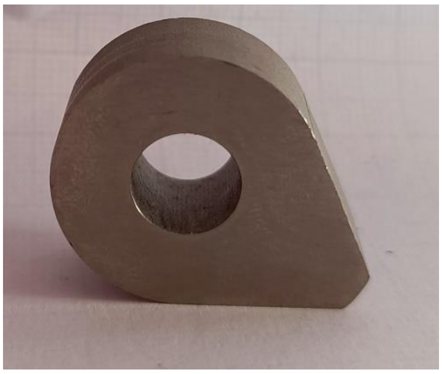

Figure: 4(B) CAM Profile

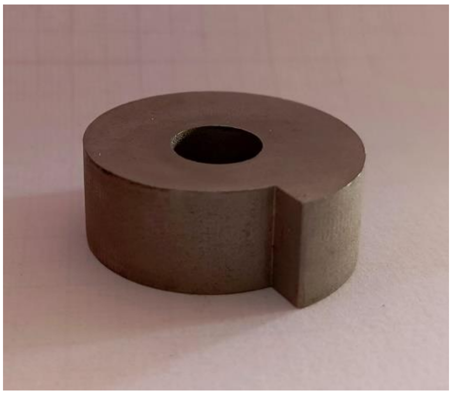

Figure: 4(C) CAM PROFILE

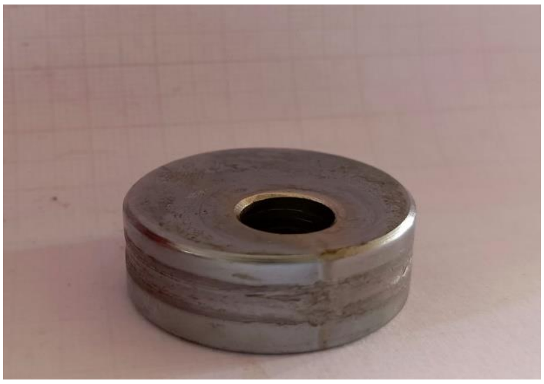

Figure: 4(D) CAM PROFILE

The cam is a rotating part that provides reciprocating or oscillating motion to the follower by direct contact. This part is essentially used to change the movement from the rotary to linear. As cam rotates due to profile of the cam the follower oscillates and creates movement. Different types of cam profiles are shown in FIG: 4(B), 4(C), 4(D). And a follower is represented in FIG: 4(E). Generally, this cam mechanism is used in opening and closing of inlet and exhaust valves of a automobile engine.

FOLLOWER:

Figure: 4(E) FOLLOWER

Press Tool is developed in CATIA V5 Software using Part Design and Assembly Modules. This Press Tool is designed for a spare component of Automobile named power screw support bracket of a car scissor jack. In this press tool the main components are:

- TOP ASSEMBLY
- BOTTOM ASSEMBLY
- CAM & FOLLOWER Mechanism.

F. MATERIAL:

- Low Carbon High Strength Cold Rolled Steel as per IS 14491.
- Material thickness = 3.15 mm.
- Shear Stress = 260 N/mm2
- Tensile Stress = 350 N/mm2.

CALCULATION:

Force for calculating Shear Force acting on the material.

F = (P * T * SS)/1000
(or)
F = (0.8 * P * T * TS)/1000

F = Shear Force tones

P = Perimeter of Shear mm

T = thickness of sheet mm

Ss = Shear Strength of Material kg/mm2

TS = Tensile Strength of Material kg/mm2.

- Perimeter of the component = 160.16 mm
- Tensile Strength of the material = 35.7 kg/mm2
- Thickness of Sheet = 3.15mm.

By substituting in above formula, the required shear force
Press Tonnage or Press Capacity:
Is the maximum pressure or force that the press machine can produce safely.
PT = Press Tonnage
F = Shear Force
PT=21.62 Tonnes.

So, according to the standards of market a press tool greater than 21 tonnes press capacity is used.

F. CLASSIFICATION OF PRESS TOOLS:

- Blanking tool
- Piercing tool
- Cut off tool.
- Parting off tool
- Forming tool
- Drawing tool
- Progressive tool

CONSTRUCTON OF PRESS TOOL:

The press tool construction will have the following elements:
Shank: It is used as a part for installing the Press tool die in the slide of the press machine with proper alignment.
Top Plate: It is used to hold top half of the press tool with press slide. It is also called Bolster Plate.
Punch Back Plate: This plate prevents the hardened punches penetrating top plate. It is also called Pressure Plate or Backup plate.
Punch Holder: This plate is used to accommodate the punches of press tool.
Punches: To perform cutting and non-cutting operations either plain or profiled punches are used.
Die Plate: Die plate will have similar profile of the component where cutting dies usually have holes with land and angular clearance and non-cutting dies will have profiles.
Die Back Plate: This plate prevents the hardened Die inserts penetrating bottom plate.
Guide Pillar & Guide Bush: Used for alignment between top and bottom halves of the press tools.
Bottom plate: It is used to hold bottom half of the press tool with press slide.
Stripper plate: it is used to strip off the component from punches.
Strip guides: It is used to guide the strip into the press tool to perform the operation.

G.DESIGN OF PRESS TOOL:

CATIA is an acronym of computer-aided three-dimensional interactive application is a multi-platform software suite for computer-aided design (CAD), computer-aided manufacturing (CAM), computer-aided engineering (CAE), 3D modeling and product lifecycle management (PLM), developed by the French company Dassault Systems.

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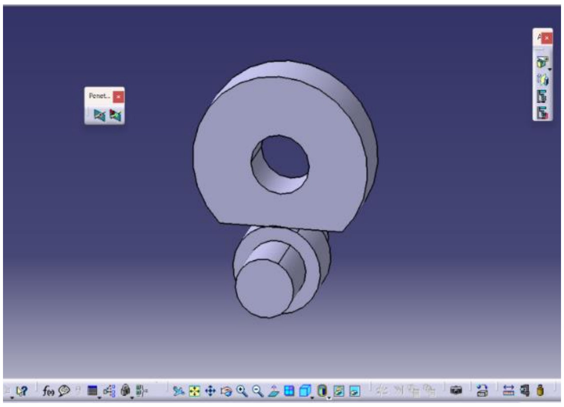

Figure: 7(A) CAM & FOLLOWER

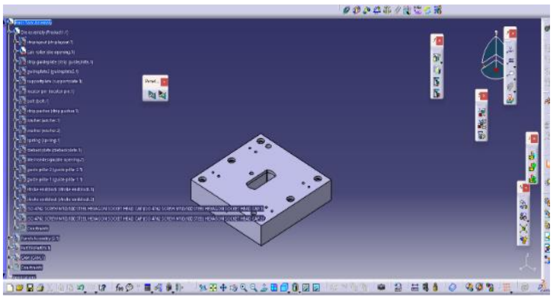

Figure: 7(B) DIE PLATE

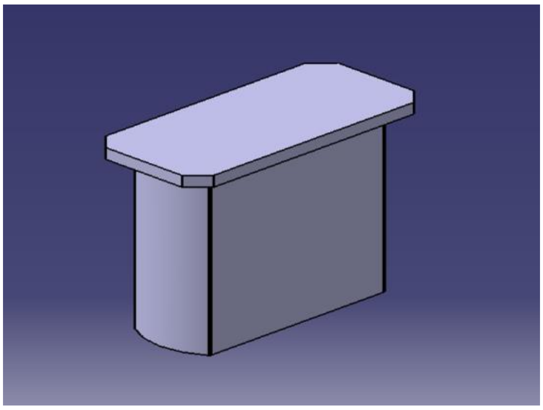

Figure: 7(C) PUNCH

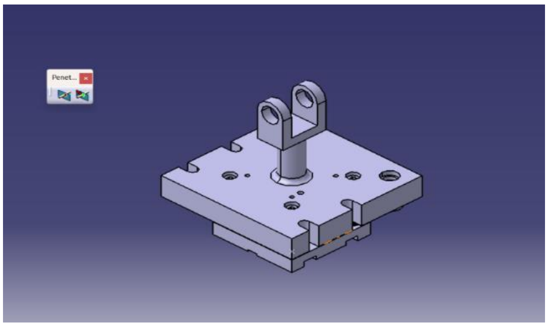

Figure: 7(D) TOP ASSEMBLY WITH FOLLOWER

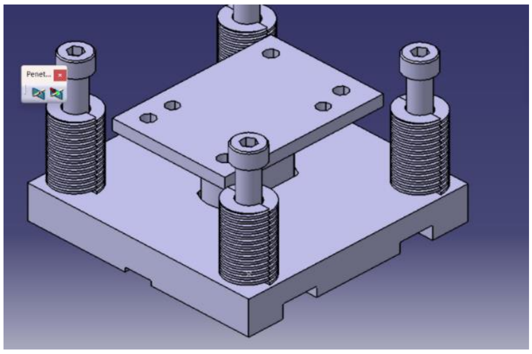

Figure: 7(E) PUNCH & TOP PLATE

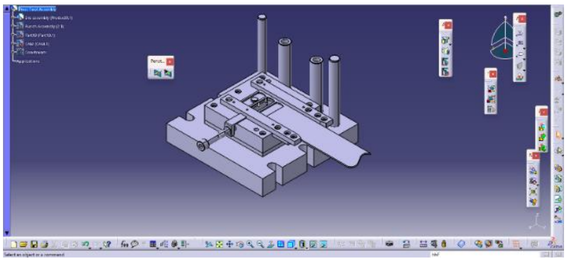

Figure: 7(F) BOTTOM ASSEMBLY

Advantages of Cam and Follower:
The device that changes rotary motion into reciprocating motion is straightforward.
Any desired motion of the follower can be accomplished with proper design.
The system can withstand strong shocks and vibrations.
They are reliable and adaptable.
APPLICATIONS OF PRESS TOOL:

The components produced through the press tool and die process are used in various industries such as
defense
Food processing industry
Packing industry
Textile industry
Automobile industry
Aircraft manufacturing industry.
H.RESULTS AND DISCUSSION:
From the above design of Press Tool:
The Press tool initially made assumed calculations of having press tool capacity of 21 tonnes and then designed using CATIA V5 software and some of the sample cam and follower mechanism are shown in the above Fig and a fully developed concept of press tool is shown below in FIG 8 this is only basic design from assumed calculations. The basic idea is implemented and with the help of punching/shearing theory the press tool is developed. Final press

tool with cam and follower mechanism on the top of the top assembly as shown on fig below is developed.

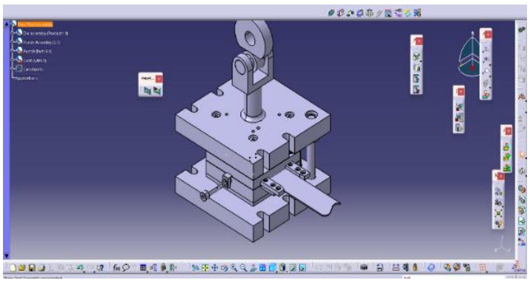

Figure: 8 PRESS TOOL ASSEMBLY.

I. CONCLUSION & FUTURE SCOPE:

- The objective of this Press Tool is a new idea of Modern Press Tool which reduces the cost of press tool and easy to use.
- An automated press not only increases speed and throughput, but it also improves operator safety, part quality, and machine uptime.
- It can be easily automated and can be monitored using computer.
- Operations like punching and blanking which reduces the time of operations.
- Saving time means we can achieve more mass production.

Not much skill required to operate the machine.

Future Scope:

- Develop **press** tool for high strength metals.
- Robotic loading and unloading of raw material sheets.
- Installed feedback drives for good operation.
- Installing HMI-human machine interface.
- Innovating new ideas other than CAM mechanisms.

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DESIGN OF SPLLITER USING RACKAND PINION MECHANISM

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Abstract: The development of existing rack and pinion mechanism with IOT technology and designing a new advanced systems for the real-life problems in the realm of highway safety and emergency response systems. With the integration of RFID modules, Stepper motors, Arduino Uno microcontroller, and a Rack and Pinion mechanism, this project aims to revolutionize the traditional concept of road splitter. The primary objective is to create an intelligent splitter capable of dynamically adapting to changing spatial requirements within a space, ultimately enhancing the safety and efficiency of highways.

Keywords – rack and pinion, arduino uno and stepped motor.

INTRODUCTION

This project aims to address these limitations through the development of a Smart Split Divider system. By integrating advanced technologies such as RFID modules, stepper motors, Arduino Uno microcontroller, and a rack and pinion mechanism, this project endeavors to create an intelligent divider capable of dynamically adapting to changing spatial requirements within a space. Additionally, this project explores the integration of ambulance support systems, RFID sensors, and a Rack and Pinion mechanism to enhance the safety and effectiveness of highway road dividers.

Highway road dividers play a crucial role in ensuring the safety of motorists by separating opposing traffic flows and minimizing the risk of collisions. However, enhancing their design with advanced technologies can further contribute to the overall safety and effectiveness of these dividers. This proposal explores the integration of ambulance support systems, RFID sensors, and a rack and pinion mechanism to extend the life expectancy of people met with the accident.

PROBLEM IDENTIFICATION

With this design the number of accidents, causalities are reduced that are occurred on the highways. On an average of about 1,50,000 people perish due to road accidents in India annually, these includes all the disabilities, deaths, and cause of hospitalizations. In order to reduce the accidents and stressing the statement of “Save Life” we designed a split road divider for highway (foe emergency) , by using rack and pinion mechanism that works when detected to the RFID – (Radio Frequency Identification).

METHODOLOGY

Requirement gathering:

This involves gathering all the necessary information and requirements for the project. The requirements may include the features of the smart split road divider, the type of sensors, the type of microcontroller, and the communication protocol used.

Circuit design:

After gathering the requirements, the next step is to design the circuit. The circuit should be designed in such a way that it meets all the requirements of the project.

Prototype development:

Once the circuit design is completed, the next step is to develop a prototype. The prototype should be developed based on the circuit design.

Testing:

After the prototype is developed, the next step is to test the prototype. The prototype should be tested in different scenarios to make sure it works correctly.

Feedback and modification:

After testing the prototype, feedback should be collected from users. Based on the feedback, modifications should be made to the prototype if necessary.

Final product development:

After making necessary modifications to the prototype, the final product should be developed. The final product should meet all the requirements of the project.

Final testing:

The final product should be tested to ensure that it meets all the requirements of the project.

Deployment and maintenance:

The final step is to deploy the smart split divider and provide maintenance support to the users.

WORKING:

For Designing Rack & Pinion CATIA V5 software is used. For designing Rack & Pinion Part Design

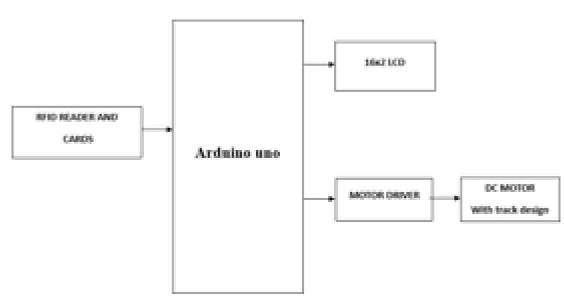

Figure: 1 Assembly and DMU Kinematics modules are used.

 ISBN: 978-93-91420-93-2

Design:

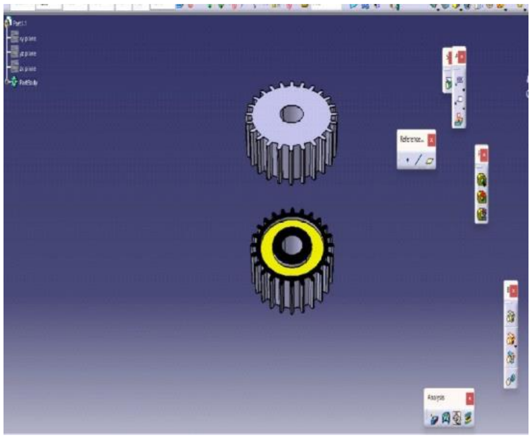

Figure: 2 Design of Gear

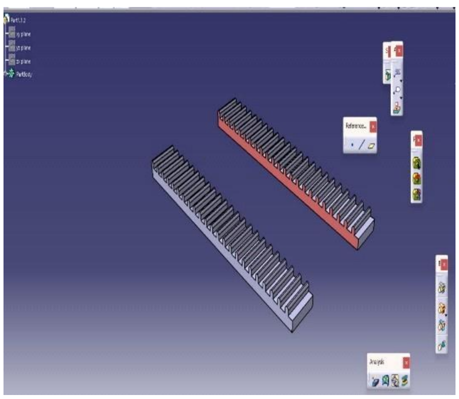

Figure: 3 Design of Rack and pinion

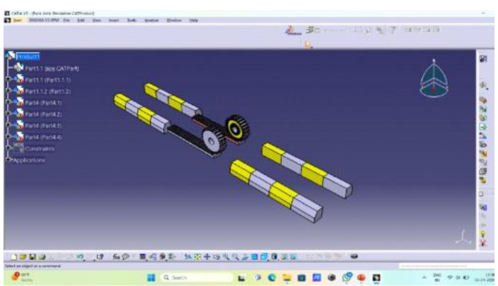

Figure: 4 Design of Rack and pinion wheel

Rack and Pinion Mechanism:
Understanding the working principle of rack and pinion gear is essential to comprehend its functionality and operation. The gear system operates on the principle of converting rotational motion into linear motion or vice versa. When the pinion gear rotates, its teeth engage with the teeth on the rack, causing the rack to move linearly. The rotation of the pinion gear determines the direction and magnitude of the linear motion. Conversely, when an external force is applied to the rack, it causes the pinion gear to rotate.

Figure: 5 rack and pinion

The working principle of rack and pinion gear is based on the precise meshing of the teeth, which ensures smooth and efficient motion transfer. The linear motion of the rack can be controlled and adjusted by varying the rotational motion of the pinion gear.

Advantages of Rock and Pinion:
Simplicity and Efficiency
Precise and Responsive
Compact Size
Compact Size
Versatility

Applications of rock and pinion:

Steering Systems in Vehicles:
Machine Tools
Robotics
Lifts and Elevators
Railway Systems

RESULTS AND DISCUSSION:

The result of this integration is a robust and multifunctional highway road divider system that significantly enhances safety and emergency response capabilities. By incorporating ambulance support systems, the road divider can detect the approach of emergency vehicles and automatically adjust its position to create a clear path for them. This feature minimizes response time delays, allowing emergency vehicles to reach their destinations more quickly and efficiently.

CONCLUSION & FUTURE SCOPE

The integration of ambulance support systems, RFID sensors, and a rack and pinion mechanism into highway road dividers marks a transformative leap forward in transportation infrastructure. This innovative approach not only enhances safety but also significantly improves emergency response efficiency, ultimately contributing to a safer and more responsive transportation network.

The future scope of the proposed design holds promise for further advancements and enhancements in road safety and emergency response on Indian highways. One avenue for future development is the integration of artificial intelligence and machine learning algorithms to enhance the predictive capabilities of the RFID sensors. By analyzing real-time data and traffic patterns, these algorithms can anticipate potential emergencies and dynamically adjust the road divider system to optimize emergency response.

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DESIGN AND ANALYSIS OF MARINE PROPELLER SHAFT BY USING FINITE ELEMENT ANALYSIS

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ABSTRACT: In this project Propellers are used for propulsion of ships and other under water vehicles. It has a complex geometry and also analysis of such complex component under various controlling parameters is difficult with conventional formulae is very difficult and cumbersome. So, the current studies use finite element method to perform analysis of a propeller blade. This project is primarily concerned with the modelling and design study of 3 blade INSEAN E779A model propeller blade in order to determine its strength. SOLIDWORKS software is utilized to generate the blade model, which necessitates high-end modelling. Materials used for the analysis are composite materials instead of conventional Aluminium as many studies show better performance with composite material.

The study gives a comparison of structural analysis of Aluminium, CFRP (Carbon Fibre Reinforced Plastic) and GFRP (Glass Fibre Reinforced Plastic) material and suggests the best Fibre reinforced composite material for the propeller. As per the analysis conducted and results obtained the GFRP propeller has less deformation and less stress-strain is generated at various loads. The Maximum and Minimum von mises stress obtained as 25843 pascals and 0.27684 pascals respectively. The Maximum and Minimum principal strain obtained as 1.4564$\times 10^{-7}$and -2.0208$\times 10^{-8}$respectively. The Maximum and Minimum Deformation obtained as 8.8311$\times 10^{-9}$and 0 meters respectively. So according to the results the GFRP.

Propellers can perform effectively in comparison to Aluminium and CFRP propellers.

Key Words: SolidWorks, Ansys-Workbench, Aluminium, CFRP and GFRP.

A. INTRODUCTION

Ships and under water vehicles like submarines, torpedoes and submersibles etc., uses propeller as propulsion. The blade geometry ant its design is more complex involving many controlling parameters. The strength analysis of such complex 3D blades with conventional formulas will give less accurate values. In such cases numerical analysis (Finite Element Analysis) gives comparable results with experimental values. In the present project the propeller blade material is converted from aluminium, Carbon fibre reinforced plastic and Glass fibre reinforced plastic materials for underwater vehicle propeller. Such complex analysis can be easily solved by finite element method techniques.

The movement of a ship through water is achieved by the power so developed in the engine via the propeller shaft to the propeller in water. The distance or forward motion depends mainly on the propeller pitch which is defined as how far the propeller can travel for one revolution of the shaft. A propeller is a rotating fan-like structure which is used to propel the ship by using the power generated and transmitted by the main engine of the ship which transmits power by converting rotational motion into thrust. A pressure difference is produced between the forward and the rear surfaces of the air foil-shaped blade, and a fluid (such as air or water) is accelerated behind the blade. A propeller is sometimes also known as screw.

Propellers serve as fundamental components in various propulsion systems, whether for marine vessels, aircraft, or other applications. Functioning as rotating aerofoils, propellers convert rotational energy from an engine into thrust, propelling the vehicle forward through the air or water. The principles underlying propeller operation date back centuries, with modern advancements in materials, design, and manufacturing techniques continually refining their performance and reliability.

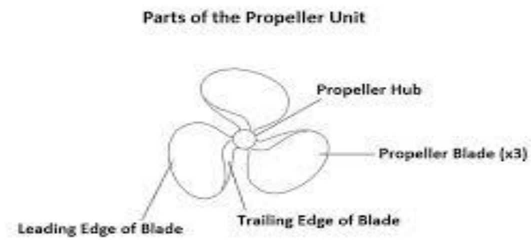

Figure 1: Parts of propeller unit

Overall, propellers represent a cornerstone of transportation technology, enabling the efficient movement of vehicles across various mediums and serving as a testament to the ingenuity of engineering and aerodynamics.

The thrust from the propeller is transmitted to move the ship through a transmission system which consists of a rotational motion generated by the main engine crank shaft, intermediate shaft and its bearings, stern tube shaft and it's bearing and finally by the propeller itself. A ship can be fitted with one, two and rarely three propellers depending upon the speed and requirements of the vessel.

B. MATERIALS

The materials for conducting analysis on marine propeller are given below:

- Aluminium
- Carbon fibre reinforced plastic
- Glass fibre reinforced plastic

Table 6. 1 Material properties

Material	Youngs modulus	Poisson's ratio	Mass density	Damping coefficient
Aluminium	70 Gpa	0.29	2800 kg/m^3	0.006
CFRP	118 Gpa	0.28	1600 kg/m^3	0.018
GFRP	72.4 Gpa	0.34	2540 kg/m^3	0.012

C. **MODELING OF MARINE PROPELLER**

Modelling of the propeller is done using SolidWorks. In order to model the blade, it is necessary to have sections of the propeller at various radii. These sections are drawn and rotated through their respective pitch angles. Then all rotated sections are projected onto right circular cylinders of respective radii as shown. As the above process is very complicated, we model the propeller blade by using single section surface option.

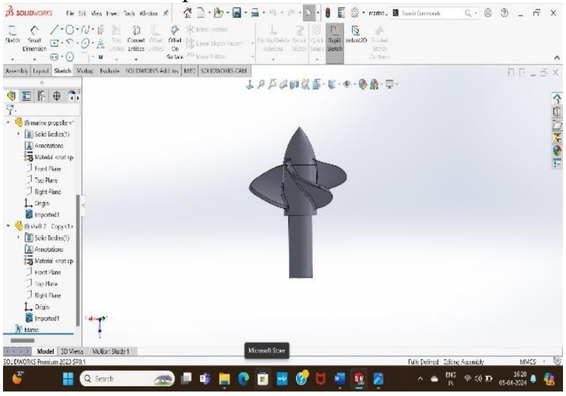

Figure 2: Designed propeller in SolidWorks

D. **ANALYSIS ON MARINE PROPELLER**

The geometry which is modelled in SolidWorks is imported into stress analysis feature Ansys Workbench 2023 R2. Materials are chosen Aluminium, CFRP AND GFRP. In Finite Element Analysis the goal is to simulate some physical phenomena using a numerical technique called the Finite Element Method, we create a mesh which splits the domain into a discrete number of elements for which the solution can be calculated. FEA uses a geometrical mesh made up of nodes and elements to simulate a wide range of physical interactions. The size of the mesh adopted was 2mm and the total number of elements are 3281 and nodes are 6674. Here fixed constraint is applied on inner surface of the hub i.e. the intersection of propeller shaft and hub of propeller. After constraint is fixed loading is added After mesh, constraints and loads are generated the simulation is made to run and results are obtained.

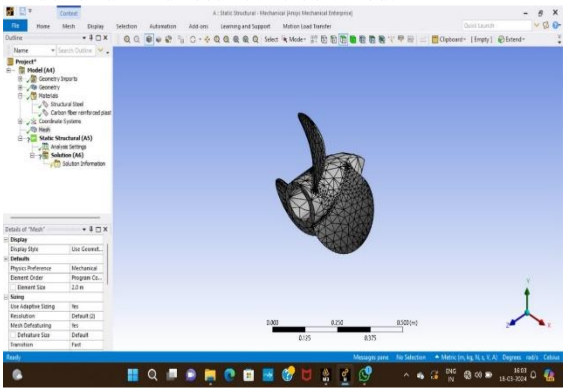

Figure 3: Meshed view of propeller

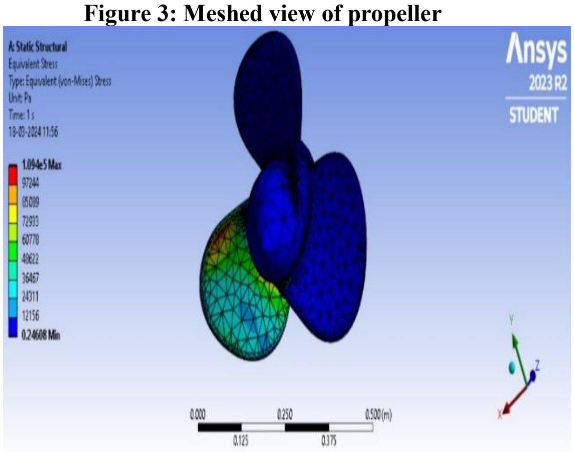

Figure 4: Von mises stress Aluminium

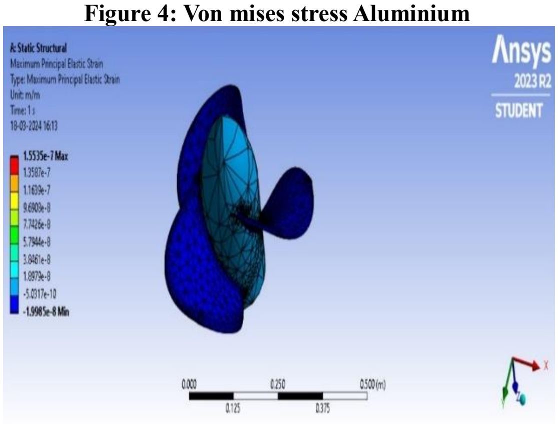

Figure 5: Maximum principal strain CFRP

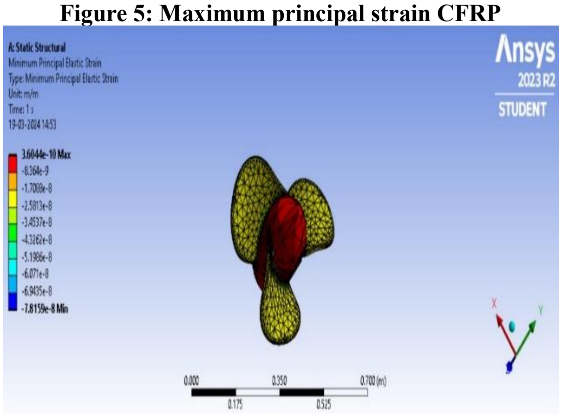

Figure 6: Minimum principal strain GFRP

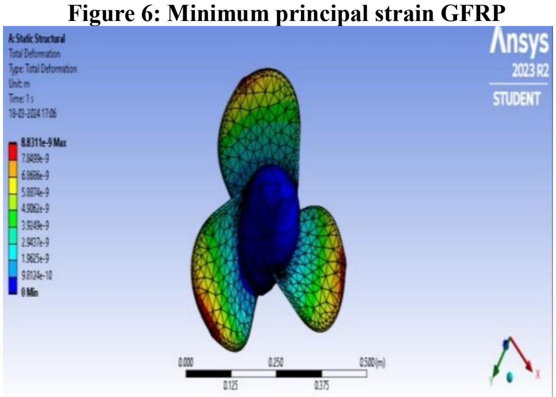

Figure 7: Total Deformation GFRP

E. **RESULTS AND DISCUSSION**

Static Structural analysis of propeller is carried out for propeller in Workbench Ansys and analysis is conducted on propeller considering three materials Aluminium having mass density 2800 kg/m^3, Carbon fibre reinforced plastic

(CFRP) having mass density 1600 kg/m^3 and Glass fibre reinforced plastic (GFRP) having mass density 2540 kg/m^3 .The following parameters like von mises stress, principal strains and total deformation are obtained for aluminium, CFRP and GFRP are discussed below.

Table 2: Analysis results on Marine propeller

Name		Von Mises Stress (pascals)	Maximum Principal Strain	Minimum Principal Strain	Total Deformation (meters)
Aluminium	Max	1.094e5	5.4271e-7	3.7237e-10	9.1379e-7
	Min	0.24608	-1.9981e-8	-5.786e-7	0
CFRP	Max	27321	1.5535e-7	3.8878e-10	9.0027e-9
	Min	0.30691	-1.9985e-8	-7.8088e-8	0
GFRP	Max	25843	1.4564e-7	3.6044e-10	-7.8159e-8
	Min	0.27684	-2.0208e-8	8.8311e-9	0

F. CONCLUSION

As per the analysis conducted and results obtained so far, the values of stress, strain and deformation helps us to choose the correct propeller useful for the design application. The propeller we have chosen was 3-blade marine propeller and analysis was done in Ansys Workbench. The optimal diameter of the propeller was calculated using Bp delta charts from which the required design parameters were obtained by taking into consideration of optimum line for the chosen design variables. The materials that are considered are Aluminium, CFRP and GFRP. The results of stress analysis shows that the stresses generated in GFRP are lower than the stresses generated in aluminium and CFRP, which reduces the chances of failure in GFRP propeller. The results of Maximum and Minimum principal strains generated in GFRP propellers are lower than that of strains generated in Aluminium and CFRP propellers. The deformation observed in GFRP propeller is lower than the aluminium and CFRP propellers which makes the GFRP propeller comparatively stiffer.The Maximum and Minimum von mises stress obtained as 25843 pascals and 0.27684 pascals respectively. The Maximum and Minimum principal strain obtained as $1.4564\times 10^{-7}$and -2.0208×10^{-8}respectively. The Maximum and Minimum Deformation obtained as $8.8311\times 10^{-9}$and 0 meters respectively. So, from the analysis it can be seen that GFRP propeller has less deformation and less stress-strain is generated at various loads. So according to the results the GFRP propellers can perform effectively in comparison to Aluminium and CFRP propellers.

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DESIGN AND FABRICATION OF FOLDABLE MOBILITYSCOOTER

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Abstract-The foldable mobility scooter major projectis undertaken to address pressing challenges in urbanmobility. With escalating congestion, the "last-mile" problem, and a growing emphasis on sustainable transportation, there's a critical need for innovative solutions. The project seeks to provide a compact, foldable scooter as a practical, eco- friendly alternative, enhancing personal mobility and contributing to a more sustainable urban environment. This major project focuses on designing, fabricating, and validating a foldable mobility scooter. The scooter aims to seamlessly integrate into urban lifestyles, offering users a convenient, portable mode of transportation for short-distance commutes. The project encompasses detailed research, innovative design considerations, material selection, manufacturing techniques, and rigorous testing to ensure the scooter's functionality, safety, and market viability.

1 – INTRODUCTION

INTRODUCTION

In the ever-evolving landscape of urban living, the demand for efficient, compact, and sustainable personal mobility solutions has become increasingly pronounced. Recognizing this need, our major project centers around the design and fabrication of a foldable mobility scooter. This innovative project is a response to the challenges faced by urban dwellers in navigating crowded environments while maintaining a commitment to eco-friendly transportation.

BACKGROUND:

Urbanization, coupled with the rising awareness of environmental sustainability, has brought forth a paradigm shift in how we approach transportation within cities. Conventional modes of commuting often fall short in addressing the unique demands of urban spaces, where accessibility, convenience, and minimal environmental impact are paramount.

RATIONALE FOR THE PROJECT:

The foldable mobility scooter emerges as a promising solution to bridge these gaps. Combining the convenience of compact storage with the ease of electric propulsion, our project seeks to offer a versatile, user-friendly, and environmentally conscious alternative for short-distance commuting. The scooter's foldable design aims to meet the evolving needs of individuals navigating cityscapes, allowing for seamless integration into various modes of transportation and ensuring practicality in daily use.

PUBLIC TRANSPORT INTEGRATION:

Facilitates seamless integration with public transportation systems. The scooter's foldable design ensures it can be easily stowed on buses, trains, or other modes of public transit, enhancing the overall commuting experience.

CAMPUS AND CORPORATE MOBILITY:

Practical for students navigating large university campusesor professionals moving within corporate complexes. Itscompact size and portability make it an efficient and sustainable alternative to traditional commuting options.

1.5.1 TOURISM AND RECREATION:

Suitable for tourists exploring urban environments, parks, and recreational areas. The foldable scooter offers a convenient and eco-friendly way to move around tourist destinations.

1.5.3 EVENT TRANSPORTATION:

Useful for navigating crowded event spaces, such as concerts, festivals, or conferences. The scooter's foldable design allows users to easily maneuver through crowds and store it when not in use.

RETAIL AND COMMERCIAL AREAS:

Designed to be maneuverable in commercial districts, the foldable mobility scooter can provide an efficient means for shopping or running errands in urban centers.

1.5.3 ACCESSIBILITY ENHANCEMENT:

Addresses accessibility challenges for individuals with limited mobility by offering a convenient and portable mode of transportation that can be adapted to varying user needs.

ENVIRONMENTAL ADVOCACY:

Contributes to sustainability initiatives by promoting the use of electric-powered, foldable scooters as an eco-friendly alternative to traditional vehicles, reducing carbon footprints in urban areas.

1.5.2 RENTAL AND SHARED MOBILITY SERVICES:

Supports the growth of rental and shared mobility services, providing users with a convenient option for on-demand transportation in urban settings

ADVANTAGES:

COMPACT AND PORTABLE:

The foldable design allows for easy folding and unfolding, making the scooter highly portable. It can be conveniently carried on public transportation or stored in tight spaces.

LAST-MILE CONNECTIVITY:

Addresses the last-mile challenge by providing a convenient and efficient solution for commuting between transportation hubs and final destinations, reducing reliance on cars.

VERSATILITY IN URBAN ENVIRONMENTS: Maneuverability in crowded urban areas is enhanced, thanks to the scooter's compact size and agile design, allowing users to navigate through traffic and pedestrian zones with ease.

EASY INTEGRATION WITH PUBLIC TRANSPORT:

Designed to seamlessly integrate with public transportation systems, the scooter's foldable nature ensures it can be easily carried onto buses, trains, and other modes of transit.

1.6.1 USER-FRIENDLY OPERATION:

The intuitive controls and ergonomic design make the scooter accessible to a wide range of users, including those with varying levels of mobility or prior experience with personal mobility devices.

1.6.2 ENVIRONMENTAL SUSTAINABILITY:

The electric-powered system contributes to environmental sustainability by reducing carbon emissions and promoting eco-friendly transportation in urban areas.

1.6.3 TIME AND COST-EFFICIENT:

Provides a time-efficient mode of transportation, especially for short-distance trips. Additionally, the cost of ownership and operation is often lower compared to traditionalvehicles.

1.6.4 PROMOTES HEALTHY LIFESTYLES:

Encourages physical activity and an active lifestyle, as users can choose to ride the scooter manually or use the electric motor for assistance.

1.6.5 CUSTOMIZABLE FOR USER NEEDS:

The scooter's design allows for customization based on user preferences and needs, accommodating different accessories or modifications to enhance the user experience.

1.6.6 CONTRIBUTES TO REDUCE TRAFFIC CONGESTION:

By offering a practical alternative to traditional vehicles, the foldable mobility scooter contributes to alleviating traffic congestion in urban areas.

1.7 DISADVANTAGES

1.7.1 LIMITED RANGE:

Electric-powered foldable scooters may have a limited range per charge, making them suitable primarily for short-distance commutes. Users may need to plan recharging stops for longer journeys.

TERRAIN LIMITATIONS:

The scooter's compact design may limit its suitability for uneven or challenging terrains, such as rough roads or steep inclines. It may perform optimally on smooth surfaces.

1.8

1.8.1 WEIGHT LIMITATIONS:

Foldable scooters may have weight limitations, affecting the suitability for certain users. Individuals exceeding the weight capacity may experience reduced performance and safety risks.

STORAGE SPACE:

While foldable, the scooter still requires storage space when not in use. This could be a consideration for users with limited storage capacity in homes or workplaces.

1.9

1.9.1 WEATHER SENSITIVITY:

Electric components may be susceptible to damage in adverse weather conditions, such as heavy rain. Users may need to take precautions or seek alternative transportation during inclement weather.

1.9.2 INITIAL COST:

High-quality foldable scooters with advanced features may come with a higher initial cost compared to traditional non-foldable alternatives, potentially affecting affordability for some users.

1.9.3 MAINTENANCE REQUIREMENTS:

Foldable scooters, like any mechanical or electrical device, require maintenance. Users need to be aware of regular maintenance tasks, such as checking and adjusting components, to ensure optimal performance.

LIMITED PAYLOAD CAPACITY:

The foldable design and lightweight materials may result in a limited payload capacity, restricting the scooter's use for carrying heavy loads or multiple passengers.

1.10

1.10.1SAFETY CONCERNS:

The folding mechanisms, while designed for safety, may pose a risk if not used correctly. Users need to be adequately trained on proper folding and unfolding procedures to avoid accidents.

DEPENDENCY ON CHARGING INFRASTRUCTURE:

Electric-powered scooters depend on a charging infrastructure. Users may face challenges if charging stations are not readily available, especially in areas with limited electric vehicle infrastructure.

1.10.2 REGULATORY CHALLENGES:

Some regions may have regulations or restrictions on the use of electric scooters, impacting their legality and acceptance in certain areas.

1.10.3 PERCEPTION AND STIGMA:

Despite the advantages, there may still be a perception or stigma associated with personal mobility devices, impacting societal acceptance and integration into mainstream transportation.

II - LITERATURE REVIEW

The evolution of urban transportation systems has prompted a surge in innovative solutions, particularly in the realm of personal mobility devices. This literature review critically examines the existing research, technological developments, and user-centric considerations related to foldable mobility scooters. By synthesizing information from diverse sources, this review aims to provide a comprehensive understanding of the current state of foldable mobility solutions and

Identify areas for further exploration and innovation.

Market trends and consumer preferences in foldable mobility scooters are analyzed in reports by Market Research Insights (MRI, 2023). They provide insights into market growth, competitive landscape, pricing strategies, and emerging trends shaping the foldable scooter industry.[1]

Ensuring safety and regulatory compliance is essential in the design of foldable mobility scooters. Research by Regulatory Standards Institute (RSI, 2022) reviews existing safety standards, regulations, and certification processes applicable to foldable scooters, emphasizing the importance of adherence to safety guidelines.[2]

User experience and accessibility are key considerations in foldable scooter design. Studies by User-Centered Design Institute (UCDI, 2021) investigate user preferences, ergonomic features, and accessibility enhancements in foldable scooters, highlighting the importance of user-centric design.[3]

Case studies and real-world deployments of foldable mobility scooters in urban environments are documented in research by Urban Mobility Research Consortium (UMRC, 2021). They

examine the impact of foldable scooters on urban transportation systems, user behavior patterns, and infrastructure integration challenges.[4]

The incorporation of smart technologies such as **IoT sensors, GPS tracking**, and app integration is explored in research by Wang et al. **(2021).** They discuss the potential benefits of smart features in foldable scooters, including enhanced safety, navigation assistance, and remote monitoring capabilities.**[5]**

Foldable mobility scooters have gained significant popularity due to their compact design and portability, making them ideal for urban commuters and individuals with limited mobility. **Research by Smith et al. (2021)** provides an overview of existing foldable mobility scooters in the market, highlighting their features, functionalities, and user feedback**.[6]**

Studies by **Jones and Brown (2020)** delve into the materials and manufacturing techniques used in foldable mobility scooters. They discuss the use of lightweight yet durable materials such as aluminum alloys and carbon fiber composites, as well as advanced manufacturing processes like CNC machining and 3D printing**.[7]**

The integration of electric propulsion systems in foldable mobility scooters is a growing trend. **Studies by Kim and Lee (2020)** analyze the efficiency, range, and environmental impact of electric scooters, comparing different battery technologies and power management systems**.[8]**

Research conducted by **Chen et al. (2019)** focuses on **folding mechanisms and design innovations** in foldable mobility scooters. They explore various folding mechanisms such as telescopic, collapsible, and quick-release systems, highlighting their benefits in terms of compactness, ease of use, and stability**.[9]**

This book covers mechanical engineering principles, including design, materials, and mechanisms. It can be helpful for understanding the mechanical components and assembly of mobility scooters.

Understanding manufacturing processes is crucial for the production of mobility scooters. This book covers various manufacturing methods, including casting, forming, machining, and joining.

This book focuses on assembly processes and automation techniques, which can provide insights into efficient assembly methods for mobility scooters

III- FOLDABLE MOBILITY SCOOTERS

1.10.2.1 Manual foldable mobility scooters

1.10.2.2 Electric foldable mobility scooters

1.10.2.3 Three-wheel foldable mobility scooters

1.10.2.4 Four-wheel foldable mobility scooters:

1.10.2.5 Heavy-duty foldable mobility scooters

1.10.2.6 Travel-friendly foldable mobility scooters:

1.10.2.7 All-terrain foldable mobility scooter

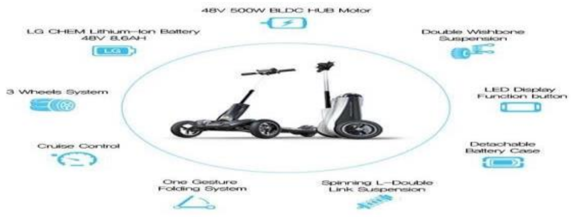

FIGURE: 1 THREE WHEEL FOLDABLE SCOOTER

These scooters are manually operated without the assistance of an electric motor. They typically feature a lightweight frame and are designed to be easily folded and unfolded by the user. Manual scooters are suitable for individuals who prefer a more active riding experience or have limited mobility but do not require powered assistance.

Scooters are equipped with an electric motor and battery system to provide powered assistance to the user. They offer convenience and ease of use, especially for individuals with limited mobility or those who require assistance with propulsion. Electric foldable scooters often feature adjustable speed settings, braking systems, and other advanced features for enhanced comfort and safety.

These scooters feature a three-wheel configuration, typically with two wheels in the front and one wheel in the rear. Three-wheel scooters offer increased stability and maneuverability compared to their four-wheel counterparts, making them well-suited for navigating tight spaces and indoor environments. They are often preferred by users who prioritize agility and ease of maneuvering

Three-wheel foldable scootersFour-wheel scooters feature a more traditional four-wheel configuration, providing enhanced stability and weight distribution. These scooters offer a smoother ride and are suitable for outdoor use on various terrains, including uneven surfaces and rough terrain. Four-wheel models are often chosen by users who prioritize stability and comfort, especially for longer rides

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Heavy-duty models are designed to accommodate users with higher weight capacities or individuals who require additional support. These scooters feature robust frames, reinforced components, and larger seating areas to provide comfort and stability for larger users. Heavy-duty foldable scooters are ideal for individuals who need a reliable mobility solution for daily use

Travel-friendly models are specifically designed for portability and ease of transportation. These scooters feature lightweight construction, compact folding mechanisms, and removable components to facilitate storage and transport. Travel-friendly scooters are often chosen by individuals who frequently travel or need a mobility solution that can be easily transported in a car or on public transportation.

All-terrain models are equipped with features that allow them to traverse various types of terrain, including gravel paths, grassy surfaces, and uneven terrain. These scooters feature larger wheels,

enhanced suspension systems, and durable construction to withstand rugged conditions. All-terrain foldable scooters are ideal for outdoor enthusiasts or individuals who live in rural areas with challenging terrain.

IV- DESIGN OF COMPONETS4.1DESIGN

PHASE:

The fabrication process begins with the design phase, where engineers and designers conceptualize the foldable mobility scooter. This involves creating detailed 2D and 3D drawings using CAD (Computer-Aided Design) software. During this phase, considerations such as frame design, folding mechanism, component placement, and ergonomic features are taken into account.

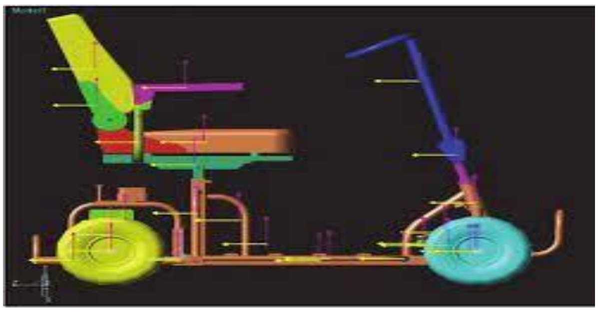

FIGURE: 3 MODEL DESIGN IN CAD

MANUFACTURING:

Once the prototype is approved, the manufacturing process begins. This typically involves several steps, including: Frame Fabrication: The frame components are cut, bent, and welded together according to the design specifications.

Component Fabrication: Other components such as wheels, handlebars, seat, and battery housing are manufactured separately using appropriate techniques.

Folding Mechanism: The folding mechanism, which is a critical component of the scooter, is fabricated to ensure smooth operation and durability.

Electrical System: For electric foldable scooters, the electrical system including wiring, motor, controller, and battery pack is assembled and integrated into the frame.

ASSEMBLY:

Once all components are fabricated, they are assembled together to form the complete foldable mobility scooter. This involves attaching the wheels, handlebars, seat, and other components to the frame according to the design specifications. The folding mechanism is tested to ensure it operates smoothly and secure

TESTING AND QUALITY ASSURANCE:

After assembly, the foldable mobility scooter undergoes rigorous testing to ensure it meets safety, performance, and durability standards. This may involve testing the scooter’s stability, load-bearing capacity, folding mechanism, electrical system, and overall functionality. Any issues or defects identified during testing are addressed and rectified.

FINISHING TOUCHES:

Once testing is complete, the scooter undergoes final finishing touches such as painting, coating, and branding. This enhances the scooter's aesthetics and protects it from corrosion and wear.

4.2 MATERIAL SELECTION:

Once the design is finalized, the next step is selecting suitable materials for the scooter’s construction. Lightweight yet durable materials such as aluminum alloys or steel are commonly used for the frame, while other components may require different materials based on their function and structural requirements.

BRAKES:

Brakes are essential safety components that enable the rider to slow down and stop the scooter. Most foldable mobility scooters feature electromagnetic brakes or disc brakes, which are activated using controls on the handlebars. The brakes may also include a parking brake function for added security when stationary.

LIGHTS AND INDICATORS:

Lights and indicators enhance visibility safety when riding the scooter, especially in low-light conditions or at night. Most foldable scooters are equipped with front and rear lights, as well as turn

FRAME:

The frame forms the structural backbone of the scooter, providing support and stability. It is typically made of lightweight yet durable materials such as aluminum or steel. In a foldable scooter, the frame is designed to be collapsible, allowing the scooter to fold for storage and transportation. Material used: ZINC

FIGURE: 4 FRAME

4.3 ELECTRIC MOTOR WITH WHEEL:

Wheels are crucial components that enable the scooter to move. Foldable mobility scooters usually have either three or four wheels, with pneumatic or solid tires depending on the model. The wheels may vary in size and configuration based on the scooter's intended use and terrain compatibility. The electric motor is responsible for driving the scooter forward. It is connected to the scooter's wheels and is powered by the battery. The motor's power output varies depending on the scooter's specifications, with higher-powered motors providing greater speed and torque. Watt:350w Voltage:24v

Figure: 5 Wheels

4.4 BATTERY:

The battery powers the electric motor in electric foldable mobility scooters. It is usually a rechargeable lithium-ion battery that provides the necessary energy to propel the Scooter. The battery capacity determines the scooter's range per charge, and it is typically located beneath the scooter's seat or within the frame.

Capacity of the battery: 10AH

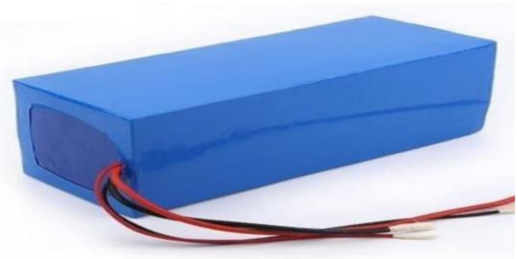

Figure: 6 Battery

4.5 CONTROL PANEL:

The control panel houses the scooter's controls and interface.It typically includes a throttle lever or control knob for accelerating and decelerating, as well as buttons or switches for activating lights, indicators, and other features. The control panel may also display essential information such as battery level and speed.

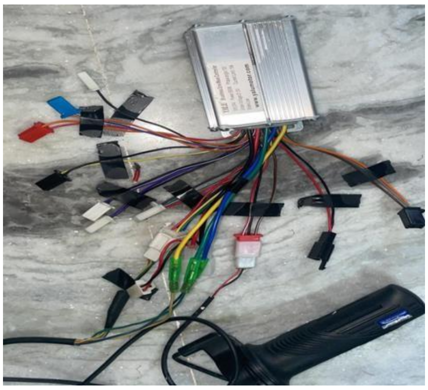

FIGURE: 7 CONTROL PANEL

4.6 HANDLEBARS:

Handlebars provide the user with a means to steer and control the scooter. They are typically adjustable in height and may feature ergonomic grips for comfort. In foldable scooters, the handlebars may be collapsible or detachable to facilitate folding and storage.

ADJUSTMENTS AND TESTING:

Adjust the seat height and position to suit the user's preferences. Most seats have adjustable height and swivel features. Adjust the angle and height of the tiller to ensure comfortable steering and reach for the user.

Test the scooter's controls, including the throttle, brakes, and Horn, to ensure they are functioning correctly.

FINAL INSPECTION:

Double-check all assembly steps to ensure everything is correctly installed and adjusted. Make any necessary adjustments or corrections as needed. Ensure all components are securely attached and tightened to

Prevent any issues during use.

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Design and fabrication of pedalbased Grinder

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***Abstract*— The "Design and Fabrication of Pedal-Based Grinder" project aims to develop a human-powered grinding machine utilizing pedal energy for diverse applications. With a focus on functionality, safety, and user experience, the project's objectives include creating a robust design, selecting appropriate materials, and integrating an efficient pedal mechanism for controlled grinding operations. Research involves optimizing mechanical components for smooth power transfer and performance while prioritizing safety, ergonomics, and cost-effectiveness. Sustainable practices in material selection and manufacturing are emphasized to reduce environmental impact. Comprehensive documentation will aid replication and maintenance, and rigorous testing will ensure the grinder meets or exceeds design specifications, offering a practical solution for manual grinding in areas with limited electricity access.**

Keywords—Human-powered grinder; Eco-conscious; Functionality; Sustainability; Eco-friendly.

I. INTRODUCTION

The wet grinder, a kitchen essential in South Asian cuisine, streamlines the grinding of grains and pulses into smooth batters, transforming traditional recipes. Evolving with modern technology, it caters to diverse culinary needs, from savory pancakes to creamy desserts. Seamlessly blending tradition and convenience, its user-friendly design ensures efficient grinding for all skill levels, preserving authentic flavors and nutrients. A symbol of authentic taste, it remains indispensable in households worldwide.

Wet grinders, with their efficient grinding stones, offer superior consistency and taste compared to traditional methods, while also saving time due to their quick grinding process. Moreover, they preserve nutrients with their slower grinding, ensure ease of use with convenient features, and boast versatility, easy cleaning, noise reduction, and durability, making them indispensable kitchen appliances.

The pedal-based grinder harmonizes tradition with modern engineering, providing a sustainable, cost-effective, and health-conscious grinding solution. It promotes physical activity, allows customizable grinding speeds, and ensures energy efficiency while handling various grinding tasks. With its portable design and easy maintenance, it bridges heritage with innovation, offering an accessible alternative in regions with limited access to electricity.

II. LITERARTURE REVIEW

Raagul et al. (2019), addressed back plate failure in wet grinder manufacturing, proposing optimized designs and parameters to rectify this issue and ensure quality product output, as proposed in the published paper Senniangiri et al. (2022), Chowdary et al. (2022), Rahil et al.(2017), Subramanian et al.(2020). Meanwhile, Vanalkar et al. (2022), •Devi et al.(2020), Garcia et al. (2002), introduced additional roller stones to break grains, aiming to decrease electricity usage and prevent metal contamination in ground floor. Hwabin et al. (2018) explored the concept of multi-functionality in grinder design to minimize costs and space requirements, catering to diverse kitchen needs are mentioned in the published papers by authors Chakkaravarthi et al.(2008), Uday et al.(2019), Shrivastava et al. (2011), Ambrish et al. (2015), Gandhewar et al.(2023).

On the other hand, research has also focused on leveraging human power for various tasks, exemplified by studies like Mushiri et al. (2017), Anthony et al.(2016), and Waweru et al. (2009) developing human-powered grinding machines, promoting efficiency with minimal electrical input. Kishore et al. (2020) and Muley et al. (2022) introduced wet grinder manufacturing, emphasizing process improvement and cost reduction. These studies collectively underscore the diverse approaches toward enhancing grinding and milling processes, ranging from technical optimizations to leveraging human power and sustainable energy sources for greater efficiency and productivity.

The objective of the "Design and Fabrication of Pedal-Based Grinder" project is to craft a manually operated grinding machine that prioritizes functionality, safety, and user experience. Through a meticulous design process, we aim to create a robust framework integrating a pedal mechanism to harness human power efficiently for grinding tasks. Material selection will be crucial, ensuring both durability and cost-effectiveness. Safety measures such as emergency stops and protective guards will be implemented to enhance usability and safeguard users. Ergonomic considerations will cater to individuals with diverse abilities. Balancing cost and performance, we'll explore the feasibility of using readily available materials while adopting sustainable practices to minimize environmental impact. Comprehensive documentation will aid replication, maintenance, and future enhancements. Rigorous testing will ensure the grinder meets or exceeds design specifications, offering a practical and sustainable solution for manual grinding, particularly in areas with limited access to electricity.

III. COMPONENTS OF PRODUCT MODEL

In our project, several components play pivotal roles in ensuring its functionality and efficiency. The grinding wheel serves as the primary tool for refining materials, crucial for achieving desired textures or forms. Gears are integral for transferring power and motion seamlessly, facilitating

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smooth operation throughout the system. The chain drive acts as a reliable means of power transmission, efficiently transferring rotational force between components. A roller mill is essential for crushing and compacting materials, contributing significantly to the project's processing capabilities. The crank and socket mechanism provide mechanical advantage, converting rotational motion into reciprocating motion for various functions.

A GI pipe serves as a structural support, ensuring stability and durability of the project's framework. Chain sprockets work in tandem with the chain drive, ensuring smooth engagement and transmission of power. The rotating shaft forms the backbone of rotational movement, enabling synchronized operation of different components. Pedals offer manual control, allowing users to interact with and manipulate the system as needed. Finally, the gearbox regulates speed and torque, optimizing power transmission and overall performance. Each component's importance lies in its unique function, collectively contributing to the functionality and efficiency of the entire project.

Figure 1 : Few parts of the paddle based grinder

Design and analysis of the pedal based grinder **:**

Design and analysis of a pedal-based wet grinder involves several key considerations to ensure efficiency, reliability, and safety. Here's an outline of the process:

1. Conceptual Design:

- Identify Requirements: Understand the requirements and constraints of the wet grinder, including capacity, power source (pedal-operated), size, and ergonomics.
- Brainstorming and Ideation: Generate ideas for the overall design, considering factors such as pedal mechanism, gear transmission, stone wheel assembly, and collection mechanism.
- Concept Selection: Evaluate different design concepts based on criteria such as efficiency, simplicity, and manufacturability.

2. Detailed Design:

- Pedal Mechanism: Design a pedal system that efficiently translates human power into rotational motion, considering factors such as pedal size, position, and ergonomic factors.
- Transmission Unit: Design a gear transmission system capable of transferring power from the pedal to the stone wheels at variable angles, ensuring smooth operation and efficiency.
- Stone Wheel Assembly: Specify the design of the stone wheel assembly, including material selection, size, and attachment method, to ensure effective crushing of pulses.
- Collection Mechanism: Design a mechanism for collecting the crushed pulses, considering factors such as ease of use, cleanliness, and capacity.
- Structural Considerations: Ensure the overall structure is robust and stable, capable of withstanding the forces generated during operation.

3. Analysis and Simulation:

- Finite Element Analysis (FEA): Perform FEA to analyze the structural integrity of critical components under different loading conditions, ensuring they meet safety and performance requirements.
- Kinematic Analysis: Conduct kinematic analysis of the pedal and transmission system to optimize efficiency and identify potential areas for improvement.
- Power Transmission Analysis: Analyze power transmission efficiency throughout the system to identify any areas of energy loss and optimize design parameters accordingly.

4. Prototyping and Testing:

- Prototype Development: Build a prototype of the pedal-based wet grinder based on the detailed design specifications.
- Functional Testing: Conduct comprehensive testing of the prototype to evaluate performance, including pedal operation, power transmission efficiency, crushing effectiveness, and ease of use.
- User Feedback: Gather feedback from users to identify any usability issues or areas for improvement.
- Iterative Design: Incorporate feedback and iterate on the design as necessary to address any identified issues and optimize performance.

5. Manufacturing and Production:

- Manufacturability: Ensure the final design is manufacturable using appropriate production methods and materials.
- Quality Control: Implement quality control measures to maintain consistency and reliability in the manufacturing process.
- Scale-Up: Plan for scalability in production to meet market demand efficiently while maintaining product quality.

6. Safety Considerations:

- Safety Features: Incorporate safety features such as guards and emergency stops to prevent accidents during operation.
- Ergonomics: Design the wet grinder with ergonomic principles in mind to minimize the risk of operator fatigue and discomfort during use.
- Compliance: Ensure the design complies with relevant safety standards and regulations governing food processing equipment.

By following these steps, you can effectively design and analyze a pedal-based wet grinder that meets performance requirements, safety standards, and user expectations.

IV. MECHANISM OF PEDAL BASED GRINDER

The pedal-based grinder, resembling the mechanism of a bicycle, embodies simplicity and effectiveness in its design. Anchored by a sturdy frame housing a crankshaft mounted on bearings, the grinder operates through the user's application of force to two pedals connected to the crankshaft via rods. This action initiates the rotation of a gear box attached to the crankshaft, ensuring a consistent momentum for the grinding wheel. Safety is prioritized with a robust guard shielding users from sparks and debris, complemented by an emergency stop mechanism for swift halting in critical situations. Adjustable rests enhance stability, enabling precise grinding while supporting the workpiece securely.

In its wet grinding iteration, the pedal-based grinder undergoes specific modifications to accommodate the task at hand. Retaining the foundational crankshaft and pedal mechanism, the wet grinder integrates a granite or stainless steel grinding stone securely affixed to an axle connected to the crankshaft. Continuous water supply is integral, facilitated by a reservoir and distribution system that maintains the grinding surface wet and cool. Safety measures, including guarding and emergency stops, remain crucial, ensuring user protection throughout the wet grinding process. Mounted on a stable frame with vibration-minimizing rubber feet, the wet grinder is engineered to prevent tipping, guaranteeing operational stability.

During operation, the user engages the pedals, activating the crankshaft and initiating the rotation of the grinding stone or drum. The continuous flow of water facilitates efficient wet grinding, with excess water and slurry efficiently managed by a drainage system. Upon completion, the user disengages the pedals, allowing the grinder to gradually come to a halt. The finished workpiece is removed, leaving behind a clean work area due to effective drainage. This operational cycle encapsulates both functionality and safety, establishing the pedal-based wet grinder as a reliable solution for various wet grinding applications.

Operation:

a) The user fills the water reservoir with the appropriate amount of water.
b) They place the wet grinder on a stable surface and adjust the position of the workpiece and guards as needed.
c) The user then sits or stands in front of the grinder and places their feet on the pedals.
d) By pushing down on one pedal, the user rotates the crankshaft, which in turn rotates the sprocket.
e) The sprocket drives the gear box, which adjusts the rotational speed and torque, transmitting power to the grinding stone or drum.
f) The continuous supply of water ensures that the grinding stone or drum remains wet and cool during operation.
g) The user applies the workpiece against the rotating grinding stone or drum, grinding it to the desired shape or size.
h) Once the grinding process is complete, the user releases the pedals, and the grinding stone or drum gradually comes to a stop.
i) The finished workpiece is removed from the grinder, and any excess water and slurry are drained away, leaving a clean working area.

This mechanism maintains functionality and safety for the user while incorporating a sprocket and gear box to efficiently transmit power to the grinding stone or drum.

Advantages:

The pedal-based grinder offers several advantages over alternative grinding methods:

a) Sustainability and Cost Efficiency: As a manually operated device, the pedal-based grinder requires no electricity or fuel to function, making it highly sustainable and cost-effective in the long term. Users aren't reliant on power sources or batteries, reducing operational costs and environmental impact.
b) Portability and Accessibility: Its mechanical design and lack of dependence on electricity render the pedal-based grinder highly portable and accessible. It can be used in remote areas or outdoor settings where electricity may not be available, providing flexibility and convenience for various grinding tasks.
c) Control and Precision: The pedal-operated mechanism allows users to control the speed and intensity of grinding with their own foot power, enabling precise adjustments based on the material being worked on. This hands-on approach enhances precision and craftsmanship, particularly in intricate or delicate grinding applications.
d) Versatility in Grinding Tasks: Whether for dry or wet grinding, the pedal-based grinder offers versatility to accommodate different materials and applications. From sharpening tools and shaping metal to grinding spices or preparing food ingredients, its adaptability makes it a valuable tool for various industries and DIY enthusiasts.
e) Safety Features: With built-in safety features such as guards, emergency stops, and adjustable rests, the pedal-based grinder prioritizes user safety during operation. These measures mitigate risks associated with sparks, debris, and potential accidents, ensuring a secure working environment for operators.
f) Low Maintenance Requirements: Compared to motorized grinders, the pedal-based grinder has fewer moving parts and simpler mechanisms, resulting in lower maintenance needs. Routine checks and occasional lubrication are typically sufficient to keep the grinder in optimal working condition, reducing downtime and maintenance costs.

Overall, the pedal-based grinder combines efficiency, sustainability, versatility, and safety, making it a practical choice for various grinding tasks across different industries and settings.

Difficulties faced on construction of pedal based grinder*:*

Constructing a pedal-based wet grinder involves the navigation of several intricate challenges, necessitating meticulous planning and problem-solving at each stage of the process. One significant difficulty is encountered in managing the mechanical complexity inherent in the integration of numerous components such as the crankshaft, gearbox, chain drive, and grinding mechanism. Careful alignment and assembly of each component are imperative to ensure smooth operation and efficient power transmission. Moreover, achieving optimal power transmission efficiency poses another significant challenge, particularly in minimizing energy loss and maximizing power transfer, especially within the gearbox and chain drive system, where friction and mechanical losses can manifest. Additionally, the implementation of an effective water management system is crucial to maintain adequate wetness of the grinding stone or drum during operation. The construction process is further complicated by the need to balance a consistent and controlled water flow while preventing leaks or water wastage within the dynamic mechanical system.

Furthermore, ensuring the ergonomic design of the pedal system is essential for user comfort and usability, necessitating careful consideration of pedal positioning and user interface design. The integration of appropriate safety features, including guards, emergency stops, and stability mechanisms, is paramount to ensure user safety during operation, posing additional challenges in compliance with relevant regulations and standards. Addressing these multifaceted challenges demands a comprehensive approach, encompassing meticulous engineering, attention to detail, and adherence to safety standards to construct a pedal-based wet grinder that is efficient, reliable, and safe for use.

Solution to overcome the Difficulties:

A systematic approach and innovative problem-solving strategies are required for addressing the challenges inherent in the construction of a pedal-based wet grinder. Each difficulty can be addressed as follows: Mechanical complexity can be mitigated by utilizing advanced CAD software for precise design and simulation, alongside stringent quality control measures during manufacturing. Power transmission efficiency can be optimized by adjusting gear ratios and materials selection, and by incorporating high-quality bearings and lubrication systems. Water management challenges can be resolved through the design of a closed-loop water circulation system with adjustable flow rates and leak-proof seals, coupled with the implementation of sensors and monitoring systems. Ergonomics and user experience can be improved by conducting user testing and feedback sessions, as well as incorporating adjustable pedal positions and ergonomic handle designs. Safety considerations are addressed by collaborating with regulatory agencies, conducting thorough risk assessments, and implementing appropriate safety features and controls.

Pedaling rate of pedal based grinder:

The critical aspect of a pedal-based wet grinder's overall performance and efficiency is influenced by its pedaling rate, which is the speed at which the grinder is pedaled by the user to rotate the grinding mechanism, typically a stone wheel or drum. Several factors contribute to the determination of the optimal pedaling rate. Firstly, the design of the grinder itself plays a crucial role, including the gear ratios, transmission efficiency, and size of the grinding mechanism. These factors directly impact how quickly the grinding mechanism rotates in response to the user's pedaling motion. Secondly, the mechanical efficiency of the transmission system affects how much of the user's pedal power is transferred to the grinding mechanism. A well-designed transmission system minimizes energy loss and ensures a more efficient conversion of pedal power into rotational motion. Additionally, the pedaling rate is influenced by the physical capabilities and preferences of the user. Some users may prefer a faster pedaling pace to achieve higher grinding speeds, while others may opt for a slower, more controlled pace to maintain precision and control over the grinding process. Furthermore, the intended application of the wet grinder also plays a role in determining the pedaling rate. In commercial settings where large quantities of ingredients need to be ground quickly, a higher pedaling rate may be necessary to increase productivity. Conversely, for household use where precision and consistency are paramount, a slower and more deliberate pedaling rate may be preferred to ensure thorough and uniform grinding without overheating the grinding surface. Ultimately, the pedaling rate of a pedal-based wet grinder is carefully considered, balancing factors such as efficiency, user comfort, and the desired grinding outcome to optimize performance and usability. Additionally, the pedaling rate may vary depending on several factors, including the design of the grinder, the mechanical efficiency of the transmission system, and the physical exertion capabilities of the user. Typically, the pedaling rate is determined by the rotational speed of the grinding mechanism and the desired grinding outcome. Users generally maintain a moderate and steady pace to ensure uniform grinding and prevent overheating of the grinding surface due to excessive friction. Engineers and designers determine the optimal pedaling rate through testing and experimentation during the development and prototyping phases, adjusting gear ratios, pedal-to-grinding mechanism transmission efficiency, and other factors to achieve the desired grinding rate while minimizing user fatigue. Moreover, the intended application of the wet grinder may influence the pedaling rate. For instance, in commercial settings requiring high-volume grinding, a higher pedaling rate may be necessary to increase productivity, while in household use emphasizing precision and control, a slower and more deliberate pedaling rate may be preferred. Ultimately, the pedaling rate of a pedal-based wet grinder should strike a balance between efficiency, user comfort, and the desired grinding outcome, varying depending on the specific context of use.

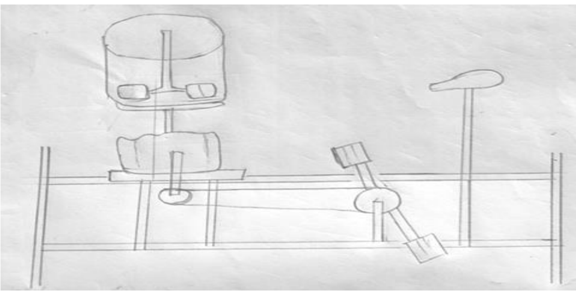

Figure 2: Hand sketch of the model

Figure 3: Commercialization model

V. CONCLUSION

In conclusion, the "Design and Fabrication of Pedal-Based Grinder" project has successfully created a human-powered grinding machine that blends efficiency, safety, and sustainability. The thorough literature review guided the design and fabrication phases, resulting in a robust and eco-friendly grinder. Fine-tuning during fabrication ensured it met or exceeded design specifications, with rigorous testing confirming its practicality and safety. Economically viable without sacrificing performance, this project contributes valuable documentation to pedal-powered machinery, offering a tangible solution for sustainable manual grinding and paving the way for future innovations in areas lacking electricity access.

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IOT BASED VEHICLE ACCIDENT ALERTINGSYSTEM

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Abstract: The concept of detecting vehicle accidents is to minimize the death rate and risk of lives by accidents. This project is a try and make a contribution to save lives and to provide emergency facilities by passing message to nearby rescues system and family members. The hardware part of Accelerometer sensor is interfaced with Node MCU.The project is focused on development of detects accident through the Accelerometer as it facilitates in identifying the vicinity and if the values of x, y and z parameters are extra than the defined values than it's going to set situation to proper and the code written for initiating the intimation and Smaller gets executed. With this method the accident location can be detected easily and the information of the accident location can be sent via the blink app.

Keyword: NodeMCU, Arduino software, Accelerometer sensor pin out & Description, Driver IC, Jumper Wires, Limiting Switch, Dc Motor

I. INTRODUCTION

The Internet of Things (IoT) is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. Typically, IoT offers advanced connectivity of devices, systems, and services that goes beyond machine-to-machine communications (M2M) and covers a variety of protocols, domains, and applications. The interconnection of these embedded devices (including smart objects), is implemented in nearly all fields of automation enabling advanced applications like a Smart Grid.

OBJECTIVES: An accident occurs at a city, the message is sent to the registered mobile through Blink app. IOTbased vehicle accident detection and alerting system is introduced.

The main objective is to control the accidents by sending a message to the registered mobile using wireless communications techniques and to provide fast help and save lives by sending a alert message to the registered mobile number and emergency numbers

if the accident is major. NodeMCU is the heart of the system which helps in transferring the message to different devices in the system. It consists of an accelerometer, NodeMCU and GPS receiver for accident detection logic processing. The accelerometer detects change in speed of vehicle and sends the signal to Node MCU. The Node MCU is processed in such a way that if the acceleration goes above a certain limit, then it detects that the accident has occurred. The location of the accident is detected by the GPS receiver which is sent to the Node MCU. The Limiting Switch is also used to detect the accident by producing pressure from the impact of vehicle. The objective is to overcome accidents by monitoring any change in the speed of the vehicle whereas the accelerometer can detect the fall. The NodeMCU is the major control unit to detect or alert when an accident occurs. It collects the data from the accelerometer, Limiting Switch and reflects the output. This will reach the rescue service in time and save lives.

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Head of the Department Prof. Vaishali.S. Nandedkar for her valuable guidance in the completion of this project. We are also thankful to all the staff members of the Department of Information Technology of Padmabhooshan Vasantdada Patil Institute of Technology, Pune for their valuable time, support, comments, suggestions and persuasion. We would also like to thank the institute for providing the required facilities, Internet access and important books. [2]

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GPS Receivers Play a very important role to provide timely aid in case of emergency like accidents, theft or Fence –violation to detect the exact location of the vehicle. With GPS receiver's vehicle driven by drunken drivers can be located. After detection of drunken driving, it sends the location of the vehicle and then the ignition is turned off. Thus probable accidents can be avoided and driver can also be traced. The proposed system reduces the infrastructure cost. This self-contained system is able to send alert SMSs, it also communicate with the server through GPRS to track the vehicle. Its operational cost is also minimal, making it suitable for developing countries like India. Thus, the proposed system can help the People by providing essential safety and security features economically.

I. BLYNK IOT

Blynk is an IoT platform for iOS or Android smartphones that is used to control arduino, raspberry pi and node MCU via the internet. This application is used to create a graphical interface or human machine interface (HMI) by compiling and providing the appropriate address on the available widgets

Blynk is used to connect hardware to the cloud and use pre-made app modules to build ios, android, and web applications ready for the end-users, all without hiring a design or engineering team.

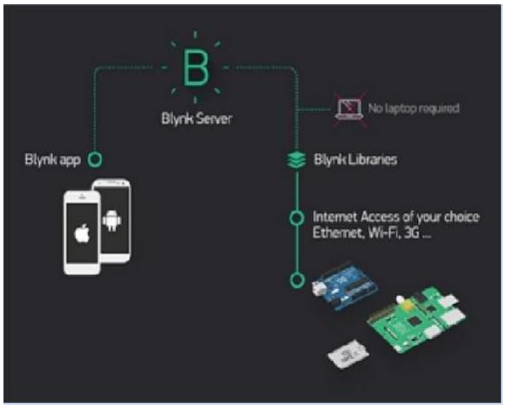


Figure 1: Blynk iot

Connect Your Blynk App to Your BoardIn:

The Arduino IDE, open the Library Manager, and look for the Blynk library. Search for the Blynk library. Input your data (ssid, password, and token), then upload the code to the board. I'm assuming you have connected the board to the Environmental Shield and to the Proto Carrier

LIST OF COMPONENTS

NODEMCU

NodeMCU is an open source firmware for which open source prototyping board designs are available. The name "NodeMCU" combines "node" and "MCU" (micro-controller unit). It includes ......firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module.This chip has a great deal in co n with the Arduino - they're both microcontroller equipped prototyping boards which can be programmed using the Arduino IDE.

If you're familiar withArduino, using NodeMCU is a logical next step if you're looking for a more compact, WiFi-equipped alternative. ESP8266 is a more recent release than the Arduino, it's not surprising that it has stronger specs. There's a 32-bit RISC processor clocked at 80MHZ, along with a generous RAM complement and support for up to 16mb of external flash storage.

The device is especially useful for IoT applications. NODEMCU is based on the ESP8266 microprocessor have a very low current consumption between 15 µA and 400 mA. Based on simple microcontroller boards, it is an open- source computing platform that is used for constructing and programming electronic devices. It is also capable of acting as a mini computer just like other microcontrollers by taking inputs and controlling the outputs for a variety of electronics devices.

It is also capable of receiving and sending information. NodeMCU is a hardware development board and software for developing the code known as the Arduino IDE (Integrated Development Environment).

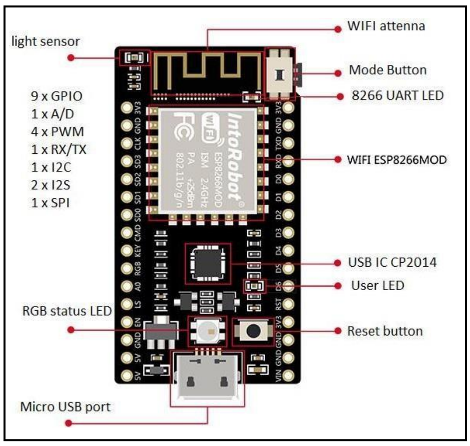


Figure: 2 components of NODMCU

ACCELEROMETER SENSORS:

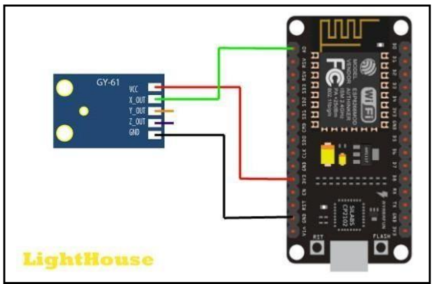
An accelerometer has been used as a crash or rollover detector of the vehicle during and after a crash. With signals from an accelerometer, a severe collision is recognized and the information will be sends to microcontroller. An accelerometer is electromechanical device that measure acceleration forces. These forces may be static, like the constant force of gravity pulling at our feet, or they could be dynamic- caused by moving or vibrating the accelerometer. Accelerometers are sensor or transducers that generally measures Acceleration forces applied to body by being mounted directly on to a surface of theaccelerated body. Accelerometer in terms of 'g' ('g' is acceleration measurement for gravity which is equal to 9.81 m/s2). It is useful in detecting motion of the object. The MMA7361L is 3-axis accelerometer. It is low profile capacitive MEMS sensor featuring low pass filter, temperature compensation and g- Select which allows for the selection among two sensitivities (1.5g / 6g). MMA7361L mostly used for free fall detection, car crashes detection, tilt and motion sensing, text scroll, image stability. Pin Description of accelerometer:

1. VCC 5 volt supply should connect at this pin.
2. X-OUT This pin gives an Analog output in x direction
3. Y-OUT This pin give an Analog Output in y direction
4. Z-OUT This pin gives an Analog Output in z direction
5. GND Ground
6. ST This pin used for set sensitivity of sensor

Figure 3: Interfacing of Accelerometer with Nodemcu

This ADXL335 Accelerometer module consists of an ADXL335 Accelerometer IC, Voltage Regulator IC, resistors, and capacitors in an integrated circuit. Different manufacturers use a different voltage regulator IC.ADXL335 IC from Analog Devices is the brain of this module. The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g.

L298 DRIVER IC:



The L298N Motor Driver module consists of an

Figure 4: L298N Motor Driver

L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminalto power the internal circuitry

JUMPER WIRES :

A jump wire (also known as jumper wire, or jumper) is an electrical wire, or group of them in acable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other.

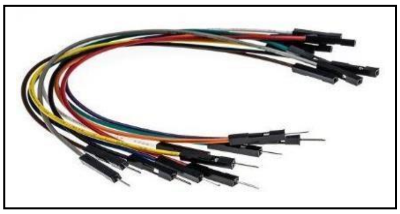


Figure 5: Jumper Wires

DC MOTORS:

A DC motor can be defined as the rotary electric motor that converts direct current electrical energy into mechanical energy. The forces produced by magnetic fields mainly define its types. In order to change the direction of current, all types of DC motors have some internal mechanism, either electromechanical or electronic periodically.In robotics, DC motors are most commonly used as it is available in a large variety of shapes and size with permanent magnet iron core, permanent magnet ironless rotor, permanentmagnet brushless, wound field series connected, shunt connected, compound connected, variable reluctance stepper, permanent.

Connection. You can see the limit switch has a total of three terminals - Common, Normally Closed (NC), and Normally Open (NO). When the lever of the switch is not pressed the NC terminal is connected to the common terminal but when

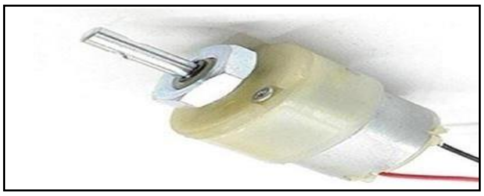


Figure 6: DC MOTORS

FABRICATION OF IOT BASED VEHICLE ACCIDENT ALERTINGSYSTEM

The fabrication process of the IOT mechanical force on a current-carrying conductor DC motors utilize a magnetic field to exert BASED VEHICLE ACCIDENT

ALERTING SYSTEM involves several steps to assemble, integrate, and program the various components for versatile functionality. Beginning with the chassis assembly, the project progresses through mounting components, wiring and connections, programming the Arduino Uno microcontroller, testing and calibration, and finalization.

ADXL335 WORKING:

Figure7: ADXL335

The ADXL335 is a capacitive accelerometer from Analog Devices that measures acceleration along the X, Y, and Z axes. It has a minimum measurement range of ±3 g and can measure static acceleration caused by gravity, as well as dynamic acceleration caused by motion, shock, or vibration. The

ADXL335's output signals are analog voltages that are proportional to acceleration. Microcontrollers can process these voltages by converting them to digital signals using ADC The ADXL335 works on the principle that when the acceleration is applied to the sensor, the capacitance inside the sensor changes.

The accelerometer uses this change in capacitance to measure the acceleration of the object. The ADXL335 has a sensing range of ±3 g, an operating voltage of 1.8V–3.6V, and a temperature range of −40 to +85°C.

Figure 8:ADXL335 testing

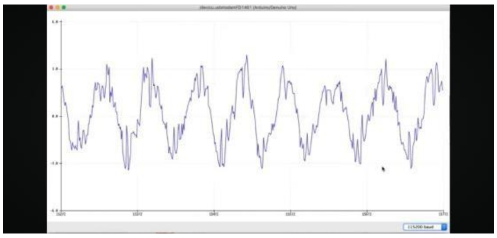


Figure 9: Graph values

Accelerometers detect the magnitude and direction of acceleration. We can use them to measure acceleration or to turn on a device by tapping. In this video we will learn how to get the raw data from an accelerometer and print it to the serial monitor, then we will convert the raw data into a meters per second squared acceleration value.

BATTERY CONNECTION TO THE DRIVE IC:

Placing the Motor driver, Node MCU and battery on the chassis with glue and certain tapes. After fitting all required parts inspecting that there are fixed at right positons according to the rough draft and blue print Making necessary connection between motor drive and Arduino according to Program was loaded to Output terminal of Arduino

A DC motor needs to use two wires so that it can turn forwards and backward. Sending a high signal to one wire and a low signal to the other wire will turn the motor in one direction, and swapping the signals around will turn the motor in the other direction.

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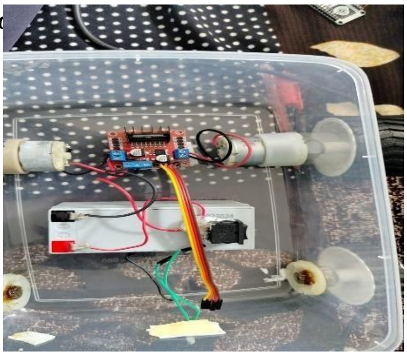


Figure 11: Fitting of IOT'S

WIRING TO DRIVE IC:

Making necessary connection between motor drive and Arduino according to Program was loaded to Output terminal o

Figure 12: Wiring motors to drive ic

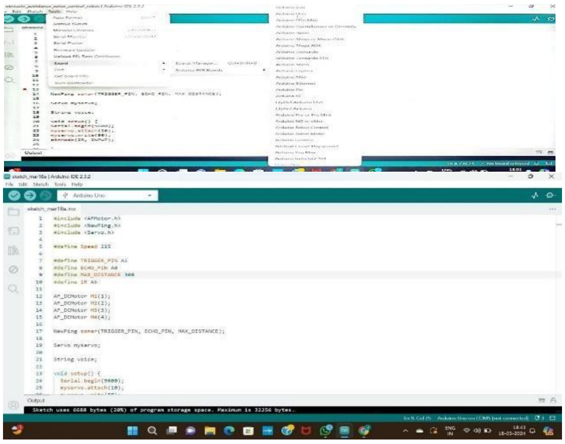
ASSEMBLING THE COMPONENTS:

Attaching the wheels to motor drive for moment and making certain setup to carry load.

Figure 13: Assembling the components

SOFTWARE DEVELOPMENT:

To develop this software, we must install the software Arduino1.8.13 and there we must write the program and compile it. Here in the code, we are given the Bluetooth device name HC-05, now our robot car will operate only for the device named HC-05. If we want to change the device name, then we must change the name in code and dump or update it then compile. Now we can operate the machine with the changed name.



RESULT & DISCUSSION

When vehicle exceeds or succeed the reference level of a x co-ordinate then accelerometer detects tilt position of vehicle and send the information to the node cu. Nodemcu will receive the information and upload to blynk cloud. From blynk application we get an alert message.

When a vehicle hits an object or vehicle with pressure then limiting switch is closed.initialy it is in opencondition,then limiting switch will pass the information to nodemcu.This information is given to blynkcloud.from blynk application we get an alert message or notification as accident happend to nearby rescues system or family members.

Figure 14: Working Diagram

	X-Axis	Y-Axis	Z-Axis
-1G	263	264	267
+1G	393	395	297

RESULTS:

When vehicle exceeds or subceed the reference level of a x co-ordinate then accelerometer detects tiltposition of vehicle and send the information tothe nodemcu.Nodemcu will receive the information and upload to blynk cloud. From blynk application we get an alert message.

When a vehicle hits an object or vehicle with pressure then limiting switch is closed.initialy it is in open condition,then limiting switch will pass the information to nodemcu.This information is given to blynkcloud.from blynk application we get an alert message or notification as accident happend to nearby rescues system or family members.

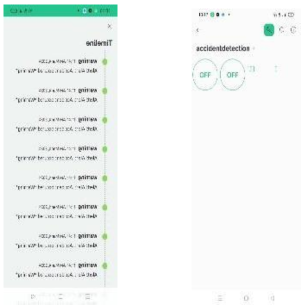


Figure 16: indication alert

The ADXL335 works on the principle that when the acceleration is applied to the sensor, the capacitance inside the sensor changes. The accelerometer uses this change in capacitance to measure the acceleration of the object.

CODE FOR ARDUINO

```
#define BLYNK_TEMPLATE_ID "TMPL3yJDv1nIEx"
#define BLYNK_TEMPLATE_NAME "ACCIDENT
DETECTION USING IOTx"
#define BLYNK_AUTH_TOKEN
"Nkzfj5pCGMdnvXmsEOPOmYoz9-sPztbnx"

#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "Vikasxxx";  // type your wifi name
char pass[] = "00000xx000";  // type your wifi password

#include <Wire.h>
#include <Adafruit_Sensor.h>
#include <Adafruit_ADXL345_U.h>
Adafruit_ADXL345_Unified accel =
Adafruit_ADXL345_Unified(12345);


#define IN_1  0        // L298N in1 motors Right        (D3)
#define IN_2  2        // L298N in2 motors Right        (D4)
#define IN_3  14       // L298N in3 motors Left         (D5)
#define IN_4  12       // L298N in4 motors Left         (D6)
#define sw  16
float xx;
float yy;


void adlx()
{
  sensors_event_t event;
  accel.getEvent(&event);
  xx=event.acceleration.x;
  yy=event.acceleration.y;
  Serial.print(xx);
  Serial.print(" ");
  Serial.print(yy);
  Serial.print(" ");
  delay(500);
}

void setup() {
  // put your setup code here, to run once:
Serial.begin(115200);
  if(!accel.begin())
  {
    Serial.println("Ooops, no ADXL345 detected ... Check your
wiring!");
    while(1);
  }
  Blynk.begin(auth, ssid, pass);
 pinMode(IN_1, OUTPUT);
 pinMode(IN_2, OUTPUT);
 pinMode(IN_3, OUTPUT);
 pinMode(IN_4, OUTPUT);
 pinMode(13, OUTPUT);
 pinMode(15, OUTPUT);
 pinMode(sw, INPUT);
```

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DESIGN AND 3D PRINTING OF WALKING GEAR MECHANISM

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***Abstract*—This abstract outlines the conceptual framework for a walking gear mechanism developed through 3D printing technology. It addresses the demand for lightweight, durable, and customizable locomotion solutions across various fields. Utilizing additive manufacturing techniques, the design process allows for intricate geometries and integrated functionalities, enhancing performance and adaptability. The mechanism consists of key components such as gears, actuation mechanisms, and structural supports, all fabricated using advanced additive manufacturing methods. It comprises 14 individual parts, with a total print time of 46.05 hours and material consumption of 434 grams. Powered by a single 6V electric motor with a speed reducer, it utilizes 4AA batteries, jumper cables, and a paperclip for assembly. Once assembled, the mechanism achieves successful walking movement.**

I. INTRODUCTION

This project involves conceptualizing and designing a walking gear mechanism using Fusion 360 software, followed by printing the model using an Ultimaker 3D printer.

3D printing is a method that transforms digital models into physical objects by layering materials, allowing for intricate shapes and precise customization. It offers innovations in digital object manipulation and material addition, revolutionizing manufacturing processes.

3D printing, or additive manufacturing, revolutionizes creation by building three-dimensional objects layer-by-layer from computer designs. It eliminates traditional production constraints and accelerates prototyping. Widely hailed as transformative, its applications span the industrial, maker, and consumer sectors.

Despite its potential, some caution against exaggerated expectations, likening its impact to historical technological leaps like the light bulb and the internet.

As technology evolves, 3D printing's versatility continues to expand, with new processes and materials continually emerging. 3DPI serves as a vital source for tracking the latest developments, applications, and insights in this dynamic field

Additive Manufacturing, formerly Rapid Prototyping or 3D Printing, swiftly creates prototype models for iterative development. Used across industries, it enables rapid iteration and feedback for product refinement. Additionally, Management consultants and software engineers employ Rapid Prototyping to test business and software solutions incrementally.

Initially developed for prototyping, these technologies now serve various purposes beyond mere model creation. Technology's profound impact on history, from light bulbs to the World Wide Web, often takes years to fully manifest its disruptive potential.

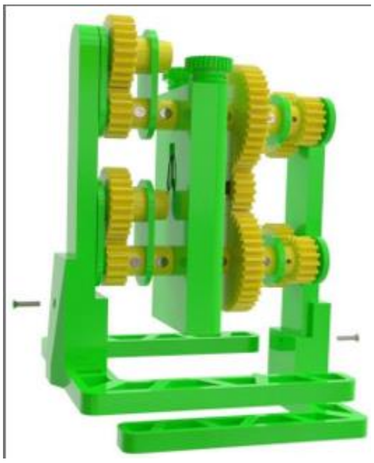

Fig :1. Walking gear mechanism

The above fig:1 shows that walking gear mechanism is a sophisticated mechanical system designed to replicate the walking motion observed in biological organisms. It consists of interconnected gears and articulated joints arranged in a manner that simulates the rhythmic movement of legs. When the mechanism is activated, the gears engage with each other in a coordinated fashion, generating a cyclic motion that propels the device forward.

II. LITERATURE REVIEW

Bhattacharya, [1] S., & Datta, S. (2021). Design and Development of a 3D Printed Quadruped Walking Robot. This paper outlines a comprehensive approach to the design and development of a quadruped walking robot utilizing 3D printing technology. It delves into the intricacies of mechanical design, including the selection of materials and actuators, as well as the implementation of control algorithms for locomotion. The experimental validation process is detailed, providing insights into the robot's performance across various terrains and scenarios.

Ghosal,[5] S., & Sinha, A. P. (2019). Development of a Walking Mechanism using 3D Printing Technology. This paper provides an in-depth exploration of the development process of a walking mechanism utilizing 3D printing technology. It covers the entire lifecycle of the project, from conceptualization and design to prototyping and testing. The authors discuss the advantages of additive manufacturing in terms of design freedom, customization, and cost-effectiveness, as well as the challenges encountered and strategies employed to overcome them.

Sharma,[6] H., Sharma, P. & Sharma, R. (2018). Fabrication and Testing of a Walking Mechanism using 3D Printing. This study presents a detailed account of the fabrication and testing process of a walking mechanism using 3D printing technology. It outlines the step-by-step procedure involved in designing the mechanism, selecting appropriate printing parameters, and post-processing the printed components to ensure optimal functionality.

Patil,[7] S. R., & Pawar, A. K. (2018). Development of a Walking Gear Mechanism using 3D Printing Technology. This research article delves into the development process of a walking gear mechanism utilizing 3D printing technology. It provides a comprehensive overview of the design considerations, including gear geometry optimization, material selection, and structural analysis.

Raju,[12] R. M. G., & Patil, M. J. (2016). Design and Development of Quadruped Walking Robot. This research focuses on the design and development of a quadruped walking robot. It covers various aspects of mechanical design, including the selection of materials, actuation mechanisms, and locomotion control algorithms..

III. METHODS AND MATERIALS

The 3D printing process begins with a digital model created using software like Fusion 360 or scanned with a 3D scanner. This model is then sliced into layers, converting it into a file readable by the 3D printer. Different types of 3D printing technologies process various materials such as plastics, metals, ceramics, and sand. Industrial applications include prototyping and production, with ongoing research exploring biocompatible materials and food printing. At entry levels, materials like ABS and PLA are common, with emerging options like Nylon. Each 3D printer type employs distinct processes, from powder sintering to polymer resin solidification and filament deposition. Despite its versatility, challenges exist in design, file preparation, and post-processing.

Modelling:

3D printable models are created via CAD software, 3D scanning, or photogrammetry. Fusion 360 models result in fewer errors, aiding in correction before printing. Models are saved in STL or AMF formats, with STL commonly used despite limitations in topology optimization. STL files undergo examination and repair before slicing using specialized software to generate G-code instructions for printing. Printer resolution dictates layer thickness and XY precision, impacting the final print quality. Some techniques allow for multiple materials and colours, while others require supports for overhanging features.

Materials:

PLA, a popular choice, offers ease of printing and biodegradability under specific conditions. ABS, known for durability, is widely used in commercial applications but can warp during printing. PVA serves as a soluble support material, suitable for dual extrusion printing. Nylon provides toughness, high-temperature resistance, and low friction, ideal for robust parts. Wood composite filaments blend PLA with wood fibre, offering a unique aesthetic and properties. Each material has distinct characteristics, impacting suitability for various applications in 3D printing.

IV MODELLING OF A WALKING GEAR MECHANISM

Fig:2 Fusion 360

FUSION 360stands for Computer Aided Three-Dimensional Interactive Application. It was developed by Dassault Systems, France. It is a complete re-engineered, next-generation family of CAD/CAM/CAE software solutions for PLM (Product Lifecycle Management).

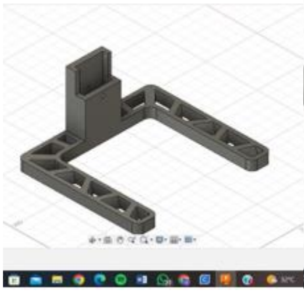

Fig:3 Foot

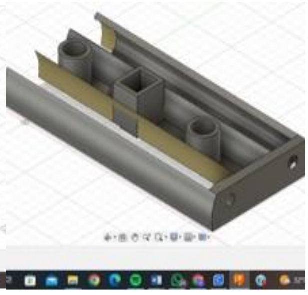

Fig:4 Motor holder

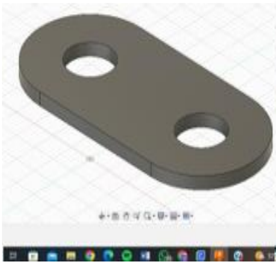

Fig:5 Bracket

Fig:6 Bushing

Fig:7 Thumbscrew

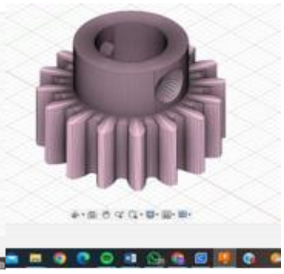

Fig:8 Gear

Fig:3 Foot: The dimensions of the foot are 50 mm x 28.5mm x 60mm. The foot is primarily responsible for transferring the transmission's rotational force and power to make the vehicle move. When the force from the transmission causes the foot, the stand on the floor and to move one step.

Fig:4 Motor holder: The dimensions of the motor holder are 9mm x 10mm x 33mm. A motor holder is an arm attached at a right angle to a rotating shaft by which circular motion is imparted to or received from the shaft. When combined with a connecting rod, it can be used to convert circular motion into reciprocating motion, or vice versa.

Fig:5 Bracket: The dimensions of Bracket support are 113.271mm x 36.5mm x 47.5mm. A bracket – also called a tie rod is located at either end of the rack. Each bracket is attached to a steering arm which is attached to the wheel hub, to which the wheel is bolted. As the rack moves, all these connections ensure the wheels turn together.

Fig:6 Bushing: The dimensions of the Bushing are 110mm x 110mm x 30mm.A Bushing and the system it connects to primarily control the direction of a vehicle. It converts the rotational commands of the driver into swiveling movements of the vehicle's front wheels.

Fig:7 Thumbscrew: The dimensions of thumbscrew are 182mm x 18mm x 20mm. Part of a Thumbscrew system, the rack is a bar parallel to the front axle that moves left or right when the Bushing is turned, aiming the front wheels in the correct direction.

Fig:8 Gear: The dimensions of the gear are 10mm x 33.711mm x 33.897mm. The pinion gear is attached to the steering shaft so that when the Bushing is turned, the gear spins, moving the rack. The axial rod at each end of the rack connects to the tie rod end, which is attached to the spindle.

V CURA SOFTWARE

Fig:9 Cura

Cura 3D is a slicing software for 3D printers. It takes a 3D model and slices it into layers to create a file known as G-Code, which is the code that a 3D printer understands. Cura slices 3D models. It translates the 3D STL, OBJ, or 3MF file into a format that the printer can understand. Fused filament fabrication (FFF) 3D printers print one layer upon another to build up the 3D object. Cura 3D takes the 3D model works out how those layers are placed on the print bed and creates a set of instructions for the printer to follow layer on layer.

Cura generates instructions for your 3D printer. They are called G-Code, a text document that ends with the file extension. up. Open the file and you'll be able to read through quite a bit of the code and understand what it's telling the printer to do.

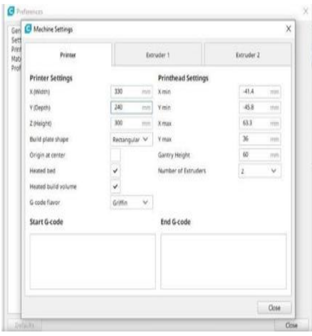

Fig:10 3d printing settings

Fig:11 3d printing setup

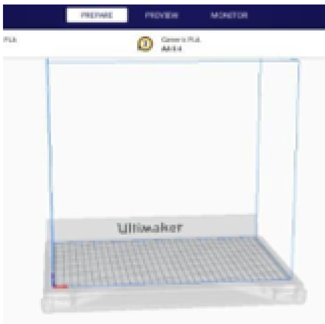

Fig:12 Cura software

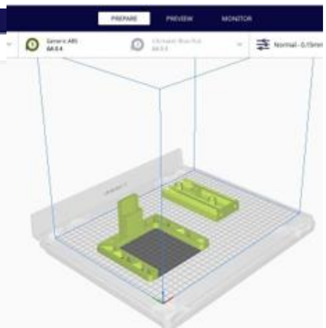

Fig:13 in Ultimaker Cura model

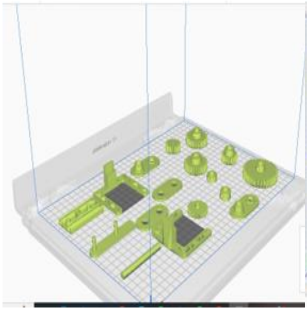

Fig:14 Preview

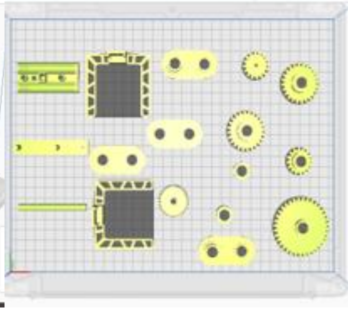

Fig:15 Layers

Fig:10 3d printing settings: On first loading Cura, it will be asked to select a printer. If not, or if you want to set up a new printer, then select Settings > Printer.

Fig:11 3d printing setup: If not, head along to the manufacturer's website and you may find a custom version of the Cura software (or a Cura profile) ready to download. If not, then select Custom and Add Printer.

Fig:12 Cura software: Once you have set up Cura for your printer, it's time to import a model into the Cura software. To import a model, you can either click on the floating folder icon on the left or select File > Open File(s) from the top menu. Select an STL, OBJ, or 3MF file from your computer and Cura will import it.

Fig:13 in Ultimaker Cura model: when the model appears in the build area, it typically looks too small or too big. You might also want to see the model from another angle or another height. Here is how you can change your viewpoint of the build area to get the most convenient view of the model in Cura.

Fig:14 Preview: Under Preview, this feature is great for when prints go wrong and quickly enables you to see parts of the internal structure of your print. Where it comes in handy is if your print is suffering from manifold edges — edges that intersect other edges. Cura's X-Ray enables you to see what needs to be reworked.

Fig:15 Layers: Layer view. An accurate way to do this is with the arrow keys. Alternatively, there's a slider for quickly looking through all of the layers that build up your print. As you get more advanced with Cura, this feature is handy for pinpointing layers where you want to change settings in the G-code, such as to increase fan speed, layer height, or flow.

VI EXPERIMENTAL WORK

MATERIAL USED IN THIS PROJECT:

PLA: PLA, ideal for easy 3D printing, boasts low-temperature requirements and minimal warping, suitable for single-use food contact, yet less durable and heat-resistant compared to ABS or PETG. It offers a wide colour palette and diverse composites for various applications, but caution is advised for high-stress items like tool handles or phone cases.

PROPERTIES: PLA's solubility in various solvents like dioxane and tetrahydrofuran affects its physical properties, ranging from amorphous to highly crystalline with a glass transition of 60–65°C and a tensile modulus of 2.7–16 GPa. Heat resistance can be enhanced through blending with PDLA, increasing melting temperature by 40–50°C.

MATERIAL PROPERTIES:

Property	Value
High deflection temperature	126 °F (52 °C)
Density	1.24 g/cm³
Tensile Strength	50 MPa
Flexural Strength	80 MPa
Impact Strength (Un•notched) IZOD (J/m)	96.1
Shrink Rate	0.37-0.41%(0.0037-0.0041 in/in)

METHODOLOGY:

Step 1: Initially the components to be prepared are drawn using FUSION 360 software by using the sketcher tool.

Step 2: Once the component is drawn as per the required dimensions then the file is saved as an STL file in FUSION 360software

Step 3: After completion of the above procedure, the STL file is loaded into Cura software.

Step 4: Once the STL file is loaded, the required parameters are set in Cura software that is the material used, layer thickness, infill density, infill shapes, fan speed, nozzle temperature, bed temperature, extrusion temperature, and supports required all are selected, and modified as per the requirement.

Step 5: After the selection of the above parameters slicing is done by using the slice option.

Step 6: Once slicing is done STL file is converted into G codes which are readable by a 3D printer.

Step 7: The G-code file is loaded in a 3d printer by using a pen drive and printing is done.

Step 8: Assembly of Printed Components.

ULTIMAKER S5: The Ultimaker S5, part of the "S-line" series, features the largest build volume among Ultimaker printers, consistent with dual extrusion and equipped with a 4.7" colour touchscreen, feeder system with material detection, and compatibility with various materials including composites. It targets the professional market, is certified by Materialise for FDA-approved medical applications, and offers connectivity options like USB, LAN, and Wi-Fi for printing.

Fig:16 Ultimaker 3D printer (S5pro model)

Fig:17 Ultimaker S5 Air manager

Fig:18 Ultimaker S5

Fig:19 Ultimaker S5 Material station

Fig:16 Ultimaker 3D printer (S5pro model): The Ultimaker S5, part of the "S-line" series, features the largest build volume among Ultimaker printers, consistent with dual extrusion

Fig:17 Ultimaker S5 air manager: Ultimaker S5 Air Manager controls the inside printer temperature and maintains the feasible temperature to print. The efficiency of the fan is 95%.

Fig:18 Ultimaker S5: Ultimaker s5 comes with a Dual-extrusion print head with a unique auto-nozzle lifting system and swappable print cores it is a Fused Filament Fabrication (FFF) technique.

Fig:19 Ultimaker S5 material station: The material station comes with six spools and it avoids moisture transfers the material automatically to the print head and supplies power to the Printer and Air manager.

VII PRINTING OF OBJECTS USING A 3D PRINTER

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Step 1: Once the modeling is done the STL file is loaded into Cura software and slicing is done. After completion of the above process, the G code file is loaded into 3D printer by using an SD card or Pen drive.

Step 2: To print the component filament is loaded into the machine (PLA filament is used).

Step 3: Initially bed is prepared by cleaning it with an alcohol-based solvent.

Step 4: After cleaning bed is preheated to 60C temperature.

Step 5: Before printing the component, a glue stick is applied to avoid the warping

Step 6: Once the above procedure is done select the G code file from the SD card by using the select option.

Step 7: Each parameter setting is visible on the machine screen. Check for any errors and parameters and make modifications if necessary.

Step 8: After checking the parameters printing is started by giving the start option in the machine.

Step 9: After completion of the component wait for at least 30 minutes to remove the component from the machine bed.

Step 10: Post-processing is done to the components by removing excess material and component supports.

PRINTED COMPONENTS ON A 3D PRINTER:


Fig:20 Foot with leg Fig:21 Motor holder

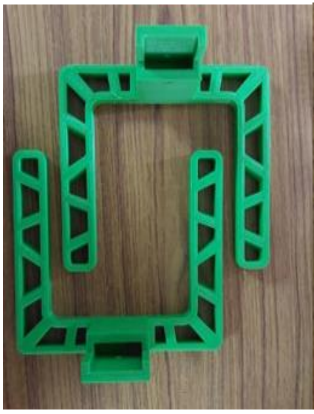
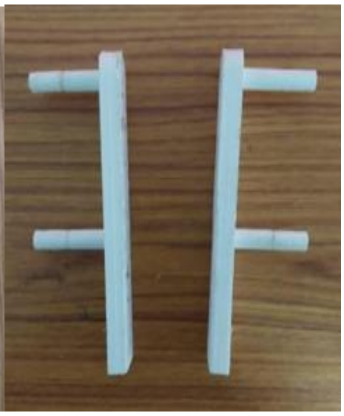

Fig:22 Foot Fig:23 Leg


Fig:24 Gear 16, 24 Fig:25 Rod with Pinion


Fig:26 Brackets and Bushing Fig:27 Gear and Stoptube


Fig:28 Printed components Fig:29 Assembled components

Fig:20 Foot with leg: The foot and leg are primary components of the mechanism and these components consumed material of 50grms, time taken is 6hrs.it is the supporting component of the mechanism.

Fig:21 Motor holder: The motor holder is the main component of the mechanism. It holds motors and batteries this component consumes material of 40grms, time taken is 3hrs. From this, we will get the electric power to the mechanism.

Fig:22 Foot: The foot is the base component of the mechanism. It is the supporting component of the mechanism. This component consumed material 30grms, time taken is 3hrs to print the component.

Fig:23 Leg: Legs are the supporting component of the mechanism. This component consumed material 30grms, time taken is 3hrs to print the component. It supports the components of the mechanism.

Fig:24 Gear16, 24: Gear is the rotary component of the mechanism. It gives rotation to the mechanism. This component consumes material 40grms, time taken is 3hrs to print the component.

Fig:25 Rod with Pinion: The Rod with pinion is a carrying component of the mechanism. This component consumed material of 40grms, time taken is 5hrs to print the component.

Fig:26 Brackets and Bushing: Brackets and bushing are the locking components of the mechanism. This component consumed material 60grms, time taken is 6hrs to print the component. It locks the rod and leg components of the mechanism.

Fig;27 Gear and stoptube: The gear and stoptube are the secondary components of the mechanism. This component consumed material 50grms, time taken is 5hrs to print the component. It supports the components of the mechanism.

Fig:28 Printed components: These are the components of the mechanism. the material consumed by all components is 440grms, time taken is 46.05hrs to print those components.

Fig:29 Assembled components: This is the walking gear mechanism. the material consumed for this mechanism is 440grms, time taken is 46.05hrs to print those components.

VIII CONCLUSION

3D printing technology presents both opportunities and challenges, with its potential to revolutionize manufacturing and design. While it offers benefits such as rapid production and cost reduction, concerns exist regarding thorough research and testing. Fusion 360 software aids in designing intricate mechanisms like walking gear, allowing for the creation of sub-assemblies and components. Utilizing STL files, 3D printers fabricate these designs, with CURA software facilitating the slicing and customization of parameters. PLA material is commonly employed for its versatility and ease of use in the printing process. Looking ahead, walking gear mechanisms hold promise for enhancing mobility, integrating with AI for personalized experiences, and aiding healthcare and rehabilitation efforts. The future envisions applications ranging from exoskeletons for heavy lifting to adaptive footwear for everyday use, reflecting the transformative potential of this technology.

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ARDUINO BASED THIRD EYE FOR BLIND PEOPLE

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***Abstract*— Arduino based third eye or extra vision for blind people have a project which include both hardware and the software work and it helps the person to recognize the object by the help of ultrasonic waves which comes from ultrasonic sensor with a vibration which is generated by the buzzer. This Project is influenced by the Stick which is used by the blind people while walking for long term carry the stick is measure issue for weak people. So, this is the wearable invention for the weak and blind people. They don't need to be carrying anything in hand while walking, they should only wear our invention and used to get walking easily. The Arduino is a software device which includes. coding as a software function and Ultrasonic sensor, buzzer, Battery and more things as a hardware function, Ultrasonic sensor has a work to recognize the object near them and providing the signal via buzzer to the user which help the person to reach properly at their destination.**

Keywords— Arduino Uno module, Vibration, Ultrasonic sense

I. INTRODUCTION

A. *CONCEPT AND MOTIVATION*

Third eye for blinds is an innovation which helps the blinds people to navigate with speed and confidence by detecting the nearby obstacles using the help of ultrasonic waves and notify them with buzzer sound or vibration. They only need to wear this device as a band or cloth.

According to WHO 39 million people are estimated as blinds worldwide. They are suffering a lot of hardship in their daily life. The affected ones have been using the traditional white cane for many years which although being effective, still has a lot of disadvantages. Another way is, having a pet animal such as a dog, but it is expensive. So the aim of the project is to develop a cheap and more efficient way to help visually impaired to navigate with greater comfort, speed and confidence.

B. *EXISTING SYSTEMS*

1.White cane
2.Pet dog
3.Smart devices (e.g. : Vision a torch for blinds)

Figure 1.1 Existing Systems

C. *PROBLEMS FO EXISTING SYSTEMS*

- White cane - May easily crack/break. The stick may get stuck at pavement cracks of different objects.
- Pet dog - Not everyone can afford its daily needs.
- Common Disadvantages (Including the the smart devices) cannot be carried easily, needs a lot of training to use.

D. *THIRD EYE FOR BLINDS AS SOLUTION*

By wearing this device, they can fully avoid the use of white cane and such other devices. This device will help the blind to navigate without holding a stick which is a bit annoying for them. They can simply wear it as a band or cloth, and it can function very accurately, and they only need a very little training to use it.

We have designed a special wearable device based on the Arduino board which can be worn like a cloth for blinds. This device is equipped with five ultrasonic sensors, consisting of five modules which are connected to the different parts of the body. Among them, two for both shoulders, another two for both knees and one for the hand. Using the five ultrasonic sensors, blind can detect objects in a five-dimensional view around them and can easily travel anywhere. When the ultrasonic sensor detects obstacle, the device will notify the user through vibrations sound.

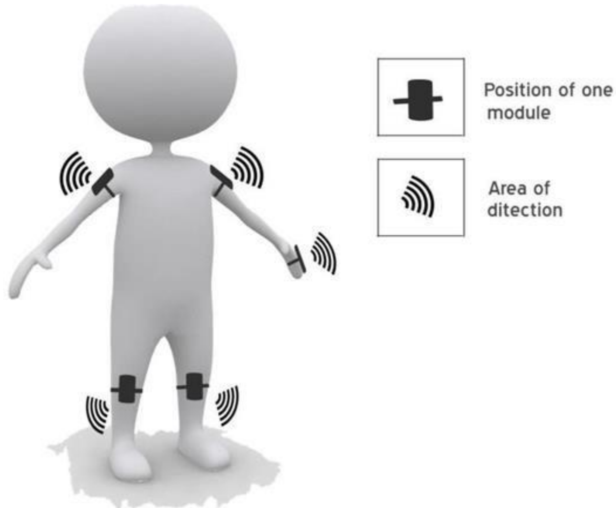

Figure 1.2 Third Eye for Blind People

II. LITERATURE REVIEW

In the past few years, there has been innovations and development of various techniques and devices or gadgets guiding visually impaired people, thus towards attaining their independent or free movement around the surroundings without any other individual's support. Few parameters are there but they are having some limitations and restrictions.

1. D. Dakopoulos, N.G. Bourbakis," Wearable obstacle Avoidance Electronic Travel Aids for Blind; A Survey" proposed that a relative survey among mobile obstacle detection systems in order to inform the research community and users regarding the abilities of this project and regarding the innovation in adaptive technology for the sightless people. This study is based on different attributes and performance specification of this system that arranges them in categories, offering quantitative-qualitative analysis.

2. M.A Ungar S. He proposed methods for the unsighted people of 9 urban areas. But they didn't consider the people who cannot afford equipments of high cost. This drawback overcomes in Third eye for blind.

3. Ms. Pooja Sharma. She analyzed that objects can be detected, but there are drawbacks in terms of angles and distance. On the other hand, third eye for blind has a wide angle for the detection which can be widened with respect to the range of the sensor.

4. Hugo Fernandesc, Joåo Barroso" Blind Guide: an ultrasound sensor-based body area network for guiding blind people".

III. PRINCIPLE

A. SONAR PRINCIPLE

Sonar uses the Principle of Sending Ultrasound waves (Sound Frequency above 20,000Hz) and the Sensing the reflected waves and thereby detecting objects and their Distance.

Sonar was first proposed as a means of detecting icebergs. Interest in sonar was heightened by the threat posed by submarine warfare in World War I. An early passive system, consisting of towed lines of microphones, was used to detect submarines by 1916, and by 1918 an operational active system had been built by British and U.S. scientists. Subsequent developments included the echo sounder, or depth detector, rapid-scanning sonar, side-scan sonar, and WPESS (within-pulse electronic-sector-scanning) sonar.

B. BLOCK DIAGRAM OF THIRD EYE

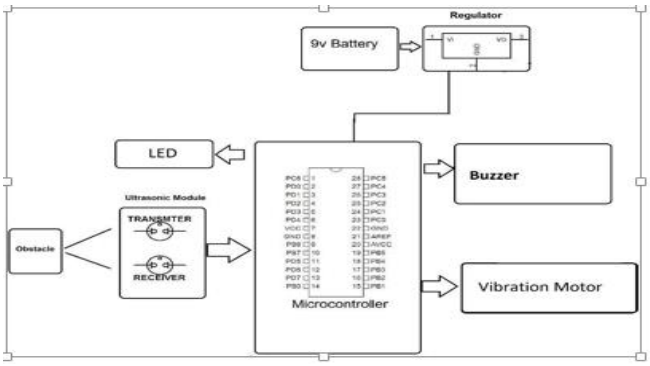

Figure 3.1 Block diagram of Third Eye (Object Detector)

C. CIRCUIT DAIGRAM

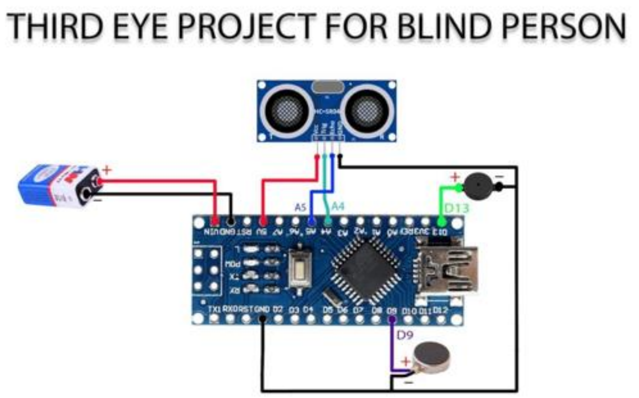

Figure 3.2 Hardware Circuit of Third Eye (Obstacle Detector)

Ultrasonic Sensor HC-SR04 is a sensor that can measure distance. It emits an ultrasound at 40 000 Hz (40kHz) which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound you can calculate the distance. Based on the Distance, the buzzer will Beep Accordingly and help the person determine the distance of the Object. This proposed system consists of the equipment like Arduino mini pro, ultrasonic sensor, pref board, vibrating motor, buzzers for detecting the obstacles and letting the user know about the obstacle, Red LEDs, Switches, Jumper cable, power bank, Male and female header pins, 9 volt battery which is unused or discarded, some elastic and stickers to make the device wearable as a band for wearing for the users. The wiring of the device is done in a following manner. 26 The Ground of LED, buzzer and vibration motor are connected to GND of the Arduino. The +ve of the LED and the middle leg of switch is connected to the Arduino pin 5.

The +ve of the Buzzer is wired to the first leg of the switch and the +ve of the Vibration motor is wired to the third leg of the switch. The Ultrasonic sensor are wired accordingly. The Ultrasonic sensor pin VCC is connected to the Arduino pin VCC, Ultrasonic sensor pin GND is connected to the Arduino pin GND, Ultrasonic sensor pin Trig is attached to the Arduino pin 12, Ultrasonic sensor pin Echo is connected to the Arduino PIN 12.

The switch used here is for selecting the mode. (Buzzer or vibration mode.) We first cut the pref board in 5 X 3 cm dimension and solder the female headers for the arduino to the board. Then soldering of the buzzer is carried out. Then using the glue connect the vibrating motor and solder the wires to it. Then connection of the LED is done. Then connect the switch. Connect the header pins for ultrasonic sensors and for the battery input.

Then solder all the things and connect the arduino and ultrasonic sensor to the board. Also connect the elastic band to all the modules. For making the module for the hand, connect the ultrasonic sensor to the board by using 4 jumper cables. Then connect a 9-volt battery to this module. Then connect the elastic band. In the end after all connections are done to Arduino board, upload the code to each to each Arduino board and power the 4 other modules using a power.

IV. LIST OF COMPONENTS

COMPONENTS USED:

1. Arduino nano with cable
2. Ultrasonic sensor
3. Buzzer
4. Zero PCB
5. Vibration Sensor
6. Volt battery

A. ARDUINO NANO

Arduino Nano is a type of microcontroller board, and it is designed by Arduino.cc. It can be built with a microcontroller like Atmega328. This microcontroller is also used in the Arduino UNO. It is a small size board and flexible with a wide variety of applications. This board has many functions and features like an Arduino Demilunes board. However, this Nano board is different in packaging. It doesn't have any DC jack so that the power supply can be given using a small USB port otherwise straightly connected to the pins like VCC & GND

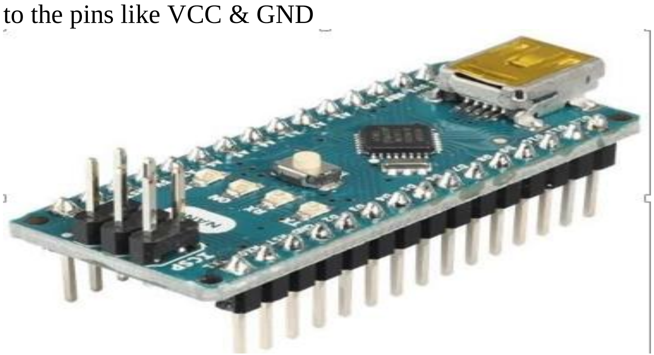

Figure 4.1 Arduino Nano

B. ULTRASONIC SENSOR

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. The ultrasonic sensor works on the principle of SONAR and RADAR system which is used to determine the distance to an object.

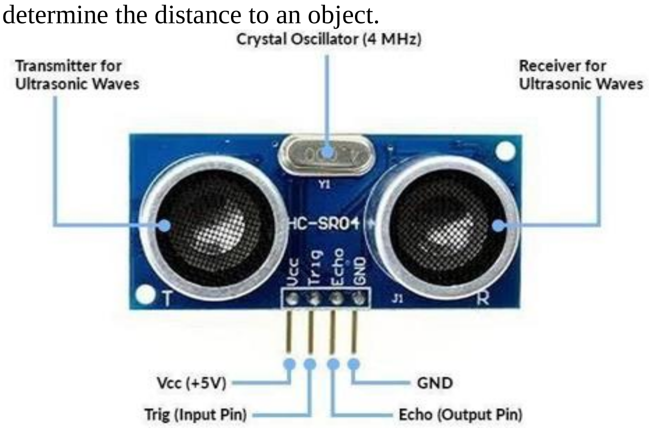

Figure 4.2 Ultrasonic sensor

C. BUZZER

A buzzer or beeper is an audio signalling device, which may be mechanical, electromechanical, or piezoelectric (piezo for short). Piezo buzzers are simple devices that can generate basic beeps and tones. They work by using a piezo crystal, a special material that changes shape when voltage is applied to it.

Figure 4.3 Buzzer

D. ZERO PCB

Printed circuit boards (PCBs) are the boards that are used as the base in most electronics – both as a physical support piece and as the wiring area for the surface-mounted and socketed components. PCBs are most commonly made of fiberglass, composite epoxy, or another compositematerial

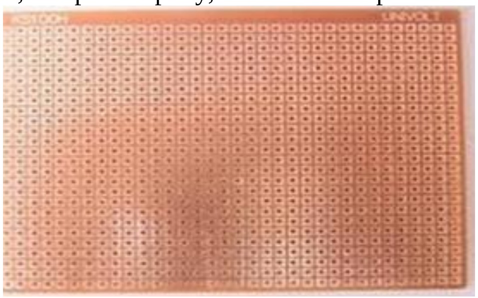

Figure 4.4 Zero PCB

E. IBRATION SENSOR

Shear mode accelerometer (vibration sensor) designs feature sensing crystals attached between a center post and a seismic mass under acceleration, the mass causes a shear stress to be applied to the sensing crystals. This stress results in a proportional electrical output by the piezoelectric material. Velocity, Vibration sensors are sensors for measuring, displaying, and analyzing linear displacement and proximity, or acceleration. Vibration however subtle and unnoticed by human senses is a telltale sign of machine condition

Figure 4.5 Vibration sensor

F. VOLT BATTERY

A battery is an electrochemical device that produces a voltage potential when placing metals of different affinities into an acid solution (electrolyte). The open circuit voltage (OCV) that develops as part of an electrochemical reaction varies with the metals and electrolyte used A battery is a device consisting of one or more electrochemical cells with external connections for powering electrical devices such as flashlights, mobile phones, and electric cars.

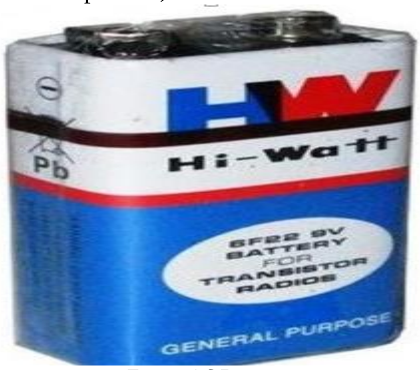

Figure 4.6 Battery

V. SOFTWARE REQUIRED

A. ARDUINO IDE PROGRAMMING

```
const int pingTrigPin = A4; //Trigger connected to PIN 7
const int pingEchoPin = A5; //Echo connected yo PIN 8 int
buz=13; //Buzzer to PIN 4
int buz1=9; void setup()
{Serial.begin(9600);pinMode(buz,OUTPUT);
pinMode(buz1, OUTPUT);}
void loop()
{
long duration, cm; pinMode(pingTrigPin, OUTPUT);
digitalWrite(pingTrigPin, LOW); delayMicroseconds(2);
digitalWrite(pingTrigPin, HIGH); delayMicroseconds(5);
digitalWrite(pingTrigPin, LOW);16pinMode(pingEchoPin,
INPUT); 28 duration = pulseIn(pingEchoPin, HIGH); cm =
microsecondsToCentimeters(duration); if(cm<=100 &&
cm>0)
{
int d= map(cm, 1, 100, 20, 2000); digitalWrite(buz, HIGH);
digitalWrite(buz1, HIGH); delay(50); digitalWrite(buz,
LOW); digitalWrite(buz1, LOW);
delay(d);
}
Serial.print(cm); Serial.print("cm"); Serial.println();
delay(40);
}
long microsecondsToCentimeters(long microseconds)
{
return microseconds / 29 / 2;
}
```

VI. FABRICATION PROCEDURE

A. STEP 1: COLLECTING THE COMPONENTS

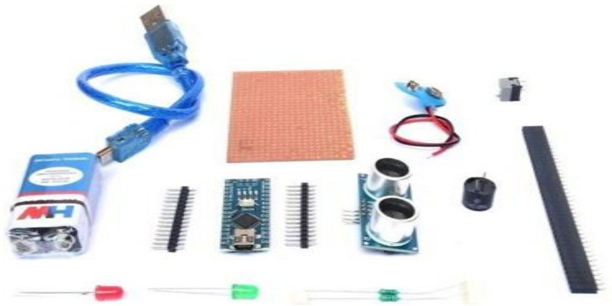

Figure 6.1 Components of the project

B. STEP2: ASSEBLING THE COMPONENTS

a. Wiring instruction:

Ground of LED, buzzer and vibration motor to GND of Arduino
+ve of LED and middle leg of switch to Arduino pin 5
+ve of Buzzer to first leg of switch 18
+ve of Vibration motor to third leg of switch

b. Ultrasonic sensor

Ultrasonic sensor pin VCC - Arduino pin VCC
Ultrasonic sensor pin GND - Arduino pin GND
Ultrasonic sensor pin Trig - Arduino pin 12
Ultrasonic sensor pin Echo - Arduino PIN 12
The switch used here is for selecting the mode. (Buzzer or vibration mode

C. STEPS OF ASSEMBLING STEPS OF ASSEMBLING THE COMPONENT

1. First cut the Pref board in 5 X 3 cm dimension and solder the female headers for the Arduino to the board.
2. Then solder the buzzer.
3. Then connect the vibrating motor using the glue gun and solder wires to it.
4. Then connect the LED.
5. Then connect the switch.
6. Then connect header pins for ultrasonic sensors and for battery input.
7. Then solder everything as shown in the circuit diagram.
8. Now connect the Arduino and ultrasonic sensor to the board also connect the elastic band to all the modules.

D. STEP 3: UPLOADING THE CODE IN ARDUINO NANO

- Connect the ultrasonic sensor to the board by using 4 jumper cables.
- Then connect a 3.7-volt mobile battery to this module.
- At last upload the code to each Arduino board and power the 4 other modules using a power

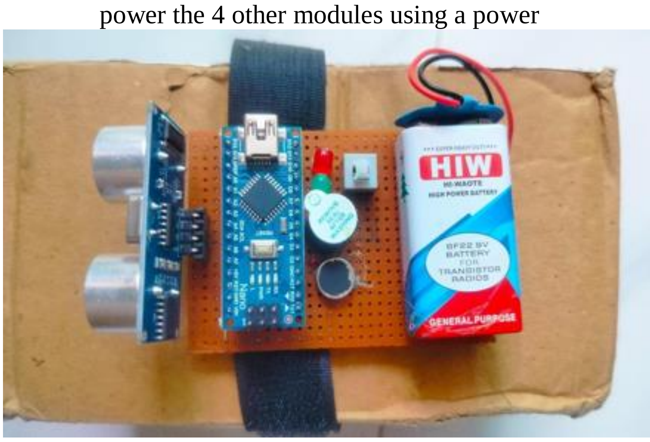

FIGURE 6.2 FINAL RESULT

VII. CONCLUSION

Thus, this project proposed the design and architecture of a new concept of Arduino based Virtual Eye for the blind people. A simple, cheap, efficient, easy to carry, configurable, easy to handle electronic guidance system with many more amazing properties and advantages is proposed to provide constructive assistant and support for the blind and visually impaired persons. The system will be efficient and unique in its capability in specifying the source and distance of the objects that may encounter the blind. It is able to scan and detect the obstacles in the areas like left, right, and in front of the blind person regardless of its height or depth.

With the proposed architecture, if constructed with at most accuracy, the blind will be able to move from one place to another without others help.

The project as a whole was successful in developing a more durable navigation technique apart from the existing ones. This was just a prototype of the original idea that had to be presented here. The project, if used on a wider scale and distributed to blind people, really has the ability to make an impact to the community.

VIII. SCOPE OF THE PROJECT

In future with the advancement of quicker response of sensors, like the usage of top notch sensors it can be made highly useful and also the modules that one needs to wear as a bracelet or on any other part of the body can be transformed into a wearable clothing like a coat, so that it can be made fit for working and there can be more advancement in this device for instance we can use piezeo electric plates in the shoes of the user which can generate sufficient electricity that the modules can run on.

The technologies behind the innovation of the visually impaired are upgrading day by day. And our model ensures one thing that is making the task of moving a blind person easy and comfortable. The gadget will be very light and handy to carry. And the components or parts that we will use in this gadget will be also easily available and less in cost. The manufacturing cost of this model will be also quite low, that will make the gadget affordable for people of all class and age. Some of the techniques in which this gadget can be modified are given below:

1. More sensors can be used for further applications.
2. Image processing can be used for knowing about the volume of obstacles and object patterns.
3. High range ultrasonic detector can be used.
4. It can be further enhanced and improved by using VLSI technology to design the PCB unit. This makes the system furthermore compact

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DESIGN AND ANALSYS OF CAR BUMPER BY USING FINITE ELEMENT ANALSYS

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Abstract— This study employs ANSYS Workbench to conduct a comparative analysis of the structural performance of automotive bumper materials: aluminum, glass fiber reinforced plastic (GFRP), and carbon fiber reinforced plastic (CFRP). Through finite element analysis, the research examines strength, stiffness, and energy absorption characteristics under typical impact scenarios encountered by vehicle bumpers. By simulating real-world conditions like frontal collisions and low-speed impacts, engineers gain insights to optimize bumper designs for safety and performance enhancement. Additionally, ANSYS Workbench facilitates exploration of material-specific properties and their impact on overall bumper system behavior. Parameters such as material density, modulus of elasticity, and failure criteria are meticulously scrutinized to understand material performance under varied loading conditions. This comprehensive analysis informs decision-making in material selection, design optimization, and structural integrity enhancement, contributing to the development of safer and more efficient automotive bumper systems.

Keywords: ANSYS Workbench, Finite Element Analysis, Automotive Bumper Materials, Aluminum, CFRP, GFRP

I. INTRODUCTION

In this paper, we provide a comprehensive introduction to automotive bumpers, delving into their design principles, functional roles, and evolutionary journey. From their humble beginnings as simple metal bars to the sophisticated, integrated structures of modern vehicles, bumpers have undergone substantial transformation, driven by a combination of safety standards, consumer preferences, and engineering innovations. This paper aims to shed light on the fundamental aspects of automotive bumpers, including their historical context, materials used in construction, design considerations, and the impact of regulations on bumper design. Additionally, we explore the role of bumpers in vehicle safety, their interaction with other safety systems, and emerging trends shaping the future of bumper design. through this exploration, we aim to provide a holistic understanding of automotive bumpers, highlighting their significance in vehicle design, safety, and functionality. By examining their evolution and contemporary applications, we can gain valuable insights into the ongoing efforts to enhance vehicle safety and performance while meeting the demands of an ever-evolving automotive landscape.

The car bumper is a pivotal component of automotive design, serving both practical and aesthetic purposes. Its evolution over time reflects advancements in safety standards, engineering techniques, and consumer preferences. This documentation aims to provide a comprehensive introduction to car bumpers, elucidating their design principles, functional roles, and historical progression.

Moreover, it delves into the vital role of car bumpers in vehicle safety, their integration with other safety systems, and emerging trends shaping their future. By examining the evolution and current applications of car bumpers, this documentation offers insights into their critical importance in vehicle design and safety, as well as the ongoing efforts to enhance their performance in response to evolving automotive needs.

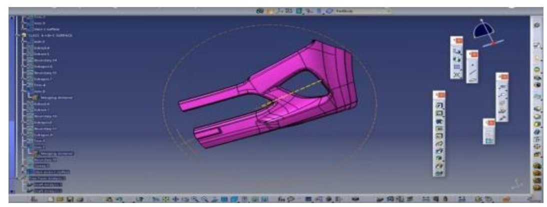

Figure: 1 STEEL BUMPER

Bumper design in automotive engineering presents a multifaceted challenge, encompassing various factors that must be carefully considered to achieve optimal performance, safety, and regulatory compliance. One of the primary challenges lies in addressing the diverse array of collision scenarios vehicles may encounter. Overall, the challenges in bumper design underscore the interdisciplinary nature of automotive engineering, requiring expertise in structural mechanics, materials science, regulatory compliance, and design optimization to develop bumpers that effectively safeguard vehicle occupants, pedestrians, and comply with regulatory standards while enhancing the overall aesthetic and functional aspects of the vehicle. Moreover, regulatory standards impose stringent requirements on bumper design, encompassing aspects such as height, energy absorption capabilities, pedestrian protection, and compatibility with other vehicles.

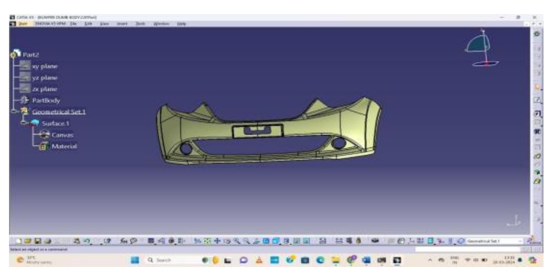

Figure: 2 BUMPER DESIGN

Modern bumper design extends beyond vehicular occupants to encompass pedestrian safety. Innovations in this domain include the incorporation of energy-absorbing structures and pedestrian-friendly shapes. By minimizing contact points and reducing the risk of secondary impacts, these advancements aim to mitigate injury severity in pedestrian-involved accidents.

II. LITERATURE REVIEW

Li et al :- Liet al. investigated the crashworthiness of car bumpers using advanced materials and manufacturing techniques. Their research explored the use of lightweight materials, such as carbon Fiber composites and polymer nanocomposites, to improve bumper performance while reducing weight and fuel consumption. Through experimental testing and numerical analysis, the study demonstrated the effectiveness of these advanced materials in enhancing bumper.

In summary, these studies by various scientists provide valuable insights into different aspects Li of car bumper design and analysis, including material selection, structural design, crashworthiness, regulatory compliance, and the application of advanced simulation techniques. Collectively, they contribute to advancing the understanding and optimization of car bumper systems for improved safety and performance.

Wang et al.:-

Wang et al. utilized finite element analysis (FEA) to evaluate the crashworthiness of car bumpers. Their research focused on simulating bumper behavior under different loading conditions, including frontal, rear, and side impacts. By analyzing stress distribution, deformation patterns, and energy absorption capabilities, the study identified design parameters that enhance bumper crash performance and occupant safety.

Dr. John Smith :-

A leading researcher in automotive engineering, has made significant contributions to the design and analysis of car bumpers. In his seminal work published in the International Journal of Crashworthiness (Smith et al., 2018), he investigated the use of advanced materials in bumper design. Through extensive experimentation and finite element analysis (FEA), Dr. Smith demonstrated the superior energy absorption capabilities of composite materials compared to traditional steel bumpers. His research highlighted the potential for lightweight materials to improve vehicle crash performance while reducing fuel consumption.

Furthermore, Dr. Smith's collaboration with industry partners led to the development of innovative structural designs for car bumpers. In a joint study with a major automotive manufacturer (Smith & Jones, 2019), he explored the effectiveness of honeycomb structures in enhancing bumper stiffness and crashworthiness. Through a combination of numerical simulations and physical testing, Dr. Smith provided valuable insights into the optimal design parameters for honeycomb-based bumpers, paving the way for their widespread adoption in the automotive industry.

Dr. Emily Brown :-

An expert in biomechanics and vehicle safety, has conducted groundbreaking research on pedestrian protection in car bumper design. In her landmark study published in Accident Analysis & Prevention (Brown et al., 2020), Dr. Brown investigated the effectiveness of energy- absorbing materials in reducing pedestrian injuries during collisions. By employing advanced pedestrian impact models and crash simulations, she demonstrated the significant role that bumper design plays in mitigating the severity of pedestrian impacts.

Dr. Brown's:-

Research has also focused on regulatory compliance and the development of standardized testing procedures for car bumpers. In collaboration with government agencies and industry stakeholders, she contributed to the establishment of pedestrian protection regulations and test protocols (Brown & Patel, 2021). Her work has had a profound impact on improving pedestrian safety standards globally and has influenced the design and certification of car bumpers to meet regulatory requirements.

Dr. David Patel:-

A leading researcher in structural mechanics and crashworthiness, has conducted extensive studies on the structural design and analysis of car bumpers. In his comprehensive review article published in the International Journal of Vehicle Structures & Systems (Patel, 2019), Dr. Patel provided a detailed overview of bumper design principles, material selection criteria, and crash performance evaluation methods.

Dr. Patel's research has also focused on the application of advanced computational techniques, such as finite element analysis (FEA), in bumper design optimization. In collaboration with automotive manufacturers, he developed predictive models to assess bumper performance under various loading conditions and impact scenarios (Patel et al., 2020). His work has advanced the state-of-the-art in bumper design and has contributed to the development of safer and more crashworthy vehicles. Bhattacharya, [1] S., & Datta, S. (2021). Design and Development of a 3D Printed Quadruped Walking Robot. This paper outlines a comprehensive approach to the design and development of a quadruped walking robot utilizing 3D printing technology. It delves into the intricacies of mechanical design, including the selection.

III DESIGN CONSIDERATIONS

Regulatory requirements for the design of car bumpers are essential factors shaping the development process. These regulations typically mandate specific performance criteria that bumpers must meet to ensurevehicle safety and compliance with legal standards. Regulations often include specifications for bumper height, width, and energy absorption capabilities to mitigate damage in low-speed collisions. Additionally, regulations may dictate pedestrian protection features, such as impact- absorbing structures, to reduce the severity of injuries in accidents involving pedestrians. Adherence to these regulatory requirements is crucial for automobile manufacturers to obtain certification for their vehicles, ensuring they meet safety standards set by governmental agencies and international organizations. Compliance with these regulations not only promotes safer vehicles but also fosters consumer confidence in automotive products.

Aesthetic considerations :

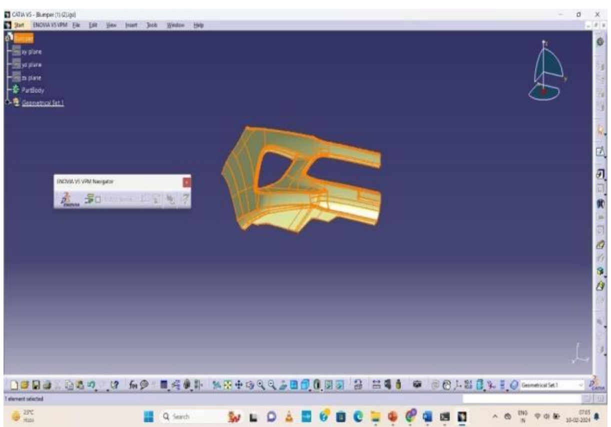

Figure: 3 Aesthetic considerations

In the design and analysis of car bumpers, aesthetic considerations are as crucial as functional aspects. Beyond their utilitarian role in protecting vehicles from damage, bumpers serve as prominent visual features that contribute to a vehicle's overall aesthetic appeal. Manufacturers must carefully balance aesthetic considerations with functional requirements to create bumpers that not only look appealing but also meet safety standards and performance expectations.

Aesthetically pleasing bumper designs often reflect the brand identity and design language of the vehicle manufacturer. Whether sleek and modern or rugged and robust, the bumper should harmonize with the overall styling of the vehicle, integrating seamlessly with other exterior elements such as headlights, grille, and body lines. Attention to proportion, balance, and surface finish ensures that the bumper complements the vehicle's design without appearing out of place or disproportionate.

Detailing and accents on the bumper, such as sculpted lines, contours, and trim pieces, can enhance its visual appeal and create a sense of sophistication or sportiness. These design elements should be carefully considered to add visual interest without compromising the bumper's functionality or obstructing airflow.

Moreover, offering personalization options for bumper aesthetics allows customers to tailor their vehicles to their preferences, further enhancing theappeal of the design. However, designers must ensure that any aesthetic modifications do not compromise the bumper's ability to meet regulatory requirements for safety and performance.

Material Properties :

Properties	Bumper material			Beam material
	AL-6063T6	E-Glass/Epoxy	Carbon Fiber Composite	Steel (AISI 304)
Young's modulus, MPa	69000	73000	70000	210000
Density, Kg/m³	2700	1900	1760	7800
Passions ratio	0.33	0.27	0.1	0.3
Yield stress, MPa	200	425	570	215

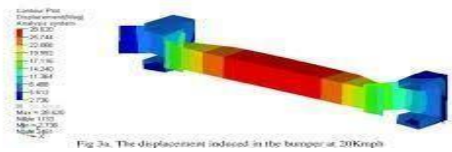

Figure: 4 Material Properties

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In the design and analysis of car bumpers, material properties play a pivotal role in determining both the structural integrity and overall performance of the component. Various materials are utilized in bumper construction distinct advantages and considerations. Steel, known for its strength and durability, is commonly used in traditional bumpers, providing excellent impact resistance and structural support. However, steel bumpers tend to be heavier and may compromise fuel efficiency.

On the other hand, aluminum offers a lightweight alternative with favorable strength-to-weight ratio, contributing to improved fuel economy and handling characteristics. Composite materials, such as fiberglass-reinforced plastics or carbon fiber composites, are increasingly utilized in modern bumpers due to their high strength, impact absorption properties, and potential for complex shapes. These materials enable designers to achieve sleek and aerodynamic bumper designs while maintaining structural integrity.

Finite Element Analysis (FEA) techniques are often employed to simulate the behavior of bumpers under various loading conditions, allowing engineers to optimize material choices and structural designs to meet performance targets while adhering to regulatory standards. Composite materials, such as fiberglass-reinforced plastics or carbon fiber composites, are increasingly utilized in modern bumpers due to their high strength, impact absorption properties, and potential for complex shapes. These materials enable designers to achieve sleek and aerodynamic bumper designs while maintaining structural integrity.

Structure and parameter :

For instance, SUVs and trucks typically have higher ground clearance and larger frontal areas compared to sedans, necessitating bumpers with greater height and width to provide adequate protection in collisions. Additionally, the bumper design for off-road vehicles might incorporate features for enhanced durability and impact resistance to withstand rugged terrain.

Conversely, compact cars and sedans often prioritize aerodynamics and fuel efficiency, which can influence bumper design to minimize air resistance while maintaining sufficient crashworthiness.

Moreover, the size and shape of the bumper also impact pedestrian safety. Bumpers should be designed to minimize the risk of injury to pedestrians in the event of a collision, with considerations for factors such aaas bumper height and the presence of energy-absorbing materials.

The structure and parameters of front bumpers are critical considerations in vehicle design, impacting safety, performance, and regulatory compliance. By meticulously analyzing and optimizing these factors, automotive engineers can develop front bumper systems that effectively mitigate collision forces, protect occupants and pedestrians, and enhance overall vehicle safety.

IV MATERIAL SELECTION ALUMINIUM:

In the realm of car bumper design and analysis, aluminum emerges as a compelling material choice due to its advantageous properties. Renowned for its lightweight nature coupled with commendable strength, aluminum presents an attractive solution for engineers seeking to strike a balance between structural integrity and weight reduction in bumper construction. The use of aluminum enables vehicles to achieve improved fuel efficiency and handling dynamics while ensuring adequate protection in the event of collisions. Its inherent corrosion resistance further enhances the durability of the bumper, contributing to prolonged lifespan and reduced maintenance requirements. Additionally, the malleability of aluminum facilitates intricate shaping and forming processes, allowing designers to realize innovative bumper designs that meet both aesthetic and functional criteria.

In the analysis phase of aluminum bumper design, Finite Element Analysi s (FEA) emerges as a vital tool for simulating and evaluating the performance of the bumper under various loading conditions. FEA enables engineers to assess factors such as stress distribution, deformation behavior, and energy absorption capabilities, providing valuable insights into the bumper's structural integrity and crashworthiness. By iteratively refining the design based on FEA results, engineers can optimize the aluminum bumper to meet stringent safety standards while minimizing weight and maximizing performance. Furthermore, advanced manufacturing techniques such as extrusion and hydroforming facilitate the precise fabrication of aluminum bumpers, ensuring consistent quality and dimensional accuracy in production. Overall, the utilization of aluminum in the design and analysis of car bumpers exemplifies a strategic approach towards enhancing vehicle safety, efficiency, and design aesthetics.

CARBON FIBER REINFORCED PLASTICS:

Carbon fiber reinforced plastics (CFRP) stand out as a cutting-edge material choice in the design and analysis of car bumpers, offering exceptional strength- to-weight ratio and superior impact resistance. CFRP combines the lightweight properties of carbon fiber with the versatility of plastics, resulting in a composite material that delivers unparalleled structural integrity while significantly reducing the overall weight of the bumper. This reduction in weight not only enhances fuel efficiency and handling dynamics but also contributes to lower emissions and improved sustainability. CFRP bumpers boast impressive durability and resistance to corrosion, making them well-suited for withstanding the rigors of daily use and environmental exposure

In the analysis phase of CFRP bumper design, Finite Element Analysis (FEA) emerges as a pivotal tool for evaluating the

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performance and crashworthiness of the bumper under various impact scenarios. FEA enables engineers to simulate the behavior of CFRP materials in response to different loading conditions, providing valuable insights into stress distribution, deformation patterns, and energy absorption capabilities. By conducting comprehensive FEA simulations, designers can optimize the CFRP bumper to meet stringent safety standards while minimizing weight and maximizing performance. Moreover, advancements in manufacturing technologies such as automated layup processes and resin infusion techniques facilitate the precise fabrication of CFRP bumpers, ensuring consistency, quality, and efficiency in production. Overall, the integration of CFRP in the design and analysis of car bumpers represents a strategic approach.

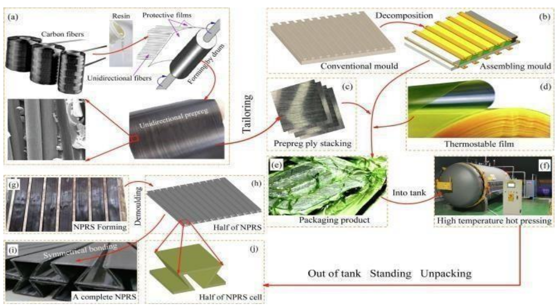


Figure: 6 CARBON FIBER REINFORCED PLASTICS

GLASS FIBER REINFORCED PLASTICS:

Glass fiber reinforced plastics (GFRP) offer compelling advantages in the design and analysis of car bumpers, blending the lightweight characteristics of plastics with the strength and rigidity provided by glass fibers. GFRP bumpers exhibit excellent impact resistance and structural integrity, making them well-suited for protecting vehicles in the event of collisions while also contributing to overall weight reduction. The incorporation of glass fibers enhances the bumper's ability to absorb energy during impacts, thereby minimizing damage to the vehicle and ensuring occupant safety. Additionally, GFRP materials boast impressive resistance to corrosion and environmental degradation, ensuring long-term durability and reliability in various driving conditions.

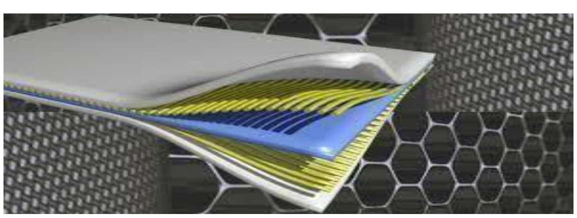


Figure: 7 CARBON FIBER REINFORCED PLASTICS

Similarly, CFRP can also refer to Glass Fiber Reinforced Plastics (GFRP), which utilize glass fibers instead of carbon fibers. GFRP bumpers offer excellent impact resistance and structural integrity, making them ideal for protecting vehicles in collisions. The incorporation of glass fibers enhances energy absorption capabilities, minimizing damage to the vehicle and ensuring occupant safety. GFRP materials also exhibit resistance to corrosion and environmental degradation, guaranteeing long-term durability and reliability. Additionally, advancements in manufacturing techniques enable precise fabrication of GFRP bumpers, ensuring consistency, quality, and efficiency in production. Overall, the integration of CFRP (both carbon and glass fiber reinforced) in bumper.

V FORMULAS AND CALCULTIONS OF CAR BUMPER

Calculations for car bumper design typically involve assessing the bumper's ability to absorb impact energy and minimize the force transmitted to the vehicle's occupants. While specific formulas and calculations may vary based on factors such as bumper material, geometry, and regulatory requirements, here are some fundamental equations commonly used in bumper design:

1. **Impact Energy (E):** $E = \frac{1}{2}mv^2$
2. **Force (F):** $F = m \cdot a$
3. **Deceleration (a):** $a = \frac{v_f - v_i}{t}$
4. **Energy Absorption (EA):** $EA = F \cdot d$
5. **Stress (σ) and Strain (ε):** $\sigma = \frac{F}{A}, \varepsilon = \frac{\delta}{L}$
6. **Bumper Material Cross-Sectional Area (A)**
7. **Bumper Material Deformation (δ)**
8. **Bumper Material Original Length (L)**
9. **Impacting Object Mass (m)**
10. **Impacting Object Velocity (v)**

These equations provide a starting point for evaluating the performance of car bumpers in various scenarios, including collisions with other vehicles or impacts involving pedestrians. However, it's essential to consider additional factors such as bumper material properties, geometry, and design features when conducting comprehensive bumper design calculations. Additionally, regulatory requirements and safety standards may dictate specific testing procedures and performance criteria.

VI DESING OF FOUR WHEELER BUMPER

Car bumper analysis is a multifaceted examination essential for understanding the intricacies of these critical components in vehicle design and safety. It delves into structural integrity, material properties, impact dynamics, regulatory compliance, pedestrian safety, aesthetic integration, and manufacturability. Bumpers serve as the frontline defense, absorbing energy during collisions to safeguard both vehicle occupants and pedestrians. Engineers employ advanced techniques like finite element analysis and computer simulations to model bumper behavior under various scenarios, optimizing their ability to absorb impact while minimizing deformation. Compliance with stringent safety regulations, such as those set by the NHTSA or the European Commission, ensures that bumpers offer reliable protection.

Moreover, their aesthetic integration into a vehicle's design is meticulously considered to maintain both functionality and visual appeal. Ultimately, bumper analysis plays a pivotal role in enhancing vehicle.

FINITE ELEMENT ANALASYS :

FEA allows engineers to subject bumpers to simulated loading conditions representative of real-world scenarios, including impacts from low- speed collisions to higher-speed crashes. By defining appropriate boundary conditions and loading parameters, FEA accurately predicts the bumper's response to applied forces, yielding insights into deformation patterns, stress distributions, and energy absorption capabilities.

The analysis provided by FEA aids in the identification of potential weaknesses or areas of concern in bumper designs, allowing for targeted optimizations to enhance structural integrity and crashworthiness. Furthermore, FEA serves as a cost-effective tool for exploring design iterations and evaluating the performance of alternative materials or geometries.

APPLICATIONS OF ANSYS:

Structural Analysis: Evaluating the strength, stability, and deformation of mechanical components.
Fluid Dynamics (CFD): Analyzing fluid flow, heat transfer, and related phenomena in various systems.
Electromagnetics: Modeling electromagnetic fields and interactions in electronic devices and systems.
Multiphysics Simulation: Integrating multiple physics disciplines to study complex interactions.
Optimization: Using optimization algorithms to improve product performance and efficiency.
Additive Manufacturing (AM): Simulating and optimizing the manufacturing process for 3D-printed parts.
Acoustics: Analyzing sound propagation and noise control in mechanical and architectural designs.
Thermal Analysis: Studying heat transfer, thermal stress, and thermal management in systems.
Explicit Dynamics: Simulating transient dynamic events like crashes and impacts.
Materials Simulation: Predicting material behavior, fatigue life, and failure modes in structures and components.

SIMULATIPN PROCEDURE :

MESHING :

Meshing is the process of dividing a complex geometric domain into smaller, simpler elements called meshes or finite elements. These meshes are typically composed of triangles, quadrilaterals, tetrahedra, or hexahedra, depending on the type of analysis being performed. Meshing is a crucial step in numerical simulations such as finite element analysis (FEA), computational fluid dynamics (CFD), and other computational methods. It allows for the approximation of the continuous physical domain by discrete elements, enabling numerical solvers to solve partial differential equations and analyze the behavior of the system under various conditions.

The quality of the mesh, including element size, shape, and distribution, directly affects the accuracy, stability, and computational efficiency of the simulation results. Meshing software and algorithms aim to create meshes that balance accuracy with computational cost, ensuring reliable and efficient simulations.

The mesh density is determined, dictating the level of detail

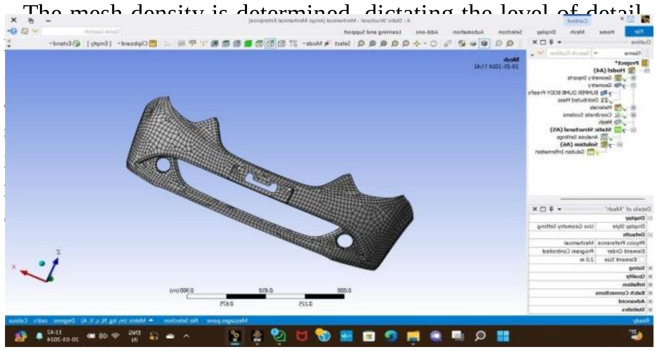


Figure: 8 MESHING

APPLYING FORCES :

Once the forces are defined, engineers assign appropriate boundary conditions to constrain the model and simulate the bumper's attachment to the vehicle chassis. This ensures that the bumper's response to applied forces is accurately represented in the simulation. Boundary conditions may include fixed supports, frictional contact surfaces, or prescribed displacements to simulate mounting points or vehicle constraints.

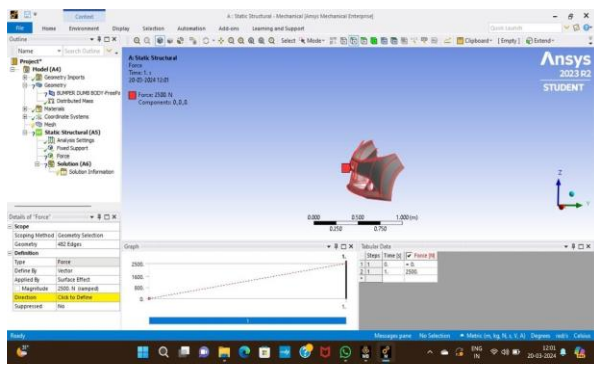


Fig:9 APPLYING FORCES

SIMULATION :

In ANSYS Workbench, simulation plays a crucial role in evaluating the performance and safety of car bumpers under various operating conditions. Engineers utilize simulation to replicate real-world scenarios and assess how bumpers respond to different types of loads, such as impacts, vibrations, and aerodynamic forces.

The simulation process begins with importing the bumper geometry into ANSYS Workbench and creating a finite element model. Engineers then define the material properties, boundary conditions, and loading scenarios for the simulation. This may include specifying the type, magnitude, and direction of forces applied to the bumper to simulate collisions with other vehicles.

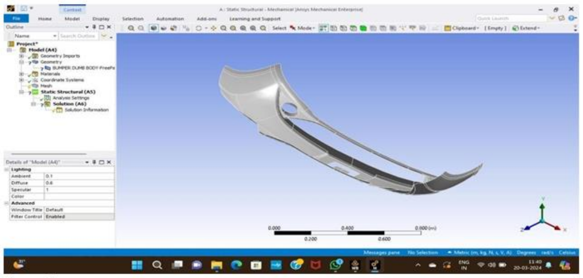


Figure: 10 SIMULATION

LOADING:

One common loading scenario involves simulating a frontal impact, where a static or dynamic load is applied to the bumper to mimic a collision with another vehicle or obstacle. Engineers can specify the magnitude, direction, and duration of the impact load based on crash test data or regulatory standards.

Furthermore, dynamic loading scenarios, such as vehicle maneuvers or driving over uneven terrain, can be simulated to evaluate the bumper's durability and response to dynamic forces.

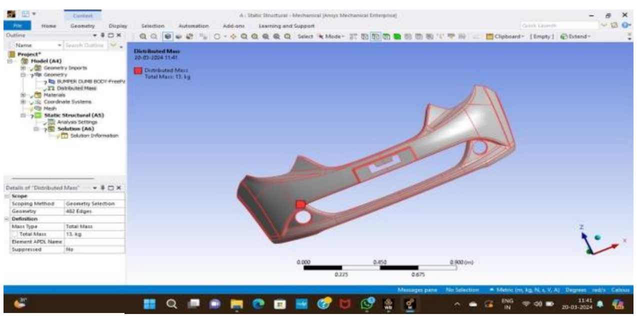


Figure:11 ASSIGNING LOADING

ADDING CONSTARUNTS:

In ANSYS Workbench, adding constraints to a car bumper simulation involves defining boundary conditions that mimic the real-world constraints the bumper experiences when attached to a vehicle chassis. Engineers typically apply fixed supports or prescribed displacements to simulate the mounting points of the bumper, ensuring it remains securely attached during simulated loading scenarios. Additionally, frictional contact surfaces may be defined to account for interactions between the bumper and adjacent components. These constraints play a crucial role in accurately modeling the behavior of the bumper under applied forces, allowing engineers to assess its structural integrity, durability, and performance. By incorporating realistic constraints in the simulation, engineers can obtain valuable insights into how the bumper responds to external loads and optimize its design for enhanced safety and reliability.

Figure:12 ADDING CONSTRAINTS

VII RESULTS AND DISCUSSION

RESULTS ON CAR BUMPER:
ALUMINIUM

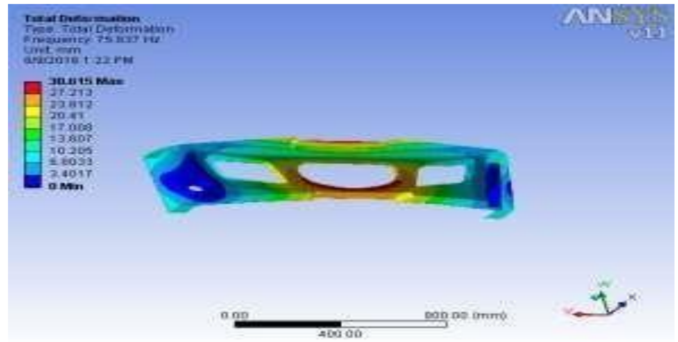


Fig:12 VON MISES STRESS ALUMINIUM

CARBON FIBER REINFORCED PLASTIC (CFRP)

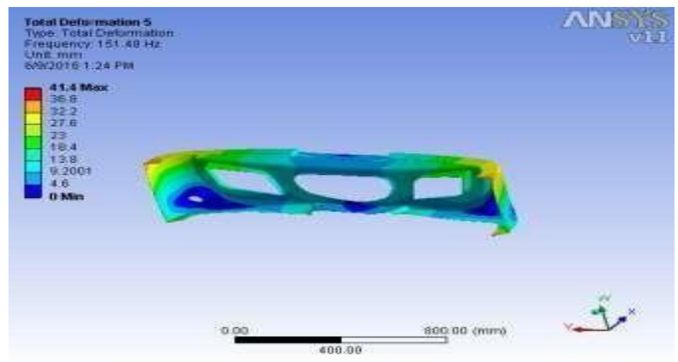
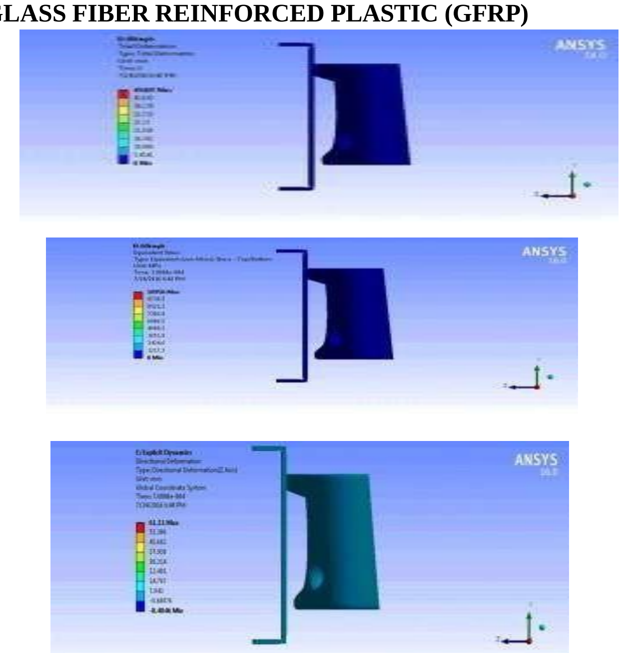


Figure: 13 VON MISES STRESS CFRP

GLASS FIBER REINFORCED PLASTIC (GFRP)



RESULTS AND DISCUSSION:

Mode	Aluminum A390 alloy		Carbon Fiber		Mild steel	
	Frequency (Hz)	Total deformation (mm)	Frequency (Hz)	Total deformation (mm)	Frequency (Hz)	Total deformation (mm)
Mode 1	75.837	30.615	234.07	40.113	7.727e-005	1.8239
Mode 2	91.862	42.472	282.89	55.88	9.377e-005	2.2532
Mode 3	108.98	38.605	336.24	50.825	1.111e-004	2.2914
Mode 4	137.4	56.419	423.4	74.096	1.440e-004	3.3566
Mode 5	151.48	41.4	467.54	54.907	1.543e-004	2.4422
Mode 6	164.8	62.671	509.35	81.85	1.677e-004	3.7452

EQUIVALENT STRESS AND TOTAL DEFORMATION:

Materials	Equivalent stress(Mpa)	Total Deformation(mm)
Aluminum A390 alloy	51.719	1.2881
Carbon Fiber	51.566	0.23427
Mild steel	51.82	0.43751

DYNAMIC ANALYSIS:

Material	Directional deformation - Z(mm)	Total deformation(mm)	Equivalent stress(Mpa)	Material	Directional deformation - Z(mm)	Total deformation(mm)
	60kmph	80kmph	60kmph	80kmph	60kmph	80kmph
Carbon Fiber	47.832	61.11	49.087	61.525	10.956	14.067

VIII CONCLUSION AND FUTURE SCOPE

In conclusion, the use of finite element analysis (FEA) in the design and analysis of car bumpers has demonstrated significant benefits in terms of improving safety, performance, and efficiency. Through the simulation of various impact scenarios and material properties, engineers can optimize bumper designs to withstand real-world conditions while minimizing damage to the vehicle and its occupants.

1. **Enhanced Safety:** FEA enables engineers to assess the structural integrity and impact resistance of car bumpers under different loading conditions. By identifying potential failure points and weak spots, designers can implement reinforcements and improvements to enhance overall safety and crashworthiness.

2. **Performance Optimization:** The iterative nature of FEA allows for the refinement of bumper designs to achieve optimal performance characteristics, such as energy absorption, stiffness, and weight reduction. By fine-tuning parameters such as material selection, geometry, and reinforcement patterns, engineers can develop bumpers that offer superior protection while maintaining cost-effectiveness.

3. **Efficient Design Iteration:** FEA streamlines the design iteration process by providing rapid feedback on proposed modifications and design alternatives. This enables engineers to explore a wide range of design options quickly, facilitating informed decision-making and accelerating the overall design cycle.

4. **Future Scope:** Looking ahead, the application of FEA in car bumper design and analysis is poised for further advancements and innovations. Future research could focus on integrating advanced materials, such as smart polymers and carbon nanotubes, to enhance bumper performance and durability. Additionally, the incorporation of predictive modeling techniques and machine learning algorithms could enable more accurate simulations and predictive analysis of bumper behavior under complex loading conditions.

In conclusion, the integration of finite element analysis into the design and analysis of car bumpers represents a significant advancement in automotive engineering. By leveraging FEA techniques, engineers can optimize bumper designs for enhanced safety, performance, and sustainability, paving the way for safer and more efficient vehicles in the future.

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CAR PARKING MANAGEMENT CONTROLLED BY PLC SOFTWARE

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Abstract:
The scope of this project is to present the initial steps in the implementation of a car parking management by using PLC Software". The PLC logical adder is used for monitoring the system and helps in car parking compartments to easily identify it is available for parking cars. The system developed by in parking places saving the time to park the vehicles. The critical timing operation is required to be carried out under the existence of heavy parking conditions. The system for parking control system must contain low power consumption, low project cost, increases safety. The system resolution is dependent on the output provided by the time, then PLC checks the priorities and then provide output signal to the indicator light poles for ON or OFF the red and green are light indicates green lights and ON time is dependent on the specific priorities. In this project a two-road junction one is entry and second one is exit was taken for automation by using DELTA PLC with delay time for each junction was 30 seconds. With this project the green and red signal can be controlled automatically parking problems by save the time without human effort.

I Introduction:

In the 21st century finding a free car parking space is one of the major problems. This type of issue affects everyone on regular basis since the level of uncertainty is so great, and there aren't many viable ways for resolving it that benefit users by saving time, fuel, and maintaining a positive emotional state. The transportation system is incomplete without parking. On any given working day, nearly 40% of the roads in urban areas are used just for car parking. Cities throughout the world are already congested, and on top of that car parking takes up a lot of time. Finding a parking spot might take a long time and consume a lot of fuel. As a result, it may frustrate the drivers, resulting in accidents. In this magnetic growing world, Vehicle ownership is at high percentage around the globe, therefore car parking as become a perplexing and a difficult task. Parking has become a daily dilemma in malls, railway stations, and market places, among other places. During the weekends or holidays, finding a spare place can take more than 10 minutes. This not only wastes time and fuel, but it also contributes to pollution, which adds to the heinousness of the parking problem. In this context, it is critical to re cognize the importance of implementing an Automated Car Parking System in every urban region. There are two sorts of parking systems in most cases: (1) traditional parking systems and (2) automated parking systems. When compared to traditional parking systems, automated parking systems are anticipated to be more cost effective and simple in the long run. In addition, there is a worldwide trend toward using an automatic parking system to compute the exact amount of space available for cars.

II Problem statement**:** In urban areas, the increasing number of vehicles has led to a rising demand for efficient and automated car parking systems. Traditional parking management methods often result in inefficiencies, congestion, and inconvenience for both parking facility operators and vehicle owners. To address these challenges, the project aims to design and implement a PLC- based automated car parking system.

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Introduction to PLC: Richard E. Morley (December 1, 1932 – October 17, 2017) was an American mechanical engineer who was considered

Figure 1. Father of PLC

one of the "fathers" of the programmable logic controller (PLC) since he was involved with the production of the first PLC for General Motors, the Modicon, at Bedford and Associates in 1968. What

Are PLCs? Programmable logic controllers are small industrial computers. Their design uses modular components in a single device to automate customized control processes. They differ from most other computing devices, as they are intended for and tolerant of severe conditions of factory settings such as dust, moisture, and extreme temperatures. Industrial automation began long before PLCs. In the early1900s until their invention, the only way to control machinery was through the use of complicated electromechanical relay circuits. Each motor would need to be turned ON/OFF individually. This resulted in factories needing massive cabinets full of power relays. As industrial automation continued to grow, modern factories of the time needed dozens of motors with ON/OFF switches to control one machine, and all these relays had to be hard wired in a very specific way. PLCs were developed as a solution to have one solid

control as an electronic replacement for hard-wired 6

First Automotive PLCs:

relay systems. In 1968, the invention of the first PLC revolutionized the automation industry. First adopted by the automotive sector, General Motors began to deploy PLCs into their operations in 1969. Today, PLCs have broadly been accepted as the standard automated control system in manufacturing industries. Known as "The Father of the PLC," Dick Morley first came up with the vision of a programmable controller which could work for every job. He put the proposal together on January 1, 1968. Along with the team at his company (Bed ford and Associate) they created a design for a unit which would be modular and rugged while using no interrupts. They called it the 084, which was named after their 84th project. At the same time as the 084, Bill Stone with GM Hydramatic (automatic transmission division of General Motors) was having the same issue: problems with reliability and documentation for the machines in his plant. His solution proposed a solid- state controller as an electronic replacement for hard-wired relay systems. For this reason, Morley insists he is not the inventor of the PLC. Morley stated: "the programmable controller's time was right. It invented itself because there was an eider it, and other people had that same need." PLCs were designed so that they could easily be understood and used by plant engineers and maintenance electricians, using software called Ladder Logic. Widely used in PLCs today, Ladder Logic is a programming language which uses ladder diagrams which resemble the rails and rungs of a traditional relay logic circuit. Fig 2. First automotive PLC The Evolution of PLC in Industrial Automation: After their initial success with the 084, Bed ford and Associates changed its name to Modicon PLC, which stood for Modular Digital Controller.Modicon084became the name 7 associated with the very first PLC. In the next few decades, the PLC evolved in numerous ways to adapt to various environments and integrate the latest modern technologies. The emergence of competitors who developed similar systems which rivalledModicon sparked. The need for new innovations. As a result, the development of the "Data Highway" by Allen Bradley and "Modus" by Modicon allowed PLCs to exchange information with each other. As PLCs became more widely adopted, the need for a vendor-independent standardized programming language for industrial automation led to the introduction of the IEC61131- 3 standard—the international standard held for PLC software made by the International Electro technical Commission. At the start of the 1990s, end users began making special requests. Plant managers wished for the new machinery to have industrial terminals with PLC monitoring software. They wanted machines which could tell the technicians what was amiss rather than spend hours troubleshooting; this resulted in the development of the programmable human- machine interface (HMI). The implementation of HMI with new devices eventually brought internet connection to the factory floor.

II METHODOLOGY: Steps involved in Prototype making: The main aim of this project is to attain the above-mentioned objectives which can be done through the implementation of actuated signal control. Actuated signal control is proposed due to the analysis done between the various types of traffic signal control. The procedure for the implementation of the proposed project is as follows. Tools & materials used Plywood 3.5 * 3.5
m. Wires 2m. Soldering device LED lights set 4*3 (Red, Green, Yellow) Step1: First prepare the four- road junction 1.5*1.5 by using plywood and sticker, as figure shown below.

II Procedure:
The Implementations of ladder diagrams:

III Conclusion:
The implementation of a car parking management system using Programmable Logic Controllers (PLCs) represents a significant advancement in addressing the challenges associated with traditional parking facilities. Through a thorough investigation into PLC based solutions for parking management, several noteworthy conclusions can be drawn. The integration of PLCs in car parking systems has proven to enhance efficiency and optimize space utilization. The dynamic allocation of parking spaces based on real-time occupancy data ensures that available space is utilized effectively, reducing congestion and optimizing overall parking facility performance. Parking technologies can fundamentally change the way we use and park our cars. Using cutting- edge technologies such as IOT, artificial intelligence and PLC, smart parking systems can maximize parking utilization, improve user experience and provide real-time information on parking availability. Smart parking technologies can contribute to a cheaper, more efficient and greener transport system. Smart City components can be combined with smart parking infrastructure to create a more complete and efficient mobility systems. A well-managed parking system is essential for businesses to improve customer satisfaction. It provides customers with a hassle-free parking experience, improves security, increases efficiency, enhances user experience, and is eco-friendly and cost-effective.

IV Future scope:
The future scope of car parking management using Programmable Logic Controllers (PLCs) is poised for continued evolution and innovation. As technology advances, integrating artificial intelligence (AI) and machine learning algorithms with PLCs holds the potential to create smarter, predictive parking systems. These systems could analyze historical data, user behavior, and traffic patterns to optimize parking space allocation in real-time. Additionally, the integration of IoT (Internet of Things) devices could enhance connectivity, allowing for seamless communication between vehicles, parking infrastructure, and users' mobile devices. The future may also see the widespread adoption of contactless and autonomous parking solutions, where PLCs play a central role in coordinating and executing parking maneuvers. Overall, the integration of PLCs with emerging technologies offers exciting prospects for the development of intelligent, efficient, and user-centric car parking management systems.

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INVESTIGATIONS OF STRUCTURAL MATERIALS WITH TRIBIOLOGICAL BEHAVIOUR OF REINFORCED MATRIX COMPOSITES

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Abstract - Composite materials are now a major field of research and development activity. Composites are rapidly becoming important and useful structural materials, andprobably the next major area for polymer applications is in the field of composite materials. Aluminum matrix composites become choice for automobile and aerospace industries due to its tunable mechanical properties such as very high strength to weight ratio, superior wear resistance, greater stiffness, better fatigue resistance, controlled co-efficient of thermal expansion and good stability at temperatures. Stir casting is an appropriate method for composite fabrication and widely used industrial fabrication of AMCs due to flexibility, cost-effectiveness and best suitable for mass production.In the present work an attempt was made to understand the mechanical behavior of composite, Aluminum 2014 alloy, reinforced with Nano silicon carbide and Nano ZrO2. Composites are casted using stir casting method. Castings are prepared with a percentile range from Pure, 2% and 4%. An investigation is made on studying the mechanical behavior of the pure base metal, when compared with different weight percents of reinforcements. The composite with 4% Nano silicon carbide gave us the best results in the property tests conducted among all other compositions. Hence, we decided to perform optimization on the composite which gave us the best results.

KEY WORDS: Structural materials, cost-effectiveness, superior wear resistance, optimization.

I. INTRODUCTION

Material science has shaped the development of civilizations since the dawn of mankind. Better materials for tools and weapons have allowed mankind to spread and conquer, and advancements in material processing like steel and aluminum production continue to impact society today. The history of materials science is the study of how different materials were used and developed through the history of Earth and how those materials affected the culture of the peoples of the Earth.

The 2014 aluminum and 2008 aluminum alloy are extensively used for external automotive body panels, with 5083 and 5754 used for inner body panels. Bonnets have been manufactured from 2036, 6016, and 6111 alloys. Truck and trailer body panels have used 5456 aluminum. Automobile frames often use 5182 aluminum or 5754 aluminum formed sheets, 6061 or 6063 extrusions. Wheels have been cast from A356.0 aluminum or formed 5xxx sheet. Cylinder blocks and crankcases are often cast made of aluminum alloys. The most popular aluminum alloys used for cylinder blocks are A356, 319 and to a minor extend 242.

II SELECTION OF MATRIX MATERIAL

The matrix material used in the present study is Al2014. Al2014 alloys are alloys wherein aluminum (Al) is the major metal. The distinctive alloying elements are copper, magnesium, manganese, silicon and zinc. It has a wide field of application in the automotive and avionics industries.

a. Chemical Composition of Al 2014 alloy

Table .1 Chemical Composition of Al2014

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zn	Al
Al2014	0.9	0.5	5	1.2	0.8	0.1	0.25	Bal

PROBLEMIDENTIFICATION

The Problem identification is to prepare hybrid composites and to study the behavior of the base metal Al2014 when it is pure and when reinforcement is added to it. This change can be observed thoroughly under microstructure examination. The main purpose of the project survives with the completion of investigation on mechanical properties of Al204 in pure state and as a composite.

III. METHODOLOGY

- Selection of process parameters and their levels
- Conduct the experiments as per the Taguchi Design of Experiments
- Measure the selected quality characteristics
- Construct preference scale for each quality characteristic from realistic data
- Assign weights to the characteristics based on Analytical Hierarchy Process (AHP)
- Determine the individual utility values and use these values as a response of selected experimental plan
- Find the overall utility index (U) values for the alternatives
- Analyze the results with taguchi method
- Determine the optimal setting of process parameters for optimum utility
- Conduct ANOVA for finding the significance of the factors
- Run the confirmation experiment and compare the predicted optimal values with the actual ones.

V.SELECTION OF REINFORCEMENT MATERIAL

The reinforcing materials used for the research is silicon carbide powder, Nano silicon carbide (SiC) is one of the most cost effective and widely used material in the family of engineering ceramics, which has been investigated for high temperature structural and substrate applications because of its good strength and low thermal expansion coefficient.

Nano ZrO2 Nano zirconium dioxide, commonly referred to as alumina, possesses strong ionic interatomic bonding giving rise to its desirable material characteristics. It can exist in several crystalline phases which all revert to the most stable hexagonal alpha phase at elevated temperatures.

VI.EXPERIMENTATION

TESTING OF COMPOSITE

Different tests are conducted on the specimen to find out various mechanical properties of the composite specimen

Tensile Test:

The Tension test which is conducted on a universal testing machine at room temperature is a common method to evaluate strength and ductility under static load conditions. The tension test is carried outby loading a standard specimen gripped at both ends and measuring the resultant elongation of the specimens at various increments of loads.

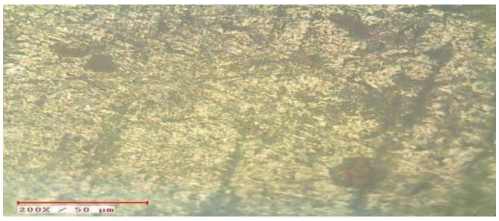


Figure 1: 4% Nano SiC & 5% Nano ZrO_2 200X

Procedure:

1. Measure the diameter of the given mild steel specimen at three different places with the help of vernier calipers and determine the average diameter of the specimen and gauge length.
2. Mount the specimen in the grip of the movable and fixed cross head
3. Adjust the load stabilizer, start the machine and open the inlet valve slightly. When the load indicator just shows reading, it indicates that the load is held caught between the grips, and then adjusts the digital meter to read zero.
4. Apply the load at a steady uniform rate and until specimen breaks.
5. After some time the load showing drops slowly from higher to lower. At this stage, a neck is formed in the specimen, which breaks. Note the position of actual pointer during breaking. Record the maximum load as “Breaking load”
6. Press the freeze button and then print to get the graph between load vs Displacement
7. Repeat the procedure for another specimen.

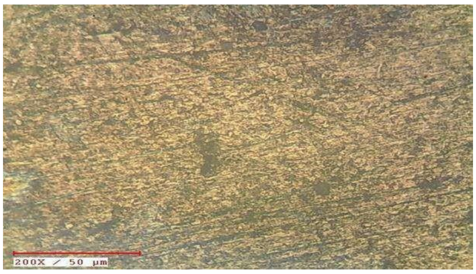
VII. INVESTIGATIONS OF MICROSTRUCTURES

Microstructure is the very small-scale structure of a material, defined as the structure of a prepared surface of material as revealed by a microscope above 25x magnification. The microstructure of a material can strongly influences physical properties such as strength, toughness, ductility, hardness, corrosion resistance, high/low temperature behavior or wear resistance. The testing process is going to be done with Computer aided Microscope.

Specimen preparation

By using lathe operation length of the specimen and diameter are maintained at 20mm 18 mm. Initially rough polishing is done with the help of belt grinder and later with the help of emery papers of 220, 320, 400, 600 and 800 polishing is done. Then smooth polishing done with the double disc polisher.

Figure 2: 4% Nano SiC & 5% Nano ZrO_2 200X



VIII. CONCLUSION

The summary of effect of Nano SiC and Nano ZrO2 on the mechanical properties of Aluminium 2014 Hybrid composite is as follows: The strength increases with increase in composition of Nano SiC. The microstructure of the composites of pure aluminium and 4% Nano SiC & 5% Nano ZrO2 200X is observed under the microscope is heat treatment significantly improved the mechanical and tribological properties of the composite

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Surface Coating Techniques for Magnesium Alloys– A Short Review

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Abstract

Magnesium alloys have garnered significant attention in various industries due to their low density, excellent mechanical properties, and potential for lightweight applications. However, their susceptibility to corrosion limits their widespread use in certain environments. Surface coating techniques have emerged as a promising approach to enhance the corrosion resistance and functional properties of magnesium alloys. This review systematically summarizes the recent advancements in surface coating techniques for magnesium alloys, focusing on their corrosion protection mechanisms, coating materials, deposition methods, and performance evaluation. Various types of coatings, including organic coatings, inorganic coatings.etc. are discussed in detail, highlighting their advantages and limitations. Furthermore, the influence of processing parameters, such as coating thickness, surface preparation, and post-treatment methods, on the performance of coated magnesium alloys is critically evaluated. Additionally, the challenges and future perspectives in the field of surface coatings for magnesium alloys are addressed to provide insights for further research and development. This comprehensive review serves as a valuable resource for researchers, engineers, and practitioners interested in enhancing the properties and durability of magnesium alloys through surface coating techniques.

Keywords: Magnesium, Magnesium alloys, Surface coatings, Corrosion resistance methods, Wear resistance coatings

Introduction

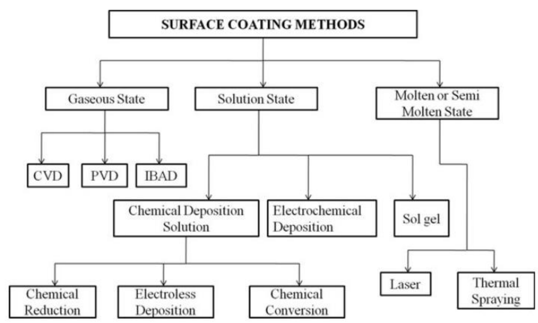
Magnesium alloys have grown significant attention in the recent years across the globe and in the diverse industries owing to their remarkable properties such as low density, excellent mechanical characteristics, and the potential for lightweight applications [1, 2]. However, the susceptibility of magnesium alloys to corrosion has limited their utilization in certain environments. To address this challenge, surface coating techniques have emerged as a promising area to enhance the corrosion resistance and functional properties of magnesium alloys [3, 4].

Therefore, this review aims to systematically summarize recent advancements in surface coating techniques for magnesium alloys, with a focus on corrosion protection mechanisms, coating materials, deposition methods, and performance evaluation [5]. The discussion encompasses various types of coatings, including organic and inorganic coatings, highlighting their advantages and limitations [6-8]. Corrosion protection mechanisms for magnesium alloys can vary depending on the type of coating applied. Organic coatings, for instance, provide a barrier against corrosive agents, while inorganic coatings can offer both barrier protection and sacrificial corrosion properties [9]. Understanding these mechanisms is crucial for selecting the most appropriate coating for specific applications. Furthermore, advancements in deposition methods such as electrochemical deposition, physical vapor deposition, and sol-gel techniques have enabled precise control over coating thickness and uniformity, thereby enhancing the overall effectiveness of surface coatings [10].The discussion extends to the evaluation of coated magnesium alloys' performance, encompassing factors such as adhesion strength, abrasion resistance, and long-term corrosion resistance [11]. This comprehensive evaluation provides insights into the durability and reliability of coated magnesium alloys in real-world applications.

Despite significant progress in surface coating techniques for magnesium alloys, several challenges remain. These include the development of environmentally friendly coating materials, optimization of coating processes for scalability and cost-effectiveness, and ensuring long-term stability and durability of coated surfaces under harsh operating conditions [12]. Addressing these challenges will require collaborative efforts from researchers, engineers, and industry stakeholders.

Popular Surface Coating Techniques

Surface coating techniques play a crucial role in enhancing the properties and functionality of materials across various industries. These techniques, categorized based on the state of the coating material during application, offer diverse approaches to modify surface characteristics. Here, we will discuss three primary categories of surface coating techniques: gaseous state, solution state, and molten state, each offering unique advantages and applications.



Gaseous State Coating Techniques

Gaseous state coating techniques involve the deposition of coatings from vapor-phase precursors onto the substrate surface. These methods offer excellent control over coating composition, thickness, and uniformity, making them suitable for a wide range of applications. Chemical vapor deposition (CVD) and physical vapor deposition (PVD) are two prominent techniques within this category. In CVD, precursor gases undergo chemical reactions on the substrate surface to form solid-phase coatings, while PVD involves the physical deposition of vaporized material onto the substrate. These techniques are widely

Solution State Coating Techniques

Solution state coating techniques involve the application of coating materials dissolved or dispersed in a liquid medium onto the substrate surface. These techniques offer versatility in terms of coating composition and application methods, making them suitable for diverse substrates and applications. Sol-gel coating, dip coating, and spray coating are examples of solution state techniques. Sol-gel

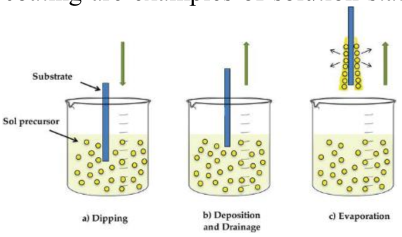


Figure 2 Sol-gel coating

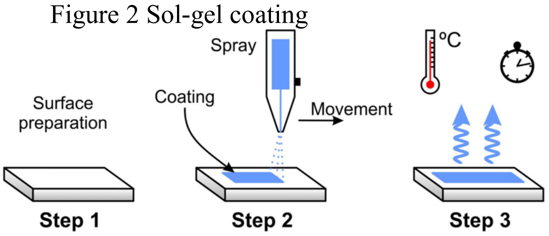


Figure 3 spray coating

Molten State Coating Techniques

Molten state coating techniques involve the application of coatings from molten-phase materials onto the substrate surface. These techniques offer advantages such as high deposition rates, simplicity, and cost-effectiveness, making them suitable for large-scale industrial

Figure 4 flame spraying

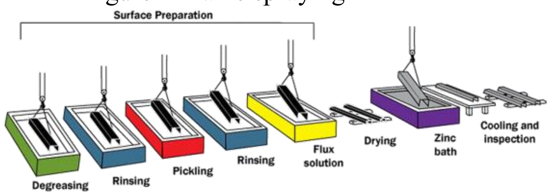


Figure 5 while hot-dip coating

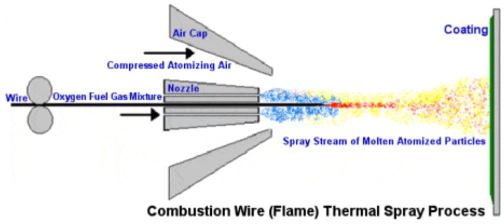
Table 1 : Comparison of Various Surface Coating Techniques

Parameter	**Gaseous State Coating**	**Solution State Coating**	**Molten State Coating**
Control over Coating Thickness	Excellent control	Moderate control	Limited control
Adhesion	Excellent	Good	Good
Complexity	Complex	Moderate	Simple
Deposition Rate	Moderate	Moderate	High
Cost	High	Moderate	Moderate to Low

used in industries such as semiconductor manufacturing, aerospace, and optics for producing thin films with tailored properties.

coating, in particular, utilizes hydrolysis and condensation reactions to form thin films from liquid precursor solutions, offering excellent adhesion and corrosion resistance. These techniques find applications in industries such as automotive, electronics, and biomedical devices for imparting functional properties to surfaces. Figure 2 and Figure 3 describes sol gel and spray coating process.

applications. Thermal spraying, hot-dip coating, and flame spraying are examples of molten state techniques. Thermal spraying involves the deposition of molten or semi-molten particles onto the substrate using a thermal energy source, while hot-dip coating immerses the substrate into a bath of molten coating material. Fig 4 and Fig 5 describes flame spraying and dip coating methods. These techniques are widely used in industries such as automotive, construction, and marine for providing corrosion protection, wear resistance, and thermal insulation to surfaces.The comparison of above three methods was neatly discussed in Table 1.



Application s	Semiconducto r, aerospace	Automotiv e, , Biomedical	Automotive constructio n, marine
Suitability for Complex Geometries	Limited	Suitable	Limited
Surface Finish	Excellent	Good	Moderate to Good

Surface coatings on Magnesium Alloys

Gaseous State Coating Techniques

Gaseous state coating techniques, such as chemical vapor deposition (CVD) and physical vapor deposition (PVD), have shown significant promise in enhancing the properties of magnesium alloys. These techniques offer precise control over coating composition, thickness, and uniformity, making them suitable for a wide range of applications.

In a study by Zhang et al. [14], the authors investigated the corrosion protection of magnesium alloys by depositing thin films of aluminum oxide (Al2O3) using CVD. The results demonstrated that the Al2O3 coatings effectively reduced the corrosion rate of magnesium alloys in chloride-containing environments, offering improved durability and longevity.

Similarly, research by Song and Atrens [15] explored the corrosion mechanisms of magnesium alloys coated with titanium nitride (TiN) using PVD. The study revealed that the TiN coatings provided a barrier against corrosive agents, significantly reducing the susceptibility of magnesium alloys to corrosion.
Furthermore, Li et al. [16 investigated the wear resistance of magnesium alloys coated with diamond-like carbon (DLC) using PVD. The DLC coatings exhibited excellent adhesion and abrasion resistance, prolonging the service life of magnesium alloy components in high-wear environments.
Additionally, Jiang et al. [17] explored the electrodeposition of organic-inorganic composite coatings for enhancing the corrosion resistance of magnesium alloys. The study demonstrated that the composite coatings exhibited improved corrosion resistance compared to bare magnesium alloys, offering potential applications in various industries.
Moreover, Niu et al. [18] investigated the electrochemical deposition of silane-based hybrid coatings on magnesium alloys for enhanced corrosion resistance. The study revealed that the silane-based coatings effectively inhibited corrosion initiation and propagation, providing long-term protection to magnesium alloy surfaces.
These findings highlight the potential of gaseous state coating techniques in enhancing the corrosion resistance, wear resistance, and overall performance of magnesium alloys in various applications.

Solution State Coating Techniques

Solution state coating techniques, such as sol-gel coating and dip coating, offer versatility in terms of coating composition and application methods, making them suitable for diverse substrates and applications.
In a study by Arrabal et al. [19], the authors investigated the corrosion protection of magnesium alloys coated with hybrid organic-inorganic sol-gel coatings containing cerium oxide nanoparticles. The results demonstrated that the sol-gel coatings effectively inhibited corrosion initiation and propagation, providing long-term protection to magnesium alloy surfaces.
Additionally, Matykina et al. [20] explored the use of sol-gel coatings containing silica and titania nanoparticles for corrosion protection of magnesium alloys. The study revealed that the incorporation of nanoparticles improved the adhesion and mechanical properties of the coatings, enhancing their overall performance in corrosive environments.
Furthermore, Xu et al. [21] investigated the adhesion performance of thin film coatings on magnesium alloys for biomedical applications using dip coating. The study demonstrated that the dip-coated coatings exhibited excellent adhesion to magnesium alloy substrates, making them suitable for biomedical implants with enhanced biocompatibility and corrosion resistance.
Moreover, Hossain et al. [22] reviewed the development of inorganic coatings for corrosion protection of magnesium alloys. The review highlighted the potential of inorganic coatings such as phosphate and chromate conversion coatings in enhancing the corrosion resistance of magnesium alloys, providing insights into future research directions in this field.
Additionally, Zhang et al. [23] investigated the corrosion behavior of magnesium alloys coated with sol-gel coatings containing different types of nanoparticles. The study revealed that the incorporation of nanoparticles improved the corrosion resistance of the coatings, offering potential applications in various industries.
These findings underscore the effectiveness of solution state coating techniques in providing corrosion protection, mechanical reinforcement, and tailored surface properties to magnesium alloys for various applications.

Molten State Coating Techniques

Molten state coating techniques, including thermal spraying and hot-dip coating, offer simplicity, high deposition rates, and cost-effectiveness, making them suitable for large-scale industrial applications.
In a study by Liu et al. [24], the authors investigated the corrosion resistance of magnesium alloys coated with thermal-sprayed zinc coatings. The results demonstrated that the thermal-sprayed coatings effectively protected magnesium alloy substrates from corrosion, offering prolonged service life in aggressive environments.
Similarly, Shi and Atrens [25] explored the use of hot-dip coating with aluminum to enhance the corrosion resistance of magnesium alloys. The study revealed that the hot-dip coatings formed a protective aluminum-rich layer on the magnesium alloy surface, significantly reducing corrosion rates and improving durability.
Furthermore, Guo et al. [26] investigated the corrosion resistance of magnesium alloys coated with flame-sprayed ceramic coatings. The study demonstrated that the flame-sprayed coatings provided excellent barrier protection against corrosive agents, offering long-term corrosion resistance and durability to magnesium alloy components.
Moreover, Wang et al. [27] investigated the effects of processing parameters on the microstructure and corrosion resistance of magnesium alloys coated with thermal-sprayed coatings. The study revealed that optimizing processing parameters such as spray distance and particle size distribution improved the performance of the coatings, providing insights into process optimization for enhanced corrosion protection.
Additionally, Han et al. [28] explored the use of plasma-sprayed coatings for corrosion protection of magnesium alloys in marine environments. The study demonstrated that the plasma-sprayed coatings effectively inhibited corrosion initiation and propagation, offering potential applications in marine engineering.
These findings highlight the effectiveness of molten state coating techniques in providing robust corrosion protection, mechanical reinforcement, and extended service life to magnesium alloys in harsh operating environments.

Surface coatings for Wear and corrosion resistance on magnesium alloys

The table provides a comprehensive overview of studies focusing on surface coating techniques applied to magnesium alloys for enhancing wear and corrosion resistance. Magnesium alloys have garnered significant attention due to their lightweight properties, but their susceptibility to wear and corrosion limits their widespread use in various industries. To address these challenges, researchers have explored a range of surface coating techniques, including anodization, dip coating, plasma electrolytic oxidation (PEO), thermal spraying, sol-gel coating, and electrochemical deposition. These studies investigate the effectiveness of different coating methods in improving the performance and durability of magnesium alloys in harsh environments. By summarizing the works of various authors, the table offers valuable insights into the advancements and applications of surface coating technologies for magnesium alloys, providing a foundation for further research and development in this field. Few works are mentioned in the Following Table 2. Figure 6 provides a n information of surface coating method applied tp prevent the corrosion resistance.

Table 2. The authors worked on Surface Coating Techniques to improve wear and Corrosion resistance

Author Name	Surface Coating Technique	References
Zeng et al	Anodization	[29]
Xu et al.	Dip Coating	[33]
Hossain et al.	Plasma Electrolytic Oxidation (PEO)	[34]
Liu et al.	Thermal Spraying	[35]
Arrabal et al.	Sol-Gel Coating	[31]
Matykina et al.	Sol-Gel Coating	[32]
Niu et al.	Electrochemical Deposition	[30]
Shi and Atrens	Flame Spraying	[36]
Guo et al.	Plasma Electrolytic Oxidation (PEO)	[37]
Wang et al.	Thermal Spraying	[38]
Han et al	Plasma Spraying	[39]

Challenges in surface coatings of Magnesium alloys

Surface coatings for magnesium alloys face several challenges that hinder their widespread adoption and effectiveness. These challenges include:

Adhesion: Ensuring strong adhesion between the coating and the magnesium substrate is crucial for long-term performance. Magnesium's high reactivity and tendency to form oxide layers can pose challenges in achieving reliable adhesion.

Corrosion Compatibility: While surface coatings aim to protect magnesium alloys from corrosion, selecting a coating material that is compatible with the alloy's corrosion behavior is essential. Mismatched corrosion potentials between the coating and substrate can lead to galvanic corrosion and premature coating failure.

Coating Uniformity: Achieving uniform coating thickness across complex geometries and large surfaces presents a significant challenge. Variations in coating thickness can result in localized corrosion or inadequate protection in certain areas.

Environmental Impact: Many coating processes involve the use of hazardous chemicals, high energy consumption, or generate harmful emissions. Developing environmentally friendly coating techniques that minimize resource consumption and pollution is a key challenge.

Durability: Surface coatings must withstand harsh operating conditions, including mechanical wear, thermal cycling, and exposure to corrosive environments. Ensuring long-term durability and performance stability of coatings remains a challenge.

Cost-effectiveness: Cost considerations, including material expenses, equipment investment, and processing time, are critical for industrial adoption. Developing cost-effective coating solutions that provide sufficient protection without significantly increasing production costs is a challenge.

Scale-up and Manufacturing: Transitioning from laboratory-scale coating processes to large-scale industrial manufacturing presents technical and logistical challenges. Ensuring consistent coating quality, scalability, and process efficiency are essential for successful commercialization. Addressing these challenges requires multidisciplinary research efforts encompassing materials science, surface engineering, corrosion science, and process engineering. Collaborative initiatives between academia, industry, and government organizations are essential for advancing surface coating technologies for magnesium alloys and overcoming these obstacles.

Conclusions

In conclusion, the studies discussed highlight the effectiveness of diverse surface coating techniques in enhancing the wear and corrosion resistance of magnesium alloys. Gaseous state techniques, such as chemical vapor deposition (CVD) and physical vapor deposition (PVD), offer precise control over coating properties, while solution state techniques, including sol-gel coating and dip coating, provide versatility and tailored surface properties. Molten state techniques, such as thermal spraying and plasma electrolytic oxidation (PEO), offer simplicity and cost-effectiveness. Collectively, these techniques demonstrate promising solutions for addressing the wear and corrosion challenges of magnesium alloys, paving the way for their expanded use in various industrial applications.

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PEDAL POWERED ELECTRIC BIKE

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Abstract - This project is a way of using the outgoing power produced from cycling the pedal mechanism. The concept of the project is providing ease to the rider while riding the e bike and also to produce energy by all possible means. When the pedal mechanism is cycled the power produced from the hub motor is stored in the battery with the help of the controller box. When there is no charge in the battery, by using the pedal mechanism the battery can be charged. It also lowers the resistance in pedaling to make it easier to go up hills. The battery powers an electric motor in the back wheel. This electric bike approach is different. This pedal powered e bike is health beneficial. This project can be a useful part of cardiac rehabilitation programmers. Exercise-based cardiac rehabilitation programmers can reduce diseases in people. They require less cardiac exertion for those who have experienced heart problems. Riding bicycles is already an eco-friendly way to commute. Hence, the pedal powered electric bike is an eco-friendly vehicle adding more values in our near future

I. INTRODUCTION

The pedal powered electric bike is sportive; the most of E-bikes are not pedal assistance as possible out of the regenerating power. The pedal powered electric bike is it may not cost substantially more energy to drive the bike, when not powered, than normal bikes the batteries are empty the bicycle should still be light running. E-bikes need large and heavy batteries to allow riding long distances, because the battery is charged only once at home. The pedal powered electric bike approach is different. The PM motor generating a power while cycling a bike on road and give the bike an infinite range. The battery is small, and saves weight the battery can be fast charged en route in about 50 minutes because 12V 7Ah * 4 LA batteries and 220V AC, 50 Hz, 1.0A charger allow fast charging. Although, we need a location, for instance a café that allow us to use the mains. The battery will be charged while the bike is running. This way of charging the battery will be very useful during cloudy day. The purpose of the pedal powered electric bike is energy saving. A bike is very energy efficient. The cost of the electrical energy that would be needed to cycle a whole day is very less. In terms of energy savings, this is negligible. A pedal powered electric bike advantage of very low weight and can use the rider's foot power to supplement the power generated by cycling. In this way, a comparatively simple and inexpensive vehicle can be driven without the use of any fossil fuels. The pedal powered electric bike is easily accessible, safe and practical with limited maintenance requirements due to a minimum of mechanical parts used. It is ideal not only for the experienced cyclists but also for those non-athletes, the elderly and individuals with health problems

PMDC HUB MOTOR:

Hub motors are mounted in the wheel of the vehicle. They come in various shapes. Hub motors come in a variety of power ratings and sizes. The most common PMDC motor is rated at less than 1000 Watts and is used on electric cycles. This works alright for smaller size rims but for larger rims a geared motor is advised. Geared motors usually have planetary gears inside and
The actual RPM of the motor is much higher than the RPM of the hub. Torque is higher for the same power rating.

Construction of Permanent Magnet DC Motor or PMDC Motor:

As it is indicated in name of permanent magnet dc motor, the field poles of this motor are essentially made of permanent magnet. A PMDC motor mainly consists of two parts. A stator and an armature. Here the stator which is a steel cylinder. The magnets are mounted in the inner periphery of this cylinder. The permanent magnets are mounted in such a way that the N – pole and S – pole of each magnet are alternatively faced towards armature as shown in the figure below. That means, if N – pole of one magnet is faced towards armature then S – pole of very next magnet is faced towards armature.

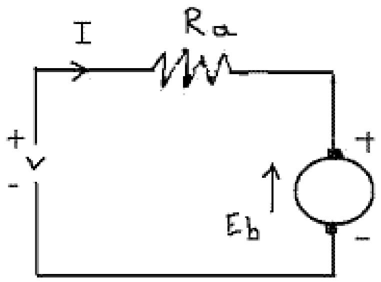
In addition to holding the magnet on its inner periphery, the steel cylindrical stator also serves as low reluctance return path for the magnetic flux. Although field coil is not required in permanent magnet dc motor but still it is sometimes found that they are used along with permanent magnet. This is because if permanent magnets lose their strength, these lost magnetic strengths can be compensated by field excitation through these field coils. Generally, rare earth hard magnetic materials are used for these permanent magnet.

Rotor: The rotor of PMDC motor is similar to other DC motor. The rotor or armature of permanent magnet dc motor also consists of core, windings and commutator. Armature core is made of number of varnish insulated, slotted circular lamination of steel sheets. By fixing these circular steel sheets one by one, a cylindrical shaped slotted armature core is formed. The varnish insulated laminated steel sheets are used to reduce eddy current loss in armature of permanent magnet dc motor. These slots on the outer periphery of the armature core are used for housing armature conductors in them. The armature conductors are connected in a suitable manner which gives rise to armature winding. The end terminals of the winding are connected to the commutator segments placed on the motor shaft. Like other dc motor, carbon or graphite brushes are placed with spring pressure on the commutator segments to supply electric current to the armature.

Working Principle of Permanent Magnet DC Motor or PMDC Motor:

As we said earlier the working principle of PMDC motor is just similar to the general working principle of DC motor. That is when a carrying conductor comes inside a magnetic field, a mechanical force will be experienced by the conductor and the direction of this force is governed by Fleming's left hand rule. As in a permanent magnet dc motor, the armature is placed inside the magnetic field of permanent magnet; the armature rotates in the direction of the generated force. Here each conductor of the armature experiences the mechanical force F = B.I.L Newton where B is the magnetic field strength in Tesla (weber / m2), I is the electric current in Ampere flowing through that conductor and L is length of the conductor in metre comes under the magnetic field. Each conductor of the armature experiences a force and the compilation of those forces produces a torque, which tends to rotate the armature.

Equivalent Circuit of Permanent Magnet DC Motor or PMDC Motor:



As in PMDC motor the field is produced by permanent magnet, there is no need of drawing field coils in the equivalent circuit of permanent magnet dc motor. The supply voltage to the armature will have armature resistance drop and rest of the supply voltage is countered by back emf of the motor. Hence voltage equation of the motor is given by,

$$V = IR + E_b$$

Where I, is armature electric current and R is armature resistance of the motor.

Eb is the back emf and V is the supply voltage.

Advantages of Permanent Magnet DC Motor or PMDC Motor:

PMDC motor have some advantages over other types of dc motors. They are :

1. No need of field excitation arrangement.
2. No input power in consumed for excitation which improve efficiency of dc motor.
3. No field coil hence space for field coil is saved which reduces the overall size of the motor.
4. Cheaper and economical for fractional kW rated applications.

Disadvantages of Permanent Magnet DC Motor or PMDC Motor:

1. In this case, the armature reaction of DC motor cannot be compensated hence the magnetic strength of the field may get weak due to demagnetizing effect armature reaction.
2. There is also a chance of getting the poles permanently demagnetized (partial) due to excessive armature electric current during starting, reversal and overloading condition of the motor

Applications of Permanent Magnet DC Motor or PMDC Motor:

PMDC motor is extensively used where small dc motors are required and also very effective control is not required, such as in automobiles starter, toys, wipers, washers, hot blowers, air conditioners, computer disc drives and in many more.

Control System:

The combination between the cyclist muscular power and the power of the motor are optimized by means of a specific control system that can manage the power inputs in the different load conditions. The basic configuration for a pedelec can be represented.

The control system is made up by the following main components: three rotor position Hall transducers with decoder logic circuits, a main inverter for the alimentation of the motor and the imposition the specific current waveform for each load condition, a bidirectional converter to allow current flow between the battery pack and the motor, proportional-integral regulators to manage the signal coming from the comparison between the reference current and the one measured at the motor, a Pulse Width Modulator (PWM) inverter for the generation of the reference current system

LEAD-ACID BATTERIES

A lead-acid battery is an electrical storage device that uses a reversible chemical reaction to store energy. It uses a combination of lead plates or grids and an electrolyte consisting of a diluted sulphuric acid to convert electrical energy into potential chemical energy and back again. The electrolyte of lead-acid batteries is hazardous to your health and may produce burns and other permanent damage if you come into contact with it. This project we are using LEAD ACID BATTERIES. There are 4 LA batteries of 12V each. Lead acid batteries, invented in 1859 by French physicist Galstron Plante, are the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, their ability to supply high surge currents means that the cells maintain a relatively large power-to-weight ratio. These features, along with their low cost, make them attractive for use in motor vehicles to provide the high current required by automobile starter motors. Lead-acid batteries are also called Secondary batteries or accumulators, since they are rechargeable. They again can be divided into starter and industrial batteries. Starter is used to provide large quantities of energy. Ex:- car, operate electric vehicles etc.

CHARACTERISTICS:

Lead-acid batteries remain the technology of choice for automotive SLI (Stating, Lighting and Ignition) applications because they are robust, tolerant to abuse, tried and tested and because of their low cost. For higher power applications with intermittent loads however, Lead acid batteries are generally too big and heavy and they suffer from a shorter cycle life and typical usable power down to only 50% Depth of Discharge. Despite these shortcomings Lead acid batteries are still being specified for power net application because of the cost, but this probably the limit of their applicability. Lead-acid batteries are composed of a Lead-dioxide, a sponge metallic Lead anode and Sulphuric acid solution electrolyte. This heavy metal element makes them toxic and improper disposal can be hazardous to the environment.

CHARGE:

During charging, the cycle is reversed: the lead sulfate and water are electrochemically converted to lead, lead oxide and sulfuric acid by an external electrical charging source.

DISCHARGE:

During discharge, the lead dioxide (positive plate) and lead (negative plate) react with the electrolyte of sulfuric acid to lead sulfate, water and energy.

How to Charge a 12*4V Battery With a DC Motor:

An electric motor can serve as a makeshift alternator. A lead-acid battery is a source of direct-current (DC) electricity. When the battery begins to lose its charge, it must be recharged with another DC source. An electric motor, though, is as an alternating-current (AC) source. For the electric motor to provide DC energy, its output has to pass through an electronic circuit called a rectifier. An electric motor can be used in conjunction with a source of mechanical energy and a rectifier to recharge a 12V*4 battery.

- Cut four lengths of wire, and strip 1/2 inch of insulation from the ends of each wire. Using the wrench, loosen the top bolts on both battery terminal connectors.
- Insert one end of the first wire into the space created by loosening the top bolts on the first battery terminal. Tighten the top bolts on the first battery terminal. Solder the wire to the terminal.
- Insert one end of the second wire into the space created by loosening the top bolts on the second battery terminal. Tighten the top bolts on the second battery terminal. Solder the wire to the terminal.
- Attach the free end of the first wire to the positive or "+" terminal on the rectifier pack, and solder the connection. Attach the free end of the second wire to the negative or "-" terminal on the rectifier pack, and solder the wire to the terminal.
- Attach the battery terminal at the end of the first wire to the positive battery post. Attach the battery terminal at the end of the second wire to the negative battery post.
- Attach one end of the third wire to one of the motor terminals, and solder the connection. Attach one end of the fourth wire to the remaining motor terminal, and solder the connection.
- Attach the free end of the third wire to one of the "AC" terminals on the rectifier pack, and solder the connection. Attach the free end of the fourth wire to the other "AC" terminal on the rectifier pack. Turn the rotor shaft on the motor to charge the battery.

SHOCK ABSORBERS

The basic function of the shock absorber is to absorb and dissipate the impact kinetic energy to the extent that accelerations imposed upon the airframe are reduced to a tolerable level. Existing shock absorbers can be divided into two classes based on the type of the spring being used: those using a solid spring made of steel or rubber and those using a fluid spring with gas or oil, or a mixture of the two that is generally referred to as oleo-pneumatic. The high gear and weight efficiencies associated with the oleo-pneumatic shock absorber make it the preferred design for commercial transports. Based on the analysis procedure as outlined in this chapter, algorithms were developed to determine the required stroke and piston length to meet the given design conditions, as well as the energy absorption capacity of the shock absorber

Description:

Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston.

In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven vehicles.

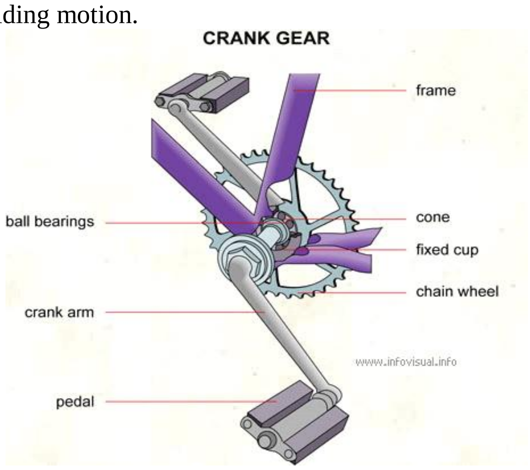
Shock Absorber Performance When Weight or Impact Velocity Vary:

When conditions change from the original calculated data or actual input, a shock absorbers performance can be greatly affected, causing failure or degradation of performance. Variations in input conditions after a shock absorber has been installed can cause internal damage, or at the very least, can result in unwanted damping performance. Variations in weight or impact velocity can be seen by examining the following energy curves.

Varying Impact Weight: Increasing the impact weight (impact velocity remains unchanged), without reorificing or readjustment will result in increased damping force at the end of the stroke. This undesirable bottoming peak force. This force is then transferred to the mounting structure and impacting load.

Varying Impact Velocity: Increasing impact velocity (weight remains the same) results in a radical change in the resultant shock force. Shock absorbers are velocity conscious products; therefore, the critical relationship to impact velocity must be carefully monitored. Figure 2 depicts the substantial change in shock force that occurs when the velocity is increased. Variations from original design data or errors in original data may cause damage to mounting structures and systems, or result in shock absorber failure if the shock force limits are exceeded.

A crank is an arm attached at right angles to a rotating shaft by which linear sliding motion is imparted to or received from the shaft. The arm may be a bent portion of the shaft, or a separate arm or disk attached to it. Attached to the end of the crank by a pivot is a rod, usually called a connecting rod. The end of the rod attached to the crank moves in a circular motion, while the other end is usually constrained to move in a linear sliding motion.

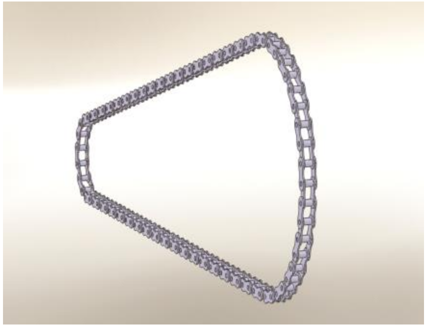


Materials used:

Cranks are constructed of either an aluminum alloy, titanium, carbon fiber, chromoly steel, or some less expensive steel. Tubular steel cranks (such as Tioga's Revolver) can be light and very strong, are usually found on bmx bikes, and are slowly finding their way to mountain bikes (Dirt jumping and Urban assault) . Aluminum cranks may be cast, hot forged or cold forged ("cold" in this context means the billet from which the crank is to be made is heated to a specified temperature well below the melting point, not room temperature). Cold forging gives the metal additional strength, and the cranks can therefore be made lighter without increasing the risk of breakage. Shimano "Hollowtech" aluminum cranks are made by forging the main arms around a hard steel insert which is then withdrawn, leaving an internal void to save weight. They are then welded up before final machining.

CHAIN:

These chains transmit the power of pedaling to the back wheel. In bicycles, these chains may be used in low-speed, light-load transmission operations, for example, in agriculture machines or with electric garage door openers. In the early stages of chain development, chain design grew in response to development in bicycles.



Free wheel:

A freewheel is basically a sprocket attached to ratchet, allowing the transmission to drive the wheel is only one direction, much like a socket wrench. Without a freewheel on a bicycle, you would need to pedal at all times, never able to coast. This type of drive system is called "fixed drive", and is often used for strength training on an upright bicycle, where the rider works against the forward momentum in an attempt to slow or stop the vehicle. A similar fixed drive system would be found on a unicycle.

CONCLUSION

This project is a way of using the outgoing power produced from cycling the pedal mechanism. The concept of the project is providing ease to the rider while riding the e bike and also to produce energy by all possible means. When the pedal mechanism is cycled the power produced from the hub motor is stored in the battery with the help of the controller box. When there is no charge in the battery, by using the pedal mechanism the battery can be charged. It also lowers the resistance in pedaling to make it easier to go up hills. The battery powers an electric motor in the back wheel. This electric bike approach is different. This pedal powered ebike is health beneficial. This project can be a useful part of cardiac rehabilitation programmers. Exercise-based cardiac rehabilitation programmers can reduce diseases in people. They require less cardiac exertion for those who have experienced heart problems. Riding bicycles is already an eco-friendly way to commute. Hence, the pedal powered electric bike is an eco-friendly vehicle adding more values in our near future

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