GANDHI INSTITUTE OF ADVANCED COMPUTER AND RESEARCH

RAYAGADA

(Approved by AICTE, Affiliated to SCTE&VT and BPUT - Odisha)

DEPARTMENT OF MECHANICAL ENGINEERING

THE MECHANICAL HORIZON

2023-24

Editorial Board

It gives us immense pleasure to present *The Mechanical Horizon*, the annual departmental magazine of the Mechanical Engineering Department. This publication stands as a reflection of the academic excellence, technical competence, and creative spirit of our students and faculty members.*The Mechanical Horizon* is a platform where knowledge meets creativity. Authored and edited by students and teachers, the magazine is published in English and showcases a comprehensive report of departmental activities. The magazine provides an opportunity for budding Mechanical engineers to express their innovative ideas, technical insights, research interests, and creative abilities. It encourages students to develop the habit of reading, writing, critical thinking, and professional communication — essential qualities for a successful engineer.

The Editorial Board comprises the Editor, Co-Editor, and Faculty Coordinators who work collectively to review and select quality contributions. We sincerely appreciate the enthusiastic participation of students and staff who contribute articles, technical papers, project summaries, site experiences, creative writings, and innovative ideas.This magazine not only documents the academic journey of the department but also serves as a source of inspiration for students to learn from the experiences and achievements of their peers. We hope that *The Mechanical Horizon* continues to motivate young minds to build not only strong structures but also strong ideas for the betterment of society.

Publisher

Gandhi Institute of Advanced Computer and Research, Rayagada

Message from Chairman

Dr. Chandra Dhwaja Panda

It is with great pleasure that I extend my heartfelt congratulations to the Department of Mechanical Engineering on the release of this year's edition of *Mechanical Horizon*. This magazine stands as a reflection of the department's unwavering commitment to academic excellence, innovation, and holistic development.

Mechanical engineering continues to be the backbone of industrial progress, driving advancements in manufacturing, automation, energy systems, and sustainable technologies. *Mechanical Horizon* captures this dynamic spirit through insightful articles, student innovations, and highlights of departmental activities that foster technical growth and creative thinking.

I am particularly pleased to see the emphasis on industry-academia collaboration, faculty development programs, and student participation in national and international forums. These engagements not only enhance learning but also prepare our students to meet real-world challenges with confidence and competence.

I commend the editorial team and all contributors for their dedication in bringing out this enriching volume. May *Mechanical Horizon* continue to inspire future engineers and serve as a beacon of knowledge and progress.

Message from Secretary

Mr. Manoj Kumar Palo

It gives me immense pleasure to present this edition of *Mechanical Horizon*, the annual magazine of our Mechanical Engineering Department. This publication is not just a compilation of articles and updates—it is a reflection of the creativity, innovation, and dedication of our students and faculty.

Over the past year, our department has continued to push the boundaries of knowledge and skill, embracing new technologies, fostering research, and encouraging hands-on learning. The spirit of mechanical engineering lies in solving real-world problems with precision and imagination, and I am proud to say that our students are embodying this vision with great enthusiasm.

I commend the editorial team, contributors, and all those who have worked tirelessly to bring this magazine to life. May *Mechanical Horizon* continue to inspire curiosity, nurture talent, and serve as a platform for sharing ideas that shape the engineers of tomorrow.

Let us keep striving for excellence, innovation, and teamwork—qualities that define not only our department but also the very essence of engineering.

Message from the Principal

Dr. Pratap Chandra Mishra

It is with great pride and joy that I extend my greetings to the readers of *Mechanical Horizon*, the annual magazine of the Mechanical Engineering Department. This publication reflects the vibrant academic culture, technical expertise, and creative spirit that define our institution.

Mechanical engineering, as a discipline, stands at the heart of innovation—transforming ideas into reality through knowledge, skill, and perseverance. Over the past year, our students and faculty have demonstrated remarkable commitment to excellence, embracing both traditional engineering principles and emerging technologies.

A magazine like *Mechanical Horizon* is more than a collection of words and images; it is a platform that showcases the intellectual pursuits, achievements, and aspirations of our department. I applaud the editorial team for their dedication and the contributors for their insightful articles and creative inputs.

I encourage all students to continue exploring, learning, and innovating, keeping alive the spirit of curiosity and problem-solving that drives engineering forward. May *Mechanical Horizon* inspire each reader to aim higher and contribute meaningfully to the progress of society.

Best wishes for continued success and excellence.

Message from the Head

Message from the Head of Department

Diploma in Mechanical Engineering

It gives me immense pleasure to extend my warm greetings to all readers of *Mechanical Horizon*, the annual magazine of the Department of Mechanical Engineering. This magazine serves as a creative platform for our students and faculty to express their technical insights, innovative ideas, and achievements.

Mechanical Engineering, being the foundation of industrial development, continues to evolve with advancements in automation, robotics, renewable energy, and smart manufacturing. Our department constantly strives to align academic learning with practical applications, nurturing students to become competent professionals and responsible citizens.

I take this opportunity to appreciate the editorial team and all contributors for their dedication and hard work in bringing out this edition. I also encourage our students to explore new technologies, engage in research, and uphold the values of innovation and teamwork.

Let *Mechanical Horizon* be a source of inspiration and knowledge that ignites curiosity and fosters a spirit of lifelong learning among our budding engineers.

Vision and Mission of the Institution

Vision

To become a globally recognized, value-driven educational institution committed to excellence in delivering quality education, nurturing students' inherent talents, and developing innovative professionals in technical and managerial fields, thereby equipping them to meet the future challenges of the global economy.

Mission

M_1: To deliver quality education through effective teaching–learning processes that foster academic excellence in technical and managerial disciplines.

M_2: To nurture students' inherent talents by encouraging creativity, critical thinking, innovation, and lifelong learning.

M_3: To develop competent and ethical professionals with strong values, leadership skills, and social responsibility.

M_4: To promote industry-oriented learning and research through collaboration, practical exposure, and adoption of emerging technologies.

M_5: To prepare globally competitive graduates capable of adapting to evolving challenges and contributing effectively to the global economy.

Vision & Mission of Department of Mechanical Engineering

VISION

To be a premier knowledge hub in mechanical engineering education, entrepreneurship, and industry engagement, producing skilled engineers ready to address industrial challenges.

MISSION

M1. To impart strong fundamental and advanced knowledge in mechanical engineering through effective teaching–learning practices and modern pedagogical methods.

M2. To promote innovation and entrepreneurship by encouraging creative thinking, problem-solving, and startup-oriented initiatives among students.

M3. To strengthen industry engagement through internships, industrial training, consultancy, and collaborative projects to enhance practical skills.

M4. To develop technically competent and ethical engineers with leadership qualities, professional integrity, and social responsibility.

M5. To equip graduates with industry-relevant skillsand adaptability to effectively address real-world engineering challenges.

CONTENT

A NON LINEARITY ANALYSIS OF A SIX DOFINDUSTRIAL ROBOT MANIPULATOR

By Sameer Kumar Sristi, 3rd Year

Due to non-linearity and having multiple solutions, it is quite complicated to analysis the inversekinematic of a 6 DOF industrial robot. There is no distinctive solution for an inverse kinematic,hence a number of predictive approaches are adopted to solve the problem. The conventional methodlike Jacobin transformation and Screw theory used to get the closed form solution of joint angles. TheANN and Fuzzy logic are applied to number of models to solve the inverse kinematic problem. Thehigher degree of polynomial solution does not solve by this method. To overcome the conventionaltechnique problem many more optimization approach is applied. The ANN and fuzzy logic showmore converge to words the acceptable solution. Here 6-DOF of industrial robot is designed and thejoint angles are simulated with the above method.

The use of Industrial robot have widely increased in worldwide during last two decades with increasing the trend.Most of the operation i.e. material handling,welding, painting and assemblingmany more are performing by robort now a days to get faster production rate.Tough, we are usingvarious technology to upgrade robot but still there are some basic problems which is unsolvablei.e Inversekinematics is one of them. Due to complexity design of manipulator and advance application, it is difficult to get close form solution.The adopted method to determine the joint position for a givenset of end effectors position is known as inverse kinematics. Due to nonlinear and complex in nature ofthe equation the inverse kinematics analysis becomes quite complicated. In the paper, we are trying tointroducing the concepts of robot kinematics and linked to open and closed kinematics chains Forwardkinematics and inverse kinematics are proportional to each other. For a given set of joint variables, thefinding of an end effectors or tool space position is called forward kinematics The Inverse Kinematicsis the opposite forward kinematics. The study of motion of different link is called kinematic. In thischapter, it is described that the relationship between joint and end effectors movements. More way, toevaluate the equations which will make direct the subordinate of end effectors coordinates on joint coordinates and vice versa.

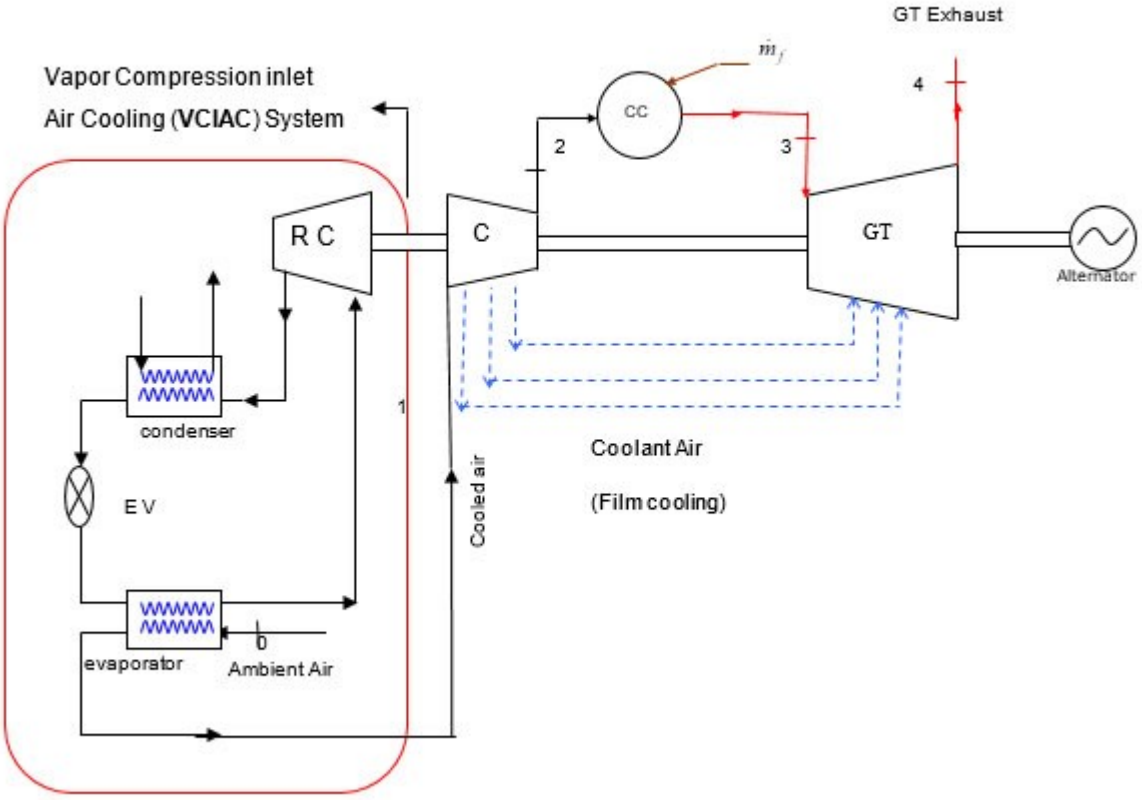
A unique solution is expected for forward kinematic problem but inverse kinematics will not give anyclosed or unique solution for different configuration of robot manipulator. So

different numerical approachand optimization technique are adopted to get closed form solution.

METHODOLOGY TO IMPROVE THERMODYNAMIC PERFORMANCE OF COOLED GAS TURBINE CYCLE

By Tapan Mahakhuda

The article analyses the integration of a vapor compression inlet air cooling system to a cooledgas turbine cycle. Air film cooling has been adopted as the cooling technique for gas turbine blades.A parametric study of the effect of compressor pressure ratio, compressor inlet temperature (CIT),turbine inlet temperature (TIT), ambient relative humidity and ambient temperature on performanceparameters of plant has been carried out. The integration of vapor compression inlet air cooling to gasturbine cycle has been observed to improve the specific work by more than 14.59 % and plant efficiencyby 4.46 %. The increase in performance parameters due to integration of vapor compression inletair cooling has been found superior in case of cooled gas turbine based combined cycle as compared touncooled cycle. With reduction in compressor inlet temperature, the cycle shows an increase in plantspecific work and plant efficiency. The work ratio representing the excess of turbine work over workof compression increases with increase in rIT and decrease in rp,c. For all values of TIT there exists anoptimum rp,c at which the plant efficiency is maximum.


GT Exhaust
Vapor Compression inlet
Air Cooling (VCIAC) System
CC
2
3
4
R C
C
GT
Alternator
condenser
E V
evaporator
Ambient Air
Cooled air
Coolant Air
(Film cooling)

THE EMERGENCE OF RESONANT TUNNELING DIODES (RTD)

By JashabantaPedenti

Since the birth of quantum mechanics, quantum tunnelling has been an intriguingphenomenonfor both scientists and scholars. Because despite being classically forbidden, aquantum particle still hasa finite probability of tunnelling through an extremely thin potentialbarrier which exceeds the energy ofthe electron and hence it has the non-zero possibility toexist on the opposite side of the barrier. Nuclearfusion and Tunnel diodes exploit quantumtunnelling phenomenon, where the tunnelling probability isgiven by, , and depends mostly onthe height (Φ) and width (d) of the barrier. Since the tunnelling probabilityexponentiallydecreases for increased height and width of the barrier, tunnel diodes are associatedwith highleakage currents and low tunnelling efficiency. So, an alternative device that is widely used forreduced leakage currents and significantly improved tunnelling efficiency is ResonantTunnelling Diodes(RTDs). RTDs are associated with quantum tunnelling based on electron wave resonance in multi-barrierheterostructures. The electrons, at certain energy levels, cantunnel through some resonant states.The quantum tunnelling through ultra-thin barriers (nm-scale) is quite a speedy process. So RTDs arecapable of performing ultra-high-speed operations. A typical double-barrier RTD constitutes a quantumwell that is sandwiched between two potential barriers. The transmission probability across the doublebarrier exhibits resonance-like peaks as and when the incident energy of the electron catches up withthe bound state energies of the finite quantum well region. This phenomenon is known as & quot;resonanttunneling" wherein the transmission probability becomes unity indicating the completetransmission of the electron across the barrier. RTD’s I-V characteristics exhibit Negative DifferentialResistance (NDR) as the transmission probability modifies with the application of bias voltage. I-Vcharacteristics of RTDs are highly sensitive to changes in resonant tunneling heterostructures and adjoininglayers’ conditions such as their thicknesses and chemical configuration. The ratio of the peakcurrent to valley current in the device termed the peak to valley current ratio (PVCR), is an essentialmeasure for device performance in digital circuits. The higher the PVCR ratio, the device is more efficient.

360 DEGREE FIRE PROTECTION ROBOT

By Kashinath Jhodia, 1st year

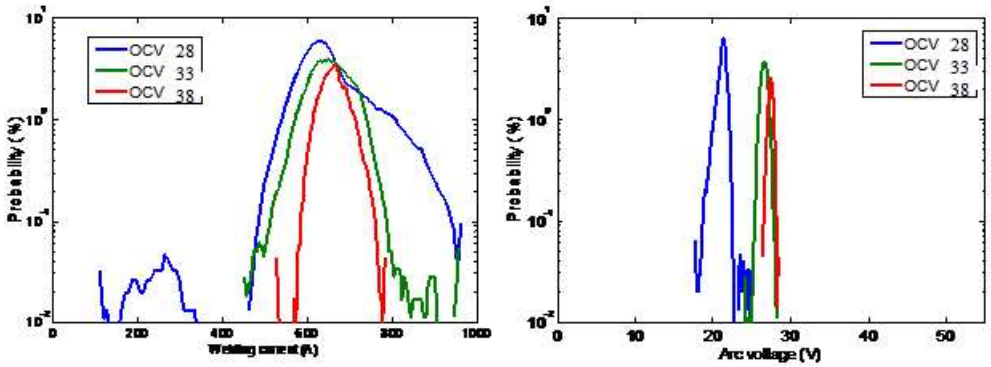
A fire fighter's work entails detecting and extinguishing fires. In this rapidly evolvingtechnological age, the world is gradually moving toward automated systems. Fire fighters, on the otherhand, are often in danger of losing their lives. The majority of the deaths were caused by toxic gasesfound in the firefighting environment. As a result, in order to resolve these issues, our system wasdeveloped. Yes, the idea behind is really commendable. It can be deployed in areas where humanaccess is not possible like nuclear reactors, for military applications, as unmanned guide vehicles forspy operations, mine diffuser, bomb detector etc. Here our project is controlled by Bluetooth usingandroid to detect the fire and to prevent all from fire. It will be regulated by self-controller and hence itwill be a 360' protection system from fire.Fire monitors and sprayers are an amiable and controllablehigh-capacity water jet used to deal with large fires. Unlike Fire extinguishers, Fire Monitors arepermanently installed and cannot be moved. While traditional fire monitors systems need a on-vehiclehuman operator to change the direction of the water jet and aim it appropriately but our model will becontrolled wirelessly and can be operated from a distant place so that no harm can be occurred duringfire extinguishing.

Nowadays, machinery and robotic design become important in helping human. This FireProtection Robot was design to help people in any destructive burnt situation where this robot canextinguish burnt area immediately using autonomous system. In real life, destructive burnt area oftenhappens without our realization. Therefore, this type of robot will require a high demand in the marketbecause of its usefulness to the human as well as the environment transmit fire information to cellphone using controller. The objective of the project will be to design an SMS electronic Fire ProtectionRobot toolkit which can replace the traditional Fire Protection Robot. The toolkit sends the fire andsends SMS to owner of the house, the system is made efficient by SIMs so that the SMS can be receivedby number of devices boards in a locality using techniques of time division multiple access.

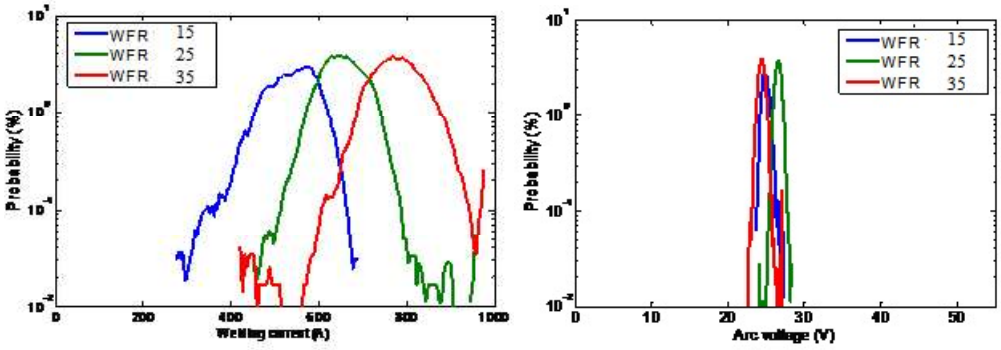
REAL TIME RECORDING OF WELDING ARC CHARACTERISTICS

By Jasobanta Naik, 1st Year

In submerged arc welding (SAW), welding arc travels under the layer of flux and welder is not able to observe and manipulate it as per the process fluctuations. Commercially available metal transfer recording units for SAW are expensive and beyond the reach of small scale industries. It is the dynamic characteristics of power source which decides the welding arc characteristics for metal transfer. These dynamic characteristics are welding current and arc voltage which are also known as V-I characteristics. In this study, a real time recording unit for SAW process is developed and characterized. The characterization of the unit was done with different welding process parameters. The developed system paves the path for further research in monitoring and control of metal transfer characteristics of welding arc.



PDD curves for (a) welding current and (b) arc voltage; when open circuit voltage is varied.



PDD curves for (a) welding current and (b) arc voltage when WFR is varied.

Conclusions

Through this study, an attempt has been made to study the welding arc characteristics of SAW by V-I transient data. Recorded data of V-I transient was processed to deduce the change in welding arc behaviour with change of open circuit voltage and wire feed rate. From PDD curves it is found that its span has decreased with increase of open circuit voltage. While, peak probability value for welding current and arc voltage has increased with increase of wire feed rate. Also, with increase of open circuit voltage, PDD curve has become more symmetrical, uni-model and narrower which is evidence of process stability. The proposed system and approach can be used for further research for change in welding heat and other process parameters such as trolley speed and contact tube to work distance.

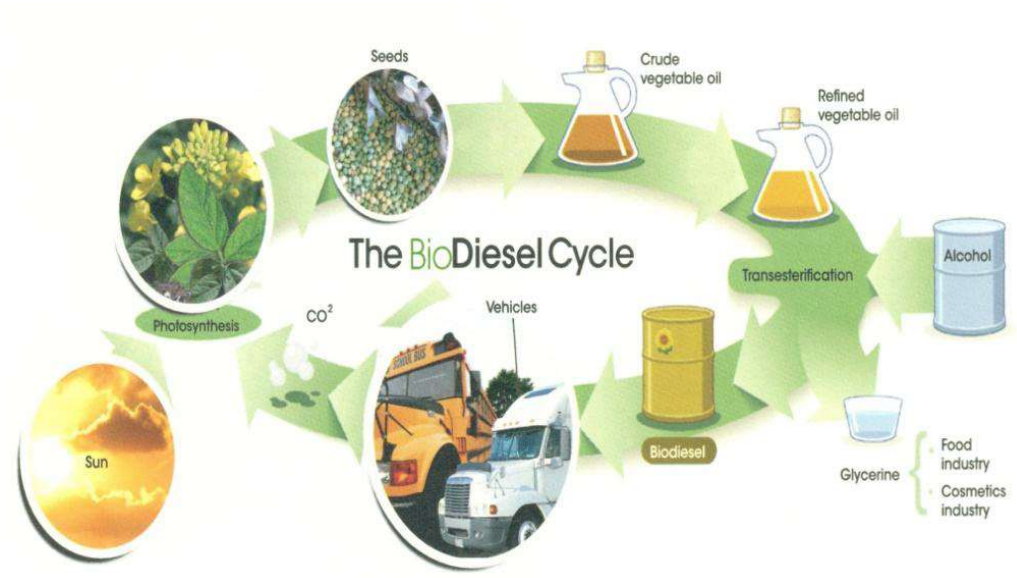
BIODIESEL

By Korada Satya Sampat, 1st Year

Biodiesel refers to a vegetable oil – or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel can be used as a pure fuel or blended with petroleum in any percentage. Much of the world uses a system known as the "B" factor to state the amount of biodiesel in any fuel mix:

a) 100% biodiesel is referred to as B100
b) 20% biodiesel, 80% petrodiesel is labelled B20
c) 5% biodiesel, 95% petrodiesel is labelled B5
d) 2% biodiesel, 98% petrodiesel is labelled B2

Blends of 20% biodiesel and lower can be used in diesel equipment with no, or only minor modifications



Benefits of Biodiesel

a) Produced from Renewable Resources.

b) Can be Used in existing Diesel Engines.

c) Grown, Produced and Distributed Locally.

d) Biodegradable and Non-Toxic.

e) Better Fuel Economy.

f) Reductions in greenhouse gas emissions, deforestation, pollution and the rate of biodegradation.

Current scenario of biofuel production in India

a) Currently, India‟s position in global biofuel map is not very prominent and contributes only 1% of the global production.

b) It will be estimated about 380 million litres of ethanol and 45 million litres of biodiesel production in recent years.

c) The Government of India has approved the “National policy of biofuels” (Ministry of New and Renewable Energy) on December 24, 2009. Since then, considerable advancements have taken place in the direction of cultivation, production and use of biofuels.
d) It has addressed the global concern about containment of carbon emission through use of environmentally friendly biofuels.

FRICTION STIR PROCESSING OF COPPER BY ADDITION OF ZN AND GRAPHITE

By Sameer Kumar Sristi, 3rd Year

Introduction Friction Stir Processing (FSP) is an innovative and eco-friendly technique to prepare a surface composite or surface processing of material. This technique is originally abstracted from the „friction stir welding“ a solid-state welding technique which was invented and patented by „The Welding Institute“ (TWI) in 1991. In present study, copper has been processed by the FSP technique. Copper plates are processed with FSP to enhance its mechanical properties. While processing, Zn and graphite powders are added individually on the plate surface in definite amounts. Both the powders are applied in the groove cut on the copper plate surface. Composition of each ingredient powder is optimized on the results of tensile properties in the processed plates. Effects of Zn and graphite addition are discussed and compared in terms of the tensile properties shown by respective processed plates. **Methodology** A plate of 5 mm thick copper is cut in to a size of 150*150 mm pieces. Process parameters are kept as- square tool pin profile, 1000 RPM rotating speed of tool, 63 mm/min translational speed of machine bed and 20 tilt angle. Groove depth and width has dimensions 2 x 2mm.

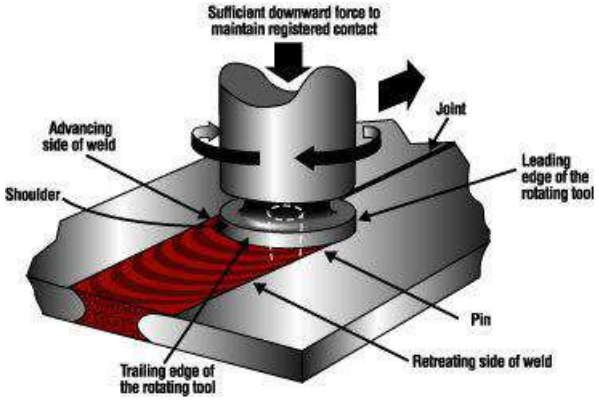


Fig showing schematic representation of friction stir processing

Highlights

Comparative study of effect of two different powders mixing in friction stir processed zone. Ingredient powder is optimized on the results of tensile properties in the processed plates. Mechanical properties are analyzed after processing. All tensile specimens are break from the intersection of HAZ and TMAZ.

Study outcomes

Outcomes of the study revealed that tensile strength is more in the processed plate in case of graphite as compare to Zn.

SOLAR BASED REFRIGERATOR

By Uttam Goroda, 3rd Year

A solar-based refrigerator is a breakthrough in sustainable technology that brings significant benefits to both the environment and society. Unlike traditional refrigerators that rely on electricity from fossil fuel-powered grids, these innovative appliances operate on clean and renewable solar energy. By harnessing the power of the sun, solar refrigerators drastically reduce greenhouse gas emissions while providing reliable cooling for food storage in remote or off-grid locations.

One key advantage of solar-based refrigerators is their ability to function without a continuous power supply. This makes them ideal for use in rural areas or during natural disasters where electricity might be scarce. These refrigerators are equipped with photovoltaic panels that convert sunlight into usable energy, allowing them to operate independently. Some models also have built-in batteries which store excess energy for use during cloudy days or at night.

Another major benefit of solar refrigeration is its potential to improve access to healthcare and quality of life in developing countries. In many regions, vaccines and medicines are often spoiled due to inadequate storage facilities or unreliable electricity supply. Solar-based refrigerators can solve this problem by offering a consistent and efficient means of preservation, ensuring that life saving medications remain effective even in resource-constrained settings.

In conclusion, solar-based refrigeration technology represents an exciting advancement in the field of mechanical engineering. Its eco-friendly operation, ability to thrive off-grid, and positive impact on healthcare make it a compelling subject for research and innovation. By exploring further possibilities within this area, engineers can contribute significantly towards creating a cleaner future while improving living conditions worldwide.

AIRLESS TYRE

By Bikash Kumar Nayak, 3rd Year

The concept of airless tires has been around for decades, but recent advancements in technology have made this idea closer to becoming a reality. Airless tires, also known as non-pneumatic or puncture-proof tires, are designed to eliminate the shortcomings of traditional pneumatic tires. One major advantage of airless tires is their resistance to punctures and blowouts. This is achieved through innovative designs such as honeycomb structures or solid rubber materials, which provide increased durability and reduce the risk of tire failure.

Another key benefit of airless tires is their reduced maintenance requirements. With no need for regular inflation and monitoring tire pressure, drivers can save time and effort on routine maintenance tasks. Furthermore, airless tires are more environmentally friendly compared to their traditional counterparts. The production process requires less energy and resources, contributing to a smaller carbon footprint. Additionally, the elimination of air in the tire reduces the risk of microplastics contaminating the environment through tire wear.

In conclusion, airless tyres offer numerous advantages over traditional pneumatic tyres in terms of durability, maintenance needs, and environmental impact. While there may still be some challenges to overcome before widespread adoption can occur – such as refining the design for optimal performance in different road conditions – it's clear that these revolutionary tyres have great potential for revolutionizing the automotive industry.

NITRO SHOCK ABSORBER

By Jagannath Hikaka, 1st Year

One of the most fascinating advancements in automotive technology is the development and implementation of nitro shock absorbers. Unlike traditional shock absorbers that rely on hydraulic fluid, nitro shock absorbers use nitrogen gas to dampen vibrations and provide a smoother ride. This cutting-edge technology not only improves vehicle performance but also enhances safety by ensuring better control and stability on the road.

Nitro shock absorbers are designed to react faster than their hydraulic counterparts, making them ideal for high-performance vehicles or off-road applications. The nitrogen gas inside these shocks allows for quicker compression and rebound, providing a more responsive suspension system. This means that even when traversing rough terrain or dealing with sudden obstacles, your vehicle will remain stable and composed.

In addition to their enhanced performance capabilities, nitro shock absorbers also offer durability advantages over conventional shocks. Because nitrogen gas is less susceptible to temperature fluctuations and degradation compared to hydraulic fluids, these shocks can withstand extreme conditions without compromising their effectiveness. Whether you're driving in sweltering heat or freezing cold weather, rest assured that your nitro shock absorbers will continue operating at peak efficiency.

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WELDING ROBOTS

By Korada Satya Sampat, 1st Year

Welding robots have revolutionized the manufacturing industry and transformed the way we think about welding. These automated machines not only improve the quality and efficiency of welding processes but also ensure worker safety by eliminating human error and exposure to hazardous conditions. With their superior precision and speed, welding robots are capable of performing complex welds with utmost accuracy, resulting in stronger and more durable products.

Apart from their technical advantages, welding robots also bring cost savings to manufacturers. By automating the welding process, companies can reduce labor costs while increasing production output. Moreover, with the ability to work continuously without breaks or fatigue, these robotic systems significantly shorten project timelines and increase overall productivity. This leads to quicker turnaround times for customers without compromising on quality.

The application of robotics in welding is not limited to traditional industrial sectors alone. In recent years, there has been a growing interest in using welding robots for unconventional applications such as art installations and architectural structures. These robots allow artists and architects to push boundaries creatively by seamlessly combining technology with artistic visions.As technology continues to advance rapidly, we can expect even more sophisticated features from future versions of welding robots. For instance, emerging technologies like artificial intelligence (AI) may be integrated into these machines to further enhance their capabilities. Welding robots powered by AI could potentially analyse complex parameters such as material properties and weld joint geometries in real-time, allowing them to automatically adjust their settings for optimized weld quality.