VOL 2 | 2023

MAHARAJA AGRASEN INSTITUTE OF TECHNOLOGY

MECHANICA

DEPARTMENT OF MECHANICAL ENGINEERING

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VISION

To be a global leader in Mechanical Engineering education, research & innovation with ethics and values.

MISSION

M1: To deliver industry relevant and skill oriented education in Mechanical Engineering, encompassing production, design, thermal, and emerging areas to address diverse global challenges.

M2: To foster ethical values with professional skills for the benefit of industry and society.

M3: To enhance the teaching-learning process through modern pedagogical tools.

M4: To promote research, innovation and entrepreneurship using sustainable technologies and continuous learning.

M5: To strengthen engagement with alumni, industry and other stakeholders for collaborative growth and capacity building.

PROGRAM EDUCATIONAL OBJECTIVES

The objectives of the department of Mechanical Engineering are to produce graduates who will have:

PEO1: Employability, entrepreneurship, leadership skills, and the ability to pursue higher education for the enhancement of knowledge.
PEO2: Ability to lead through research and innovation in the field of Mechanical Engineering.
PEO3: Engineering competence with good communication skills, professionalism, moral values as well as foundation for lifelong learning.
PEO4: Technical capabilities pertinent to Mechanical and allied engineering and to provide innovative and sustainable solutions for industrial and societal problems.

PROGRAM SPECIFIC OUTCOMES

PSO1: Ability to explore and apply advanced technologies such as robotics, AI-ML, data science etc. in the field of Mechanical Engineering.

PSO2: Ability to conduct experiments and use of simulation tools for engineering problems, meeting industry and societal needs.

PSO3: Ability to pursue advanced studies, develop entrepreneurial skills and manage engineering projects in creating innovative solutions.

Message From Founder & Chief Advisor's Desk

It is indeed a matter of great pride that the Department of Mechanical Engineering, MAIT is publishing its annual technical magazine in July, 2024.

The technical magazine, I understand, showcases the research activities and industry – academia interaction activities which the department has adopted during last year.

I sincerely acknowledge the dedicated efforts of the faculty and staff of the Department of Mechanical Engineering in the successful release of this magazine.

I also extend my heartfelt congratulations to the Editorial Team for ensuring its publication.

I wish them all the very best in their future endeavors.

Dr. Nand Kishore Garg
Founder & Chief Advisor, MATES

Message From Chairman's Desk

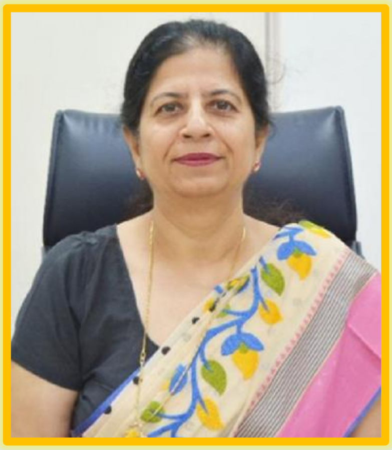
I am gratified to know that the Department of Mechanical Engineering, MAIT has taken an initiative to publish the Technical Magazine in the month of July 2024. This is productive as well as a great platform for the students, researchers, faculty members and industry experts to disseminate achievements in research and developments in computer science and technology.

I gratefully acknowledge Dr. Vaibhav Jain, Head of the Mechanical Engineering Department, along with the faculty and students, for their valuable contributions to the publication of the Technical Magazine. My special appreciation goes to the Editorial Team for their commendable coordination in bringing this issue to life.

Wishing them continued growth and success in all their endeavors.

Sh. Vineet Kumar Lohia
Chairman, MATES

Message From Director's Desk



I am extremely happy to know that the Department of Mechanical Engineering, MAIT is publishing its annual technical magazine in July 2024.

This annual technical magazine will showcase the interaction of the Mechanical Department with Industry Professionals, Academicians and Research Scientists. It will also show the research by faculties of Mechanical Engineering.

I wholeheartedly applaud the Head of the Department, the Editorial Team, and the coordinators for their commendable efforts in publishing this issue. I extend my best wishes for continued success in all their future publications.

May their passion and dedication continue to inspire excellence in every edition.

Prof. (Dr.) Neelam Sharma
Director
Maharaja Agrasen Institute of Technology

Message From Dean's Desk

It is a moment of pride for us to print the new edition of the annual technical magazine of the Mechanical Engineering. Creativity and innovation are the catalyst of advancement. For the time immemorial, education emancipates. No study is complete when the scope of further research is available.

Research is the fuel for advancement and development. This magazine will share and exchange the scientific knowledge of our teachers who are not only academicians but also researchers with the students.

I congratulate and compliment the entire team, faculty members, staff and fellow students for initiating this magazine to exchange their views and knowledge on recent research and developments**.**

Prof. (Dr.) S.S. Deswal
Dean
Maharaja Agrasen Institute of Technology

Message From Head of the Department

It is a matter of great pride and privilege for us to be associated with the department of mechanical engineering for this 5th year. The year 2023-24 has been a year of accomplishments for the Department.

One faculty member of the Department received their Ph.D. degrees from Jamia University and Delhi Technological University. The department celebrated 'Earth Day' in association with Institute innovation cell (IIC) and ASHRAE Student Branch MAIT. A huge number of faculty members and students participated in this online event.

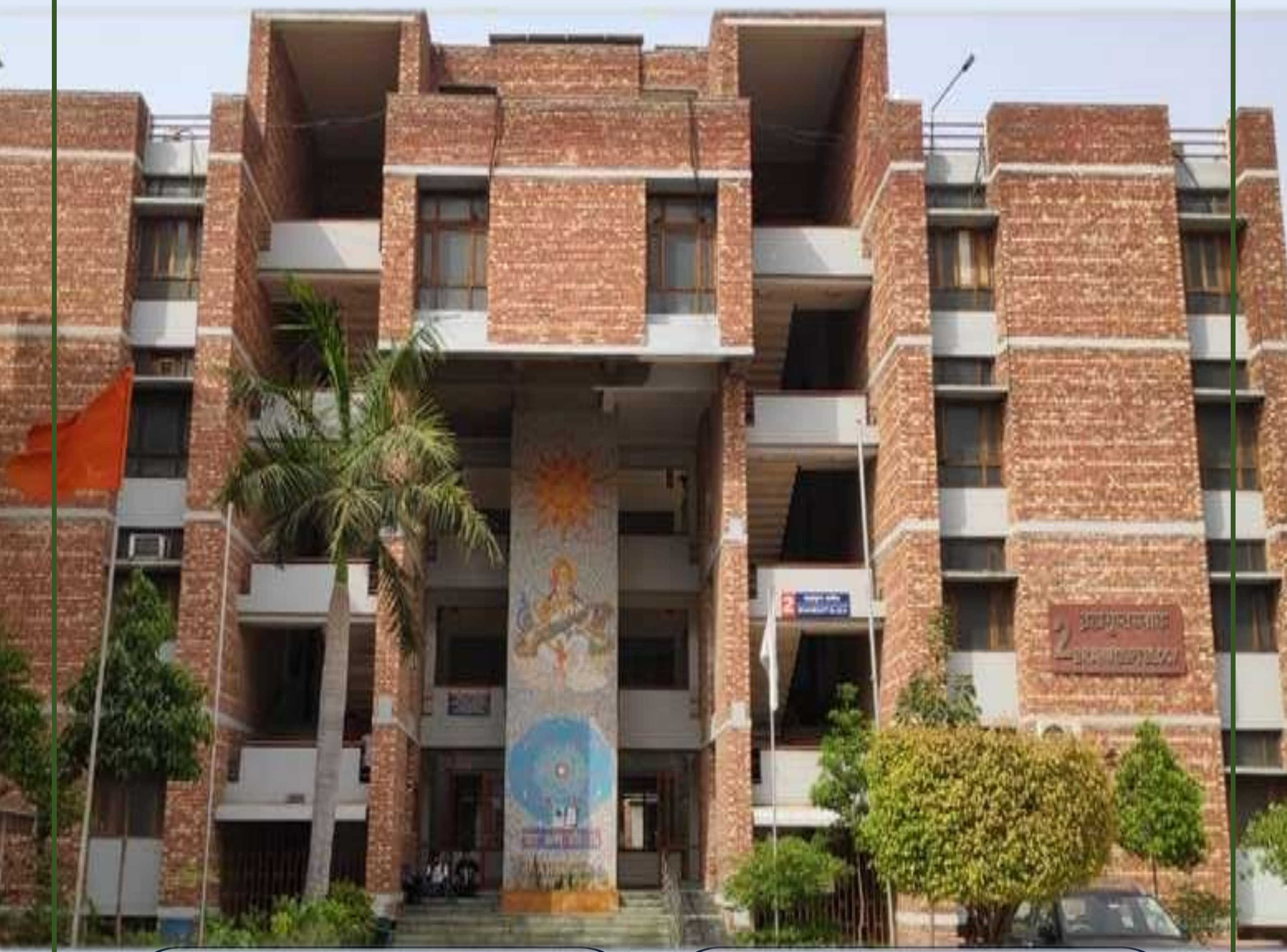
Many events were organized by the department. Several hands-on activities have been also arranged by department students, faculties, and the ASHRAE society of MAIT.

It is a difficult task to include information about all the activities of the department in an annual magazine like this.

I congratulate Dr. Garima Sharma & Dr. Alok Kumar who worked tirelessly to bring out this edition of the magazine.

Dr. Vaibhav Jain
Head, Department of Mechanical Engineering
Editor-in-Chief, Technical Magazine

Faculty Members
Department of Mechanical Engineering



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Dr. Anil Kumar Dahiya
Mr. Anil Gupta
Dr. Deshdeep Gambhir
Dr. Sidharth
Dr. Kanchan Mudgil
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Dr. Piu Jain
Mr. Rakesh Chander Saini
Ms. Surbhi Upadhyay
Dr. Sachin Gupta
Dr. Ramakant Rana

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Explore the Ocean of Faculty Perspectives

Revolutionizing Cooling Systems: Ejector Technology in Refrigeration

Dr. Vaibhav Jain

In this article, a spotlight is shined on an emerging technology that's reshaping the landscape of cooling systems - ejector technology. With its potential to enhance energy efficiency, reduce environmental impact, and revolutionize the way we approach refrigeration, ejector technology is a game-changer that's gaining momentum in the industry.

Understanding Ejector Technology in Refrigeration

At its core, ejector technology harnesses the principles of fluid dynamics to create pressure differences that enable efficient heat transfer. In the context of refrigeration, ejectors play a critical role in boosting the efficiency of vapor compression systems, which are commonly used in various cooling applications.

Supercharging Energy Efficiency

Ejector technology addresses a significant challenge in traditional refrigeration systems: energy consumption. Conventional refrigeration relies on energy-intensive compressors to raise the pressure of the refrigerant vapor, which requires a substantial amount of electricity. Ejectors, on the other hand, leverage the energy of high-speed fluid jets to compress the vapor, reducing the load on the compressor and, consequently, decreasing energy consumption.

This efficiency enhancement doesn't just translate to cost savings; it also contributes to a reduction in greenhouse gas emissions. As the world seeks more sustainable ways of energy consumption, ejector technology emerges as a pivotal tool in achieving these goals.

Environmental Benefits

Ejector technology aligns perfectly with the global push towards eco-friendly practices. By improving energy efficiency and minimizing the reliance on conventional refrigerants that contribute to ozone depletion and global warming, ejectors are making strides in sustainability. Additionally, ejectors enable the use of natural refrigerants, such as carbon dioxide (CO_2) and ammonia (NH_3), which have lower environmental impact compared to traditional synthetic refrigerants.

Applications and Real-world Impact

The applications of ejector technology in refrigeration are widespread and diverse. From commercial refrigeration units to industrial cold storage facilities, ejectors can significantly enhance the performance of cooling systems. Supermarkets, for example, can benefit from ejectors integrated into their refrigeration systems, resulting in reduced energy bills and a smaller carbon footprint.

Beyond the retail sector, industries like pharmaceuticals, food processing, and chemical manufacturing rely heavily on refrigeration. Ejector technology not only improves the efficiency of their processes but also ensures the preservation of sensitive products and materials.

Challenges and Future Prospects

While the potential of ejector technology in refrigeration is evident, there are challenges that researchers and engineers are actively addressing. Design optimization, integration into existing systems, and scalability remain areas of focus. As more studies delve into the intricacies of ejector-based refrigeration, these challenges are expected to be overcome, further driving the adoption of this technology.

In conclusion, ejector technology is transforming the landscape of refrigeration by championing energy efficiency, sustainability, and innovation. As industries increasingly recognize the importance of environmentally conscious practices, ejector-based refrigeration emerges as a promising solution that not only meets cooling needs but also contributes to a greener future.

Stay tuned as we continue to explore the ever-evolving world of refrigeration and the remarkable strides being made with ejector technology. The journey to more efficient and sustainable cooling solutions is well underway, and we're excited to be a part of it.

Utility of Computational Fluid Dynamics (CFD) in Modern Engineering

Dr. V. N. Mathur

Computational Fluid Dynamics (CFD) has emerged as a pivotal tool in engineering, offering profound insights into fluid behavior through advanced simulations. By solving complex fluid flow equations numerically, CFD enables engineers to predict and analyze fluid dynamics in various systems, leading to optimized designs, enhanced performance, and cost-effective solutions across multiple industries.

1. Aerospace and Automotive Engineering

In aerospace engineering, CFD plays a crucial role in optimizing aircraft designs. By simulating airflow over wings, fuselages, and control surfaces, engineers can minimize drag, enhance lift, and improve fuel efficiency. This predictive capability allows for the refinement of designs before physical prototypes are built, reducing development time and costs. Similarly, in the automotive industry, CFD is instrumental in designing vehicles with improved aerodynamics. It helps in reducing drag, enhancing fuel efficiency, and optimizing engine cooling systems, thereby contributing to more sustainable and efficient vehicles.

2. Energy Sector: Power Generation and Renewable Energy

CFD is extensively used in the energy sector, particularly in thermal power plants. It aids in designing low NOx burners by simulating combustion processes to reduce harmful emissions. Additionally, CFD assists in optimizing heat exchangers like economizers and superheaters by analyzing temperature and pressure distributions, leading to improved thermal efficiency and reduced operational costs. In renewable energy, CFD simulations are employed to model wind turbine performance, optimizing blade designs for maximum energy capture and efficiency.

3. Environmental Engineering and Building Design

In environmental engineering, CFD is utilized to study pollutant dispersion, aiding in the design of systems that minimize environmental impact. It helps in analyzing airflow patterns to optimize ventilation systems, ensuring better air quality and energy efficiency in buildings. By simulating natural ventilation and HVAC systems, CFD contributes to designing buildings that are both comfortable and energy-efficient, aligning with sustainable architectural practices.

4. Chemical and Process Engineering

CFD is indispensable in chemical and process engineering for modeling fluid flow, heat transfer, and chemical reactions within reactors and pipelines. It allows for the optimization of mixing processes, enhancing reaction rates and product quality. By simulating various operating conditions, CFD helps in designing more efficient and cost-effective chemical processes, reducing the need for extensive physical experimentation.

5. Biomedical Engineering

In biomedical engineering, CFD is applied to simulate blood flow in arteries and veins, aiding in the design of medical devices such as stents and prosthetic valves. It helps in understanding the hemodynamic environment, leading to improved device designs that minimize adverse effects and enhance patient outcomes. Additionally, CFD is used in respiratory studies to model airflow in the lungs, contributing to better understanding and treatment of respiratory diseases.

6. Agricultural Engineering

CFD applications in agricultural engineering focus on optimizing irrigation systems and greenhouse environments. By simulating water distribution and airflow, CFD assists in designing systems that maximize water use efficiency and crop yield. It also aids in creating controlled environments within greenhouses, ensuring optimal conditions for plant growth and reducing resource wastage.

7. Educational and Research Applications

Beyond industrial applications, CFD serves as a valuable educational tool, providing students with practical experience in fluid dynamics simulations. It enhances understanding of theoretical concepts through hands-on learning. In research, CFD facilitates the exploration of complex fluid phenomena, contributing to advancements in various scientific fields, including environmental science, bioengineering, and climate studies.

Conclusion

The utility of Computational Fluid Dynamics spans a broad spectrum of engineering disciplines, offering a powerful means to simulate and analyze fluid behavior in complex systems. Its applications lead to optimized designs, improved performance, and cost savings, making it an indispensable tool in modern engineering. As computational power continues to grow, the scope and accuracy of CFD simulations are expected to expand, further solidifying its role in advancing engineering practices and innovations.

Smart and Adaptive HVAC Systems

Dr. Deshdeep Gambhir

Smart and adaptive HVAC (Heating, Ventilation, and Air Conditioning) systems represent a significant advancement over traditional climate control methods. By integrating technologies like artificial intelligence (AI), the Internet of Things (IoT), and advanced sensors, these systems offer enhanced energy efficiency, comfort, and responsiveness to environmental and occupancy changes.

Core Components of Smart HVAC Systems

1. **Advanced Sensors and IoT Integration**
   - Smart HVAC systems utilize a network of sensors to monitor various parameters such as temperature, humidity, occupancy, and air quality.
   - These sensors provide real-time data, enabling the system to adjust its operations dynamically to maintain optimal indoor conditions.
2. **Smart Thermostats**
   - Devices like smart thermostats learn user preferences and occupancy patterns to optimize heating and cooling schedules.
   - Features such as geofencing allow the system to adjust settings based on the user's location, enhancing energy savings.
3. **Zoning Capabilities**
   - Smart HVAC systems can divide a building into multiple zones, each with independent temperature controls.
   - This zoning ensures personalized comfort and prevents energy wastage in unoccupied areas

Adaptive Control Strategies

1. **AI and Machine Learning Integration**
   - AI algorithms analyze historical and real-time data to predict and adjust HVAC operations proactively.
   - This predictive capability allows the system to anticipate changes in occupancy or weather, optimizing performance accordingly.
2. **Reinforcement Learning Techniques**
   - Advanced systems employ reinforcement learning to continuously improve their decision-making processes based on feedback.
   - Such systems can adapt to new environments and usage patterns without explicit reprogramming.
3. **Occupant-Centric Controls**
   - These controls focus on individual comfort by considering occupant preferences and behaviours.

- By collecting data on occupancy and user feedback, the system fine-tunes its operations to enhance comfort while conserving energy.

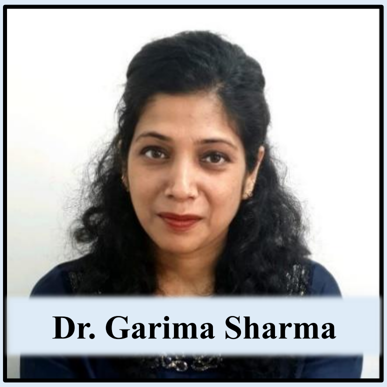
Benefits of Smart and Adaptive HVAC Systems

- **Energy Efficiency**
  - By adjusting operations based on real-time data and predictive analytics, these systems reduce unnecessary energy consumption.
  - Studies have shown significant energy savings and reductions in carbon emissions with the adoption of AI-driven HVAC solutions.
- **Enhanced Comfort**
  - Personalized settings and adaptive controls ensure consistent indoor comfort tailored to individual preferences.
- **Predictive Maintenance**
  - Continuous monitoring allows for early detection of potential issues, enabling timely maintenance and reducing downtime.
- **Remote Accessibility**
  - Users can monitor and control their HVAC systems remotely via smartphones or computers, offering convenience and flexibility.

Considerations and Challenges

- **Initial Investment**
  - The upfront cost of installing smart HVAC systems can be higher than traditional systems. However, long-term energy savings often offset this initial expenditure.
- **Data Privacy and Security**
  - As these systems collect and transmit data, ensuring the privacy and security of user information is paramount.
- **Technical Complexity**
  - The integration of advanced technologies requires specialized knowledge for installation and maintenance.

Understanding AI and ML in Mechanical Engineering


Dr. Garima Sharma

- **Artificial Intelligence (AI):** Refers to the simulation of human intelligence in machines programmed to think and learn. In mechanical engineering, AI enables systems to perform tasks such as decision-making, problem-solving, and pattern recognition.
- **Machine Learning (ML):** A subset of AI that involves training algorithms on data to make predictions or decisions without explicit programming. ML is particularly valuable in mechanical engineering for analyzing complex datasets and optimizing system performance.

Core Applications in Mechanics

1. Predictive Maintenance
ML algorithms analyze real-time sensor data (e.g., temperature, vibration) to predict equipment failures before they occur. This proactive approach reduces downtime and maintenance costs.

2. Design Optimization
AI-driven tools assist engineers in optimizing designs by evaluating numerous parameters simultaneously, leading to improved performance and reduced material usage.

3. Simulation Acceleration
Traditional simulations can be time-consuming. AI accelerates this process by creating surrogate models that approximate complex simulations, enabling faster iterations during the design phase.

4. Autonomous Systems
In robotics and autonomous vehicles, AI processes sensor data to make real-time decisions, enhancing navigation and operational efficiency.

5. Material Property Prediction
ML models predict mechanical properties of materials based on processing parameters, aiding in the development of new materials and manufacturing processes.

Types of Machine Learning Techniques

- **Supervised Learning:** Models are trained on labeled datasets to predict outcomes, such as failure probabilities based on historical data.
- **Unsupervised Learning:** Algorithms identify patterns in unlabeled data, useful for anomaly detection in machinery operations.
- **Reinforcement Learning:** Agents learn optimal actions through trial and error, applicable in optimizing control systems and maintenance schedules.

Real-World Implementations

- **Automotive Industry:** AI tools like DrivAerNet++ analyze vast datasets of car designs to optimize aerodynamics and fuel efficiency, reducing development time and costs.
- **Manufacturing:** Companies like BMW utilize AI-powered digital twins to simulate and optimize assembly lines, enhancing production efficiency.
- **Engineering Software:** Platforms such as Altair's HyperWorks integrate AI to accelerate simulations, allowing engineers to focus on innovation and strategic tasks.

Sustainable Manufacturing: Integrating Environmental Responsibility


Ms. Surbhi Upadhyay

Definition: Sustainable manufacturing involves producing goods through processes that minimize negative environmental impacts, conserve energy and natural resources, and ensure safety for employees and communities.

Key Principles:

1. **Eco-Friendly Design**: Developing products with minimal environmental footprints, considering factors like material selection, energy consumption, and end-of-life disposal.
2. **Resource Efficiency**: Optimizing the use of raw materials and energy to reduce waste and emissions throughout the production process.
3. **Waste Minimization**: Implementing strategies to reduce, reuse, and recycle waste generated during manufacturing.
4. **Lifecycle Assessment**: Evaluating the environmental impacts of a product from raw material extraction to disposal to inform sustainable decision-making.

Benefits:

- **Environmental Protection**: Reduces pollution and conserves natural resources.
- **Economic Advantages**: Enhances efficiency, potentially lowering production costs.
- **Regulatory Compliance**: Meets environmental regulations and standards.
- **Brand Reputation**: Appeals to environmentally conscious consumers, strengthening market position.

Circular Manufacturing: Creating Closed-Loop Systems

Definition: Circular manufacturing is a production model that emphasizes the reuse, refurbishment, remanufacturing, and recycling of materials and products to create a closed-loop system, minimizing waste and resource consumption.

Core Strategies:

1. **Design for Durability and Reusability**: Creating products that are long-lasting and can be easily repaired or repurposed.
2. **Material Recovery**: Implementing processes to reclaim materials from end-of-life products for use in new manufacturing cycles.
3. **Product-as-a-Service Models**: Shifting from product ownership to service-based models, encouraging manufacturers to maintain and upgrade products over time.
4. **Supply Chain Collaboration**: Engaging stakeholders across the supply chain to facilitate material circularity and information sharing.

Advantages:

- **Waste Reduction**: Significantly decreases the amount of waste sent to landfills.

- **Resource Conservation**: Reduces the need for virgin material extraction.
- **Economic Resilience**: Mitigates risks associated with resource scarcity and price volatility.
- **Innovation Stimulation**: Encourages the development of new business models and technologies.

Synergy Between Sustainable and Circular Manufacturing

While sustainable manufacturing focuses on reducing environmental impacts during production, circular manufacturing extends this by ensuring that products and materials remain in use for as long as possible. Integrating both approaches leads to a more holistic and effective strategy for environmental and economic sustainability.

Integrated Practices:

- **Lifecycle Thinking**: Considering the entire lifecycle of products in design and production decisions.
- **Closed-Loop Supply Chains**: Establishing systems where end-of-life products are collected and reintegrated into the manufacturing process.
- **Stakeholder Engagement**: Collaborating with customers, suppliers, and policymakers to support sustainable and circular initiatives.

Real-World Applications and Initiatives

- **Green Factories**: Facilities designed to minimize environmental impact through energy efficiency, waste reduction, and the use of renewable energy sources.
- **Textile Recycling in the UK**: Projects like Project Reclaim aim to establish commercial-scale post-consumer polyester recycling, promoting circularity in the fashion industry.
- **Automotive Industry**: Companies are exploring remanufacturing and refurbishing vehicle components to extend their lifecycle and reduce waste.

Future Outlook

The transition to sustainable and circular manufacturing is gaining momentum, driven by environmental concerns, regulatory pressures, and consumer demand for responsible products. Advancements in technology, such as digital twins and AI-driven analytics, are facilitating this shift by enabling more efficient and transparent manufacturing processes.

Embracing these models not only contributes to environmental preservation but also offers competitive advantages in an increasingly sustainability-focused market.

Ionocaloric Refrigeration: Eco-Friendly Cooling

Dr. Naveen Solanki

Ionocaloric refrigeration is an innovative cooling technology that leverages the ionocaloric effect—a thermodynamic phenomenon where the addition or removal of ions induces significant temperature changes in a material. This method offers a sustainable and environmentally friendly alternative to traditional refrigeration systems that rely on harmful refrigerants.

Fundamental Principles

The ionocaloric effect operates by manipulating the electrochemical potential of a material through the addition or removal of ions. This process alters the material's phase transition behavior, leading to temperature changes. The refrigeration cycle involves four key steps:

Isentropic Mixing: Ions are introduced into the solid material, lowering its melting point and causing it to melt while absorbing heat from itself, resulting in a temperature drop.

1. **Isothermal Heat Absorption**: The material, now in a liquid state, absorbs heat from the surroundings at a constant temperature.
2. **Isentropic Separation**: Ions are removed from the liquid, raising its melting point and causing it to solidify while releasing heat to itself, leading to a temperature increase.
3. **Isothermal Heat Rejection**: The solid material releases heat to the surroundings at a constant temperature.

This cycle enables efficient cooling without the need for volatile refrigerants.

Experimental Demonstration

Researchers at Lawrence Berkeley National Laboratory, including Drew Lilley and Ravi Prasher, demonstrated the ionocaloric effect using a system composed of ethylene carbonate (a common organic solvent) and sodium iodide (NaI). By applying a voltage of less than 1 volt, they achieved a temperature change of up to 25°C. This significant temperature shift showcases the potential of ionocaloric refrigeration to compete with, or even surpass, the efficiency of conventional vapor-compression systems.

Environmental Advantages

Ionocaloric refrigeration offers several environmental benefits:

- **Zero Global Warming Potential (GWP)**: Unlike hydrofluorocarbons (HFCs) used in traditional systems, ionocaloric materials do not contribute to global warming.
- **Non-Toxic and Non-Flammable**: The materials used are safe and pose minimal environmental risks.
- **Carbon-Negative Potential**: Ethylene carbonate can be synthesized using carbon dioxide, potentially making the process carbon-negative.

Challenges and Future Outlook

While promising, ionocaloric refrigeration faces several challenges:

- **Cycle Speed**: Current systems have slower cycle times compared to conventional refrigeration methods.
- **Material Optimization**: Further research is needed to identify and develop materials with optimal ionocaloric properties.
- **System Integration**: Engineering efforts are required to integrate ionocaloric systems into existing cooling infrastructures

Vehicle-to-Everything (V2X) Communication

Rishank Dabas
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Vehicle-to-Everything (V2X) communication is an advanced automotive technology that enables vehicles to interact wirelessly with various elements of their environment, including other vehicles, infrastructure, pedestrians, and networks. This interconnected system aims to enhance road safety, improve traffic efficiency, and support the development of autonomous driving.

Core Components of V2X Communication

V2X encompasses several specific communication types:

- **Vehicle-to-Vehicle (V2V)**: Enables direct communication between vehicles to share information such as speed, position, and heading, helping to prevent collisions and improve traffic flow.
- **Vehicle-to-Infrastructure (V2I)**: Allows vehicles to communicate with road infrastructure like traffic signals and road signs, facilitating adaptive traffic management and providing drivers with real-time information.
- **Vehicle-to-Pedestrian (V2P)**: Facilitates communication between vehicles and pedestrians or cyclists, enhancing safety for vulnerable road users by alerting drivers to their presence.
- **Vehicle-to-Network (V2N)**: Connects vehicles to cellular networks, enabling access to cloud services, real-time traffic updates, and other internet-based information.

Communication Technologies

V2X communication relies on two primary technologies:

- **Dedicated Short-Range Communications (DSRC)**: A Wi-Fi-based technology operating in the 5.9 GHz band, offering low-latency communication suitable for safety-critical applications.
- **Cellular V2X (C-V2X)**: Utilizes existing cellular networks (4G LTE and 5G) to provide broader coverage and support for a wider range of applications, including non-line-of-sight scenarios.

C-V2X has gained momentum due to its scalability and integration with modern cellular infrastructure.

Benefits of V2X Communication

- **Enhanced Safety**: By sharing real-time information, V2X can reduce accidents through collision avoidance systems and timely warnings about road hazards.
- **Improved Traffic Efficiency**: Adaptive traffic signal control and real-time traffic information help in reducing congestion and optimizing travel times.
- **Environmental Impact**: Efficient traffic flow leads to reduced fuel consumption and lower greenhouse gas emissions.

Real-World Applications

- **Emergency Vehicle Alerts**: Some vehicles can receive notifications about approaching emergency vehicles, allowing drivers to yield appropriately.
- **Adaptive Traffic Signals**: Traffic lights can adjust their timing based on real-time traffic conditions and the presence of emergency vehicles, improving response times and reducing delays.
- **Pedestrian Safety**: Vehicles can detect pedestrians at crosswalks and issue warnings to drivers, enhancing safety in urban areas.

Challenges and Considerations

- **Infrastructure Investment**: Widespread adoption requires significant investment in roadside units and communication infrastructure.
- **Standardization**: Ensuring interoperability between different manufacturers and technologies is crucial for seamless communication.
- **Data Privacy and Security**: Protecting the data exchanged between vehicles and infrastructure from unauthorized access is essential.

Future Outlook

The integration of V2X communication is a stepping stone toward fully connected and autonomous transportation systems. As technology advances and infrastructure develops, V2X is expected to play a pivotal role in shaping safer and more efficient roadways.

Advanced Sustainable Materials

Sanskar
04214811122

Advanced sustainable materials are revolutionizing engineering by offering eco-friendly alternatives that maintain or enhance performance while reducing environmental impact. These materials are designed to be biodegradable, recyclable, or derived from renewable resources, aligning with the principles of a circular economy.

Key Categories of Advanced Sustainable Materials

1. Biodegradable Polymers and Biocomposites
Biodegradable polymers, such as polylactic acid (PLA) and polyhydroxyalkanoates (PHAs), are derived from renewable resources and decompose naturally, minimizing environmental pollution. When reinforced with natural fibers like hemp, flax, or bamboo, they form biocomposites that are lightweight, strong, and suitable for applications in automotive parts, packaging, and construction materials.

2. Recyclable Alloys and Composites
Innovations in metallurgy have led to the development of recyclable alloys that retain their properties after multiple recycling cycles. These materials are crucial in industries like aerospace and automotive, where material performance is critical, and sustainability is increasingly prioritized.

3. Bio-Based Composites
Bio-based composites utilize natural fibers and bio-resins to create materials that are both strong and environmentally friendly. These composites are gaining traction in sectors such as construction and transportation, offering a sustainable alternative to traditional composites.

4. Mycelium-Based Materials
Mycelium, the root structure of fungi, can be cultivated to produce lightweight, biodegradable materials suitable for packaging, insulation, and even structural components. These materials are grown using agricultural waste, making them a sustainable option that also contributes to waste reduction.

5. Innovative Materials from Waste
Researchers are exploring the use of waste materials to create new, sustainable materials. For example, Carbonium, a composite made from aerospace by-products, offers high strength and a reduced environmental footprint, finding applications in industries like watchmaking and jewelry.

Applications Across Industries

- **Automotive**: Use of biocomposites and recyclable alloys for lightweight, fuel-efficient vehicles.

- **Construction**: Incorporation of bio-based composites and mycelium materials for sustainable building practices.
- **Packaging**: Adoption of biodegradable polymers to reduce plastic waste.
- **Consumer Goods**: Integration of innovative materials like Carbonium for eco-friendly products.

The advancement of sustainable materials in engineering not only addresses environmental concerns but also opens new avenues for innovation across various industries. By embracing these materials, engineers and manufacturers can contribute to a more sustainable and resilient future

Urban Sustainability Innovations

Piyush
20114811123

\Urban sustainability innovations are transforming cities into resilient, eco-friendly, and inclusive spaces. These innovations address environmental challenges, enhance quality of life, and promote economic vitality. Here's an in-depth exploration of key urban sustainability innovations:

1. Green Infrastructure and Urban Rewilding

Integrating nature into urban environments mitigates climate impacts and enhances biodiversity.

- **Urban Rewilding**: Cities worldwide are embracing rewilding by restoring natural habitats within urban settings. This includes creating green corridors, reintroducing native species, and establishing urban forests. Such initiatives improve air quality, reduce urban heat islands, and provide recreational spaces for residents.
- **City Farms**: London's city farms, like Horsenden and Stepney City Farm, transform underutilized urban spaces into community hubs for sustainable agriculture, education, and mental health support. They employ eco-friendly practices and foster community engagement.

2. Sponge Cities and Water Management

To combat urban flooding and water scarcity, cities are adopting innovative water management strategies.

- **Sponge Cities**: This concept involves designing urban landscapes that absorb and reuse rainwater through permeable surfaces, green roofs, and constructed wetlands. Cities like Sanya, China, and Karachi, Pakistan, have implemented sponge city principles to reduce flood risks and enhance water resilience.

3. Carbon-Neutral Neighborhoods

Developing neighborhoods with net-zero carbon emissions is a growing trend.

- **Bahnstadt, Heidelberg**: This German district is designed for energy efficiency, utilizing smart meters, green rooftops, and extensive bike paths, resulting in buildings that use 80% less energy for heating
- **Bryant, Ann Arbor**: Once an energy-burdened community, Bryant has transformed into America's first carbon-neutral neighborhood through energy upgrades like improved insulation and solar panels, significantly reducing utility bills.

4. Circular Economy and Adaptive Reuse

Cities are fostering circular economies by repurposing existing structures and promoting sustainable business models.

- **BlueCity, Rotterdam**: An old indoor swimming pool has been converted into a hub for circular economy startups, focusing on sustainable innovations and waste reduction.

5 Sustainable Transportation

Promoting eco-friendly transportation options reduces emissions and enhances urban mobility.

- **Copenhagen, Denmark**: The city has invested in extensive cycling infrastructure and public transport, encouraging residents to opt for sustainable commuting methods.

6. Green Buildings and Urban Agriculture

Incorporating greenery into buildings and promoting urban farming contribute to sustainability.

- **Brooklyn Grange, New York**: This rooftop farm not only supplies fresh produce but also mitigates the urban heat island effect and manages stormwater

7. Community Engagement and Participatory Planning

Engaging residents in sustainability initiatives ensures inclusivity and effectiveness.

- **Grenoble, France**: The city has implemented participatory democracy in its climate action plans, allowing citizens to propose and implement environmental initiatives, leading to significant reductions in greenhouse gas emissions.

Digital Twins and Simulation

Prisha Sagar
35114811122

Digital Twins and Simulation are transformative technologies reshaping industries by enabling real-time monitoring, predictive analytics, and optimization of physical systems. Here's an in-depth exploration of these concepts:

What Is a Digital Twin?

A **Digital Twin** is a dynamic, virtual representation of a physical object, system, or process. It integrates real-time data from sensors and other sources to mirror the state, behavior, and performance of its physical counterpart. This continuous synchronization allows for monitoring, analysis, and optimization throughout the lifecycle of the asset.

What Is Simulation?

Simulation involves creating a virtual model to study the behavior of a system under various conditions. Unlike digital twins, simulations are typically static and do not update in real-time. They are used to predict outcomes, test scenarios, and inform decision-making without the need for physical prototypes.

While simulations are valuable for testing hypotheses and designs, digital twins offer a more comprehensive and interactive approach by providing real-time insights and enabling proactive interventions.

Applications of Digital Twins and Simulation

1. Manufacturing and Industry 4.0

Digital twins are integral to smart manufacturing, allowing for:

- **Predictive Maintenance**: Monitoring equipment health to anticipate failures and schedule maintenance proactively.
- **Process Optimization**: Analyzing production processes to identify inefficiencies and implement improvements.
- **Product Lifecycle Management**: Tracking products from design through end-of-life to enhance quality and sustainability.

Companies like BMW utilize digital twins to simulate and optimize factory layouts, reducing time and costs associated with physical modifications

2. Healthcare

In medicine, digital twins enable:

- **Personalized Treatment**: Creating patient-specific models to predict responses to therapies.
- **Surgical Planning**: Simulating procedures to improve outcomes and reduce risks.
- **Medical Training**: Providing realistic simulations for education and skill development.

For instance, virtual models of fetal hearts are used to study congenital diseases, enhancing diagnostic and treatment strategies.

3. Urban Planning and Infrastructure

Cities employ digital twins to:

- **Monitor Infrastructure**: Assessing the condition of bridges, roads, and utilities in real-time.
- **Traffic Management**: Analyzing traffic patterns to optimize flow and reduce congestion.
- **Disaster Response**: Simulating emergency scenarios to improve preparedness and response strategies.

Orlando's digital replica, for example, aids in infrastructure planning and environmental impact assessments.

Enabling Technologies

The effectiveness of digital twins and simulations is enhanced by:

- **Internet of Things (IoT)**: Providing real-time data through interconnected sensors and devices.
- **Artificial Intelligence (AI) and Machine Learning (ML)**: Analyzing complex data sets to identify patterns and make predictions.
- **Cloud Computing**: Offering scalable resources for data storage and processing.
- **Edge Computing**: Enabling data processing closer to the source for faster decision-making.

Platforms like Ansys Twin Builder integrate these technologies to create comprehensive digital twin solutions.

Robotics and Automation

Naman Bagai
70314811122

Robotics and Automation in Mechanical Engineering

Robotics and automation are integral to modern mechanical engineering, driving innovation and efficiency across various industries. Mechanical engineers play a pivotal role in designing, developing, and optimizing robotic systems and automated processes. Their expertise ensures that these technologies are not only functional but also safe, efficient, and adaptable to evolving industrial needs.

Role of Mechanical Engineers in Robotics and Automation

Mechanical engineers are central to the development of robotic systems, encompassing tasks such as:

- **Design and Prototyping**: Creating mechanical structures, actuators, and end-effectors that define a robot's capabilities.
- **System Integration**: Ensuring seamless interaction between mechanical components, electrical systems, and software.
- **Control Systems**: Developing algorithms and feedback mechanisms that govern robot behavior and response to environmental stimuli.
- **Testing and Optimization**: Evaluating prototypes under real-world conditions to refine performance and reliability.

Their work bridges the gap between theoretical concepts and practical applications, making advanced robotics feasible and effective in various sectors.

Applications in Mechanical Engineering

Mechanical engineers apply robotics and automation across multiple domains:

- **Manufacturing**: Robots perform tasks like welding, assembly, and material handling, enhancing precision and reducing human error.
- **Healthcare**: Robotic systems assist in surgeries and rehabilitation, offering high precision and minimizing invasiveness.
- **Agriculture**: Automated machinery handles planting, harvesting, and monitoring, improving efficiency and yield.
- **Logistics**: Robotic arms and automated guided vehicles streamline sorting and packaging processes.
- **Aerospace**: Robots conduct inspections and maintenance of aircraft, ensuring safety and compliance.t

These applications demonstrate the versatility and impact of robotics and automation in advancing mechanical engineering practices.

Emerging Trends and Challenges

Mechanical engineers are at the forefront of addressing challenges and exploring new frontiers in robotics and automation:

- **Collaborative Robotics (Cobots)**: Designing robots that work alongside humans, enhancing productivity while ensuring safety.
- **Soft Robotics**: Developing robots with flexible structures that can handle delicate objects and navigate unstructured environments.
- **AI Integration**: Incorporating artificial intelligence to enable robots to learn from experience and adapt to new tasks.
- **Sustainability**: Creating energy-efficient and environmentally friendly robotic systems.
- **Ethical Considerations**: Addressing the societal impacts of automation, including job displacement and data privacy.

Mechanical engineers are instrumental in advancing these areas, ensuring that robotics and automation evolve in ways that benefit industries and society.

Education and Career Opportunities

Mechanical engineering programs increasingly offer specializations in robotics and automation, equipping students with the skills needed to thrive in these fields. Graduates can pursue careers in industries such as automotive, aerospace, healthcare, and consumer electronics, where their expertise in robotics and automation is highly valued.

In conclusion, robotics and automation are transforming mechanical engineering, and mechanical engineers are key drivers of this transformation. Their work not only enhances industrial processes but also paves the way for innovative solutions to complex challenges.

Internship / Summer Training Corner

S. No.	Enrollment No.	Student Name	Organization Name
1	00114811119	Prajjwal Rawat	Northern Indian railways, Tughlakabad
2	00114808220	Amit Singh Bisht	ZiptraxCleanTech, New Delhi
3	00214811119	Satvik Sharma	Northern Indian railways, Tughlakabad
4	00214808220	Hari Shankar Parsad	Kion India Pvt. Limited
5	00314808220	Jatin Singh	Defence Research and Development Organization, Hyderabad
6	00414811119	Shreshth Virmani	Noida Metro Rail Corporation, Noida
7	00414808220	Narendra Singh	DMRC Shastri Depot
8	00514808220	Pawan Kumar	Coursera
9	00614811119	Pulkit	Data Analytics,Coursera
10	00614808220	Purushotam Kumar	DMRC
11	00714811119	Anubhav Bhatt	UDEMY, Inc
12	00714808220	Som Nath Jha	Shree cement
13	00814811119	Jai Mehta	Web Design Factory & Hazi Sarai Hansi
14	00814808220	Sumit Tiwari	Tata Motors (DV Motors Pvt Ltd)
15	00914811119	Sumit Dixit	RVM CAD Faridabad
16	00914808220	Vaibhav Mudgal	Jay Bharat Maruti Limited, IMT Manesar
17	01014811119	Swastik Rawat	Greater Kailash
18	01014808220	Vinay	Bharat Petroleum, Loni Lubes Plant
19	01114811119	Siddharth Bisht	AIESL, Aviation complex IGT-2
20	01214811119	Subham	Northern railway, Tughlakabad
21	01314811119	Amit Kumar	Industrial Area, Ajanta Compound, Ghaziabad
24	01614811119	Nitish Singh	Unique Seal Engineering Co., Ghaziabad
25	01814811119	Shashank Nigam	Escorts
26	01914811119	Shrey Aggarwal	HKKR Global Pvt. Ltd.
27	02014811119	Aman Shukla	TRW Sun Steering Wheel Pvt. Limited, Gurgaon
28	02114811119	J.Keshav	Bharat Gears Ltd, Faridabad
29	02214811119	Jatin Gupta	Northern railway, Tughlakabad
30	02414811119	Khalin Juneja	Introduction to CFD simulation in ANSYS, Udemy

S. No.	Enrollment No.	Student Name	Organization Name
31	02614811119	Ujjwal Sahu	Neeraj Enterprises
32	02714811119	Pratyaksh Gupta	
33	02814811119	Harshit Rathee	Divisional Training Centre/Mech. (DSL), Northern Railway, Tughlakabad
34	02914811119	Aman Dogra	Salcomp Manufacturing India Pvt. Ltd., Noida
35	03014811119	Jyotirmaya	Minda Industries Bahadurgarh
36	03114811119	Manish Mangla	Neeraj Enterprises
37	03214811119	Arshlaan Siddiqui	
38	03314811119	Atul Singh	Neeraj Enterprises
39	03514811119	Harsh Goyal	Bhatia Alloy
40	03614811119	Inderpreet Singh Rooprai	Solar Energy for Engineers, Architects and Code Inspectors, Coursera
41	03714811119	Vijay	Northern Indian railways, Tughlakabad
42	03814811119	Biswa Narayan Sahoo	Online Course on 3D printing
43	03914811119	Himanshu Jaiswal	
44	04014811119	Shiven Gupta	Nestle India
45	04114811119	Aabhas Bhatia	Bharat Petroleum, Loni Lubes Plant
46	04214811119	Shivam Singh	UM Autocomp Private Limited, Nehru Place, New Delhi
47	04314811119	Dhrish Sharma	Aeon Integrated Building Design Consultants LLP, Noida
48	04414811119	Shubham Mehra	Northern Indian railways, Tughlakabad
49	04514811119	Chetan Kumar	Northern Indian railways, Tughlakabad
50	04614811119	Daksh Gandotra	Northern Indian railways, Tughlakabad
51	04714811119	Yash Mathur	Business Development Internship, Bengaluru, Karnataka
52	04814811119	Chirag Gahlot	Savmuk Infra Rays
53	04914811119	Param Madan	Airtek
54	20114811119	Rishabh Jain	Gas Turbine Research Establishment (DRDO), Bengaluru
55	20214811119	Nitin Yadav	National Fertilizers Ltd., Panipat
56	20314811119	Aryan Bisht	
57	35114811119	Dhruv Gupta	ARSM ACC Power Pvt Ltd

S. No.	Enrollment No.	Student Name	Organization Name
58	35114808220	Abhishek Aggarwal	Hydro Power Plant, Karian, Chamba
59	35214811119	Anshuman Dev	Northern Indian railways, Tughlakabad
60	35314811119	Arjit Mann	
61	35414811119	Aman Pandey	Northern Indian railways, Tughlakabad
62	35514811119	Ikroop Singh Grover	Jay Bharat Maruti (JBM, Neel Metals Pvt Ltd), Gurugram
63	35614811119	Rohan Pandey	Manufacturing Seals, Ghaziabad
64	75114808220	Ajmal Rafiq Deedar	J K Mechanical Engineering Department, Srinagar
65	75214808220	Arunav Sharma	Hydropower Plant, NHPC, Karian, Chamba, Himachal Pradesh

Research Publications

Experimental Performance Evaluation of Ice Slurry Refrigeration System using PG & EG Depressants

Arshlaan Siddiqui, Jatin Gupta, Aabhaas Bhatiya, Ujjwal Sahu, Atul Singh, Manish Mangla, Vaibhav Jain, Neelam Sharma

ICGTS-2024

The use of certain types of depressants is one of the primary contributors to global warming and ozone depletion, the demand for effective and sustainable cooling systems has increased the use of ice slurry as a promising substitute in a variety of applications. But there is still much work to be done to produce ice slurry effectively. To improve the formation of ice crystals, the process, and overall system effectiveness, this study report presents an experimental examination of a mechanical scraper ice slurry generator using ethylene glycol, and propylene glycol as depressants at three different percentages, namely 10%, 18%, and 25%. The study comprises the measurement of several parameters at various state points, such as mass flow rate, pressure, temperature, and enthalpy, as well as the computation of performance parameters, the link between slurry temperature and time, and a comparison of the system's coefficient of performance (COP) at various concentrations. In this study, a -10°C temperature was attained for a 25% volume-by-volume aqueous solution of propylene glycol, representing the lowest temperature recorded on our system.

Development of IoT based Air Conditioning Trainer assisted with Four Way Reverse Valve

Krishna Anurag Tripathy, Akshat Dixit, Naman Srivastava, Vibhor Suryavanshi, Prabhat Choraria, Saurabh Dabral, Vaibhav Jain, Neelam Sharma

ICGTS-2024

With the cost of gas increasing day by day and the switch to renewable sources of electricity becoming more viable, the need for a system which works as an air conditioner round the year is needed. Therefore, the solution to this problem is to design a single unit which works as an air conditioner in summers and as a heater in winters, while being energy efficient. Electric resistance heaters are expensive as well as consume mor power, increasing operational costs. To overcome this problem a single un is designed which performs round a year and is cost effective. This device suitable for its functionality as per the climate of India. The major component which helps in gathering the data for predictive maintenance and remote control through smartphones is Internet of Things (IOT). By establishing a connection between the air conditioner to the internet and web servers, it is possible to remotely control and monitor the device, as well as automate certain functions.

Innovative Design Approach of Mechanical Skimmer for Restoration of Water-bodies from Aquatic Weeds

Surabhi Lata, Siddharth

IEEE

Emerging technologies and technological innovations define new horizons for the mankind but are adversely affecting the blanket of earth and its creatures. The deteriorating conditions of the natural environment is being taken care of through various schemes of cleanliness, new policies and general awareness among people. The presented investigation provides a solution to an environmental problem faced in the areas where rivers, canals and lakes are present. The trash and debris (human produced or natural) present in these water bodies are source of pollution and also obstruct the natural beauty of the place. The water-bodies have excessive growth of aquatic weeds which flow 1–2 cm below water surface. These aquatic weeds obstruct the flow of water and get hinged and coagulate on any solid surface which appear as floating heap of waste. Till date, these weeds are removed manually with a temporary arrangement of equipment. A solution to this is proposed in the form of design modification of frontal part of mechanical skimmer i.e., the conveyor but with an introduction of third shaft. The shaft was designed with 8 fins equidistant at an angle of 45 degrees with few assumptions made during the design of fins. The design of the shaft was validated through the static structural analysis which was performed for total deformation and Von mises stresses. The solution converged at 10 steps with a total deformation of 2.378%. The entire project aims at scavenging the trash debris and restoring the natural beauty of all water-bodies on the mother earth.

Unlocking competitive edge and sustainability through Make-to-Order manufacturing: an empirical

Surbhi Upadhyay, S.K. Garg, R. Sharma

In order to minimise the adverse impacts on the environment, manufacturers, policymakers, and society have all been interested in sustainable manufacturing. Several factors related to Configurable Product, Customer Need, Emerging Technology, Information Technology, Market Performance, Organisation Readiness are being studied by the researchers in this process. Make To Order (MTO), as an approach towards management of manufacturing helps to reduce the over production and thus wastage of the items and helps in sustainable manufacturing along with improving the competitiveness of the organisation. The goal of this study is constructing a sustainability model using a MTO manufacturing system. From the responses of structured questionnaires, PLS-SEM (SMART PLS 4), i.e. Partial Least Squares approach to structural equation modelling has been used to develop the model and determine the strength of the relation between items. The empirical findings demonstrate that all the approaches have a significant effect on MTO manufacturing system. Competitive Advantage acts as a mediator for the relationship between MTO and Sustainable manufacturing. The current literature on sustainable manufacturing initiatives has been extended and improved by these findings, and give researchers a fresh angle from which to further explore this idea.

Effect of Surface Coatings on the Tribological Properties of Sliding Contacts

V. Sharma, S. Joshi, R. Mittal, I. Kaushik

SAE Technical Paper

The present work discusses the effects of Electrolytically deposited chromium coating on the Tribological behaviour of piston ring material. The frictional behaviours were evaluated using the linear reciprocating Tribometer under varying conditions of load and temperature. Test temperatures of 25, 50, and 100 degrees Celsius and loads of 20, 30, and40N were applied during the tests to obtain the wear response of the coating under conditions similar to real piston cylinder/ring friction conditions. Tests were carried out with a constant sliding speed of 0.1 m/s. Optical micrographs and scanning electron microscope were used to analyze the nature of wear. It has been found that for lubricated or non-lubricated and coated or uncoated specimens, on increasing load, wear and surface roughness both increased for pins and plates. For dry conditions and a fixed load of 30N, wear of coated pins is found to be increasing with temperature from 25°C to 100°C, but plate wear shows a fully opposite variation in wear with increasing temperature thus wear decreased. Therefore, a substantial resistance to wear has been achieved by the hard chromium coating of pins.

Experimental Modelling and Process Optimization of Abrasive Water Jet Machining of Glass Fibre Reinforced Polymer Composites

Anil Kumar Dahiya, Basanta Kumar Bhuyan, S. Kumar

International Journal on Interactive Design and Manufacturing-2023

This paper describes an experimental investigation, modelling and optimization during abrasive water jet machining (AWJM) of glass fibre reinforced polymer composite. Four process parameters namely water pressure, stand-off distance, traverse rate and abrasive mass flow rate are considered to study their influence on maximum delamination length (Max. DLL), surface roughness (Ra) and kerf taper (Kt). The secondorder regression models are developed for the maximum delamination length, surface roughness and kerf taper in AWJM of glass fibre reinforced polymer composite using response surface methodology based central composite design approach. From the regression models, it is revealed that delamination decreases with an increase in abrasive mass flow rate, with a decrease in traverse rate. Surface roughness decreases with increase in water pressure and decrease in traverse rate. Kerf taper decreases with increase in water pressure; and decrease in traverse rate and stand-off distance. Further, response surface methodology based desirability function is performed to minimize the Max. DLL, Ra and Kt and the desirability values were found for Ra = 0.936, Kt = 0.942 and Max. DLL = 1 with a combined desirability rating of 0.959 which was reasonably good and acceptable. From the confirmation test of multi-response optimization, it was obvious that the percentage error at optimum level of process parameters for Ra, Kt, and Max. DLL were less than 6.312%, 7.229%, and 4.318%, respectively.

Torsion test for a BAJA chassis using gyroscopic sensor and validation of CAE results

Ramakant Rana

Materials Today: Proceedings

Vehicle dynamics plays an important role in vehicle stability, handling, ride quality and control. The dynamics of vehicle are also dependent on vehicle chassis and hence torsional stiffness of chassis is an important property to consider. High torsional stiffness results in less vibrations and better handling. This paper presents a torsional analysis of the chassis of an All-terrain Vehicle (ATV) used in BAJA SAE competition. Experimental analysis is performed where chassis is put under load and deflections are measured using a gyroscopic sensor. FEM simulations are performed and results are compared to calculate error. The paper concludes with ways to improve torsional stiffness.

Identifying the Enablers for adaptation of FinTech: A Literature Review

Piu Jain

International Journal of Management and Applied Science

FinTech, which has become a significant financial sector innovation, has rapidly expanded as a result of new legislation, an expanding economy, and technological advancements. The number of FinTech companies will rise, according to researchers. Thus, it is essential to gain a deeper knowledge of what Enablers fundamentally support FinTech innovation and their objectives. Recognizing and classifying the crucial enablers of FinTech is the aim of this research study. Thirteen enablers are identified and grouped in technology, economic, and customer aspects.

Influence of Process Parameters on KERF Properties of GFRP with Abrasive Water Jet Machining

Anil Kumar Dahiya, Basanta Kumar Bhuyan, Puneet Kumar, Sachin Salunkhe, Shailendra Kumar

International Journal of Materials Engineering Innovation

Abrasive water jet machine (AWJM) is used in industries to remove and shape the composite materials and other hard-to-cut engineering materials. In this study, experimental investigation on glass fibre reinforced polymers (GFRP) using AWJ machine for cutting performance is discussed. There are various factors which influence the quality of the surface in AWJM. Water pressure, traverse speed, standoff distance, and abrasive mass flow rate are only several of the variables evaluated in this paper. Minitab 18's Taguchi technique is utilised to design the experiment, and ANOVA is performed to determine the significance and impact of process factors on responses.

Issues and challenges of mass customization Author links open overlay panel

Piu Jain

Materials Today: Proceedings

Mass customization has evolved as an important research area in today's rapidly changing economic landscape. Even though theoretically suitable, practically several critical barriers inhibit its implementation. The purpose of this study is to investigate the issues and challenges associated with mass customization when an organisation transitions from mass manufacturing to mass customization. In businesses striving to implement mass customization, challenges are identified with the help of a literature review. Overcoming these challenges might commence with effective material management.

Optimization of process parameters for machining defects of glass fibre reinforced polymer composite machined by AWJM

Anil Kumar Dahiya

Materials Today Proceedings

For the machining of composites like glass fibre reinforced polymers (GFRP), abrasive water jet machining (AWJM) is generally used. AWJM has proven to be a cost-effective and efficient metal removal process of composites, in which a high-speed jet of abrasive and water strikes on workpiece surface to erode the material. In this paper, an experimental investigation is described which is focused on investigating the effect of process parameters on defects like delamination, pulling out of fibres and embedment of abrasive particles of machined samples during AWJM of GFRP composites. For design of experiments response surface methodology (RSM) based on the central composite design (CCD) approach is used. Water pressure (WP), traverse rate (TR), stand-off distance (SOD) and abrasive mass flow rate (AMFR) are considered to study their influence on delamination. The scanning electron microscope (SEM) is used to investigate the microscopic features of machined surfaces. It is revealed that delamination decreases with an increase in AMFR, with a decrease in TR, Further, optimization based on the desirability function is also performed to minimize the delamination. The optimal combination of the cutting parameters (SOD = 2.6 mm, WP =175-MPa, TR = 104 mm/min and AMFR = 582 g/min) gives the optimized values of Max.DLL is 0.299 mm.

Novel Robotic Platform for Affordable and Customizable Testing and Prototyping

Ramakant Rana

EVERGREEN Joint Journal of Novel Carbon Resource Sciences & Green Asia Strategy

The robotic platforms currently available for testing the software stability and functionality are expensive and are not highly customizable in terms of hardware. This makes the platforms out of reach of the grasp of researchers and small-scale start-ups. We have proposed a design of a robotic platform that is easier to manufacture and cheaper to build (totaling under USD1000). The components used are easily available and are cheaper as compared to the components of currently available robotic solutions. The design features of the platform are explored along with factors and features that make the proposed platform favourable to small-scale researchers and start-ups. The components of the platform are discussed along with their purpose in the design. A model that is highly customizable, easy and cheap to manufacture, and capable of carrying out general tasks of navigation and manipulation was made. Scaling the model physically down to making its smallest gearbox (in wrist actuator) of about 10 cm in diameter, was also made possible using the design principles proposed in the paper. Further scope of improvement and ideas for the next version design were also explored.

Industry Expert Corner

Fan Blades

Mr. Abhishek Jain
Air Flow Private Limited

Fan Blades: The Silent Drivers of Airflow Efficiency

In the world of mechanical and thermal systems, fan blades are critical components that often operate behind the scenes, yet they play a defining role in system efficiency, performance, and longevity. As someone deeply involved in the design and application of fan systems across various industries, I've come to appreciate the engineering precision and material science that go into developing effective fan blades.

The Heart of Air Movement

At their core, fan blades are designed to convert rotational motion into airflow. This seems simple, but the execution is highly complex. Depending on the type—axial or centrifugal—the blade geometry, pitch angle, curvature, and number of blades all vary significantly to suit specific functions. For instance, axial fans, which move air parallel to the axis of rotation, require thinner and more aerodynamically optimized blades. In contrast, centrifugal fans, which move air perpendicularly, benefit from wider blades with robust mechanical strength.

The aerodynamic efficiency of a fan blade impacts not only the air delivery but also energy consumption and noise levels. A well-designed blade can reduce power requirements and minimize turbulence, which leads to quieter operation and longer component life.

Material Choices Matter

Selecting the right material for fan blades is crucial and depends largely on the operating environment. In HVAC systems and general industrial use, aluminum and galvanized steel are popular due to their strength, light weight, and corrosion resistance. In high-performance or corrosive environments, composites like fiberglass-reinforced plastic or carbon fiber offer excellent strength-to-weight ratios and design flexibility.

For extreme conditions such as jet engines or gas turbines, advanced materials like titanium and nickel-based superalloys are used. These blades are engineered to withstand high temperatures and stress, often featuring internal cooling channels and precision-balanced profiles.

Balancing Efficiency, Durability, and Noise

One of the primary challenges in fan blade design is optimizing airflow without compromising noise levels or durability. High-speed fans, especially in electronics or residential settings, must be quiet. Innovations such as serrated trailing edges, variable pitch angles, and biomimetic shapes inspired by nature—like owl wings or whale fins—are being employed to reduce noise while maintaining efficiency.

Another often overlooked aspect is balance and vibration. Even slight imbalances in blade weight or symmetry can lead to vibration, reducing the lifespan of both the fan and its housing. Precision manufacturing and dynamic balancing are therefore essential parts of the production process.

The Future of Fan Blade Design

With the global push toward energy efficiency and sustainability, the future of fan blade technology lies in smarter, lighter, and more adaptable designs. Advances in additive manufacturing are allowing for intricate geometries that weren't possible before. Meanwhile, embedded sensors and AI-driven monitoring systems are enabling predictive maintenance, reducing downtime and increasing system reliability.

In conclusion, while fan blades might appear to be simple rotating components, they are in fact complex products of advanced engineering, materials science, and innovation. Their design directly impacts airflow efficiency, energy usage, acoustic comfort, and system longevity—making them indispensable in both industrial and everyday applications.

Water Purification

Mr. Gaurav Aggarwal
Scientist
Department of Science and Technology

Water Purification: Engineering Clean Water for a Sustainable Future

As an industry expert in the field of environmental engineering and sustainable technology, I've seen firsthand the growing importance of water purification in our world. Clean water is not just a basic human necessity—it's a critical component of public health, industrial processes, and environmental protection. With increasing population pressure, pollution, and climate change-induced water scarcity, the demand for effective, affordable, and scalable water purification technologies has never been greater.

The Fundamentals of Water Purification

Water purification is the process of removing physical, chemical, and biological contaminants from water to make it suitable for specific uses, whether it's drinking, industrial processing, or agricultural irrigation. Depending on the source and intended application, purification techniques may vary. For example, groundwater might require only minimal filtration, while wastewater or river water may need multi-stage treatment including chemical dosing, biological filtration, and advanced disinfection.

The core methods used in water purification include sedimentation, filtration, chemical treatment (such as chlorination), and disinfection (commonly with UV or ozone). In recent decades, more advanced technologies like reverse osmosis (RO), nanofiltration, and membrane bioreactors (MBRs) have been integrated into water treatment plants around the world, enabling higher levels of purification with improved efficiency.

Modern Technologies and Innovations

One of the most transformative technologies in modern water purification is **reverse osmosis**, especially for desalination in arid regions. RO systems force water through semipermeable membranes that trap salts, bacteria, and other impurities. Though energy-intensive, ongoing improvements in membrane technology and energy recovery systems are making RO more cost-effective and environmentally sustainable.

Ultrafiltration and nanofiltration membranes have also revolutionized industrial and municipal water treatment. These membranes offer high precision in removing pathogens, suspended solids, and certain dissolved compounds without relying heavily on chemical treatments.

In the rural and developing world, **point-of-use (POU) purification systems**—such as biosand filters, ceramic filters, and solar disinfection (SODIS)—offer affordable solutions that require minimal infrastructure. These systems play a vital role in bridging the gap where centralized treatment is not feasible.

Sustainability and Challenges

While technology has advanced significantly, challenges remain. One key concern is the environmental footprint of purification processes—particularly those that consume large amounts of energy or produce chemical waste. There is also the issue of **microplastics and emerging contaminants**, such as pharmaceutical residues and PFAS ("forever chemicals"), which are not always removed by conventional treatment systems.

To address these concerns, the industry is moving toward **integrated, energy-efficient, and low-waste systems**. Hybrid treatment units that combine biological, chemical, and membrane-based methods are being adopted for their versatility and lower environmental impact. Moreover, the use of AI and IoT in water treatment plants is improving process control, leak detection, and system optimization.

Conclusion

Water purification is no longer just a municipal service—it is a cornerstone of sustainable development, public health, and industrial efficiency. As we face new environmental and technological challenges, our focus must remain on innovation, scalability, and accessibility. Whether through cutting-edge membrane systems or simple village-scale solutions, the goal is clear: to provide clean, safe, and reliable water for everyone, everywhere.

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