Abstract Proceedings
of
5th International Conference on
Recent Advances in Mechanical Infrastructure
(ICRAM-2025)

Organized by:

Department of Mechanical and Aerospace Engineering
Institute of Infrastructure Technology Research
And Management (IITRAM)
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In Collaboration with

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Indian Institute of Technology
Roorkee (IIT Roorkee)
and
Department of Mechanical Engineering
Sardar Vallabhbhai National Institute of Technology, Surat

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PREFACE

Institute of Infrastructure, Technology, Research and Management (IITRAM) is an Autonomous University as declared in the Gujarat Government Act no. 5 of 2013- broadly known as IITRAM Act, provides Engineering education with undergrad and post grad courses in Civil, Mechanical, Electrical branches. It also offers PhD programs in engineering branches of Civil, Mechanical and Electrical. It is initiated to facilitate outstanding technical education in the field of Infrastructure, Science, Technology and Management at Ahmedabad. To cultivate skill based Engineers, IITRAM has advanced curriculum, labs, and industry tie-ups to produce advanced, skilled and trained professionals for technologically advanced nation. This Institute recognizes, that in addition to academic excellence the need of the hour is having exposure to live projects and gaining on-field experience right from the word go.

This Proceedings is brought out to mark the occasion of the 5th International Conference on Recent Advances in Mechanical Infrastructure (ICRAM-2025) during January 10-12, 2025 organized by Department of Mechanical and Aerospace Engineering, IITRAM, Ahmedabad. This conference provides a forum for discussion on issues, concepts, skill development and possible innovations in the mechanical infrastructure sector. ICRAM-2025 aims at bringing the best technical minds working in the field of mechanical engineering on a common platform to share their knowledge of technical expertise, experience and forthcoming challenges in the development of infrastructure in the country. Moreover, it will be a great opportunity for the enthusiastic students and research scholars to learn from the experiences and vision of eminent scientists and innovators.

The conference conveners would like to thank the delegates who have contributed for the conference proceedings. We would also like to thank our outstanding Keynote speakers: Dr. Prabal Talukdar is currently working as a CEA Chair and Professor (HAG) in the Department of Mechanical Engineering of IIT Delhi., Dr Vishal Uttamrao Bagade Scientist 'F' Gas turbine research establishment, DRDO, Min of Defence, Lt Gen P R Shankar is a retired Director General of Artillery. He is an alumnus of National Defence Academy Khadakvasala, Defence Services Staff College, Wellington, Army War College, Mhow, Naval Post Graduate School, Monterrey and National Defence College, New Delhi, Sylvie Lorent Associate Dean for Research and Innovation and College of Engineering Chair Professor in Mechanical Engineering, Villanova University, Brigadier P S Ramesh, is a former Indian Army officer with a strong academic and research orientation. He is among the pioneers of Unmanned Aircraft Systems (UAS), popularly referred to as drones, in India and has spent more than two decades

developing a niche specialisation in the technology and Lt Col Narendra Tripathi is a highly respected veteran of the Indian Army, having served for over 25 years in the Indian Army. An alumnus of the prestigious National Defence Academy (NDA), he was commissioned into the Corps of Electronics and Mechanical Engineers of Indian Army in 2000 after graduating from the Indian Military Academy (IMA) for sharing their deep insights on future challenges and trends. During the conference 6 invited talks and 120 oral talks were presented, which are included in the contents of these proceedings. We also would like to thank all the reviewers for their great effort on reviewing the papers submitted to ICRAM 2025. Special thanks to all the researchers and students who with their work and participate in the conference. We are grateful to the Management of IITRAM for their help and support in organizing this mega event.

Message from the Chief guest

I am pleased that Department of Mechanical and Aerospace Engineering, Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad has organised the Fifth International Conference on Recent Advances in Mechanical Infrastructure (ICRAM 2025) in collaboration with the Centre for Space Science and Technology (CSST), IIT Roorkee, and the Department of Mechanical Engineering, SVNIT Surat. It is both a privilege and a pleasure to be the Chief guest of such a significant event.

In today's rapidly evolving world, infrastructure development faces unique and complex challenges, driven largely by globalization and technological advancements. IITRAM, inaugurated by **Shri L. K. Advani**, former Deputy Prime Minister of India, and **Shri Narendra Modi**, then Chief Minister of Gujarat and now Hon'ble Prime Minister of India, was established with the vision of fostering innovation, research, and development in infrastructure technology.

I congratulate the organizing team for selecting an important issue that will generate ideas to carve a path towards attaining the infrastructure development goals for Viksit Bharat with the use of technological advancements.

Wishing you an inspiring exchange of ideas and a highly successful conference ahead.

Thank you, Jai Hind!

Shri Rushikesh Ganeshbhai Patel

Message from Director, IIT Roorkee

I am happy to know that the Department of Mechanical and Aerospace Engineering, Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad is organising the Fifth International Conference on Recent Advances in Mechanical Infrastructure (ICRAM 2025) in collaboration with the Centre for Space Science and Technology (CSST), IIT Roorkee, and the Department of Mechanical Engineering, SVNIT Surat.

The goal of this conference is to unite leading academicians, scientists, researchers, scholars, industrialists, and decision-makers from various engineering disciplines worldwide. It aims to facilitate the exchange of new ideas, share knowledge, and explore recent developments in mechanical infrastructure domain. Additionally, the conference will highlight advanced defense technologies and future developments for sustainable infrastructure.

This conference serves as a crucial platform for sharing innovative ideas and finding practical solutions to current challenges. It also provides an opportunity for global stakeholders to collaborate meaningfully and advance the field.

I extend my best wishes for the success of the conference.

K.K. Pant

Message from Director, SVNIT Surat

It is with great pleasure that I welcome you to Fifth International Conference on Recent Advances in Mechanical Infrastructure (ICRAM) 2025 jointly organized by the **Dept. of Mechanical and Aerospance Engineering, IITRAM**, **Centre for Space Science and Technology (CSST), IIT Roorkee**, and the **Dept. of Mechanical Engineering, SVNIT Surat.**

This conference, focusing on the latest advancements in Mechanical Infrastructure, is a timely and important initiative that aligns with the growing demand for innovative and sustainable solutions in the field. I am confident that **ICRAM-2025** will bring together a distinguished group of researchers, engineers, and industry professionals to share their insights, knowledge, and experiences. The exchange of ideas and the discussion of cutting-edge research will undoubtedly contribute to the advancement of Mechanical infrastructure and its practical applications. I hope that this conference will inspire new ideas, foster collaborations, and drive innovation in the field of Mechanical infrastructure.

To all participants, I encourage you to engage actively, share your perspectives, and take full advantage of the opportunities this conference offers. May the discussions and connections made here pave the way for future collaborations and discoveries.

I extend my best wishes to the organizers, participants, and all those involved in making ICRAM- 2025 a successful event. Thank you for being part of ICRAM 2025. I wish you a productive and enriching experience.

Prof. Anupam Shukla

Message from Director General, IITRAM Ahmedabad

The Institute of Infrastructure, Technology, Research and Management (IITRAM) was established by the Government of Gujarat as an autonomous university with a mission to transform engineering education by advancing technical and managerial knowledge in the field of infrastructure. Its primary objective is to serve as a center of excellence in research and teaching across all areas related to infrastructure. The Institute aspires to achieve national recognition and prominence in infrastructure and associated fields.

I am delighted to learn that the Department of Mechanical and Aerospace Engineering at the IITRAM, Ahmedabad, is organizing the Fifth International Conference on Recent Advances in Mechanical Infrastructure (ICRAM 2025). This event is being held in collaboration with the Centre for Space Science and Technology (CSST) at IIT Roorkee and the Department of Mechanical Engineering at SVNIT Surat.

I would like to congratulate the organizers of ICRAM 2025 for their remarkable achievement in collecting papers from different countries and various parts of India for this conference. This is a significant accomplishment for IITRAM. These efforts will undoubtedly generate many interesting results and new knowledge, potentially leading to further commercialization activities.

I am very happy to welcome all the delegates to this conference.

Prof. Pramod Kumar Jain

Message from Director, IITRAM

It is with great pleasure I welcome participants to the Fifth International Conference on Recent Advances in Mechanical Infrastructure (ICRAM 2025). This conference serves as a platform for researchers, academicians, and industry professionals to share their latest findings, innovations, and advancements in the field of mechanical infrastructure.

I extend my heartfelt gratitude to all the dignitaries, keynote speakers, authors, and participants for their invaluable contributions and unwavering support. Each contribution not only highlights the current trends and challenges in mechanical infrastructure but also paves the way for future developments and collaborations. The dedication and hard work have made this conference a resounding success.

I would also like to acknowledge the efforts of the organizing committee, reviewers, and volunteers who have worked tirelessly to ensure the smooth execution of this event. Their commitment and enthusiasm have been instrumental in bringing this conference to fruition.

As we embark on this journey of knowledge exchange and innovation, I encourage all participants to engage actively in the discussions, share their insights, and foster new collaborations. Together, we can drive the field of mechanical infrastructure towards new heights of excellence.

Thank you for your participation, and I wish you all a fruitful and enriching experience at ICRAM 2025.

M K Barua

Prof M.K. Barua

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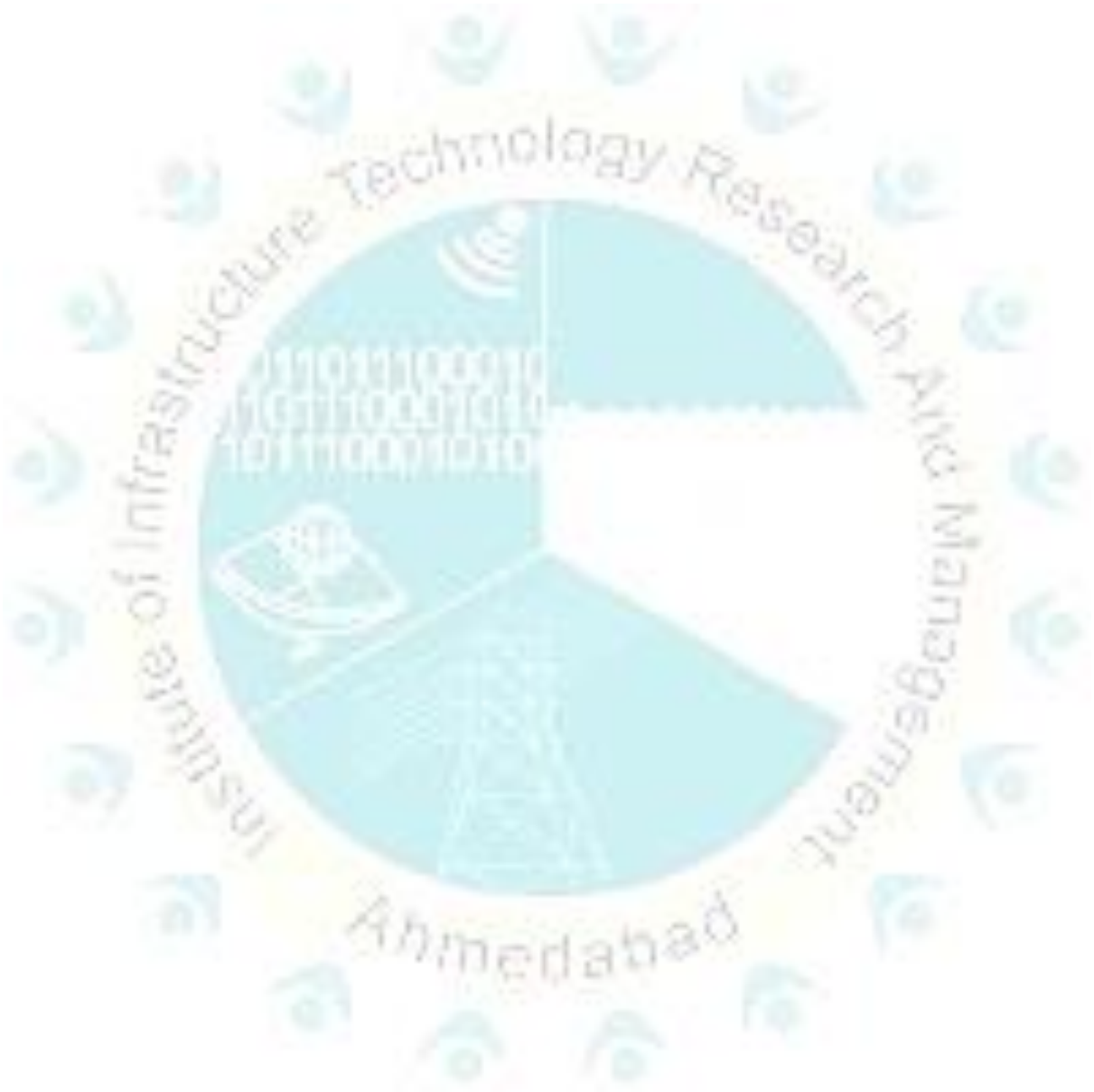

Part I: Recent Advances in Thermal and Fluid Sciences

Modelling and Simulation Studies of Diver Propulsion Vehicle

S. Mohanty1, 3*, Anirban Bhowmik2, Tanish Sai. E2, Anubhab Saha2, A. Garg3, S. K. Dwivedy3

1School of Mechanical Engineering, VIT Bhopal University, Madhya Pradesh, 466114, India
2Department of Production Engineering, National Institute of Technology Agartala, 799046
3IIT Guwahati Technology Innovation and Development Foundation, Assam, 781039, India

Email:siba.mech@gmail.com

Abstract. In this work design and simulation studies of an underwater diver pro-pulsion vehicle (DPV) is carried out. The developed CAD model is analyzed us-ing CFD simulations to evaluate the hydrodynamics parameters and study the performance of the design model. The design of the DPV with enlarged wings shows a better performance in reducing 20% of the drag and providing more sta-bility than without wings. The design model of the DPV consists of two thrusters adjacent to the handle, a sonar for mapping the water bodies, and a camera for underwater visualization. The various electronic parts of the DPV are housed in a water-tight enclosure in the middle part of the DPV for maneuvering it through the two-joy stick button attached to the handle. The DPV popularly known as an underwater scooter provides a new concept for underwater navigation with ease and has a wide range of applications in the military and underwater explorations.

Keywords: Underwater scooter, Design, CFD, Drag

Optimizing Brake Specific Energy Consumption in a Single-Cylinder Diesel Engine Fuelled with Diesel and Polymer-Based Fuels

Maulik A Modi[1][0000-0001-9417-6135] and Tushar M Patel[2][0000-0001-9763-3442]

[1] Kadi Sarva Vishwavidyalaya, Gandhinagar 382016, Gujarat, India
[2] LDRP-ITR, Kadi Sarva Vishwavidyalaya, Gandhinagar 382016, Gujarat, India
maulikmodi325@gmail.com

Abstract: Plastic materials, while versatile, pose significant environmental challenges due to disposal and recycling issues, with millions of tons entering landfills and oceans annually. This study investigates the use of polymer-based fuels from low-density polyethylene (LDPE), high-density polyethylene (HDPE), and polypropylene (PP) pyrolysis oils in diesel engines as alternative fuels to address both plastic waste and energy production. A 3.5 kW single-cylinder compression ignition engine was used to test various fuels, optimizing four parameters—fuel type, compression ratio (CR), injection pressure (IP), and engine load—using the Taguchi method. Brake Specific Energy Consumption (BSEC) was measured to assess engine efficiency. Results showed that engine load most significantly influenced BSEC, followed by fuel type, IP, and CR. Optimal BSEC was achieved with LDPE-PO and PP-PO under specific conditions, with prediction errors of 3.9% and 3.7%, respectively. While LDPE exceeded CO limits, PP showed better emission performance, meeting BS-VI standards. The Taguchi method successfully optimized engine performance, reducing evaluation time and improving fuel efficiency. PP was more environmentally friendly, and the model's low error margin supports its reliability. Future research is recommended to refine this approach further.

Keywords: Taguchi method, BSEC, pyrolysis oil, low density polyethylene, high density polyethylene, polypropylene.

Enhncing Peak Hour Efficiency of Traditional and Stepped Solar Stills: An RSM Approach

Krunalkumar B Patel[1[0000-0001-8397-0923]], Tushar M Patel[2[0000-0001-9763-3442],] Kirankumar A Patel[3[0000-0001-5040-2380]] and Saumil C Patel[4[0009-0004-3360-0093]]

[1] Kadi Sarva Vishwavidyalaya, Gandhinagar, 382016, Gujarat, India
[2,3,4] LDRP-ITR, Kadi Sarva Vishwavidyalaya, Gandhinagar, 382016, Gujarat, India

Email: krunalpatel31185@gmail.com

Abstract: Solar stills are essential for harnessing solar energy to produce potable water, particularly in arid regions where access to clean water is limited. This study focuses on extending a mathematical model using Response Surface Methodology (RSM) to predict and optimize the efficiency of traditional and stepped solar stills. Key design parameters—including water level, water flow rate, and cover glass thickness—were systematically analyzed for their impact on peak hour efficiency. Extensive data collection was conducted under various operating conditions to inform the RSM model, which produced a predictive equation accounting for complex interactions among input variables. The findings reveal that the peak hour efficiency of stepped solar stills is higher than that of traditional stills. Significant parameters were ranked as follows: solar still type, water level, cover glass thickness, and water flow rate. Interactions between water level and cover glass thickness, along with quadratic effects, significantly impacted efficiency. The model showed high accuracy, achieving an adjusted coefficient of determination of 99.02% and a coefficient of determination of 99.35%. Optimal conditions for maximum efficiency were identified as a stepped solar still with a cover glass thickness of 4 mm, a water flow rate of 15 kg/h, and a water level of 10 mm, yielding predicted and experimental efficiencies of 21.90% and 22.14%, respectively. The regression error of 1.08% indicates the high precision of the RSM model. This approach effectively streamlines the evaluation of solar still design variables, enhancing efficiency optimization efforts.

Keywords: solar still, water level, water flow rate, cover glass thickness, RSM, CCD, peak hour efficiency

Numerical Simulation of Magnetohydrodynamic Flow Past Stationary Object Using Immersed Boundary Method

A Kishan and Ranjith Maniyeri*

Biophysics Laboratory, Department of Mechanical Engineering,
National Institute of Technology Karnataka (NITK), Surathkal, 575025, Karnataka, India
Email: mranji1@nitk.edu.in

Abstract: Magnetohydrodynamic (MHD) flow refers to the study of behavior of electrically conductive fluid flow when external magnetic field is applied. It has numerous uses across various branches of engineering and industrial appli-cations. It also has prominent application in biomedical field. The presence of an object in MHD flow field has prime importance for above applications. Ac-cordingly, this work presents an attempt to apply the immersed boundary meth-od (IBM) using fractional step based finite volume scheme to capture the inter-play of both hydrodynamic and magnetic field past a circular and square cylin-der within a channel. Numerical simulations are performed using a two-dimensional computational framework to analyze the unsteady Navier-Stokes equations in association with Lorentz force. Role of magnetic field in stream-wise, transverse and oscillating directions on MHD flow past circular and square cylinder are studied. The findings indicate that as magnitude of magnetic field increases, the length of recirculation zone decreases. For the circular cyl-inder, the critical Hartmann numbers are found to be 5 and 7 in the streamwise and transverse directions, respectively, while for the square cylinder, they are 10 and 13 at Reynolds number of 40. In addition, impact of magnetic field, when circular shaped cylinder is oscillating is also studied and noted that Hart-mann number of 6 is required to suppress the recirculation zone completely at Reynolds number of 40.

Keywords: Magneto-Fluid-Solid Interaction, Magnetohydrodynamics, Recircu-lation length.

Effect of changing internal geometries on the melting performance of shell-and-tube latent-heat thermal energy storage system

Nabyendu Mukherjee[0009-0002-9541-8735], Rahul Kumar Sharma[0009-0009-6293-5745], and Dibakar Rakshit[0000-0002-8469-5924]

Indian Institute of Technology Delhi, India
Email: esn232348@dese.iitd.ac.in

Abstract: Thermal Energy Storage is an alternative energy storage technology that can solve the problem of the intermittent nature of renewable energy sources. In the past, many attempts have been made to design a practical thermal energy storage design. There are two types of thermal energy storage: sensible and latent. In this work, Latent Heat Energy Storage (LHTES) technology has been designed to get an optimal melt time of the Phase Change material in the system. Solar salt (60%NaNO3+40%KNO3) has been selected as the phase change material subject to a temperature of 525 K. As the solar salt begins to melt at 496 K, this simulated study aims to completely dissolve the solar salt in the shortest possible time. As the melting time is strongly dependent upon the geometry of the design, seven simple designs are considered by varying the area of the tubes in a shell and tube Phase Change Material heat exchanger, bottom tubes/tube eccentricity, and an- gular position between the tubes. Out of the different configurations, the pro- posed single-tube eccentric design reduces the melting time by about 43.40% compared to the basic design. Also, the effect of increasing the heat transfer perimeter over the increase in eccentricities has been considered. Reducing the an- gular position between two tubes by 45° for a given geometry decreases the melting time by 47.80% for achieving 90% melting of the phase change material. This suggests that a combination of eccentricity and angular orientation is an important factor to consider in the design of latent heat thermal energy storage systems

Keywords: Thermal Energy Storage, Phase Change Material based heat ex- changer, Latent Heat Storage.

Computational Analysis of Sedimentation of Particle in a Channel Using Immersed Boundary Method

Sumedh Patil and Ranjith Maniyeri*

Biophysics Laboratory, Department of Mechanical Engineering,
National Institute of Technology Karnataka (NITK), Surathkal 575025, Karnataka, India
Email: mranji1@nitk.edu.in

Abstract: This study investigates the sedimentation of circular particle in the vis-cous incompressible fluid within two-dimensional (2-D) channel. For the fluid-structure interaction problem, a two-dimensional computational model is devel-oped by employing an immersed boundary method, discretizing and solving non-dimensionalised Navier-Stokes equations on a finite volume staggered grid sys-tem. The forces and velocities are interpolated using momentum forcing function. Fractional-step method is implemented to solve the simulation to calculate inter-mediate pressure and velocities. Lagrangian parameters calculated from im-mersed boundary method is used to track the position by using Newton's motion equations. The validation of the code is done by comparing settling velocity and time with existing research results. Later the simulations are carried out by off-setting the position of the particle in the transverse and the longitudinal direction. Further the effect of density ratio is studied. Various scenarios for settling veloc-ity, settling time and position of the particle is found and discussed in the paper.

Keywords: Fluid-structure interaction, Sedimentation, Settling velocity.

HEAT TRANSFER ANALYSIS OF DOUBLE TUBE HEAT EXCHANGER WITH TAPPERED FINS AND ANGLED PLATES

E. Sammaiah1, Dr. Mohd. Mohinoddin2, Dr. Narsimhulu Sanke3

1 (Research scholar, Department of Mechanical Engineering, University College of Engineering, OU, Hyderabad)
2 (Professor, Department of Mechanical Engineering, Muffakham Jah College of Engineering and Technology, Hyderabad)
3 (Professor, Department of Mechanical Engineering, University College of Engineering, OU, Hyderabad)

Email:1sammaiah347@gmail.com, 2drmohdmohinoddin@gmail.com, 3nsanke@osmania.ac.in

Abstract: Increasing the thermal efficiency of heat exchangers immediately reduces costs, increases the amount of energy consumed, and marks the material used. In applications that need thermal transfer procedures, improved heat exchange will also significantly boost heat efficiency and the cost-effectiveness of design and operation. Double tube heat exchangers are best suited for high temperature and high pressure applications due to their narrow diameters. Increasing the thermal efficiency of heat exchangers immediately reduces costs, increases the amount of energy consumed, and marks the material used. In applications that need thermal transfer procedures, improved heat exchange will also significantly boost heat efficiency and the cost-effectiveness of design and operation. Double tube heat exchangers are best suited for high temperature and high pressure applications due to their narrow diameters.

Keywords: Double-pipe heat exchanger (DPHE), Tapered fins with tapered fins and angled plates, heat flux, Heat transfer coefficient.

Numerical Study on the Characteristics of Stratified and Churn Flow for Liquid-Liquid Flow in a Square-Crossection Y and T-Type Microchannels

Awesh Kumar Singh2*, Tanuja Sheorey1, Vijay Kumar Gupta1

[1]Department of Mechanical Engineering, PDPM Indian Institute of Information Technology Design and Manufacturing,
Jabalpur, Madhya Pradesh, India
Email:20pmeo09@iiitdmj.ac.in

Abstract: In the present study, a 3D volume of fluid (VOF)-based computational fluid dynamic (CFD) model was performed through numerical analysis of two immiscible liquids, water, and kerosene. The geometry of the microchannel is selected as Y-type and T-type in a square-cross section for a liquid-liquid flow process. The analysis of liquid-liquid immiscible fluid flow pattern in the microchannel. The volume of the fluid model is used to track the interface between the two-phase flows. It was performed, a parametric study of microchannels that were increasing the flow rate ratio, it was observed that the flow behaviours found stratified flow, wavy flow, and churn flow in microchannels in a different type of channel geometry. When the flow rate ratios were increasing, the pressure dropped increased across the length of the channel. It is observed that the average volume fraction of the aqueous solution increases with increased flow rate ratios in 45 and 60-degree inlet Y-type microchannel. The mixing efficiency in the 60-degree inlet Y-type microchannel was higher than in the 45-degree inlet Y-type microchannel, but it is highest in the T-type microchannel due to the churn flow pattern. The shear stress analysis of Y-type and T-type microchannels shows that increasing the flow rate ratio increased the shear stress in all three types of micro channels.

Keywords*:* Computational Fluid Dynamics; Microfluidics; Two-Phase Flow; Volume of Fluid Model.

Finite Difference Method Based modelling of heatstroke using bioheat transfer equations

Pramath Bhat and Ranjith Maniyeri*

Biophysics Laboratory, Department of Mechanical Engineering, National Institute of Technology, Karnataka (NITK),
Surathkal, 575025, Karnataka, India
Email: mranji1@nitk.edu.in

Abstract: This study presents an attempt to model the onset of heatstroke using bioheat transfer equations to investigate the effects of environmental conditions on the human thermoregulatory response. A thermoregulatory model is devel-oped to understand the impact of factors such as humidity and metabolic rate on core and skin temperature dynamics. Results showed that, under high humidity, the body's ability to cool is significantly reduced, leading to exhaustion within 1 hour of exposure. At higher metabolic rates or during intense physical exertion, core temperatures reached critical levels associated with heatstroke (T >=40.6℃) within 2 hours of exposure.

Keywords: Thermoregulation, Thermoreceptor, Bioheat transfer

On the Correlation of Structural, Mechanical and Thermal Properties of Epoxy-Based Hybrid Nanocomposites

Deepak Awasthi[1*], Manikant Paswan[2] and Pallav Gupta[1*]

[1]Department of Mechanical Engineering, A.S.E.T., Amity University Uttar Pradesh, Noida-201313 (INDIA)
[2]Sant Longowal Institute of Engineering and Technology, Longowal-148106, Punjab (INDIA)
Email: oomdeepakawasthi@gmail.com

Abstract: Epoxy-based hybrid polymer matrix nanocomposites have emerged as a transformative material class - offering remarkable enhancements in mechanical, thermal and structural properties. This paper presents a comprehensive review of the current research on the structural, mechanical and thermal behaviour of these advanced materials and focuses on the influence of various hybrid nanofiller combinations. By incorporating nanofillers such as graphene, carbon nanotubes (CNTs), nanoclays into epoxy matrices - the resulting nanocomposites exhibit superior properties due to improved dispersion, interfacial bonding and interactions between fillers. The review discusses the key factors influencing composite performance and includes nanofiller characteristics, fabrication methods and hybridization strategies.

The findings note that hybrid nanocomposites show significant improvements with tensile strength increasing up to 70%, thermal stability enhanced by 20–30°C and thermal conductivity boosted by 60% compared to neat epoxy. Mechanisms of reinforcement - such as effective load transfer and strong interfacial adhesion are explored in detail - highlighting the role of surface functionalization and optimized dispersion techniques. The paper concludes with a discussion on future research directions, emphasizing the need for standardization in material design and characterization to fully harness the potential of epoxy-based hybrid nanocomposites for high-performance applications in aerospace, automotive and electronic industries.

Keywords: Epoxy; CNTs; graphene, Interfacial adhesion, Characterization; Aerospace applications,

Effect of Bed Roughness and Flume Slope on Specific Energy Ratio of Hydraulic Jump: An Experimental Investigation

Sanjeev Kumar Gupta, Vijay Kumar Dwivedi

Department of Mechanical Engineering, IET, GLA University Mathura, U.P., India, 281406
Email: sanjeev.gupta@gla.ac.in

Abstract: In this investigation, a rapidly varied flow configuration with three different surface roughness differed from 10 to 30 mm at different bed slopes varied from 0° to 6° was used. The Reynolds number and the Froude number both varied during the experimentation from 4540 to 24350 and 2.45 to 8.65 respectively. Considering the Reynolds number, an empirical correlation for specific energy ratio is developed. As compared to the classical jump, the specific energy ratio rises by 9.77% at the 6° channel slope and it also increases by 10.97% with a rise in the roughness of the flume from 0 mm to 30 mm.

Keywords: Energy dissipation, Specific energy, Froude number, Bed roughness, Bed slope

Modeling and shock analysis of HNBR and Sorbothane isolators for a naval ship component

Romi Dhakad[1[0009-0006-6783-4423]] and Anil Kumar[2[0000-0002-5650-5484]]

[1,2] Indian Institute of Technology, Roorkee-247667, India
Email: romi_d@me.iitr.ac.in

Abstract: Military ships carry sensitive articles and equipments that experience shock loads caused by underwater explosions in the vicinity of the ship. Unwanted shock loads of this kind have the potential to damage extremely energetic objects and compromise the accuracy of extremely delicate machinery. This research aims to perform a finite element (FE) analysis of ring-shaped hydrogenated nitrile butadiene rubber (HNBR) and Sorbothane isolators to protect a sensitive article stored inside a cylindrical-shaped component of a naval ship using ABAQUS. These materials have nonlinear elastic and viscous properties, which are modeled in the ship component's FE model by the Ogden order three and generalized Maxwell models, respectively. The material constants of these models are determined using the experimental test data of HNBR and Sorbothane. A transverse shock with a peak amplitude of 60 g is applied at the outer surface of the component, and responses are measured in the form of acceleration of the article, deformation, and stress distribution in the isolators. The proposed HNBR and Sorbothane isolators of considered length provide 97.16% and 98.23% shock reduction with 15.23 mm and 9.5 mm maximum deflection in the isolators, respectively. Moreover, the maximum stress developed in the isolators is within the tensile strength of the materials.

Keywords: Ogden model, Generalized Maxwell model, HNBR, Sorbothane, naval ship component, Shock analysis, ABAQUS.

Upgrading Multi-Cylinder SI Engines to CNG Direct Injection by Cylinder Head Modifications for Enhanced Performance

Rajeshkumar J. Patel [1[0009-0000-3808-1502]] and Kirankumar A. Patel [2*[0000-0001-5040-2380]]

1 Kadi Sarva Vishwavidyalaya, Gandhinagar, 382016, Gujarat, India
[2] LDRP-ITR, Kadi Sarva Vishwavidyalaya, Gandhinagar, 382016, Gujarat, India

Email: kpatelp@gmail.com

Abstract: The 1298 cc four-cylinder, four-stroke spark ignition engine was modified for CNG direct injection through adjustments to the cylinder head. A key challenge in this conversion was the placement of the CNG injector relative to the spark plug, as the original head design was optimized for petrol operation and lacked the necessary compartments. To cater to both aspects of the setup adjustments were made to the cylinder head which resulted in a compression ratio. The research adopted a technique by introducing CNG into the combustion chamber while the compression stroke was ongoing, similar, to how diesel engines function. This process entailed creating openings on the cylinder head near the exhaust valve side, for CNG infusion. Brass connectors were affixed in these apertures linking them to high pressure CNG injectors located outside the cylinder head through steel tubing coated with rubber. The high pressure CNG was delivered to the injector rail through a two stage pressure reducer system, in place. The gas operation was overseen by a customized CNG engine control module and specialized software. The conversion process involved installing components like a CNG tank, injector emulator timing advance processor (TAP) and sensors. The performance of the engine was tested using both CNG SI and CNG-DI systems across speeds ranging from 1000, to 3100 rpm. The results showed that the CNG-DI system managed to reduce fuel consumption by 3 to 10% and improve brake efficiency by 1 to 2%. Moreover, it demonstrated a 4 to 6 % increase, in volumetric efficiency and a leaner air fuel ratio when compared to the CNG SI system.

Keywords: Compressed Natural Gas (CNG), CNG Sequential Injection (CNG-SI) system, CNG Direct Injection (CNG-DI) system, Performance, Design modification, Cylinder head.

Enhancement of Horizontal Axis Wind Turbine Performance using active and passive methods-A comprehensive review

Singh Anup Tejnarayan[1], Dr. K. Balaji[2], Singh Nishikant[3] and Yash Chauhan[3]

[1]Assistant Professor, Department of Aeronautical Engineering, , Parul Institute of Engineering and Technology, Parul University, Limda, Vadodara, 391760 Gujarat, India
[2]Associate Professor, Department of Aeronautical Engineering, , Parul Institute of Engineering and Technology, Parul University, Limda, Vadodara, 391760 Gujarat, India
[3] Student, Department of Aeronautical Engineering,, Parul Institute of Engineering and Technology, Parul University, Limda, Vadodara, 391760 Gujarat, India

Email: arobalaji@gmail.com

Abstract: This paper explores methods for controlling the boundary layer in the Horizontal Axis Wind Turbine (HAWT) to enhance its performance. This study includes active and passive flow control methods at various speeds using numerical and experimental analysis. Most of the simulations in the literature were conducted using Computational Fluid Dynamics (CFD) software, mainly the Reynolds Averaged Navier-Stokes (RANS) solver, with very few using other solvers. Among the active flow control methods of injection, suction, co flow jet (CFJ) method and passive methods of vortex generator, slat, gurney flaps are considered effective for improving the performance of HAWT. Reducing drag and maximizing lift improves the aerodynamic performance and power output of the wind turbine. There have been limited experimental studies using wind tunnels to improve aerodynamic performance through the both mechanism. This study aims to analyze various parameters such as design, velocity, pressure, Reynolds number, and Mach number to delay the separation of incoming and outgoing flows. The use of the flow control method proves to be a useful and promising approach for future wind turbines, while also identifying a research gap. The benefits include lower operating costs, longer lifespan, and quieter operation.

Keywords: Airfoil, Active methods, Co Flow Jet, RANS, Passive methods, Wind turbine

Thermal performance of a Compound Parabolic Concentrator (CPC) Solar Water Heating System: A case study

Neeraj Agrawala, Neeraj Kulkarnia, Akshay P. Dhaigudea, Ajay Pendaseb

1Department of Mechanical Engineering, Dr. Babasaheb Ambedkar Technological University Lonere, Maharashtra India
2 Heatray Solar Pvt. Ltd, Mumbai

Email: neerajagrawal@dbatu.ac.in

Abstract: A tailored made fully automatic Programmable Logical Control (PLC) controlled Compound Parabolic Concentrator (CPC) based solar water heating plant is designed, installed, commissioned and tested at ACG Capsule Pvt Ltd Pithampur, Indore (22.61° N, 75.67° E) to cater the demand of 60,000 liters of hot water at 80°C per day. The total aperture area of CPC collector installed in four different interconnected sites is 1152 m^2. CPC plant is enabled to generate average quantity of hot water 48,500 liters per day. The recirculation mode was adopted in one of the site "A" which enhances the solar energy utilization factor efficiency by 25.23 %. The payback period is calculated below 3 years with the impact to replace the use of high speed diesel of 1,56,000 liters/year by solar CPC which can emit 6315 tons of CO2 in 15 years.

Keywords: Solar energy, hot water, Compound Parabolic Concentrator (CPC) collector, recirculation.

Comparative Study of Battery Thermal Management: Analyzing Natural Convection, Immersion Cooling, and Hybrid Immersion-Thermoelectric Techniques

Ummid Isamiya Shaikh[1], Suyog Mane[2], Shriman Patil[3], Atharva Manwadkar[4]

[1,2,3,4] Pimpri Chinchwad College of Engineering, Nigdi, Pune, India

Email: ummid.shaikh@pccoepune.org

Abstract: Lithium-ion batteries have become prevalent in battery-electric vehicles (BEVs) owing to their high energy density, longevity, and reduced environmental impact. Battery Thermal Management (BTM) is crucial in BEVs for dissipating cell heat, improving performance, and protecting against fire hazards due to potential Thermal Runaway (TR). The researchers investigated many cooling strategies for controlling heat dissipation of battery cells, such as air cooling, liquid cooling, Phase Change Material (PCM) cooling, heat pipe cooling, etc. This study evaluates the effectiveness of three cooling strategies: Natural Convection Cooling (NCC), Immersion Liquid Cooling (ILC), and Immersion Liquid Cooling integrated with Thermoelectric Cooling (ILC+TEC). The objective is to regulate temperature rise and homogeneity of a 13s7p battery pack designed for electric two-wheeler application under 1C discharge conditions.

The results indicate that the ILC+TEC combination is superior to other studied methods in controlling the battery pack's maximum temperature (T_{max}). It gives the lowest value of 43.2 ^{o}C for T_{max}. The Standalone ILC method preserves the temperature homogeneity in the battery better than the other investigated methods. The results provide an insight into the merits and drawbacks of each cooling approach, guiding the advancement of efficient and effective BTM solutions.

Keywords: Li-Ion Battery, battery thermal management, thermo-electric cooling, immersion liquid cooling

Effect of Channel Configuration on Transient Behaviour of Minichannel Heat Sink

Kumari Deepika1, Amiy Govind Singh1, and Pawan Kumar Singh1

1Department of Mechanical Engineering, IIT (ISM) Dhanbad, Dhanbad-826004, Jharkhand, India

Abstract: This study investigates the transient heating characteristics of mini-channel heat sinks (MCHS), addressing a gap in existing research which predominantly focuses on steady-state analyses. Through comprehensive numerical simulations, three distinct mini-channel geometries are examined: conventional mini channels, pin fin mini channels, and strip fin mini channels. Transient heating is modeled using functional forms, specifically cosine and step functions, to ensure a consistent heating amplitude throughout each thermal cycle. The primary objective is to compare these geometrical configurations based on their responses to functional heating profiles. The analysis evaluates key performance metrics, including temperature distribution and thermal cooling efficiency at the base of the heat sink. Results indicate that strip fin mini channels outperform both conventional and pin fin designs by maintaining lower temperatures, thereby enhancing thermal cooling performance. Although pin fin mini channels demonstrate the highest thermal efficiency, they are associated with a significant pressure penalty, particularly at high flow rates, which may limit their practical application in scenarios requiring elevated flow conditions. These findings provide valuable insights for the design and optimization of MCHS, emphasizing the trade-offs between thermal performance and pressure requirements in different mini-channel configurations

Keywords: Minichannel heat sink, Transient Heat Transfer, Response Time, Channel Configuration

A review of the recent progress of Nano fluid application in parabolic trough solar collector

Karan S. Vasava *[1], Dr.Gunjan Kumar [2]

1. Department of Mechanical Engineering, UPL University of Sustainable Technology, Ankleshwar, India-393135
2. Department of Mechanical Engineering, UPL University of Sustainable Technology, Ankleshwar, India-393135
Email: karanvasava20.kv@gmail.com

Abstract: Solar energy represents a pivotal renewable resource for achieving a sustainable future, with its capacity to mitigate greenhouse gas emissions and enhance long-term energy security. Concentrating solar collectors, particularly parabolic trough collectors (PTCs), are capable of reaching high temperatures (400-500 °C). This technology employs a parabolic reflector to focus sunlight onto a receiver tube filled with heat transfer fluid (HTF), which absorbs and transports heat for further use. Recent advancements focus on optimizing HTF, with hybrid nanofluids developing as superior alternatives to traditional oils and water. These nanofluids exhibit enhanced thermal properties, including higher thermal conductivity and specific heat capacity, leading to improved heat transfer efficiency and system effectiveness. Research indicates that the incorporation of hybrid nanofluids can significantly raise the thermal performance of PTCs, contributing to increased energy production and a reduction in reliance on fossil fuels. This paper explores the mechanisms and advantages of hybrid nanofluids in enhancing the operational efficiency to transform solar energy systems and climate change challenges.

Keywords: Parabolic trough solar collectors; Nano fluid; Hybrid Nano fluid

The Effect of Cooling Tower Fan on the Performance of the Chiller Plant

Ankitsinh Chauhan 1[0009-0001-8358-5790], Vimal Patel [0000-0001-5748-3726], Ashok Parekh, Ishant Patil and Nachiket Shah

1, 2,3,4,5 Sardar Vallabhbhai National Institute of Technology, Surat. Gujarat, India.
Email: ankitsinh.svnit@gmail.com

Abstract: This study delves into the crucial influence of cooling tower fan oper-ation on the performance of a chiller plant, with a specific focus on the Chiller Plant at SVNIT. Continuous operation of the chiller plant led to unexpected dam-age to the cooling tower's belt drive, rendering the cooling tower fan non-opera-tional. Consequently, the efficiency of heat transfer in the condenser was signif-icantly impaired. In response, we analysed and calculated several vital parame-ters, including the Coefficient of Performance (COP), heat rejection in the con-denser (Qc), work required for the compressor (Wc), and heat absorbed by the refrigerant in the evaporator (Qe). Our findings revealed that in the absence of the cooling tower fan, relying solely on natural convection, the COP of the chiller plant reached a minimum value of 5.49. However, after implementing a belt drive to facilitate forced convection for the cooling tower fan, the COP of the chiller plant experienced a noteworthy improvement, reaching approximately 6.27. Ad-ditionally, the utilization of forced convection resulted in an impressive reduction of 8.9% in compressor work, signifying enhanced energy efficiency. This study underscores the critical role of cooling tower fan operation in optimizing chiller plant performance, with practical implications for energy-efficient HVAC sys-tems. It highlights the potential benefits of employing forced convection mecha-nisms, such as belt drives, to ensure efficient heat transfer in the condenser, ulti-mately contributing to improved energy utilization and reduced operational costs in cooling.

Keywords: Cooling tower, Chiller Plant, Cooling Tower Fan, Energy effi-ciency, VCRS.

Frictional Dynamics of Hexagonal Boron Nitride For Water Desalination

Bharat Bhushan Sharma
Gati Shakti Vishwavidyalaya, Vadodara, Gujarat-390004, India
Email: bharat.sharma@gsv.ac.in

Abstract: Hexagonal boron nitride (hBN) is a two-dimensional (2D) material that is currently being investigated in a range of applications, including atomically thin coatings, nanofluidic, and water desalination. Many of these applications bring the hBN surface into direct contact with water. In this study, we look at the frictional properties of 2D hBN surfaces used in water desalination, such as nanoslits or sheets containing nanopores. We used free energy calculations using molecular dynamics simulations of the hBN–water interface. We find that the nanoslit exhibits higher friction compared to 2D nanosheets or sheets containing nanopores. Our results underscore the importance of investigating frictional properties in these materials for water desalination.

Keywords: 2D materials, hexagonal boron nitride, molecular dynamic simulations, friction, water slip length.

Design and Optimization of a Single Proton Exchange Membrane Fuel Cell: Experimental Study and CFD Simulation of Diverse Flow Field Configurations

Aneesh Jose

School of Engineering & Technology, Christ University Kengeri Campus, Bangalore, Karnataka
Email: aneeshjones@gmail.com

Abstract: The efficiency of a fuel cell largely depends on several parameters, with the bipolar plates being crucial for achieving performance close to theoretical values. This is attained by ensuring an optimal contact area between the membrane exchange assembly and the bipolar plates, as well as by directing the flow fields correctly. In this study, six different designs of bipolar plate flow fields with serpentine patterns are explored, and these designs are simulated using computational fluid dynamics. The designs encompass various configurations, including serpentine flow with 1, 2, 3, 4, and 5 channels, as well as quadrant serpentine flow. Through analysis of pressure and velocity distributions, the serpentine flow 2-channel design emerges as the most efficient, boasting balanced pressure distribution and low velocity. Subsequently, these bipolar plates are fabricated using milling centers and tested in a computerized fuel cell workstation, with results compared to those of a conventional single serpentine bipolar plate. Experimental findings reveal that the serpentine flow 2-channel design exhibits a 5% improvement in performance compared to the conventional single-channel fuel cell design.

Keywords: Fuel Cell, serpentine Channels, Bipolar plate channel designs, Computational fluid dynamics, Fuel cell Performance.

NUMERICAL INVESTIGATION OF LI ION BATTERY PACK USING MULTI SCALE-MULTI DIMENSIONAL ELECTROCHEMICAL THERMAL MODEL

Gaurang Makwana1, Dr Ojas Satbhai2*, Nilesh pawar3

1Pandit Deendayal Energy University, Dept of Mechanical Engineering, Gandhinagar, Gujarat, India
2Pandit Deendayal Energy University, Dept of Mechanical Engineering, Gandhinagar, Gujarat, India
Email: satbhaiojas@gmail.com.

Abstract: Thermal management of battery is very crucial part of any battery system. Electrochemical reaction within battery pack during charging and discharge generate lots of heat and if temperature increase above critical point then it will leads to thermal runaway, fire, and explosion. Electrochemical-Thermal model find out various electrical and thermal properties distribution along battery pack. Voltage, Current density, Temperature, State of charge, Total heat generation and many other parameters we can find out for battery pack with electrochemical-thermal performance. This Model is containing number of Electrical and thermal variables by changing this variable we can also improve thermal and electrical performance. This paper represent 23Ah Battery Pack made up with Two Prismatic cell and by Newman's P2D Electrochemical Thermal Model in Ansys Fluent to see Quantitative data for 1C, 3C, 5C and 10C discharge rate and Further more by changing electrode thickness and Particle size radius how its effecting the thermal and electrical performance of battery pack.

Keywords: Batter Thermal management, electrochemical Model

Parametric Investigation on the Solar Desalination System by Varying Basin Water ppm and Water Level

Sanjay Jain
sanjay.jain@nirmauni.ac.in

Abstract: Two different single-slop passive-type conventional solar stills were fabricated and experimentally assessed at Ahmedabad (latitude 23°07', longitude 72°32'), Gujarat, India. This study mainly focuses on the performance comparison of these two different solar stills made of Galvanized Iron (GI) and Aluminium. The performance of these two single-slop solar stills (Area 0.5 m2) was evaluated by considering nine different cases. This experiment was carried out by varying two main parameters: water level and ppm of water in the basin, in combination with three different water levels (at 30 mm, 40 mm and 50 mm) and three different ppm (500 ppm, 1000 ppm and 1500 ppm). According to the experimental results, at 1500 ppm and 30 mm of water level, the highest daily productivity was observed as 4.24 L/m2 day and the maximum daily efficiency was calculated as 43.1 % in the galvanized solar still, while in aluminium solar still, it was 3.71 L/m2 and 37.67 % respectively. The maximum efficiency observed in the GI solar still was 13.56 % more or 1.46 times that of the aluminium solar still. The exergy efficiency was 3.07 % and 2.81% in GI and aluminium solar still respectively. Moreover, the distillate cost per litre (CPL) for GI and aluminium solar still was found to be 1.48 and 1.86 respectively. Thus the galvanized solar still performed outstandingly compared to aluminium solar still with respect to productivity, thermal efficiency and exergy efficiency.

Keywords: solar still, galvanized iron, aluminium, productivity, thermal efficiency, exergy efficiency.

Vacuum Pressurized Areca Husk Fibres: Mechano-Chemical Extraction and Optimization via RSM-PSO

Subhankur Dutta[0000-0002-5609-4785], Chebolu Himavantha Sri Raghava Naga Sai[0009-0005-6470-3156], Amit Kumar Singh*[0000-0002-3259-5067] and Morampudi Pavan Kumar[0009-0003-8479-3561]

Department of Mechanical Engineering, National Institute of Technology Nagaland, Chumoukedima-797103, Nagaland, India
subhankur91@gmail.com
himavanthachebolu54@gmail.com
amit.kumar965@yahoo.com
morampudipavan482@gmail.com

Abstract. The natural fibres obtained from various sources may be economically utilized to replace the synthetic fibres in fibre-reinforced composite materials. This study initiates by performing a novel vacuum pressurization impregnation (VPI) treatment of ripe areca husk fibres (AHF), followed by their mechano-chemical extraction. Further, the physical, thermal and morphological features are compared with the untreated ones with techniques like x-ray diffraction (XRD), thermogravimetric analysis (TGA) and scanning electron microscopy (SEM). The extraction parameters are optimized using response surface methodology (RSM) and particle swarm optimization (PSO) to minimize the hemicellulose content, which influences moisture absorption and fibre performance. The results show that VPI-treated AHF exhibits lower cellulose crystallinity, enhanced thermal stability and reduced porosity as compared to untreated fibres. The RSM develops a quadratic model with a precision of 41.6830 and detecting any potential outliers, while PSO predicts optimal conditions of 7.2017% NaOH concentration, 1466.3 RPM stirrer speed and 8.805 hour of stirring time, achieving an optimal response value of 0.319 gram hemicellulose with an error of 0.62%. The study concludes that PSO is more efficacious than RSM in optimizing the extraction process for minimizing hemicellulose. Overall, the VPI-treated AHF shows great potential as a sustainable reinforcement in composite materials, offering improved mechanical and thermal properties through optimized extraction techniques.

Keywords: Areca husk, vacuum pressurized, particle swarm optimization.

Pool Boiling Heat Transfer Performance of Cu-Al2O3 Coated Copper Microporous Surface

Sudhir Kumar Singh1, Deepak Sharma2, *

1 Mechanical Engineering Department, Thapar Institute of Engineering & Technology, Patiala, 147004, India
2Mechanical Engineering Department, National Institute of Technology Hamirpur, 177005, (H.P.), India.

Email Address: dsharma@nith.ac.in

Abstract. Pool boiling is highly effective in dissipating large heat fluxes at relatively low surface superheat temperatures, making it a key focus in multiphase heat transfer research, making it valuable in numerous thermal managements. In the current research, nucleate boiling characteristics of Cu-Al2O3 studied & compared with bare copper surface. A two-step electrodeposition method is used. A rise in critical heat flux of 89.23 % & heat transfer coefficient of 85.73 % have been observed with the Cu-Al2O3 coated surface over uncoated Cu surface. The Cu-Al2O3 coated surface showed an excellent heat transfer performance over uncoated substrate because of formation of enhanced porosity, active nucleation sites density, surface roughness, wettability & bubble release frequency.

Keywords: Nucleate boiling, Critical heat flux, Heat transfer coefficient, Electrodeposition

A Machine Learning Approach to Li-Ion Battery Module

Ram U. Kalyankar[1], Kalpak R. Sagar[2], Vipul M. Patel[1], Hemantkumar B. Mehta[1]

[1] Mechanical Engineering Department, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat 395007, India
[2] Mechanical Engineering Department, Shri Guru Gobind Singhji Institute of Engineering and Technology, Nanded, Maharashtra 431606, India

Abstract. This paper investigates the effectiveness of four machine learning models namely Linear Regression (LR), Decision Tree Regression (DTR), K-Nearest Neighbors Regression (KNNR), and Random Forest Regression (RFR) in forecasting current, voltage, and temperature of a 10-Ah Li-ion 3S4P battery module during charging cycles. The models were trained and tested on data collected at various C-rates (0.5C, 1C) and ambient temperatures (30°C, 35°C). The MSE and R^2 metrics were used to compare and publish the performance findings. Results show that RFR and KNNR models outperformed other models, with KNNR model demonstrating greater forecasting capabilities for intermediate unseen data (0.75C). This research highlights the potential of machine learning models in accurately predicting Li-ion battery behavior, enabling improved battery thermal management and optimization.

Keywords: Li-ion battery, BTMS, machine learning, regression models, state of charge, forecasting.

Comparative Assessment of Machine Learning Models for Li-Ion Battery Module

Mihir Pandya[1], Ram U. Kalyankar [1], Vipul M. Patel[1], Hemantkumar B. Mehta[1]

[1] Mechanical Engineering Department, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat 395007, India

Abstract. This paper examines how well four machine learning models Random Forest Regression (RFR), K-Nearest Neighbours Regression (KNNR), Decision Tree Regression (DTR), and Linear Regression (LR) predict the temperature, voltage, and current of a 24-Ah Li-ion (LFP) 4S4P battery module during charging cycles. The models were trained and evaluated using data gathered at different ambient temperatures (30°C, 35°C) and C-rates (0.5C, 0.75C, 1C). The performance results were published and compared using the MSE and R2 measures. The RFR and KNNR models outperformed the other models, according to the results. By accurately forecasting Li-ion battery behavior, machine learning models have the potential to improve battery temperature management and optimization, as demonstrated by this study.

Keywords: Li-ion battery, BTMS, machine learning, regression models, state of charge, forecasting.

Review paper on development of techniques to optimize evaporation ratio and auxiliary power consumption of water tube coal fired AFBC boiler by improving its combustion and reducing its losses.

Chirag V. Kapuria[1]*, Dr. Chetankumar M. Patel[2]

1 Mechanical Engineering, PhD scholar, Faculty of technology, RK University
2 Mechanical Engineering, Professor, Head of Department, Faculty of technology, RK University
Email: ck5719@gmail.com

ABSTRACT: Coal-fired process boilers are used in the chemical industry for consistent energy supply. The cost of coal is rising, and this natural resource is being reduced. Review on literature has been done based on coal consumption reduction in coal-fired boilers and auxiliary power, evaporation ratio improvement and various techniques that can reduce auxiliary power consumption in a coal-fired process boiler. Study is also been done on the feed water circuit operation to reduce boiler feed water power consumption. Study is done based on each loss optimization of boiler using thermodynamic analyses. This includes various techniques like soot blower installation, automatic combustion control system and low temperature economizer

Keywords: Evaporation Ratio, Auxiliary Power Consumption, Coal-fired Boiler Atmospheric Fluidized Bed Combustion Boiler (AFBC)

Effect of different refrigerants on the performance of chiller plant of SVNIT, Surat

Ankitsinh Chauhan 1[0009-0001-8358-5790], Vimal Patel [0000-0001-5748-3726], Ashok Parekh, Anurag Soni, Dirgh Modi, Jaya singh, Lakshya Mishra, Nischay Khasiya, and Shaili Gandhi

1, 2, 3,4,5,6,7,8,9 Sardar Vallabhbhai National Institute of Technology, Surat. Gujarat, India.

Email:ankitsinh.svnit@gmail.com

Abstract. This paper presents the compression of heat loss by the refrigerant in condenser, input power required of a compressor, COP, mass flow rate, and vol-ume flow rate of the refrigerant for the same quantity of the refrigerant capacity for the different types of refrigerants for the chiller plant of SVNIT, Surat. The input operational data are taken from the chiller plant of the SVNIT. The refrig-erant R-134a use as a refrigerant in the chiller plant and compute data using Cool-Pack software for R-408A, R-402A, R-507 and, R-512 refrigerants. The power consumed by the compressor, heat loss by the refrigerant, and mass flow rate of refrigerant are less for the refrigerant R-152a and R-134a than others. The vol-ume flow rate of the R-152a is higher than the R-134a, and a higher volume flow rate of refrigerant leads to larger system size. The refrigerant R-152a has the highest COP 6.1 and 5.78 for the R-134a. The refrigerant R-152 is slightly flam-mable, and due to the larger system size, the R-134a is desirable to use as a re-frigerant for chiller plants even R-152a has higher COP than the R-134a.

Keywords: Chiller Plants, Energy efficiency, Experimental VCRS system, Com-pression of different refrigerants

A State-of-the-Art Short Review of Solar Parabolic Trough.

Abhishek Thakur [1*], Sushil Kumar [2**], Krishan Kumar[3], Khushmeet Kumar[4], Sushma Singh[4], and Pawan Kumar[1]

[1]School of Physics and Materials Science, Shoolini University, Solan, (H.P.), 173229, India.
[2]Department of Physics, Hansraj College, University of Delhi, Delhi-110007, India.
[3]Mechanical Engineering Department, IIT Ropar, Punjab, 140001, India
[4]Baddi University of Emerging Sciences and Technology, Baddi (HP), 173205, India,

*abhishekthakur00722@gmail.com,**sushil8207@gmail.com

Abstract: When it comes to solar energy harvesting, solar concentrating devices are key technologies. These devices concentrate sunlight into a small area to generate high temperatures that may be used for the production of electricity or different industrial uses. Increasing the intensity of solar radiation is one of the ways these systems improve their efficiency in converting solar energy, particularly in large-scale operations. There is a wide variety of solar concentrators that fall under the point and line focus types of solar concentrators. Using a parabolic-shaped reflector, the parabolic trough collector (PTC) can concentrate sunlight into a receiver tube, which then incorporates the concentrated solar energy. The majority of their applications are in thermal power generation plants, and they have been enhanced with the addition of cutting-edge tracking systems, coating materials, and nanofluids as heat transfer media. The current investigation is centered on a concise evaluation of the most recent developments in PTC technology, which is considered to be state-of-the-art. Among the upcoming developments in solar concentrating devices are the creation of materials that can withstand high temperatures, the integration of photovoltaic and thermal systems, and the utilization of automation and artificial intelligence to optimize sun tracking and enhance overall system performance.

Keywords: Solar thermal collector, Solar concentrating Technology, Point focusing Device, Line focusing device.

CFD Study of Isothermal Non-Swirling Turbulent Jet Under Confined Conditions in an Axial-Tangential Swirl Burner Using K-Omega Turbulence Modelling

Kenneth C Linoj1, Nikesh Devasthali1, Manish Kale1, *Rohit Sharma1[0000-0001-5481-8041]

[1]School of Mechanical Engineering, VIT Bhopal University, Madhya Pradesh – 466114, India
[1]cheruparambil.kenneth2020@vitbhopal.ac.in
[1]nikesh.2020@vitbhopal.ac.in
[1]manish23phd10010@vitbhopal.ac.in
[1]*rohit.sharma@vitbhopal.ac.in

Abstract. Non-swirling turbulent jet have a widespread application in industries such as cyclone separators, internal combustion engines, and computational dynamics research. This study investigates he isothermal non-swirling turbulent jet under confinement conditions in an axial plus tangential type of swirl burner with a constant Reynolds number (Re) = 21800. Computational Fluid Dynamics (CFD) simulations were conducted for a confined jet case with zero geometric swirl number (S_g = 0) using the Shear Stress Transport (SST) k-omega turbulence model. An optical quartz octagonal chamber is placed over the nozzle of the swirl burner, which is used for analyzing and visualizing the flows under confinement. The velocity contours for the mean radial, axial, and tangential in vertical planes focusing on the near-exit region of the nozzle were analyzed under confined conditions. The CFD results obtained are compared to previous experimental data and the comparisons between the present study and experimental findings show a strong agreement between each other.

Keywords: Computational Fluid Dynamics, Non-swirling turbulent jet, Confinement, Reynolds number, Geometric swirl number, SST k-omega turbulence model, Octagonal Chamber.

Thermal Analysis of Vehicle Radiator Using CFD Simulation

Ved Kolte1 , Pushpam Kunal1 , Ajit Kumar Parwani1

[2]Department of Mechanical and Aerospace Engineering, IITRAM, Ahmedabad- 380008, India

*ajitkumar.parwani@iitram.ac.in

Abstract. Vehicle radiators play a critical role in managing engine temperatures by dissipating heat generated during operation. Efficient cooling is essential to prevent engine damage and maintain optimal performance. Conventional coolants, such as water or ethylene glycol, often struggle to meet the demands of modern engines, especially under high loads. Recent advancements in thermal fluids have introduced nanofluids—coolants infused with nanoparticles like Al_2O_3 (alumina)—as a promising alternative to enhance heat transfer. This study explores the performance of a radiator using Al_2O_3- water nanofluids simulated in ANSYS Fluent.

Keywords: Vehicle Radiators, Nanofluids, Water (H2O), Alumina (Al2O3)

A Review of Thermal Enhancement in Solar Air Heaters Through Absorber Plate Modification.

Abhishek Thakur1*, Sushil Kumar 2**, Khushmeet Kumar3, Sushma Singh3, Krishan Kumar4, and Pawan Kumar1

1 School of Physics and Materials Science, Shoolini University, Solan, (H.P.), 173229, India
2Department of Physics, Hansraj College, University of Delhi, Delhi-110007, India.
3 Baddi University of Emerging Sciences and Technology, Baddi (HP), 173205, India,
4Mechanical Engineering Department, IIT Ropar, Punjab-140001, India

*abhishekthakur00722@gmail.com ,**sushil8207@gmail.com

Abstract. Solar air heaters (SAHs) are essential for harnessing solar energy (SE) in heating applications, including crop drying, room heating, and preheating air for industrial use. An essential element in a SAH is the absorber plate (AP), which captures SE and conveys heat to the air that circulates over or beneath it. The heat transmission from the AP to the air considerably affects the overall efficiency of the SAH, prompting continuous study into optimising AP designs to improve performance. A key method for enhancing SAH efficiency is altering the AP to augment turbulence in the airflow. Introducing various patterns or textures to the AP surface enhances turbulence, hence increasing the heat transfer (HT) rate from the AP to the air. Augmented turbulence facilitates greater heat absorption by the air, resulting in improved SAH efficiency. Nonetheless, this enhancement must be weighed against the supplementary energy necessary for air circulation through the heater, referred to as pumping power. Pumping power denotes the energy required to sustain airflow, which escalates with heightened resistance or turbulence within the heater. Consequently, a metric known as effective efficiency is frequently employed to assess the overall performance of SAHs with varying AP configurations. This rating accounts for both enhanced heat transmission and the energy expenses related to pumping, yielding a more precise assessment of the heater's efficiency. This article provides a thorough overview of recent artificial roughness techniques utilised in air collectors to enhance HT rates in solar air heaters. The study seeks to elucidate the effects of various roughness designs on turbulence and effective efficiency, hence offering critical insights for the enhancement of solar air heater technology in sustainable energy applications.

Keywords: Solar Air Heater, Nusselt Number, Friction factor, Thermal Performance.

Effect of thermal exposure into the mechanical properties of Al6061 alloy

Puneet Sharma1, Bhavya Bhargava2, Saurabh Dewangan3*

1, 2, 3Department of Mechanical Engineering, Manipal University Jaipur, Jaipur, Rajasthan, India

Email: 1puneetps508@gmail.com, 2bhavyabhargava29@gmail.com, *3saurabh22490@gmail.com

Abstract: The present work deals with the finding out the pre- and post-quenched effect on the tensile strength and microstructural changes of TIG welded AA 6061 plates. Optical microscopy was used for microstructural analysis. A significant enhancement in overall tensile properties was noted after adopting heat treatment and water quenching technique. Due to uniform distribution of alloying elements over the primary Al matrix after water quenching, the strength gets improved. In contrary, the heating and aging may cause alloy precipitation towards the grain boundary of primary Al.

Keywords: AA 6061; Heat treatment; Quenching; Tensile properties; Microstructure

Development of an Inverse Method-based Numerical Model to Estimate Heat Generation in a Battery

Riddhi Lotake, Nirmal Patel, Vipul M. Patel

Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology, Surat, Gujarat, India

riddhi.lotake@gmail.com

Abstract. Accurate estimation of volumetric heat generation of a Li-ion battery is crucial for thermal modeling, thermal safety, and the design of thermal management systems for electric vehicles. Existing experimental methods for measuring the volumetric heat generation of Li-ion batteries are expensive and time consuming, lacking insight into sensitivity to operating conditions and hotspot locations. The primary objective of this work is to develop a novel inverse heat transfer method-based numerical model where commercial solver ANSYS Transient Thermal can be integrated with Genetic algorithm to determine internal heat generation in a domain if temperature data are provided. The experimental temperature data taken from the research article is taken as a reference input and the proposed model is used to estimate the internal heat generation rate (QHg) of a Liion battery. The results demonstrate the effectiveness of the inverse method in estimating the heat generation rate, with the RMS error between estimated and experimental temperatures ranging from 0.03832 to 0.06035 and for the estimated heat generation rate was 0.17125, showing a strong agreement with the values reported in the referenced study.

Keywords: Inverse Methodology, Genetic Algorithm, Li-ion battery, Numerical Model

Numerical Study of Two-Phase Flow Film Cooling on a Flat Plate Using Mist-Air Injections

Arjun Sikka[1], Dushyant Singh[1], and Ashutosh Kumar Singh[2]

[1]Department of Mechanical Engineering, National Institute of Technology Jalandhar, Punjab-144008, India
[2]Department of Mechanical Engineering, National Institute of Technology Manipur, Imphal, Manipur 795 004, India

Abstract: The present study aims to numerically model air/water mist film cooling on a flat plate using elliptic-shaped hole b Euler Lagrangian approach. A parametric study has been presented to study the effect of mist loading fraction on heat transfer and fluid flow characteristics of air/water mist film cooling on a flat plate at constant blowing ratio M = 0.6, density ratio (ρ_j/ρ_g) of 1.13, hot gas temperature T_g = 326.55 K and coolant temperature T_j = 288.8 K. The present numerical model is in good agreement with previous experimental results, with a maximum error of 18%. Air/water mist film cooling provides better heat transfer compared to air film cooling. The centerline film cooling effectiveness increases with an increase in mist loading fraction from 5% to 10%.

Experimental Analysis of a Liquid Desiccant Regenerator Cum Solar Air Heater with Undulated Absorber Plate

Ashish B. Khelkar*[0009-0008-3034-162X], Mrinal Pradhan and Rajat Subhra Das

Department of Mechanical Engineering, NIT Meghalaya, Shillong-793003, India

ashishkhelkar05@gmail.com

Abstract. Solar air heaters (SAHs) have emerged as one of the most economi-cal, low-maintenance and sustainable thermal collectors to harness solar radia-tion for a variety of applications ranging from space heating/drying to crop/spices drying. This study suggests a method for improving the low heat transfer rate of conventional smooth SAHs by using a corrugated absorber plate. The design is such that it can be used alternatively as an open-type direct-contact liquid desiccant regenerator. The system is fabricated at the mechanical workshop of NIT Meghalaya, and the thermal-hydraulic performance is checked experimentally. Plywood was used as a material for the SAH casing. The length and width of the SAH are L = 6 ft. and W = 4 ft., respectively. The absorber plate is made up of a corrugated tin surface with amplitude (A) and wavelength (λ) of 8 mm and 80 mm, respectively. The airbox houses five fans, each with a maximum capacity of 150 CFM. This fan is used for forced circula-tion of working fluid from the bottom side of the SAH and channelizes the air to flow through the space between the glazing and the absorber plate. The glaz-ing is made up of clear glass with a thickness of 5 mm. The height of the glaz-ing can be adjusted with the help of nut and bolt arrangements, where the gap between the glazing and absorber plate can be varied from 50 mm to 200 mm. The pressure difference across the channel is measured by differential pressure instruments (testo 440 dp), the temperature of the absorber plate and glass cover is measured using a temperature gun (testo 835-T1), and the velocity of the air is measured by a vane probe (testo 141). Moreover, a computational work is performed to study the effect of turbulence on the heat transfer characteristics inside the SAH. The computational model is developed using the ANSYS Flu-ent 2023-R1. The grid dependency study is also performed prior to the paramet-ric study of the SAH. The result from the computational study shows a similar trend with the experimental result. The results of the SAH observed the maxi-mum temperature of the absorber plate in the range of 72-78 °C, glazing tem-perature of 36-45°C, and the maximum thermal efficiency of the SAH is 58-64%.

Keywords: Solar air heater, Corrugated absorber plate, Thermal efficiency.

Experimental investigations on subcooled flow boiling in MCHS

Ashish Prajapati[1], Nishant Shah[2], Hemantkumar B. Mehta[3] and Jyotirmay Banerjee[4]

[1] Department of Mechanical Engineering, Government polytechnic Chhotaudepur

[2,3,4] Department of Mechanical Engineering, Sardar Vallabhbhai National Institute of Technology Surat

Abstract. This study investigates microchannel heat sinks (MCHS) for mitigating flow boiling instability and enhancing thermal performance in high-end engineering applications. Two MCHS configurations, fabricated from oxygen-free copper substrates, are examined: closed and open designs, each with 44 parallel microchannels (500 µm depth, 200 µm width). Degassed deionized water serves as the working fluid, with mass fluxes of 520 kg/m²s and wall heat fluxes spanning 22-147 W/cm². Results show open MCHS designs reduce temperature fluctuations and improve heat transfer, particularly at high heat fluxes. These findings suggest open microchannels can effectively mitigate flow boiling instabilities, enhancing overall system efficiency in thermal management applications for modern electronics.

Keywords: Flow Boiling, Open MCHS, Instability Mitigation, Boiling curve.

Impact of Alumina Nano Additive on Performance and Emission Behavior of a Diesel Engine Fueled with Plastic Pyrolysis Oil

Padmanabhan Sambandam[1], Nalini Ramachandran U[2], S. Banupriya[3], S. S. K. Deepak4, A. Lalitha Saravanan[5], Anil Singh Yadav[6] and Abhishek Sharma[7]

[1]School of Mechanical and Construction, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai 600062, Tamil Nadu, India

[2]Department of Applied Sciences, Chemistry Section, University of Technology and Applied Sciences, Muscat, Sultanate of Oman

[3]Department of Civil Engineering, St. Joseph's College of Engineering, Chennai 600119, Tamil Nadu, India

[4]Department of Mechanical Engineering, Bhilai Institute of Technology, Raipur 493661, Chhattisgarh, India

[5]Department of Mechanical Engineering, SRM Institute of Science & Technology, Vadapalani Campus, Chennai-600026,Tamil Nadu, India

[6]Department of Mechanical Engineering, Bakhtiyarpur College of Engineering (Science, Technology and Technical Education Department, Govt. of Bihar), Bakhtiyarpur, Patna 803212, Bihar, India

[7]Department of Mechanical Engineering, Government Engineering College Palamu (Department of Higher and Technical Education, Govt. of Jharkhand), Medininagar 822118, Jharkhand, India

email: drasharma58@gmail.com

Abstract: Preservation of fossil resources such as crude oil or natural gas is necessary to sustain ongoing economic progress. Aside from conventional energy sources such as coal and oil, there are various other possibilities that are sustainable, including biomass, hydroelectricity, and wind power. Another crucial factor to take into account is the implementation of an efficient method for disposing of waste. There has been a substantial increase in the production of various items, resulting in the generation of waste. Plastics have traditionally been a favoured material for a wide range of items due to its exceptional versatility and low cost. This research article seeks to address the problems of plastic waste management and the scarcity of traditional fuel sources, with the goal of fostering a more sustainable ecosystem. The potential use of the plastic biodiesel obtained from various grades of waste plastics using alumina was examined for diesel engine applications. The analysis involves the creation of a fuel called PO20 blend, which is formed by combining 20% plastic biodiesel with conventional diesel. Alumina additives were mixed with PO20 plastic biodiesel at quantities of 25ppm, 50ppm and 75ppm to enhance the performance of the engines as an alternative fuel source.

Keywords: Energy recovery, waste plastics, diesel engine, alumina, emission, nano additives.

Design and Thermal Analysis of Effective Cooling System in Sodium-Ion Battery

S. Baskar1, M. Ruban1, S. S. K. Deepak2, Chandrasekaran M3, Vinod Kumar T3, Prashant Kumar4, Abhishek Sharma5 and Anil Singh Yadav6

1School of Engineering, Vels Institute of Science, Technology & Advanced Studies, Chennai 600117, Tamil Nadu

2Department of Mechanical Engineering, Bhilai Institute of Technology, Raipur 493661, Chhattisgarh, India

3Department of Mechanical Engineering, Vels Institute of Science, Technology & Advanced Studies, Chennai, 600117, India

4School of Mechanical Engineering, Vellore Institute of Technology, Vellore 632014, Tamil Nadu, India

5Department of Mechanical Engineering, Government Engineering College Palamu (Department of Higher and Technical Education, Govt. of Jharkhand), Medininagar 822118, Jharkhand, India

6Department of Mechanical Engineering, Bakhtiyarpur College of Engineering (Science, Technology and Technical Education Department, Govt. of Bihar), Bakhtiyarpur, Patna 803212, Bihar, India

*Corresponding author email: drasharma58@gmail.com

Abstract: It is crucial to have well-thought-out thermal management designs for the batteries used in electric vehicles. This study's primary objective is to develop a practical thermal management system for use with modern vehicle battery modules. For battery, modules that now use an oil cooling system, an active cooling system is proposed. Improper thermal management of batteries is a common source of failure, therefore understanding what causes it is essential for developing better battery modules. Solid works is used to create the plans for the thermal management system. Radiator coolant oil is used as the fluid to transmit heat from the battery to keep the helical passage and outside flow passage at a constant temperature. ANSYS CFD software is used to simulate the battery modules' thermal management system. The collected data is used to validate the simulation results and analyze the battery's temperature.

Keywords: Computational fluid dynamics; Coolant oil; lithium-ion batteries; Sodium-ion battery, Solid works

An Experimental Study on the Evaluation of Performance of Nano-Enhanced Phase Change Materials for Thermal Energy Storage

Rohit1, Santosh Kumar Singh2, Dipti Tiwari3, Anil Singh Yadav4, Santosh P. Alone5 and

Abhishek Sharma6,

1Department of Mechanical Engineering, United University, Prayagraj 211012, Uttar Pradesh, India

2Department of Mechanical Engineering, United College of Engineering and Research, Prayagraj 211010, Uttar Pradesh, India

3Department of Applied Sciences, United College of Engineering and Research, Prayagraj 211010, Uttar Pradesh, India

4Department of Mechanical Engineering, Bakhtiyarpur College of Engineering (Science, Technology and Technical Education Department, Govt. of Bihar), Bakhtiyarpur, Patna 803212, Bihar, India

5Mechanical Engineering Department, Madhukarrao Pandav College of Engineering, Bhilewada, Bhandara 441924, Maharashtra, India

6Department of Mechanical Engineering, Government Engineering College Palamu (Department of Higher and Technical Education, Govt. of Jharkhand), Medininagar 822118, Jharkhand, India

*Corresponding author email: drasharma58@gmail.com

Abstract: The growing demand for energy and the use of fossil fuels are more pressing issues than ever in quickly emerging countries. The goal of this research is to improve pure paraffin's capacity to store thermal energy. The melting temperature increased by 2 0C when Al2O3 nanoparticles were present, but decreased by 1.6 ◦C and 1.7 ◦C when Magnesium oxide and Paraffin CuO nanoparticles were present. CuO- paraffin wax, Magnesium oxide- paraffin wax, and Al2O3-paraffin wax all had thermal conductivities that were 48 percent, 39 percent, and 13 percent higher than those of pure paraffin, respectively. Copper Oxide-enhanced paraffin showed a 10.95% decrease in discharge time, suggesting that it is suitable for uses like electronic thermal management or defrosting systems that demand rapid heat transfer. The discharged time was, however, interestingly Magnesium oxide augmented paraffin showed a modest 2.25% reduction in discharge time which shows its viability for use in applications demanding heat retention such as insulation to prevent heat loss in construction materials. The results showed promise of e-nano building- enhanced Phase changing materials in construction as well as energy storage systems, thus, helping to provide an efficient sustainable energy solution for a variety of industries.

Keywords: Nanoparticles, Performance, Thermal energy storage, Nano enhanced phase changing materials.

Exergy analysis of a Solar Photovoltaic Thermal System

R Ashok Kumar1, S. Gopinath2, Boopathy G3, Nishikant Kishor Dhapekar4, Reena M Majumdar5, S. Shankar6, Sudarshan7 and Krishna Kant Pandey8,*

1Department of Mechanical Engineering, R.M.D. Engineering College, Kavaraipettai 601206, Tamil Nadu, India

2Department of Mechatronics Engineering, Rajalakshmi Engineering College, Thandalam 602105, Tamil Nadu, India

3Department of Aeronautical Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai 600064, Tamil Nadu, India

4Department of Civil Engineering, MATS University, Raipur 493441, Chhattisgarh, India

5Department of Mechanical Engineering Madhukarrao Pandav College of Engineering, Bhilewada, Bhandara, Maharashtra, India

6Department of Mechanical Engineering, Cambridge Institute of Technology, Bengaluru 560036, Karnataka, India

7Mechanical Engineering Department, Bakhtiyarpur College of Engineering, Bakhtiyarpur, Patna 803212, Bihar, India

8Department of Mechatronics Engineering, Manipal University Jaipur, Jaipur 303007, Rajasthan, India

*Corresponding author email: krishna.pandey@jaipur.manipal.edu

Abstract: Exergy analysis, also known as second law efficiency performance analysis, was assessed using parameters like the experimental day's solar radiation (G), the glass cover's transmittance (τ), the solar panel's area (Amod), the mass of air (ṁ), the specific heat of air (Cp), ambient temperature (Ta), PV glazing temperature (Ts), and the air temperatures at the inlet (Ti) and outlet (To). The buoyant forces diminish with increasing ambient temperature, which in turn causes the mass flow rate of air inside the air flow duct to drop. As a result, the output air temperature rises as the rate of heat transfer increases. Other factors that affect the output air temperature include the physical geometry of various setups. This research article deals with three kinds of used cases for evaluating its exergy performance on the solar photovoltaic thermal collector. This thermal system can be investigated through two types of mass flow rates namely 0.0085 kg/s and 0.0113 kg/s. Solar radiation and ambient temperature of parametric studies were carried out on the system. The average performance of this system mutually agreed with previous literatures.

Keywords: Exergy, Solar Radiation, Ambient Temperature, Cases, Mass Flow Rate.

Heat transfer in an injection molding process using a numerical simulation approach with ANSYS Fluent

Vishal Kumar , Mohammed Rahiq, Ajit Kumar Parwani

Department of Mechanical And Aerospace Engineering

Abstract This paper investigates heat transfer phenomena in the injection molding process using a numerical simulation approach with ANSYS Fluent. The study focuses on accurately modelling the thermal interactions between the polymer melt and the mold, incorporating conduction, convection, and material-specific properties. The simulation provides insights into temperature distribution, cooling rates, and the influence of process parameters on product quality. Results highlight critical zones affecting cycle time and dimensional stability, offering valuable guidelines for optimizing mold design and process efficiency. This approach demonstrates the potential of computational tools in enhancing injection molding performance and product reliability

Convection in Rotating Annulus In the Presence of Bi-directional Thermal Forcings

Ayan Kumar Banerjee

School of Sciences, Woxsen University, Hyderbad, India and

Corresponding author: ayanbanerjee1@gmail.com

Abstract: This study combines laboratory experiments and 2D axisymmetric simulations to explore convection in arotating cylindrical annulus with localized spot heating and uniform cooling. The effects of Taylor (Ta) andRayleigh (Ra) numbers on flow dynamics and heat transport were investigated under constant heat flux andconstant temperature conditions, with Pr=7. Experiments covered Ta=8:8_107 to 2:7_109 and Ra=2_108o 1_109, while simulations extended to Ta = 2_107 and Ra = 2:4_107. Convection is confined to boundary layers, with diffusion dominating the interior flow. At Ta = 0, isotherms are horizontal, while rotation spreads them due to quasi-hydrostatic and geostrophic balances. At low to moderate Ta, baroclinic waves enhance heat transfer, peaking at an optimal Tamax. Beyond this, waves break into eddies, reducing Nu. At very high Ta, steady large-scale circulation dominates, making Nu(¥) _ Nu(0). High heat fluxes result in significant temperature variations near the heating plate, even at lower rotations. These results underscore the complex interplay of rotation, thermal forcing, and heat transport.

Aspect ratio dependence in the Convection in Rotating Annulus In the Presence of Localized Heating: An Axisymmetric Study

Ayan Kumar Banerjee
School of Sciences, Woxsen University, Hyderbad, India and
Corresponding author: ayanbanerjee1@gmail.com

Abstract: We conduct two-dimensional (2D) axisymmetric simulations to model a rotating convective system driven bylocalized heating. The system comprises a cylindrical annulus with peripheral spot heating along the outer edge of the bottom surface and uniform cooling along the inner edge. This configuration creates both radial and vertical thermal gradients near the outer edge, mimicking thermal gradient patterns observed in atmospheric flows.The study explores variations in convective dynamics by varying the aspect ratio (G) across a Rayleigh number range of Ra = 2:4_107 to 1:2_109 and Taylor number range of Ta = 1:6_107 to 1:2_109, including the non-rotating case (Ta = 0). Convection remains confined to narrow boundary layers, while diffusion dominates in the fluid interior. Without rotation, isotherms remain horizontal. Under rotation, the isotherms spread due to a combination of quasi-hydrostatic and quasi-geostrophic balances within the flow's interior. The Nusselt number (Nu) demonstrates complex dependencies on Ra, Ta, and G. At moderate to high Ra, Nu follows a Ra1=4scaling and is largely unaffected by rotation, whereas at low Ra and high Ta, rotational suppression significantly reduces Nu. Aspect ratio (G) also plays a crucial role, with rapid increases in Nu at low G due to confined convective flows, transitioning to slower growth for G > 1 as convective structures stabilize. Additionally, the ratio of thermal to Ekman boundary layer thickness (dT =dE) modulates heat transfer efficiency, with high rotation weakening Nu when dE < dT , while bulk mixing stabilizes Nu when dE > dT .

Exploring Tunability in the Flexural Properties of a Composite Beam Inspired by the Biomechanics of Fish Scales

Hari Bahadur Dura1 Paul J. Hazell1 Hongxu Wang1 Juan P. Escobedo-Diaz1

1School of Engineering and Technology, The University of New South Wales, Canberra, Australia, 2600

Abstract. This paper explores the flexural tunability of protective structures inspired by the elasmoid fish scale. The sample measured 150 mm (length), 20 mm (width), and 10 mm (thickness), featuring two distinct layers: a 5 mm thick hybrid (scale-tissue) region and an additional 5 mm soft tissue sub-layer. The influences of scale volume fraction, relative scale size, and material properties on flexural stiffness were investigated. Increasing the scale volume fraction by 20 times resulted in a 60.1% increase in flexural stiffness. An increase in scale volume fraction (i.e., decrease in tissue volume fraction) led to a significant increase in energy absorption by the scales and a slight improvement in the energy absorption by the tissue. The ratio of energy absorbed by scale to tissue was noteworthy, reaching 72.1% for scales with the highest volume fraction and 7.3% for scales with the lowest volume fraction. Similarly, at a constant scale volume fraction, the flexural stiffness and energy absorption were highly influenced by the scale-tissue material properties. The scale-to-tissue energy absorption ratio for the thinnest scale-tissue design of ABS-TPU stood at 37.1%, while for the thickest scale-tissue design was 29.7%. The tunable features in the hybrid scale-tissue designs were attributed to the relative scale-tissue size, material properties, and strain compatibility.

Keywords: bioinspired systems, modeling, simulation, test

Numerical Analysis of Strut and Cavity Configurations for Improved Combustion Efficiency in Scramjet Engines

Riya Dewangan[1], Ajit Kumar Parwani[2*]

[1]Department of Mechanical Engineering, Lovely Professional University, Phagwara-144411, India

[2]Department of Mechanical and Aerospace Engineering, IITRAM, Ahmedabad- 380008, India

riyadewangan0211@gmail.com; *ajitkumar.parwani@iitram.ac.in

ABSTRACT: This study explores the enhancement of combustion efficiency in scramjet combustors through the optimization of strut and cavity configurations. Utilizing both strut and cavity as hydrogen injection points, we aim to improve the mixing and combustion processes within the scramjet. Computational Fluid Dynamics (CFD) simulations were conducted using the SST $k-\omega$ turbulence model in conjunction with the finite rate/eddy dissipation model to accurately capture the complex interactions between turbulence and chemical reactions. The simulation results were validated against experimental data from the published DLR experiments. Our findings indicate that the strategic placement of hydrogen injection points significantly enhances the combustion efficiency, highlighting the potential for optimized designs in scramjet applications.

Keywords: Scramjet, Strut, Cavity, Combustion efficiency, Shock waves

Part II: Recent Advances in Material and Manufacturing Infrastructure

A review on the use of nano-powders during electric discharge machining of titanium alloys

Jash Modi[1], Jay Vora[1], Kumar Abhishek[2], Manoj Jagdale[3], Soni Kumari[4], Rakesh Chaudhari[1]*

[1] Department of Mechanical Engineering, Pandit Deendayal Energy University, Gandhinagar 382007, Gujarat, India
[2] Department of Mechanical Engineering, IITRAM, Ahmedabad 380026, Gujarat, India
[3] Department of Mechanical Engineering, Vishwakarma Institute of information technology (An Autonomous Institute affiliated to SPPU), Pune 411048, India
[4] Department of Mechanical Engineering, GLA University, Mathura, 281406, U.P., India
Corresponding author: *rakesh.chaudhari@sot.pdpu.ac.in

Abstract. Difficult-to-cut materials like titanium, and its alloys exhibit superior properties like high resistance to corrosion, excellent strength-to-weight ratio, and more stability at elevated temperature. Due to this, these are widely preferred in aerospace, biomedical, and automotive industries for components like turbine blades, implants, and high-performance engine parts. Machining of such materials become challenging due to its low elastic modulus, hardness and poor thermal conductivity. The traditional machining methods imposes lot of challenges. Thus, electrical discharge machining (EDM), a type of non-traditional processes was found to be more appropriate in processing of such materials. The challenges faced by the EDM process are lower cutting rate, larger tool wear, reduced surface quality, and recast layer thickness. To eliminate those challenges, the highly electrically and thermally conductive nano-powders needs to be added to the dielectric fluid of EDM. These nano-particles in the dielectric gives the improved machining performance and surface morphology. The powders such as alumina (Al_2O_3), aluminium (Al), multiwall carbon nanotubes (MWCNTs), nano-graphene, expanded graphite, silicon (Si), and silicon carbide (SiC) are used as a powder additive. The addition of these nano-powder results in the reduction in breakdown strength of the dielectric fluid which in turn improves the ignition mechanism. Thus, the present paper discusses a brief overview of the use of different nano-powders during the EDM of titanium alloys.

Keywords: POWDER-MIXED EDM; NANO-POWDER; MACHINING PERFORMANCE; TITANIUM ALLOYS.

Multi Response Optimization - An Innovative Method for Optimizing Roller Burnishing Process

Kirankumar A Patel1[0000-0001-5040-2380], Saumil C Patel2[0009-0004-3360-0093], Krunalkumar B Patel3[0000-0001-8397-0923] and Tushar M Patel4[0000-0001-9763-3442]

[1],2,4 LDRP-ITR, Kadi Sarva Vishwavidyalaya, Gandhinagar, 382016, Gujarat, India
3 Kadi Sarva Vishwavidyalaya, Gandhinagar, 382016, Gujarat, India
kpatelp@gmail.com

Abstract. Multiple quality characteristics are a serious concern for the rapidly increasing sector in recent years. To address this issue, the current study describes a novel approach to optimizing several rollers burnishing quality characteristics called as the desire function. Various multi-character models have been constructed by adjusting roller burnishing settings between lower and upper limits for different combinations of responses with the goal of improving surface roughness. Spindle speed, interference, feed rate, and number of tool passes were used as model variables, whereas Surface Roughness, Dimensional Deviation, Cylindricity, and Parallelism were used as response features to construct prognostic models. Practical work was carried out on the Al alloy 6061 using a 5-level design. The results showed that the greatest desirability of 0.943 was attained for all four response characteristics at an ideal spindle speed of 50.001 rpm, an interference of 5.747 mm, a feed rate of 0.095 mm/rev, and five tool passes. The computed model's validity at maximum desirability value has been confirmed by executing confirmation experiments in the most favorable scenario. The desirability technique is effective for optimizing multi-response characteristics throughout the roller burnishing process, as demonstrated by the results of optimum process parameter combinations.

Keywords: Desirability function, Optimization, Burnishing process, Multi response, Surface roughness.

Nanofluid Applications in Minimum Quantity Lubrication: A Review of Machining Technique

Soni Kumari, Sanjeev Kumar Gupta

Department of Mechanical Engineering, IET, GLA University Mathura, U.P., India, 281406
soni.1802@gmail.com, sanjeev.gupta@gla.ac.in,

Abstract. This review focuses on applying nanofluids in Minimum Quantity Lubrication (MQL) for machining processes, emphasizing their potential to enhance cutting performance while reducing environmental and economic costs. The objective is to analyze the advancements in nanofluid-based MQL systems, highlighting their impact on improving tool life, surface quality, and thermal management compared to conventional lubricants. The novelty of this study lies in its comprehensive evaluation of various nanoparticles, such as metal oxides and carbon-based materials, and their distinct effects on lubrication and cooling mechanisms in different machining techniques. At an optimal nanoparticle concentration of 3%, the cutting temperature is reduced by 50% and lubrication efficiency is enhanced by 60%. By consolidating experimental findings and addressing implementation challenges, this review offers valuable insights into optimizing nanofluid formulations for sustainable and efficient machining operations.

Keywords: Nanofluid, MQL, Cutting fluid, Lubrication efficiency,Sustainab machining

Development of Filter Less Air Purifier Using 3D Printing

Farde Kishor D.Research Scholar,R.K. University, Rajkot er.kishor3108@gmail.com

Dr. Dave Marmik Assistant Manager,Atul Greentech Pvt. Ltd, marmik.dave@rku.ac.in

Abstract – The COVID-19 pandemic has had a profound global impact on public health. In 2020, more than 50 million individuals were exposed to the virus, resulting in over 1.5 million deaths from respiratory complications. The severe acute respiratory syndrome coronavirus 2 is the source of COVID-19 (SARS-CoV-2), is a newly emerged infectious disease. Our understanding of its transmission is continually evolving through scientific and medical research. The virus spreads primarily through contact with mucous membranes in the eyes, nose, and mouth, potentially leading to severe illness or death. Similar to measles and influenza, COVID-19 is a viral infection that can spread through aerosols, although other modes of transmission are also possible. AIRDETO, a filterless air purifier, utilizes advanced technologies like electrostatic plasma, ionization, UV light, and photocatalysis to effectively sterilize and purify indoor air.

Keywords — Air purifiers (APs), Bacterial aerosol, 3-D printing, Additive manufacturing,

Optimization of Machining Parameters for Electro- Chemical Discharge Machining Process using Hybrid Entropy-VIKOR Method

Dheeraj Soni[1*], Bhagwan Das Gidwani[2] and Rohitashwa Shringi[3]

1,2,3Rajasthan Technical University, Kota, Raj. 324010, India
*dheeraj.soni10@gmail.com

Abstract. Optimization of the machining parameters in any manufacturing industry is a crucial aspect since it is necessary for enhancing productivity and quality of the workpiece with least wastage. Therefore, the present article is focused on optimizing the machining process parameters of Electrochemical Discharge Machining (ECDM) using Multi Criteria Decision Making (MCDM) approach. The machining parameters chosen are Applied Voltage, Inter-electrode Gap and Electrolytic Concentration each having three different levels. The design of experiment is chosen as per Response Surface Methodology (RSM) approach resulting in 17 numbers of experimental runs.For MCDM, hybrid Entropy-VIKOR Method has been used to get the optimal machining parameters for four selected responses i.e., Material Removal Rate, Entrance Overcut, Taper Angle and Machining Time. The results obtained through this method reported A3B3C2 i.e., 60V AV, 30% EC and 45mm IEG as the optimal parameter combination which is marked as Rank 1.

Keywords: Optimization, ECDM process, MCDM, RSM, Entropy-VIKOR.

A Sustainable Approach for Plastic Waste Management and Recycling.

Aryan Thakar, Priyanshu Lunagariya, Pooja Limbasiya,Bhavin Tanna, Sneh Soni

Contributing authors: 22bei009@nirmauni.ac.in;
22bei037@nirmauni.ac.in; 22bei036@nirmauni.ac.in;
22bei065@nirmauni.ac.in; sneh.soni@nirmauni.ac.in;

Electronics and Instrumentation Engineering, Nirma University, Ahmedabad, Gujarat, India - 382481.

Abstract-Plastic waste has become a global crisis, with only a small percentage being recycled. This project seeks to Address this issue by converting plastic waste into valuable products through a comprehensive multi-step process. This involves de-labelling, sorting, shredding, dyeing, and extrusion, where a screw extruder melts and mixes the plastic to produce items like plastic bricks for construction,roads made from a plastic-concrete mixture, and molded products such as automotive components using injection, blow, rotational, and compression molding techniques. Additionally, calendering is employed to create thin sheets, packagingstrips, and filaments for 3D printing, while plastic granules produced through these processes serve various industrial applications.The production process is optimized with programmable logic controllers (PLCs),enabling real-time monitoring to enhance efficiency and product consistency. Sensor data, analyzed through AI and machine learning, helps optimize products and predict equipment life, minimizing mechanical failures. Sensors like temperature, humidity, ultrasonic, and pressure are used to monitor key parameters, reducing maintenance costs. Automation is further enhanced with smart conveyors, IoT integration, and cloud-based monitoring, addressing traditional manufacturing challenges. By recycling plastic waste using these advanced methods, more plastic is diverted from landfills, significantly lowering pollution and greenhouse gas emissions. This contributes to protecting wildlife and their habitats, paving the way for a cleaner, greener future for upcoming generations.

Keywords: Waste Recycling, Extrusion, Molding, Color Sorting, De-labelling,Calendering

Corrosion Behavior of M50 NiL Steel by Liquid Nitriding Method for Aerospace Bearings

B. Venkatesh[1], P.Pavan Kumar[2], C.Anil Kumar Reddy[3], Manish Roy[4], R.Vamshi[5], L.Harinath[6]

[1,2,3,5,6] Department of Mechanical Engineering, Vardhaman College of Engineering, Telangana -501218, India
[4] Defence Metallurgical Research Laboratories, Kanchanbagh, Telangana-500058, India
*Corresponding Author: anilreddymechanical@gmail.com

Abstract: In the aerospace sector, M50 N steel is utilized for high-performance bearing steel in aero-engine shafts. M50 denotes a high alloy steel that employs nitriding for secondary strengthening. The heat treatment prior to nitriding aims for a strong core and hardened surface, with nitriding minimally affecting these traits. Surface coating enhances the hardness and corrosion resistance of M50 bearing steel. The nitriding process omits tempering and hardening steps. Liquid nitriding is utilized in this context. The nitriding procedure was conducted over various temperatures and durations for experimental assessment. This study's primary goal is to evaluate the microstructure, hardness, and corrosion resistance of bearing steel. Research has investigated the corrosion behavior of M50 bearing steel in environments like sodium chloride (NaCl) solutions. The material is initially shaped using electrical discharge machining (EDM) for precise dimensions. Heat treatment is crucial for improving corrosion resistance. Electro potentiodynamic testing evaluates the surface roughness of materials through diverse parameters. Materials are immersed in the solution for three hours. By using Potentiostat apparatus corroded surfaces are characterized and Tafel plots are drawn, and from the results obtained it is evident that lower temperature samples exhibited better corrosion rate than untreated M50 NiL steel.

Keywords: Bearing Steel, Hardness, OCV, Liquid Nitriding, Corrosion.

Assessing the Impact of Polymer and Additive Properties in the Rotational Molding Process: A review

Prashant Khanna[1, a], PL. Ramkumar[2, b]

1Department of Mechanical Engineering, Parul University, Vadodara, Gujarat, India
2Department of Mechanical and Aerospace Engineering, Institute of Infrastructure Technology Research and Management, Ahmedabad, Gujarat, India

aprashantkhanna2003.pk@gmail.com, bplramkumarno1@gmail.com

Abstract: This study investigated the viability of using various fiber-polymer composites in the rotational molding process. The intricacy of scaling up the rotational molding process is covered in this analysis. This process is employed in the production of stress-free hollow plastic products. The different fibers and polymers that are used to manufacture items using the rotational molding technique have all been thoroughly studied in this research. There are two sections to this study. The variety of polymers utilized in the procedure, as well as their characteristics, advantages, and disadvantages, are covered in the first section. The second section deals with the research of different fibers that have been integrated with the polymers. It has been observed that the optimum polymers for the rotational molding process are polyethylene grades. It was found that linear low-density polyethylene (LLDPE) is the best grade for rotational molding due to its simplicity of processing. Lower tensile and impact strength in the final molded goods is the only drawback of employing LLDPE. Incorporating fibers into the LLDPE resin could enhance this. Natural fibers are becoming more and more important in the rotational molding process due to their eco-friendliness, even if artificial fibers offer superior mechanical qualities. The literature research leads to the conclusion that boosting processability in the rotational molding process can be greatly aided by a sufficient diversity of fiber additives and polymer resin bases.

Keywords: Rotational Molding, Polymers, Additives, LLDPE, Composite

A parametric study on bead morphologies of SS309L using GMAW process

Vidhi Padhiar[1], Waako Stephen[2], Jay Vora[2], Kumar Abhishek[3], Soni Kumari[4], Rakesh Chaudhari[2]*

1 Department of Electronics and Communication Engineering, Pandit Deendayal Energy University, Gandhinagar 382007, Gujarat, India
2 Department of Mechanical Engineering, Pandit Deendayal Energy University, Gandhinagar 382007, Gujarat, India
3 Department of Mechanical Engineering, IITRAM, Ahmedabad 380026, Gujarat, India

4 Department of Mechanical Engineering, GLA University, Mathura, 281406, U.P., India

Corresponding author: *rakesh.chaudhari@sot.pdpu.ac.in

Abstract. Gas metal arc welding (GMAW)-based Wire-arc additive manufacturing (WAAM) method has gained popularity due to exhibition of better features like effortlessness in deposition of material at a higher rate and fabrication of multi-walled components with minimum cost. The additive components of stainless steels has gained a lot attention for multiple applications owing to their favourable characteristics such as excellent strength, high resistance to rust and corrosion, durability, and aesthetic nature. GMAW method requires a systematic approach to control input variables to built a multi-walled component. Thus, the present has made an attempt to attain the appropriate process conditions for bead morphologies of bead height (BH), and bead width (BW). GMAW process was employed for single-layer depositions by considering voltage, gas mixture ratio, and travel speed as design variables. SS309L was used as filler wire material with SS316L material as substrate plate. Box-Behnken technique of RSM has been used to design a systematic planning of experimentation. The obtained results were analysed by using ANOVA, normal probability plots, and main effect plots. Empirical relations were also developed between design variables and output measures. Author believes the current study will be suitable for researchers as starting point to select appropriate design variables.

Keywords: WIRE ARC ADDITIVE MANUFACTURING; SS309L; GMAW; BEAD GEOMETRY; ADDITIVE MANUFACTURING.

Performance evaluation of indirect solar dryer using phase change material

Bhumika Vanal 1[0009-0000-7527-1890], Jatin Patel 1,* [0000-0001-6574-8210],
Rajat Saxena 1 [0000-0003-1052-9592]

1 Department of Mechanical Engineering, School of Technology, Pandit Deendayal Energy University, Gujarat, India
*jatin.patel@spt.pdpu.ac.in

Abstract. This research investigates the use of the phase transition material in an indirect solar dryer, to upgrade the drying process of *Moringa Oleifera* and *Solanum lycopersicum.* The dryer uses solar energy to generate heat, which is used for drying these vegetables. Phase change materials (PCMs) stores extra heat energy in the time of day and release the heat during the off-sunshine time, by extending the drying process beyond the solar energy. This study focuses on the analysis of the performance of the dryer system with and without PCM, with the aim of achieving efficient drying behaviour in less time under an indirect solar dryer integrated. In the system with PCM, the drying process is rapidly fast and more efficient. The moisture content in *Moringa Oleifera* drops from 0.85 to 0.1 in six hours, while for *Solanum lycopersicum* reduces from 1 to below 0.2 in just twelve hours. The PCM ensures consistent heat and allows steady moisture removal. Without PCM, drying takes considerably longer time about 22-23 hours for *Solanum lycopersicum* and often *Moringa Oleifera* incompletely dried. As moisture content curve shows a rapid initial moisture loss followed by steady loss over time. The drying rate curve reflects the quick evaporation of moisture from the surface of both vegetables. The findings offer the potential of PCM integrated into an indirect solar dryer as an energy-efficient drying method for drying nutrient-rich vegetables. This method not only reduces the time for drying but also ensures a sustainable solution towards agricultural applications.

Keywords: Drumstick Drying, Tomato Drying, Phase Change Material, Drying Characteristics, Indirect Solar Dryer

Sustainability assessment of dry turning Hastelloy-X using Al2O3-ZrO2 ceramic tool for Green Manufacturing

Hariketan Patel1[0000-0001-5999-7990] and Hiralal Patil2[0000-0002-6936-2558]

1 School of Computing, Engineering and the Built Environment, Edinburgh Napier University, Edinburgh, UK

2 GIDC Degree Engineering College, Navsari, Gujarat, India hari.mech.patel@gmail.com

Abstract. The importance of sustainability in machining processes is increasing due to limited resources and growing environmental considerations. Hastelloy-X is difficult-to-cut material, especially in a dry environment. The present work was carried out by using Alumina–Zirconia (Al2O3-ZrO2) ceramic inserts in a dry machining environment. Machining experiments were performed with vary-ing cutting speeds (100, 125, 150, 174, and 200 m/min.), feed rates (0.05, 0.1, 0.15, 0.2, and 0.25 mm/rev), and depth of cut (0.1, 0.2, 0.3, 0.4, and 0.5 mm). A total of 25 experiments were performed using Taguchi's L25 orthogonal array. Consequently, the tool face wear (TFW), tool wear loss (TWL), surface rough-ness and material removal rate were analysed for a comprehensive understand-ing of the machinability and tool wear. At low cutting speeds and high depths of cut, high deterioration and catastrophic fracture were observed, while by lower-ing the cutting speed and depth of cut the built-up edge (BUE) formed. From the workpiece material at elevated temperatures, diffused iron (Fe) and chromi-um (Cr) react with oxygen (O) to form mild oxides that initiate the BUE. Tool face wear and surface roughness both are most influenced by cutting speed, fol-lowed by depth of cut and feed rate. Tool face wear has direct correlation to the surface roughness. The sustainability assessment considers multiple criteria, in-cluding energy consumption, coolant cost, waste generation, operator health, surface roughness, workpiece cleaning, coolant recycling and disposal, tool cost, and noise level. Each criterion is rated on a scale of 1 to 10 to quantify its impact and significance in the sustainability assessment. Finally, the results Product Sustainability Index (PSI) index value 7 indicate that the ceramic tool offers significant benefits in productivity, environmental sustainability and workpiece quality for machining Hastelloy-X. The lower energy consumption, noise levels and tool wear rate make it an attractive option. However, the mod-erate tool cost rating suggests potential for further cost reductions to enhance the economic sustainability of the machining process.

Keywords: Sustainability assessment, machinability, dry machining, ceramic tool, Product Sustainability Index.

Multi-response optimization of machining parameters of CNC turning operation on AL6063 using grey relational analysis

Mohamad Masud Faridi[1], Imtiaz Ali Khan[2], and Umair Arif[3*]
1,3Department of Mechanical Engineering, Z.H.C.E.T, Aligarh Muslim University, Aligarh (UP)-202002, Masudfaridi@zhcet.ac.in
2Professor, Department of Mechanical Engineering, Z.H.C.E.T, Aligarh Muslim University, Aligarh (UP)-202002, iakhan.me@amu.ac.in
3Umairarif@zhcet.ac.in

Abstract: With the advent of emerging technologies, there is a growing demand to enhance overall efficiency with respect to energy, productivity, and tooling. As a result, there is a focus on making machining processes simultaneously sustainable, productive, and efficient. In this research, the influence of machining parameters in CNC lathe, such as feed, cutting speed, and depth of cut, were evaluated under both dry and wet conditions. Since sustainable production requires a balance between energy consumption and quality, response variables like surface roughness and material removal rate (MRR) were analyzed. A Taguchi-gray integrated approach was utilized in this study. For single-response analysis, Analysis of Variance (ANOVA), main effect plots, and response tables were employed. A multi-objective function was then developed using the gray relational methodology. The ANOVA results indicated that depth of cut had the greatest impact on surface roughness and MRR, followed by feed in Study 1. In Study 2, under wet conditions, feed emerged as the most significant factor affecting surface roughness, while cutting speed was the primary contributor to MRR. According to the gray relational analysis, the optimal combination for realizing the best MRR and SR in both environments was a cutting speed of 700 rpm, a feed rate of 0.18 mm/rev, and a depth of cut of 1 mm.

Keyword – Sustainable machining, green machining, Al6063 alloy, Mult objective optimization, Grey relational grade.

Experimental studies in Modal Analysis and Order Analysis of a Rotor System to Determine Fault

Dinesh Kumar Pasi[1[0000-0002-1231-0335]], Manoj Chouksey[2]and Ashesh Tiwari[3]

[1, 2]Shri G. S. Institute of Technology & Science, 23, Park Road-452001, Indore, India
[3]Institute of Engineering and Technology, D. A. V. V., Indore, India

[1]dkpasi25@gmail.com

Abstract. Different faults develop in the machines under operating condition, e.g. unbalance, misalignment, rotor bent, rotor crack etc. Vibration signals can be used to track these faults by utilizing some suitable analysing technique. Order analysis is one of such techniques through which sound and vibrations signals are analyses to extract information about the faults. In real world situation order analysis provides a complete diagnostic for various rotating machines like turbines, generators, electric motors, pumps etc. In this study, order analysis technique is applied on vibration signals gathered from a run up test of Machie Fault Simulator (MFS). Two-disc rotor shaft system is considered for harvesting the vibrations and rotational speed data for performing the studies. One of the faults is induced in the MFS in the form of unbalance mass attached to a disc. Colour maps have been drawn to find out various frequency components against the speed change during run-up. Order tracking has also been carried out, which is particularly useful in finding out contribution of various orders as the speed changes. The observations can be used as guidelines for fault diagnosis under such cases.

Keywords: Modal Analysis, Order analysis, Fault identification.

Optimization of Process Parameters in Incremental Sheet Forming: Enhancing Quality Characteristics for Advanced Manufacturing Applications

Narinder Kumar[1] and Harpreet Singh[2]

1 Department of Mechanical Engineering, Chandigarh Engineering College CGC, Landran, Mohali, Punjab, India

2 Department of Mechanical Engineering, Chandigarh University, Gharuan, Punjab

narinder.5282@cgc.edu.in

Abstract: The Single Point Incremental Forming (SPIF) technique is an innovative method for sheet metal processing, whereby a sheet blank is firmly clamped at its edge while a single-point tool gradually deforms it along a predetermined trajectory in successive downward increments. This method provides three-dimensional sculpting without using dies. Surface roughness and non-uniform thickness distribution provide significant challenges in the parts formed by using SPIF process, highlighting the essential need to study the effect of forming parameters on these characteristics throughout the process. This study employs a systematic methodology to predict and optimize the impacts of three essential parameters namely tool diameter, tool rotating speed and feed rate on surface roughness and material thinning. Experiments are conducted on AA 1200 aluminum alloy, and the data is examined using the Taguchi technique and variance analysis. The findings of this research identify the key factors that may effectively minimize surface roughness while increasing wall thickness, therefore improving product quality and manufacturing efficiency..

Keywords: Incremental forming, Surface roughness, Aluminium alloy.

Effect of process parameters on Dimensional Accuracy, Printing Time, and Material Consumption in FDM Printing of PC-ABS with Graphene

Naveen Kumar Suniya1, Arvind Kumar Verma2

Abstract. Additive manufacturing (AM) is revolutionizing production processes by enabling the creation of complex geometries with high precision and reduced material waste. Fused Deposition modelling is most extensively used method of additive manufacturing to build the parts. This study investigates the influence of key process parameters like layer thickness, printing speed, infill density, infill style, and printing temperature on the printing time, dimensional accuracy and material consumption of 3D-printed parts using PC- ABS with graphene. Specimen were prepared according to"L27" orthogonal array. The Taguchi method was employed to identify the optimal settings that enhance dimensional accuracy while minimizing material usage and printing time. Taguchi method also used to determine most influential factor for performance parameters.

Keywords: 3D Printing, Additive Manufacturing, Dimensional Accuracy,Taguchi Method.

Effect of weld parameters on Ultrasonic Welding of Dissimilar Metals:A Review

Madhavi ACHARYA, 1 Dr.Vishvesh BADHEKA

1Department of Mechanical Engineering, School Of Technology, Pandit Deendayal energy University, Gandhinagar ,Gujarat, GJ382007, INDAI
madhavi.dphd22@pdpu.sot.ac.in.,+919429519125
2 Department of Mechanical Engineering, School Of Technology, Pandit Deendayal energy University, Gandhinagar ,Gujarat, GJ382007, INDAI, Vishvesh.Badheka@spt.pdpu.ac.in.,+919824025256

Abstract: Lightweight dissimilar metal combinations are essential in aviation, automobile and electric industry. Ultrasonic welding is environment friendly solid state welding for joining lightweight similar and dissimilar metals. Paper reviews the effect of welding parameter and interlayer on weld quality. Interlayer is applied to achieve better weld quality. Al-Cu, Al-Ni, Al-SS, Al-Mg, Mg-Ti etc. have been effectively joined by Ultrasonic welding. Weld parameter influence the ultrasonic welding process. Weld energy, weld time and vibration amplitude are the main parameters to achieve sound weld of dissimilar metals.

Keywords: Ultrasonic spot welding, Dissimilar metal, Weld Parameter.

Review on: Effect of Graphene nano platelets on Magnesium alloys

Arsh Shaikh1, Shafiq Raza1,Jahanvi Dave1, Kelvin Vikani1, Daulat Kumar Sharma2 and H.H Jadav2

1U.G Student Of Metallurgy Department, Government Engineering College Gandhinagar 382028,Gujarat India.
2Faculty Of Gujarat Technological University, Ahmedabad 382424, Gujarat India.

Abstract: The review paper investigates how adding graphene nanoplatelets (GNPs) to magnesium alloys can improve both their mechanical and corrosion resistance. Magnesium is frequently used in the aerospace and automobile sector due to its lightweight nature. Its poor ductility and strength, however, present difficulties. The incorporation of GNPs enhances the hardness, tensile strength, elastic modulus, and corrosion resistance of magnesium alloys. GNPs have a large specific surface area with good mechanical strength. The paper covers various manufacturing approaches of GNP-reinforced composites in magnesium matrix, like stir casting, melt deposition, and powder metallurgy. Important discoveries show that adding as little as 0.5 weight percent of GNP can greatly improve corrosion resistance by 40–60% while increasing tensile strength by as much as 50%. According to microstructural research, GNPs are uniformly dispersed, which guarantees efficient reinforcement and fine-tunes grain size without changing phase composition. The potential of GNP-reinforced magnesium alloys for demanding applications needing great performance and durability is highlighted in this review.

Keywords: Graphene nanoplatelets, Mg alloys, properties enhancement, corrosion resistance, metal matrix composite, microstructure.

Advancements and Challenges in Multi-Material Additive Manufacturing (MMAM) with Machine Learning Integration

Praveen G. Kohak1, Kanif M. Markad2*

1DVVP College of Engineering, Ahmednagar (MH)
2 DVVP College of Engineering, Ahmednagar (MH)

Abstract: delves into the intricate intersection of Multi-Material Additive Manufacturing (MMAM) and Machine Learning (ML), exploring their synergistic applications and addressing inherent challenges. The article unfolds the potential of ML in optimizing MMAM processes, particularly in designing metamaterials with unique properties. Focusing on structural engineering, it delineates ML's impact on computational cost reduction, design resolution enhancement, and predictive performance improvement. The integration of ML with MMAM is exemplified through various studies, showcasing ML algorithms' effectiveness in predicting stress-strain curves, material strength, and optimization of mechanical metamaterials. The article navigates through the challenges of Metal-Metal, Metal-Ceramic, Metal-Polymer, and Polymer MMAM, elucidating the complexities of material compatibility, bonding, and dimensional accuracy. ML emerges as a crucial ally in overcoming these challenges, offering solutions in predicting material interactions, optimizing parameters, and ensuring robust bonds between dissimilar materials. Emphasizing the evolving landscape of 3D printing, the article explores the revolutionary strides in metal-ceramic and metal-polymer MMAM, underlining the role of ML in optimizing the design process. It concludes by underscoring the transformative potential of ML in advancing MMAM, fostering innovation, and overcoming limitations in multi-material extrusion-based 3D printing.

Keywords: Multi-Material Additive Manufacturing (MMAM), Machine Learning (ML), metamaterials, 3D printing

Influence of Metal Matrix Composites on Mechanical and Metallurgical Properties in Friction Stir Processing: A Critical Review

Ritu Jain[1], Akash Shukla[2], Kedar Badheka[3]

1PG Scholar, 2-3Assistant Professor Mechanical Engineering Department,
Parul Institute of Engineering and Technology, Parul University, Vadodara, Gujarat,
India

Abstract. Recently, the innovation has been centralized on new materials and processes for applications in aerospace, automotive, marine, and biomedical implants. The traditional techniques include physical and chemical vapour deposition, which require high quantities of energy input liberated by harmful chemical products. The FSP, however, is regarded as a quite solid-state process. The FSP refines the micro-structure and introduces reinforcement as B4C, silicon carbide, and MoS2, and then the hardness, tensile strength, and wear resistance increase. This review categorizes the recent research carried on the effects of reinforcements, grain refinement, process parameters, tool design, and multi-pass processing. The results present that the efficient optimization of all these parameters further Elevates the structural and tribological performance of MMCs to a large extent, which indicates the high promise for improved performance by FSP in high-demand sectors like aerospace and automotive industries.

Keywords: Friction Stir Processing (FSP), Metal Matrix Composites (MMCs), Boron Carbide (B4C), Grain Refinement, Process Parameters, Wear Resistance

Tool Profile and its Impact on Mechanical Behaviour of Joints Formed through Friction Stir Welding: A review.

Chandrakant Swain[1], Akash Shukla[2], Kedar Badheka[3]

1PG Scholar, Mechanical Engineering Department, Parul Institute of Engineering and Technology, Parul University, Vadodara, Gujarat, India
2Assistant Professor, Mechanical Engineering Department, Parul Institute of Engineering and Technology, Parul University, Vadodara, Gujarat, India
3Assistant Professor, Mechanical Engineering Department, Gujarat Power Engineering and Research Institute, Mehsana, Gujarat, India

Abstract. Friction Stir Welding (FSW) is a key solid-state welding technique for aluminium alloys. This technology conquers the key problems caused by conventional fusion welding, namely oxidation and cracking. The review focuses on the role of material attributes, design of tool, and process variables on the FSW joint quality. The degree of variables including rotational speed, feed rate, and tool geometry frequently affect the tensile strength, hardness, and ductility. Tilt angle, plunge depth, and pin design were the parameters on which optimal control was made to produce welds free of defects. The review is quite keen on establishing a balance between input heat and material flow to reduce defects while allowing for designs in hybrid tooling to enhance mechanical properties. Future research directions include more efficient designs of the tool along with optimization of parameters for achieving higher strength within the joint along with general performance of the weld**.**

Keywords: Friction stir welding (FSW), Tool profiles, Process parameters, Mechanical properties, HAZ, Microstructure

Experimental study on Zn based biodegradable compo-sites developed using microwave sintering

Shruti C Bhatt1*(0000-0003-0288-9504), Mayur A Makhesana1, Nilesh D Ghetiya1

1Department of Mechanical Engineering, Institute of Technology, Nirma University, Ahmedabad, India; *Corresponding Author E-mail: shruti.mehta@nirmauni.ac.in

Abstract. In recent years, Zinc (Zn) based biomaterials (BMs) have been considered as novel materials due to their intermediate degradation properties. Pure Zn exhibits inadequate mechan-ical, biocompatible properties, so to improve the performance characteristics bio-ceramic mate-rials have been combined to achieve specific biocompatibility and biodegradability. In this work, Zn-Hydroxyapatite (Zn-HA) and Zn-HA-Manganese (Zn-HA-Mn) composites were synthesized using a microwave-based sintering process. The degradation effect due to the addition of HA and Mn has been checked in a simulated body fluid solution (SBF). Zn-5HA has been found to have better degradation characteristics than other samples. The addition of Hydroxyapatite (HA) and Manganese (Mn) to the Zn matrix in Zn-5HA-4Mn samples led to an increased corrosion rate and elevated pH levels. The rate of weight loss due to immersion testing of all samples have been found from high to low: Zn-HA-Mn > Zn-HA > Zn. Further, the compression testing of the de-veloped composites shows that Zn-HA composite exhibits higher mechanical integrity than other combinations.

Keywords: Zinc, Metal matrix composite, Microwave sintering, Biodegradable, Character-ization

Optimization of Texture Attributes to Enhance Load Carrying Capacity of Thrust Bearing

Vivek Kumar[0000-0002-9207-6832]

Department of Mechanical Engineering,
Netaji Subhas University of Technology (NSUT) Dwarka, New Delhi, India.
vivek.kumar@nsut.ac.in

Abstract: This paper deals with the numerical simulation of texture surface thrust bearing utilizing a Newtonian lubricant. Reynolds' equation is applied to model the lubricant flow within these bearings, which feature square and rectangular micro-depressions oriented in both circumferential and radial directions. The fi-nite element method is employed to solve Reynolds' equation, enabling the cal-culation of film pressure, load-supporting capacity, and frictional power loss. The texture shapes are optimized based on dimple size, depth, and length to maximize load-bearing performance. It was found that square dimples outperform rectan-gular dimples in terms of both load-carrying capacity and frictional power loss. The numerical results reveal a substantial increase in load-supporting capacity (+83.91%) with the optimized geometric parameters for both square and rectan-gular dimples, while frictional power loss was significantly reduced (-48.8%) due to the use of micro-dimples.

Keywords: Thrust bearing, Textured surface, Load-carrying capacity, FEM.

Influence of textured surface and micropolar lubricant on the performance of three-lobe hole-entry hybrid journal bearing compensating with orifice restrictor

Chandra B. Khatri1, Sumita Chaturvedi2, Saurabh K. Yadav3, Satish C. Sharma4

1 Janakpur Engineering College, Lalitpur 44600, Nepal
1 E-mail: chandrakhatri86@gmail.com
2 Integral University, Lucknow, Uttar Pradesh 226026, India
2 E-mail: sumita@iul.ac.in
3 Institute of Infrastructure, Technology, Research and Management (IITRAM), Gujarat 380026, India
3 E-mail: saurabhme.iitr@gmail.com
4 Indian Institute of Technology, Roorkee, Uttarakhand 247667, India
4E-mail: sshmefme@iitr.ac.in

Abstract: The integration of surface texturing and micropolar lubricants in journal bearing design has recently garnered significant attention for improving bearing performance, particularly in high-speed applications. This study investigates the combined influence of surface texturing and micropolar fluids on the static and dynamic performance characteristics of two-lobe hole-entry hybrid journal bearings. The study uses Eringen's micropolar fluid theory and finite element method (FEM) to derive the governing Reynolds equation and solve for lubricant flow and pressure distributions. The results indicate a substantial improvement in load-carrying capacity, reduced friction, and enhanced stiffness and damping coefficients when compared to traditional Newtonian-lubricated smooth journal bearings. These findings provide a foundation for the design of more efficient and stable journal bearing systems in industrial applications.

Keyword: Hybrid Journal Bearings, Surface Texturing, Micropolar Lubricants, Finite Element Method (FEM), Non-Circular Bearings

Modelling of breaking strength in semi-matured coir fibres: a machine learning approach

Subhankur Dutta[0000-0002-5609-4785], Chebolu Himavantha Sri Raghava Naga Sai[0009-0005-6470-3156], Bhuvaneshwari Yadav Killadi[0009-0002-7823-7131] and Amit Kumar Singh*[0000-0002-3259-5067]

Department of Mechanical Engineering, National Institute of Technology Nagaland, Chumoukedima-797103, Nagaland, India

subhankur91@gmail.com
himavanthachebolu54@gmail.com
killadibhuvaneshwari@gmail.com
amit.kumar965@yahoo.com

Abstract. The abundance of natural fibres can facilitate its cost-effective utilization in fibre-reinforced composites by substituting the synthetic variant. In this study, a vacuum pressurization impregnation (VPI) treatment of semi-matured coir (SMC) fibres is done, followed by a mechano-chemical extraction procedure. After that, tests like thermogravimetric analysis (TGA), x-ray diffraction (XRD) and scanning electron microscopy (SEM) are done to examine the thermal features, crystallinity and morphological aspects of the fibres. The results are compared with non-VPI SMC fibres, extracted through a similar way. It is found that the VPI-treated SMC fibre exhibits higher crystallinity, lower thermal deterioration and reduced porosity as compared to non-VPI SMC fibre. An experimental design is created to systematically assess the breaking strength of these fibres, with predictions made using ANFIS, a machine learning model. Furthermore, particle swarm optimization (PSO) is taken to build a PSO-ANFIS model, for optimizing the ANFIS parameters. The results indicate that the PSO-ANFIS model outperforms standalone ANFIS, yielding superior predictive performance with lower root mean square error (RMSE) and higher R^2 values, specifically 0.59951 and 0.99563 respectively. These findings support the potential of VPI-treated SMC fibres as effective reinforcements in natural fibre composites and highlight the PSO-ANFIS model's efficacy for accurate breaking strength prediction. It may be beneficial for similar applications in practical composite material design.

Keywords: Coir fibre, vacuum pressurization, machine learning.

Influence of Laser Powder Bed Fusion Process Parameters on the Tribological Properties of AlSi10Mg Parts: A Review

Sonal Modi1[0009-0001-9103-5588] and Vishvesh Badheka 2[0000-0001-8026-381X]

1 Research Scholar, Mechanical Engineering, Pandeet Deendayal Energy University, Gandhinagar, Gujarat, India sonal.kphd23@sot.pdpu.ac.in
2 Professor and Dean, Mechanical Engineering, Pandeet Deendayal Energy University, Gandhinagar, Gujarat, India Vishvesh.Badheka@spt.pdpu.ac.in

Abstract Laser powder bed fusion (LPBF), the well-known technique for producing AlSi10Mg components, lets process factors be altered to produce distinctive microstructures and enhanced surface and tribological characteristics. Variables like laser power, scan speed, layer thickness, & build orientation significantly affect wear resistance, surface rough-ness, and mi-crostructure. Perfect laser power guarantees the full melting of powder particles, hence improving layer adhesion and mechanical properties. On the other hand, scan speed controls thermal gradi-ents, therefore affecting sur-face characteristics and residual stresses. Layer thickness determines surface quality and manufacturing efficiency; thinner layers enhance surface finish but need longer processing times. Furthermore, build orientation significantly affects wear behavior as vertical orientations usually exhibit anisotropic properties owing to layering-induced texturing while horizontal orientations usually provide more uniform wear performance. Studies on post-processing techniques especially heat treatments have underlined their significance in reducing internal stresses and improving the tribological properties of LPBF-made AlSi10Mg compo-nents. These advances improve the internal structure and resistant to wear of the substance, mak-ing it suitable for high-performance uses. The intricate link between LPBF process parameters and the tribological performance of AlSi10Mg alloys is shown in this work by synthesizing ex-perimental data. The knowledge provided helps to develop improved production techniques to get exceptional wear resistance in certain industrial uses.

Keywords LPBF, AlSi10Mg, Tribology, Wear, Layer thickness, Build Orientation, Spot size, Laser power.

Investigation of Step Size Application Directions in Incremental Sheet Forming Process

Devang A Patel[1,2] Hardik R Dodiya[2] Viral P Parekh2, Akash B Pandey3, and Sekar Saladi2,*

[1] Gujarat Technological University, Ahmedabad, Gujarat, India
[2] Sardar Vallabhbhai Patel Institute of Technology, Vasad, Gujarat, India
[3]The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, India
*sekarsaladi.mech@svitvasad.ac.in

Abstract. The Incremental Sheet Forming (ISF) process has the capability of producing a shape in sheet metal locally and progressively along a predefined tool path. The process can form the parts from a CAD file without using a die. Most of the work in the published literature on toolpath optimization is focused on step-size optimization only. However, the direction in which the step size is applied is equally critical in toolpath development. Owing to this inspiration, this experimental investigation intended to analyze the toolpath in terms of step size application direction. To conduct the experiments, a full-factorial design with one categorical factor step size application direction (horizontal, vertical, and inclined) having 3 levels and two numeric factors namely step-size (0.25 mm, 0.75 mm) having two levels and wall angles (31^0,45^0, and 59^0) having three levels were planned using Minitab. Average sheet thickness, average internal surface roughness, and forming time are the ISF process responses to showcase the quality of the process and the formed sheets. After the accomplishment of the experiments, it was revealed that step size application direction has a significant impact on surface roughness and forming time, although the influence on the average sheet thickness is negligible. The wall angle has a considerable impact on average sheet thickness and average surface roughness (Ra). An inverse association between surface roughness and wall angle is observed. The forming time was reduced by increasing the step size value for all the step size application directions.

Keywords: Incremental Forming, Toolpath, Step Size Direction, Wall Angle, Forming Time

Performance analysis of xanthan gum-based abrasive media for the finishing of FDM printed parts using AFM

Nitin Dixit[1][0000-0003-0115-1591], Varun Sharma[2] and Pradeep Kumar[2]

[1] Punjab Engineering College (Deemed to be University), Chandigarh-160012, India
[2] Indian Institute of Technology Roorkee, Uttarakhand-247667, India
ndixit111@gmail.com

Abstract. The abrasive flow machining (AFM) process has applications in finishing internal geometries with intricate shapes. Abrasive media has crucial role in such applications due to self-deformable behaviour under applied load. The parts manufactured using additive manufacturing techniques have high surface roughness, limiting their application. In the present study, an attempt has been made to analyse the finishing behaviour of xanthan gum (XG) based abrasive media. The cylindrical acrylonitrile butadiene styrene (ABS) parts were printed using fused deposition modeling (FDM) and finished using AFM. An abrasive media composed of natural gum-based hydrogel and SiC abrasives has been prepared and used for finishing The effect of extrusion pressure, abrasive concentration, and layer thickness were investigated on material removal (MR) and percentage improvement in surface roughness (% ΔR_a) using one-factor-at-a-time approach. The experimental results show a maximum MR of 36 mg and a maximum % ΔR_a of 27.63 %.

Keywords: Abrasive Flow Machining, Abrasive Media, Extrusion Pressure, Abrasive Concentration, Hydrogel, Fused Deposition Modeling

SMART FACTORY PRODUCT DEFECT DETECTION USING DEEP LEARNING

Deo Prakash1, Arya Singh1, Yash Deep Singh Bais1, Vaishnavi Majumdar1, Eshani Patel1 and Om Prakash Sahu2

1 Student Artificial Intelligent and Machine Learning
2 Professor and Dean, AIML, IRC, SSIPMT, Raipur Chhattisgarh
deo.prakash@ssipmt.com,aaryasingh@ssipmt.com,yash.
deepsingh@ssipmt.com,vaishnavi@ssipmt.com
eshani.patel@ssipmt.com,om.sahu@ssipmt.com

Abstract: This study aims to develop an automated defect detection system for smart factories using state-of-the-art deep learning models. The objective is to create a system that improves real-time quality assurance, reduces manual effort, and enhances produc-tion efficiency. The traditional manufacturing industry is undergoing a significant trans- formation with the emergence of industry 4.0, characterized by the integration of ad-vanced technologies such as the Internet of Things Artificial Intelligence, and robotics. These innovations lead to the development of smart factories that enhance production efficiency and improve product quality. However, ensuring product quality remains a critical challenge due to the complexities of modern manufacturing processes. Traditional quality assurance methods, including manual inspections and rule-based algorithms, of-ten fall short in addressing these challenges. This paper proposes a deep learning-based product defect detection system specifically designed for real-time applications in smart factory environments. By using Convolutional Neural Networks (CNNs) and transfer learning techniques with pre-trained models such as VGGNet, ResNet, DenseNet, Mo- bileNet V2, and Inception V3, the system aims to automate the inspection process, im- proving efficiency and accuracy. The proposed system demonstrates high accuracy and rapid defect classification, contributing to enhanced quality control. This research en-courages the adoption of AI-driven defect detection systems in smart factories, ultimately leading to improved product quality, cost savings, and competitive advantages in the manufacturing sector.

Keywords: Industry 4.0, Smart Factories, Deep Learning, CNN, Transfer Learning, Internet of Things, Artificial Intelligence.

A review on the challenges and future scope for copper welding

Raghvendra Darji1, Vishvesh Badheka2, Deepika Harwani3*, Divji Vaishnav1

1 Matter Motor Works Pvt. Ltd, DCT - Khodiyar, Ahmedabad, Gujarat
2 Department of Mechanical Engineering, School of Technology,
Pandit Deendayal Energy University, Gandhinagar, Gujarat 3 Department of Mechanical Engineering, R.C. Technical Institute, Ahmedabad, Gujarat

deepika.mech.rcti@gmail.com

Abstract. During the fusion experiments, high heat flux can cause difficulties. Copper, having high thermal conductivity, can be employed to reduce the amount of excess heat. Any component can be easily fabricated using copper and its al-loys. However, welding of copper is cumbersome. The same properties which make copper commercially and industrially applicable produce problems during its welding. The properties such as thermal conductivity, reflectivity and fluidity in its liquid state make the welding tedious. Conventional arc welding processes have been utilized to a lesser extent in comparison to the newly developed pro-cesses that have been explored more for the welding of copper. However, weld-ing copper and its alloys is not that easy with advanced processes. This study reviews the challenges of copper welding by various processes. Challenges dur-ing the laser and laser-arc hybrid welding processes, gas tungsten arc welding process, ultrasonic welding and friction stir welding process have been high-lighted. The area of copper welding has not been explored much by the research-ers; hence the paper also discusses the ideal conditions for the welding of copper and also presents the relevant future scope.

Keywords: Copper, challenges, laser beam welding, friction stir welding, gas tungsten arc welding.

Sustainable development of the Fiber Reinforced Composites from Industrial and Agriculture Waste for Structural Application

Vibhooti Narayan Mishra[1], Abhay Gupta[2] Yogendra Singh Rajpoot[3], Divya Pratap Singh[1]

[1]Rajkiya Engineering college, Azamgarh UP, [2]Alliance University Bangalore, [3]Rajkiya Engineering College, Mainpuri, UP.

Abstract: The agriculture, polymer, and textiles industries have the highest production yields to fulfill human requirements, but they also contribute heavily to environmental contamination and creation of waste worldwide. A scarcity of post-consumer disposal is a major challenge for the majority of developing nations, as unsustainable nature of this trash has produced severe environmental degradation. These by-products and wastes can be turnout into useful products to fulfill the needs of the society to some extent. The development and applications of various composites from industrial waste will be explored in this work. The increasing utilization of composite materials in heavy industries has also resulted in an increase of waste generation due to the limited of sustainable and effective End-of-Life (EoL). This work highlights the reuse and other form of recovery of EOL Composites. The researchers become more interested in natural fibers, plastic waste from Hydrapulper (PWH), plastic & wood waste, waste poly (ethylene terephthalate), waste textile fibers, and waste glass materials as substitute reinforcement & matrix for fiber-reinforced polymer composites. Therefore, the results of this review might be used as a basis for further studies on composites using waste with the aim of improving the sustainable and ecofriendly development.

Keywords: Industrial waste, Fiber reinforced composites, Sustainable development, Biodegradable, EOL Composites

Effect of Liquid Nitriding on Surface layer of M50 NiL Steel for Bearing Applications

C.Anil Kumar Reddy[1], Pothamsetty Kasi V. Rao[2],B.Venkatesh[3], B.Nageswara Rao[4]
[1.2.4], Department of Mechanical Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram-522502, India
[3]Mechanical Engineering, Vardhaman College of Engineering, Hyderabad-501218, India

*Corresponding Author: anilreddymechanical@gmail.com

Abstract: The synergistic effect of liquid nitriding duration and temperature on the characteristics of the nitrided region formed on M50NiL steel has been systematically examined. The nitriding procedure was conducted at temperatures of 525°C, 550°C, 560°C, and 570°C for durations of 3, 6, 8, and 12 hours. This nitriding methodology enhances not only the hardness but also other attributes such as wear resistance, fatigue resistance, and surface hardness. In the present investigation, the impact of the nitriding process on the microstructural and mechanical characteristics of M50NiL steel is analyzed. The resulting nitrided layers were characterized through optical microscopy, scanning electron microscopy coupled with energy dispersive X-ray spectroscopy (EDS), and X-ray diffraction analysis. The findings indicate that the thickness of the nitride layer increases in correlation with the nitriding temperature. Empirical data demonstrated that the nitrides ε-Fe2-3(N, C) and γ'-Fe4(N,C) present within the compound layer contribute to the enhancement of microhardness. Furthermore, the augmentation of the salt bath nitriding parameters, specifically treatment time and temperature, correlates with an increase in surface hardness and hardness profile. When M50NiL bearing steel was subjected to liquid nitriding at 525°C, the resultant nitrided layer primarily consisted of a thin ε-Fe2–3N layer. The depth of the nitrided layer exhibited significant variation with increasing treatment temperature. The liquid nitriding process effectively enhanced surface hardness. EDS analysis indicated a heightened concentration of nitrogen in the nitrided sample subjected to treatment at 560°C for 12 hours. The steel specimen identified as LN 525, which underwent nitriding for a duration of 8 hours, exhibited superior wear resistance compared to the other nitrided samples. Polarization studies reveal that after a 12-hour nitriding period at 570°C, the developed expanded austenite began to contract concurrently with a reduction in nitrided layer thickness, hardness, and corrosion resistance. The effects of prolonged nitriding time have been attributed to the diminished chemical potential of nitrogen within the salt bath, resulting in the outward diffusion of nitrogen from the sample to the salt bath. Following nitriding at 525°C for 8 hours, the nitrided layer of M50NiL steel demonstrated exceptional corrosion resistance.

Keywords: Liquid Nitriding, Corrosion resistance,, Micro hardness, Compound Layer, X-ray diffraction.

Microstructural and compressive behavior of Al/SiC composite foams

Venkata Ramana Menda2 Siva Prasad Dora1 Shoba Chintada1* Bommana Diwakar1

1* Dept. of Mechanical Engineering, GITAM (Deemed to be University), Visakhapatnam, 530045, India, *Email: shobachintada@gmail.com, Ph: +919985032287
2 Research scholar, Dept. of Mechanical Engineering, GITAM (Deemed to be University), and Associate Professor, Dept. of Mechanical Engineering AITAM, Tekkali

Abstract: Aluminum foam produced via the powder metallurgy (PM) route is prone to several issues that can affect its microstructure and mechanical properties resulting in poor compression. Non-uniform pore size distribution may occur because of inconsistent mixing or uneven distribution of the foaming agent within the aluminum powder matrix which may lead to weak regions in the foam, reducing its mechanical performance, such as compression strength. This paper focus on utilizing silicon carbide (SiC) particles with 0, 5%, 10% and 15% and urea as space holder to prepare Al/SiC composite foams. The effects of different reinforcement content on the pore structure and distribution of aluminum foam composite were focused on, and axial quasi-static compression tests were conducted. The results indicate that variations in reinforcement significantly influenced the porosity and pore distribution of aluminum foam. Al/SiC 10% composite foam demonstrated outstanding compressive strength of 48.78 MPa which is three times more than traditional unreinforced aluminum foam.

Keywords: Al/SiC composite foams, microstructure, compressive behavior, porous materials.

Microstructural and Mechanical behaviour of Al/Ni-pSiC composites fabricated by Powder Metallurgy technique

Araya Haripriyani1 Shoba Chintada1* Siva Prasad Dora1
Kollabathini S V S Sarath Chandra1

1* Dept. of Mechanical Engineering, GITAM (Deemed to be University), Visakhapatnam, 530045, India,
*Email: shobachintada@gmail.com, Ph: +919985032287

Abstract: Aluminium matrix composites reinforced with ceramics have superior mechanical and thermal properties when compared to monolithic aluminium alloys. But poor wettability and undesirable chemical reactions are a major problem while fabricating such composites. The interaction between the reinforcement and the matrix was recognised as a critical factor. In this study an attempt is made to enhance wettability via metal coated ceramic particles. Silicon carbide (SiC) particles were deposited with nickel-phosphorous (Ni-P) coatings through Electroless Nickel-phosphorous plating method. Also, the plated powders with varying reinforcement i.e., 5%, 10%, and 15 % are incorporated to produce Aluminium reinforced Ni-p plated SiC composites (Al-(Ni-p) SiC composites) and comparisons are drawn with pure Al and Al/SiC sintered composites. To probe the surface and the interface region, techniques such as SEM, EDS spectra and X-ray diffraction are utilised effectively. The density and porosity of prepared composites is measured. X-ray diffraction (XRD) is used to assess the existence of intermetallic compounds (if any) and contaminations. Mechanical studies such as hardness, ultimate tensile strength (UTS) and yield strength (YS) found to incline with the increase in Ni-p plated SiC content. Ni-P plating is found favourable for avoiding agglomeration, ensuring uniform dispersion, less interaction with aluminium to develop any intermetallic compounds such as the Al4C3 phase.

Keywords: Powder metallurgy, Electroless Ni–P plating, Microstructure, Aluminium, Silicon carbide.

Welding Copper to Magnesium: A Comprehensive review of Fusion and Solid-State Approaches

Waman Kharat1, Shantisagar Biradar2, Vishvesh Badheka3

1 Department of Mechanical Engineering, Maharashtra Institute of Technology, Aurangabad 431010, Maharashtra, India
2Department of Mechanical Engineering, MSS's College of Engineering and Technology, Jalna 431203, Maharashtra, India
3Department of Mechanical Engineering, School of Technology, Pandit Deendayal Energy University, Gandhinagar 382426, Gujarat

Email Id: waman.kharat@gmail.com

Abstract: This paper presents a focused review of joining techniques for Copper to Magnesium and its alloys, which include fusion and solid-state welding. Copper's electrical conductivity and corrosion resistance make it a necessity for electrical and electronic applications. The lightweight properties of magnesium alloys, on the other hand, make them essential in the aerospace, automotive, and structural sectors. Among the various techniques, friction stir welding (FSW) stands out as an effective technique, exhibiting significant potential in joining Copper to Magnesium and providing an acceptable method for the formation of strong joints. Employing the binary phase diagram of magnesium and copper facilitates understanding of the ensuing microstructure during the welding process. In summary, this research highlights the significance of strategic joining techniques, particularly FSW, for allowing efficient bonding of Copper and Magnesium, providing critical insights that advance their applications across industries. The efficient joining of Copper and Magnesium creates novel possibilities for improved efficiency and broader applicability in several kinds of technological applications.

Keywords: Friction stir welding, Copper, Magnesium, Joining techniques

Experimental Investigation on Mechanical Characterization of Carbon Nanotube Filled- Glass Fiber Epoxy Laminated Composite

Piyushkumar Gandhi 1, Achchhe Lal 2, B.M.Sutaria3
1 Department of Mechanical Engineering, Svnit, Surat, India, pag.ngpp@gmail.com,
2 Department of Mechanical Engineering, Svnit, Surat, India, achchhelal@med.svnit.ac.in,
3 Department of Mechanical Engineering, Svnit, Surat, India, bms@med.svnit.ac.in,

ABSTRACT: Present study deals with the influence of multi-walled carbon nanotube (MWCNT) on glass fiber reinforced polymer (GFRP) composites concerning their mechanical characterizations. The process of fabrication includes preparation of the MWCNT/epoxy/fiber multi-phase composites by magnetic stirring, ultrasonication and subsequent molding by hand layup method. The appropriate post-processing was performed for the curing and cutting to prepare the samples for the mechanical characterizations as per the ASTM standards. An enhancement in the mechanical properties was noticed due to the incorporation of the MWCNT. The tensile strength was improved by 6.2 % and 21% for GFRP composites with 0.1% and 0.2% MWCNT respectively as compared to pure GFRP. These observations were also validated with improvement in the interfacial bonding between the glass fiber and the modified matrix as shown in the morphological fractography. Fractographic analysis figured out various failure modes in all composites.

Keywords: Carbon nanotubes, Fractography, glass fiber reinforced polymer (GFRP), Modified matrix, Mechanical testing.

Productivity Assessment Studies for A Solar Module Manufacturing Plant

Shrivathsan Velamur1, MB Kiran2[0000-0001-5855-8670] and Abhishek Kumar2[0000-0002-6022-3068]
Department of Mechanical Engineering, School of Technology,
Pandit Deendayal Energy University, Gandhinagar, Gujarat venkatshrivathsan@gmail.com

Abstract : The aim of the present research work is to conduct productivity assessment studies, to improve operational efficiency and provide recommendations for produc-tivity improvement for a Solar Module Manufacturing Plant. An effort is made in this work to construct a Current state value stream map for capturing the ex-isting data for subsequent analysis of a Solar panel manufacturing plant. After a thorough analysis the Future state value stream map is developed. The recom-mendations derived from the Future Value Stream help the organization imple-ment corrective solutions to existing bottlenecks in order to enhance customer satisfaction. Also, the requirement for incorporating the Lean tools in organiza-tions leads to better productivity as well as provide in-sights on potential con-straints.

Keywords: Solar Module, Current Value Stream, Future Value Stream

Challenges in Additive Manufacturing - a Review

Preksha Khopkar1, Vinay Sukhiyajiwala2 and 3MB Kiran0000-0001-5855-8670
1,2,3 Pandit Deendayal Energy University, India
lncs@springer.com

Abstract: Additive Manufacturing (AM), commonly known as 3D printing, has significantly transformed manufacturing by allowing for rapid prototyping, customization, and the fabrication of complex geometries across various industries, such as aerospace, automotive, and healthcare. This review provides an in-depth exploration of AM's advancements, particularly focusing on challenges related to material selection, process reliability, and scalability in different fields. The use of Multi-Criteria Decision-Making (MCDM) and optimization techniques, including mathematical programming and statistical methods, has enabled better decision-making regarding materials,suppliers, and logistics. Specific applications in polymer AM for impeller production are reviewed, emphasizing the optimization challenges involved in selecting polymers with optimal mechanical properties. Moreover, the review highlights the increasing importance of sustainability in AM, demonstrating how MCDM andoptimization frameworks contribute to environmentally friendly manufacturing practices. These insights support the potential for AM to become more efficient and sustainable, while addressing current limitations in precision, material diversity, and process control.

Keywords: Additive manufacturing, 3D printing, Industry 4.0

Impact of Annealing on Microstructure Evolution and Deformation Behavior in SS304 Stainless Steel

Kamal Kumar Pradhan1, Chhabi Ram Matawale2
1Shri Rawatpura Sarkar University, Raipur, Chhattisgarh, India
2Indian Institute of Management, Raipur, Chhattisgarh, India
Corresponding author e-mail: kamalpradhan09@gmail.com

Abstract: Analyzing the microstructural behavior of materials operating under fluctuating temperature conditions has become essential, as these fluctuations significantly impact material properties at both micro and molecular levels. Stainless steel, particularly, is widely utilized across various temperature ranges. This research focuses on investigating the effects of heat treatment on the mechanical properties, microstructural evolution, and deformation behavior of stainless steel, specifically grade 304, given its prevalence and performance in temperature-variable environments. In this study, stainless steel grade 304 undergoes heat treatment and microstructural analysis under ambient conditions and elevated temperatures. The full annealing was conducted at room temperature, as well as at 1010°C and 1120°C. The annealing process led to small, redistributed grains in the deformed material, which improved its properties compared to untreated SS304. Post-annealing, the material exhibited an increase in fine, equiaxed grains and a reduction in large, elongated grains. The annealed samples at 1010°C and 1120°C demonstrated microstructural changes along cellular walls, where a limited number of dislocations unraveled. This suggests that annealing may prompt dislocation along cellular walls to move to more energetically stable regions, fostering the formation of sub-grain boundaries and enhancing the mechanical characteristics of SS304.

Keywords: Annealing, Heat Treatment, Stainless Steel (SS 304), Microstructure, Mechanical property.

Understanding the failure mechanism of bidirectional glass fiber reinforced composites under tensile loading through micro-mechanical modeling

Tatva Vyas, Bimal Das
School of Engineering and Applied Science, Ahmedabad University, Ahmedabad, Gujarat, India

Abstract: This study investigates the deformation and failure mechanism of bidirectional glass fiber-reinforced polymer composites (GFRP) under tensile loading through experiment and micro-mechanical modeling. Bidirectional GFRP composites were made using hand lay-up process. Uniaxial tensile tests were performed to determine the in-plane macroscopic mechanical properties of the material. A three-dimensional representative volume element (RVE) model coupled with a finite element method (FEM) simulation was performed to understand the failure mechanism under uniaxial loading of the composite. Stress distribution in the loading direction shows that the fibers aligned to the loading direction are subjected to a tensile state of stress, whereas those oriented transverse to the loading direction are subjected to a compressive state of stress. Moreover, the distribution of equivalent plastic strain reveals that failure initiation occurs in the matrix region. The prediction of elastic modulus in the loading direction from RVE-FEM deviated by 8% compared to the experimental elastic modulus.

Keywords: Glass Fiber Reinforced Polymer (GFRP), Representative Volume element (RVE), Failure, Tensile, Equivalent Plastic Strain

Bending and Wear Behaviour of Aluminium Alloy Pipes of Circular Cross-Section at Different Strain Rates

Nishant Kumar1, N. K. Singh2 and S. S. Banwait3
1,3Department of Mechanical Engineering, National Institute of Technical Teacher Training and Research Chandigarh, Chandigarh, India
2Department of Mechanical Engineering, National Institute of Technology Patna, Patna, India Email Ids: 1kumar.nishant57@gmail.com, 2nilambersingh@nitp.ac.in, 3ssb@nitttrchd.ac.in

Abstract: This paper investigates the bending and wear behaviour of hollow alu-minium alloy pipes of circular cross section. Three-point bending tests were conducted at different strain rates (0.001 s-1, 0.01 s-1 and 0.1 s-1) and span lengths (100 mm, 120 mm and 140 mm) on universal testing machine to understand the bending behaviour of the hollow pipes. The wear behaviour of the pipes was analysed under three different loads (30 N, 40 N and 50 N) and speeds (200 rpm, 300 rpm and 400 rpm) on pin-on-disc machine. It is found that the bending strength of the pipe is sensitive to the strain rate and the specimen geometry. Also, the wear and friction characteristics of the cir-cular pipe change with varying loads and speeds.

Keywords: Aluminium alloys, circular cross section, Bending and wear.

A Review on Chemical treatment, preparation and mechanical properties of Banana fiber reinforced polymer composites

Siva Ramasamy1, Jayakrishna Kandasamy2, Karthick M3, Nalini Ramachandran U4, Nishikant Kishor Dhapekar5, Renuka Shyam Narain6, Soni Kumari7 and Krishna Kant Pandey8,*

1Department of Mechanical Engineering, Sathyabama Institute of Science and Technology, Chennai 600119, Tamil Nadu, India

2School of Mechanical Engineering, Vellore Institute of Technology, Vellore, 632014, Tamil Nadu, India

3Department of Mechanical Engineering, Vel Tech Rangarajan Dr. Sagunthala R&D institute of Science and Technology, Chennai 600062, Tamil Nadu, India

4Department of Applied Sciences, Chemistry Section, University of Technology and Applied Sciences, Muscat, Sultanate of Oman

5Department of Civil Engineering, MATS University, Raipur 493441, Chhattisgarh, India

6School of Education, Indira Gandhi National Open University, Maidan Garhi 110068, New Delhi, India

7Department of Mechanical Engineering, GLA University, Mathura 281406, Uttar Pradesh, India 4Department of Mechatronics Engineering, Manipal University Jaipur, Jaipur 303007, Rajasthan, India

*Corresponding author email: krishna.pandey@jaipur.manipal.edu

Abstract: The application of fiber reinforcement improves material quality. Reinforced fiber offers better mechanical properties and can be lightweight. The demand for eco-friendly materials has progressively increased in recent years due to their lack of environmental impact. As a result of their environmental friendliness, natural fiber reinforced materials are becoming increasingly popular. The banana plant yields one of the most widely used fibers, which is widely used in the manufacture of natural fiber reinforced composites. Several studies are being carried out to learn more about the chemical treatment processes that are utilized to improve the various properties of composites. Fire resistance, enhanced strength, decreased elongation, biodegradability, moisture absorption, and other properties are among these. Banana is widely available throughout Southeast Asia. These fibers are extracted from the banana plant's stem, which is frequently abandoned after the fruit is picked. Banana fiber composites have dramatically improved mechanical, physical, and chemical properties. This research examines banana fiber reinforced composites and their potential uses in depth.

Key words*:* Banana fiber, polymer, composite,

Raw material handling for Manufacturing Plant using PLC and Cloud Connectivity

Vrund Shah,Sneh Soni, Aryan Thakar
Instrumentation and Control Engineering Institute of Technology, Nirma University Ahmedabad, India
19BIC064@nirmauni.ac.in ,snehsoni24@gmail.com,22BEI009@nirmauni.ac.in

Abstract: Raw material handling Systems have grown more complicated in contemporary industrial settings, necessitating exact control and automation to satisfy production goals. A number of possibilities are opening up for this process' optimization through cloud connectivity as a result of the development of the cloud technology. Providing real-time monitoring and control over diverse components Programmable Logic Controllers, Supervisory Control and Data Acquisition and Cloud Connectivity systems have proven to be useful tools in automating raw material handling system operations. In the context of supply chain management, this technology enables continuous stock tracking, enhanced demand forecasting, enhanced logistics administration, increased transparency, and automated maintenance. In this study, the architecture, programming, and integration of PLC, SCADA and Remote Dashboard with other automation systems are discussed in relation to the automation of raw material handling systems.

Keywords: PLC, SCADA, NODE RED, Raw material handling System, Remote dashboard

Preliminary study on surface quality assessment of diamond-turned magnesium alloy

Mayank Kumar1, Kamlesh Joshi2, Rakesh G. Mote1

1Department of Mechanical Engineering, Indian Institute of Technology Bombay, Mumbai, 400076, India
2Department of Mechanical and Aerospace Engineering, Institute of Infrastructure, Technology, Research and Management, Ahmedabad, 380026, India

* Corresponding Author Email address: kamleshjoshi@iitram.ac.in

Abstract: Diamond turning is used in many industrial applications to achieve a very fine surface quality and high form accuracy. Machining of soft material is challenging as material response affects the surface roughness generation mechanism. Magnesium alloys are widely used materials in the biomedical industries for implants, automobile industries, and lightweight material application in electronic, manufacturing, and aerospace industries. In the present work, diamond turning of magnesium alloy AZ31B is carried out using polycrystalline diamond tool. In the machining parameters, spindle speed and depth of cut remain fixed, whereas the feed rate is changed. The diamond turning is performed under the wet machining condition. The effect of feed rate on the quality of diamond-turned surfaces is analyzed. The minimum roughness (*Ra*) of 164±21 nm is achieved on the surface diamond-turned with a mid-level feed rate. Furthermore, the concentric tool marks, scratches, and surface defects related to inclusions are visible on the machined surface. The future work can be carried out with a detailed analysis of the correlation of surface roughness generation mechanism with process parameters.

Keywords: Diamond turning, surface roughness, magnesium alloy, polycrystalline diamond, machining.

Finite Element Modelling of Eco-Friendly Brake Pads

S. Padmanabhan1, Mohd Majid2, T. Somanathan3, Vijay Baban Jadhav4, Verma5, Abhishek Kumar Jain6, Raman Kumar7 and Krishna Kant Pandey8'*
1School of Mechanical and Construction, Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai 600062, Tamil Nadu, India
2Department of Mechanical Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur 148106, Punjab, India
3Department of Chemistry, School of Basic Sciences, Vels Institute of Science Technology and Advanced Studies, Chennai 600 117, Tamil Nadu, India
4Department of Mechanical Engineering, Sanjivani Pratishtha Institute of Technology Polytechnic, Ahmednagar 414306, Maharashtra, India
5Department of Mechanical Engineering, Cambridge Institute of Technology, Bengaluru 560036, Karnataka, India
6Department of Mechanical Engineering, MATS University, Raipur 493441, Chhattisgarh, India
7Civil Engineering Department, Bakhtiyarpur College of Engineering, Bakhtiyarpur, Patna 803212, Bihar, India
8Department of Mechatronics Engineering, Manipal University Jaipur, Jaipur 303007, Rajasthan, India

*Corresponding author email: krishna.pandey@jaipur.manipal.edu

Abstract: Brake pads are a component of disc/drum brakes used in a variety of automotive and non-automotive applications. Typically, brake pads consist of steel acking panels and friction material. Recent changes to the manufacture process of these pads have increased their sustainability by incorporating renewable crops. This has been demonstrated by the use of natural fibres such as banana rind, palm fronds, and sugar cane. It is possible to replace aramid fibre with a more cost-effective and environmentally friendly alternative without sacrificing efficacy. Copper, lead, tin, antimony trisulphide, and whisker materials were eliminated from the formulation of brake friction materials in order to make them environmentally sustainable. This has been done to mitigate any potential negative environmental effects. As indicated by the weighted average dependent degree in extension evaluation, the eco-pad exhibited superior quality on the whole. The brake liner is a component that facilitates a mobile object's deceleration or cessation of motion The safe operation of a vehicle's braking system requires the dependable absorption of kinetic energy from moving elements. The dissipation of heat is caused by the brakes' absorption of energy. The vehicle's velocity is reduced by the release of heat into the encircling atmosphere. Due to the interference between the brake drum and brake lining, the life expectancy of the brake lining is likely to be reduced. Modelling brake shoes requires the use of the SOLIDWORKS 2020 software and precise measurements taken from the brake shoe of the Hero Passion Pro motorcycle. To evaluate the effectiveness of three distinct categories of braking materials, namely static structural, steady-state thermal, and wear testing, the ANSYS19.2 software employs a FEA approach in order to achieve optimal results. This study evaluates distinct eco-friendly braking materials: composite banana peel, included in the experiments are total deformation, equivalent von Mises stress, equivalent elastic strain, total heat flux.

Keywords: Brake pad, Eco friendly, Banana peel particles, Structural, Thermal analys

Effect of transition depth on the work hardening of bime-tallic liner plate with a chromium carbide overlay and an austenitic manganese steel impact plate subjected to abrasive wear

Mamookho Elizabeth Makhatha1, Kgotso Bhabha1, Sergei Sherbakov2, Daria Pod-gayskaya2, Pawan Kumar1,2* and Vishwanatha. H. M3.

1University of Johannesburg, Faculty of Engineering and the Built Environment, Department of Engineering Metallurgy, John Orr Building, DFC, 25 Louisa St, Doornfontein, Johannes-burg, 2028, South Africa

2Joint institute of mechanical engineering of the National Academy of Sciences of Belarus, 220072 Minsk, Belarus

3Department of Mechanical and Industrial Engineering, Manipal Institute of Technology, Ma-nipal, Manipal Academy of Higher Education, Manipal, Karnataka, India-576104

*kumarpawan@mail.ru

Abstract. In the present investigation, the effect of transition depth on the work hardening was studied when a bimetallic liner plate with a chromium carbide overlay (on a mild steel substrate) and an austenitic manganese steel impact plate were subjected to abrasive wear. In addition to the standard ASTM G65 test procedure, a non-standardized test was also carried out using high-velocity projectile testing. The bimetallic liner plate with a chromium carbide overlay on a mild steel substrate showed a lesser mass loss and the enhanced resistance to wear as compared to the austenitic manganese steel impact plate. The enhanced resistance to wear is attributed to the carbide phase in the chromium carbide overlay sample. The austenitic manganese steel impact plate sample showed a lower maximum mean work hardening depth as compared to the chromium car-bide overlay sample. The increase in the microhardness in the chromium car-bide overlay sample was due to the cluster of carbides which hindered the movement of dislocations during abrasion and also due to the increased impact force. The microstructure of the austenitic manganese steel impact plate sample tested as per ASTM G65 standard did not show the evidence of significant work hardening. The microstructural analysis was not conclusive as it did not show the presence of slip/Taylor lattice bands. Therefore, it limits the ASTM G65 ability to determine the transition depth range due to sliding abrasion. However, the microstructure at lower magnification for chromium carbide overlay sample clearly depicted the carbides/dislocation accumulation at the grain boundaries and the grain interior. On the other hand, the higher magnification microstruc-ture showed the nature of the work-hardened area indicating the formation of slip bands in the vicinity of the work-hardened area which was the indicative of the plastic deformation and stress concentration.

Keywords: wear, work hardening, abrasion, microstructure, dislocation, climb, slip plane.

ROTATIONAL MOLDING TECHNIQUE-AN AESTHETIC MECHANISM FOR BIOMEDICAL APPLICATION

Nikita Gupta1, P.L. Ramkumar1
1 1 Institute of Infrastructure Technology Research And Management Khokara Ahmedabad 380026
plramkumarno1@gmail.com

Abstract. The process of manufacturing a dental implant screw that produces accurate and efficient tooth crowning is the subject of the current invention par-ticularly focusing on utility of roto molding mechanism. The technique uses a turret rotational moulding machine with a rim that can rotate on a perpendicular axis. The rim also has slots spaced regularly along its outer surface to accommo-date several moulds in the shape of dental implant screws. To achieve the final screw implants, the process consists of charging (S1) biocompatible resin mate-rial into the moulds held in the rim, heating (S2) in an electric oven, cooling (S3) with a forced air/water spray, and finally withdrawing the moulds from the rim slots. This technique satisfactorily can provide a better option in this field of bi-omedical for which the idea has been proposed.

Keywords: Rotational Molding, Dental Screw Implant, Biocompatible.

Elucidating the Effect of Friction stir welded Polypropylene and HDPE Joints

Katakpara Jahnavi1, PL. Ramkumar2, Ajit Kumar Parwani3, Vishvesh Badheka, Abhishek Kumar5

1,2,3 Department of Mechanical and Aero-Space Engineering, Institute of Infrastructure, Technology, Research and Management (IITRAM), Ahmedabad, Gujarat, 4,5 Pandit Deendayal Energy University, Gandhinagar, India

Abstract Determination of optimum process parameters for any welding process is essential for obtaining good weld quality. In this work, the focus is to investigate the effect of process parameters on weld quality of Polypropylene and HDPE joints using Friction Stir Welding (FSW) process and to determine the optimum process parameters which can yield sound quality weld. Tool rotational speed, tool transverse speed, and tool tilt angle have been considered as control parameters. The experiments have been designed according to Taguchi's L9. The best process settings for creating a strong weld between polypropylene and HDPE using friction stir welding were obtained with the traverse speed as 50 mm/min, rotational speed of 765 rpm, and the tool tilt angle of 1º. The rotational speed was identified as the most critical processing parameter.

Keywords: Friction stir welding, HDPE, Polypropylene, Process Parameters, Weld Quality

Part III: Recent Advances in Smart Infrastructure

A Review on Aerodynamic Enhancements and Drag Reduction Techniques for Vehicles

Putu N Imsong1, Gagandeep Roop Rai2

1M.E Scholar, Department of Automobile Engineering, Chandigarh University, Punjab, 140413, India.
2Assistant Professor, Department of Automobile Engineering, Chandigarh University, Punjab, 140413, India.

Corresponding author: nputu_ims@yahoo.com

Abstract: In the quest for enhanced automotive efficiency and performance, understanding the complex interplay between aerodynamics and vehicle design is paramount. The rise of Computational Fluid Dynamics (CFD) has revolutionized the way engineers simulate airflow around vehicles, allowing for precise analyses of drag and lift characteristics without the high costs and logistical challenges associated with traditional wind tunnel testing. This review consolidates various studies that utilize both CFD and experimental wind tunnel methods to investigate the aerodynamic performance of different vehicle models, with a focus on drag coefficient (Cd), lift forces, and the impact ofmodifications such as spoilers and body shape. Through a comprehensive examination of empirical data and computational models, the findings underscore the critical role of aerodynamic design in reducing fuel consumption, improving stability, and minimizing environmental impact. Integration of CFD alongsidewind tunnel experiments presents a holistic approach to automotive aerodynamics, paving the way for innovative design solutions that align with contemporary demands for efficiency and sustainability. This article aims to provide an extensive overview of current methodologies, results, and future directions in automotive aerodynamics research, contributing to the ongoing discourse in this dynamic field.

Keywords: Aerodynamics; Computational Fluid Dynamics; Drag; Spoiler;

Synergetic Effect of Dual Reinforcement in Epoxy Based Hybrid Metal Matrix Nanocomposites for Aerospace Applications

Deepak Awasthi[1*], Manikant Paswan[2] and Pallav Gupta

[1]Department of Mechanical Engineering, A.S.E.T., Amity University Uttar Pradesh, Noida-201313 (INDIA)
[2]Sant Longowal Institute of Engineering and Technology, Longowal-148106, Punjab (INDIA)

E-Mail Id: oomdeepakawasthi@gmail.com

Abstract: The evolving landscape of aerospace engineering continually demands materials that exhibit superior mechanical strength, durability, and thermal stability. This paper explores the development and characterization of epoxy-based hybrid polymer matrix nanocomposites (HPMNCs), tailored for aerospace applications. Through a synthesis of epoxy resin with various nanofillers, including carbon nanotubes and graphene oxide, we fabricate a composite material designed to meet the stringent requirements of aerospace environments. The study systematically evaluates the mechanical properties, such as tensile strength, impact resistance, and flexural modulus, alongside thermal behaviors, including thermal conductivity and glass transition temperature. The inclusion of nanoscale reinforcements within the epoxy matrix significantly enhances its mechanical properties due to the effective load transfer and the inherent strength of the nanofillers. Thermal analysis reveals that these nanocomposites exhibit improved thermal stability and reduced thermal expansion coefficients, essential for maintaining structural integrity under the thermal extremes of aerospace operations. Scanning electron microscopy (SEM) analysis provide insights into the dispersion quality of nanofillers and the interfacial bonding between the matrix and reinforcements. The experimental results are corroborated with theoretical models to predict the behaviour of these composites under various loading and environmental conditions. The findings suggest that epoxy-based HPMNCs not only fulfill but exceed the performance expectations for aerospace materials, offering potential for significant advancements in aerospace design and manufacturing. This study lays the groundwork for further research into the scalability of these materials and their practical implementation within the aerospace sector, paving the way for lighter, more efficient aircraft designs.

Keywords: Epoxy; Nanofillers CNTs; Graphene Oxide; Mechanical properties;34Thermal behavior.

Vibration reduction in AESA radar transmit/receive module via particle damping: an experimental study

Sunil Kumar [0000-0003-4454-6972] and Anil Kumar [0000-0002-5650-5484]
Department of Mechanical and Industrial Engineering, IIT Roorkee
Roorkee-247667, Uttarakhand, India
sunil_k1@me.iitr.ac.in

Abstract. Vibration may compromise the integrity of the electronic components on printed circuit boards (PCBs). Thus, effective vibration reduction measures are essential to ensure maximum performance and longevity when designing electronic assembly enclosures. This study uses the particle damper for vibration suppression in a PCB enclosure. First, with finite element modeling, modal analysis is performed to identify the modal-sensitive areas where particle dampers can be installed. An electrodynamic vibration shaker is then used for sinusoidal sweep testing to verify the finite element modal analysis results. Experimental investigations are carried out on the enclosure with particle damper for various input acceleration loads, and the effect of a damper's filling ratio on the enclosure's response is studied. The findings suggest that the response reduces as we increase the filling ratio to a limit. If the filling ratio is increased further from this limit, the response starts increasing due to particle locking phenomena. Moreover, the peak amplitude with the proposed particle damper decreased by 88%, 81%, and 67% for input acceleration loads of 1 g, 1.5 g, and 2.0 g, respectively.

Keywords: Vibration reduction, PCB enclosure, Particle damping.

Fault diagnosis of gearbox using Random Forest and Artificial Neural Networks

Sheo Kumar[1] and Praveen Kumar Agarwal[2]
[1,2] Department of Mechanical Engineering, Motilal Nehru National Institute of Technology Allahabad, Prayagraj-211004, Uttar Pradesh, India

E-mail: pka@mnnit.ac.in

Abstract. Fault identification of rotary machinery systems is essential for industries due to the need for increased productivity along with improved machine conditions during operation. Numerous artificial intelligence methods have been used in the literature for the fault diagnosis of gear systems constructed on features extracted from vibration signals. In the present work, the fault detection of the helical gear system using Random Forest (RF) and Artificial Neural Networks (ANN) is proposed. The dataset for the fault diagnosis consists of vibration signals from the helical gearbox comprising healthy gears and gears with chipped and worn teeth. These vibration signals are used to determine the several condition parameters in the time domain. These parameters are further utilised by RF and ANN classifiers for the effective fault diagnosis of the helical gearbox. The performance measures are compared for both classifiers, and results demonstration that the RF classifier executes superior and more accurately than the ANN classifier for diagnosing the helical gearbox.

Keywords: Fault Diagnosis, Random forest, Artificial Neural Networks, Helical Gearbox.

A Brief Overview of Machine Learning Application in the Management of Water Resources System

Soni Kumari, Sanjeev Kumar Gupta
Department of Mechanical Engineering, IET, GLA University Mathura, U.P., India, 281406
soni.1802@gmail.com, sanjeev.mnnita@gmail.com

Abstract. This paper presents a concise overview of the application of machine learning (ML) techniques in managing water resources systems, highlighting their potential to optimize operations, enhance decision-making, and address the growing complexities of water management. The study aims to bridge the gap between traditional management practices and modern computational approaches by exploring how ML methods can model hydrological processes, predict water demand, assess water quality, and support sustainable resource allocation. The objective is to examine the capabilities of ML algorithms, such as neural networks, support vector machines, and ensemble learning models, in addressing challenges like climate variability, population growth, and data scarcity. The review synthesizes recent advancements and showcases case studies demonstrating the integration of ML in real-world scenarios. By identifying current limitations and future research directions, the study provides a foundational understanding for stakeholders to leverage ML tools for effective, adaptive, and resilient water resource management

Keywords: Machine learning, Water management, Flood prediction, Water quality, Hydropower management

Development of Unmanned Surface Vehicle for Bathymetry Survey

S. Mohanty1, 3*, S. K. Sharma2, S. Ghosh2, P. Das2, P. K. Sahu2, A. Garg3, S. K. Dwivedy3

1School of Mechanical Engineering, VIT Bhopal University, Madhya Pradesh, 466114, India
2Department of Production Engineering, National Institute of Technology Agartala, 799046, India
3IIT Guwahati Technology Innovation and Development Foundation, Assam, 781039, India
*Corresponding author: siba.mech@gmail.com

Abstract. In the present paper, a wireless unmanned surface vehicle (USV) is designed, simulated, and fabricated for river bed mapping and underwater visualization. The USV can also be utilized for rescue operations of human beings in various water bodies. The USV is equipped with two thrusters, sonar, a camera with a gimble, and an antenna for real-time data transmission and controlling the USV wirelessly through an onboard transmitter and a ground control station. The USV is designed considering symmetricity, positive buoyancy and simulated in an underwater environment under various flow velocity and pressure variations to evaluate the drag and lift coefficients. Based upon the design and simulations an initial prototype is fabricated. The fabricated USV is field-tested in the lake. The USV presents a promising new approach for riverbed mapping, riverine re-search, and management.

Keywords: Unmanned surface vehicle, bathymetric surveys, CFD, Fabrication.

Gripping Framework for Securing an AUV During Underwater Docking Inside Underwater Docking Station

Arijit Kumar Bose1,2 * and Mainakh Das3
1 Department of Mechanical Engineering, Calcutta Institute of Technology, Uluberia, Howrah, India
2 Academy of Scientific and Innovative Research (AcSIR), CSIR-CMERI, Durgapur, India
3 Department of Mechanical Engineering, C.V. Raman Global University, Bhubaneswar, Odisha, India

Abstract. Underwater docking stations were developed to recharge the battery of an Autonomous Underwater Vehicle (AUV) and retrieve the data collected by the AUV during its mission autonomously; as there is no human intervention during AUVs mission. In dynamic ocean environment stability of the AUV must be ensured as these operations, e.g., power and data transfer may be interrupted if there is any disconnection due to dislocation of the AUV inside the docking station during ongoing power and data transfer. Therefore, maintaining the positional accuracy of the AUV inside the underwater docking station during recharging its battery and data transfer is important. In this paper a conceptual gripping system to secure the AUV during docking has been discussed. The AUV will be mechanically locked in required position by this gripping system to ensure positional accuracy for uninterrupted power and data transfer. For ease of operation and maintenance simple mechanical design has been used while basic kinematic mechanism driven by a single actuator is utilized to operate the system

Keywords: Underwater Docking, Underwater Robotics, Underwater Locking Mechanism

Identification of Remaining Useful Life of an Aircraft Engine using Principal Component Analysis (PCA)

Drashti Mokariya 1, a) [0009-0007-8907-2025], Srushti Chaudhari 2, b), [0009-0009-8840-9807], Keval Bhavsar *, 3, c) [0000-0001-6567-1655], Umang Parmar 3, d) [0000-0003-4339-5121], Swapnil Vegad 3, e) [0009-0009-2779-4510] and Gunjan Kumar 4, f) [0009-0009-3429-1604]

1 Department of Aeronautical Engineering, Aditya Silver Oak Institute of Technology, Ahmedabad, India - 382481
2 Department of Computer Engineering, Silver Oak College of Engineering and Technology, Ahmedabad, India - 382481
3 Department of Mechanical Engineering, Aditya Silver Oak Institute of Technology, Ahmedabad, India – 382481
4 Department of Mechanical Engineering, UPL University of Sustainable Technology, Vataria, India – 393135
a) djmokariya1899@gmail.com b) srushtichaudhari83@gmail.com
c) kevalbhavsar42@gmail.com
d) umangparmar138@gmail.com
e) swapnil.vegad@gmail.com
f) gunjan.k91@gmail.com

Abstract. A key aspect of this research is the proactive maintenance enabled by predicting the Remaining Useful Life (RUL) of critical components. RUL prediction, a part of Condition Monitoring and Prognostics and Health Management (PHM), allows for real-time monitoring, fault prediction, and preventive actions. The incorporation of advanced technologies, sensor selection methodologies, and maintenance policies contribute to the comprehensive approach to monitoring and managing the health of aircraft systems. The paper discusses the application of these methods to aircraft engines, emphasizing the importance of accurate estimation of RUL ensuring the safe and reliable operation of aero-engines. In this paper, data preprocessing and sensor selection is carried out using Principal Component Analysis (PCA). The cost function is used to give the penalty to the model during its training. At last poly fit function is used to predict the RUL.

Keywords Aircraft Engine, Remaining Useful Life, Principal Component Analysis, Prognostics and Health Management, Condition Monitoring.

Prediction of Remaining Useful Life (RUL) of an aircraft engine using RReleifF algorithm and Machine Learning Models

Rumit Oza1, a) [0009-0007-5855-2077], Srushti Chaudhari2, b) [0009-0009-8840-9807], Drashti Mokar-iya 1, c) [0009-0007-8907-2025], Keval Bhavsar *, 3, d) [0000-0001-6567-1655], Umang Parmar 3, e) [0000-0003-4339-5121], and Swapnil Vegad 3, f) [0009-0009-2779-4510]

1 Department of Aeronautical Engineering, Aditya Silver Oak Institute of Technology, Silver Oak University, Ahmedabad, India - 382481
2 Department of Information Technology, Silver Oak College of Engineering and Technology, Silver Oak University, Ahmedabad, India - 382481
3 Department of Mechanical Engineering, Aditya Silver Oak Institute of Technology, Silver Oak University, Ahmedabad, India – 382481
a) ozarumit1157@gmail.com
b) srushtichaudhari83@gmail.com
c) djmokariya1899@gmail.com d) kevalbhavsar42@gmail.com
e) umangparmar138@gmail.com
f) swapnil.vegad@gmail.com

Abstract: Aircraft plays a vital role in both civil aviation as well as in military services as it enhances economic growth, connectivity over the globe and na-tional security as well. As the main component, engines face extreme conditions, leading to wear and reduced reliability. Predicting engine failures accurately is critical to minimizing downtime, optimizing maintenance, and preventing cata-strophic events. This study focuses on predicting the Remaining Useful Life (RUL) of aircraft engines using the NASA CMAPSS dataset. The dataset has readings of various sensors mounted on the flight. In this study, a two-stage pre-processing approach is implemented. During the first stage of preprocessing, sta-tistical calculations are used to identify the redundant sensors and hence the same are removed from the dataset to improve computational power. In the second stage, the RReliefF algorithm is implemented to rank and select the important sensors for the prediction of the RUL. These selected sensors are fed to four Ma-chine Learning(ML) models which are evaluated using two performance matrices namely MAE and RMSE. This study highlights the potential effective prepro-cessing with ML Models significantly improves the accuracy of RUL predictions and demonstrates the potential of ML in revolutionizing engine maintenance strategies to meet global aviation demands.

Keywords: CMAPSS, Remaining Useful Life (RUL), Aircraft Engine, Ensem-ble Bagging Tree, Exponential Gaussian Process Regression.

Enhancing Emergency Response and Operational Efficiency in Extraterrestrial Missions Through Drone-Based Delivery Systems

Aagam Jain1[0009-0009-8171-4067] and Pushpdant Jain2[0000-0002-4933-4496]

1School of Mechanical Engineering, VIT Bhopal University, Indore-Bhopal Highway, Ko-thrikalan, Dist. Sehore, Madhya Pradesh-466114, India
1 Lunex, EuroSpaceHub Academy, EMMIHS23 (EuroMoonMars, International MoonBase Alli-ance, HI-SEAS, 2023)
2School of Mechanical Engineering, VIT Bhopal University, Indore-Bhopal Highway, Ko-thrikalan, Dist. Sehore, Madhya Pradesh-466114, India
pushpdant@gmail.com

Abstract: This research investigates the implementation of a drone-based delivery system for transporting medical supplies during simulated emergency scenarios, aiming to showcase the system's rapid response capabilities in critical, life-threatening situations. The study involved the deployment of drones in the Ha-waii Space Exploration Analog and Simulation (HI-SEAS) facility, a site that replicates the conditions of lunar and Martian environments. During the first ex-travehicular activity (EVA-1), a drone successfully delivered urgent medications to a crew member experiencing a medical emergency, demonstrating its swift aerial delivery capabilities. In a subsequent mission (EVA-2), the drone was em-ployed to transport essential equipment and tape to repair a crew member's cracked helmet, caused by a thunderstorm, thereby ensuring the maintenance of oxygen supply integrity. The drone achieved a maximum cruise velocity of 10 meters per second, covering approximately 500 meters in 50 seconds, signifi-cantly outperforming traditional ground-based delivery methods in rough terrain. The findings from this research underscore the potential of drone-based systems to enhance the safety and operational efficiency of extraterrestrial missions. By providing timely delivery of critical supplies and equipment across challenging terrains, drones offer a promising solution for emergency response and logistics in future missions to the Moon and Mars, ultimately contributing to the success and sustainability of human exploration beyond Earth.

Keywords: Aerospace, Drone, Emergency Vehicle, Mission

Experimental Investigation and Performance Assessment of Drone Equipped with Li-Po batteries at low-temperature Application

Soham Prajapati, Shatakshi Singh, Abhishek Rawat, Dileep K Gupta

Soham Prajapati is with the Electrical and Computer Science Engineering, Institute of Infrastructure, Technology, Research And Management (IITRAM), Ahmedabad, 380026, Gujarat, India; e-mail: soham.prajapati.20e@iitram.ac.in
Shatakshi Singh is with the Electrical and Computer Science Engineering, Institute of Infrastructure, Technology, Research And Management (IITRAM), Ahmedabad, 380026, Gujarat, India; e-mail: shatakshi.singh.20m@iitram.ac.in
Dr. Abhishek Rawat is with the Electrical and Computer Science Engineering, Institute of Infrastructure, Technology, Research And Management (IITRAM), Ahmedabad, 380026, Gujarat, India; e-mail: arawat@iitram.ac.in
Dileep K Gupta is with the Advanced HVAC Laboratory, Institute of Infrastructure, Technology, Research And Management (IITRAM), Ahmedabad, 380026, Gujarat, India; e-mail: dileep.vnit@gmail.com

Abstract. Drones, usually referred to as Unmanned Aerial Vehicles (UAVs), are increasingly prevalent across various domains, including aerial photography, package delivery, surveillance, and defense applications. The performance of drones utilizing Li-Po batteries is of dominant importance for their lower discharge rates, lightweight construction, and small form factor. However, it is critical to acknowledge that Li-Po battery performance is sensitive to environmental temperatures, particularly in colder conditions, presenting a substantial challenge. In this work, an attempt has been made to study the performance characteristics of drones equipped with Li- Po batteries in lower temperature environments with a focus on conditions as extreme as -7◦C. The experimentation involved the utilization of a standardized drone model, uniformly outfitted with a 3S, 5300mAh Li-Po battery and equipped with a Pixhawk flight controller. Subsequently, the various temperature conditions were meticulously evaluated during the experimental process. The findings have conclusively established a substantial correlation between temperature and Li-Po battery performance. The observations have revealed that when drones operate in extremely low-temperature conditions, typically at or below -5◦C, there is a pronounced deterioration in both flight endurance and overall drone performance. This degradation is primarily attributed to the remarkable escalation in the discharge rate of the Li-Po battery under such frigid conditions. The consequential decline in battery capacity and voltage output at lower temperatures has exerted a profound impact on the drone's ability to maintain stable flight, resulting in significantly reduced flight durations.

Keywords: Li-Po battery, Lower Temperature, Drone, Fly time, Discharge time, UAVs.

Analysis of High-Accuracy position Control methods for UAVs Using Lidar and Optical flow Technology

1th Patel Bhavya
dept. of Electronics and communication engineering
Sardar Vallabhbhai National Institute of Technology
Surat, India

2th Abhishek Rawat
SMIEEE dept. of Electrical and Computer Science Engineering
Institute of Infrastructure Technology Research and Management)
Ahmadabad, India
arawat@iitram.ac.in

Abstract: This research focuses on enhancing position Control of drone in GPS-denied environments through innovative sensor integration and advanced algorithms. Traditional GPS
and barometric-based systems are unreliable indoors, in spoofing, GPS denied areas or in urban canyons, necessitating alternative approaches. We integrated a LiDAR Distance Sensor and an
optical flow sensor with a drone's flight controller to achieve precise altitude and position estimation. This advancement enhances drone capabilities in critical applications such as search and rescue, inspection, and surveillance within challenging environments.The methodologies, implementation details, and performance evaluations presented underscore the viability and effectiveness of our approach in enabling drones to operate effectively where GPS signals are unreliable or absent.

Index Terms: UAV, GPS-denied environments, Lidar, Optical flow, Position control, Altitude estimation, Sensor integration, Drone navigation.

Finite Element Analysis of Bending Behaviour of Steel Tape Springs

Megha Thaker[1][0000-0001-6258-3596], Shashikant Joshi[2][0000-0002-1322-448X], Hemant Arora[3][0000-0002-2309-6397], Dhaval Shah[4][0000-0001-6800-5236], Aaryan Agarwal[5]

[1] Nirma University, Ahmedabad, Gujarat 382481, India
21FTPHDE59@nirmauni.ac.in
[2] Nirma University, Ahmedabad, Gujarat 382481, India
s.j.joshi@nirmauni.ac.in
[3] Space Applications Centre, Indian Space Research Organisation, Ahmedabad, Gujarat 380015, India
hemant_arora@sac.isro.gov.in
[4] Nirma University, Ahmedabad, Gujarat 382481, India
dbshah@nirmauni.ac.in
[5] Nirma University, Ahmedabad, Gujarat 382481, India
19bme001@nirmauni.ac.in

Abstract. The tape spring, characterized by its straight, thin-walled elastic strip with a curved cross-section, possesses inherent properties that facilitate elastic folding and energy release upon unfolding. In aerospace applications, such as deployable antennas, solar panels, and structural booms, metallic tape springs have been utilized for years. This study focuses on exploring the finite element (FE) method to determine the force-rotation and force-displacement relationship during the folding of tape springs under various loading conditions, including cantilever and compression loadings. Both experimental and FE approaches are employed to analyze the force-rotation and force-displacement relation for equal and opposite sense bending. Non-linear structure simulations are conducted using Altair Radioss, a non-linear explicit dynamic solver. Different boundary conditions (BCs) are applied to the tape spring to investigate the effects of cantilever and compression loading. The FE and experimental results are compared and are in good agreement.

Keywords: Tape spring, Cantilever bending, Compression bending, Non-linear finite element analysis, Deployable structure.

Embedding Design Thinking Process to Develop an Adaptable Multi-Purpose Fumigation Device

Milan Sanathara[1[0000-0003-3665-2206]] and Marmik Dave[2[0009-0006-7269-5640]]
[1] Faculty of Technology, RK University, Rajkot, Gujarat, India
[2] Atul Greentech, Ahmedabad, Gujarat, India
milu.mechanger88@gmail.com

Abstract. Product design is the process of discovering a market opportunity, clearly articulating the problem, producing a suitable solution, and testing the product with real environment. Design thinking is one of the modern approaches in product design and development which incredibly helpful when solving challenges that are unclear or poorly defined. It generally reframes the issue from a human-centered perspective as it generates many ideas during brainstorming sessions and uses a hands-on technique during prototyping and testing. This study represents step by step implementation of significant phases of design thinking process to develop an electrical fumigation device mainly useful in *Ayurvedic* therapies. Fumigation (*Dhoopan*) is an ancient therapy in which dry herbal ingredients are burnt slowly to generate the medicated smoke. The device is adaptable and multi-purpose in all kinds of fumigation therapies along with air and surface sanitization with fume's temperature control facility. Stainless steel (SS304) provides anti corrosiveness as well as aesthetic appearance. A comprehensive study has also been carried out to evaluate the effectiveness of the device in terms of air sanitization. It can reduce bacterial colonies by 40% and fungi spores by 32.75% within the specified location compared to the traditional fumigation. The device is also useful to common civilians in terms of air and surface disinfection for domestic applications.

Keywords: Design Thinking, Product Design, Fumigation, Dhoopan.

A Study on Image Steganography for Text Hiding in Images for Authentication Purposes

shraddhapomal7@gmail.com

Abstract. With the exponential growth of digital data transmission and concerns over data security, the need for secure and covert methods of information exchange has become crucial. Image steganography, the practice of hiding data within images, offers a powerful means to conceal sensitive information. This paper explores image steganography techniques to hide text within images for the purpose of authentication, focusing on the Least Significant Bit (LSB) method. We analyze the performance of various steganographic approaches in terms of imperceptibility, capacity, and robustness. Additionally, we investigate their potential applications in digital watermarking and secure authentication systems, ensuring data integrity and confidentiality.

Effect of Parameters on Thin Film Coating using Sputtering Method: A Comprehensive Review

Bhavya Patel1 [0009-0007-0183-8867], Nitesh Patel2 [0000-0002-1509-9101], Kamlesh Chauhan3 [0000-0002-9431-7425]

1, 2 Parul Institute of Engineering & Technology, P.O. Limda, Ta. Waghodia 391760, Vadodara
3 139, CHARUSAT Campus, Highway, Off, Nadiad - Petlad Rd, Changa, Gujarat 388421

Abstract. The present research paper is devoted to the detailed description of the multiple relations between magnetron sputtering parameter characteristics and their consequences for thin film coatings. The research convincingly demonstrates how these parameters relate to each other. It sufficiently explores how changes in sputtering power, gas flow rates, substrate transfer, coating thickness, and deposition time affect the structure, optical, electrical, and mechanical characteristics of multiple thin film groups. The survey of recent related articles shows that many researchers have already confirmed that each of these parameters influences the film properties as well as its crystallanity, smoothness, light transmittance, conductivity, and hardness. Thus, there is enough information to show that by changing these parameters in the sputtering process, researchers can manipulate the film characteristics allowing its use in different spheres such as the electronic, optical, or biomedical. The paper underscores the importance of comprehensive optimization of thin film performance, mechanistically resultant from a multitude of underlying parameters since they are mutually interdependent trends. The research is simply instrumental to scientists and engineers working with thin-film coatings as far afield as the newest of hi-tech applications, including but not limited to photovoltaics and medical implant technology where further breakthroughs are now only just ahead.

Keywords: Magnetron Sputtering, Sputtering Parameters, Thin Film Coating.

Model Free Isothermal Isoconversion Rheo-Kinetics of 2-Oxazolidone Modified Novolac Epoxy Film Adhesive

Ranajit Pal,1,2,3* Suraj Sudhi4 and Rajeev Raghavan5

1Polymers and Special Chemicals Division, Propellants Chemicals and Materials Entity, Vikram Sarabhai Space Centre, Thiruvananthapuram – 695022.
2Department of Applied Chemistry, Cochin University of Science and Technology, Cochin – 682022.
3Surface Treatment and Thermal Painting Division, Space Applications Centre, Ahmedabad – 380015.
4Propellant Engineering Division, Propellants Chemicals and Materials Entity, Vikram Sarabhai Space Centre, Thiruvananthapuram – 695022, India
5Analytical and Spectroscopic Division, Propellants Chemicals and Materials Entity, Vikram Sarabhai Space Centre, Thiruvananthapuram – 695022.
ranajitp@gmail.com

Abstract. The present work is outlined for the model free isoconversion rheokinetics of 2-oxazolidone modified novolac epoxy film adhesive through rheological assessment under isothermal condition at different temperatures viz.160, 165, 170 and 175 °C during its curing process. Effect of polyethersulfone (PES), which is used for toughening the film adhesive, on the isothermal curing reaction of film adhesive is also studied. Model free isothermal isoconversionrheo-kinetic analysis is attempted while curing reaction via both integral and differential methods of Vyazovkin and Friedman, respectively. Curing behavior is predicted and compared with experimental data at each temperature. It is found that the prediction is >90% and > 85% accurate for integral and differential method, respectively. Activation energy obtained in both approaches are showing the dependency on the extent of conversion and it is seen in the range of 165 to 132 kJmol-1 for WO-PES & 188 to 141 kJmol-1 for W-PES in integral method and 114 to 90 kJmol-1 for WO-PES & 108 to 78 kJmol-1 for W-PES in differential approach. Contradictory behavior of activation energy in these approaches is attributed to the presence of non-reactive PES.

Key words: epoxy novolac resin, polymeric film adhesive, isothermal isoconversion methods, Rheo-kinetics, Complex viscosity, Vyazovkin method and Friedman method.

Optimizing Resource Allocation in Operations Management through Hybrid ANN and TOPSIS Models

Sanjay Kumar[a], Deepak Kumar[b], & Niteen Bhairam[c]

[a,c]Department of Mechanical Engineering, ISBM College of Engineering Pune.
Savitribai Phule Pune University, Maharshtra, India
[b]Reliability Engineer, Orbit and Skyline Semiconductor, Mohali, Punjab, India

Email- sanjay.k0737@gmail.com
dpknhl@gmail.com
niteen.bahiram@isbmcoe.org

Abstract: This research focuses on contemporary strategies and methodologies in operations management, emphasizing resource allocation optimization. Key factors like demand variability, production capacity, and technological advancements are examined. The study explores decision-making processes in dynamic operational environments, balancing conflicting objectives such as cost minimization and service level maximization. It delves into hybrid models, specifically those combining Artificial Neural Network (ANN) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), evaluating adaptability, efficacy, and associated advantages and limitations. The research provides insights guiding the feasibility and applicability of these models for resource optimization. Successful applications of hybrid ANN and TOPSIS models across industries are investigated, offering real-world examples, strategic applications, best practices, and challenges. The paper contributes valuable insights for organizations implementing similar approaches in operations management strategies.

Keywords: Operations Management, Resource Allocation Optimization, Hybrid Models (ANN and TOPSIS), Decision-making in Dynamic Environments.

Pragmatic Energy Conservation in a Biotechnology Plant through On Site Energy Audit

Hitesh R. Thakare1 and T N Agrawal2

1 BEE Certified Energy Auditor (EA – 27707), Department of Mechanical Engineering, SVKM's Institute of Technology, Dhule, Maharashtra, India – 424 001
2 Accredited Energy Auditor (EA – 2296), T N Agrawal & Co. Nashik – 422 101
thakare.hitesh@gmail.com

Abstract: Small scale industries face significant difficulties in terms of maintaining their profit margin. At the same time, expertise to deal with energy conservation is not generally available on site. Energy can constitute a significant portion of total expenses for any small-scale organization. Present work aims to put forth salient findings from on site energy audit conducted in a biotechnolo-gy plant situated in Taloja MIDC near Mumbai, Maharashtra. Significant ener-gy saving was observed in thermal insulation as well as electrical system of the plant. Two energy conservation measures are identified which require zero in-vestment while remaining two measures have payback period of 5.42 months and 04 months only. This audit has helped the organization to reduce its energy consumption by 55.60 KVA, resulting in monetary saving of Rs. 2,60,881/year. Total saving proposed is Rs. 7,06,201/- with a necessary investment of Rs. 1,06,514/-. Electricity bill analysis and thermography has been deployed as an important tool for energy conservation during this audit.

Keywords: Energy audit, small scale industry, energy conservation, electricity bill analysis.

Automated Inspection of 3D Printed Components Using Deep Learning

Vinay Panchal | Dr. MB Kiran

Vinay.pmc21@sot.pdpu.ac.in

Department of Mechanical Engineering School of technology, PDEU Gandhinagar, Gujarat – India

Abstract: Automated inspection of 3D-printed components is essential to quality and consistency in additive manufacturing processes. Inspection through traditional means is time-consuming, taking labor hours to evaluate, which basically down scales the process. This paper looks at exploring the application of deep learning techniques to inspect 3D printed components for automatic detection of defects such as layer separation, porosity, and geometric inaccuracies. The approach can train a CNN and make use of computer vision techniques to ensure an accuracy in the identification of flaws, besides reducing inspection time and even serving as an overall efficiency tool in production. Experimental results reveal that deep learning models can learn and effectively detect subtle variations in 3D printed parts, thereby providing a reliable alternative to the conventional inspection methods. This should automatically lead to a much higher reliability and throughput of additive manufacturing, bringing the technology closer to industrial viability.

Keywords: additive manufacturing, deep learning, convolutional neural networks, automated inspection of 3D printing, defect detection, quality control, computer vision, industrial automation.

An economic assessment of the novel double basin solar still

Pansal, K. K. [1*], Ramani, B. M.[2]

[3] L.D. College of Engineering, Assistant Professor, Ahmedabad, Gujarat, India
[2] S.L.T Institute of Engineering and Technology, Professor, Rajkot, Gujarat, India

Abstract: An economic study of double basin solar stills is presented in this research. The system's life-cycle cost is calculated by factoring in things like tax benefits, interest rates, subsidies, and inflation rates. The system's estimated life duration was limited to 15–30 years for economic analysis. With a projected 30-year expected life, the distillate produced from a modified double basin solar still costs 61 paisa per liter. A cost payback time of 125 days and 235 days obtained respectively with double and single basin solar still coupled with vacuum tubes. An energy payback period of 1.17 years was found for the newly developed double basin solar still. A single basin solar still may obtain a carbon credit ranging from 46$ to 315$ over a 5 to 30 years lifespan, with a 5-year step. The carbon credit acquired for double basin solar still is from 95$ to 610$. CO_2 mitigation costs $2.4 per ton. The amount of CO_2 mitigated varies depending on whether a double basin solar still is used (40 tons to 254 tons) or single basin solar still (19tons to 131 tons).

Review on the Cooling Technologies for Rocket Engines in Spacecrafts

Aastha Maheta, Riya Jaiswal, Ajit Kumar Parwani

Institute of Infrastructure Technology Research and Management, Ahmedabad 380026

Abstract. Rocket engines are critical to space exploration, providing the thrust needed to escape Earth's gravity and place payloads into orbit or beyond. However, these engines generate immense heat due to the combustion of fuels at extreme temperatures and pressures. Effective thermal management systems are vital for maintaining engine integrity, safety, and efficiency. This report classifies the Rocket engines and explores the cooling technologies including regenerative, ablative, film, and passive cooling techniques in different components of chemical rocket engines. The report concludes with emerging trends such as transpiration cooling and hybrid thermal management methods, offering insights into the future of rocket propulsion systems.

Keywords: Rocket Engine, Spacecraft, Regenerative cooling, Film cooling, Ablative cooling, Passive cooling

Development and Characterization of Agar-Based Tissue Phantom for Photothermal Therapy

Nikunj Patel1, Mayank Madia1, Vipul M. Patel1, Sumit Kumar2, Hemant B. Mehta1

[1]Department of Mechanical Engineering, S.V. National Institute of Technology, Surat, Gujarat, India
[2]Department of Mechanical Engineering, National Institute of Technology Rourkela, Odisha India

dr.nikunj45@gmail.com

Abstract: Photothermal therapy involves the treatment of various human organs and tissues. To facilitate this, agar-based tissue phantoms are fabricated, as their thermal properties can be formulated to closely replicate those of human tissues. Agar-based mediums are cost-effective, biocompatible, and flexible, with their properties adjustable by varying concentrations. They also serve as ethical and practical alternatives for experiments. To optimize thermal properties that closely match human tissue, agar concentrations ranging from 1.5 g to 4.0 g were mixed with 100 ml of distilled water. This mixture was stirred at 750 RPM using a magnetic stirrer at 92°C, enhancing the quality of tissue simulation for preclinical photothermal therapy applications. These investigations highlight the significant potential of agar-based tissue-mimicking materials (AB-TMMs) as effective platforms. The aim is to assess the thermal characteristics of AB-TMM, including thermal conductivity, diffusivity, volumetric heat capacity, and specific heat capacity. This analysis was conducted using the advanced Trident C-Therm device with the flex TPS (ISO-22007) technique. The findings reveal variations in thermal conductivity based on agar concentration, with the highest value of 0.6644 recorded at 2.8 g of agar.

Keywords: Thermal Characterization, Photothermal therapy, Agar-based Tissue

Vakra Pitthika: A multiutility furniture design forcompact spaces with various use cases.

Harsh Vara1 and PL. Ramkumar2

1,2 Department of Mechanical and Aerospace Engineering, Institute of Infrastructure Technology Research and Management (IITRAM), Ahmedabad 380026, Gujarat, India

Abstract. The primary role of furniture in our contemporary society is to serve a specific activity, such as eating, working at a desk, storing goods, or visual delight. Concentration on functions alone raises problems with the satisfaction of various needs within one product and many products sold today lack durability, ergonomic support, and user-centered design. Given the fact that most of the population, 70% of the urban population, lives in a relatively compact space, it has become highly impractical to accommodate several furniture pieces in such limited areas. Our research targets the multi-purpose furniture solution which unifies different uses into one compact piece. We were able to design a multi-purpose item that acted as an office desk, table for studying or an informal dining setting, storage unit, and relaxation area while incorporating the integrated, stackable mini table and chair. Inevitably, we wanted to have the unit light in weight and versatile
enough to possibly fill all these different needs of the users. Through iterations and prototype testing, we came up with our design that balanced functionality,simplicity, and affordability. This final product, apart from being cost effective,also compact, is ideal for modern living spaces where efficiency and flexibility are key concerns. Combining versatility with user-friendly design, thispiece of furniture offers a solution to today's cramped homes by bringing together a series of functionalities into one adaptable unit.

Keywords: Multifunctional Furniture, Compact Spaces, User-Centered Design,Product Design.

Study of Electric Propulsion in Trainer Aircraft

Akhil C.K1, Balaji K1, Pavan Kumar Dharmireddi1, Ishwaragowda V Patil2 and Pri-yanshu Yadav1

1Department of Aeronautical Engineering,Parul Institute of Engineering and Technology, Parul University Vadodara, India
2Department of Aeronautical Engineering KLS Gogte Institute Of Technology, Belagavi, India

arobalaji@gmail.com

Abstract. The objective of this paper is to evaluate the performance of an electric engine by replacing the piston engine over a trainer aircraft. The Numerical and theoretical methods are used to analyze the various parameters in actual flying conditions through the calculations of thrust estimation, power-to-weight ratio and thrust-to-weight ratio. The results show that the replacement of an electric engine produces a thrust increment of 81%, a 7% increment of power-to- power-to-weight ratio, and an 18 % increment in ROC compared to the existing piston engine. The novelty of the work is to replace the piston engine with the same power-producing electric engine and performances are analyzed in actual flying conditions. Electric engines are used to minimize emissions and operational costs and enhance the performance of current and future aircraft.

Keywords: Aircraft Performance, Electric Propulsion, Power to weight ratio, Thrust.

An Investigation of Velocity Analysis on Front Frame Bumper Design

S. Padmanabhan1, Mohd Majid2, Nishikant Kishor Dhapekar3, P. Umamaheswarrao4, Rajiv Govindrao Nimje5, Srimanickam. B6, Soni Kumari7 and Krishna Kant Pandey8,*

1School of Mechanical and Construction, Vel Tech Rangarajan Dr. Sagunthala R&D Institute

of Science and Technology, Chennai 600062, Tamil Nadu, India

2Department of Mechanical Engineering, Sant Longowal Institute of Engineering and Technology, Longowal, Sangrur 148106, Punjab, India

3Department of Civil Engineering, MATS University, Raipur 493441, Chhattisgarh, India

4Department of Mechanical Engineering, Bapatla Engineering College, Bapatla 522102, Andhra Pradesh, India

5Department of Mechanical Engineering, Madhukarrao Pandav College of Engineering, Bhilewada, Bhandara 441924, Maharashtra, India

6Department of Mechanical Engineering, Cambridge Institute of Technology, Bengaluru 560036, Karnataka, India

7Department of Mechanical Engineering, GLA University, Mathura 281406, Uttar Pradesh, India 8Department of Mechatronics Engineering, Manipal University Jaipur, Jaipur 303007, Rajasthan, India

*Corresponding author email: krishna.pandey@jaipur.manipal.edu

Abstract: The design and analysis of a composite automobile bumper are described in this research paper using advanced engineering tools for performance evaluation under impact conditions. The bumper was modeled with CATIA software, and impact behavior was analyzed using ANSYS to study critical parameters, including total deformation, total velocity, maximum elastic shear strain, and maximum shear stress at ten m/s and 20 m/s. E-Glass was selected as the proposed composite material and was compared to regular materials like Aluminium Alloy (Al Alloy) and Stainless Steel (SS). The results showed that E-Glass performed competitively in total deformation and shear stress, better than Al Alloy for some conditions while almost matching Stainless Steel in performance. E-Glass total deformation of 0.0002846 mm at ten m/s and 0.0009659 mm at 20 m/s indicates that it has retained elastic strength against impact loads. The maximum shear stress is within moderate levels for e-glass like Al Alloy and significantly lower than that of stainless steel. Besides, it shows superior resistivity to elastic shear strain concerning common materials, thus proving itself efficient in energy absorption and resistance to impacts. This study states that E-Glass is a viable and efficient material for automotive bumpers, having an optimal balance between strength, durability, energy absorption, and cost-effectiveness; this material is lighter and corrosion-resistant than conventional metal alternatives.

Keywords: chassis, frame, front bumper, design, structural analysis, dynamic velocity, composites

Stress intensity distribution in steel pipeline with a semi-elliptical internal corrosion defect subjected to internal pressure

Sergei Sherbakov2, Pawan Kumar1 and Daria Podgayskaya1*

1Joint institute of mechanical engineering of the National Academy of Sciences of Belarus, 220072 Minsk,

*dapodgayskaya@gmail.com

Abstract. The present work investigated the stress intensity distribution in a steel pipeline with a semi-elliptical internal corrosion defect subjected to internal pres-sure. A total of 9 different internal corrosion defect conditions were considered for a finite element analysis. The analysis of the stress-strain state of models of undamaged/as-received sections of a pipeline was done using the hypothesis of a large length of the pipeline with a 2-dimensional formulation where the cross-section is modelled as a ring. However, for the corroded section, a 3-dimensional formulation was used by considering the semi-minor axis (a), semi-major axis (b), and the thickness (t) of the internal corrosion defect. The current work con-siders only the internal damage to the wall of the pipe having an external diameter of 720 mm under the influence of an internal pressure of 4.5 MPa. One-quarter of the section was used for analysis due to symmetrical conditions in the longi-tudinal direction for pipeline steel. The maximum stress intensity ($Kmax.$) was observed along either the a or b axes of the internal corrosion defect. It was also observed that the lowest K was just outside the curvature of the internal corrosion defect profile which indicated the stress partitioning "at the vicinity" and "curva-ture" of the internal corrosion defect quantitatively. The internal corrosion defect with the smallest semi-major axis length and largest semi-minor axis length pro-vided the largest stresses which enabled the pipeline into the most critical failure condition. However, an internal corrosion defect of 30 mm, b of 134 mm and a of 30 mm, b of 62.1 mm provided a safe design and the pipeline did not yield under the influence of an internal pressure. The $Kmax.$ exceeded the flow stress of the pipeline with an internal corrosion defect having a of 157.4 mm, b of 26 mm; a of 454 mm, b of 62.1 mm; and a of 454 mm, b of 26 mm envisages the plastic regime before the ultimate tensile stress; hence the pipeline deformed per-manently and it required maintenance for safe operation.

Keywords: steel pipeline, stress intensity, internal corrosion defect, internal pressure, finite element analysis, analytical solution.

Analysis of Lux Level in a Classroom of an Educational Institution in Dhule City through Simulation

Hitesh R. Thakare, Trupti Wagh, Sakshi Ahire, Harshit Mahajan

Department of Mechanical Engineering,
SVKM's Institute of Technology, Dhule, Maharashtra, India – 424001

thakare.hitesh@gmail.com

Abstract. Buildings are estimated to consume about 40% of global energy. For an educational institution, lighting level are important to ensure smooth and un-obstructed teaching learning process. Measurement of lux levels at several points is a tedious and time-consuming task. Present paper aims to simulate the lux level conditions for a classroom at SVKM's Institute of Technology, Dhule. The objective is to build a simulation model, expected to replicate the lux level scenario using IES VE Software. It is observed that lux level is excessively high near the windows. This analysis helps in decision making regarding switching off the lights in the relevant zone of the classroom.

Keywords: Building Energy Simulation, lux level, IES VE.