The Institution of Engineers (India)
8 Gokhale Road, Kolkata 700020
A Scientific and Industrial Research Organisation
recognised by Department of Scientific and Industrial Research
Government of India
ISO 9001:2015 Certified

Compendium on R&D Projects

under the grant-in-aid-scheme

Volume 12 September 2023

The Institution of Engineers (India)

Notification for

R&D Grant-in-Aid

To promote appropriate technology, assist in building up design & research talents and, most importantly, to help in nurturing potential R&D venture amongst engineering students pursuing Diploma/UG/PG/PhD courses, The Institution of Engineers (India) had instituted the R&D Grant-in-Aid program way back in 2001.

Like every year, the Institution invites applications for funding R&D projects and research initiatives aimed at improving the life-style of common people from engineering students pursuing full time Diploma/UG/PG/PhD engineering program from AICTE/UGC/NAAC approved Institutions/Colleges/Universities. The application form and guidelines are available in our website https://www.ieindia.org. The projects should be carried out under the guidance of faculty members who are Corporate Members of IEI. Membership criteria for student(s), guide(s) and Institution(s) are as follows:

Project Category	Student/Applicant Membership	Guide(s) Membership	Institutional Membership
1. Diploma	Exempted [Membership of Student Chapter is desirable]	AMIE/MIE/FIE	Not Mandatory
	Preferably 'Student Member' (SMIE)	AMIE/MIE/FIE	Applicant's Institute should preferably be an Institutional Member with valid NIRF Rank
2. UG (BE/BTech/AMIE/Equivalent)	'Student Member' (SMIE)	AMIE/MIE/FIE	Applicant's Institute should preferably be an Institutional Member with NBA / NAAC Accreditation or valid NIRF Rank
3. PG (ME/MTech/Equivalent)	AMIE/MIE/FIE	MIE/FIE	Applicant's Institute should preferably be an Institutional Member with NBA / NAAC Accreditation or valid NIRF Rank
4. PhD	AMIE/MIE/FIE	MIE/FIE	Applicant's Institute should preferably be an Institutional Member with NBA / NAAC Accreditation or valid NIRF Rank

The soft copy of the duly filled-up applications (in editable format), as per the proforma available in our website www.ieindia.org, should be sent through email to research@ieindia.org and one printed copy of the same should reach the following address:

Director (Technical)

The Institution of Engineers (India), 8 Gokhale Road, Kolkata 700 020

Applications received in format other than that available on our website will not be accepted. Application should be forwarded through the Guide, Head of the Department or Head of the Institution. Please note that preference will be given to project proposals received from Institutions who are members of The Institution of Engineers (India) and with NBA / NAAC Accreditation or valid NIRF Rank. Kindly go through the guidelines (visit link https://www.ieindia.org/webui/IEI-Activities.aspx#RnD-Initiative) carefully before filling up the application.

The grant is not intended for the faculty members who have access to other avenues of research funding. Proposals received will be scrutinized and the recipients of R&D Grant will be informed accordingly.

Message from the

President

I am delighted to extend my warm congratulations on the publication of the Compendium on R&D Project Outcomes, a result of our relentless pursuit of knowledge and innovation. This milestone achievement reflects the dedication and collaborative spirit that define our Institution.

I would like to extend my heartfelt appreciation to the Research and Development Committee (RDC) and the secretariat at Institution of Engineers (India) for their diligent effort that have culminated in this remarkable compendium.

I must also extend my gratitude to the brilliant young minds who have embarked on the path of research. Your curiosity, passion, and ingenuity are invaluable assets not only to our Institution but also to the future of our great nation. As we celebrate the publication of this compendium, we celebrate you—the future of our country.

Today, as we stand on the cusp of technological marvels, exemplified by endeavors like Chandrayaan 3 and the prospect of placing the next human footprint on the moon, the significance of research cannot be overstated. These remarkable feats are a result of unyielding dedication to exploration and the pursuit of knowledge.

I take immense pride in highlighting that The Institution of Engineers (India) has been recognized as a SIRO-certified organization—an acknowledgement of our commitment to fostering research and development. It is crucial to remember that a nation's economy thrives when it stands on the solid foundation of research. The discoveries and innovations documented in this compendium are the building blocks of our country's growth. Each insight, each breakthrough contributes to the tapestry of progress that shapes our economic and technological landscape.

As we celebrate this publication, let us renew our commitment to the spirit of inquiry and discovery. Let us continue to support and mentor young minds, guiding them towards paths of research that hold the promise of a brighter future.

Once again, I congratulate each contributor to this compendium and look forward to witness the remarkable transformations that our collective efforts will bring forth.

Er Shivanand Roy, FIE
President, The Institution of Engineers (India)

Message from Chairman
Committee for Advancement of Technology and Engineering

It is with great pleasure that I reach out to you as the Chairman of the Committee for Advancement of Technology and Engineering (CATE) through the publication of the Compendium of Research and Development. Our committee has been tirelessly engaged in compiling a comprehensive Compendium that showcases the remarkable outcomes of the sponsored Research and Development projects sponsored by IEI.

As an institution that takes immense pride in nurturing innovation and knowledge, IEI have consistently supported and funded research endeavors across various domains. Our unwavering commitment to advancing research is evident through the R&D Grants-in-Aid scheme provided to undergraduate, postgraduate, and doctoral scholars. These projects, driven by the curiosity and passion of our researchers, have yielded substantial contributions to their respective fields.

The Compendium we are unveiling encapsulates the essence of our dedication to research and development. The projects featured in this Compendium underscore the profound impact of our collective efforts on scientific, technological, and societal fronts.

This compendium will provide us with an opportunity to recognize the dedication and hard work of our scholars and researchers. Furthermore, the R&D Grant-in-Scheme will provide a platform to foster collaboration and discussions that drive innovation forward.

I extend my heartfelt gratitude to each and every one for unwavering effort and enthusiasm. It is the collective commitment that propels our institution's journey towards excellence.

Dr G Ranganath, FIE
Chairman, CATE, IEI

Message from Chairman
Research & Development Committee

It brings me immense pleasure to announce the release of the 12th volume of our much-awaited Compendium, showcasing the remarkable outcomes of our sponsored Research and Development projects. As the Chairman of the Research and Development Committee, I am thrilled to present this compendium as a testament to IEI's dedicated effort to encourage the students to take up research.

Our institution has consistently strived to foster an environment that nurtures innovation and promotes knowledge creation. The Compendium Volume 12 serves as a window into the world of possibilities that research and innovation open up. It is a celebration of hard work, dedication, and intellectual curiosity that have fueled these projects. Each entry in this compendium reflects the synergy between academic rigor and creative exploration, leading to outcomes that contribute to the advancement of knowledge and the betterment of society.

It is my sincere hope that seeing peers' accomplishments will encourage more students to embark on the journey of research.

I commend each student who has contributed to this compendium, and I extend my gratitude to the faculty members for their guidance and mentorship. Together, we are shaping an environment where research thrives and transforms lives.

Let us continue to strive for excellence, to push the boundaries of knowledge, and to lead the way in research and innovation.

Best regards,

Dr Raghupatruni Bhima Rao, FIE
Chairman, RDC, IEI

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F.No. 11/97/1988-TU-V

Date: 28th April 2022

The Secretary & Director General
The Institution of Engineers (India),
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Subject : **Registration of Research Institution, other than a Hospital, for the purpose of availing Customs duty exemption in terms of Government Notifications No. 51/96-Customs dated 23.07.1996; No. 24/2007-Customs dated 01.03.2007; No. 43/2017-Customs dated 30.06.2017; No. 45/2017-Central Tax (Rate) & 47/2017-Integrated Tax (Rate) dated 14.11.2017; No. 9/2018-Central Tax (Rate), No. 09/2018-Union Territory Tax (Rate) & No. 10/2018-Integrated Tax (Rate) dated 25.01.2018; and State Tax (Rate) as applicable and all notification, as amended from time to time.**

CERTIFICATE OF REGISTRATION

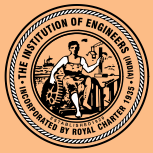
This is to certify that **The Institution of Engineers (India), Kolkata, West Bengal** is registered with the Department of Scientific and Industrial Research (DSIR) for the purpose of availing Customs duty exemption in terms of Government Notifications No. 51/96-Customs dated 23.07.1996; No. 24/2007-Customs dated 01.03.2007; No. 43/2017-Customs dated 30.06.2017; No. 45/2017-Central Tax (Rate) & 47/2017-Integrated Tax (Rate) dated 14.11.2017; No. 9/2018-Central Tax (Rate), No. 09/2018-Union Territory Tax (Rate) & No. 10/2018-Integrated Tax (Rate) dated 25.01.2018; and State Tax (Rate) as applicable and all notification, as amended from time to time. The Registration is subject to terms and conditions mentioned overleaf.

This Registration is valid upto **31.03.2025.**

Please acknowledge the receipt.

Yours faithfully,

(Dr. P.K. Dutta)
Scientist - 'F'



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(Established in 1920, Incorporated by Royal Charter 1935)

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A Century of Service to the Nation

The Institution of Engineers (India)

Volume 12, September 2023

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Compendium on R&D Projects under IEI Grant-in-Aid Scheme

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Publisher

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Study of Level-of-Safety on Two-Lane Rural Highways in Indian Traffic Conditions

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Effects of shoulder types and conditions on crash incidents

Effect of midblock access points on highway traffic crashes

OBJECTIVES

Based on research gaps, the study aims at understanding safety issues on highways under

(a) diverse characteristics of roadways, i.e. width of pavement and shoulders, their conditions and highway accessibility (b) varied driving conditions via innate cognitive mechanisms, i.e. temporal variability of the exogenous variable in terms of daytime and night time exposures on drivers' visibility and

(c) mixed traffic situations that exhibit a wide range of vehicle types in terms of statics and dynamics in its composition by way of the multifaceted computational framework.

Thus, the objective of the study was to determine the factors affecting the safety of roadways via extensive field-based study and intensive search of the historic crash incidents.

ACHIEVEMENTS

The study investigated risk factors for road accidents, especially under mixed traffic. Based on field studies on highways that exhibit heterogeneity in traffic mix and site-specific crash data for the past ten years, the study highlights several factors that might affect highways' safety aspects. The study also describes how those factors influence a crash incident on highways.

The basis for selecting study sites was abutting land use, roadway, and traffic characteristics; the study selected thirteen segments on the existing highway network in the state of West Bengal, India, covering a wide spectrum of such road attributes. A systematic investigation based on site-specific accident data to capture the highway sections' safety features revealed that the crash rate has steadily increased for years with traffic regardless of

roadway category and conditions. Several risk factors that affect road accidents were identified: mid-block access, pavement and shoulder conditions, vehicle involvement, time of day, and road configuration, i.e., two and multi-lane.

The empirical observation indicates that the crash rate is relatively lower on multi-lane highways; however, the severity of any crash on such a road is relatively high. Due to the lane-based unidirectional traffic movement, crash frequencies on multi-lane roads are less during daylight hours. However, during night time, drivers are often unable to meet traffic contingencies, thereby increasing crash risk. The majority of crashes on two-lane highways are, on the other hand, due to unsafe driving manoeuvres.

The study also observed that frequent mid-block accesses and poor shoulder conditions reduce scopes to rectify driving errors and increase crash risk as a consequence. Further, variations in driving behaviour across road users might cause turbulence on roads and eventually lead to a mishap. For instance, actions attributable to age, intoxication, psychological stress, fatigue and compulsive acts may cause a crash occurrence. Thus, the outcomes of the study elucidates that proactive safety assessments considering identified risk factors are essential while designing highways.

PUBLICATIONS

1. BasuS., Saha P. Evaluation of risk factors for road accidents under mixed traffic: Case study on Indian highways. IATSS Research, Elsevier 46(4): 559-573, 2022.

   https://doi.org/10.1016/j.iatssr.2022.09.004

2. Saha P., Roy N., BasuS. Influence of safety in performance assessment of two-lane highways: a critical review. Transportation Research Procedia, Elsevier. 44: 35-39, 2020.

   https://doi.org/10.1016/j.trpro.2020.02.006

3. BasuS., Saha P. Assessment of Crash Risks at Highway Access Points with Restricted Sight Visibility. Lecture Notes in Intelligent Transportation and Infrastructure, Springer, 2020.

   https://doi.org/10.1007/978-3-030-38666-5_9

4. BasuS., Datta A., Mondal S., Saha P. Reliability-Based Safety Assessment of Mixed Vehicular Traffic Under the Influence of Time-of-Day. Lecture Notes in Networks and Systems, Springer, 2020.

   https://doi.org/10.1007/978-3-030-44610-9_20

5. BasuS. Assessment of level-of-service-of-safety of highways in the Indian context. PhD thesis (submitted), IIEST, Shibpur, 2022.

Engineers participate in the activities which make the resources of nature available in a form beneficial to man and provide systems which will perform optimally and economically."

L. M. K. Boelter

In Vitro Studies on Effects of Carbon Nanotubes on Antioxidant Mechanism in Human Neuronal Cells

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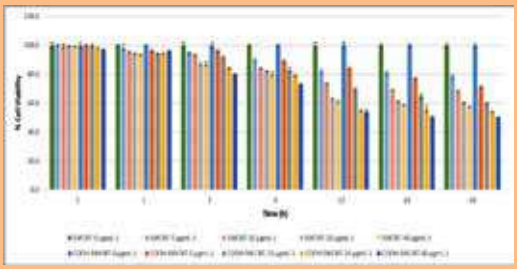
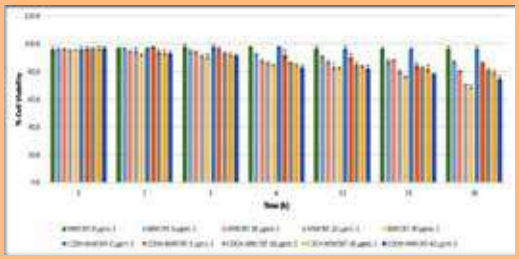


Percentage cell viability assessed by trypan blue assay for LN18 cells treated with SWCNT and COOH-SWCNT at concentrations 5, 10, 20 and 40 µgmL-1 and time intervals of 0, 1, 3, 6, 12, 24 and 48 h.



Percentage cell viability assessed by trypan blue assay for LN18 cells treated with MWCNT and COOH-MWCNT at concentrations 5, 10, 20 and 40 µgmL-1 and time intervals of 0, 1, 3, 6, 12, 24 and 48 h.

OBJECTIVES

Based on research gaps, the study aims at understanding safety issues on highways under

- Assessing the cellular effects of pristine & functionalized single walled carbon nanotubes (SWCNT) and multi walled carbon nanotubes (MWCNT) on neuronal cells through in vitro studies
- Studying the effects of pristine & functionalized SWCNT & MWCNT on the innate antioxidant mechanisms in neuronal cells
- Testing the effect of added antioxidants in the antioxidant status of pristine & functionalized SWCNT & MWCNT treated neuronal cells

ACHIEVEMENTS

- Cytotoxicity of pristine SWCNT and COOH-SWCNT was evaluated by Trypan Blue Assay and MTT Assay on LN18 neuronal cell line
- Cytotoxicity of pristine MWCNT and COOH-MWCNT was evaluated by Trypan Blue Assay and MTT Assay on LN18 neuronal cell line

PUBLICATIONS

- Vaniyamparambath Vijayalakshmi, Bindu Sadanandan, Anjanapura Venkataramanaiah Raghu (2022) Pristine and Carboxylic Functionalized Single Walled Carbon Nanotubes in High Concentrations are Cytotoxic to the Human neuronal Cell LN18. Results in Chemistry. Accepted. DOI: https://doi.org/10.1016/j.rechem.2022.100484
- Vaniyamparambath Vijayalakshmi, Bindu Sadanandan, Anjanapura Venkataramanaiah Raghu (2022) In Vitro Comparative Cytotoxic Assessment of Pristine and Carboxylic Functionalized Multi Walled Carbon Nanotubes on LN 18 Cells. Journal of Biochemical and Molecular Toxicology. Under review

Design and Development of a Fiber optic Sensor to Monitor Humidity Influencing Deterioration in Sewage Treatment Plant

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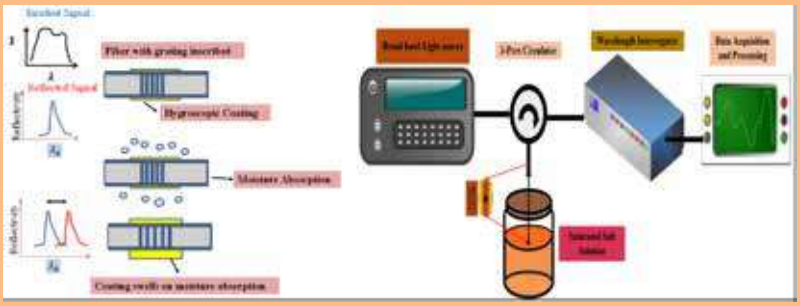

Figure 1: Hygroscopic behaviour and schematic of experimental setup

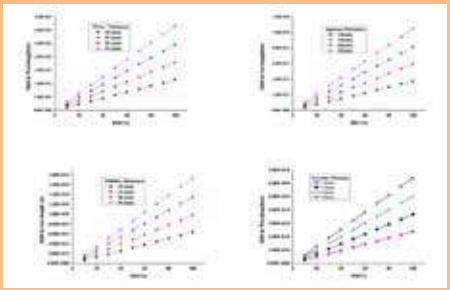

Figure 2: Optimization of coating materials for harsh environments

OBJECTIVES

Deterioration of concrete structures is a significant issue that requires special focus in massive structures such as wastewater treatment plants. The impact of deterioration on structural integrity necessitates distinctive consideration in examining the external factors supporting microbial degradation. Microbial Induced Corrosion is a very significant type of disintegrating mechanism for concrete structure exhibit in sewer environments that greatly affects the lifespan of concrete structures and may reduce the life time from 100 years down to 30–50 years in worst cases down to 10 years or fewer. MIC due to sulfuric acid (H_2SO_4) is the major cause of the degradation of concrete materials.

MOTIVATION

Multitudes of research work are ongoing in reducing the effect of H_2SO_4 that constitutes changing sewer environment to inhibit the H2SO4 production, using proper hydraulics in sewer design, using an enhanced concrete mixture with the addition of biocides. Another dimension of reducing the rate of concrete corrosion is through proper maintenance of environmental factors via appropriate monitoring techniques External environmental factors such as humidity and temperature enhances the process of microbial degradation demands special monitoring.

OBJECTIVES

This project proposal aims to develop a highly accurate and sensitive fibre-optic relative sensor that can be used to monitor the humidity to prevent the early onset of microbiologically induced corrosion in sewage treatment plants. In this study, Bragg Grating coated with polyimide has been experimented with different humidity conditions and sensitivity has been analysed over a wide range of humidity. It shows the linear Bragg shifts over

the range of 11% to 97% with the sensitivity of 2.0 pm/%RH which is an optimum value for sewer environment deployment. Assessment metrics such as resolution, sensitivity, response time and limit of detection (LOD) were also analyzed. The proposed sensor anticipated to perform with better resolution, high accuracy under harsh acidic environment compared to the existing sensors. Proposed Fiber Bragg Grating based humidity sensors can be used in sewage treatment plants for long duration without calibration.

The major objective of the work is to design and develop an indigenous fiber-optic humidity sensor with high accuracy and resolution. The objective is achieved through two phases by (i) Optimizing the coating material and thickness of coating material, (ii) measuring the performance of fabricated sensor with optimized coating material and thickness through experimental investigation.

CONTRIBUTIONS

Coating material is used to measure humidity through grating inscribed in fiber optic. The hygroscopic coating material imposes strain on expansion and contraction on observing humidity. The strain affects the periodicity of grating which in turn affects the reflected wavelength. Humidity is measured using wavelength shift of reflected light through Fiber Bragg Grating (FBG) inscribed in optical fiber.

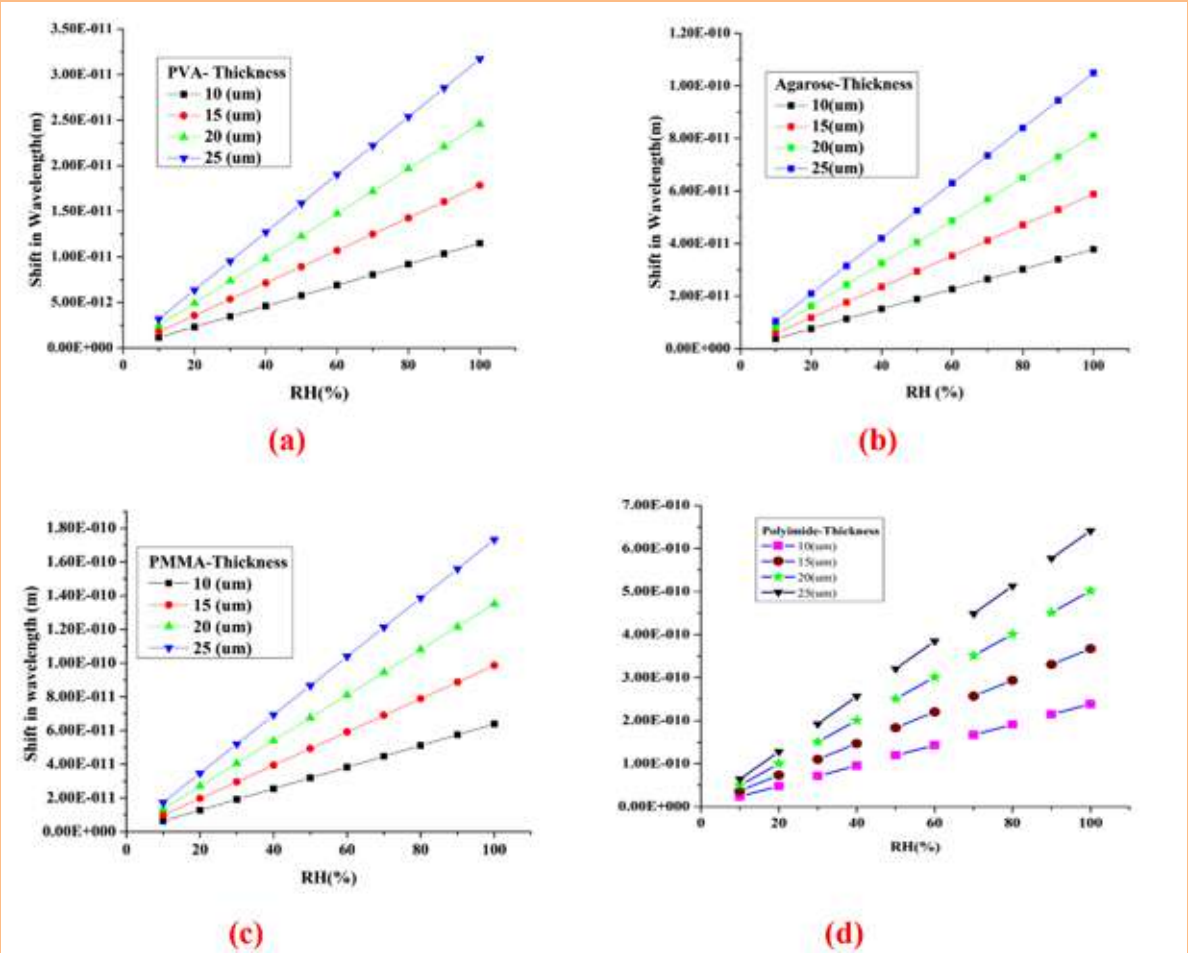

Figure 3: Wavelength shift of FBG coated with a) PVA, b)Agarcose, c)PMMA, d)Polyimide

Four different types of hygroscopic material such as Agarcose, Polyvinyl Alcohol (PVA), Polyimide and Poly Methyl Methyl Acrylate (PMMA) with different coating thickness is investigated with FBG using simulation tool MATLAB and COMSOL to optimize the coating material and thickness.Among all the materials Polyimide

coating provides humidity sensitivity around 21 times of PVA, 4 times of PMMA, 6 times of Agarcose. Further absorption profiles were investigated with COMSOL Multiphysics.

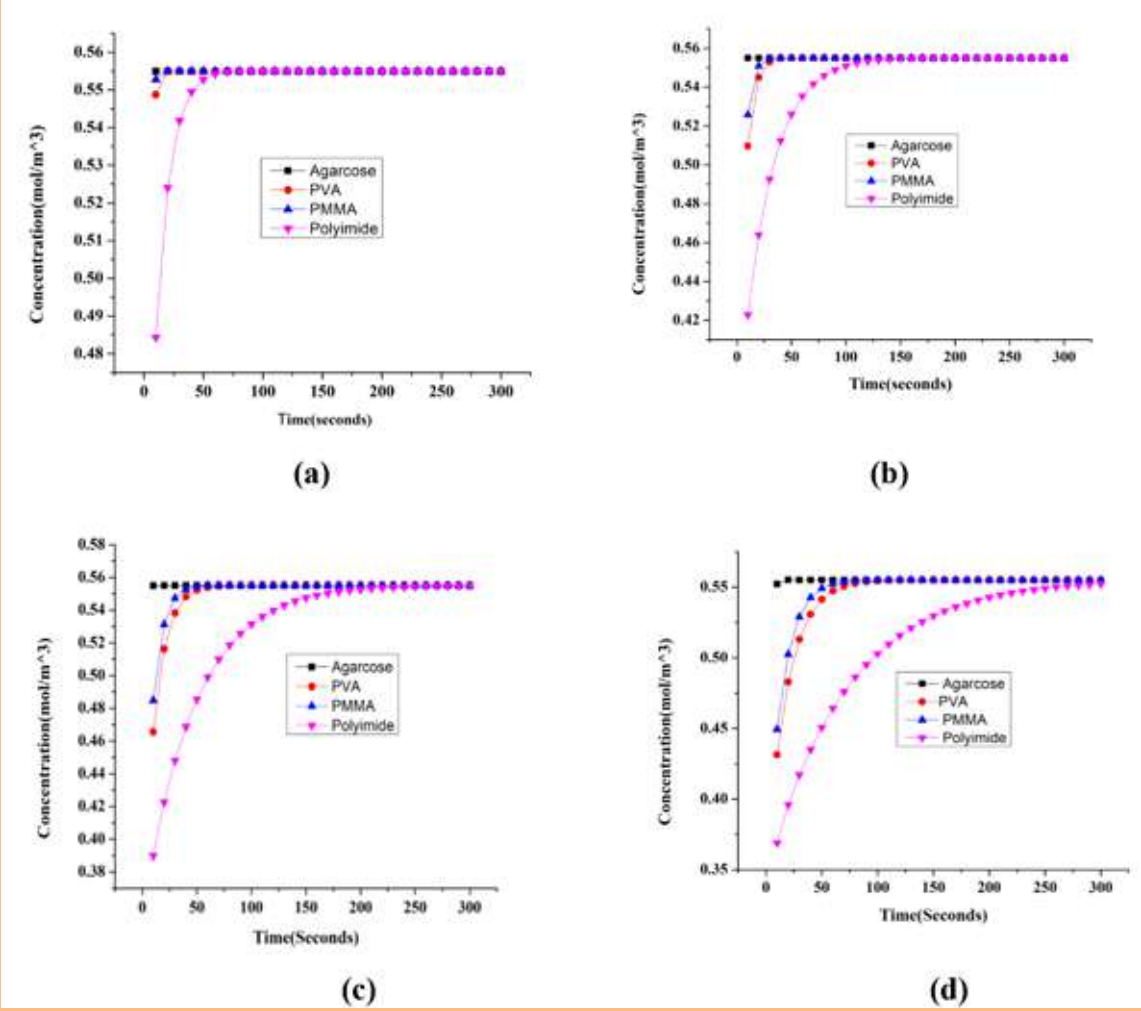

Figure 4. Absorption time of coating materials with thickness (µm) a) 10, b) 15, c) 20, d) 25

Table 1. List of Components for Humidity Sensing using Grating

S.No	Components	Range
1.	Broadband source	(1535-1565) nm
2.	Interrogator	(1525-1570) nm
3.	Circulator	3 port circulator
4.	Polyimide Coated Grating	Thickness of coating-10
5.	Saturated Salt solution	(11.3-97.3) %RH

Through simulation it is inferred that Polyimide coating provides Sensitivity : 21 times of PVA, 4 times of PMMA, 6 times of Agarcose and Absorption time: 12 times of Agarcose, 3 times of PVA, 2 times of PMMA. So polyimide coating material of 10 micrometer is chosen for fabricating the humidity sensor. The experimental investigation was carried out with coating thickness optimized grating and the components used in experiment is listed in Table 1.

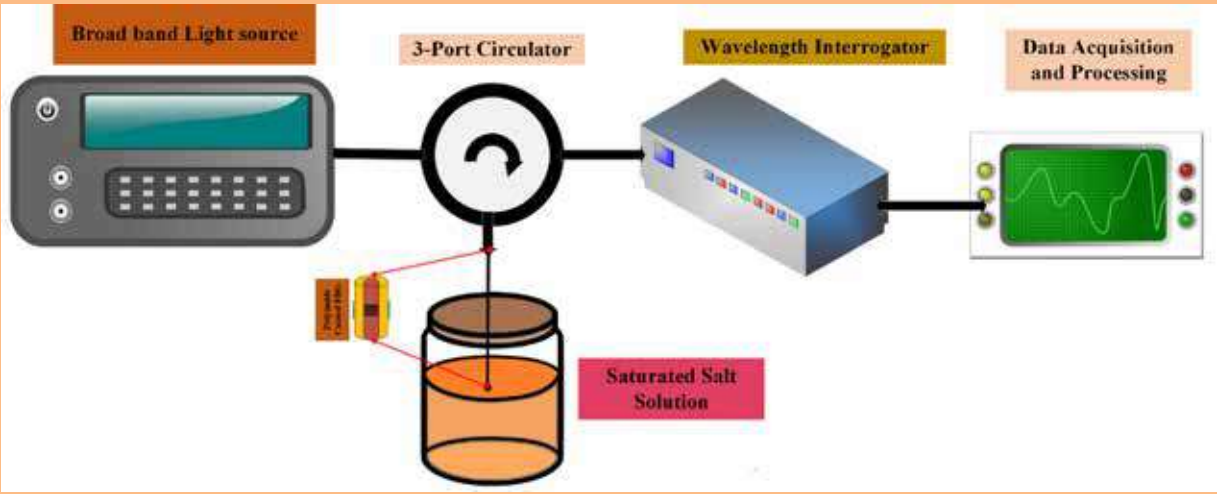

Figure 5. Schematic for the measurement of humidity using Grating

The schematic and experimental setup for the measurement of humidity was shown in Figure 3 & 4.

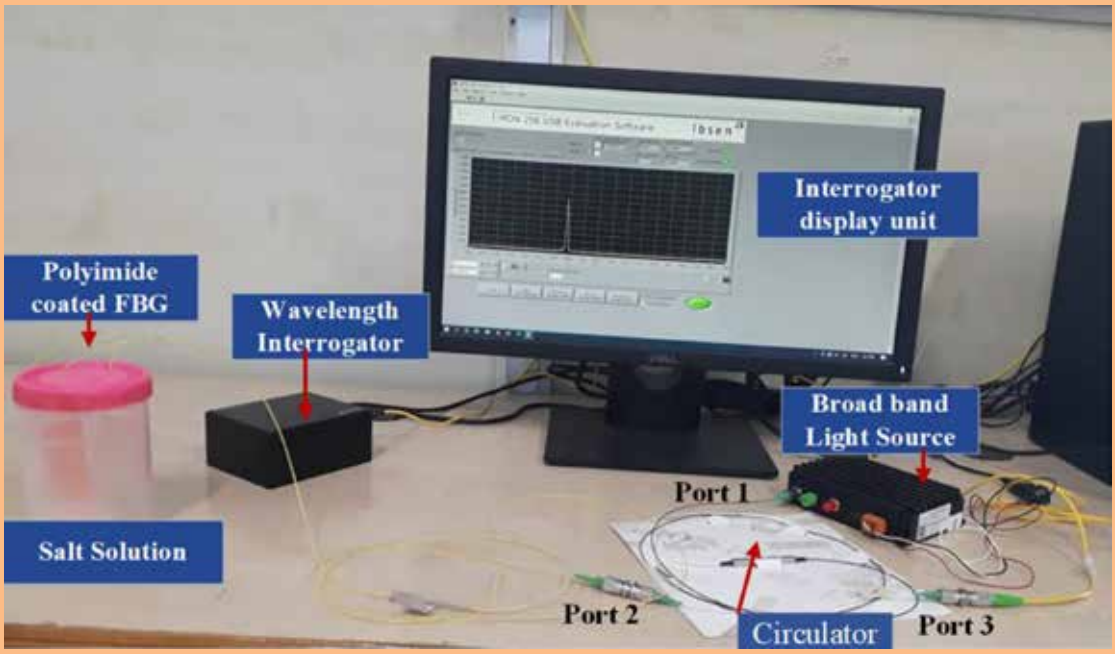

Figure 6 : Experimental setup of Humidity sensing

The Broad-Band Optical Source (Model No.: DL-BX9-CS5153A, Denselight semiconductors Pte Ltd, Singapore) consists of super-luminescent light emitting diode that supplies 1.92 mW of input for the wavelength spectrum of 1535 nm to 1565 nm. The optical source is coupled to an optical circulator with three ports (Model No.: F-CIR-15-P-FA, NewPort,US). The light signal in the first port is then transmitted to the second port where the Grating is connected. The signal from FBG sensing unit is carried to the interrogator (Model No.: I- MON 256 USB, IBSEN, Denmark) through the circulator third port. An FBG interrogator unit is a detector that measures the change in optical wavelength with a precision of 0.3 pm and the measurement range of 1530–1570 nm. To facilitate the observations for different humid conditions, the containers with different saturated salt solutions were employed. The real time demonstration image for the analysis of the proposed humidity sensor is given in Figure 4.

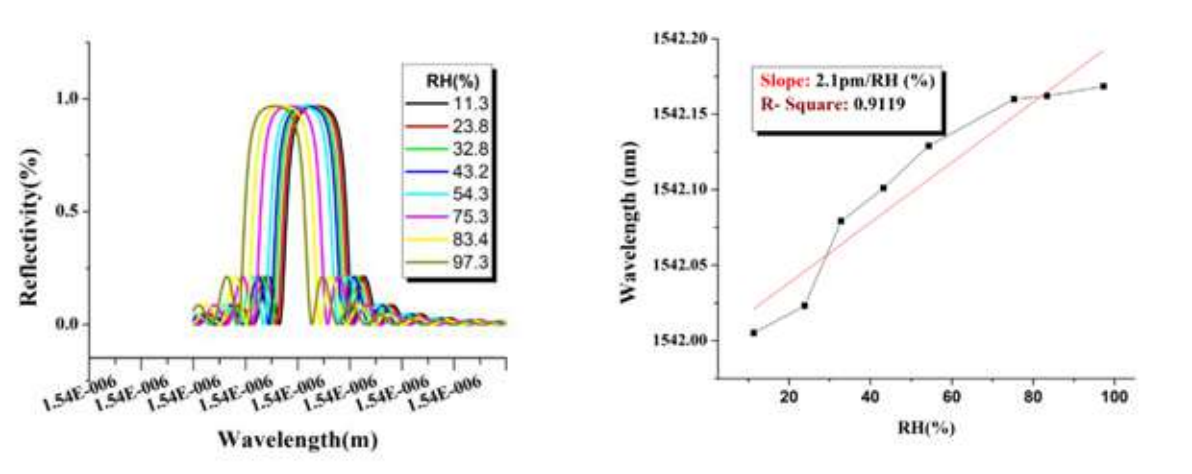

Figure 5: Bragg Shift at different humidity Sensitivity of polyimide coated FBG

The sensitivity of polyimide coating coincides with simulated results with sensitivity of 2.1pm/%RH. Polyimide coating of thickness of 10 can provides good sensitivity. The performance of sensor is evaluated using assessment metrics includes sensitivity, Figure of Merit (FOM), Limit of Detection (LoD) and resolution are briefed in Table 2.

CONCLUSION

The hygroscopic materials were investigated to best suits for coating on grating for measuring the humidity using simulation tools MATLAB and COMSOL. The coating material with optimized thickness was used for coating and experimented under different humidity conditions. The experimental investigation for humidity monitoring at constant temperature with FBG coated with polyimide of 10 thickness provides Sensitivity of 2.1pm/%RH with Linearity of 0.9119. In Future with optimized perforated encapsulating material for packaging, the designed sensor best suits for deployment in harsh environments like sewage for monitoring humidity.

ACHIEVEMENTS

- Optimized the coating material for transducing humidity to measurable wavelength by comparing different types of hygroscopic material using MATLAB.
- Investigate the effect of thickness of coating material and find best suited thickness with acceptable sensitivity using COMSOL.
- Analysing the absorption profile of coating material to investigate the time response of coating material using COMSOL
- Customized the fabrication of coated FBG with optimized thickness and analyse the results experimentally with fabricated grating under different humidity conditions.

Development of Hydroxyapatite Reinforced Magnesium based Composite through Spark Plasma Sintering for Bio Medical Applications

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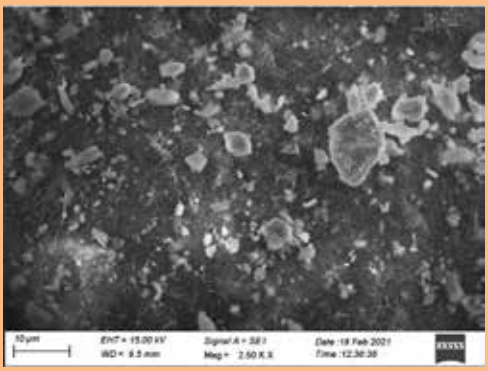
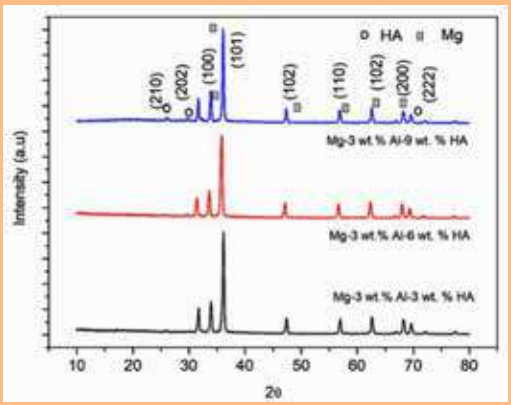


SEM Image of the Mg/3Al/9HA composite powders



XRD Pattern of Mg/3Al/HA composites

OBJECTIVES

The aim of this work is to develop magnesium alloy (Mg/3Al)-based composites, reinforced with hydroxyapatite (HA) by powder metallurgy (PM) method and to analyse the effect of Hydroxyapatite content in the Magnesium matrix on mechanical Properties, corrosion properties and wear behaviour of the composites. In this work, Mg alloys were reinforced on the basis of weight percentage (wt.%) of HA to produce Mg3Al alloy as well as Mg3Al/3HA, Mg3Al/6HA and Mg3Al/9HA composite samples. Microstructural studies on the various Mg3Al/HA composites were carried out, using scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) and X-ray diffraction (XRD). Pin on Disc (POD) machine was used to conduct the wear test for the prepared composite samples. Wear behaviours of the composites were analysed with aid of Taguchi method. Worn surface analysis was performed, using SEM. From the results obtained, better wear resistance property was obtained with the sample Mg3Al/9HA.Evidently, the addition of HA content to the Mg/3Al alloy increased its mechanical strength, due to uniform distribution of HA in the matrix. From signal-to-noise (S/N) ratio analysis, it was observed that the optimum parameters were obtained at HA content of 9 wt.%, speed of 2 m/s, displacement of 750 m and applied load of 5 N for minimum WR. Similarly, the optimal parameters for minimal coefficient of friction (COF) were 9 wt.%, 1 m/s, 750 m and 5 N. Leveraging from these composite samples, the results obtained stand to advance knowledge on tribology of composite materials, guide the choice and application of the materials, especially where wear and friction are inevitable. Better corrosion resistance was obtained while increasing the HA content in the Mg/3Al matrix.

ACHIEVEMENTS

Hydroxyapatite Reinforced Magnesium (Mg/3Al) based Composite has been developed through powder metallurgy route for Bio Medical Applications and the properties such as density, porosity, compressive strength, hardness, wear and corrosion were investigated. Some excellent properties had been obtained for 9 wt. % of HA reinforced Mg/3Al matrix composites. The proposed composites have been studied for the microstructure using Scanning Electron Microscope Analysis. The compositions of the composite have been verified and found that no intermetallic phase were formed in the composites.

This work has been published in highly reputed science citation indexed international journal.

S. Jayasathyakawin, M. Ravichandran, SikiruOluwarotimi Ismail, D. Srinivasan, Effects of hydroxyapatite addition on the microstructure and mechanical properties of sintered magnesium matrix composites, Materials Today Communications, Available online 10 February 2023, 105582. https://doi.org/10.1016/j.mtcomm.2023.105582.

S. Jayasathyakawin (Ph.D Scholar) completed his Ph.D in the Faculty of Mechanical Engineering, K.Ramakrishnan College of Engineering (Autonomous) Trichy with part of this research work and the viva voce examination was conducted on 05-06-2023.

PUBLICATION

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S. Jayasathyakawin, M. Ravichandran, SikiruOluwarotimi Ismail, D. Srinivasan, Effects of hydroxyapatite addition on the microstructure and mechanical properties of sintered magnesium matrix composites, Materials Today Communications, Available online 10 February 2023, 105582. https://doi.org/10.1016/j.mtcomm.2023.105582

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> “Technology innovation is starting to explode and having open-source material out there really helps this explosion. You get students and researchers involved and you get people coming through and building start ups based on open source products.”
>
> Tim Berners-Lee

Analysis and Design of Modified Sepic Converter with Wide Bandgap Device for High Frequency Applications

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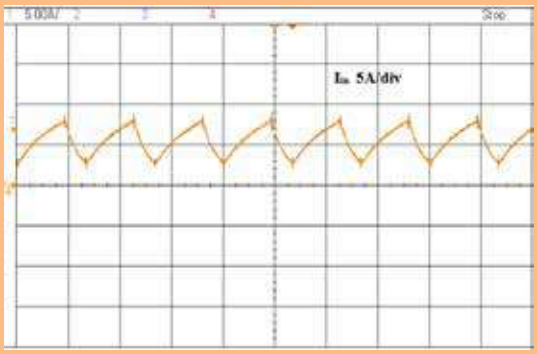
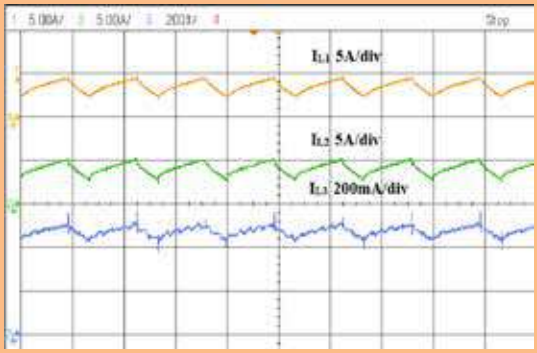
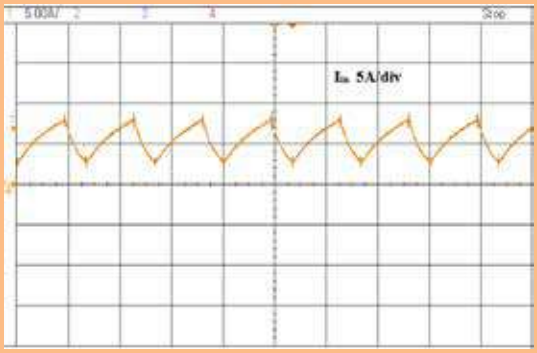
Laboratory Setup of TSEGS converter



Input current (5A/div, 10µs/div)



Inductor currents (5A/div, 5A/div, 200mA/div, 10µs/div),



Closed Loop operation under varying input voltage condition (20V/div,50V/div,0.5A/div,10µs/div)

OBJECTIVES

Several renewable energy sources have emerged as reliable power supplies for remote areas in recent years. Boost converters that always preferred are not economical due to restricted output voltage and efficiency. Also, the voltage at the output stage and power transferring capability of DC – DC converters are restricted due to the effect of the parasitic elements. The proposed converter will be intended to attain high gain voltage deprived of using a transformer and coupled type of inductor. In recent days, the usage of high-frequency power converters is popular because of its benefits such as advanced power density and improved dynamic response. Thus, the designed converter is also analyzed with wide bandgap devices for high-frequency power conversion. This work will be an effective solution for a majority of energy sources, such as solar panels, fuel cells etc, offer low terminal voltages at remote locations. A modified SEPIC based DC – DC converter with

soft switching characteristic for high frequency and high-power applications will be implemented. The circuitry elements are designed in a fashion that it can withstand higher temperature, provide a fast response for power transfer and reliable on the operation under any high-frequency condition. The advent of a wide bandgap power device is more predominant to offer improved efficiency and high switching frequency than the outdated Silicon (Si) based power device. The major objective is to lessen the increased switching losses, owing to the rise in switching frequency. Therefore, a critical property for high-frequency converters is the soft switching characteristic. FPGA device is very promising for high-frequency DC – DC converters. It is used here to provide high speed in response, best device for control, communication feasibility and it can be integrated on a single chip. Upon the successful implementation of the designed converter, improved efficiency and high-power density are accomplished.

ACHIEVEMENTS

A two-switch enhanced gain modified SEPIC (TSEGS) converter with reduced conduction losses, greater voltage gain, and increased efficiency are emphasized in the proposed design.The proposed converter also has an enhanced voltage gain, making it appropriate for commercial and clean energy applications. This topology is progressed by the inclusion of a capacitor with the diode of the SEPIC converter. Thus, the problems of existing boost topologies with equal voltage gain are remedied. Also, this designed converter has a notable feature of reduced voltage stress across all the capacitors. Finally, the results of the TSEGS converter are experimentally validated and verified with theoretical analysis. The proposed topology can also be implemented with a wide range of frequencies using different wide bandgap devices like GaN devices etc. Hybrid converters such as DC-DC-AC can be developed and soft computing techniques such as Fuzzy, Neuro-fuzzy, adaptive neuro-fuzzy etc., can be utilized for control operation and make it suitable for space power applications and grid applications. A two-switch enhanced gain SEPIC (TSEGS) converter has been proposed with a discussion on steady-state analysis. The design equations and the voltage gain equation has been derived from the steady-state analysis. The operation and analytical waveforms of the proposed TSEGS converter have been illustrated for both continuous and discontinuous conduction modes. From the comparative study, it is evident that the TSEGS converter has a more significant advantage by offering better voltage gain at a reduced duty cycle. The efficiency and power loss investigation of the TSEGS converter are also undertaken. Thus, the results of the TSEGS converter are experimentally validated and verified with theoretical analysis.

1. During the execution of the project, there was a high level of learning about designing, analysing, small signal modelling of a DC-DC converter and also gained knowledge in Verilog programming for generating pulse of desired switching frequency.
2. Around 8 B. Tech students and 4 M. Tech students got trained during the execution of the project.
3. This project work has enabled to upgrade the infrastructure by procuring the components and equipment such as Regulated DC Power Supply (0-30V/10A), FPGA board and High frequency drivers.

PUBLICATION

1. Published paper entitled “Analysis and Design of Two-Switch Enhanced Gain SEPIC Converter,” in IEEE Transactions on Industry Applications (2023), doi: 10.1109/TIA.2023.3242237.
2. Published paper entitled “Improved Gain Switched Inductor Super Lift Cell-based Modified SEPIC Converter for Dc Microgrid,” in Springer Electrical Engineering(2023). https://doi.org/10.1007/s00202-023-01775-w.
3. Presented paper entitled “Modified SEPIC Converter Fed BLDC Motor for EV Application” – 2022 37th Indian Engineering Congress by the Institution of Engineers (India) Tamilnadu State Centre during December 16th – 18th 2022.

Application of Pyrolytic Products of Prosopis Juliflora with Nano Catalysts in Composite Manufacturing and Energy Storage Devices

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Wood Cutting Machine

Fabricated setup of Pyrolysis Process

OBJECTIVES

Owing to the boom in population together with the increased industrial activities, the demand for energy is arising day by day across the globe. The dwindling resources of fossil fuel made researchers to search for potential alternatives to meet the rising demand. In this proposed work, the stems of Prosopis juliflora (Biomass) which is an invasive weed will be dried naturally and reduce to the required size by employing appropriate cutting mechanism. Further, the dried biomass will be subjected to proximate analysis, elemental analysis and Thermogravimetric analysis (TGA) to study the thermal decomposition behaviour of Prosopis juliflora. Simultaneously, the two nano catalysts namely Ni, Ag and Al2O3 will be synthesized in the laboratory by adopting appropriate techniques and will be characterized by employing XRD, FESEM, etc. Based on the results of TGA, the appropriate temperature at which the pyrolytic distillation of the biomass has to be performed will be established. The biomass loaded with nano catalysts in different proportions will be allowed to undergo pyrolytic distillation and the products obtained namely, solid char, condensable liquid and non-condensable gaseous constituents will be collected separately and characterized appropriately. The biochar collected after each distillation process will be coated in different proportion on the copper substrate and its electrochemical characters will be studied by employing Cyclic Voltammetry and Galvano Static Discharge studies to evaluate

the energy storage capacity of the char. Furthermore, both the biooil and biochar obtained will be admixed with the conventional epoxy resin in varying proportions to prepare the composite plates by employing coconut fiber and the mechanical properties of the composite plate will be evaluated appropriately. Also, the biooil in different proportion will be mixed with conventional diesel fuel and the performance characteristics of a diesel engine will be studied.

ACHIEVEMENTS

In the proposed work, the invasive speciel Prosopis Juliflora (biomass) is subjected to thermal decomposition in the developed pyrolysis setup. Further, the biomass is allowed to decompose thermally in the presence of the synthesized nano metallic and metallic oxide particles. Physicochemical characterizations such as FESEM, EDAX and elemental mapping ensure the surface morphology, constituents and distribution of constituents over the surface of the material. The products obtained during the distillation process is collected and characterized separately. The biooil and biochar is admixed with conventional epoxy resin and its sutiabiity in the preparation of composite is tested. Also, the bio oil is blended in different proportions and its efficacy as a engine fuel is evaluated. Further, biochar loaded with catalysts were used as composite electrode material which is coated over graphite sheet to evaluate the capacitance of the produced energy storage system. The biochar is coated over graphite sheet of dimensions 25 mm * 10 mm. Cyclic Voltammetry is done to find the specific capacitance of electrodes formed using biochar produced at various pyrolysis temperature ranging from 400°C to 550°C. Enhanced surface area and electrical conductivity of the catalysts added are the reasons attributed to the increase in specific capacitance. The composite electrode material of biochar loaded with Ag nanoparticles as catalyst showed higher capacitance of 276.94 F/g even at lower pyrolysis temperature. The capacitance values have been higher due to the enhanced surface area as a result of reduced diameter compared to prosopis juliflora. The exceptional characteristics of silver nps such as higher electrical conductivity, higher surface-to-volume ratio, chemical stability, and catalytic properties, have helped in increasing the specific capacitance.

Legacy of IEI

Hon'ble President of India, Mr Ram Nath Kovind and Mr Banwarilal Purohit, Hon'ble Governor of Tamilnadu at the Valedictory Session of the 32nd Indian Engineering Congress, Chennai, December 2017

Design and Development of Girth Bagging Equipment using the Principles of Ergonomics

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Girth Bagging Equipment

Application of Girth Bagging Equipment

ACHIEVEMENTS

Agriculture is the backbone of India, even today most of the farming activities are manually done. The farming activities range from sowing of seeds to harvesting, sorting, and storage of food grains. Particularly, grain bagging process involved sweeping, piling, filling the gunny bags and transporting them to storage area is considered labour intensive. Often, farmers performing the task underwent sever health issues that caused occupational injuries and accidents eventually resulting in musculoskeletal disorders (MSD). In the study, local villages were visited and farmers were interviewed to know about all the work-related injuries that they commonly faced. The outcome of the study resulted in understanding the issues such as chronic body ace, shoulder pain, upper and lower back pain caused musculoskeletal disorders. Therefore, it was felt to simplify the process of grith bagging by designing an ergonomic material handling equipment to mitigate the issues of MSD.

A pilot study was performed to observe and record the farmers present posture during sweeping, piling, filling and transporting filled bags from one place to another. The recorded information was critically examined and analysed using a commercially available software in order to determine the Rapid Upper Limb Assessment

(RULA) score. The software output showed a score of 7 for the current bagging method, which is considered as HIGH risk that required actions to mitigate MSD. Based on the above findings, a grith bagging equipment was designed using the principles of ergonomics. Anthropometric measurements of Indian men was considered in fabricating the equipment. The designed equipment had a grain collecting tray, hopper, swelling handling bar, hand grip, gunny bag hangers, storage platform and wheels for easy portability. The proposed equipment had a metal tray attached to the bottom of the swelling handle that collected the grains, the handle was pulled downwards by the person allowing the grains to move through the hopper due to gravity into the bags that were securely hung to the equipment frame. The study was further performed on the person while using the proposed equipment and it was analyzed using the software. The software output resulted in a RULA score of 2 which is considered as a very good work posture that significantly minimized the issues of MSD. Also, the proposed equipment reduced the manpower required from 4 to 1 and enhanced farmer productivity by up to 68%.

Hence, it was noticed that the designed grith bagging equipment showed promising results in better working postures in comparison to the traditional handling methods and also improved manpower utilization & productivity which is a significant improvement in grith bagging process.

OBJECTIVE

- Mitigate musculoskeletal disorders amongst the farmers particularly in processing the harvested food grains.
- Enhancing the productivity of girth bagging workers.

PUBLICATION

1. Technical paper titled “Design and development of girth bagging equipment using the principles of ergonomics”is accepted for publication in Journal of Mines, Metals & Fuels- Q4 (in-press).

Legacy of IEI

Prime Minister Mrs Indira Gandhi cutting the Golden Jubilee Cake

IoT Supervised Machine Learning Module for Palatable Water Production in PV/T System using Industrial Sludges and Nautical Husks

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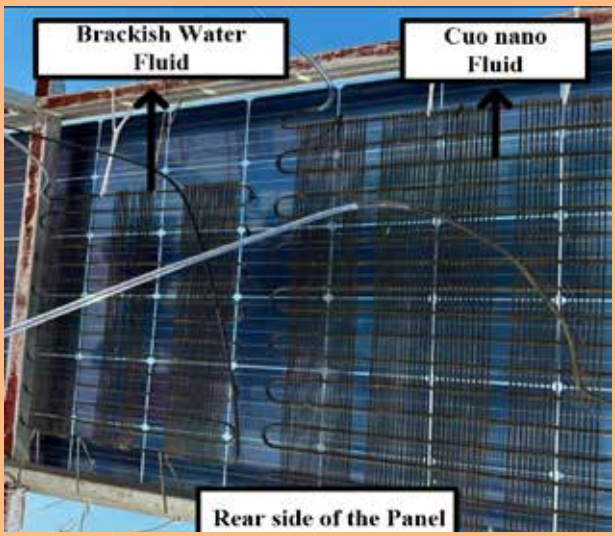
Overall Diagrammatic Representation



Rear Side of the Panel

OBJECTIVES

The Primary objective of this project is the generation of palatable water form atmospheric air with help of Single Slope Solar Still is designed for maximum production of palatable water to reduce water scarcity problem.

EXPERIMENTAL PROCEDURE

The mechanism is supervised by the Artificial Intelligence tools through IoT. The present work is about the performance of single slope solar still toenhance the desalination of water using liquid desiccants. For experimentation purpose, calciumcarbonate extracted from aquatic waste shell is selected as desiccant, with better dehumidification.

Heat Exchanger Assembly

- The Heat Exchanger is a typical coaxial cylinder with 3 tubular designs.
- Here, the middle tube carries the hot nanofluid. Such that both thermal conductivity and heat efficiency gets increased.

Liquid Desiccant & Heat Exchanger Fluid

- Nano desiccant material is extracted from aquatic waste Vespericolakarokorum shell abundant with $CaCO_3$.
- Nano fluids for heat exchanger are extracted from the sludge of electroplating industries.
- CuO extraction from the residue is found to be abundant with high thermal conducting properties and optimized for best results.

Solar Still Design

- Single Slope Still is designed for maximum production of palatable water.
- The upper basin is made to flow with the prepared liquid desiccant and lower basin is filled with brackish water.

Optimization

- Liquid desiccant is optimized done graphically using Design Expert 11 Software with its moisture retention property, considering its concentration & specific heat capacity.

AI Tools

- AI tools are used to predict overall still performance and solar power generation using load forecasting techniques.
- Random Forests and Ensemble methods are employed for supervision to extract maximum power

Data Acquisition

- The manipulated data is transmitted by using wifi/Node MCU modules and displayed in dashboards through Think Speak forum. The Entire Data in logged and plotted for further reference.

ACHIEVEMENTS

India is the biggest user of groundwater – it extracts more groundwater than China and the US put together – the second and third on the list. Groundwater meets more than half of the total requirement of clean water in the country. On 26th August 2019 in Biarritz, Prime Minister Narendra Modi addressed the G7 summit in a session on 'Biodiversity Ocean, Climate'. He spoke about how India and how his government is taking steps to deal with conserving water and harnessing solar energy for a sustainable future. If one looked at the numbers, India is still a water-surplus country and receives enough annual rainfall to meet the need of its 1.2 billion population. India received 4,000 billion cubic meters of rain against its requirement of 3,000 billion cubic meters, according to the Central Water Commission. The problem is only 8% of this is captured, which is among the lowest in the world.

PUBLICATION

1. Gurukarthik Babu Balachandran, Siva Balan Avudaiappan., 2023. Role of Nano Materials in Enhancing Performance of PV/T System: A Comprehensive Review. National Conference on Industry 5.0: Emerging Technology Engineering in National Institute of Technical Teachers Training & Research, Chennai.

Smart Staircase Cleaning and Mopping Robot

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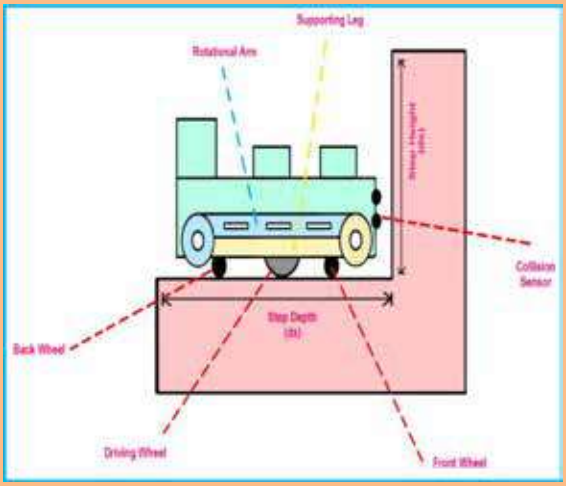
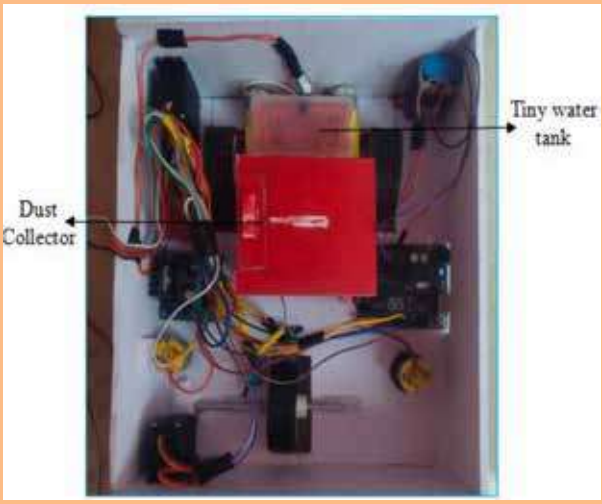


Robot Design



Inner View of the Robot

OBJECTIVES

Using robots for cleaning surfaces, glass, rooms, etc. are not new and are in the field of research for more than a decade. But when it comes to staircase cleaning, we see that the research area is only a few years old. The main reason is the enormous difference is design mechanism when it comes to vertical climbing robots compared to the robots that move over surface. These robots function in 3-D space where as surface cleaning robots function in 2-D space which is comparatively easier to design and implement compared to the 3-D space robots. Hence it is proposed to design and develop a lightweight staircase cleaning and mopping robot which can be widely used in hospitals, multi-storey buildings, shops, etc.

In this robot, a pair of legs will be used for stair climbing. Rotating around the main body, the legs of the robot will drive the feet to execute revolving but translational motions, thereby allowing the robot to climb. The new robot will be highly compact compared with most traditional stair-cleaning or climbing robots, because only one motor is going to be utilized to drive the climbing mechanism and the legs will be retracted at both sides of the robot when it is not climbing. Thus the climbing mechanism will use only one motor to drive the legs for climbing, and the legs can be retracted at both sides of the robot when it is not climbing. Consequently, the new robot will be compact enough to move along with the risers to do cleaning on the stairs.

The rotating mops on the front of the robot and a foam roller at the backside can do the mopping process perfectly. There is a water pump and water reservoir to throw water on the floor and make the mops moist for proper cleaning. The foam roller is movable which means it can be lifted when not in use. Then moppers are constructed and are placed in the front of the robot. There is a water pump which carries the water from the reservoir and spills it near the mops on the floor. A rubber tube will be connected to the inlet of the pump to take water from the reservoir from the pump and the tube will be used to take water from the pump to the floor. The two mop rotors are connected in parallel such that the left one runs anticlockwise and the right one turns clockwise when seen from the front.

ACHIEVEMENTS

- A detailed and depth survey was made on existing staircase cleaning robots. This survey also includes the mopping process of floor cleaning robots.
- The climbing mechanism on the stairs is designed and compared with other climbing mechanisms on the stairs.
- The designed climbing mechanism is implemented using necessary hardware components and the same has been embedded in the designed robot.
- The cleaning and mopping process is achieved through the vacuum units which consist of two different types of brushes, namely main roller brushes and six-armed brushes, and are also controlled by motors.
- The robot is tested against the climbing, cleaning, and mopping process processes are controlled with the help of the program dumped in Arduino.

PUBLICATION

K. Surya Perumal, S. Thahir Ibrahim, Dr. S. Dheenathayalan & Dr. K. Mohaideen Pitchai, "Design and Implementation of Smart Staircase Cleaning and Mopping Robot" submitted in the IEEE International Conference on Innovative Data Communication Technologies and Applications [ICIDCA 2023] organized by Department of CSE, Graphic Era Hill University, Dehradun, Uttarakhand, India, 14-16 March 2023.

Legacy of IEI

Smt Pratibha Devisingh Patil, President of India, lighting the lamp to mark the General Assembly 2007 of the World Federation of Engineering Organizations (WFEO), hosted by The Institution of Engineers (India) at New Delhi

Experimental Evaluation of Mixed Mode Fracture Toughness of Aluminium Metal Matrix Composites and Validation Through Mathematical Modeling

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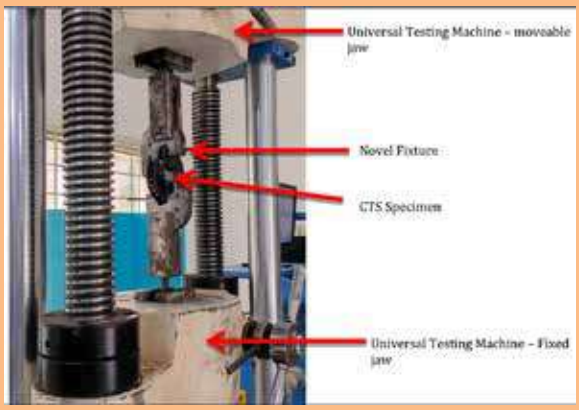
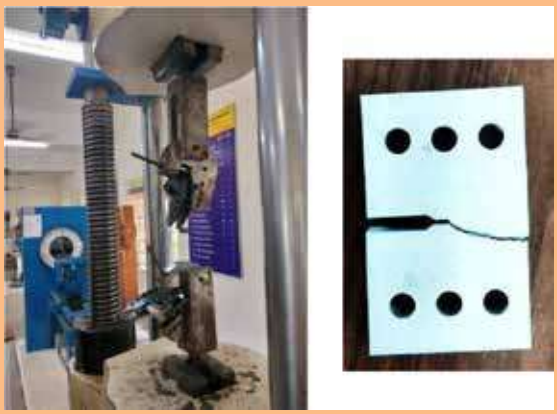


Fracture Testing –fixture with CTS Specimen in UTM



Specimen in the UTM after fracture, fractured specimen

OBJECTIVES

The metal matrix composite materials in the sense, soft metals are improved in their material properties by infusing the hard reinforcement particles in it. The soft metals used are titanium, copper, nickel, magnesium, and aluminium. Among the above metals, aluminium is the metal used widely in aerospace, military and industrial applications because of its good mechanical, thermal, electrical properties and cost-effectiveness. Mostly brittle and ductile fractures of materials are the predominant categories of failure modes. So most of the researches are executed based on pure tensile mode of fracture (Mode I) and fatigue fracture. But the real fracture is not only coming under the mode-I in the advanced applications. Here the main objective of the proposed project is to evaluate the mixed-mode (mode I/II/III) fracture toughness for aluminium metal matrix composites. A new loading fixture should be fabricated to give the mixed-mode loading and the fracture test should be carried out using the new loading fixture on the Al metal matrix composite fracture specimen. The results should be validated through numerical analysis and mathematical modeling. The proposed Experimental technique is expected to most effective to evaluate the mixed-mode fracture toughness of metal matrix composite materials and the validation process is expected to most accurate with the experimental evaluation.

ACHIEVEMENTS

1. The Novel Fixture has been fabricated successfully.

FABRICATION PROCESS OF FIXTURE: Fixture fabrication process is having the following steps

- Mold creation:
- Preparing and clamping the mold:
- Pouring Molten Metal into Mold:
- Allowing Metal to Cool:
- Remove Hardened Casting from Mold:
- Drilling Metal from Final Casting:
- Surface Hardening:
- Polish & Finish Final Product:

2. CTS specimen has been tested and the fracture toughness has been evaluated for AMMC.

Testing of the specimen in UTM Machine :

The three type of mode of load is applied on the testing specimen and the mixed mode of load is also applied on the specimen, how the material is crack is propagated and how much load the testing specimen can withstand on it.

These are the different mode of testing with the different angle of the fixture where α represent the in plane angle of the fixture and the β represent the out plane angle of the fixture

Tensile testing in the specimen :

The fixture is fixed in the UTM machine and the inplane angle of the fixture is α = 0° and the outplane of the fixture is β= 0° where this angle represents the tensile mode testing is acting on the specimen.

Tensile mode before loading

Tensile mode after loading

Broken piece of Tensile load

Shearing testing in the specimen :

The fixture is fixed in the UTM machine and the inplane angle of the fixture is α = 90° and the outplane of the fixture is β= 0° where this angle represents the shearing mode testing is acting on the specimen.

Shear mode after loading

Broken piece shear loading

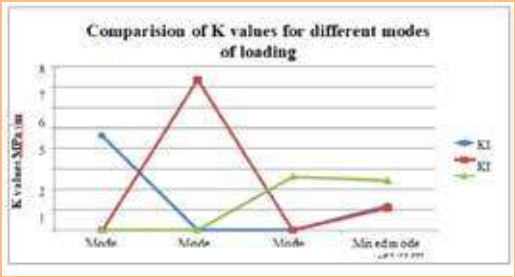
Mixed Mode of testing in the specimen :

The fixture is fixed in the UTM machine and the inplane angle of the fixture is α = 30° and the outplane of the fixture is β= 60° where this angle reprents the mixed mode of testing is acting on the specimen , here the three types of different load is acting on it.

Mixed mode After loading **Broken specimen of mixed mode loading**

The fracture test is conducted in the UTM with the use of special fixture on CTS specimen of AMMC. The fracture load "P" is taken from the experiment and the Stress Intensity factors for different modes were calculated using calibration factors. Finally, the Fracture Toughness value (KT) is determined the calculation. The fracture toughness values of AMMC with different modes of loading is shown in the Table.

Loading Condition	α (°)	β (°)	Pmax (KN)	KI MPa√ m	KII (MPa√m)	KIII (MPa√m)	KT (MPa√m)
I	0	0	10	4.60	0.00	0.00	4.60
II	90	0	10.05	0.00	7.33	0.00	7.33
III	0	90	5.55	0.00	0. 0	2.60	2.60
I/II/III	30	60	5.95	1.19	1.09	2.41	2.90



Comparison of K values for different modes of loading

DISCUSSION ON THE RESULT

In the Hardness testing the Rock well hardness of the metal matrix composite is higher than the pure Aluminium metal obviously. It shows that the dispersion of the reinforced particle is more or less uniform in the matrix material. Then the fracture testing is carried out for finding the stress intensity values and the Fracture toughness values for the AMMC for different modes of loading. The stress intensity factures are higher values in their individual modes, zero in the other mode and an average value in the mixed mode. The fracture toughness values for mode II is very high and the mixed mode fracture toughness value is very low.

PUBLICATION

1. Gururaj C, Rajakarunakaran S, Mr.Jerlin Nafel J R, Mr. Rishikesh K, Mr. Nandhakrishnan R, Pitchipoo P "Experimental Evaluation of mixed mode fracture toughness of pure Aluminium metal through a special fixture" - in the International Conference on Contemporary Research Advancements in Mechanical Engineering - 2023 (ICCRAME 2023) organized by Ramco Institute of Technology on 24th & 25th March, 2023.

Development of CoCrFeNiMn High Entropy Alloys (HEAs) by Additive Manufacturing (AM) Assisted Metal Injection Molding (MIM)

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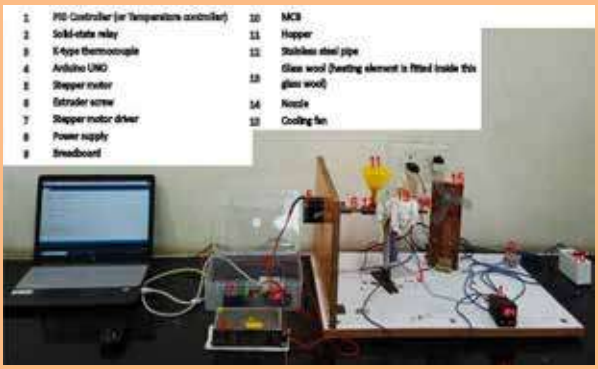

Developed Filament Extruder

3D printed 20:80 Al:PLA composite

OBJECTIVES

1. Powder feedstock preparation to develop strong AM printed components.
2. Development of AM nozzle (based on feedstock characteristics) to print component using AM assisted MIM process.

PROCEDURE

To fabricate Al-PLA composites, PLA granules are melted at 185°C and held for 30 minutes in muffle furnace. After reaching the desired temperature (between 180°C to 185°C), Al powder was added to the melt slowly and stirred. For the study, different wt.% of Aluminium powders were added in PLA melt to develop different Al: PLA composites (60:40,70:30,80:20). Later, the optimized composition is selected for filament development using the in-house developed filament extruder. For filament extrusion, an in-house filament extruder has been developed. The auger drill bit is inserted in a stainless-steel pipe with 1.5 mm clearance between the inner surface of the pipe and the outer surface of the auger bit. The auger bit is used to feed the material to the front of the pipe where nozzle of 1.75 mm is fitted. To rotate the auger bit, a Nema 23 stepper motor with 18.9 kg-cm rated torque is used with a TB6600 stepper motor driver. The controller was made using Arduino UNO to control the rpm of the motor. 125 W heating element is surmounted on the pipe near to the nozzle. A k-type thermocouple is fitted near the heating element to sense the temperature. The heating element is connected to a solid-state relay (SSR) which in turn is connected to a temperature controller which is used to control the temperature and set a constant temperature. The extruded 1.75 mm, Al/SS: PLA filaments are thereafter to the assembled 3D printer to fabricate the component which is later sintered to get strong densified part.

RESULTS

Different weight percentages (60, 70, 75, 80) of metal Al:PLA composites are studied. Using an in-house manufactured filament extruder; different compositions of metal-PLA composite filaments are successfully extruded. A good composite was achieved for 60:40 Al: PLA composition at 220°C. Microstructure results showed uniform distribution of Aluminium particles in PLA matrix. These composite filaments were used as a feedstock material for an FDM 3D printing machine to create metal 3D parts. The FDM printer was designed and operated using the parameters calculated as discussed in section 1.1 to obtain good prints with 60:40 Al: PLA and 30:70 SS: PLA composite compositions. However, with increase in metal addition, filaments became brittle and created issues during their 3D printing. Therefore, further studies on raw material preparation are required to increase metal content in PLA matrix.

ACHIEVEMENTS

1. Fabricated extruder for Metal alloy: PLA filament:

   In house filament extruder as shown in Fig 1 has been developed for fabrication of different compositions of Al: PLA and SS:PLA filaments

2. 3D printing of composite structure

   Developed composite filaments of 1.75 mm has been printed into 3D parts using 3D printer shown in Fig 2.

Legacy of IEI

Dr Shankar Dayal Sharma, Hon'ble President of India, lighting the lamp to mark the inauguration of the Platinum Jubilee of IEI on December 17, 1994, in presence of HE Governor of West Bengal Shri K V Raghunatha Reddy and Shri Jyoti Basu,Chief Minister of West Bengal

Determination of Microplastics in Contaminated Soil and Removal

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Organic matter digestion step

Contaminated agricultural site image

OBJECTIVES

The goal of this novel research was to identify, characterize and suggest end use of the removed microplastics from urban/semi-urban contaminated soil. The objective of this proposed research work is explained in the following text.

The First objective was to identify microplastic (MP) contaminated soils in the study region; with data quantification for uncontaminated soil as base reference. This activity is followed by soil sampling using standard operating procedures/ peer reviewed publication references. The sample obtained was subjected to drying and homogenization followed by sieve analysis. The next step- the oxidation treatment for which boiling hydrogen peroxide(H2O2) and Fenton's reagent catalyses' the reaction, commonly used in soil analysis to remove soil organic matter. This is followed by density separation by NaCl of MPs from sample. Saturated NaCl solution is used to achieve maximum density separation. The supernatant obtained from either of the methods was then subject to vacuum filtration unit with cellulose and anopore filter of different sizes.

The second objective was to classify and identify the MPs from the results obtained from the first objective. The identification and characterization of MPs obtained from the processed sample was studied using Scanning electronmicroscope (SEM) and Energy dispersive X-ray analysis spectroscope (EDX). The MPs are also identified and classified using FT-IR spectroscopy.

The third objective was to identify removal methods of MPs from soil by choosing appropriate options either by microorganisms or fungal degradation, bacterial degradation, microalgae, adsorption, magnetic extraction,electrostatic separation, biofiltration, chemical coagulation, electrocoagulation, etc.

ACHIEVEMENTS

The persistence of microplastics (MPs) in agricultural lands using plastic mulch will be an issue of major environmental concern in meeting the sustainable development goals (SGDs) of the near future. This research work aims at identifying and removal of MPs from rainfall runoff water (RRW) from MP contaminated agricultural lands using the novel electrochemical coagulation (ECC) treatment technology. The MPs were extracted from the soil samples before identification. In this project, the level of contamination of agricultural soil and urban informal landfill soil by microplastics was determined. The abundance of microplastics based on their shape and size was analyzed. The extraction of MPs from the soil samples was done by density separation by NaCl method; followed by organic matter digestion by Fenton's reagent. Identification of the extracted microplastic particles was done by scanning electron microscope, energy dispersive spectroscopy and FT-IR spectroscopy which allowed us to determine the polymer type of MP particle extracted from both contaminated agricultural and landfill soil samples. Removal of microplastics from the agricultural runoff water was done by the novel electrochemical coagulation method with efficiency up to 98.5%. The batch ECC experimental results showed higher order removal of MPs from RRW in addition to utilization of alkalinity, removal of COD and chlorides from RRW giving clear supernatant. The water quality parameters influencing the removal of MPs from RRW were analyzed. Through analytical observations, MP particles showed degradation into fibres, flakes, fragments, and bur etc. It is interpreted that MP particle disintegration into nano sized plastics (NPs) in the soil/runoff water can greatly increase the COD values and impair the salt mass balance. This research allowed us to evaluate the level of contamination of the semi-urban vegetable farmland and urban informal landfill soil by microplastics. This data is useful to the agenda of National 'Clean India' program for effective plastic debris removal management; provide avenues for developing and using new methods for removal of microplastics from microplastic contaminated soil. The data also allows to develop allows a conceptual framework for estimating the risk and impacts of Microplastics associated with soil and water. Microplastic removal from the environment enhances the welfare and improves ambience of natural eco-systems.

PUBLICATION

1. Presented a paper titled "Identification of microplastics in contaminated urban informal landfill soil with removal methods" in International Conference on Engineering Innovation (ICEI 2022), organized by the Jain Institute of Technology, Davangere, India in association with Technical Institute for Engineers, Bangalore on 3rd June, 2022.
2. Submitted research article titled "Identification and removal of microplastics from contaminated semi-urban agricultural soil using electrochemical treatment technology" at Chemical papers, Springer.
3. Submitted research article titled "Identification of microplastics (MP) from urban informal solid waste landfill soil; MP associations with COD" at Water Science and Technology, IWA.

Smart Brief

Since the 1990s, new areas of tribology have emerged, including the nano tribology, bio tribology and green tribology. These areas study the friction, wear and lubrication properties at nano-scale, in bio medical applications (human joint prosthetics, dental implants) and ecological aspects involved in study of tribology of clean energy sources, green lubricants and biomimetic tribology.

Establishing Novel Screw Hydroturbine with Optimal Design: Sustainable Potential in Rural India Electrification

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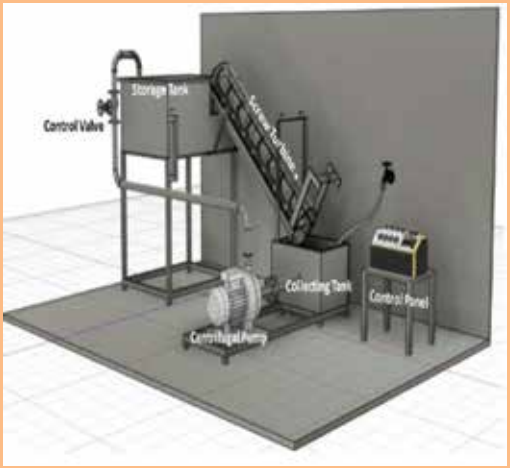

Schematic showing facility - Novel Screw Hydroturbine with Optimal Design

Final fabricated facility - Novel Screw Hydroturbine with Optimal Design

OBJECTIVES

The main objectives of the present work are formulated as follows:

- Screw hydroturbine's efficiency is always a function of turbine geometry and mechanical losses. We have to study how to maximize the volume of water lifted and efficiency in one turn of the screw by combining internal and external parameters, using Modelling and Experimental Study optimization.
- Here we developed one experimental testing facility, which helps in understanding
  - ❖ The effect of variation of mass flow rate
  - ❖ Effect of variation of the angle of inclination (β)
  - ❖ Effect of variation of number of blades on the flow pattern and pressure on the turbine system
- Developed a model that predicts Screw Hydroturbine's performance and accounts for inlet loss, outlet loss, gap leakage losses, overflow leakage losses, and frictional effects.

ACHIEVEMENTS

A specific research plan has been developed to achieve these objectives, which will help develop a new test facility. Low-head hydroturbine development can also provide the following:

1. Long-term economic benefits to local populations
2. Enhance sport fishing chances in head ponds by improving water access and navigation
3. Improve resource users' access to previously inaccessible places
4. Community members will receive income and jobs as a result of the benefit.

The obtained results show the compatibility of the turbine being utilized for electricity generation in distant places, which will enhance the living standards of the people and open up new opportunities for development in these places.

PATENT

Establishing Novel Screw Hydroturbine with Optimal Design: Sustainable Potential in Rural India Electrification [Under preparation]

PUBLICATION

Establishing Novel Screw Hydroturbine with Optimal Design: Sustainable Potential in Rural India Electrification [Under review in Journal of Hydraulic Engineering, 2022].

Mr Tathagata Roy, Hon'ble Governor of Tripura delivering inaugural address during the 30th Indian Engineering Congress at Guwahati in December 2015

Legacy of IEI

Design, Development and Fabrication of a 10 Tonne Portable Hydraulic Press for Powder Compaction

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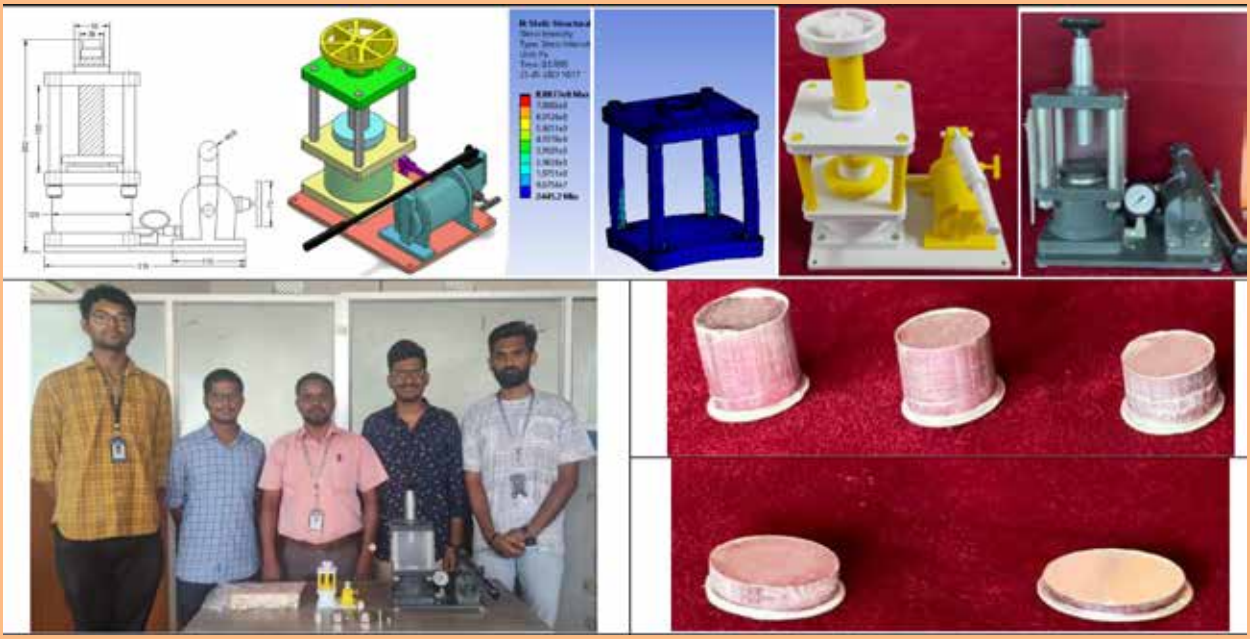

Design, Development and Fabrication of a 10 Tonne PortableHydraulic Press for Powder Compaction

OBJECTIVES

1. To make indigenous design for a portable 10 tonne hydraulic press for powder compaction
2. To model the machine in 3D as per the design dimensions
3. To perform finite element (static structural analysis) to check the structural integrity of the housing
4. To manufacture a prototype model of the machine and check the feasibility and intricacies involved in fabrication
5. To fabricate the machine and produce powder compacts with different weightpercentages of aluminium AA7075 and graphene.

ADOPTED PROCEDURE

Presses are pressure exerting machine tools which are widely used in achieving multiple manufacturing operations such as forming, blanking, piercing, bending, and shearing in the industries. A hydraulic press is a machine that uses pressurized liquid to generate compressive force. These machines are made up of a simple cylinder and piston mechanism. These presses are preferred when very large nominal force is required. This is a very flexible pumping system and can be used to produce a variety of volume wells. A Hydraulic Press works on Pascal's Law. Pascal's Principle states that when pressure is added to a liquid at rest, there is an identical increase in pressure at all points. It deals with the law governing the equilibrium and motion of fluid. It has the advantage of producing larger forces when compared to the electrical and mechanical systems.

The aim of the project is to design, develop and fabricate a portable 10 tonne hydraulic press for powder compaction is done successfully. For a load of 10 tonnes, Firstly, the area on the cap side of the cylinder is calculated with an initial assumption of the relief valve pressure. Based on the calculated area, the bore diameter of the cylinder is determined. The standard bore diameter of the cylinder available in the market is adopted to the higher side. Secondly, the flow rate of the fluid in the pump is calculated, assuming flow velocity of the fluid. Thirdly, with motor speed, volume of discharge and pump efficiency assumptions, the displacement of the pump is finalized. Finally the motor power for the pump is arrived at based on the torque developed and the power requirements for the motor to run the pump. The nearest standard Horse Power (HP) for the motor on the higher side, commercially available in the market is adopted. The dimensions of the hydraulic press with hydraulic circuit are finalized. The designed dimensions are converted into 2D engineering drawings, 3D models are generated. Finite Element Analysis is performed for the hydraulic press housing, for strength in ANSYS through static structural analysis. The design is found to be safe from the von-mises stresses induced. A 3D model is printed in the Ultimaker 3D printing machine by Fused deposition Modelling. The 3D printed assembly of model is checked for the feasibility of the fabrication. The portable 10 tonne hydraulic press for powder compaction is fabricated as per the designed dimensions successfully. The fabricated machine is tested for performance through experimental investigations and tested successfully. The powder compacts are made with AA7075 powder alone and in various percentage compositions of AA7075 and graphene powders. The machine is producing metal compacts to the industry standards.

ACHIEVEMENTS

1. In this project, a low cost experimental set up is fabricated for powder compaction of light alloys. The aim of the project is to design, develop and fabricate a portable 10 tonne hydraulic press for powder compaction is done successfully
2. For a load of 10 tonnes, a hydraulic pump with a relief valve setting of 12 MPa and further a 3 phase induction motor with 1440 rpm is selected. The thickness of the hydraulic press housing is determined based in the pump and motor power.
3. The 2D drawing of the designed parts and 3D models are generated for the structural analysis of the housing. Static structural analysis of the hydraulic press housing performed is observed to be safe from the von-mises stresses induced.
4. A 3D model is printed and the assembly of model is checked for the feasibility of the fabrication.
5. The portable 10 tonne hydraulic press for powder compaction is fabricated as per the designed dimensions successfully. The powder compacts are made with AA7075 and graphene powders with different weight percentages and tested successfully.

Development of Semi-autonomous Wide-area Surveillance System for Multiple Emergency Situations

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Starting phase of flight

At the beginning of flight

Under controlled flight

At very high altitude

OBJECTIVES

For monitoring environmental and disaster situations as well as providing video embedding capabilities, several drone-based surveillance systems have already been created or suggested. The majority of the time, however, a specific sort of activity is focused with design, which limits its capacity to be reused. More specifically, payload flexibility is not taken into account along with real-time monitoring. If implemented, this feature can benefit sick persons who are staying alone. Additionally, by dispersing compressed CO_2, it can be effective in circumstances of early breakout. Civil security is now taken into consideration, thus a multi-purpose surveillance system is now required. This system not only offers medical services to the most remote areas, but also works in tandem to safeguard civilians using a variety of methods.

Accurate control

ACHIEVEMENTS

We have created a wide-area surveillance FPV UAV that is semi-autonomous and can transport payload. Real-time monitoring, coordination, and payload flexibility are all features of the drone. The solution is successful in that it allows the drone to effortlessly travel through a very small area that is narrower than it would normally be under regular operating conditions. Our UAV monitoring systems will offer consumers interested in civic security and public safety a lot of advantages. Both the final PID value setting and the take-off flying condition are correctly calibrated. This is a significant step towards creating a fully autonomous drone soon.

In the testing stage, the entire system is capable of surveillance coupled with a 1 kg payload. The entire system is easily controllable in order to move through a very small space that is smaller than the system itself. Also, because of the camera's attachment, images can be taken while flying. Nonetheless, the camera's resolution has a direct impact on the image quality. When capturing images, the setting is also important. In test conditions, both the payload and the surveillance system are currently operating without a hitch. Flexibility in payload and real-time coordination has been accomplished. Despite being semi-autonomous large area surveillance UAV, further adjustments can be performed. Very accurate control can be made near the roof of the houses which s very much desirable for flying in congested areas.

The semi-autonomous wide-area surveillance UAV that was suggested in the project's motivation section is implemented at a very low cost and has the ability to carry payload and take photos in real-time. The fact that the entire system was constructed for less than INR 15,000 (roughly) says volumes about the quality of the work. The literature review for this project shows that there are very few reports of this kind of inexpensive unmanned vehicle. All of the photographs may be stored in the cloud and later easily accessed. As a result, this effort might be seen as both real-time monitoring and surveillance. The weather when taking the photo is, nevertheless, the biggest disadvantage. A extremely high resolution camera, which also has a negative effect on the cost function, can solve this problem.

Design and Development of IoT-based Smart Devices to Measure Air and Soil Condition in Agriculture Fields

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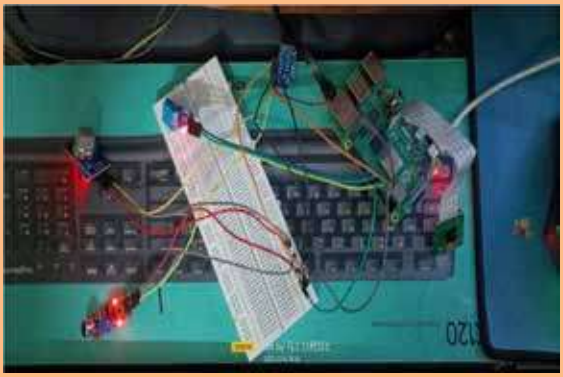
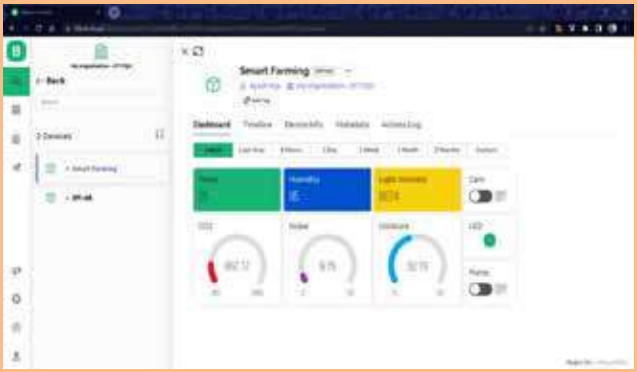


Prototype Model



Snapshot from Blynk Web

OBJECTIVES

In this project, we are using various devices and sensors and with the help of the Internet of Things (IoT), we are connecting with the internet to partially automate the farming methodologies. Farming is a labour-intensive process and with the growing population and degrading climate, it becomes difficult to scale up agricultural production. With the help of a central node and various sensors, we are trying to monitor and measure agricultural parameters like temperature and humidity, soil moisture, light intensity, plant health, atmospheric carbon dioxide (CO2) content, and pest monitoring for the output response we are using a relay to control the water content in the soil.

In this prototype model, various sensors measure the intended parameters and send them to the central node. From this central node, the sensed data is transferred to the Blynk Cloud website and Blynk Mobile App. The user can monitor the parameters and accordingly give the desired response through the cloud service with the help of smart devices like smartphones or other handheld devices without being physically present at the agricultural perimeter. The user can remotely give the desired response from faraway places. In this model, the output response is turning on and off a water motor with the help of a relay.

An advanced IoT-based devices namely “SmartTech-Agri” have been designed and developed. These proposed devices are employed to measure and monitors the health condition of soil, plant and agricultural product in regular basis. These devices are also responsible for safety and security of the field. The UNO_R3_Wi-Fi_ATMEGA328P_ESP8266 development board are employed which can measure and monitor several parameters

like moisture, temperature-humidity, Ph, NPK, etc. The PIR, motion, gas, smoke, color sensors are located in the field and transmit the data through a Web application. The data is sent to the cloud platform via TCP and is fetched from the sensor using the REST API protocol. This approach will lower the agricultural industry's overall labour costs and cut down on water waste.

ACHIEVEMENTS

The major contributions of our project are as follows:

i. Design an effective irrigation system to measure continuous monitoring of moisture.

ii. Proposed smart devices responsible for safety, security and protection of agricultural field especially in firing condition, and attacking of birds and animals.

iii. Detection of pesticide in agricultural field.

iv. Monitoring and detection of green house gases, temperature, humidity and light in green house agricultural production system.

v. Continuous monitoring and detection of the health condition of plant and their product using color sensor.

vi. Develop a prototype model of smart digital agriculture by employing Raspberry Pi.

vii. Develop a communication security application protocol (REST API).

viii. Analysis and visualization of the data stored in cloud platforms (Amazon Web Services, MS Azure, Google, etc) are being accessed through smart devices.

PUBLICATION

"Design and Development of IoT-based Smarttech-Agri Devices for Smart Agriculture Crop Field", (IEIB-D-22-00492), [1]Tapan Maity, [2]Samaresh Paul, and [3]Dr. Jagannath Samanta, Journal of The Institution of Engineers (India): Series B

Legacy of IEI

Shri Atal Bihari Vajpayee, Hon'ble Prime Minister of India, greeted by Shri G P Lal, President of the Institution on the occasion of World Congress on Sustainable Development during January 20-23, 2000

Smart Economical Irrigation and Air Pollution Control and Monitoring System for Rural and Industrial Area

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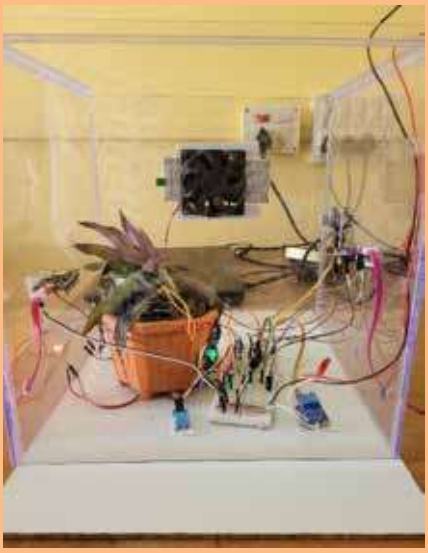


Full Set Up of the project

Snapshot from Blynk Web

OBJECTIVES

The system proposed here is suitable for monitoring the quality of the cultivated yield in a pollution-free environment. The main objective of the proposed module is to detect the moisture level of the soil and maintain a specified moisture level and temperature of the soil. Along with maintaining the proper soil moisture the proposed system also monitors & controls the air quality of the atmosphere by detecting the pollutants present in the atmosphere and filters the pollutants of air. It also gives a message to the user if the pollutant level goes beyond the level. Hence, resulting in improvement of the quality of crops. The continuous data acquisition of the soil and air parameters leads to prevention of soil erosion and drought or the pollution caused by the power plants and industrial factories the effect of any particular element present in the air can also be monitored and under control with the help of the proposed module. Automated water supply will reduce the power consumption of the pump and wastage of water is reduced.

Moreover, the power supplied to the whole system is from rechargeable photovoltaic batteries that will save artificial energy consumption.

The selector switch is also introduced in the system for manual operation in the cases of some crops which need over flooded cultivation. These will decrease the human labor of the farmers and integrates the gross yield per

acre of the cultivation, which makes the farming process more sustainable, advanced and hassle-free.

TOOLS AND COMPONENTS

NodeMCU, Soil moisture sensor. DHT11, MQ135, Relay, Motor Pump

PROCESS OF WORKING

The proposed system is completely based on the wireless sensor technology, which makes the system automated and smart for enhancing the irrigation in the rural and suburban area. The function of the system can be analyzed in two units: (i). Smart Irrigation Unit (ii) Smart Air Pollution Monitoring and Control Unit.

The function of Smart Irrigation Unit is to measure the volumetric water content of the soil and in according to that control the action of the motor pump and to monitor a suitable temperature and humidity level to provide a proper atmospheric condition to crops. The microcontroller is programmed such a way that the five important irrigation actions can be

implemented to the system for the time-to-time monitoring of the system mentioned as follows:

i. Control the timer attached with the sprinkler system;

ii. Fixed duration for manual irrigation with the push button;

iii. Scheduled date and time irrigations through the web page for any desired time;

iv. Automated irrigation with a fixed duration, if at least one soil moisture sensor value of the wsn drops below the programmed threshold level;

v. Automated irrigation with a fixed duration, if at least one soil temperature sensor value of the wsn exceeds the programmed threshold level

The function of Smart Air Pollution Monitoring and ControlUnit is to measure the air index of the atmosphere surrounded by the farming land to study the air pollution of the corresponding area. To prevent harmful pollutant materials, this unit has hepa filters on the walls of area. The aqi of the filtered air is further checked and if the value goes beyond the controlled zone the system will send an alert message to the local authority so that necessary control actions could be taken.

RESULTS

1. **Soil Moisture Sensor Data Acquisition**

created-at	Type	entry-id	Type	field1
2021-02-24T14:29:44Z	DateTime	255	Integer	100
2021-02-24T14:30:00Z	DateTime	256	Integer	100
2021-02-24T15:32:21Z	DateTime	262	integer	100
2021-02-24T16:36:47Z	DateTime	269	integer	100
2021-02-24T17:35:50Z	DateTime	270	integer	-0.1
2021-02-24T18:31:39Z	DateTime	291	integer	-0.1
2021-02-24T19:35:10Z	DateTime	292	integer	-0.1
2021-02-25T07:13:15Z	DateTime	302	integer	68.23
2021-03-04T19:33:27Z	DateTime	339	integer	53.27
2021-03-04T20:06:34Z	DateTime	349	integer	53.08
2021-03-04T20:46:55Z	DateTime	350	integer	53.08
2021-03-04T21:58:08Z	DateTime	354	integer	52.79

2. Temperature Sensor Data Acquisition

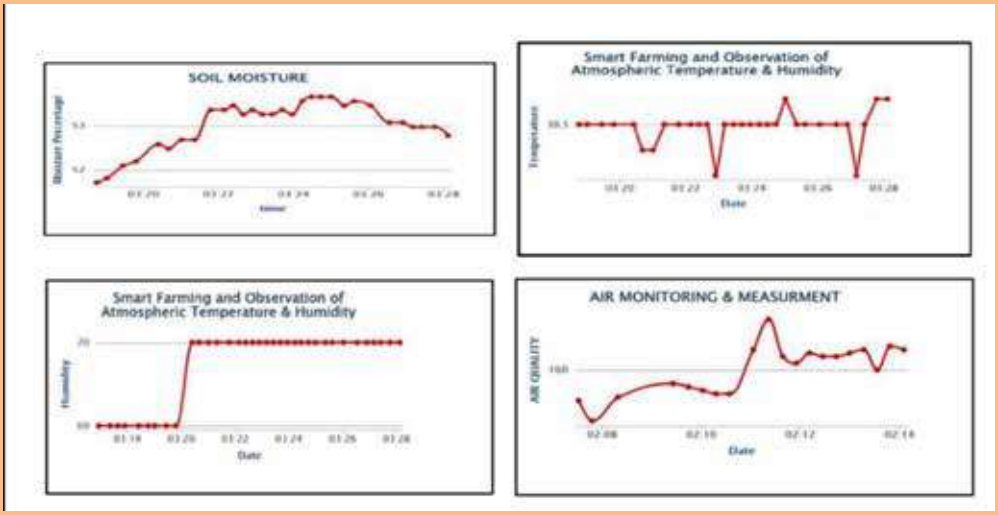
created-at	Type	entry-id	type	field2
2021-02-24T14:29:44Z	DateTime	255	integer	30.40
2021-02-24T14:30:00Z	DateTime	256	integer	30.40
2021-02-24T15:32:21Z	DateTime	262	integer	30.30
2021-02-24T16:36:47Z	DateTime	269	integer	30.50
2021-02-24T17:35:50Z	DateTime	270	integer	29.80
2021-02-24T18:31:39Z	DateTime	291	integer	29.60
2021-02-24T19:35:10Z	DateTime	292	integer	0.00
2021-02-25T07:13:15Z	DateTime	309	integer	30.10
2021-03-04T19:33:27Z	DateTime	339	integer	30.50
2021-03-04T20:06:34Z	DateTime	349	integer	30.50
2021-03-04T20:46:55Z	DateTime	350	integer	30.50
2021-03-04T21:58:08Z	DateTime	354	integer	30.60

3. Humidity Detecting Sensor Data Acquisition

created-at	type	entry-id	type	field3
2021-02-24T14:29:44Z	dateTime	255	integer	62.00
2021-02-24T14:30:00Z	dateTime	256	integer	62.00
2021-02-24T15:32:21Z	dateTime	262	integer	61.00
2021-02-24T16:36:47Z	dateTime	269	integer	60.00
2021-02-24T17:35:50Z	dateTime	270	integer	65.00
2021-02-24T18:31:39Z	dateTime	291	integer	65.00
2021-02-24T19:35:10Z	dateTime	292	integer	0.00
2021-02-25T07:13:15Z	dateTime	309	integer	41.00
2021-03-04T19:33:27Z	dateTime	339	integer	70.00
2021-03-04T20:06:34Z	dateTime	349	integer	70.00
2021-03-04T20:46:55Z	dateTime	350	integer	70.00
2021-03-04T21:58:08Z	dateTime	354	integer	70.00

4. AQI Detecting Sensor

created-at	type	entry-id	type	field1
2021-02-25T02:32:08Z	dateTime	233	integer	2
2021-02-25T02:32:24Z	dateTime	234	integer	222
2021-02-25T02:32:41Z	dateTime	235	integer	237
2021-02-25T02:32:57Z	dateTime	236	integer	168
2021-02-25T02:33:15Z	dateTime	237	integer	154
2021-02-25T02:33:44Z	dateTime	238	integer	128
2021-02-25T02:34:32Z	dateTime	241	integer	118
2021-02-25T02:34:49Z	dateTime	242	integer	115
2021-02-25T02:35:05Z	dateTime	243	integer	112
2021-02-25T02:36:41Z	dateTime	249	integer	111
2021-02-25T02:36:58Z	dateTime	250	integer	109
2021-02-25T02:37:14Z	dateTime	251	integer	112
2021-02-25T07:06:24Z	dateTime	252	integer	58.06



Graphical layout of the data aquisitions

ACHIEVEMENTS

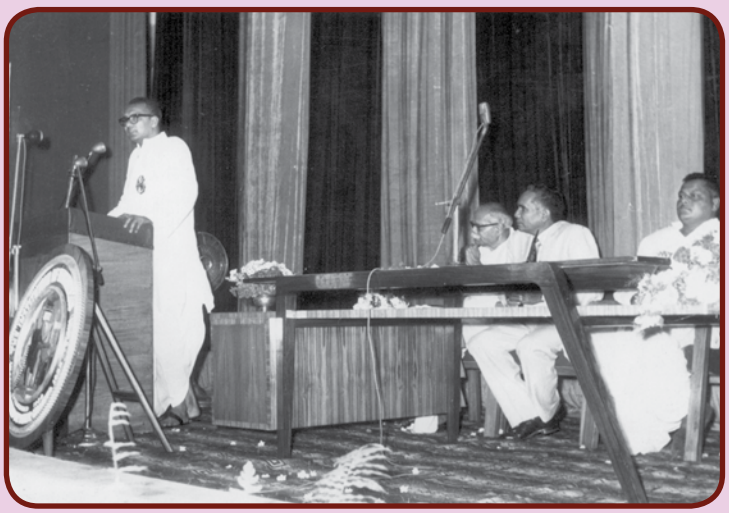
Winner at IEI Kolkata Student Conclave GNIT, Kolkata held at October 2021

PUBLICATION

i. Published as a Patent entitled as "A Smart Irrigation System With Controlled Pollutants Present In The Air In Rural And Industrial Area".

ii. Published Journal at Pramana Research Journal, Volume 12, Issue 5, 2022, "Smart Economical Irrigation and Air Pollution Control and Monitoring System for Rural and Industrial Area."

Legacy of IEI



Mr B Patnaik, Chairman, Planning Board, Orissa State addressing the Orissa Centre of The Institution of Engineers (India) at the 5th Annual General Meering

Real-Time Implementation of Fractional Order PID Controller for Quadratic Boost Converter in Electric Bicycle using Evolutionary Computation

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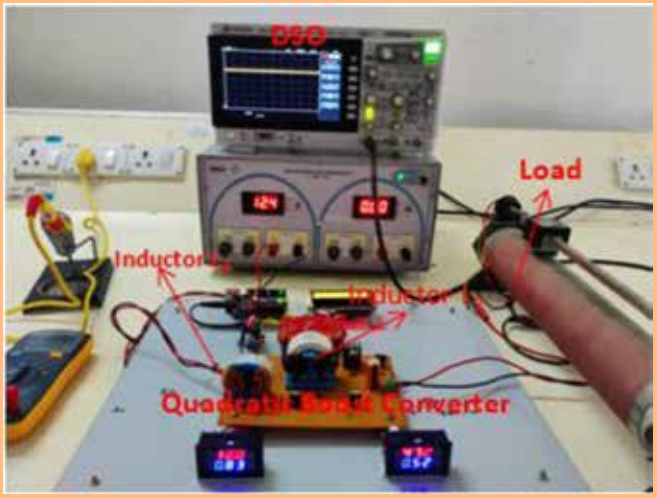
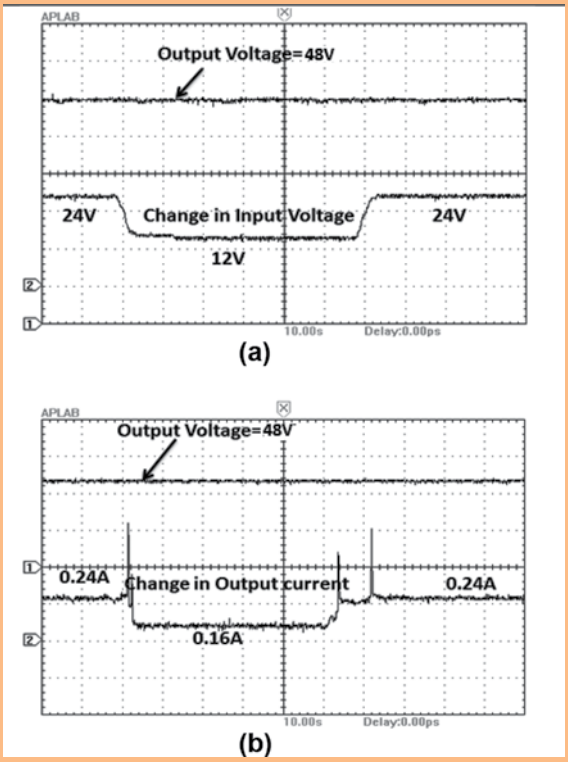


Experimental Setup for Fractional Order PID Controller for Quadratic Boost Converter



Experimental dynamic response of Quadratic Boost Converter under various (a) line and (b) load conditions

OBJECTIVES

Most of the power converters use PID controllers due to its simplicity and applicability to a wide range of problems. Quadratic Boost converters are one of the power converters which is commonly required in Electric vehicles, photovoltaic system etc. The output voltage is regulated using the switching pulse. Control of power converters plays an important role in achieving the requirements and standards of the relevant application. Whatever the application be major aspects driving the end goal will be reliability, energy efficiency, power density, complexity, and cost. The advent of converters in automation demands the controller domain to be more robust and flexible which drives the quality of control to the next level. This pushes the demand for a better performing controller which will be more trustworthy and accurate in control parts. PID controllers continue

to provide a better result for the controller action. Research was conducted to further improve traditional controller robustness. The limitations of the device, such as its sensitivity to process parameter adjustments and power degradation as system order increases forced researchers to strive for a solution for the new controller, which culminated in the introduction of fractional calculus to PID controllers. The entry of fractional calculus to the controller parameters, integrative and derivative part of PID controllers, makes the fractional controller. This makes controllers accessible with a maximum of five regulation parameters (Kp, Ki, Kd, λ, μ) against the three PID controller parameters (Kp, Ki, Kd). By applying the fractional operator, the advantages of having better control over dynamic systems and less prone to shifting parameters of a controlled system can be fully optimized.

OBJECTIVES

- To obtain optimal gains of Fractional Order PID (FOPID) controller in Quadratic Boost Converter (QBC) using evolutionary computation.
- To improve the dynamic performance of QBC using optimal FOPID controller.
- To build a hardware prototype for validating computed optimal FOPID parameters in the converter.

ACHIEVEMENTS

The proposed control methodology has been tested in a simulation MATLAB/Simulink 2019a environment and validated in real-time under various line and load conditions.

- Optimal gains of Fractional Order PID (FOPID) controller were obtained in Quadratic Boost Converter (QBC) using evolutionary computation.
- The dynamic performance of QBC was improved using optimal FOPID controller.
- Hardware prototype was built for validating computed optimal FOPID parameters in the converter.

The performance of the proposed multi-objective framework has been compared in terms of time domain specifications. It is observed that the FOPID optimal controller has reported better time domain specifications than the conventional PID controller. Also, it is demonstrated that the proposed converter design outperformed the line and load disturbances with lesser transient and better stability margins.

Legacy of IEI

Shri V P Singh, Chief Minister of Uttar Pradesh inaugurating 60th Annual General Meeting & Diamond Jubilee Celebration of Uttar Pradesh State Centre of the Institution in 1981

IoT Based Smart Food Waste Monitoring System

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Assembled Prototype

Employee data in mobile application

OBJECTIVES

The primary objective of an IoT-based smart food waste monitoring system is to reduce food waste. By accurately measuring and monitoring food waste in real-time, the system can help identify patterns and areas where food waste occurs. This information can then be used to implement targeted strategies and interventions to minimize waste and promote more efficient consumption of food resources. Another objective of the smart food waste monitoring system is to achieve cost savings for businesses and Institutions. By identifying and addressing areas of food waste, organizations can optimize their purchasing, production, and storage processes. This can lead to significant cost reductions by avoiding unnecessary expenses related to wasted food. The IoT-based system enables data collection and analysis, providing valuable insights into food waste patterns and trends. The objective is to leverage this data to make informed decisions and implement targeted strategies. By analyzing the collected information, organizations can identify areas for improvement, optimize operations, and develop evidence-based policies to further reduce food waste.

ACHIEVEMENTS

One of the key achievements of an IoT-based food waste monitoring system is a significant reduction in food waste. By accurately measuring and monitoring food waste in real-time, the system provides valuable insights that can be used to implement targeted strategies. This leads to more efficient consumption of food resources and a decrease in overall food waste generation. The implementation of a smart food waste monitoring system can result in cost savings for businesses and Institution. By identifying areas of food waste and optimizing purchasing, production, and storage processes, organizations can reduce unnecessary expenses. This cost-saving achievement is particularly beneficial for commercial establishments, such as Industries and Institutions. The IoT-based system enables better resource management by providing real-time data on food waste.

PUBLICATION

S Gurumoorthy, S Kannan, A S Vigneshwar "IoT Based Smart Food Waste Monitoring System", International Conference on Recent Innovation in Computer Communication and Manufacturing, dated 12th April 2023.

Legacy of IEI

Mr Keshari Nath Tripathi, Hon'ble Governor of West Bengal delivering inaugural address during the 31st Indian Engineering Congress at Kolkata in December 2016

Process Automation and Control Study on Solar Photovoltaic Thermal Water Collector System

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Schematic view of scaled solar PV/T system

Schematic view of the real-time solar PV/T system

OBJECTIVES

1. To design a solar PV/T water collector system: Primary objective of this work is to design a solar PV/T water collector system, solar energy based hybrid device which combines working principle of stand-alone solar PV module and water heater. It occupies less space in comparison with stand-alone systems. Design of such solar PV/T water collector system includes both electrical and thermal parameters.

2. To enhance heat transfer rate naturally by geometrical modifications: Increasing rate of heat transfer between heat transfer fluid and hot surface is directly proportional to increase in performance of solar PV/T water collector system. It is proposed to design a modified conventional flow system.

3. To compare performance of newly developed and conventional solar PV/T water collector system: In order to observe percentage change (increase or decrease) in performance of newly designed solar PV/T water collector system. It is proposed to compare its performance with conventional solar PV/T water collector system unit in terms of exergo-energetic aspect.

4. To conduct experiments with constant mass flow rates: An important parameter which influences performance of any thermo-fluid system is mass flow rate. Such a newly proposed system is to be tested under fixed mass flow rate of 0.5 kg/min.

5. To formulate fuzzy model: Fuzzy model based performance predicting are highly flexible, accurate, efficient, reliable etc in comparison with remaining prediction techniques. Such model is designed with an objective to obtain/identify effective combination of performance deciding parameters. It is proposed to design a set of two fuzzy inference system (mamdani and sugeno) for predicting and validating performance of solar PV/T water collector system under study.

6. To design automatic data monitoring and control system: To monitor and control the performance deviation of solar PV/T water collector system, it is planned to design a automatic control system.

ACHIEVEMENTS

- A real time solar photovoltaic thermal water collector kit is designed and fabricated.
- It's been available to our UG and PG students for demonstration purpose.
- A awareness among the student community to generate electricity and hot water simultaneously using solar PV/T module
- Area occupied is optimal in comparison with remaining stand-alone solar system
- First fuzzy logic expert system model for predicting solar double slope distillation still performance is developed.

Legacy of IEI

Mohammad Hidayatullah, Vice President of India, Mother Teresa and Shri Jyoti Basu, Chief Minister of West Bengal during the Diamond Jubilee Celebration of The Institution of Engineers (India) in 1980

Providing Water Conservation Method to Farms with Conveyor Belts by Rotational Drip System

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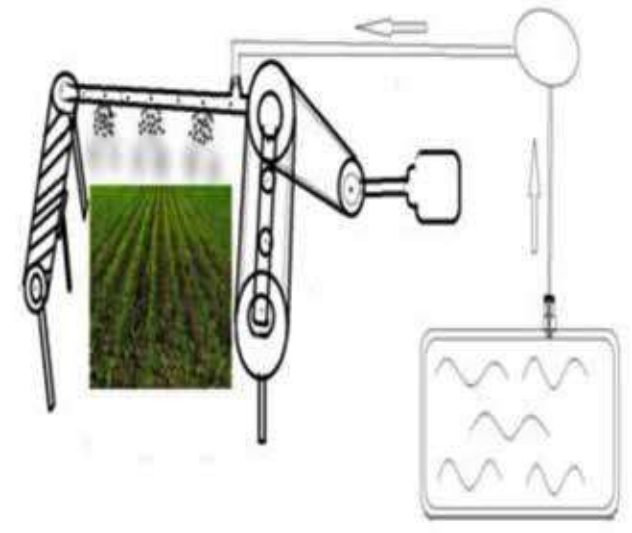

Schematic work flow shows the Water supplying to the entire farm field by using a Conveyor Setup (Motor, Pump and a Belt)

The Final project in real time implementation of the drip mode using a single drip pipe in a rotational process.

OBJECTIVES

1. The main objectives of this present project works are as follows:
2. The water conservation and the fluid supplements to the needed specific areas, reduces the cost.
3. Soil erosion studies are stated that the gradual increase of the soil manure and the plants grow strength.
4. These studies are carried us to many different ways in which this project accurately works on all types of whether conditions and helpful in many operational ways.
5. The Implementation of this project is useful in multi ways and covers all places of field.
6. Drip irrigation System should be handled in proper manner so that it works in efficient manner and gives the results as per Estimations.
7. Reduced the pipe leaks, damages and cracks usually occurs by the over temperature.

8. No need to bother about the property damages like leaks, cracks and breakings with humans or Animals occurrences.
9. We completely solve these Folding and Joint setting issues in the drip pipes.
10. The project having a nature feasibility so that the setup is placed in all regions with respect to shape, size, type of field.
11. The Fertilizers, Pesticides and all the chemical compounds are supplied easily to all parts of the plant which includes leaves, bark, stem, roots etc due to the rotational system the mode of mixing completely dissolves all chemicals and sprays well.
12. This project having a lot of Scope in many areas mostly in future because of the Water Scarcity and many of Issues related to Water Pollution causes many of harmful effects in the Supplying of Water to Farm Fields.

ACHIEVEMENTS

In order to achieve these objectives, a specific research plan has been developed that will brings out the roles played by the each and every component within the part of this project.

Towards this end of this project, the work is conceptualized in 3 phases:

a. To Make sure that, gather all the required materials and arrange them in a proper designed way.
b. The whole setup of all components in the field as per the shape of land and the type of crop in it.
c. Study of the working process is to check the working nature and to be estimated and gave the proper functionality of all working components in this test facility.

The approach of this model, results in occuring the suitable, stable and a safe one to the future farming.

Some of the benefits from this project are summarized as follows:

a. These test results can also be used to make many of the future developments and make to enhance the project to additional features. These things also make to change the present drip system to a best and efficient type mode of Automatic and Self-Adjusted Drip Irrigation System.
b. This project is helpful to the farmers in the higher altitudes and having the large area of farm lands. This project reduces the initial cost by minimizing the basic requirments and fulfill their needs in the present drip irrigation system.

A better understanding of the combination with the nature and science behind this project results to best mode of water conservation and cost effective to reduce the man power and makes farming easy to the future generations with the minimum resources also.

With engineering, I view this year's failure as next year's opportunity to try it again. Failures are not something to be avoided. You want to have them happen as quickly as you can so you can make progress rapidly.

Gordon Earle Moore

Design and Fabrication of River Cleaning Machine

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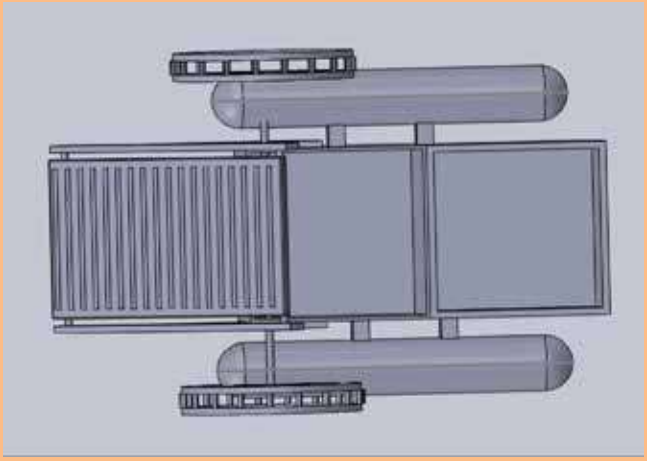
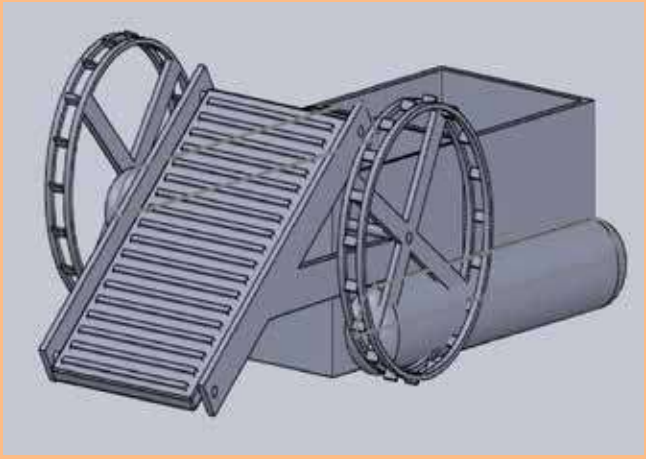
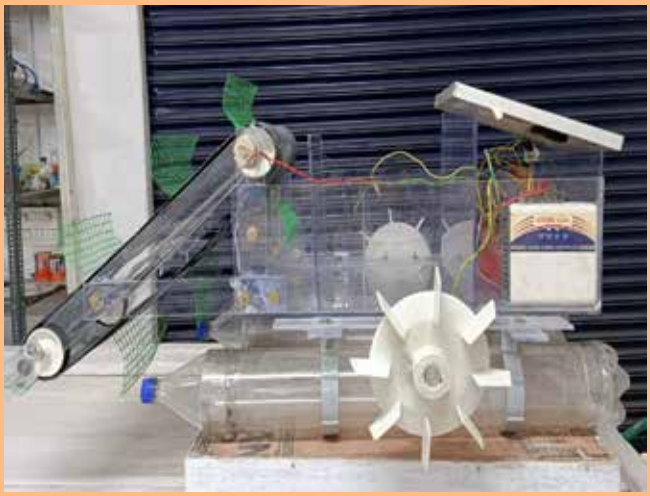


CAD Model Top view



CAD Model Right Side View



Final Assembled Model

During Testing in the Lab

Running Model

Model with Team Members

OBJECTIVES

1. Develop a fully automated river cleaning machine that is powered by solar energy and designed to consume minimum power while effectively cleaning the river.
2. Implement a remote-control system using Blue-tooth technology to allow for precise control and manoeuvrability of the cleaning machine.
3. Utilize green energy by incorporating a solar panel and solar controller to power the machine and reduce the reliance on traditional power sources.
4. Incorporate an efficient impeller design and paddle wheel system to ensure effective cleaning of the river while consuming minimum power.
5. Construct a durable frame using acrylic sheet and bearings to ensure stable operation and longevity of the machine.

ACHIEVEMENTS

1. The river cleaning machine designed and fabricated using the components such as solar panel, solar controller, battery, DC motor, bearings, coupling, belt drive, and acrylic sheet frame has shown promising results in effectively cleaning the river.
2. The use of solar power in the machine has made it a green energy solution with minimum power consumption, making it an environment-friendly and sustainable solution.
3. The use of remote-control technology, in combination with Arduino Mega and Blue-tooth, has made the machine fully automated and easy to operate from a distance.
4. The paddle wheel and intake have helped in efficient waste management by collecting and separating the waste materials from the water.

Overall, the project has successfully achieved its objective of designing a fully automated river cleaning machine powered by solar energy, which is an effective and sustainable solution for maintaining the cleanliness of the rivers.

Manufacturing of Passive Solar Tracking System

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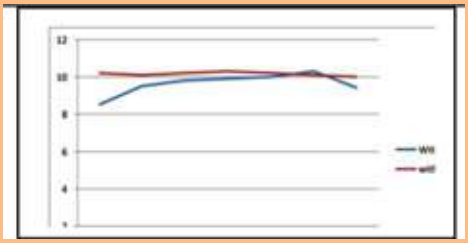
Model with the Students



Comparison of Conventional and with Tracker output of system

OBJECTIVES

1. To design the Solar tracker without consuming any energy produced by PV module.
2. To Provide the efficient Mechanical solution as passive tracking system.
3. To experiment the rise of net output of power using solar tracking and without tracking.
4. To write a research paper after finding the agreeable outcomes from experiments.

DESIGN PROCESS

Design process for the proposed solar power system involves several key steps:

1. Defining the requirements: This involves identifying the power requirements of the system and the specific application of the system, such as water pumping or irrigation in agriculture and domestic.
2. Selecting components: Based on the power requirements, suitable solar panels, tracking mechanism, and portable power unit will be selected.
3. Designing the sliding mechanism: A sliding mechanism will be designed to facilitate the movement of the solar panel, ensuring optimal positioning for maximum energy generation.
4. Designing the tracking mechanism: The tracking mechanism will be designed to adjust the tilt angle of the solar panel automatically based on the position of the sun, maximizing the energy output.
5. Designing the portable power unit: The portable power unit will be designed to provide flexibility in power requirements and ease of transportation.
6. Integrating the components: All components will be integrated to form a cohesive solar power system that is efficient, portable, and suitable for various settings.

7. Testing and refinement: The system will be tested and refined to optimize its efficiency and performance, ensuring that it meets the power requirements of the application.

CAD Model of Proposed solution

RESULT

We know that the angle between the sun's rays and the solar panel is crucial for achieving maximum efficiency. We can conduct an observation by changing the angle of the solar panel at the same time with the same load to determine how the output changes in relation to the position of the solar panel.

TIME	VOLTAGE (V)	CURRENT (A)
08:00 AM	8.5	0.681
10:00 AM	9.5	0.692
12:00 PM	9.8	0.705
02:00 PM	9.9	0.706
03:00 PM	10	0.705
04:00 PM	10.3	0.699
05:00 PM	9.4	0.698

Output of the steady 5 w solar panel with respect to time

TIME	ANGLE	VOLTAGE (V)	CURRENT(A)
08:00 AM	80	10.2	0.699
10:00 AM	75	10.1	0.702
12:00 PM	85	10.2	0.709
02:00 PM	90	10.3	0.710
04:00 PM	85	10.2	0.705
06:00 PM	80	10.1	0.698

Output of the 5 watt solar panel with tracker with respect to time

Table: 5W Solar Panel output without Tracker and Model with Tracker system

From above comparison following points are observed

1. Solar tracker without consuming any energy produced by PV module is designed
2. We got the mechanical solution as passive tracking system alternate to active tracking system
3. 15% rise of net output of power using the designed passive solar tracking is achieved as compare to without tracking.
4. Skill of publishing a article is gained.

The suggested solution of tracking system without any use of energy that develop from PV panel is a better aggregate which provides 15% more energy generation as predicted in review. Overall, the project offers a promising solution for optimizing solar energy capture through passive solar tracking. The report provides a comprehensive understanding of the project's design, manufacturing, and potential future developments. By implementing this passive solar tracking system and considering the future scope, it is expected that the designed and manufactured model will contribute to the advancement of solar energy utilization, promoting sustainable and efficient energy generation.

Selection of Cutting Tool through Determination and Prediction of Cutting Force during Turning of Inconel-718 Super-alloys

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Force Dynamometer attached with Lathe during Experiment

Lathe tool digital strain gauge dynamometer

OBJECTIVES

Inconel-718 is a high strength thermal resistant nickel based super alloy. This Ni-based super alloy is highly strain rate sensitive material which work hardens readily and contains hard particles making it a very difficult-to-cut material, having very high yield strength, tensile strength, creep rupture and corrosion-resistant qualities. It is generally utilized for various services in tremendous environments subjected to high pressure and kinetic energy. In practice, it is constituent elements of gas turbine blades, combustors, turbocharger rotors and seals, high temperature fasteners, chemical processing and pressure vessels, steam generators and core components in nuclear pressurized water reactors. Inconel-718 also used in manufacturing aircraft engines in their essential parts including blades, sheets and discs. It widely used in rocket engines and cryogenic applications for providing good toughness at low temperatures.

The difficulty in machining of Inconel-718 in production plant resolves into short tool life and poor surface integrity. The current study aims at analysis of cutting force during turning of Inconel-718 at dry condition at various cutting speeds, feed and depth of cut so as to select cutting tools used. It is observed that, at high cutting speeds lubrication has no significant effect in turning of Ni-based alloy. The proposed methodology is based on Taguchi's L18 orthogonal array on the basis of five input parameters like, speed, feed, depth of cut, tool type

and tool nose radius, having 3 levels of parameters, each considered to examine the impact on cutting force as a response.

CONCLUSION

We predicted that feed was the most prominent factor for cutting force and axial force, followed by speed as important factor. • Using PCD insert tool at high speed with medium depth of cut gives satisfactory result along with good MRR. • As Nose Radius is inversely related to shearing action and directly related to strength of tool so optimal value of r = 0.4 allows to machine with higher cutting feeds for PCD insert. • On increasing depth of cut with nose radius radial force decreases and reduces vibration. • Ceramic cutting tools induce tensile residual stresses with much higher magnitude than CBN cutting tools which decrease fatigue strength and cause fatigue failure. • Cutting speed was reported as one of the most significant parameters of tool wear in machining of the super alloys. • Low speed turning reported less tool wear than high speed turning hence tool life is more in low speed turning keeping feed rate and nose radius fixed • For ceramic tool, however, higher flank wear was observed at low speed (Vc = 60m/min) and with the increase of cutting speed from 90 to 120 m/min there was a decrease in flank wear. • Larger tool radius is favorable in terms of productivity, larger nose radius led to increased residual stresses. Therefore, in machining of the final surface, size of the tool nose should be kept under control due to residual stress concerns.

PUBLICATION

Raja Mondal, Sayan Sarkar, Debashis Sarkar, “Selection Of Cutting Tool Through Prediction Of Cutting Force During Turning Of Inconel-718 Super-Alloys”, first international conference on multidisciplinary Research (online mode) 2020 Organised by Society for Advanced Multidisciplinary Research & Practices in collaboration with Astronomical Instruments Design Laboratory, IEE dept. Jadavpur University, Kolkata, West Bengal, India, 29-30 August, 2020.

Legacy of IEI

Lord Irwin, Viceroy and Governor General of India, laying the Foundation Stone of the First Institution Building in 1930

The Institution of Engineers (India)

Recognized as Scientific & Industrial Research Organization by
Ministry of Science & Technology, Govt. of India

IEI R&D Grant-in-Aid Scheme

INSTRUCTIONS TO AVOID REJECTION OF PROJECT PROPOSALS DURING INITIAL SCRUTINY

(I) MUST FURNISH THE FOLLOWING GENERAL INFORMATION PRECISELY

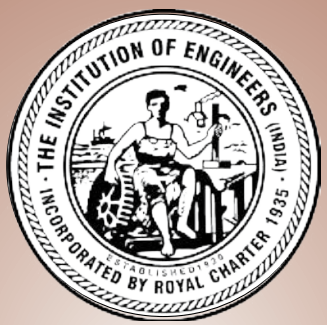
1. The project title should have clarity and must be relevant to the proposal.
2. Attach supporting documents for NBA / NAAC Accreditation or valid NIRF Rank for the Institutions.
3. Applications from Institutional Members [IMs] will be preferred.
4. Do not include names of more than two guides for a single project proposal .
5. Both the guides should be Corporate Members (AMIE/MIE/FIE- for UG Project Proposals and MIE/FIE- for PG & PhD Project Proposals). In case they are not, they must send the membership form with requisite fees along with project proposal.
6. Guide(s) should be from the same Institution as that of the Applicant(s).
7. A guide will not be allowed to carry out more than one project simultaneously.
8. Maximum number of students/applicants that can apply for a single UG Project Proposal must be limited to five. In case of PG & PhD only one student per project is allowed.
9. UG Applicants should be Student Members (SMIEs) of the Institution, whereas, PG & PhD students must be Corporate Member. In case they are not, they must send the membership form with requisite fees along with project proposal.
10. The 'Completion Date of Study' (Item D) should not be earlier than 'Project Completion Date' (Item H) or should not exceed the maximum duration prescribed for each category.
11. Inclusion of different category of applicants (UG/PG/PhD) in a single project proposal is not permitted.
12. Only full time students pursuing a course in engineering at UG/PG/PhD is eligible for funding. Faculty Members or those who are pursuing part-time course in engineering will not be considered as students.
13. PG applicant must enclose 'Enrolment Certificate' whereas PhD applicant must enclose 'Enrolment Certificate' as well as 'Registration Certificate' along with project proposal.
14. Project proposal will be considered for scrutiny only when the soft copy sent via email is followed with a hard copy of the proposal which must be signed and sealed by all concerned in required places.

(II) MUST ESTABLISH NOVELTY & FINANCIAL FEASIBILITY OF THE PROPOSAL

1. 'Review of R&D in the proposed area' (Item G) should be well documented and must establish novelty/uniqueness of the proposal.
2. Under item 'G', a list of 'References' should be provided for the earlier works carried out in the area.
3. The Applicant's Institute must extend its infrastructural facilities or provide partial funding for carrying out the project.
4. Proposals receiving Industry Support in cash/kind will be given preference.
5. It is expected that the proposal must provide complete information about items being procured. Procurement under non-permissible heads will not be considered for funding. In order to avail maximum grant 'Details of Financial Requirements' [Item-O] must be filled up with reference to upper ceiling of funding available under various Heads.

(III) INFORMATION SHEET & PAYEE DETAILS MUST BE COMPREHENSIVE

1. The 'Information Sheet' must be completely filled along with Membership Numbers for Guides, Students & Institute. Contact Numbers and E-mail of Guide(s) and Students must be furnished.
2. Payee Details should include all requisite details along with the GST number of the Institution.
3. Project proposal should be accompanied by hard copy of cancelled cheque. The cancelled cheque should be from the same account against which payee details have been provided and should bear the name of signatory authority.
4. Request of transfer of grant to account other than Principal/Director/Registrar/Dean (R&D) will be not entertained.



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