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Foreword

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The Indonesian Consortium of Mechanical Engineering Higher Education

FOREWORD

The Indonesian Consortium of Mechanical Engineering Higher Education (BKS-TM Indonesia) organises a scientific meeting called The International Symposium on Advances and Innovation Mechanical Engineering (ISAIME) every year. The 4th ISAIME 2023 was held on October 5, 2023, by the Mechanical Engineering Study Program, Faculty of Engineering, University of Pasundan Bandung, with the theme “Improving Mechanical Engineering Human Resources and Technology Capabilities for Facing the Challenge of Industry 4.0”.



The 4th ISAIME 2023 activity has displayed all the potential and progress in the industrial/business community and the mechanical engineering field, including mechanical application design, energy conversion, manufacturing process, materials engineering, and mechanical engineering education. All potentials displayed in the field of mechanical engineering must be a vehicle for the development of science and technology with an environmental perspective and the development of human resources. On this occasion, two keynote papers from the University of Technology Sydney and Université de Franche Comté, France, and 75 papers were divided into four group areas: mechanical application design, energy conversion, manufacturing processes, and materials engineering.

The holding of The 4th ISAIME 2023 event is inseparable from the sponsorship support from companies and agencies that have been established, for which we would like to express our most profound appreciation. Likewise, to all parties who have provided assistance and participation, including the paper's authors, which is a networking asset for all of us. Hopefully this meeting can continue with real work for advancing science and technology with an environmental perspective and developing human resources in mechanical engineering.

Depok, December 27 2024

Sekretaris Jenderal BKS-TM Indonesia



Prof. Dr. H. Ario Sunar Baskoro, S.T., M.T., M.Eng



Enhancing Fuel Economy Standards and Labels for Sustainable Road Transport

T M Indra MAHLIA

Distinguished Professor

Centre for Green Technology, School of Civil and Environmental Engineering, Faculty of Engineering and Information Technology University of Technology Sydney, NSW 2007, Australia

Adjunct Professor

*Department of Mechanical Engineering,
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Abstract

With a particular emphasis on motor vehicles, road transport has emerged as a dominant contributor to escalating energy consumption and the alarming rise in harmful emissions. Motor vehicles stand at the forefront as the primary energy consumers within the transportation sector. Addressing this challenge necessitates a comprehensive approach, with policymakers actively considering implementing and enhancing fuel economy standards and labels for motor vehicles. This presentation presents a critical perspective on the pivotal role of developing and refining fuel economy standards and labeling protocols to curtail energy consumption in the transportation sector. A fundamental step in this direction is establishing a robust test procedure for evaluating the energy performance of vehicles. This test procedure, comprising a meticulously defined series of laboratory tests, is the technical foundation upon which all related programs are built. This presentation explores existing fuel economy testing procedures, standards, labels, and incentive programs globally. It offers insights into international best practices and underscores the need for continual improvement in these standards. Furthermore, it delves into the prospect of elevating the standards for countries that have already embraced such programs, aiming to foster a sustainable and eco-friendly future for road transport.



The role of composites in the energy transition: the example of hydrogen energy storage

Dominique PERREUX

Université de Franche Comté, FEMTO-ST/DMA,
24 Rue de l'Épître, 25000 Besançon, France

Abstract

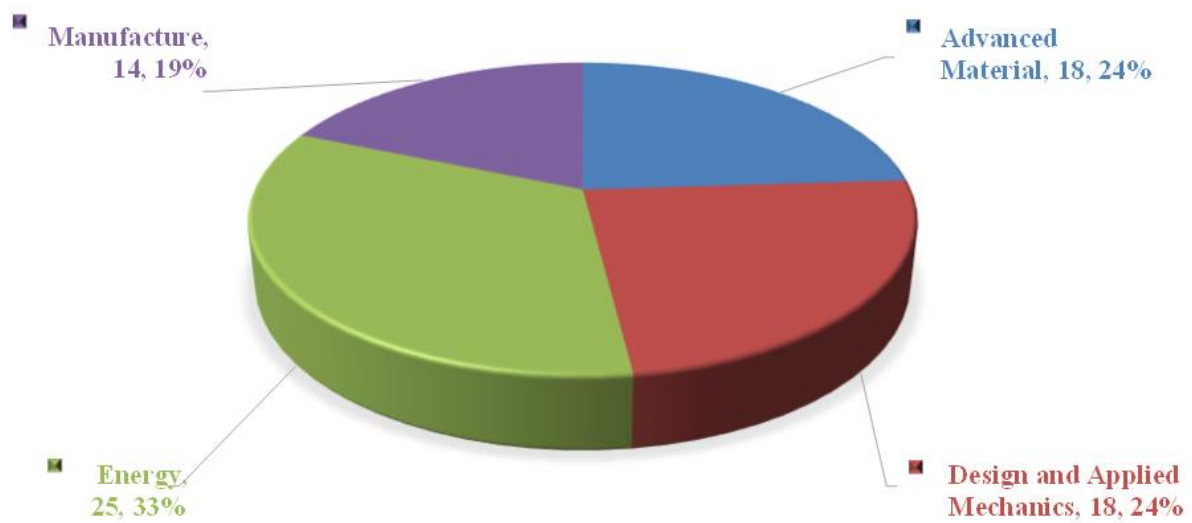
We are living in a special moment in human evolution. Our industrial civilization has produced greenhouse gases for many years, and today we are facing a global challenge to change our methods of energy production to continue to progress but to decarbonize our lives. This energy transition leads to specific needs in terms of materials. In this presentation, we show the place that composite materials could take. First, we will discuss the global context of energy. Then, we will show where composite materials can be used and in what proportions for producing renewable or non-renewable energy. The case of electricity production by renewable primary energy is particular in that, in most cases, this production is intermittent. It is therefore necessary to supplement this production with a means of storage to meet the needs, which are variable but continuous. In the last part of the presentation, we focus on Hydrogen energy. Indeed, Hydrogen is a way to store electricity and then can solve intermittent energy production. Hydrogen storage is a challenge for developing this energy vector, and for the storage, we will show that composite materials seem inescapable. Finally, we will conclude this presentation by discussing the new developments of hydrogen aircraft, showing the issue of hydrogen storage in this industrial sector.

Thursday, October 5th, 2023
The Aryaduta Hotel, Jalan Sumatera No. 51 Bandung, Indonesia

Time	Description	Action
07:30 - 08:00	Registration	MC
	Opening	MC
08:00 - 09:30	Indonesia Raya's Song	MC
	Speech by chair of ISAIME and SNTIM	MC
	Speech by chair general secretary of BKS-TM Indonesia	MC
	Speech by dean of Engineering Faculty Unpas	MC
	Speech and opening the event by Rektor of Unpas	MC
	Do'a	MC
	Entic dance	MC
	Keynote speech Prof Indra Mahlia (University of Technology Sydney)	MC
	Keynote speech Prof Dominique (University of French Comte)	MC
09:30 - 10:00	Coffee break	Committee
10:00 - 12:00	PARALLEL SESSION 1	Moderator
12:00 - 13:00	Break and ishoma	Committee
13:00 - 16:00	PARALLEL SESSION 2	Moderator
16:00 - 16:30	Break and ishoma	Committee
16:30 - 18:00	PARALLEL SESSION 3	Moderator

Topic Papers

Topic	Papers
Advanced Material	18
Design and Applied Mechanics	18
Energy	25
Manufacture	14



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The International Symposium on Advances and Innovation in Mechanical Engineering (ISAIME 2023) 04/10/2023 - 05/10/2023 Bandung, Indonesia

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Close all abstracts

Preface

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011001

Foreword

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The Indonesian Consortium of Mechanical Engineering Higher Education (BKS-TM Indonesia) organises a scientific meeting called The International Symposium on Advances and Innovation Mechanical Engineering (ISAIME) every year. The 4th ISAIME 2023 was held on October 5, 2023, by the Mechanical Engineering Study Program, Faculty of Engineering, University of Pasundan Bandung, with the theme “Improving Mechanical Engineering Human Resources and Technology Capabilities for Facing the Challenge of Industry 4.0”.

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developing human resources in mechanical engineering.

List of The 4th ISAIME 2023 Committe, Topic Papers and Author list are available in this pdf.

<https://doi.org/10.1088/1742-6596/2972/1/011001>

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011002

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All papers published in this volume have been reviewed through processes administered by the Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

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- **Conference submission management system:** Morressier
- **Number of submissions received:** 88
- **Number of submissions sent for review:** 79
- **Number of submissions accepted:** 75
- **Acceptance Rate (Submissions Accepted / Submissions Received × 100):** 85.2
- **Average number of reviews per paper:** 1.15
- **Total number of reviewers involved:** 26
- **Contact person for queries:**

Name: Editor

Email: prosiding@bkstm.org

Affiliation: Badan Kerjasama Teknik Mesin Indonesia

<https://doi.org/10.1088/1742-6596/2972/1/011002>

Energy

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012001

Investigation of temperature distribution in a novel pyrolysis reactor using Computational Fluid Dynamics

Illa Rizianiza, Ahmad Indra Siswantara, Tanwir Ahmad Farhan, Candra Damis Widiawaty and M. Hilman Gumelar Syafei

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Pyrolysis is one of the most complex energy conversion processes because it involves various physical and chemical phenomena that interact and occur simultaneously. One factor that influences both the quality and quantity of the pyrolysis product is the temperature distribution within the reactor. The reactor plays a crucial role in the pyrolysis process, facilitating the thermal degradation and decomposition of the feedstock. This paper presents the investigation of the temperature gradients within the pyrolysis reactor using CFD. The research employed a slow pyrolysis methodology, utilizing sheep manure as the feedstock. The heat required for the process was generated by an Internal Combustion Engine exhaust gas, which was directed through a helical pipe located within a fixed-bed reactor. The temperature range for pyrolysis is typically observed to be within the range of 523–673 K, while the reactor temperature in the CFD simulation varies between 400–730 K. To determine the accuracy of the prediction, a comparison is conducted between the predictions and the experiments, followed by an error assessment utilizing the Mean Absolute Error metric. The result of the calculation of the mean absolute error is 98.58 K or 22.53%. However, if observed overall still has the same temperature distribution trend between experiment and simulation

<https://doi.org/10.1088/1742-6596/2972/1/012001>

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012002

Natural Circulate Flow Rate Comparison using Water and Al_2O_3 as Working Fluids Based on Power Control in Medium-scale Passive Cooling Experimental Facility

Ryan Oktaviandi, Muhamad Rafel, Dwi Yuliaji, Roy Waluyo, Sunandi Karisma, Putut Hery Setiawan, Deendarlianto and Mulya Juarsa

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The use of natural circulation as a passive cooling safety system in reactors has been implemented by nuclear power plants worldwide, including the AP1000 reactor from Westinghouse and the SMART reactor from KAERI, both featuring the Passive Residual Heat Removal System (PRHRS) to prevent overpressure and overheating in the reactor cooling system during accidents. The type of working fluid used influences the natural circulation flow rate. This research compared the mass flow rate of natural circulation using water and Al_2O_3 -nanofluid as working fluids under varying heater power for steady-state conditions. The experiment involved varying the heater power in the heating tank at 1400 W, 2800 W, and 4200 W. Data was collected experimentally and analysed to calculate the mass flow rate for both water and nanofluid as working fluids. The results show that nanofluids can increase the mass flow rate compared to water due to differences in density, which affect the flow rate. The highest mass flow rate was observed at 4200 W, where the Al_2O_3 -nanofluid achieved a mass flow rate of 0.0456 kg/s, compared to 0.0454 kg/s for water.

<https://doi.org/10.1088/1742-6596/2972/1/012002>

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012003

Thermal Effect on Natural Circulation Flow using Water and Al₂O₃ Nanofluids Inside Rectangular Loop in Vertical Position

Nur Rochman Budiyo, Deendarlianto, Ryan Oktaviandi, Dwi Yulijati, Roy Waluyo, Esa Putra Ariesta Raharjo, Putut Hery Setiawan, Shendy Akbar Maryadi, Muhamad Rafel and Mulya Juarsa

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Passive cooling technology in closed circuits without the use of pumps works based on the principle of natural circulation, where the variable geometry and working fluid used will affect the amount of flow rate that occurs. The impact of changes in the working fluid and thermal effects on the natural circulation flow rate needs to be studied for their effectiveness. This research aims to investigate the characterization of thermal effects on natural circulation flow using water fluid and Al₂O₃ Nanofluid in a rectangular loop in a vertical position. The research method was carried out experimentally by varying the heating water temperature from 50°C, 60°C, and 70°C with the cooling water temperature set at 10°C. The analysis was carried out for steady conditions. The experimental results show that the highest temperature difference occurs in the heating water temperature variation of 70°C and 10°C cooling water with an average temperature difference of 6.5°C at steady state. In contrast, the lowest temperature difference occurs at 50°C heating water temperature of 4.8°C. So, the highest mass flow rate in water fluid is 0.01728 kg/s at a temperature of 70°C, and the lowest is 0.01167 kg/s at 50°C. As for the results of the correlation comparison between the mass flow rate of water fluid and nanofluids, the highest value was obtained for Al₂O₃ nanofluids of 0.01736 kg/s, and the lowest was 0.01173 kg/s.

<https://doi.org/10.1088/1742-6596/2972/1/012003>**OPEN ACCESS**

012004

Analysis of the Application of Combined Flow Controls on Vehicle Models by a Computational Approach

Rustan Tarakka, Nasaruddin Salam, Jalaluddin, Gerard Antonini Duma, Ikhlas Kitta, Kasbawati, Damora Rhakasywi, Muhammad Ihsan Mukrim, Nur Al Faqih Imam Ja'far and M. Dzulfakar Syaifullah

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Aerodynamics on the vehicle body is among the most important aspects to optimize the use of vehicle fuel. In general, a vehicle moving in the air will undergo aerodynamic drag due to airflow in direct contact with the vehicle body. Two of the major contributors to excessive aerodynamic drag are the pressure drop and flow separation occurring at the rear of the vehicle. The use of combined flow control by dimple and suction gives a positive is expected to contribute to controlling the flow separation occurrence. This study analyzes the effect of a combination of active flow control by suction and passive flow control by dimples on the aerodynamic drag of the vehicle model. The vehicle model was the vehicle model with a suction speed of 0.5 m/s. The study was carried out by a computational approach with the k-epsilon turbulence model. The upstream velocities used are 16.7 m/s, 19.4 m/s, and 22.2 m/s, respectively. The study results which obtained show that the use of combined flow control suction and dimples in the model induces significant effects on aerodynamic drag, by reducing the drag coefficient up to 14.82%.

<https://doi.org/10.1088/1742-6596/2972/1/012004>**OPEN ACCESS**

012005

Development of a New Model “MAGIC BOILER” for Faster Steam Production: Second-Phase Progress

Shaffira Adelina Aristiana, Ibnu Roihan and Raldi Artono Koestoer

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Boilers, essential vessels for applications like water heating and steam generation, hold significant roles in various sectors, from industry to households. Indonesian home industries, primarily focused on food and fashion, rely on boilers. However, high energy consumption, coupled with escalating energy prices, poses profitability and sustainability challenges. To tackle this, we propose the “MAGIC BOILER,” an innovative, energy-efficient electric water boiler. Its unique design, featuring an enhanced heating surface, maximizes heat output and optimizes electrical input. Comparative tests demonstrate the “MAGIC BOILER” achieving an 8.74% faster heating rate with an additional 0.01 m² surface while operating at 150 W power input. This advancement proves crucial in effectively addressing industry challenges.

<https://doi.org/10.1088/1742-6596/2972/1/012005>

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012006

L-Heat Pipe Simulation for Lithium-Ion Electric Vehicle Battery Cooling Systems

Wayan Nata Septiadi, Ketut Astawa, Rolland Pierce Eleazar, Dandi Ramadhani, Nabel Rafa Angel Bhaswara and Kadek Dananta Jayendra

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The Li-ion battery is electrical storage in the form of chemical energy and is considered the strongest candidate for electrical-based automotive applications. The performance of the battery greatly affects the performance of electric vehicles. There is a need for effective thermal management to control battery temperature below a defined temperature such as 50°C. The thermal management system in the battery can be done by passively cooling it using heat pipes and heat sinks. This research was conducted by simulating the Makara Electric Vehicle's electric scooter battery module which was applied with a heat pipe-based cooling system. The simulated module focuses on heat pipes and 18650 lithium-ion batteries with discharge rate variations of 1C, 2C., and 3C. The method used is literature study and CFD simulation. The results show that the heat pipe cooling system can reduce battery temperature at each discharge rate variation of 12,85%, 16,23%, and 23,74%. Heat Pipe can absorb the highest heat of 68,1178 kW when the module uses a 3C battery.

<https://doi.org/10.1088/1742-6596/2972/1/012006>

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012007

Combustion Profile of Bio-pellet Produced from Sawdust Using Wet Torrefaction Method with Various Concentrations of Acetic Acid

Indah Ayu Pertiwi, Muhammad, Abubakar, Adi Setiawan and Rizky Iskandar

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Sawdust is one of the industrial wastes which naturally contains low energy density. An effective method is needed to utilize this biomass as a solid fuel product. This work aimed to investigate the physical and combustion properties of bio-pellets produced from sawdust under the wet torrefaction method. To prepare sawdust bio-pellet a number of steps were carried out including the wet torrefaction process, dough preparation, pelletizing, and drying. Wet torrefaction was performed by

hydrothermally treating the sample in an autoclave at a temperature of 130°C and pressure of 2 atm (g) for 80 minutes. For the hydrothermal process, the used acetic acid solution was varied with variations of 1.3 M, 1.8 M, and 2.3 M. Properties of the product were analyzed under proximate and bomb calorimetry analyses. To evaluate the combustion properties a purposely built test apparatus was developed equipped with a data logger system. Based on the results it can be observed that increases in torrefaction temperature and acetic acid concentration resulted in an increase in the calorific value as well as decreases in the ash content. The highest calorific value was 4745 kcal/kg obtained from sawdust torrefied in acetic acid with a concentration of 2.3 M at a temperature of 130°C. This sample also exhibits the lowest ash content which is only 1.97%. The combustion test disclosed a maximum combustion temperature of 589°C with a burning rate of 0.711 g/min. Overall, the wet torrefaction applied in this investigation was beneficially enhanced the properties of bio-pellet products.

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012008

Drying Characteristics of Roselle (*Hibiscus Sabdariffa*) Calyces Under Low-Temperature and – Relative Humidity Atmosphere

Adjar Pratoto, Fajar Putra Harapan Limbong and Endri Yani

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Roselle (*Hibiscus sabdariffa*) offers nutritional and medicinal benefits for human life. To preserve its quality and shelf life, the post-harvest measures should be taken appropriately. Drying is the common method to preserve its shelf life and occasionally its quality. The current study is concerned with the experimental investigation of the drying characteristics of Roselle calyces at low temperature and low relative humidity conditions. A household refrigerator was utilized to produce low temperature and low humidity environment. The experiment included two different drying loadings; the first used 550 g of fresh calyces, while the second used 275 g. During drying, the air temperature and relative humidity in the drying chamber fluctuated in a saw-like manner and their profiles mirrored each other; whenever the temperature increased, then the relative humidity decreased, excepting that after the first point of inflection both temperature and relative humidity decreased. The air temperature ran between 1°C to 4°C. At the first stage, the relative humidity dropped to 30%, then increased, and fluctuated between 50% and 60%. The drying loading did not affect the air temperature and relative humidity profiles, excepting the extent to which the curves ceased. The moisture loss took place fairly slow at first and faster afterwards. The drying rates did not reveal a constant-rate period. Both drying loadings showed similar drying rate profile, except that for higher drying loading, the profile shifts to the higher moisture content.

<https://doi.org/10.1088/1742-6596/2972/1/012008>

OPEN ACCESS

012009

Performance study of storage thickness of the flat-plate solar collector

Jalaluddin Haddada, Rustan Tarakka, Muhammad Syahid and IR Muhammad Anis

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A solar water heater (SWH) system is the most frequently used devices for utilization of solar energy. Thermal energy storage devices are required to improve the performance of the solar water heating system. This study investigates the influence of storage thickness on the performance of a collector that incorporates phase change material (PCM) into an absorber plate collector at the bottom for thermal storage. The approach utilized in this work is an experimental method, which involves conducting trials to determine the influence of storage thickness on the efficiency of solar water heater collectors utilizing paraffin wax as thermal storage medium. The experiments were conducted using variations in the thickness of the PCM, with a flowrate parameter of 10 liters/hour and a PCM thickness of 4 mm, 7 mm, and 10 mm, taking into account the inlet and outlet temperatures. The results of the study show a comparison of efficiency between standard collector plates with variations in the thickness of the PCM. The efficiency of the standard flat collector plate is 79.84%, while for plate efficiency with variations in PCM thickness of the 4 mm is 83.93%, for the collector plate efficiency of 7 mm is 81.29%, and for the collector plate efficiency of 10 mm is 82.30%.

<https://doi.org/10.1088/1742-6596/2972/1/012009>

OPEN ACCESS

012010

Computational Fluid Dynamics-based Simulation and Analysis of Air Conditioning System Application in Watercress Mini Plant Factory

Farid Abdillah, Firman Bagja Juangsa, Azaria Haykal Ahmad and Prihadi Setyo Darmanto

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The projected population of Indonesia to reach of around 320 million people in 2045 is worried to threaten the growth of various plants. The threat occurs due to various human activities that result in reduced land for growing plants and climate change. Plants are needed by humans as a source of food, medicine, and other valuable products. Plant Factory (PF) is a place for indoor plant production with climatic conditions that can be adjusted according to needs and is used as an effort to increase plant production on limited land. The Mini Plant Factory (MPF) is a small-scale of PF. This study concerns to simulate the MPF model in order to understand better the distribution of air temperature and velocity in it. Computational Fluid Dynamics (CFD)-based simulations were carried out in the bright period (plants carry out photosynthesis) and dark period (plants carry out transpiration). Transient simulations conducted to determine the duration of the AC compressor turns on and off in a day operation. The duration is used to calculate the operating costs of the MPF. The investment costs and income are also calculated to estimate the payback period of MPF. The air temperature around the planting rack is kept close to 21°C in the bright period and 19°C in the dark period. Within 24 hours, the AC compressor is on for 9.2 hours and off for 14.8 hours. The investment cost incurred to make MPF on an existing building is IDR 22,961,471.00. MPF can generate income of IDR 11,673,851.00 annually. The payback period of MPF project in this study was around two years.

<https://doi.org/10.1088/1742-6596/2972/1/012010>

OPEN ACCESS

012011

Study utilization of circulated Al₂O₃-water nanofluid in engine cooling process

Reza Setiawan, Aripin, Agustian Suseno, Vera Pangni Fahriani, Boni Sena, Bobie Suhendra, Iwan Nugraha Gusniar, Rizal Hanifi, Viktor Naubnome, Suciani Rahma Pertiwi *et al*

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Researchers and industries are trying to enhance engine efficiency to mitigate global warming and reduce the emission of toxic gases, particularly in Karawang Regency, the hub of largest automotive manufacturing sector in Southeast Asia. The engine cooling system is critical, as it consumes approximately one-third of the input energy. A key factor influencing this efficiency is the type of coolant utilized. Traditional coolants such as water, glycerol, and ethylene glycol have been widely used, yet their performance remains inadequate in the rapidly evolving industrial landscape. Therefore, it is essential to develop and evaluate new coolant fluids with promising potential. Aluminum oxide-water (Al_2O_3 -water) nanofluid presents a viable option for future engine cooling applications. The high thermal conductivity of Al_2O_3 nanoparticles can enhance the heat absorption capabilities of the base fluid. The proposed research method is experimental, encompassing several stages preliminary study, nanoparticle preparation, nanofluid fabrication, setup of testing equipment, testing procedures, analysis, and conclusion. The research variables include nanofluid concentrations of 0.1% and 0.3% by volume, along with flow rates of 0.024 kg/s and 0.032 kg/s. Results indicated that the highest increase in heat transfer was observed with the 0.3% Al_2O_3 -water nanofluid, followed closely by the 0.1% Al_2O_3 -water comparison to water-based fluid.

<https://doi.org/10.1088/1742-6596/2972/1/012011>

OPEN ACCESS

012012

Identifying the potential of waste cooking oil, waste lubricating oil, and tar as alternative fuel for bioethanol processing stoves

Mahrus Khoirul Umami, Ibnu Irawan, Rullie Annisa and Teguh Prasetyo

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The air mass flow rate greatly influences the optimal flame temperature in the combustion process. Stoves with unstable combustion temperatures result in non-optimal flame temperatures. An unstable combustion temperature is shown by the flame which tends to dim and the temperature decreases. Another impact is the emergence of smoke or exhaust gas which will cause air pollution. The temperature in the stove must be maintained constant to produce a perfect flame. The perfection of combustion is influenced by three factors, namely the ratio of air and fuel (air-fuel ratio, AFR), homogeneity of the mixture, and burning temperature. Based on those situations, this research aims to obtain the ideal air mass rate to obtain good ignition results and low emission values. Three types of liquid waste in the form of waste lubricating oil, waste cooking oil, and tar oil were chosen in the experiment. Gas chromatography-mass spectrometry (GC-MS) testing has obtained chemical formulas for waste lubricating oil, waste cooking oil, and tar. The stoichiometric AFR for these three wastes can be calculated after the chemical reaction on the combustion of each fuel has been determined. AFR stoichiometry is used as a basis for determining the ideal air mass flow rate applied in the experiment. The experimental results show that the highest flame temperature for the waste lubricating oil is 876.8°C at an air mass flow rate of 0.00359 kg/s. The highest flame temperature in combustion with the waste cooking oil fuel is 891.3°C at an air mass flow rate of 0.00213 kg/s. For tar fuel, optimal combustion occurs at an air mass rate of 0.00343 kg/s and produces the highest flame temperature of 787.1°C.

<https://doi.org/10.1088/1742-6596/2972/1/012012>

OPEN ACCESS

012013

An experimental study on the thermal performance on electronic cooling using BatiX heatsink-PCM

M. Sulttan Aliefiansyah, Andhy M. Fathoni, Gerardo Janitra Puriadi Putra and Nandy Putra

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Increasing computational capabilities and the miniaturization of computer devices have led to an increase in heat flux, which can result in a decrease in the lifespan of CPUs. In fact, 55% of CPU failures are caused by excessive heat. This has driven research in CPU heat dissipation. This experimental study utilizes a Parangkusumo batik-inspired heatsink design, with copper as the material, manufactured using 3D Printing metal. Additionally, the experiment combines the BatiX heatsink with PCM RT 35, injected into the heatsink to enhance heat dissipation. The experiment involves varying the heat load, air temperature, and airflow velocity to assess the heat dissipation performance at higher temperatures and determine the Nusselt correlation on the BatiX heatsink fins. The findings demonstrate that the addition of PCM can reduce CPU surface temperature by up to 8% and increase the setpoint time within the range of 5-10%.

<https://doi.org/10.1088/1742-6596/2972/1/012013>

OPEN ACCESS

012014

Performance study of Photovoltaic/Thermal (PV/T) collector with cross-cut fins

Amrizal, Calvin Andyansa Falah, Amrul, Muhammad Irsyad and Ahmad Yonanda

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A photovoltaic (PV) panel's efficiency rises with a drop in operating temperature. Cross-cut fins can be suggested to absorb the PV panel's waste heat. These fins become useful because they enhance the effective surface area to disperse residual heat. Thus, this study aims to evaluate the electrical and thermal performance of Photovoltaic/Thermal (PV/T) with cross-cut fins compared to cases without fins. Moreover, the cross-cut fins are built in staggered and inline configurations and are fastened beneath the PV's surface. Photovoltaic/Thermal (PV/T) performance is measured indoors using a solar simulator with twelve 300 W halogen lamps. Several factors are adjusted under the solar simulator's radiation levels, ranging from 500 to 1000 W/m², and the air mass flow rate, ranging from 0.0085-0.256 kg/s. The findings show that the PV/T collector greatly enhances thermal and electrical performance with cross-cut fins. Results from this work show that the PV/T collector with cross-cut fins achieves the maximum thermal efficiency and electrical efficiency of around 75.77% and 6.93%, respectively, at a constant air mass flow rate of 0.0256 kg/s and radiation of 1000 W/m². Regarding the maximum temperature difference, it is found to be 11.15°C compared to the conventional one. However, comparing the two arrangements provides a slight difference in the performance results.

<https://doi.org/10.1088/1742-6596/2972/1/012014>

OPEN ACCESS

012015

Energy Audit and Management System for Smart Classroom of Green Design Building

Sally Cahyati, Rosyida Permatasari, Martinus Bambang Susetyarto and Muhammad Alwan Ridhoarto

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The design of an energy audit is the first step in the energy management process to support the 12th SDGs program on responsible consumption and production in achieving energy sustainability. The energy audit plan is applied to the smart classroom equipped with SPEM (Smart Plug Energy Monitoring) by considering thermal comfort based on the results of the CFD simulation using the CLTD calculation approach and finding the proper number and position of the air conditioning location. To maintain the comfortable condition of a smart classroom that has 9.3 m in length, 8.3 m in width, and 3 m in height, and 21-person capacity plus various types of equipment inside with a cooling load of 11364,169 Watt or equivalent to 38776,159 Btu/hour, 2 units of 2 HP air conditioning with a capacity of 19000 Btu/hour per unit are required. EMAS (Energy Audit and Management System) is a program designed by combining the results from CFD calculation concepts with conventional energy audit concepts to calculate Energy Using Intensity (EUI) and find the potential for energy savings while maintaining the thermal comfort of the room continuously in real-time. The ideal position for the smart classroom was determined to be on the south wall, which meets the thermal comfort standards and has 24 out of 27 airflow velocity measurement points that comply with SNI 03-6572-2001.

<https://doi.org/10.1088/1742-6596/2972/1/012015>

OPEN ACCESS

012016

Analysis of the Effect of Inlet velocity on Pressure drop on Cyclone separator to be used in Pyrolysis system

Ahmad Indra Siswantara, Adi Syuriadi, Ridho Irwansyah, Gun Gun Ramdhan Gunadi, Dianta Mustofa Kamal and Supriyadi

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Pyrolysis is a process of chemical decomposition of biomass through heating at high temperatures (above 300°C), with no or little oxygen, which produces green fuels such as: syngas, bio-oil, and bio-char. The most important component of a pyrolysis system is the cyclone separator. The function of the cyclone separator is to remove solid particles from the syngas formed, so that the syngas becomes cleaner. Therefore, to improve the performance of the cyclone separator, it is necessary to test it experimentally. Pressure drop is an important variable in determining the performance level of the cyclone separator in the pyrolysis system. The cyclone types tested are Stairmand and Lapple types. Based on the experimental results, inlet velocity is very influential on the pressure drop of the cyclone separator. The greater the inlet velocity value, the higher the pressure drop value. The highest-pressure drop is in the Lapple type of 16.26 mbar compared to the Stairmand type of 12.16 mbar with each inlet velocity of 13 m/s.

<https://doi.org/10.1088/1742-6596/2972/1/012016>

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012017

Design of Humidifier Control System for Psychrometric Chamber in the University of Indonesia

Ardiyansyah Yatim, Ridho Irwansyah, Aldi Pradana, Jassim Addi and Aurelie Adam

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Currently, the Air Conditioner is one of the tools that has become a necessity for people all over the world. Most homes, office buildings to shopping centers use Air Conditioners to increase comfort. Therefore, the use of electricity due to air conditioning is quite large and always increases with the increase in population. This is the government's concern because the increase in energy required is increasing. The government wants to try to reduce the consumption of electrical energy due to the use of air conditioning without reducing the need for air conditioning for the community. One of the solutions of the Indonesian government, the Ministry of Energy and Mineral Resources, is to apply an energy label for the use of air conditioners by using the Energy Efficiency Ratio (EER) as a parameter to calculate how much EER is in air conditioners. To achieve this, a controlled room called the Psychrometric Chamber is needed where the temperature and humidity of the air can be adjusted as needed. This study aims to complete the humidifier system on the chamber room. The result of this research is the design of a humidifier system as a humidity control system in the Psychrometric Chamber.

<https://doi.org/10.1088/1742-6596/2972/1/012017>

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012018

Optimization Of Angle Deflection on Pelton Turbine Bucket Using CFD

Mochamad Ghani Hanif Suryaningrat and Rosyida Permatasari

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The Pelton turbine is a type of water turbine that is often used in hydroelectric power plants. This Pelton turbine is generally used for locations with a head height of more than 30 meters. The water in the Pelton turbine moves fast, and it extracts energy from the water by slowing down the water, making it an impulse turbine. This study aimed to determine the optimal efficiency of the Pelton turbine by analyzing the blade design using variations in the deflection angle. The fluid flow velocity from the bucket with variable deflection angles of 15°, 17°, and 19° was analyzed using the Computational Fluid Dynamics (CFD) method with SolidWorks simulation software. The simulation data were then analyzed and described using the velocity triangle method. From the simulation, the largest value of turbine power is 329,54kW, and efficiency is 95.98% at an angle of 15° with a discharge of 0.35 m³/s.

<https://doi.org/10.1088/1742-6596/2972/1/012018>

OPEN ACCESS

012019

Investigation of Operating Temperature as a Key Factor in Determining Photovoltaic Module Cooling Specifications

Toto Supriyono, Ghazali Omar, Noreffendy Tamaldin, Bambang Ariantara, Mohammad Yamin, Muhammad Rizki Sumartono and Dian Anisa Rokhwah Wati

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Many studies have shown that the temperature of photovoltaic modules (PVM) significantly affects their performance. An effective thermal management system is required to maintain optimal efficiency. This investigation is part of an ongoing study on PVM thermal management that aims to maintain the PVM power output at high temperatures, that is, above 30°C. To design an efficient cooler, it is important to determine the operating temperature range of the PVM. This study focused on measuring the temperature of the back surface of a PVM with a capacity of 120 W using a thermocouple connected to a temperature data logger. Measurements were

carried out in 3 (three) stages to improve the operating temperatures' accuracy, accuracy, and trend. The first phase was carried out in September, October, November 2020, July 2021, and June 2023, from 6:00 am to 6:00 pm. The measurement was in the parking area on the second floor of the Faculty of Engineering, Pasundan University, Bandung. The results of the 3rd phase of the investigation revealed that the rear surface temperature ranged from 19°C in the morning at 06:00 to a peak of 64.5°C at 12:15 when the irradiance reached 535 W/m². Then, the temperature gradually drops to approximately 30°C at 17:00 and drops back to approximately 24°C at sunset. Based on these findings, the optimal operating temperature range for PVM chillers is 30°C to 70°C, providing important data as a cooling design parameter.

<https://doi.org/10.1088/1742-6596/2972/1/012019>

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012020

Impact of Cooler Temperature Variations on Flow Boiling Phenomena in a Natural Circulation Rectangular Loop

Sunandi Kharisma, Dwi Yuliaji, Adhika Enggar Pamungkas, Arif Adtyas Budiman, Muhammad Rafel, Shendy Akbar Maryadi, Ryan Oktaviandi, Nur Rochman Budiyan, Putut Hery Setiawan, Wayan Nata Septiadi *et al*

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The passive cooling system that utilizes natural circulation is effective in removing decay heat from nuclear reactors, with the direct passive residual heat removal system being the most efficient. This study employs the Rectangular-TP FASSIP-04 Ver.2 Loop with a direct heating model to investigate two-phase natural circulation flow. The coolant water temperature is set at 10°C, 15°C, and 20°C with a constant heating power of 5600 watts, to measure temperature characteristics, flow rate, flow regimes, and heat removal rate. The results show that higher coolant temperatures accelerate the achievement of steady-state conditions, reduce the average steady-state temperature, and increase the flow rate and Reynolds number. In contrast, lower coolant temperatures accelerate temperature drop and improve heat removal effectiveness during the transient cooling phase, as well as help maintain flow stability. These findings highlight the importance of controlling coolant temperature in influencing the thermal dynamics and flow stability of the system.

<https://doi.org/10.1088/1742-6596/2972/1/012020>

OPEN ACCESS

012021

Experimental Study of Counter Current Flow Limitation for Water and Air Injection in Cold Conditions Inside a Semi-Spherical Narrow Channel

AC Amelia, Ronald Akbar, Putut Hery Setiawan, Iwan Roswandi, AS. Pamitran and Mulya Juarsa

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The International Nuclear and Radiological Event Scale (INES) determined that the Three Mile Island Unit 2 (TMI-2) severe accident is at the fifth level. The damage caused the core reactor to melt and formed debris collected at the bottom of the RPV. However, the Reactor Pressure Vessel (RPV) integrity was still maintained because of the heat transfer phenomenon. The boiling heat transfer has different characteristics based on the gap size. At gap sizes below 2 mm, the heat transfer is influenced by Counter Current Flow Limitation (CCFL). Based on the previous explanation, this study aims to observe the phenomenon of CCFL in a semi-spherical geometry to illustrate the lower plenum RPV. The test section is semi-spherical and made from stainless steel 316 with a 300 mm diameter. It is covered with a 340 mm

diameter of quartz glass bel-jar adjusted with a 2 mm gap, and the working fluid is water injected by air with three different levels. The experimental data in liquid and gas superficial velocities will be processed to obtain the CCFL correlation and predicted with the correlations from several researchers. The experimental result showed that the liquid and gas superficial velocities are directly proportional to the level of air injection and impact the slope and constant of the CCFL correlation. From the data prediction with the CCFL correlations from the other researchers, it can be known that the CCFL in semi-spherical test geometry is quite similar to the other geometry.

<https://doi.org/10.1088/1742-6596/2972/1/012021>

OPEN ACCESS

012022

Reynolds and Grashof Numbers Analysis on Steady State Natural Circulation Flow using FASSIP-02 Large Scale Test Loop

Pryawrata Putera Moniaga, Imansyah Ibnu Hakim, Mulya Juarsa and Putut Hery Setiawan

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The Station Blackout incident at the Fukushima Dai-ichi Nuclear Power Plant, which caused the failure of the active cooling system (with a pump) has made research on passive safety systems (without a pump) in nuclear safety technology increasingly developing and becoming an important issue. The focus of the research that researchers will characterize the natural circulation flow based on correlation of non-dimensional number like Reynolds Number, Grashof Number and geometrical ratio for large scale facilities. In addition, other parameters are boundary conditions, such as the difference in the total pipe length, pipe diameter, and the height difference between the heating outlet and the cooling inlet being the determining parameters. The correlation results between Re versus Gr/N_G with fixed numbers were a is 2.89 and b is 0.38, similar to other researchers' data. These results will be compared with the correlation of non-dimensional numbers Vijayan et.al., the comparison results show that the correlation of non-dimensional numbers in the FASSIP 02 large-scale loop is in the turbulent regime.

<https://doi.org/10.1088/1742-6596/2972/1/012022>

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012023

The Influence of Silicon Dioxide as a Fuel Additive in a Diesel Engine Fuelled by Pure Palm Oil

Rico Aditia Prahmana, Prihadi Setyo Darmanto, Iman Kartolaksono Reksowardojo, Tirta Prakoso and Firman Bagja Juangsa

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In the last decade, the Indonesian government has implemented a program to use biodiesel as a substitute for fossil diesel to reduce dependence on fossil fuels. On the other hand, the development of biodiesel as an alternative fuel to replace fossil diesel has several challenges, one of which is the production of biodiesel, which is more complicated and requires a long process. However, the direct use of crude palm oil (CPO) in diesel engines is not recommended because it has many drawbacks. Research recently shows that fuel additives in diesel engines have promising prospects. Therefore, to solve the problem, this study used pure palm oil (PPaO) as the primary fuel, with the addition of silicon oxide (SiO_2) as a fuel additive in diesel engines. The results showed that using SiO_2 additive in PPaO can increase thermal

efficiency by 18.8% at 60% load compared to diesel fuel (DF). Nevertheless, using this fuel increased specific fuel consumption (SFC) by 3.9% on average and increased the opacity by 153% compared to diesel fuel. These results indicate that SiO₂ has the potential to be developed as an effective additive to PPaO fuel that can improve the efficiency and performance of diesel engines.

<https://doi.org/10.1088/1742-6596/2972/1/012023>

Design and Applied Mechanics

OPEN ACCESS

012024

The Behavior of Thin-walled Aluminum Circular Tube Due to Changes in Ratio of Diameter to Thickness (D/t) Subjected to High-velocity Impact

Witono Hardi, Kifli Umar and Mohammad Shalahuddin Abdul Aziz

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Thin wall structures in various geometrical shapes are widely used in many applications of energy absorbers. A steel impactor collides with the thin-walled aluminum alloy tube in an axial direction at 40 m / s high velocity. The cylinder tube responds well when subjected to dynamic axial loads due to its ability to absorb impact energy by converting kinetic energy to plastic strain energy. In this study, we changed the ratio of diameter to thickness (D/t) by a fixed cross-sectional area of 317 mm². The research results modeled by finite element analysis (FEA) show that the larger the D/t ratio, the larger the maximum deformation. The reaction forces obtained by specimens are relatively constant. The maximum energy absorbed by the models is the same as the absorbed kinetic energy, but the higher the D/t ratio, the longer the time required for the energy absorption process. The collapse mode indicates that with the increasing D/t ratio, the collapse mode was changed from axisymmetric to non-axisymmetric. The energy absorption response of cylinder tubes is highly affected by the D/t ratio. This study's results will be considered when constructing a high-velocity impact energy absorption system.

<https://doi.org/10.1088/1742-6596/2972/1/012024>

OPEN ACCESS

012025

Thin-walled tube load cell for bolt torsion test

Tono Sukarnoto, M. Ihram Maulana, Muhammad Fadhlan, Wahyu Yulia Defi and Stephen Wijaya

 View article

 PDF

The purpose of this research is to know that thin-walled load cell can be used properly to measure the torque for high quality bolt torsion testing. The load cell made from SUS 304 tube completed with four holes was designed. It was developed from the previous one that using intact tube. For strain sensing in orientation at +45 degree and -45 degree, two rosette strain gages were used in the opposite position. The strain gages connected in full Wheatstone bridge configuration to a

Computing Data Log-ger. Set up calibration equipment for torsion load only was built for this load cell and the result is constant 12.85 for Data Logger setting. A torque wrench was used for setting maximum load applied and load cell with Data Logger measure and counting the actual torque. For the experiment two size hexagonal zinc coated steel bolt M8 and M10 were used for testing sample. Test result shows that all samples can reach mini-mum torque load that mentioned in specification.

<https://doi.org/10.1088/1742-6596/2972/1/012025>

OPEN ACCESS

012026

Application Hexa-Drone Rice Seed Transporters and Sowers Using Autonomous System

Andi Amijoyo Mochtar, Andi Hasizah, Rahimuddin, Rustan Tarakka, Ilyas Renreng, Salengke, Lukman Kasim, Hadi Ikram Ismail and Irwan

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The use of Hexa-drones has grown rapidly, especially in the field of agricultural drones. In this study, hexa-drones are used to transport and sow rice seeds in wetlands to improve farmer performance and efficiency. the hexa-drone consists of six arms equipped with a motor with a global positioning system (GPS) using an Autono-mous mechanism that can be controlled using a remote control at a certain distance in both manual and automatic modes. The design of a seed hopper integrated with a hexa-drone framework is carried out to spread rice seeds. Simulation of seed stocking using Ansys software with several variations of sowing machine motor speed. The seeding mechanism uses Spreading which is equipped with a Y-shaped forked nozzle to adjust the volume of seeds sown. The results of seed seeding modeling show that with motor speeds between 100-170 rpm it is more efficient than other speed variations. This is due to the higher speed compared to other variations of the occurrence of blockage between the slit space and the mouth of the Y-shaped nozzle.

<https://doi.org/10.1088/1742-6596/2972/1/012026>

OPEN ACCESS

012027

Design for sustainable behaviour effect: Identifying behaviour changes pattern through eco feedback strategy

A Y T Panuju, G S Wahyudi, M T Al Ghazali, Martinus, A Riszal, A Hamni and Y Burhanuddin

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Research in the field of design for sustainable behavior (DfSB) has been conducted quite extensively, but studies that provide evidence of the effects of design strategies on measurable changes in consumer behavior are still scarce. Moreover, this study introduces a framework to comprehend the behaviour changes after interacting with DfSB. This research further investigates the relationship between behavioural changes and increased environmental awareness resulting from the implementation of one eco-design concept in a dual-tub washing machine, namely the addition of an eco-feedback component. Through a series of experiments, it was found that the difference in respondents' educational backgrounds did not have a significant influence, but increased awareness showed a positive correlation with eco behavioural changes among the respondents. Additionally, behavioural changes were also identified to be influenced by other factors that are difficult to quantify, such as past habits and respondents' perception of cleanliness. The results of this research are expected to contribute to the process of designing products that are more targeted and measurable in order to encourage consumer behaviour to be more environmentally friendly, especially in everyday household products.

<https://doi.org/10.1088/1742-6596/2972/1/012027>

OPEN ACCESS

012028

Conceptual design of heating power control system for passive cooling system simulation facility using PID control-based LabView

Pricylia Valentina, Adhika Enggar Pamungkas, Iwan Roswandi, Mulya Juarsa, Agus Sunjarianto Pamitran and Ronald Akbar

 View article  PDF

The on-off control system applied for heating power control in passive cooling system simulation (FASSIP) facilities resulted in a high overshoot of the experimental data. Developing a heating power control system into a PID control system is expected to reduce overshoot without increasing the rise time of the experiment. LabView-based PID control system for heating power control can be done by specifying the desired setpoint and then keeping the actual temperature of the water stable with minimal error. The temperature difference between the setpoint and the actual temperature becomes the input data of the PID system to calculate and analyze the amount of heating power so that the water temperature in the heating tank remains at the setpoint value. The output of the PID control system can be in the form of a duty cycle switch controller or it can also be an analog signal fed to the power controller (Silicon Controlled Rectifier/SCR) so that the power provided to the heater is in accordance with the calculation of the PID system.

<https://doi.org/10.1088/1742-6596/2972/1/012028>

OPEN ACCESS

012029

Reduction of UAV vibration response by addition of T-Spar in wing structure

Lovely Son, Mulyadi Bur, Eka Satria and Wahyu Fadillah Wafid

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This study is performed to evaluate the vibration response of UAVs during flight tests. The UAV's vibration response is measured using the existing accelerometer installed on the UAV flight controller. An additional accelerometer is placed inside the UAV fuselage near the flight controller board for high-frequency vibration measurement. The vibration response analysis shows that the maximum acceleration response occurs when a UAV is flying in turning mode. An additional T spar is added between two existing tubular spars in the UAV wing to increase the wing stiffness. It was shown from the flight test that the acceleration response amplitude reduces by 26,84% when using T spar on the wing structure.

<https://doi.org/10.1088/1742-6596/2972/1/012029>

OPEN ACCESS

012030

Design of monitoring and control device for biogas production in a pilot scale anaerobic digester

Muhammad Daud, Sabarullah, Siti Nurjannah, Adi Setiawan, Arnawan Hasibuan, Faisal and Edy Yusuf

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Response to reviewer

Comment from the reviewer :

Introduction

The introduction is well-written and explains the formulation of the problem and the purpose of the study well.

Methodology

The methodology explains the experimental method entirely and accurately

Results and discussion

The discussion results are good but not supported by previous research references.

Response:

Additional sentence was put in the last paragraph. It's refer to literature no 12.

Conclusion

The conclusion is too short and does not explain the purpose of the problem accurately

Response:

An explanation about how accurate the set up when calibration to assure the measurement accuracy was added in conclusion.

Thin-walled Tube Load Cell for Bolt Torsion Test

by Tono Sukarnoto

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Thin-walled Tube Load Cell for Bolt Torsion Test

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Abstract. The purpose of this research is to know that thin-walled load cell can be used properly to measure the torque for high quality bolt torsion testing. The load cell made from SUS 304 tube completed with four holes was designed. It was developed from the previous one that using intact tube. For strain sensing in orientation at +45 degree and -45 degree, two rosette strain gages were used in the opposite position. The strain gages connected in full Wheatstone bridge configuration to a Computing Data Log-ger. Set up calibration equipment for torsion load only was built for this load cell and the result is constant 12.85 for Data Logger setting. A torque wrench was used for setting maximum load applied and load cell with Data Logger measure and counting the actual torque. For the experiment two size hexagonal zinc coated steel bolt M8 and M10 were used for testing sample. Test result shows that all samples can reach mini-mum torque load that mentioned in specification.

1. Introduction

In this research we were testing structural bolts using a set up consisting of a thin-walled tube load cell connected with a data logger to measure torque. The load cell was developed from the previous version. The difference is there are four holes in symmetrical position around the wall. These holes were made to increase sensitivity for detecting longitudinal and tangential strain on the tube surface without sacrificing the load cell body strength. The previous version and current version load cell showed in Figure 1.

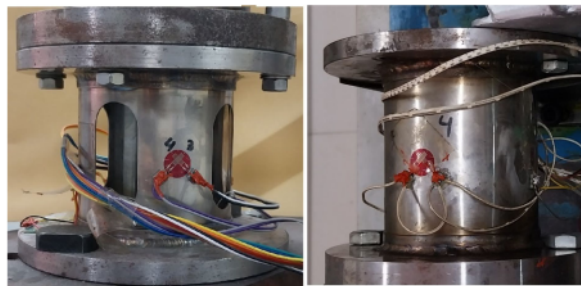


Figure 1. Thin-walled tube load cell, previous version (right) and current version with four holes.

For load cell calibration we use a set up that can load pure torsion on the load cell. It consists of an arm, sling wire, pulley, and some dead weight to give various torsion loads.

For further research we wish to upgrade our load cell from measuring static torque to measuring dynamic torque. Though the calibrating process is the same, measuring dynamic torque is more complicated due to the transmitting signal from rotating part to the stationary part. Muftah et al did this dynamic torque measurement using V-shaped strain gauge on a rotating shaft using a slip ring to transmit signal from rotating shaft to the stationary part achieving linearity error and hysteresis less than 0,5 % with a torque up to 8 Nm [1].

The purpose of this research is to know that thin-walled tube load cell can be used properly to measure the torque for high quality bolt torsion testing. This research was done at Basic Phenomenon laboratory, Mechanical Engineering Department Universitas Trisakti.

2. Literatur Review

2.1 Loadcell

There are various types of load cell for measuring strain from torque load, some of them are shown in Figure 2 [2]. Hollow tube load cell is the type of loadcell we use in this research.

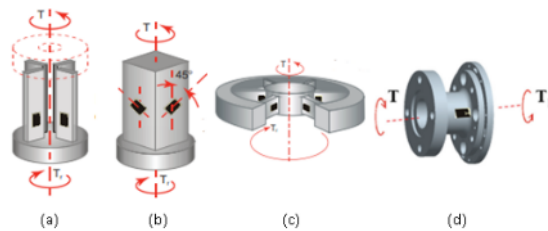


Figure 2. Various type of load cell, (d) is hollow tube load cell [2].

Another application of this load cell can be used on robotic joints. It requires high sensitivity in one torque component while a very low sensitivity for other components of torque and forces. Though Farhad et al uses different load cell design, which is a hollow hexaform load cell, it achieves sensitivity of 45,7 mV/Nm and torsional stiffness of $3,4 \times 10^4$ Nm/rad for the type B sensor and 96,5 mV/Nm and torsional stiffness of $1,5 \times 10^4$ Nm/rad [3].

3.2 Threaded Fastener

Threaded fasteners are commonly used to form mechanical connections in many applications, from automotive to structural steel and many others, primarily because they are inexpensive and easy to assemble and disassemble. To ensure the strength connection tightening bolts are important. There are several tightening strategies used for bolted joints in the industry, such as torque control, angle control, yield control, and stretch control. Tightening over the yield point is a relatively new method for achieving higher preloads in screwed joints, at least in the automotive industry. In the construction and railway industries, however, the so called *torque and angle method* [4,5,6] also known as turn-of-nut method or angle controlled tightening, has been in use for a quite long time.

For some special applications, angle controlled tightening strategy is used where maximum fastener strength utilization and more consistent clamp load are required [7].

Bolts/screwed joints can fail either under pre-loading due to tightening of bolt or from external loading. Pre-loading includes torsional shear stress caused by the friction of the threads, crushing of the threads, tensile stress due to stretching of bolt, etc. External forces on bolt can induces tensile stress, shear stress or both depending on how the bolt joints are connected [8]. Bolt failure under tension either by pre-loading or external loading can be reduced by increasing the threaded length [9].

In this research we focused on the shear stress due to initial loading from tightening on how much torque is applied until the bolt fractured. Although the most common fails due to fatigue, it is also noted that the low tightening torque can cause separation between the members which leads to higher cyclic stress. For static loading this phe-nomenon is negligible but worth mentioning. [10]

2.3 Bolt Torsion Testing

Indonesia National Standard SNI: 8458:2017 conduct method for testing high quality bolt tightening. The method is to define torque value set on torque wrench to reach minimum specific clamp forces [11].

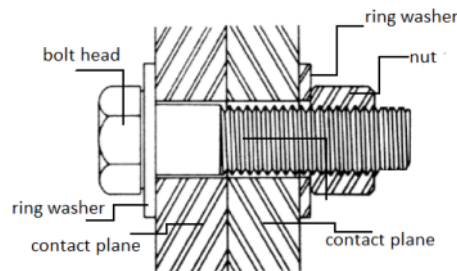


Figure 3. Bolt instalation on calibration apparatus [11]

In this method, torque value comes from torque wrench setting. Bolt tightening must be continuously done without impact till reach the preset torque.

3. Experiments

3.1 Equipment & materials

This experiment is using own design and built thin-walled tube load cell as shown in Fig. 4. The tube material is SUS 304 with two couple rosette strain gage FCA 6-11 for measuring strain in orientation of +45 and -45 degree. The strain gages have a gage factor 2.11 with 120 Ohm resistance. This load cell was also completed with two strain gages for measuring strain in axial direction but not used in this application. These two rosettes were connected in full Wheatstone bridge circuit to Computing Data Logger.

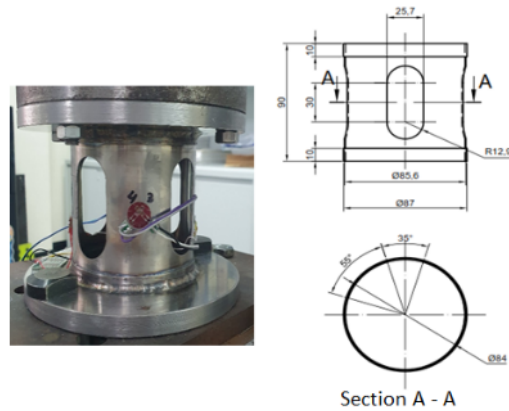


Figure 4. Thin-walled tube loadcell

The computing data logger was used for counting and recording torque from loadcell. A torque wrench was used for loading torque on bolt specimen.

Fig. 5 and Fig. 6 shows set up equipment for loadcell calibration. A digital scale is used to measure the force that is in same plane and perpendicular to moment arm. This force comes from the weight that hanging by cable sling trough a pulley. For calculation we use data from the scale.

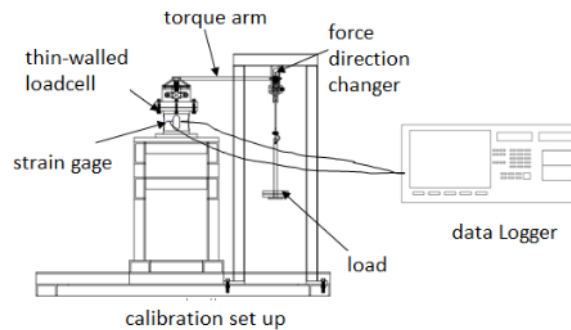


Figure 5. Calibration set up using Data Logger

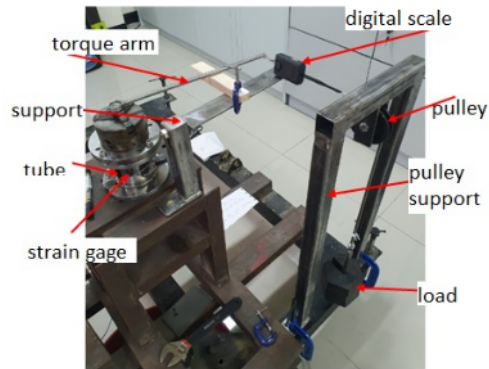


Figure 6. A photograph of loadcell calibration set up from above.

Sample bolts are hexagon steel zinc plated ISO 4017 grade 8.8 for M8x30 and grade 5.8 for M10x20.

3.2 Experimental Method

The step by step of the experiment method is shown in Fig 7.

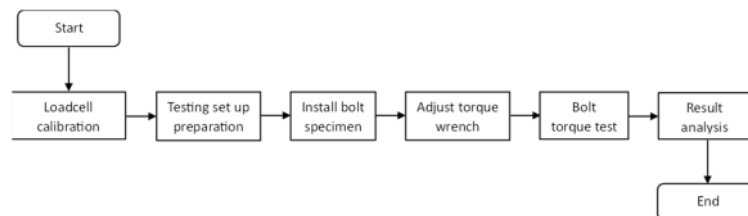


Figure 7. Step by step in experiment

Set up equipment for bolt testing is shown in Fig 8. The sample bolt positioned with head on top, between head and nut there are two pieces steel plate. The nut was clamped with chuck that connected to load cell flange.

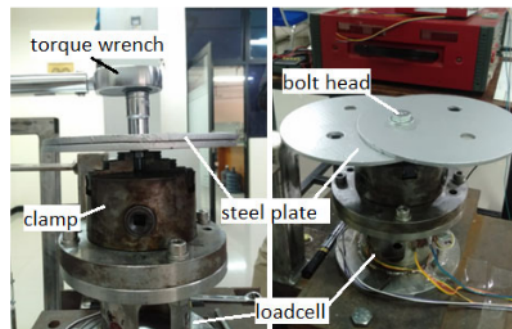


Figure 8. Set up for bolt torsion testing, position before wrench applied (right photo).

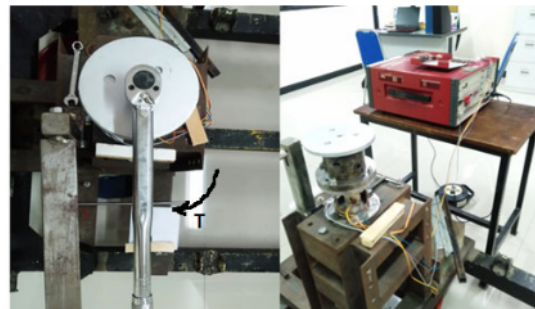


Figure 9. Torque load direction (left photo) and collecting data with data logger.

Torque direction and data collecting with computing data logger are shown in Fig. 9. The testing conduct on steel bolts M8x30 and M10x20.

4. Result and Discussion

4.1 Calibration Result

The result of calibration presented on Table 1

Data from Table 1 becomes a reference in determining constant for data Logger torque counting. The constant is 12.85 for result torque in N mm. The relationship between theoretical torque from Table 1 and Data logger Torque is shown in Fig. 10.

Table 1. Force and torque loading for calibration

Load [kg]	Force from scale		Torque
	[kg]	[N]	Nmm
0	0	0	0
1	0,98	9,61	3511,44
2	1,97	19,33	7058,71
3	2,97	29,09	10623,90
4	3,96	38,80	14171,17
5	4,95	48,51	17718,44

Fig 10 shows that theoretical torque and data logger torque are almost similar and linear with deviation less than 3 percent. This is more sensitive than using hub sprocket type [12] especially for low and precision applications. So, the equipment is ready for bolt torsion testing.

4.2 Torsion Testing

For each bolt M8 and M10 we use three samples. Torque applied gradually increase till bolt weakened due to torque overloading.

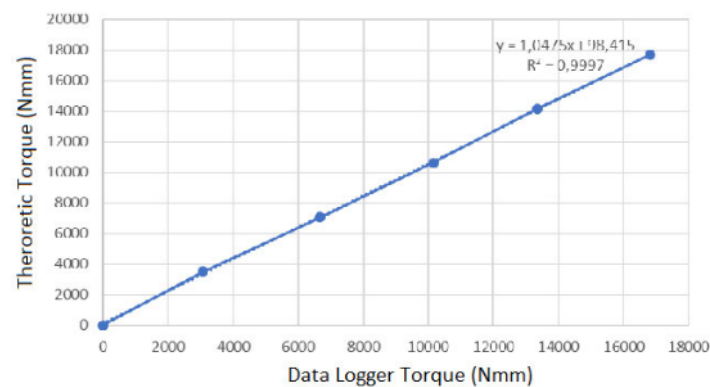


Figure 10. Graph from theoretical torque vs Data Logger torque.

The testing results for bolt M8 and M10 are shown in Table 2.

From Table 2, the lowest maximum torque for bolt M8 is 31,09 Nm. It's higher than torque on specification for grade 8.8 i.e., 28.8 Nm. For M10 the lowest torsion is 43.27 Nm that is higher than specification for grade 5.8 i.e., 30.85 Nm.

The bolt condition after testing shows in Fig 11. Some samples are totally fracture and some others were still intact and not broken.

Table 2. Torsion results for bolt M8 and M10

Sample	Max torque (Nm)	$t_{\max}$ (MPa)
M8		
1	31,09	407
2	36,87	483
3	33,79	442
average	33,92	444
M10		
1	46,26	293
2	43,27	274
3	43,27	274
average	44,26	280



Figure 11. Bolt condition after testing, one at the right is condition before tested.

5. Conclusion

The thin-walled tube load cell with Computing data Logger can be satisfy for data recording bolt torque testing. Calibration chart result has $R^2 = 0,9997$ for given load range from 0 to 18 Nm so the load cell and data logger measurement are similar with theoretical calculation and provides accurate measurement results. The torque testing for all bolt samples meets standard ISO 4017 grade 8.8 for M8x30 and grade 5.8 for M10x20.

6. Acknowledge

Many thanks to our mentor Dr Ir Soeharsono, MSc for providing the load cell and direction for load cell applications during research in our laboratory.

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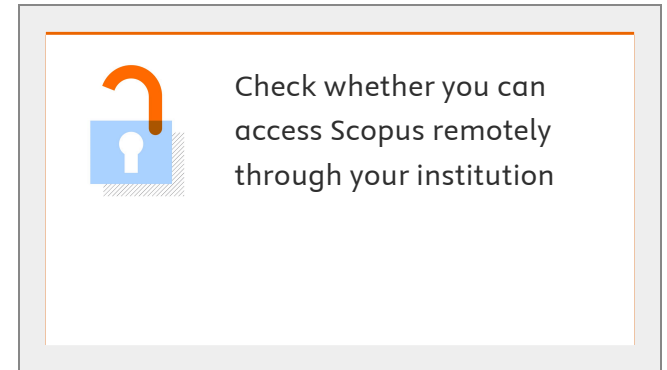
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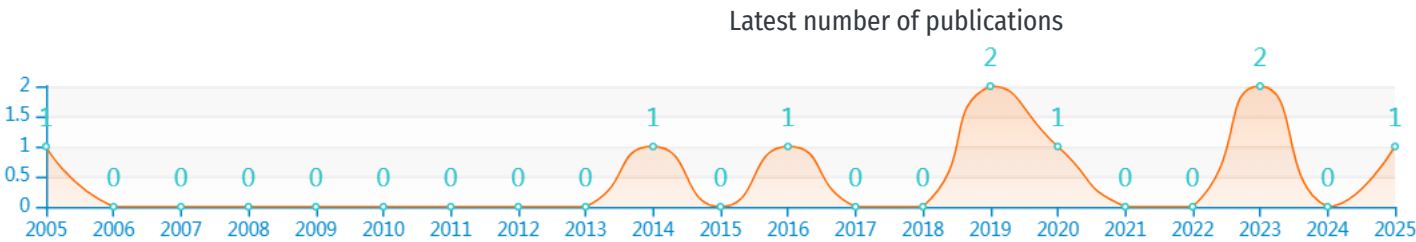
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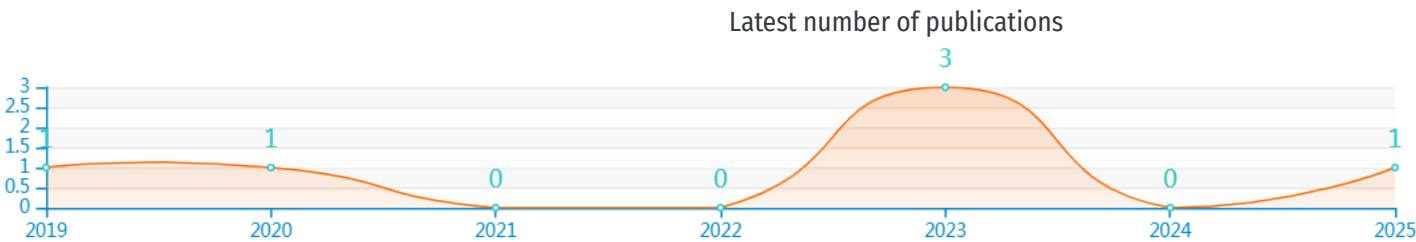
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