DIGEST

Volume 1, 2024

RESEARCH & INNOVATION
COLLEGE OF ENGINEERING

DIGEST

RESEARCH & INNOVATION
COLLEGE OF ENGINEERING

ABOUT THE MAGAZINE

The "Digest: Research & Innovation, College of Engineering" e-magazine is a publication created by the Office of Research & Innovation in the College of Engineering, Universiti Teknologi MARA. Its primary objective is to showcase the research and innovation of our esteemed researchers specialising in various engineering fields within the college. The publication provides a platform for researchers to publish their findings and innovative solutions to various engineering and scientific challenges. The ultimate goal of this effort is to promote research visibility and enhance the reputation of Universiti Teknologi MARA to global standards. This initiative aims to inspire greater interest and participation in research to improve our institution and society.

Published by :
Kolej Pengajian Kejuruteraan, Universiti Teknologi MARA, 40450 Shah Alam, Selangor Darul Ehsan, Malaysia

Phone: **+603-5543 5052** Email: **penyelidikankpk@uitm.edu.my**
Website: **https://engineering.uitm.edu.my/research_and_innovation**

Perpustakaan Negara Malaysia

No. e-ISSN: 2805-573X

FOREWORD *by* PNC

Congratulations to the Office of Research and Innovation on the publication of the first issue of this e-magazine. This publication aims explicitly to promote the visibility of the College of Engineering, UiTM research endeavours and those who undertake them.

I am delighted to see a wide range of articles showcasing the impressive research conducted by our esteemed researchers—their dedication to research, particularly towards developing solutions to attain Sustainable Development Goals (SDGs).

We are committed to furthering our contributions towards impactful research and developing knowledge-based technologies that benefit society. The publication of this magazine will assist in enhancing the visibility of KPK research and innovation.

We remain steadfast in our commitment to excellence and look forward to continuing progress in this area.

PROF. DR HAMIDAH MOHD SAMAN
Assistant Vice Chancellor
College of Engineering
Universiti Teknologi MARA

FOREWORD by the DEAN

We are delighted to welcome you to the KPK E-magazine's inaugural edition. This platform was created to give our esteemed researchers a place to showcase their research activities, innovations, findings and original work. It's also a great opportunity for all KPK researchers and academicians to become more visible, encourage partnerships, and present their work to a wider audience.

A primary strategy for steering the UiTM toward being a world-renowned university by 2025 is to prioritize research that has a significant and practical impact. wherein the discoveries, conclusions, and outcomes of the research could be advantageous to various stakeholders as well as society at large. It is essential that, all KPK researchers should realise and unleash their full potential in order to become a globally respected or internationally renowned research leaders in their field. impactful and translational research should be done in groups to ensure sustainability of the knowledge in conducting impactful translational research.

In order to maintain the momentum of conducting research and promote innovation, the office of research and innovation KPK would like to request all academics and researchers to provide their continuous support. Additionally, I want to sincerely thank all writers and collaborators who have shared their wide range of research study topics. In order to help this magazine succeed and sustain, we cordially request all scholars and researchers to contribute their research highlight summary into this e-magazine.

We extend our congratulations to the editorial team on this remarkable achievement. Let us all work together to showcase our research activities and innovations to the world.

Thank you all for your contributions and support.

Prof. Ts. Dr. Aidah Jumahat
Dean Research and Innovation
College of Engineering
Universiti Teknologi MARA

PATRON

Prof. Ts. Dr. Aidah Jumahat

EDITOR

Dr. Nurul Fadhilah Kamalul Aripin

TEAM

Dr Rahidawati Sharudin
Dr Noor Sa'adah Abdul Hamid
Fariza Hamidon
Ir Mohd Fadhil Majnis
Dr Freddawati Rashiddy Wong

TABLE OF **CONTENTS**

17

OIL-BASED INK FROM BIOCHAR OF USED *MASHAF* VIA MICROWAVE TECHNIQUE: A WASTE CIRCULARITY OPTION IN QURAN PRINTING INDUSTRY

Assoc. Prof. Ir. Dr. Siti Shawalliah Idris,
Nur Aqilah Najlaa Azran
School of Chemical Engineering

18

QUANTIFICATION OF CARBON DIOXIDE SEQUESTRATION BY DUCKWEED: PROMOTING CIRCULAR ECONOMY IN TILAPIA AQUACULTURE

Ir. Dr. Luqmanulhakim Baharudin
Ts. Raja Shazrin Shah Raja Ehsan Shah
GalaxyTech Solutions (M) Sdn. Bhd. &
School of Chemical Engineering,

19

HYDROTHERMAL SYNTHESIS OF ZINC OXIDE (ZnO) FOR TETRACYCLINE REMOVAL

Ir. Dr. Lim Ying Pei, Alia Nabila Johar
School of Chemical Engineering

20

PLANT-BASED NATURAL SILICONE OIL FROM HELIANTHUS ANNUUS

Dr. Harumi Veny, Nor Ashiqin binti Zairi
School of Chemical Engineering

21

PID CONTROLLER OPTIMIZED BY GREY WOLF OPTIMIZER FOR SEMI-ACTIVE VEHICLE SUSPENSION SYSTEM

Ts. Dr. Muhamad Sukri Hadi,
Ahmad Hazim Mohd Zam Zam
School of Mechanical Engineering

22

THE GREEN REVOLUTION OF NANO SILICA SYNTHESIZED FROM AGRICULTURAL WASTE

Dr. Fuzieah Subari
School of Chemical Engineering

23

AI-UCOS: ANTIMICROBIAL INFUSED-USED COOKING OIL SHELLAC

Dr Miradatul Najwa binti Muhd Rodhi,
Nur Zahirah 'Ainaa' Mohd Asri
School of Chemical Engineering

24

STUDY ON THE TRIBOLOGICAL CHARACTERISTIC OF FOOD-GRADE BIO-LUBRICANT USING FOUR-BALL EXPERIMENTS

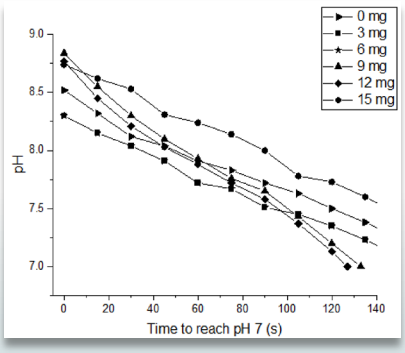
Mohamad Mazwan Mahat
Iffah Aqilah Ismail
School of Mechanical Engineering

Amyira Natasha Mahari
School of Chemical Engineering

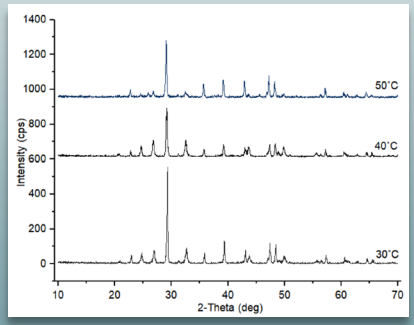
- *Assoc. Prof. Dr. Fazlena Hamzah*
- *School of Chemical Engineering*
- *fazlena@uitm.edu.my*

Expert UiTM link

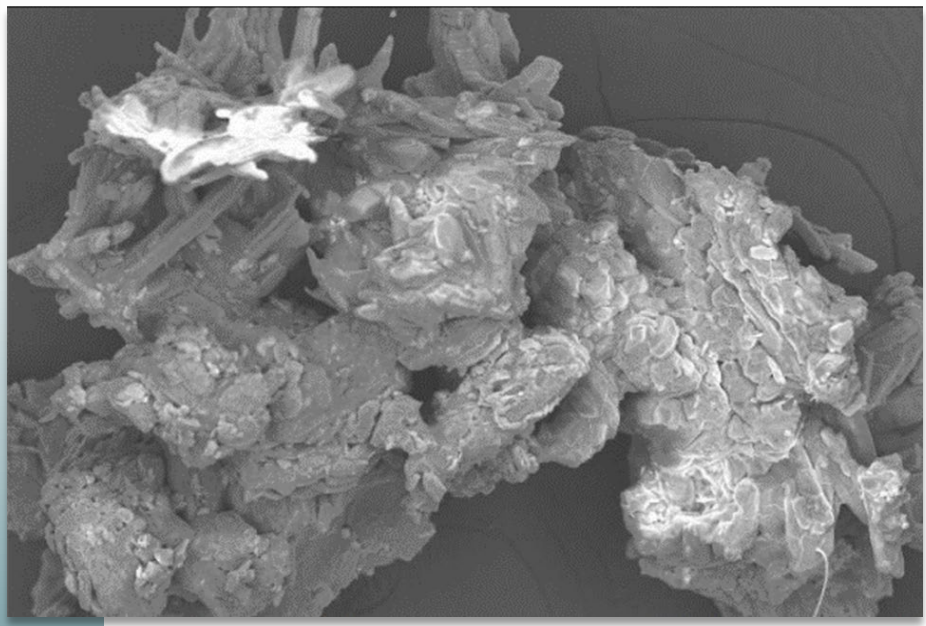
ZINC CYCLEN DEVELOPED FOR CARBON DIOXIDE HYDRATION PROCESS



Effect of Zn – Cyclen loading to the time taken to reach pH7



XRD analysis of $CaCO_3$ at different temperature reactions



Our study found that Zinc-cyclen can accelerate hydration and precipitation processes, with the amount of precipitated $CaCO_3$ and the time it takes for the solution to reach pH 7 influenced by CO_2 pressure and Zinc-cyclen concentration. Higher CO_2 pressure led to more precipitate $CaCO_3$ mass, but it took longer for the solution to reach pH 7.0. The optimal Zinc-cyclen concentration was 0.6 g/L, resulting in 1.845 g of $CaCO_3$ precipitate and 9.36 minutes to reach pH 7.0. The study suggests that Zinc-cyclen concentration has a marginally significant impact on precipitate production and time to reach pH 7.0.

CO_2 emissions, primarily caused by burning fossil fuels, are a major contributor to global warming. Multinational efforts are developing CO_2 hydration technologies to combat climate change, such as using biomimetic complexes resembling Carbonic anhydrase (CA). Simulating (CA) is an efficient and sustainable method for reducing CO_2 emissions. Naturally occurring (CAs) and their clones are being explored for CO_2 collection methods. Alcohol, such as ethanol, is used for CO_2 hydration due to its accessibility and non-poisonous nature. Zinc (II) cyclen, a small molecule CA mimic, was examined under harsh conditions, showing that absolute ethanol inhibited the catalyst's activity. Zinc-cyclen has a 5-fold lower activity and slower CO_2 hydration kinetics than CA. Improving small molecule CA mimics is crucial for their continued performance in industrial settings.

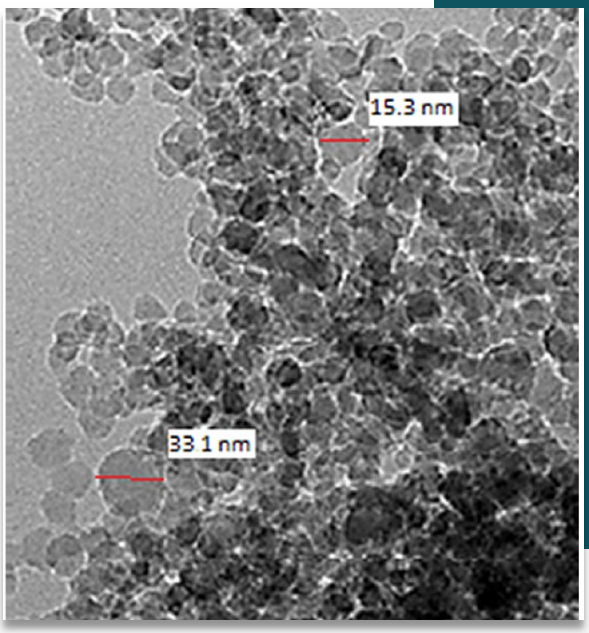
Our recent research aims to optimize the efficiency of the CO_2 hydration process by varying Zinc-cyclen concentration and pressure, analyzing the morphology of Zinc-cyclen and precipitates, and evaluating the performance of Zinc-cyclen using the CO_2 hydration process as the study method.

- *Assoc. Prof. Ir. Dr. Irnie Azlin Zakaria*
  School of Mechanical Engineering
- *irnieazlin@uitm.edu.my*

Nur Ezreen Sabrina Mohd Zulkeflee
School of Mechanical Engineering

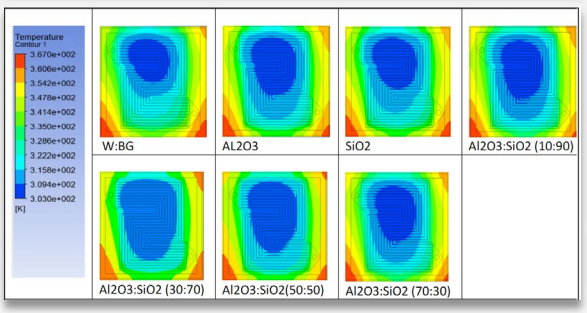
Expert UiTM link

NANOFLUIDS ADOPTION AS AN ALTERNATIVE HEAT TRANSFER FLUIDS IN PEM FUEL CELL COOLING

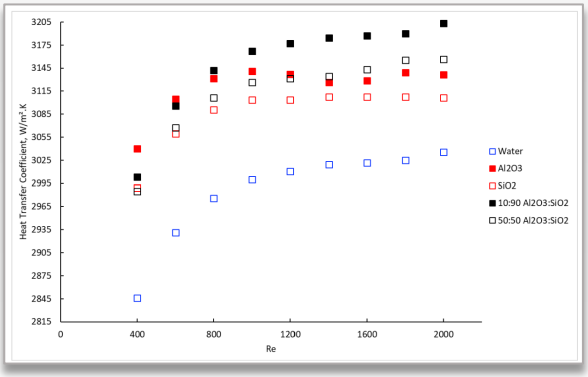


Heat transfer fluids play a crucial role in optimizing thermal management in various applications. The primary purpose of a heat transfer fluid is to facilitate the efficient transfer of heat from one location to another. Nanofluids are fluids consisting of base fluid and nano-sized particles with sizes less than 100 nm suspended within them. Base fluids can be water, ethylene glycol mixture, propylene glycol mixture, or engine oil. The engineered nanofluids significantly alter the base fluid's properties in terms of heat transfer enhancement.

Several thermo-physical properties works have been conducted on mono-Al_2O_3 and mono SiO_2 in various base fluids, including water, water: Ethylene Glycol, and water: BioGlycol. The reported properties are mainly thermal conductivity, dynamic viscosity, and electrical conductivity. The mono-Al_2O_3 and mono SiO_2 were then combined based on volume ratio to form hybrid Al_2O_3:SiO_2 nanofluids. The volume ratio of 10:90 in water showed the highest enhancement in thermal conductivity as compared to its Mono Al_2O_3 and SiO_2, with an enhancement percentage of 3.53% and 3.95%, respectively. In terms of electrical conductivity (EC), the addition of hybrid (Al_2O_3:SiO_2) nanofluids in BioGlycol, which is derived from corn, has suppressed the EC base fluid 60:40 W:BG by 24% lower. This is favourable for an electrically active heat transfer application, which requires a minimum value of electrical conductivity property.



Temperature Contour at Re 600 for Serpentine Cooling Plate



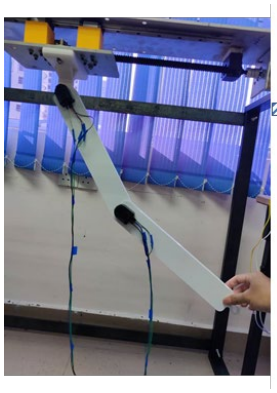
Effect of nanofluids to heat transfer performance

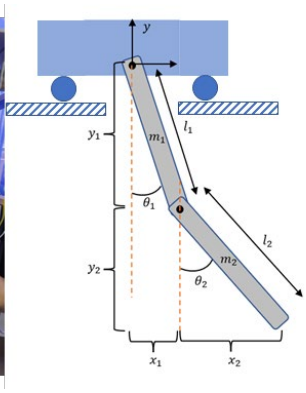
Various research studies have been conducted to adopt the technology of nanofluids as a cooling medium. The Proton Exchange Membrane Fuel Cell (PEMFC) is among the applications studied. The PEMFC is a greener alternative to internal combustion engines (ICE) due to its higher efficiency of up to 60 % compared to ICE of 25 %. The PEMFC utilizes electrochemical reactions of pure hydrogen and oxygen from the air to produce electricity to power vehicles and machinery. Aside from electricity, the PEMFC output is merely heat and water. It contributes to global climate change by reducing greenhouse gas emissions and promoting environmental sustainability. Hybridizing 10:90 Al_2O_3:SiO_2 nanoparticles in a PEMFC single cooling plate can increase the heat transfer by 5.52 % compared to the base fluid. However, further work needs to be done mainly on the effect of an increase in viscosity value, which in turn increases the pumping power requirement and also the compliance to the strict limit of 5 µS/cm for its electrical conductivity value.

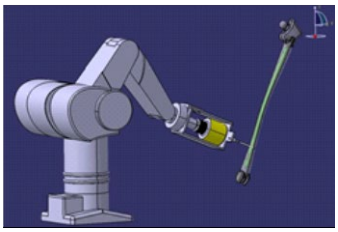
Nur Azareena Azman
School of Mechanical Engineering

Prof. Ir. Dr. Muhammad Azmi Ayub
UiTM-Toyohashi University Laboratory
School of Mechanical Engineering
muhammadayub@uitm.edu.my
Expert UiTM link

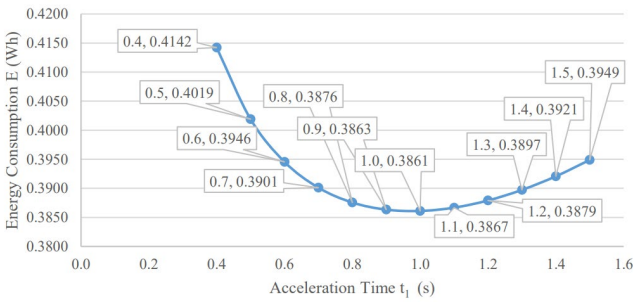
Intelligent Motion Control of Robotic Mechanism



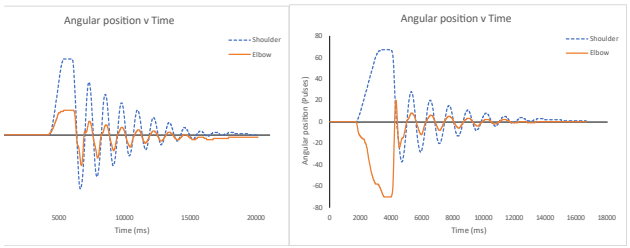




6-DOF Robotic Arm Manipulator



Optimization of Energy Usage



Vibration Suppression

Robotic mechanisms are increasingly used in various industries, including agriculture, automotive, aerospace, medical, and logistics, due to their controlled features. With the increasing demand for repetitive high-speed and high-precision operations, intelligent control coupled with adaptive motion strategy is crucial to address the issues of excessive vibration and energy usage. These are important for economic justification besides several motion constraint parameters such as end-effector travel distance, speed, and acceleration during the robot's operations. These parameters are important to avoid workpiece breakage, machine tool fatigue, excessive vibration, and energy usage for an extended period of repetitive operations.

This research study investigates models and methods for vibration suppression and energy optimisation of a DC motor-driven robotic mechanism. The prototypes used are six degrees of freedom (DOF) robotic arm manipulator and three degrees of freedom underactuated robotics crane with the developed computer algorithm. The under-actuated crane mechanism consists of a double link system where rotation motions consist of two parts, each belonging to respective links. Link 1 is a rotation motion due to the DC motor embedded with the encoder. Link 2 is the swing motion affected by link 1.

A robot dynamics model was developed as a function of natural frequencies and energy consumption. Based on this function, the linear segment with parabolic polynomial blend trajectory planning was utilised for vibration suppression and energy optimisation. Machine learning via gradient of the steepest descent algorithm is implemented to search for the parameter's adjustment and the self-tuning adaptive motion controller gains. The four parameters considered are total motion distance and time, maximum velocity and acceleration.

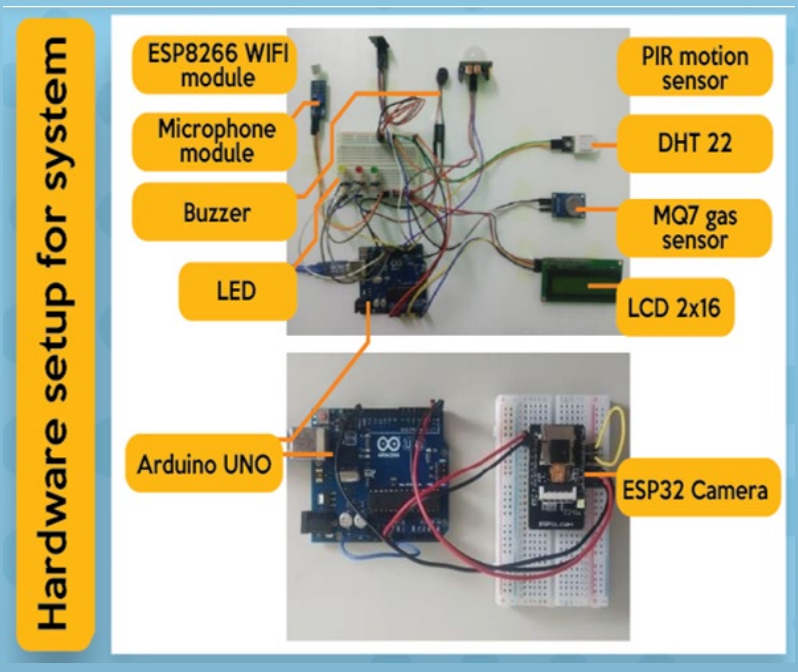
Experimental results show that this intelligent tuning approach is feasible and efficient, offering a starting point for achieving desired control performance. The settings can be adjusted and customised to suit the system's needs and goals, resulting in a customised and enhanced motion control experience.

Muhammad Hazimin Mohamad Hilmi
School of Mechanical Engineering

Ir. Dr. Rozina Abdul Rani
School of Mechanical Engineering
rozina7370@uitm.edu.my
Expert UiTM link

SMART SAFETY SYSTEM FOR VEHICLES

Recent technological developments have paved the way for multi-functional systems such as smartphones and enhanced vehicle technology. Modern cars are getting more ecologically friendly and technologically advanced. Much technological advancement has made our lives better, faster, and easier. However, several car deaths occur throughout the year as a result of human error and inhalation of harmful emissions. Children are frequently left in cars by their guardians, and fatalities occur due to a lack of oxygen for breathing, hyperthermia, and an increase in temperature in the vehicle. In several other cases, people were found dead after being inhaled excessive amounts of carbon monoxide in their cars. Not only that, but the car theft rate is also at an all-time high, causing consumers to feel worried.



Thus, the difficulties mentioned earlier were addressed by utilizing IoT to develop a smart safety system for vehicles. The Arduino UNO is used as a microcontroller in this project, along with the ESP8266-01 Wi-Fi Module and Blynk application, to warn the user via their smartphone of the status of their vehicles and to monitor if there is a theft attempt. The system also includes sensors such as the MQ7 Carbon Monoxide Gas Sensor, the HC-SR501 Passive Infrared (PIR) Motion Sensor, the DHT22 Temperature Sensor, the Sound Sensor Module, and the ESP32 Camera, which allow users to monitor the temperature within the vehicle, sense high levels of carbon monoxide concentration, and monitor for any children who may have been left unintentionally. When a motion or sound is detected in the car, the system alerts and notifies the user via a message to the smartphone. It also produces an alarm sound to alert anyone nearby while allowing users to monitor the condition of their car via live-streaming video. The system will also alert the vehicle owner via a message and alarm as soon as it detects the presence of carbon monoxide. This system will be easy to use and successfully address all the problems raised by taking advantage of the smartphone.

Intan Suraya Mohd Shokri
School of Chemical Engineering

Noor Harliza Abd Razak
School of Chemical Engineering
harliza8566@uitm.edu.my
Expert UiTM link

NaOH-modified *Leucaena Leucocephala* Pods To Remove Pb (II) From Water

Lead (Pb) is a highly toxic and hazardous heavy metal that can be present in significant concentrations in contaminated water. Adsorbent from agricultural by-products is generally considered an effective, relatively inexpensive and eco-friendly treatment technique. Modification has shown great promise in improving the adsorption capacity and pore development of adsorbents. This research investigated the potential of Leucaena leucocephala pods, an agricultural by-product, as an adsorbent for capturing lead (Pb) ions from aqueous solutions. The pods were modified with NaOH, and new chemically modified Leucaena leucocephala pods for sequestration of Pb(II) from an aqueous solution were obtained. Subsequently, the study aimed to determine the optimal conditions for effectively removing Pb (II) ions from synthetic aqueous solutions by analyzing the impact of adsorbent dosage, solution pH, and contact time. The experimental results revealed that the optimum adsorbent dosage was 0.04 g, resulting in a remarkable percentage removal of 99.12%.

Similarly, a pH of 5 exhibited excellent performance, achieving a percentage removal of 98.61%. The contact time was fixed at 80 minutes, while the concentration of Pb (II) solution was maintained at 50 mg/L with a volume of 25 ml. These findings strongly indicate that modified Leucaena leucocephala is an efficient bio-sorbent for removing Pb (II), offering promising potential to mitigate toxic metal pollution in tropical aquatic ecosystems.

Beauty Beware:
PROBING USER AWARENESS AND UNMASKING HEAVY METALS IN COSMETICS

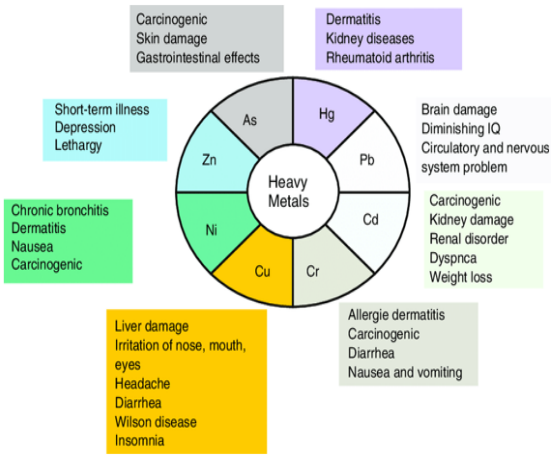
Dr. Farah Hanim Ab Hamid
School of Chemical Engineering
farah88@uitm.edu.my
Expert UiTM link

Dr. Rozana Azrina Sazali
School of Chemical Engineering
rozana592@uitm.edu.my
Expert UiTM link

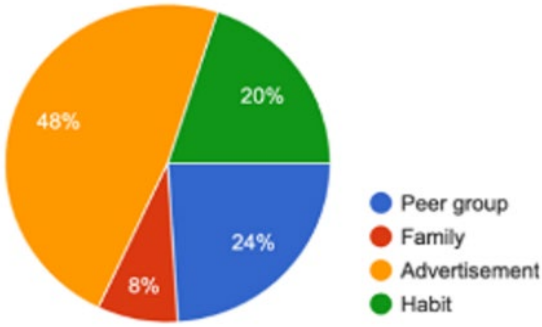
Cosmetics are materials frequently applied to the human body's outer skin. Due to its frequent and ongoing use, it has become a need nowadays among Malaysians. Despite its popularity, numerous cosmetic products harbour heavy metals, which, over time, can pose health risks as they accumulate. The dumping of cosmetic products, especially in the local market, is causing concern among consumers, especially regarding the monitoring of ingredients used. The consumer's perception is important in choosing, analysing, and interpreting information. There needs to be a report describing the perception of the user on cosmetic products and the concentration of heavy metals in unauthorised cosmetics in Malaysia's local markets.

In our most recent study, a survey was conducted to explore customers' perceptions regarding cosmetic selection. The results indicated that brand advertisements predominantly swayed respondents when choosing cosmetic products. Following closely were habitual preferences related to cosmetic products and the influence of peer groups who frequently use such products. This study also aims to assess the concentration of toxic metals such as lead, cadmium, arsenic, and mercury in popular fairness creams widely used by Malaysians. The findings found that one of the samples surpassed the allowed concentration for a cosmetic product. Brand B is the riskiest face cream, followed by Brand C and Brand A. Specifically; Brand B was found to contain 4440 ppm of mercury, exceeding the permissible limit set by the Malaysian standard.

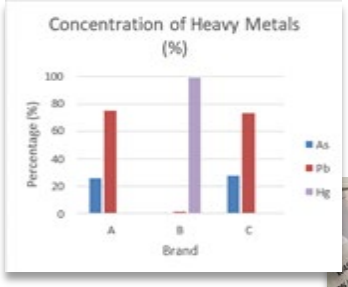
This study offers valuable insights, highlighting the significance of understanding and being aware of cosmetic ingredients. It demonstrates that certain products in the market pose risks when lacking approval from the appropriate authorities. The findings could enhance user awareness and lead to improvements in this regard.



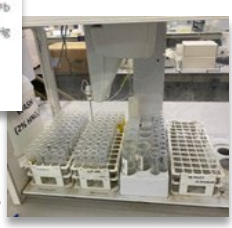
Health risks caused by heavy metals in human body



Factors that influence respondents in choosing cosmetic product



Heavy metals concentration for random three brands



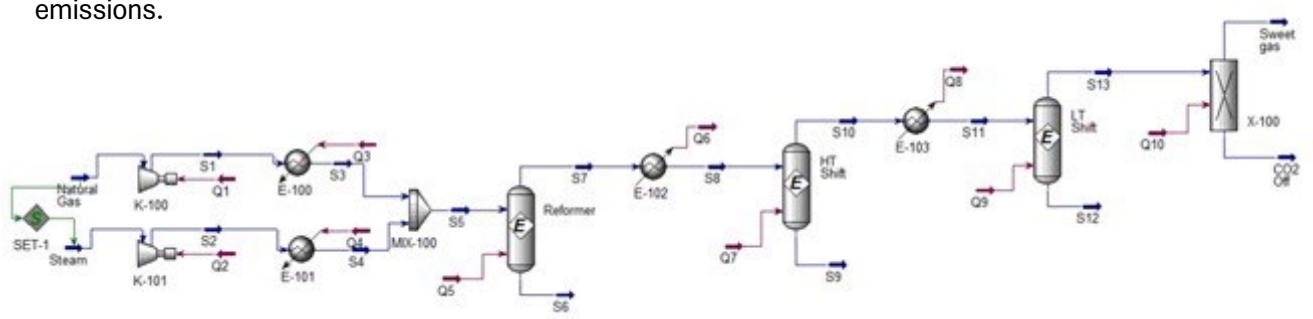
Sampling process

Mohamad Farizzuddin Mohamad Fauzi
School of Chemical Engineering

Dr.-Ing. Amizon Azizan
School of Chemical Engineering
amizon@uitm.edu.my
Expert UiTM link

DECARBONIZATION OF METHANE INITIATIVE CASE STUDY PROPOSAL ON HOW/WHAT TO MODEL OF METHANE CONVERSION TO HYDROGEN

Decarbonization is the process of reducing carbon dioxide emissions from the atmosphere, primarily using low-carbon energy sources. Methane (CH_4), classified as a greenhouse gas, plays a substantial role in the phenomenon of global warming and climate change. Methane can be converted into valuable products, and hydrogen (H_2) is an emerging energy product recently under investigation. Hydrogen can be generated from methane using several methods, such as Steam Methane Reforming (SMR). Hydrogen production can be divided into two categories: fossil fuels, renewable resources, and biomass or water. Understanding decarbonization is of utmost importance in mitigating the adverse impacts of greenhouse gas emissions and, at the same time, fostering a sustainable energy practice. The Earth's temperature has risen by over 1°C in the past 120 years, contributing to global warming. The concentration of carbon dioxide in the atmosphere reached a record high in 2021, highlighting the need for decarbonization to reduce emissions.



Process flow diagram of the base case

Name	Type
K-100	Compressor
K-101	Compressor
E-100	Heater
E-101	Heater
MIX-100	Mixer
Reformer	Reformer reactor
E-102	Cooler
HT Shift	High temperature shift reactor
E-103	Cooler
LT Shift	Low temperature shift reactor
X-100	Pressure swing adsorption unit

Nomenclature for equipment used.

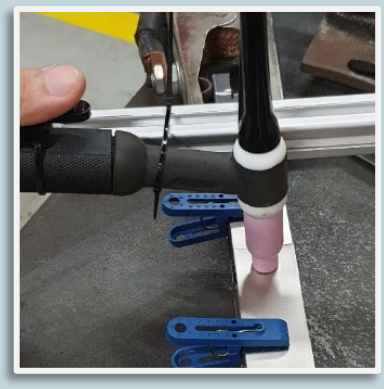
Methane, with 21 times more greenhouse gas potential than carbon dioxide, can be converted into valuable products. Our study explores CH_4 decarbonisation and the process simulation model of CH_4 conversion to H_2. It has significant implications for addressing climate change. Our research using Aspen HYSYS on CH_4 decarbonisation and its conversion to H_2 through SMR found that the steam-to-carbon ratio, reforming temperature, and pressure significantly influence CH_4 conversion, H_2 yield, and purity. Higher temperatures were found to enhance CH_4 conversion, while higher pressures were beneficial for industrial applications. The findings provide valuable insights into optimising reformer reactors for efficient H_2 production and contribute to decarbonisation and sustainable energy solutions. Implementing decarbonisation measures via SMR is a promising step towards meeting global emissions reduction targets and fostering a cleaner, greener energy landscape.

This research addresses the critical issue of optimizing joining methods for electric vehicle (EV) battery interconnects, focusing on the unique application of micro-TIG welding. Unlike conventional joining methods, such as laser welding or ultrasonic bonding, micro-TIG welding is explored for its potential to enhance the mechanical, microstructural, and electrical properties of lap joints in nickel-plated steel, commonly used in EV battery packs.

The results of this research demonstrate that varying the micro-TIG welding process parameters, particularly increasing current modulation, significantly influences the mechanical strength, microstructure, and electrical resistance of the welded joints. Higher current modulation, specifically at 25A, consistently yields superior performance in terms of ultimate tensile strength, yield strength, and Young's Modulus. The low K Factor associated with this condition indicates reduced electrical resistance, a crucial factor for efficient battery interconnects.

The significance of these findings lies in their potential to optimize micro-TIG welding as a joining method for battery interconnects, contributing to the development of safer and more efficient electric vehicles. By improving mechanical strength and electrical conductivity, the research directly addresses challenges related to EV battery pack integrity and safety. Furthermore, the study's broader impacts include advancements in joining technologies for battery manufacturing, potential applications in other industries, and overall support for sustainable transportation.

Electro-Thermo-Mechanical Behaviours of Joints Integrity for Electric Vehicle Battery Interconnects



The process of micro-TIG welding

Example of micro-TIG welding (Alexy, 2019)

Tensile testing of the specimen

This research provides valuable insights into the electro-thermo-mechanical behaviours of micro-TIG-welded joints and offers a unique perspective on optimizing this technique for electric vehicle battery interconnects.

The results contribute to the ongoing development of electric vehicles and sustainable transportation solutions, emphasizing the importance of suitable joining methods for enhancing performance, safety, and efficiency in EV battery packs.

Dr. Amalina Amir
School of Mechanical Engineering
amalina.amir@uitm.edu.my

Expert UiTM link

Ahmad Akmal Abd Manan
School of Mechanical Engineering

Alexy M, van de Wall D, Shannon G, Boyle ML. Batteries need strong connections–are resistance, laser and Micro-TIG welding the best suited joining technologies?. Biuletyn Instytutu Spawalnictwa. 2019;1(2019):53-63.

Nur Aqilah Najlaa Azran
School of Chemical Engineering

Assoc. Prof. Ir. Dr. Siti Shawalliah Idris
School of Chemical Engineering
shawal075@uitm.edu.my
Expert UiTM link

Oil-based Ink from Biochar of Used *Mashaf* Via Microwave Technique: A Waste Circularity Option in Quran Printing Industry

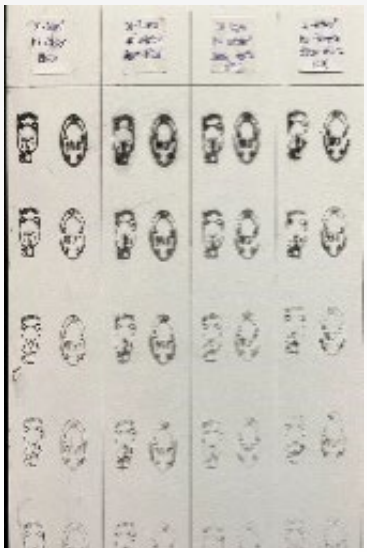
Biochar of Used Mashaf obtained under Microwave Pyrolysis

Oil-based ink

Current calls by the United Nations through the Sustainable Development Goals aim to reduce the negative environmental impact of cities by 2030, particularly in air quality and waste management. Malaysia, too, faces challenges in the aspect of managing waste; the greenhouse gas emissions from its daily activities generate waste. Reducing waste in landfills by providing emerging technology is important.

In the aspect of disposing of particular materials such as used Mashaf, special care must be taken to maintain holiness as prescribed by the Fatwa Committee in the National Council for Islamic Religious Affairs in Malaysia. This used Mashaf, which is not in good condition to read because of damage, torn out, scribbled, etc., will be incinerated, and its ash shall be disposed of according to the prescribed method. With the increase of enrolment in Quran users and consumers, especially the Tahfiz students, there is a need for technology that could solve the problem while at the same time improving environmental sustainability through waste circularity.

Our lab has carried out investigations to resolve the issues that lead to waste circularity. We convert the used Mashaf into biochar, which is then used to replace carbon black in the ink formulation. The ink could be used for printing Al-Quran, which indeed can ensure the waste circularity is maintained within the use of making Al-Quran. The used Mashaf was subjected to a thermal decomposition process using a microwave technique to obtain the biochar. Contaminant removal was carried out on the biochar using different chemicals, followed by formulating the oil-based ink. The treated Quran biochar was examined using X-ray fluorescence and elemental analysis. The ink was further studied for oil-based ink formulation with a standard carbon black ink formulation for printing. The biochar, which contains impurities like TiO_2, SiO_2, and CaO, has been used as a carbon black substitute in printing ink. An acid digestion method has been used to remove contaminants, resulting in higher TiO_2 and SiO_2 levels and reduced CaO. The ink from untreated used Mashaf biochar is practical, as it preserves the ideal particle size. Microwave pyrolysis of wastepaper, particularly mashaf Quran, has been explored as a sustainable waste management solution in Malaysia.

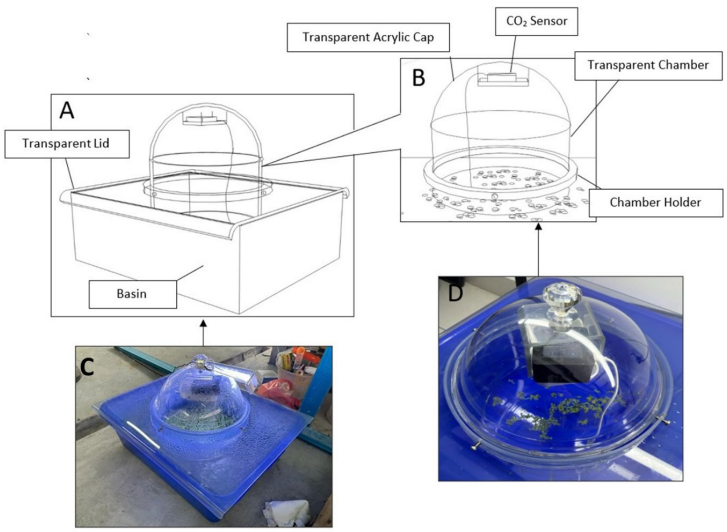


Stamping method on standard A4 paper 60 gsm

Ir. Dr. Luqmanulhakim Baharudin
School of Chemical Engineering
luqman.b@uitm.edu.my
Expert UiTM link

Ts. Raja Shazrin Shah Raja Ehsan Shah
GalaxyTech Solutions (M) Sdn. Bhd.
rshazrin@galaxytechsolutions.my

QUANTIFICATION OF CARBON DIOXIDE SEQUESTRATION BY DUCKWEED: PROMOTING CIRCULAR ECONOMY IN TILAPIA AQUACULTURE

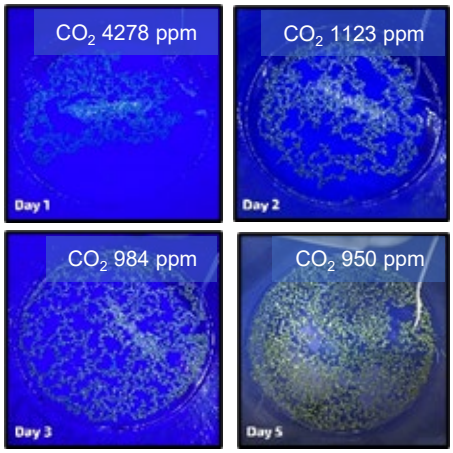


Static chamber assembly

The global demand for fish is predicted to double by 2050. Tilapia is a commonly farmed species because of its nature, which produces high yields. However, high-density farming can lead to increased greenhouse gas emissions due to respiration and poor water quality. Introducing a circular economy in the farming line can greatly reduce emissions, contributing to a more sustainable aqua environment. CO_2 can be sequestered using biological methods such as photosynthesis by macrophytes like duckweed, which are fast-growing plants. Duckweed, with its leaf-stem structure and roots, can take up more CO_2 than other plants. Ambient conditions between 20°C to 30°C are ideal for their growth.

Our study focuses on investigating the effectiveness of Lemna minor duckweed, which is used to treat tilapia water in sequestering CO_2 from the atmosphere. A laboratory-scale duckweed pond was built using a 55 L basin. The CO_2 flux was measured using the static chamber method. A transparent chamber was placed in the middle of the basin. CO_2 concentration in the chamber was collected periodically under constant luminosity and temperature.

The investigation results by our student, Muhammad Aikhal Azmy, in his final year project indicated that the duckweed population increased while the peak CO_2 concentration decreased by days. Tilapia pond effluent naturally contains high amounts of organic matter and microorganisms. Other than tilapia respiration, the decomposition of the organic matter by the microorganism also produces CO_2. In addition to the CO_2 consumption as an influencing factor to the duckweed population growth, the latter is also dependent on nutrient consumption, where increased concentrations of nitrogen (N) and phosphorus (P) correspond to a gradual increase in duckweed biomass yield. The results of our simple experiment suggest that the duckweed culture effectively sequestered CO_2 from the atmosphere, supporting the potential of duckweed as a tool for carbon sequestration.

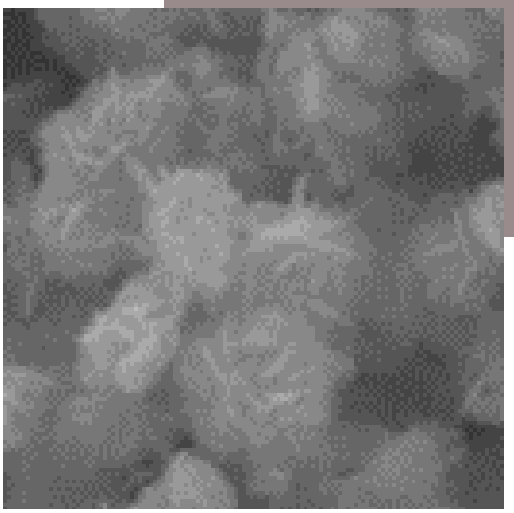


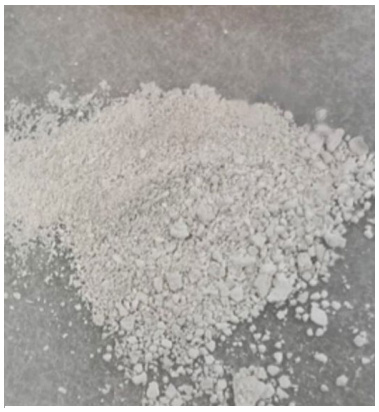
Duckweed population growth effectively reduces CO_2 release over time, demonstrating its potential for CO_2 sequestration.

Ir. Dr. Lim Ying Pei
School of Chemical Engineering
yingpei@uitm.edu.my
Expert UiTM link

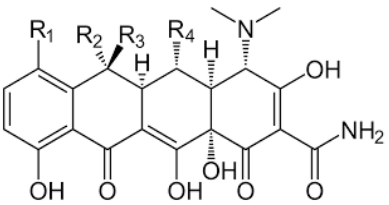
Alia Nabila Johar
School of Chemical Engineering

Hydrothermal Synthesis of Zinc Oxide (ZnO) for Tetracycline Removal



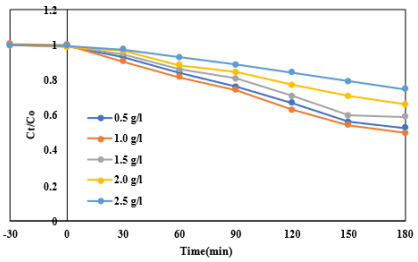


ZnO



Tetracycline

The prevalent presence of Tetracycline (TC) in wastewater, attributed to its extensive utilisation in treating infections in humans and animals, presents potential environmental hazards. Addressing this concern, advanced oxidation processes (AOPs) employing photocatalysis have emerged as efficacious means for TC elimination. This research focuses on synthesising a ZnO photocatalyst through hydrothermal, utilising zinc acetate as a precursor. Various characterisation techniques, including FTIR, XRD, FESEM, SEM-EDX, and UV-VIS analyses, were employed to assess the synthesised ZnO. The study evaluated TC photocatalytic degradation efficiency in batch mode, manipulating parameters such as ZnO dosage (0.5 – 2.5 g/L), TC concentration (5 – 25 ppm), and light sources (solar, visible, and UV). Optimal conditions for TC removal were observed at 70.17% with 1 g/L of ZnO under UV light irradiation at a TC concentration of 5 ppm. This investigation provides valuable insights into the optimal operational conditions for ZnO as a photocatalyst for degrading antibiotics. This research on ZnO photocatalysis for TC degradation not only promotes environmental protection by improving water quality and sustainability but also indirectly contributes to public health efforts by addressing antibiotic resistance and fostering progress in the field of photocatalysis for environmental pollutant removal.



Effect of dosage on photodegradation of tetracycline by ZnO

Photocatalytic degradation of tetracycline

Plant-based Natural Silicone Oil from Helianthus Annuus

Dr. Harumi Veny
School of Chemical Engineering
harumi2244@uitm.edu.my
Expert UiTM link

Nor Ashiqin binti Zairi
School of Chemical Engineering
nrashiqinzairi@gmail.com

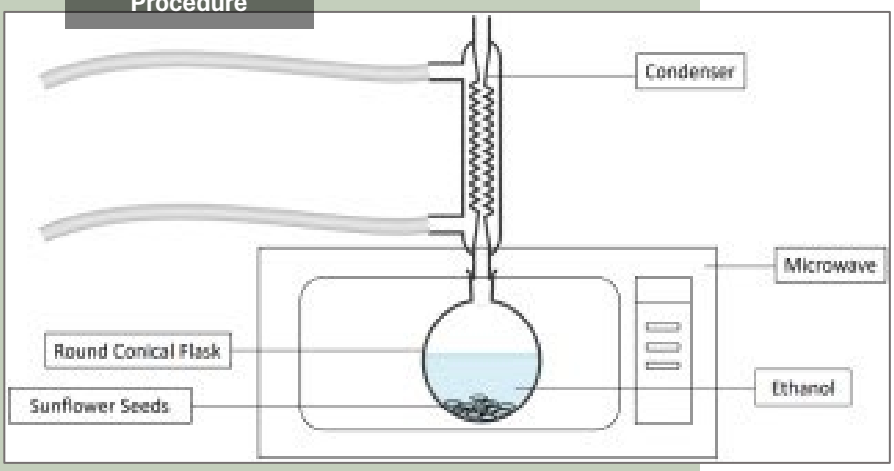
People nowadays prefer to choose and apply natural ingredients instead of synthetic ingredients in a product. There are many benefits in using natural ingredients in a product, such as vitamins and minerals that could be supplied to the skin and hair. Natural silicone oil is a plant-based silicone oil that will be introduced to replace synthetic silicone oil. This research is done to see the ability of a plant to replace silicone oil in cosmetics and to observe variables that may increase the characteristic of the oil to be like polydimethylsiloxane. Natural ingredients for cosmetics would give many benefits to humans, such as no irritation to the skin, may supply vitamins to the skin, and fewer chemicals that may cause redness and breakouts would be used. A study has yet to be done to replace silicone oil by using a natural source, as this study will do. This research would give an advantage and idea to academia and the cosmetic industry to investigate more on how to enhance this research on an industrial scale other than conducting a study on another natural source to replace other chemical and cosmetic ingredients since the raw material of this study is sustainable. The raw material will be easy to obtain. The study shows that varying the percentage of bleaching clay does not show enough changes to one of the important properties, the oil's colour.

However, other properties have been successfully achieved according to the properties of the standard silicone oil. 0.5% of bleaching shows little changes in the colour; meanwhile, 1.0% and 1.5% of bleaching clay clearly show a small change in the result. Hence, further studies must be done to ensure that the property meets the desired quality of standard silicone oil.

Natural silicone oil from Helianthus Annuus

Microwave-assisted extraction set-up

Extraction Procedure

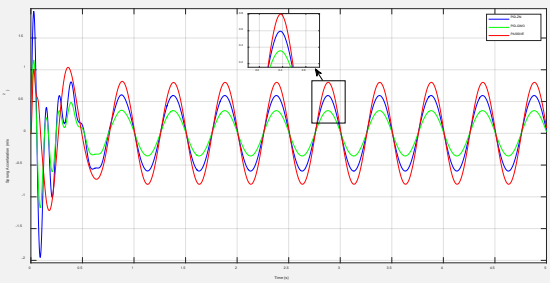


PID CONTROLLER OPTIMIZED BY GREY WOLF OPTIMIZER FOR SEMI-ACTIVE VEHICLE SUSPENSION SYSTEM

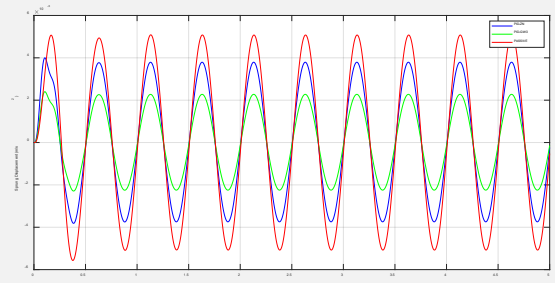
Ts. Dr. Muhamad Sukri Hadi
School of Mechanical Engineering
msukrihadi@uitm.edu.my

Expert UiTM link

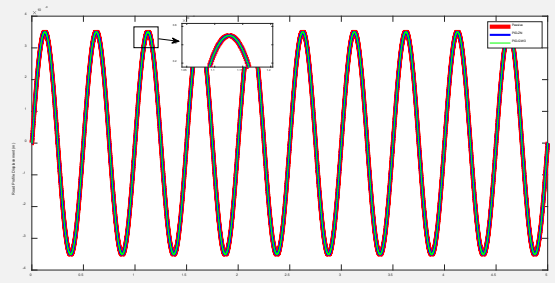
Ahmad Hazim Mohd Zam Zam
School of Mechanical Engineering



Sprung acceleration for sinusoidal disturbances



Sprung displacement for sinusoidal disturbances



Road profile for sinusoidal disturbance

Modern automobiles have evolved from leaf and coil suspension in 1904 to electronic suspension in the 1980s, where the suspension system provides the user with easy control of the vehicle and makes the driver and passenger comfortable with the impact of particular road conditions. Control suspension systems have been extensively researched using smart artefacts to improve ride comfort and road holding. Suspension systems come in three types: passive, active, and semi-active. The semi-active suspension combines the benefits of both passive and active suspension for enhanced comfort, safety, and energy efficiency. Various controllers have been introduced, but the PID controller is the most common control algorithm used and has been universally applied in many industrial applications.

The PID controller is favoured due to its affordability, simplicity in control structure and ease of maintenance. However, the drawback of this controller is finding the right parameter values, which is time-consuming to achieve the system's optimal performance. Therefore, the grey wolf optimizer (GWO) is proposed to enhance the controller performance. GWO is a popular optimization algorithm that mimics grey wolfs' social structure and hunting tactics. This research investigates the advantages of this novel optimization algorithm in improving vehicle suspension systems.

In this study, the quarter semi-active suspension system with a Magneto-Rheological (MR) damper is developed in a MATLAB/Simulink environment. The semi-active damper model is designed using the Spencer model and used to incorporate it with the MR damper system. A Proportional-Integral-Derivative (PID) controller is fine-tuned using the grey wolf optimization (PID-GWO) algorithm and compared its performance against a PID controller tuned by Ziegler-Nichols (PID-ZN) approach. The system is subjected to both sinusoidal and random disturbances in order to test the robustness of the system.

Ultimately, the proposed PID-GWO controller showed the highest percentage improvement in sprung acceleration, sprung displacement, and unsprung acceleration in both disturbances. In contrast, the PID-ZN controller showed the lowest percentage improvement in these areas. This study provides valuable insights into reducing vibrations in the semi-active suspension system. The results demonstrate the effectiveness of the PID-GWO controller in reducing vibrations in the semi-active suspension system.

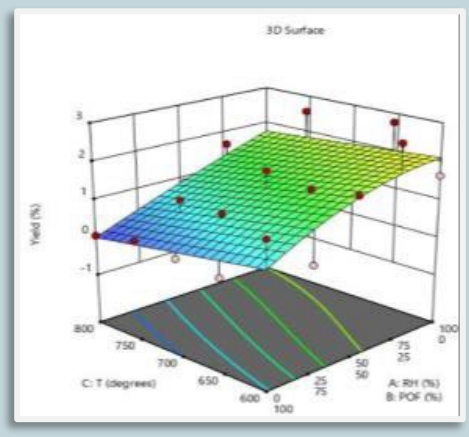
Nano silica synthesized from agricultural waste is a nanomaterial produced from converting agricultural waste such as rice husk, bagasse, wheat straw, and sugarcane bagasse into nano silica. Nano silica synthesized from agricultural waste is a novel and eco-friendly nanomaterial that can provide a valuable by-product and reduce the environmental impact as a result of its accumulation. Agricultural waste such as rice husk and palm oil fibre could be a source of nano silica since they have a high silica content. Rice husk contains 93% silica, while palm oil fibre has 34.1%. However, the extraction of nano silica from a mixture of rice husk and palm oil fibre has yet to be extensively studied.

In our recent study, we synthesized nano silica from rice husk and palm oil fibre using the sol-gel method. The relationship between the nano silica yield produced with agricultural waste mass ratio and heating temperature was studied using response surface methodology (RSM). The findings show that the most suitable heating process temperature to produce nano silica is 600°C, which gives the highest yield of nano silica. The best mass ratio of rice husk is 100%, resulting in the highest yield of nano silica. However, a 50:50 mixture of rice husk and palm oil fibre is also a good option, as it produces a high yield of nano silica. The presence of the Si-O-Si bond in the nano silica was confirmed by Fourier Transform Infrared (FTIR), which indicates the silica element. The data was best fitted by a quadratic linear model using response surface methodology (RSM).

The Green Revolution of Nano Silica Synthesized from Agricultural Waste

Raw of palm oil fiber and nano silica

Raw rice husk and nano silica



RSM contour plot

This study provides insight into producing green nano silica from a combination of different agricultural waste for various applications. The use of a statistical approach allows researchers to explore the effects and interactions of the response variable more indicatively.

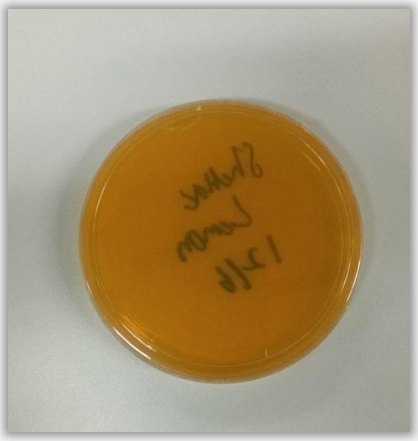
Dr. Fuzieah Subari
School of Chemical Engineering

Dr. Fuzieah Subari
School of Chemical Engineering
fuzieahsubari@uitm.edu.my
Expert UiTM link

Nur Zahirah 'Ainaa' Mohd Asri
School of Chemical Engineering

Dr Miradatul Najwa Binti Muhd Rodhi
School of Chemical Engineering
miradatul@uitm.edu.my
Expert UiTM link

AI-UCOS: ANTIMICROBIAL INFUSED-USED COOKING OIL SHELLAC



Used cooking oils (UCO) are commonly obtained from the food processing business, as well as in homes. With less knowledge, people use the wrong way to dispose of UCO by lobbing it into the sink channelled into the drain, which later will cause the drain to clog and lead to flash floods, which cause the government to spend millions to clean these clogged drains. UCO may be reused in various ways, including producing soaps, candles, and renewable energy. Therefore, in this study, the UCO was used as one of the components in the formulation of antimicrobial-infused- UCO shellac (AI-UCOS) using dried citrus waste of orange (Citrus sinensis), lemon (Citrus limon) and key lime (Citrus aurantifolia). It was known that ascorbic acid possesses antimicrobial properties, and the highest concentration of ascorbic acid was found in lemon-AI-UCOS, resulting in the highest antibacterial activity.

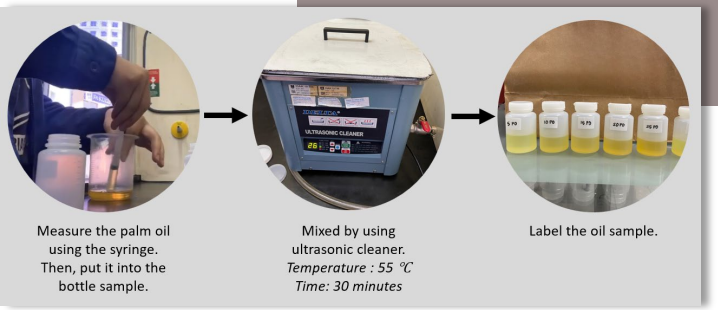
Furthermore, lemon-AI-UCOS proved to have the ability to inhibit the growth of microbes within the most extended period. However, moisture in AI-UCOS may reduce the antibacterial properties and alter the characteristics, which may create a favourable environment for microbial growth; especially those that thrive in moist conditions such as fungi. Hence, AI-UCOS undergo an improvement process prior to commercialisation for public use. Nevertheless, AI-UCOS has economic, environmental, and social impacts, which may contribute to increasing the society's revenue and decreasing government spending on environmental issues.

Mohamad Mazwan Mahat
School of Mechanical Engineering
mazwan@uitm.edu.my

Iffah Aqilah Ismail
School of Mechanical Engineering

Expert UiTM link

Study on the Tribological Characteristic of Food-grade Bio-lubricant using Four-ball Experiments



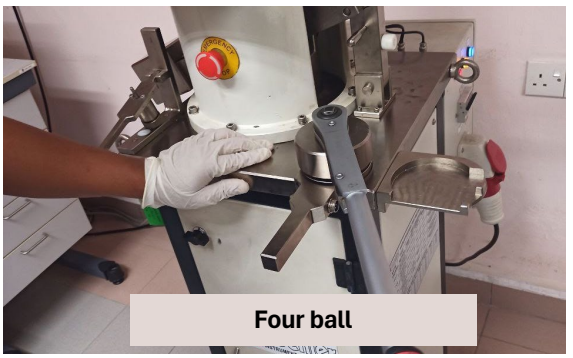
Palm oil blends

Food-grade lubricants are crucial in the food processing industry and are used in various industries, including automotive and industrial applications. They can be solid, liquid, or semi-solid and are classified based on their physical appearance. Research focuses on gear oils designed to protect gearbox components and withstand high loads, temperatures, and ambient conditions. Industrial gear oils must have appropriate viscosity, oxidative and thermal stability, solid load-carrying capacity, demulsibility, foam resistance, and corrosion protection. Companies are developing higher-quality lubricants to reduce costs and improve efficiency. Vegetable oil is a popular alternative to mineral oil due to its biodegradability, non-toxic, renewable, and inexpensive properties.

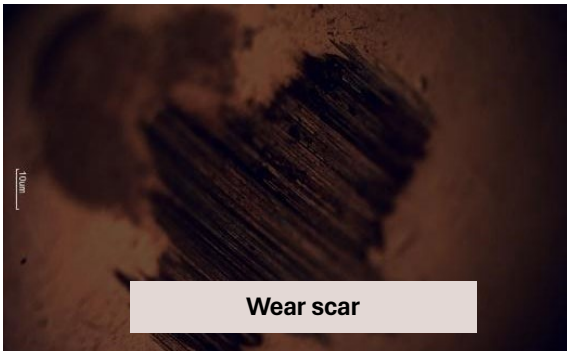
A recent study explores the potential of palm oil as a substitute for mineral-based oil in food-processing industries. It focuses on the tribological characteristics of palm oil in addition to food-grade industrial gear oil. The research aims to develop environmentally friendly lubricants by determining the mechanical properties of the chosen lubricant composition based on wear and friction coefficient. This will help achieve anti-wear properties and non-toxicity for industrial gear oil applications. The new formulation would focus on cost reduction, longer lubricant life, and improved gearbox efficiency.

The results showed that adding 30% palm oil to 85W140GL5 Gear oil resulted in the lowest coefficient of friction and stable friction torque over 60 minutes of the fourball experiment. This study concluded that adding an optimum amount of palm oil to gear oil can improve anti-wear and anti-friction characteristics by lowering the coefficient of friction and producing a smaller wear scar diameter. However, the increase in palm oil volume did not guarantee an enhancement in tribological characteristics, as both COF and WSD trends showed random increases and decreasing values.

The wear scar diameter size trend is not linear, as the wear scar diameter does not decrease linearly when the volume of palm oil is increasing. It shows the optimum volume of palm oil will increase the anti-wear characteristic. This study proves that palm oil blended with mineral oil lubricants can exhibit favourable tribological properties, including reduced wear scar diameter, when a suitable ratio of oil and additives is incorporated into the lubricant composition.



Four ball



Wear scar

RESEARCH & INNOVATION

COLLEGE OF ENGINEERING

eISSN 2805-573X