
SOMChE
Navigating the Frontier of Sustainability
32nd SOMChE 2021
KUCHING, SARAWAK, MALAYSIA.

# Welcome Messages

## Pro Vice-Chancellor and Chief Executive Officer of Swinburne University of Technology Sarawak Campus (Swinburne Sarawak)

Selamat Datai! Welcome to the 32nd Symposium of Malaysian Chemical Engineers in the beautiful yet dynamic city of Kuching!

I would like to thank the Institution of Chemical Engineers (IChemE) for this prestigious symposium series. It is our privilege to host the 32nd Symposium of Malaysian Chemical Engineers in partnership with the Institution of Chemical Engineers.

The symposium's theme 'Navigating the Frontier of Sustainability' aligns well with Swinburne Sarawak's sustainability agenda as articulated in the United Nation's 17 Sustainable Goals. The theme also responds to the challenges facing society and our planet with the current pandemic.

The 32nd Symposium of Malaysian Chemical Engineers, with an assemble of a wide range of speakers, will provide you with a stimulating 2-day program. This Symposium provides a forum for chemical engineers to meet, share the latest research findings, and stimulate new thinking and ideas to address many of the worldwide sustainability topics including food security, clean water and sanitation, waste management, affordable and clean energy, climate change, and sustainable cities.

The Organising Committee has done a great job organising the 32nd Symposium of Malaysian Chemical Engineers despite various restrictions due to the ongoing pandemic. Therefore, it is good to see the 32nd Symposium of Malaysian Chemical Engineers being held here over the next two days.

We hope you will have a very rewarding Symposium that will stimulate ongoing collaborations, both professionally and socially, into the future.

Again, welcome to Swinburne Sarawak, and enjoy our online Sarawakian hospitality!

**Prof. Lau Hieng Ho**

# Welcome Messages

## Chair of the Institution of Chemical Engineers (IChemE), Malaysia

The 32nd Symposium of Malaysian Chemical Engineers (SOMChE) will be held on 15 to 16 July 2021 at Swinburne University of Technology Sarawak Campus in Kuching, Sarawak. SOMChE brings together chemical engineers and chemical engineering researchers from across Malaysia and the region, especially among academics, who gather to share their insights and innovations relevant to chemical engineers across the wide range of industries we work in. The theme for 2021 is ***"Navigating the Frontier of Sustainability".*** Our focus is to encourage papers that explore the emerging opportunities and challenges for the chemical engineering profession and process industries throughout our region around this theme. Our plenary and other invited speakers have been specially selected to challenge our thinking and bring alternative perspectives to this discussion. Building on previous conferences, SOMChE is the opportunity for the chemical engineering profession and associated disciplines to come together as a friendly collaboration, to network and learn from each other. It provides a platform for cross-pollination across a wide range of industries, facilitating innovation. Industry and academia will come together to discuss and debate the latest advances and best practices to face the challenges of the 21st century in our region.

I am hopeful the participants will take a few days to forge networks and partnership. This symposium continues to be a wonderful opportunity for Chemical Engineers to understand each other's work and explore opportunities.

IChemE continues to be part of this annual gathering. I know participants will benefit from the keynote speeches and parallel sessions.

Have a great symposium and a fruitful discussion.

**Prof. Law Chung Lim**

# Welcome Messages

## Co-chairs of SOMChE2021

On behalf of the organising committee (OC), we are delighted to welcome all speakers and delegates to our 32nd Symposium of Malaysian Chemical Engineers (SOMChE2021) hosted together by Swinburne University of Technology Sarawak Campus and Institution of Chemical Engineers (IChemE) Malaysia. Despite the shift of the event from physical to virtual asynchronous mode due to pandemic situation, the response has been overwhelming. More than a hundred chemical and process engineers and other relevant engineers and scientists from Malaysia, Philippines, Indonesia, Brunei, Australia, Taiwan, and Czech Republic still submitted their works to this event. We thank you for supporting us from the original preparation of the event back in 2019 through the postponement till the date of the event in July 2021.

Present industrial chemical processes rely heavily on non-sustainable fossil-fuel based resources. The theme "*Navigating the Frontier of Sustainability*" serves to address the ongoing global sustainability issues and present viable long-term solutions. We look forward to the course of the next two days whereby numerous interesting works will be presented and probe fascinating discussions pertaining to a diverse range of topics, from green and sustainable processing, environmental and waste management, bioprocessing and biotechnology, materials science and engineering, and energy in terms of energy conversion and management, and renewable and alternative energy.

SOMChE2021 will definitely bring us one step closer to bridging the gap between research and industry in solving sustainability concerns. We hope that everyone will be able to make the most of this experience and establish meaningful research collaborations through this virtual conference.

**Prof. Su Hieng Tiong**
**Assoc. Prof. Jaka Sunarso**

# ORGANISING COMMITTEE

| | |
|---|---|
| **CO-CHAIRS** | **Prof. Su Hieng Tiong**<br>**Assoc. Prof. Jaka Sunarso** |
| **VICE CHAIR** | **Dr. Chew Jiuan Jing** |
| **SECRETARIAT TEAM** | **Dr. How Bing Shen (Chair)**<br>Ms. Shirleen Lo Lee Yuen<br>Ms. Karen Kong Gah Hie<br>Mr. Yeo Lip Siang |
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| **PUBLICITY** | **Dr. Elammaran Jayamani (Chair)**<br>Mdm. Ting Lik Fong<br>Dr. MD. Bazlul Mobin Siddique |
| **DESIGN & PRINTING** | **Dr. Irine Runnie Henry Ginjom (Chair)**<br>Ms. Jenny Liew Ngi San (Designer) |
| **VIRTUAL REGISTRATION** | **Dr. Siti Salwa Hashim (Chair)**<br>Dr. Elaine Yeu Yee Lee<br>Ms. Ee Sia<br>Ms. Emily George Jimbai<br>Mr. Jeremiah Idek Angking<br>Mdm. Nurlida Mohamad Salleh |
| **ADVISORY PANEL** | Dr. Peter Morin Nissom<br>(Sarawak Research Development Council)<br>Prof. Michael Cloke (IChemE)<br>Assoc. Prof. Hwang Siaw San (Swinburne Sarawak)<br>Prof. Lau Hieng Ho (Swinburne Sarawak) |

# Program Schedule

| Day 1 (15th July 2021) | |
|---|---|
| Time | Agenda |
| Commencement of SOMChE2021<br>Participants may begin logging in to the COMET system | |

| Day 2 (16th July 2021) | |
|---|---|
| Time | Agenda |
| 1550 | Participants gather for live conference closing ceremony |
| 1600-1610 | Closing speech presented by Prof. Lau Hieng Ho |
| 1610-1620 | Closing speech presented by Ms. Tharshinye Soomaran |
| 1620-1625 | Announcement of next SOMChE host |
| 1625-1635 | Award giving ceremony |
| 1635-1640 | Group photo session |

# Plenary Speakers

**Prof. Suryadi Ismadji**
Widya Mandala Catholic University, Surabaya, Indonesia

**Presentation Title**
"Removal of biocides compounds in the liquid phase using clays – lignocellulosic derived carbon composite"

**Presentation Abstract**

Biocides are chemical substances or microorganisms that are used to destroy or weaken harmful organisms for control purposes. Currently the use of biocides is uncontrolled which results in serious environmental pollution and human health problems. Some of the biocides that are often used for preservatives and to kill microorganisms in health care and household products are triclosan and paraben compounds (methyl paraben and ethyl paraben). In this study, we employed the adsorption process to remove these biocides compounds from water environment. Montmorillonite – durian shell activated carbon composite was employed as the adsorbent. The adsorption kinetic, equilibria, and thermodynamic of adsorption were comprehensively studied.

**Biography**

Suryadi Ismadji was born in Surabaya on December 23, 1969. He obtained his Bachelor degree in Chemical Engineering from Widya Mandala Catholic University (WMCU) in 1992. His Master degree was obtained from Institut Teknologi Sepuluh Nopember Surabaya (ITS) in 1996. He got his Doctor of Philosophy from The University of Queensland in 2002. Currently he is a Professor in the Department of Chemical Engineering WMCU. Suryadi has won a few major awards such as Australian Alumni Award 2010 for Research and Innovation and Indonesian Toray Science Foundation (ITSF) Science and Technology Award 2010. His research interest comprises of adsorption, supercritical fluid technology, clays & clays mineral, biofuels, activated carbons and microporous & mesoporous materials: synthesis & applications.

**Prof. Ir. Suzana Yusup**
Universiti Teknologi PETRONAS

**Presentation Title**
"Sustainable process engineering from perspective of thermochemical conversion of biomass"

**Presentation Abstract**

Biomass can be utilised for production of process heat, steam, and power through thermal conversion routes to ranges of biofuels and bioproducts. Resource sustainability drives the potential of biomass as renewable sources of energy. Biomass as resources also supports diversification of fuel supply, reduction of greenhouse gases, increased of rural income based on agricultural activities, and enable restoration of degraded land for planting of biofuel crops. The merits of sustainable processes need to be considered through life cycle analysis. The talk covers how sustainable development goals, green chemistry and green technology principles are applied in thermochemical conversion of biomass. Further, link between sustainable metrics and processes is discussed. In addition, biorefinery concepts and examples are highlighted and selected case studies related to thermochemical conversion processes of biomass are shared.

**Biography**

Prof. Ir. Dr. Suzana Yusup is the Director of Center for Biofuel & Biochemical Research (CBBR) Program @ Head of HICoE CBBR UTP, and a Professor at Chemical Engineering Department, Universiti Teknologi PETRONAS, Malaysia. She received her first degree in Chemical Engineering from University of Leeds, Master of Science in Chemical Engineering from University of Wales and Doctor of Philosophy in Chemical Engineering from University of Bradford, UK. Her research interest is in biomass conversion to biofuel, biobased products, and green processes. She has experience in leading research grant and as visiting professors, delivered short courses, seminars, workshop, forum, and speakers at conferences nationally and internationally. Among recognition received are Malaysia's Research Star Award 2019: International Collaboration, Malaysia's Research Star Award 2017: Women in Science Award in the Area of Engineering, Malaysia's Rising Star Award 2016: The Women in Science Award Under "Highly Cited Review" Category, Top Research Scientist Malaysia (TRSM) 2016, Best Women Inventor Award: SIRIM Invention, Innovation & Technology Expo 2018, Leaders in Innovation Fellowship under MIGHT and the Royal Academy of Engineering United Kingdom and Asia Research Award 2012 from The Society of Chemical Engineers, Japan (SCEJ).

**Prof. Raymond R. Tan**
De La Salle University

**Presentation Title**
"Computational Solutions for Large-Scale Carbon Drawdown"

**Presentation Abstract**

Projections by the Intergovernmental Panel on Climate Change indicate the need to achieve net zero carbon emissions by the middle of the century. This target will require large-scale carbon drawdown through the commercialization of negative emissions technologies (NETs). NET options range from low-tech (e.g., reforestation) to high-tech (e.g., direct air capture). In this talk, I will discuss some of my recent work on the development and application of process systems engineering (PSE) tools for planning carbon management networks based on different NETs. The scope of the talk covers different PSE methodologies, such as mathematical programming, pinch analysis, process graphs, and machine learning.

**Biography**

Raymond R. Tan is a Professor of Chemical Engineering, University Fellow, and the current Vice-Chancellor for Research and Innovation of De La Salle University. He is also an Academician of the Philippine National Academy of Science and Technology. In the Scopus database, he has over 400 publications and 8,000 citations, with an h-index of 48. He works in the research area of process systems engineering, with applications to process integration and carbon management. He is editor-in-chief of *Process Integration and Optimization for Sustainability*, associate editor of *Sustainable Production and Consumption* and of *Cleaner Engineering and Technology*, and serves as editorial board member of *Clean Technologies and Environmental Policy*. He is the author of the books *Process Integration Approaches to Planning Carbon Management Networks* and *Input-Output Models for Sustainable Industrial Systems*, and editor of the books *Recent Advances in Sustainable Process Design and Optimization* and *Process Design Strategies for Biomass Conversion Systems*. He has received multiple scientific awards from government and professional organizations in the Philippines, and is listed in the recent Reuters Hot List of the world's top 1000 climate researchers.

**Mr. Nik Suhaimi Mat Hassan**
Sime Darby Plantation

**Presentation Title**
"Engineering solutions for the palm oil mill of the future: Increasing oil extraction and sustainability through biotechnology"

**Presentation Abstract**

The edible oil industry involving extraction and processing of oils and fats from vegetable sources has witnessed a tremendous growth over the decade accounting for rapid expansion of urbanisation and industrialisation. Consequently, concerted efforts have been undertaken to increase the palm oil extraction rate (OER) at mills. This paper explores the commercial application of enzymatic treatment on sterilised palm fruitlets and diluted crude oil (DCO) stream in a 60 tonnes per hour oil palm mill. Firstly, the sterilised palm fruitlets dosed with enzymes in a pre-digester vessel at 70 °C for a retention time of 30 minutes resulted in an increment of 0.83% OER. In the second method, enzyme was dosed directly into DCO yielded in an OER increment of 0.71% to 1.19%. Concurrently, other technologies such as prolonged SOXHLET extraction, ultrasonic treatment and supercritical fluid extraction were used measure the potential oil. This finding is further supported with electron microscopy and confocal microscopy images of treated samples showing disintegration and thinning of cell walls and higher free oil droplets. Quality assessment of palm oil extracted via enzymatic treatment showed no adverse impact and was comparable to the edible oil standards. Sustainability-wise, the life cycle assessment (LCA) study showed that the use of enzyme in palm oil mill for OER increment reduces land use and GHG emission.

**Biography**

Nik Suhaimi Mat Hassan has been with Sime Darby Plantation since 2006. He is currently holding position as Chief Engineer, Value Creation – Processing & Engineering in Sime Darby Plantation Research & Developments. He has graduated in Chemical & Processing (B Engineering & MSc) from University Kebangsaan Malaysia and currently pursuing his PhD in Engineering at Universiti Sains Malaysia.

His work focuses on oil mill process improvement, particularly on process improvement, product quality enhancement and new product development. He is tasked to provide technical supports for mills on technology evaluation, assessment, advisory and troubleshooting works. He has vast experience in conducting researches and transforming laboratory test into pilot and commercial scales. His interdisciplinary skills resulted in few successful commercialisations of in-house developed processes, where he involved in the plant process design as well as mechanical design. He contributed 7 patents on palm oil mill process improvement. His outstanding and inventive research knowledge in engineering resulted in commercialization of internal developed processes and award within the company and nationally.

**Prof. Datuk Dr. Taufiq Yap Yun Hin**
Universiti Malaysia Sabah

**Presentation Title**
"Sustainable Aviation Biofuels and the Impact to Climate Change"

**Presentation Abstract**

Over 2.2 billion passengers flew all over the world with about 15 thousand aircrafts for many reasons. Aviation industries created many jobs worldwide and contributed nearly 8% to world gross domestic product. Even though air transportation become so important, unfortunately it gave a significant impact to the environment. Projections anticipate 5% annual growth in airline passengers up to 2050, with emissions reaching 3,100 Mt annually in a high growth scenario. Aviation sector has to play a bigger role in order to reduce the global greenhouse gas (GHG) emissions. Air transportation become important. Aviation industry generates 32 million jobs worldwide and contributes nearly 8% to world gross domestic product. However, the aviation industry gave impact on climate change. As the aviation skies continue to crowd so does the impact of $CO_2$ emissions. This lecture will review the challenges facing for the sustainable aviation biofuels industry and how the catalytic manufacturing process can be reducing carbon footprint.

**Biography**

Prof. Datuk Dr. Taufiq Yap Yun Hin was born in Kota Kinabalu, Sabah on 14th January 1968. He got his primary education at SRJK St Agnes, Kota Kinabalu, Sabah from 1974 until 1979. He then continued his secondary education at SMJK All Saints, Kota Kinabalu, Sabah from 1980-1986. He earned his BSc (Hons) and MSc in 1992 and 1994, respectively at Universiti Putra Malaysia. He then went on to earn his PhD (1997) in heterogeneous catalysis at University of Manchester Institute of Science and Technology (UMIST), United Kingdom.

Prof. Taufiq-Yap started his career as a lecturer at the Department of Chemistry, Universiti Putra Malaysia (UPM) since August 1997 and promoted as a full professor on 1st October 2007. He was the founding Head of Catalysis Science and Technology Research Centre (PutraCAT) from 1st Sept 2008 until 2014. Professor Taufiq-Yap currently is the Vice Chancellor of Universiti Malaysia Sabah. His research interest lies in the catalytic production of bioenergy from biomass and wastes. He published more than 400 scientific publications includes various reviews on biodiesel and hydrogen production. He was invited as speakers in national and international conferences (over 100 Plenary or Keynote/Invited lectures). He is currently the Regional Managing Editor for Asia-Pacific for Bulletin of Chemical Reaction and Catalysis, Editorial Board member for Catalysis Survey from Asia, Malaysian Journal of Chemistry, Malaysian Journal of Analytical Chemistry, Vietnam Journal of Catalysis and Adsorption and Malaysian Journal of Catalysis. Throughout his career, Prof. Taufiq-Yap has been the recipient of the following Awards and Distinctions: National Young

Scientist Award (2002); The Outstanding Young Malaysian Award (2008), Top Research Scientist Malaysia (2013) and Malaysia's Research STAR Award (2018). Prof. Taufiq-Yap was appointed as Fellow of Academy Science of Malaysia (2015), Fellow, Malaysia Institute of Chemistry (2009) and Fellow, Royal Society of Chemistry, UK (2008); He was also appointed as Visiting Professor at several universities *i.e.* Nagoya University, Japan (2011 and 2012), Universiti Teknologi PETRONAS (2012) and Curtin University Sarawak (2011-2015). He was elected as Titular Member of International Union for Pure and Applied Chemistry (IUPAC). He is currently the President of Malaysian Catalysis Society (2016-now) and Executive Council Member of Asia-Pacific Association of Catalysis Society (APACS).

**Dr. Anuar Hamid**
East 101 Sdn. Bhd.

**Presentation Title**
"Engineering in the Age of AI – Case Studies from the Oil & Gas Industry"

**Presentation Abstract**

A lot of our day-to-day activities are decided by artificial intelligence (AI) algorithms, whether we realise it or not. From the next video or movie to watch on the streaming platform, to the fastest route to get home without paying tolls, AI allows us to see many hidden patterns that exist all around us and help us to make informed judgment.

Unsurprisingly, AI is heavily exploited by technology companies like Google and Facebook. Traditional industries like oil and gas seem to start embracing AI, albeit at a much slower pace. In this talk, I will present several examples of how AI is being utilised for real-world engineering applications, specifically in oil and gas industry. These include:

- Symbol detection in process and instrumentation diagrams (P&IDs)
- Hybrid vs. first-principle modelling and simulation
- Model identification for advanced process control (APC)
- Soft sensors
- Predictive maintenance
- Robotic routine inspection of offshore facilities

I will also present the tools and skill sets typically required to embark on such projects. I hope this talk will inspire and convince more chemical engineers to either incorporate AI in their research or engineering workflow.

**Biography**

Anuar Hamid is the Process Engineering Manager at East101 Sdn. Bhd. He holds a PhD in Computational Petroleum Engineering from Imperial College London (2019) and an MEng Electrical & Electronic Engineering (specialising in Control Systems) from the University of Manchester (2009). For the past 12 years, he has served various clients in the oil & gas industry (such as Shell, PETRONAS, ExxonMobil, BASF) in his capacity as an engineering consultant. He also collaborates in AI-related projects with academics from various institutions including Herriot-Watt University and the University of Nottingham.

**Prof. Dato Abdul Wahab Mohammad**
Universiti Kebangsaan Malaysia

**Presentation Title**
"Water Reuse and Recycling: Issues and Challenges for Membrane Technology"

**Presentation Abstract**

Water reuse and recycling (WR&R) have become very important over the last few years due realization that water resources are dwindling in many parts of the world. According to the United Nations Global Water Report in 2017, wastewater reuse could be a potential untapped water resource that will help to increase water availability while at the same time reducing water pollution problems. The importance of WR&R has been spelled out clearly in many occasions. The Sustainable Development Goals (SDG) 6 which is to ensure availability and sustainable management of water and sanitation for all, has set a very specific target on water reuse and recycling. The target has been set that by 2030, there will be major "improvement on water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".

In Malaysia, the estimated volume of wastewater generated by municipal and industrial sectors is 2.97 billion cubic meters per year. This is a huge amount of water that can be reused and recycle provided that effective and economical technologies for WR&R can be implemented. Membrane technology has been shown to be very effective in many projects related to WR&R. However there are several issues and challenges that need to be overcome in order for the technology to be implemented successfully. Among the major challenges are on producing membranes that will have low fouling and higher chemical tolerance, designing effective process by integration of membranes with other technologies, and process intensification through hybrid approaches. The talk will discuss and provide future perspectives on these issues including providing a few examples of the projects that have been implemented with local industries in Malaysia.

**Biography**

Abdul Wahab Mohammad was born in 1967 in Sg Seluang, Kedah, Malaysia. He is currently Professor in Membrane and Separation Technology at the Department of Chemical and Process Engineering, Universiti Kebangsaan Malaysia (UKM) also the Deputy Vice Chancellor for Research at UKM. He is also a Fellow at the Research Centre for Sustainable Process Technology (CESPRO). He received his PhD from University of Wales Swansea in the area of nanofiltration membranes, and MSChE from Purdue University, USA and BSChE from Lehigh University, USA. His research interest is on membranes science and applications, nanoparticles, wastewater treatment, water reuse

and recycling, sustainable separation technology and engineering education. He has managed to secure more than 20 research projects on these areas of research from industries as well as national and international funding agencies. He has published more than 300 journal papers with citation exceeding 10,500 and h-index of 48. He is the Chief co-editor of the Journal of Water Process Engineering (a Q1 Journal) which was launched in 2014. He was the co-recipient of 2008 Prince Sultan International Water Prize for his work on nanofiltration membranes and 2015 MTSF Science Award. Abdul Wahab is a registered Professional Engineer (PEng) in Malaysia and a Chartered Engineer (CEng) in United Kingdom. He is a Fellow of IChemE and also a Fellow of the Academy of Sciences Malaysia.

**Prof. Sankar Bhattacharya**
Monash University

**Presentation Title**
"What to do with end-of-life plastics and tyres - Fuel, Monomer or Hydrogen?"

**Presentation Abstract**

The world annually produces eight million tonnes of waste plastics and 1.6 billion waste tires. While some of these are recycled, a significant quantity is still not disposed of to avoid landfilling or going to the waterways. While waste plastics have been used to make new solid products such as furniture, gradual loss of strength occurs with every reuse; there will come a time when these end-of-life plastics cannot be recycled any longer to solid products. Similarly, waste tires are at times recycled to make new solid products. However, with every reuse of solid products, they approach their end of life eventually requiring disposal in some form. The end-of-life plastics or tires are however significant energy sources containing hydrocarbons and can be further utilized to produce liquid fuels, carbon to some form, back to a monomer, or to hydrogen. As a strategy, this will avoid these materials from going into landfills.

This presentation will start with a general overview of research on wastes covering biomass, electronic waste, waste paints, optical fibres, and end-of-life plastics and tires. It will then present the results of thermal and thermo-catalytic conversion of end-of-life plastics and tires to liquid fuel, monomer, and hydrogen. The presentation will provide a brief description of a scheme for such processing.

**Biography**

Sankar Bhattacharya is a Professor of Chemical Engineering at Monash University, Australia. He came to academia in mid-2009 from the International Energy Agency after working in industry and research establishments in India, Thailand and France. He started his career working as a design and commissioning engineer in coal-fired power stations in India. After five and a half years of work in India, he pursued MS degree with research thesis on biomass pyrolysis, and then spent eighteen months in Thailand working on a German government-funded biomass processing to fuels project. Following his PhD in Australia, he spent twelve years in commissioning and running test programs using large combustion and gasification pilot plants for technology development – in South Australia commissioning the first CFBC pilot plant on lignite combustion, in Victoria leading the HTW gasification trials and also in EERC Grand Forks, North Dakota on transport reactor trials – a first-ever oxygen-blown gasification trials using Australian and US lignites. These were followed by stints with Anglo Coal Australia as a Principal Process Engineer and the International Energy Agency, Paris leading their Cleaner Fossil Fuels program. At Monash University, he carried out entrained flow gasification and

slag viscosity work for Mitsubishi Heavy Industries and JPower. He is the holder of four patents, edited three books, authored six book chapters and over 150 journal papers on energy, fuels and biochemicals. He has supervised thirty postgraduates to completion and is a Fellow of the Australian Institute of Energy.

# List of Accepted Abstracts Title

# Environmental and Waste Management

| Registered Authors | Paper Title | Paper ID |
|---|---|---|
| Abu Zahrim Yaser | Composting of Food Waste in Passive Aerated Bioreactor with Turning Mode | SOMChE2020.001 |
| Ng Yee Sern | Investigation on The Use of Aluminium Rich Sandy Soil as Natural Adsorbent In The Removal of Lead From Water | SOMChE2020.005 |
| Ang Wei Lun | Microwave-assisted Synthesis of Photoluminescent Carbon Dots from Palm Fronds Biomass Waste | SOMChE2020.034 |
| Nor Afifah Khalil | Microcrystalline Cellulose (MCC) as Adsorbent in Copper Removal from Aqueous Solution | SOMChE2020.126 |
| Adeline Lim Kher Li | Evaluation of Oil Palm Trunk as Potential Precursor for the Production of Activated Carbon in POME Treatment | SOMChE2020.136 |
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| Vasanthi Sethu | Aloe vera as a Natural Flocculant for Palm Oil Mill Effluent (POME) Treatment – Characterisation and Optimisation Studies | SOMChE2020.177 |
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| Marineil Gomez | Modified Kinetic Models for Cr (VI) Adsorption in Polymer Inclusion Membranes | SOMChE2020.215 |
| Denny Ng | Development of Optimisation Model for Black Soldier Fly-based Aquaculture Feed Supply Chains in Malaysia | SOMChE2020.216 |
| Aida Syafiqah Abdul Rahman | Effect of Magnetite on Alginate-based Composite Bio-sorbent Hydrogel Beads for Copper Removal | SOMChE2020.221 |
| Joseph Albert Mendoza | Correlating Water Quality Parameters on The Eutrophication Potential of Laguna Lake (Philippines) using Artificial Neural Network (ANN) Modelling | SOMChE2020.225 |
| Lai Jia Chi | Effect of External Heat Source on Temperature and Moisture Variation for Composting of Food Waste | SOMChE2020.231 |

# Environmental and Waste Management

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| Lai Jia Chi | Study of Forced Aeration System for Fruit and Vegetable Waste Composting | SOMChE2020.232 |

# Material Science and Engineering

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| Syafiqa binti Mohd Saleh | Impact of Heavy Hydrocarbon Impurities on PTFE Membrane Stability | SOMChE2020.025 |
| Nurul Waheeda binti Abdu Rahman | Grease Formulation and Characterization from Waste Automotive Engine Oil with The Use of Complex Thickener | SOMChE2020.084 |
| Nur Athirah Bt Mohamad Radzi | Studies on the Modification of Fly Ash Structure with Alkaline Pre-treatment as a Green Composite Potential Flame Retardant Filler | SOMChE2020.085 |
| Mah Shee Keat | The Impact of The Mulberry (Morus Nigra L.) Leaf Extract on The Physicochemical Properties Of Poly(Vinyl Alcohol) Blend Films | SOMChE2020.086 |
| Nurzulaikha Rosli | Fabrication and Characterization of Chitosan-Titanium Oxide Nanotubes Scaffolds Reinforced with Tiger Milk Mushroom | SOMChE2020.122 |
| Suriani binti Haji Yaakob | Iodide-based Ionic Liquid Impregnated on High Surface Area Porous Solid as Adsorbent for Mercury Uptake from Produced Water | SOMChE2020.125 |
| Muhammad Jahanzail Kamran | Comparison of Chemically Surface Treated Luffa Cylindrica Using Scanning Electron Microscopy (SEM) | SOMChE2020.131 |
| Eko Sulistiyono | Extraction of Magnesium from Salt Pond Waste with Low Lithium Grade Using Sodium Silicate Reagent | SOMChE2020.166 |
| Lew Guo Liang | Synthesis and Characterization of Perovskite-Supported CoNi Catalyst for CO Oxidation via Exsolution | SOMChE2020.167 |
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| Muhammed Ali S.A. | Effect of Open Pore and Pore Interconnectivity in The Ni-SDC Cermet Anode Microstructure on The Performance of Solid Oxide Fuel Cells | SOMChE2020.202 |
| Lanisha Devi a/p Anbealagan | Synthesis and Characterization of (3-Aminopropyl) Triethoxysilane (APTES) Functionalized Zeolite AlPO-18 | SOMChE2020.214 |

# Material Science and Engineering

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| Rhoda Leron | Functionalization of Polylactic Acid Thin Films via Polydopamine-Assisted Chelation of Copper (II) Ions for Antibacterial Applications | SOMChE2020.219 |
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| Mohd Faizar Bin Banjar | Fundamental Study of Colloidal Stability and Dispersion of Novel Nanosized Conductive Polyaniline (PANI)/Natural Rubber Latex (NRL) Film for Antimicrobial Applications | SOMChE2020.224 |
| Nurul Huda | Membrane Pervaporation Performance Applied for Brackish Water Prepared By Vacuum Impregnation Method | SOMChE2020.226 |
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# Environmental and Waste Management

[SOMChE2020.001]

# Composting of Food Waste in Passive Aerated Bioreactor with Turning Mode

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## Abstract

Almost 45% of municipal solid waste in Malaysia consisst of food waste. Composting is one of the sustainable ways to manage food waste compared to incineration and landfilling. This paper investigates the physicochemical and phytotoxicity characteristics during food waste composting in passive aerated bioreactor assisted with compost turning. The initial compost mixture consists of 124 kg of food waste mixed with 62 kg of dry leaves. The composting process was conducted for 40 days, and physicochemical characteristics i.e., temperature, moisture content, total organic carbon, pH and conductivity were monitored. Seed germination test was conducted with cabbage seeds (*Brassica oleracea*). The highest temperature and final moisture content obtained were 42 °C and 78%, respectively. The seed germination index value was 127%, indicating that the compost is suitable for plant growth.

**Keywords** Composting, Food waste, Passive aerated, Germination index

[SOMChE2020.005]

# Investigation on The Use of Aluminium Rich Sandy Soil As Natural Adsorbent in The Removal of Lead from Water

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## Abstract

The feasibility of aluminium rich sandy soil collected from Jeram as natural adsorbent in removing lead (Pb) from water was investigated without any surface modification. The investigation on the effect of initial concentration, solution pH, and soil:solution ratio was carried out using response surface methodology. The adsorption efficiency was increased at higher pH and soil:solution ratio, as well as lower initial concentration, as a result of higher availability of adsorption sites and less adsorbate competition. The adsorption followed Langmuir isotherm and monolayer chemisorption with an adsorption capacity of 10.64 mg $g^{-1}$. The process followed pseudo-second order kinetic model, with a rate constant of 0.011 g $mg^{-1}$ $min^{-1}$ at optimum adsorption pH of 4-5.

**Keywords** Lead, Water treatment, Soil, Adsorption isotherms, Adsorption kinetics

[SOMChE2020.034]

# Microwave-assisted Synthesis of Photoluminescent Carbon Dots from Palm Fronds Biomass Wastes

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## Abstract

Oil palm fronds (OPF) is one of the largest biomass sources in Malaysia that has been underutilized. In this work, OPF has been used as a precursor to synthesize carbon dots (CDs) via microwave irradiation method. The impacts of irradiation power and duration and the reacting solution have been investigated. It was discovered that CDs with the highest photoluminescence intensity was obtained at microwave irradiation power of 385 W for 30 s. Irradiation at lower or higher power resulted in incomplete or over carbonization that reduced the fluorescence property. In addition, CDs synthesized with diethylene glycol (DEG) as reacting solution possessed higher photoluminescence intensity as compared to ultrapure water solution. This could be attributed to more complete CDs formation that happened at higher temperature, which could only be achieved by DEG solution (higher boiling point). The CDs were then tested as a sensor for lead (II) ions. The UV-vis absorbance was found to be reduced with the presence of lead (II) ions. This indicated that the lead (II) ions might interact with CDs and disrupted with the absorbance of UV light. Overall, OPF could be a potential precursor for the synthesis of low-cost and easily available CDs for environmental applications.

**Keywords** Carbon dots, Palm fronds biomass, Microwave synthesis, Heavy metal sensing, Photoluminescent

[SOMChE2020.126]

# Microcrystalline Cellulose (MCC) as Adsorbent in Copper Removal from Aqueous Solution

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## Abstract

Many studies have been done on natural adsorbent, natural/raw cellulose, modified cellulose and modified MCC as media for removing copper. However, the usage of unmodified microcrystalline cellulose (MCC) as adsorbent to remove heavy metals contaminants such as copper from aqueous solution is scarcely being explored. Thus, the current study was done to assess the performance of the unmodified MCC, without any modification, based on the adsorption capacity and the Cu removal efficiency under varied process parameters. The MCC was successfully used for $Cu^{2+}$ or Cu (II) removal at pH < pH6. The adsorption parameters such as pH (1-6), contact time (0.5 - 24 hours), temperature (25 – 70 °C), initial Cu concentrations (1 – 5 mg/L) and MCC dosage (0.05 g – 0.5 g) are significantly influenced the adsorption performance of the MCC. This study indicated the adsorption process occurred at pH ranging from pH 2.8 to pH 6 with 3 to 24 hours of duration are required to achieve the equilibrium condition. Lower temperature ranges (25 to 30 °C) are more favourable for adsorption than higher temperature ranges (40 - 70 °C). The increased in initial Cu concentration enhanced the adsorption capacity of MCC but decreased Cu removal. On the other hand, the increased in the MCC dosage resulted in the decrease in adsorption capacity, however, increased Cu removal. MCC dosage of 0.225 g managed to remove Cu (II) with 95% efficiency at the initial Cu concentration of 1 mg/L, pH 5 and temperature 25 °C within 24 hours of contact time with 0.18 mg/g of adsorption capacity. Overall, high Cu removal efficiency (up to 95 %) was achieved by the MCC which render its usage as adsorbent.

**Keywords** Adsorbent, Microcrystalline cellulose, Copper removal

[SOMChE2020.136]

# Evaluation of Oil Palm Trunk as Potential Precursor for The Production of Activated Carbon in POME Treatment Application

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## Abstract

In the conventional treatment of palm oil mill effluent (POME) used in Malaysia, treated POME can still pollute receiving water bodies as colour is one of the major contaminants that is not completely removed. Adsorption by activated carbon (AC) is one of the promising wastewater treatment technique that can address this issue. However, the high cost of coal-based AC can be limiting factor for its wider application in palm oil industry. This work looks into resource recovery (i.e., use of waste stream) from plantation as precursor of AC synthesis. Hence, the suitability of oil palm trunk (OPT) as feedstock for AC synthesis and subsequent application in POME colour removal in the mill is investigated. Test matrix generated by statistical software (i.e., Design Expert) using Central Composite design (CCD) was employed to evaluate and optimize the effect of impregnation ratio, activation temperature and activation time with iodine number and yield as the response functions. The combination of parameters for optimal balance of iodine number and yield was identified to be at impregnation ratio of 2.29 under activation condition of 6 min and 450 °C. Experimental run at the optimized parameter was performed for validation and POME adsorption test was conducted on the optimized AC. The result shows that the optimum AC produced has the ability to remove the organic pollutants and colour of POME at the dosage of 15% w/v within 48 hours.

**Keywords** Palm-based biomass, Optimization, Wastewater treatment

[SOMChE2020.170]

# Used Lubricating Oil Recovery Process and Treatment Methods: A Review

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## Abstract

Used lubricating oil (ULO) is considered hazardous as it is able to cause pollution and affect the environment. The presence of degraded additives, contaminants, and by-products of degradation render ULO more toxic and harmful to health and environment than virgin base oils. Recovery of ULO generally comprises cleaning, drying, and adsorption in order to eliminate water, sludge, and impurities. As the ULO is one of the hazardous wastes generated in various industries, such as industrial and automotive, it should not be used or disposed of in ways that are harmful for the environment. Recovery of ULO carries out many advantages which includes lower environmental impact, higher energy saving and lower risks. The main objective of this paper was to thoroughly review various recovery process principles and treatment methods for ULO. Importance of ULO recycling and various techniques along with their limitations were also discussed. The significance of this study lies in reviewing the roles of adsorbent and adsorption reclamation processes of ULO and few promising adsorbents were earmarked for further study.

**Keywords** Used lubricating oil, Recycling; Treatment, Pollutants, Contaminants, Removal methods, Environmental pollution

[SOMChE2020.177]

# *Aloe vera* as a Natural Flocculant for Palm Oil Mill Effluent (POME) Treatment – Characterisation and Optimisation Studies

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## Abstract

Coagulation and flocculation process have been proven to be effective in removing colloidal particles in water and wastewater treatment. Nowadays, there has been great attention in the improvement and implementation of natural coagulant and flocculant in wastewater treatment, to replace the chemical coagulant and flocculant that would cause harm to the environment and human health. High content of contaminants in palm oil mill effluent (POME) must be treated to conserve the quality of water. In this research, fenugreek as natural coagulant and aloe vera as natural flocculant were studied and evaluated. It aimed to study the effectiveness of natural coagulant-flocculant on the removal of turbidity (TUR), total suspended solids (TSS) and chemical oxygen demand (COD) from POME by using a central composite design (CCD) in the Design Expert software. The effects of three factors such as pH, coagulant dosage and flocculant dosage were analysed using jar test experiment and optimised using response surface methodology (RSM). The optimum results obtained from process optimisation analysis were pH 4, 24.13 g of coagulant dosage and 20 ml of flocculant dosage that are sufficient to remove 82.78% of TUR, 83.40% of TSS and 32.95% of COD. The maximum error between the optimised values and the experimental values (82.78% for TUR, 83.08% for TSS and 33.76% for COD) were below 4%, indicating that satisfactory agreement was achieved. This showed that modelling and optimisation of the coagulation-flocculation process can be achieved by RSM approach. Moreover, characterisation of fenugreek and aloe vera using zeta potential analysis and Fourier transform infrared (FTIR) spectroscopy spectral analysis was also determined. It was found that the interactions between coagulant-flocculant and colloidal particles involve the mechanisms of charge neutralisation, adsorption and bridging, due to the active components such as amine (N-H) and hydroxyl (O-H) groups contained in the fenugreek and aloe vera.

**Keywords** Aloe vera, Central composite design, Flocculation, Palm oil mill effluent, Response surface methodology

[SOMChE2020.212]

# Evolution of Predictive Emissions in PETRONAS

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## Abstract

The effect of global warming and unprecedented black swan events give rise to innovative solutions to keep manufacturing companies stay afloat. Many countries have started to employ more stringent emissions limits and stricter monitoring enforcements. PETRONAS is not spared from these policies and with the enforcement of Clean Air Regulation Act (CAR) 2014, PETRONAS embarked on its emissions monitoring via statistical modelling methods. Traditional analysers are still employed for the emissions monitoring, but the focus of the paper is to spotlight the efforts in utilising soft sensors in ensuring compliance to CAR2014. Soft sensors are predictive models developed to infer primary parameters. The models can be derived via statistical tools or based on first principles using chemical engineering knowledge. The use of soft sensors is not only pervasive in the manufacturing industry but is also widely used elsewhere as it provides an indication of the future position of the primary indicators for the specific industry. The paper will also provide some insights on potential next steps in supporting PETRONAS efforts in its Sustainability Agenda. It also tells the story of collaborative efforts in maintaining good positive governance and relationship with its stakeholders.

**Keywords** Emissions, Sustainability, Control, Soft sensors, Predictive

[SOMChE2020.213]

# Assessment of Air Pollution Control Technologies to Reduce SOx Emission from Thermal Oxidizer for Oil and Gas Industry

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## Abstract

Many countries have put in place, various legislations that govern air emission limits/pollutants from the industries. The common pollutants being monitored are Sulphur Oxides ($SO_X$), Nitrogen Oxides ($NO_X$), Carbon Monoxide (CO), Carbon Dioxide ($CO_2$), Volatile Organic Compounds (VOCs), particulate matters and dioxins. In Malaysia, the regulatory requirement aims to regulate emissions of air pollutants from industrial activities including oil and gas, power plants, waste fuel plants and asphalt mixing plants. One of the emission limits under Clean Air Regulation (CAR2014) is emission level for $SO_X$ should be less than 600 mg/m$^3$ (reference condition at 3% of $O_2$, 273 K, 101.3 kPa) whereby sum of $SO_2$ and $SO_3$ expressed as $SO_X$. Excessive $SO_X$ emission can affect both health and the environment. Short-term exposures to $SO_2$ can harm the human respiratory system and make breathing difficult. People with asthma, especially children, are sensitive to these effects of $SO_2$. At high concentrations, gaseous $SO_X$ can harm trees and plants by damaging vegetation and decreasing growth. $SO_2$ and other sulfur oxides can contribute to acid rain which can harm sensitive ecosystems. Aligning with the regulation requirement, Group Technical Solution (GTS) under PETRONAS has embarked on assessment of technology solutions to meet the emission limit on $SO_X$ emission limit for thermal oxidizers which cover new and existing facilities. This paper describes on the work methodology and approach adopted during the assessment. The objective of the assessment is to determine the suitable process technology to reduce $SO_X$ emission in order to achieve the desired emission limit for flue gas at outlet stream of thermal oxidizer. Thorough evaluation was carried out based on proposal submission from various technology providers and Vendors. The selection criteria was developed and established. For existing thermal oxidizers, the assessment is more complex taking into consideration the nature of brownfield project and to ensure the proposed modification has minor impact to operability and maintainability of existing facilities. This study has successfully enabled identification of available process technologies to meet the desired emission limit at thermal oxidizer outlet for Oil and Gas Industry and supporting environmental protection.

**Keywords** Emission, Technology, Sulphur, Thermal oxidizer

[SOMChE2020.215]

# Modified Kinetic Models for Cr (VI) Adsorption in Polymer Inclusion Membranes

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## Abstract

Hexavalent chromium (Cr (VI)) is considered to be one of the most toxic elements found in environmental samples. To eliminate toxic Cr (VI) ions in natural waters, polymer inclusion membranes (PIMs) have been developed to provide high selectivity of metal ion transport. The investigation of the effectiveness of the recovery of Cr (VI) ions from aqueous solutions by using PIMs with varying amounts of plasticizer was studied. The influence of the pH, feed phase, and stripping phase as a function of time was also discussed in this paper. Pseudo-first-order (PFO) and Elovich kinetic models were modified to describe the amount of Cr (VI) ions that have accumulated onto the PIMs at a specific time and to evaluate the performance of the PIMs. A quantitative analysis of the modified PFO and Elovich models based on their non-linear representation and using the coefficient of determination ($R^2$) indicates that the adsorptive properties of the PIMs are best described by the modified non-linear pseudo-first-order kinetic model ($R^2 > 0.9748$), suggesting that the sorption process is physisorption. To show the applicability of the modified model to other transport studies, modified PFO was fitted into the experimental data that studies the transport of Zn (II) ions onto PIM ($R^2>0.95$).

**Keywords** Polymer inclusion membranes (PIMs), Pseudo-first-order kinetic model, Elovich model, Hexavalent chromium (Cr (VI)), Accumulation factor

[SOMChE2020.216]

# Development of Optimisation Model for Black Soldier Fly-Based Aquaculture Feed Supply Chains in Malaysia

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## Abstract

Aquaculture is identified as one of the critical food supplies in Malaysia. Due to the increasing demand for aquaculture products, the demand for protein sources for fish feed is also increased accordingly. Black soldier fly larvae is identified as one of the main protein sources that can be used in fish feed. Such larvae can be grown using different types of organic materials, such as food waste, agriculture waste, etc. As Malaysia is the second-largest palm oil producer in the world, therefore, a large number of agricultural wastes, also known as palm-based biomass (e.g., empty fruit bunches, mesocarp fibre, decanter cake, etc.) are generated annually. Based on the current industry practise, palm-based biomass can be converted into value-added products. However, using palm-based biomass as feedback to grow black soldier fly larvae is a relatively recent discovery. Thus, a viable supply chain model has yet to be established. In this work, a mathematical optimisation model is developed via commercial optimisation software (Lingo v.16) to synthesise an optimum black soldier fly-based aquaculture feed supply chain that utilised palm–based biomass as the feedstock. Based on the optimised result, the annual operating cost of the aquaculture feed supply chain is estimated as RM 5.2 million.

**Keywords** Supply chain optimisation, Black soldier fly, Aquaculture feed, Palm-based biomass

[SOMChE2020.221]

# Effect of Magnetite on Alginate-based Composite Bio-sorbent Hydrogel Beads for Copper Removal

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## Abstract

A composite magnetite alginate-based bio-sorbent in hydrogel beads form as adsorbent for copper ion removal was prepared through this work. Three types of composite bio-sorbents which are cellulose-magnetite-alginate (CeMA), chitosan-magnetite-alginate (CMA), and alginate-magnetite (AlgM) hydrogel beads was synthesized by physical cross-linking method. Ratios of magnetite 0, 0.1, and 1.0 was used during the synthesis of bio-sorbents to observe the effect of magnetite ratios on copper ion removals. Based on the performance of bio-sorbents on copper removals, magnetite ratio of 0.1 shows the best copper removal capability for both CeMA and CMA. Aside that, addition of magnetite in alginate-based composite bio-sorbent improves the copper removal up to certain ratio in 24 hours to reach adsorption equilibrium. In addition, through this work, magnetite embedded bio-sorbent with simple synthesized method was done by utilizing the capability of alginate to instantaneously form hydrogel beads upon addition into calcium chloride ($Ca^{2+}$). Therefore, this work proves the potential of magnetite embedded in alginate-based composite bio-sorbent hydrogel beads for heavy metal industrial wastewater.

**Keywords** Magnetite hydrogel beads, Alginate, Cellulose, Chitosan, Copper

[SOMChE2020.225]

# Correlating Water Quality Parameters on the Eutrophication Potential of Laguna Lake (Philippines) Using Artificial Neural Network (ANN) Modelling

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## Abstract

Eutrophication threatens about 30-40% of global lakes and rivers and is one of the most common concerns for natural water bodies. Various studies have determined the causes of eutrophication through continuous monitoring of water bodies. Laguna Lake is an important water body in the Philippines due to its geographic location and ecological importance. However, few studies have studied the lake in predicting the likelihood of eutrophication using mathematical models. In this study, we used Artificial Neural Network (ANN) modelling in MATLAB® to correlate different water quality parameters like: Dissolved Oxygen (DO), Dissolved Phosphorus (DP), Total Phosphorus (TP), and Temperature (T) to one another to determine the eutrophication potential in Laguna Lake (Philippines). Correlation analyses showed that DO and DP has showed significant correlation of ~0.80 to one another which could be due to DP being used primarily for algal growth. TP and T also showed significant correlations with other water quality parameters. Overall, the water quality parameters studied were critical and significant in potentially causing eutrophication in Laguna Lake. The results may provide awareness on the effects of these parameters in determining or predicting eutrophication in Laguna Lake, and possibly help in creating a proper framework for sustainable management strategies.

**Keywords** Artificial neural network, Dissolved oxygen, Eutrophication, Temperature,

[SOMChE2020.231]

# Effect of External Heat Source on Temperature and Moisture Variation for Composting of Food Waste

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## Abstract

This paper investigates the outcome of having an external heat source on temperature and moisture variations in food waste composting process. Food waste accumulation is growing concern in many countries. Converting food waste into usable compost is desirable tactic than dumping to crowded landfill sites. Closed composting was applied in this work, which relies on a controlled but uninterrupted airflow during organic material degradation process. However, undesirable odour released at low aeration rate due to low temperature and high moisture content found in the compost. Finding the ideal aeration rate with the least possible loss of moisture is needed, which was discussed in this paper. The vegetable-fruit waste used in the experiment was given an aeration rate of 0.3 L/min at a moisture setting of 60% and 70%. For 15 mins/day, the forced aeration was carried out at 3-day intervals. Results showed that 0.3 L/min with 60% and 70% moisture content attained best temperature peak of 32.4°C and 31.6 °C, respectively at day 16 for 28 days composting. A strong odour continued to exist with the compost was mitigated by using external additional heat source (light bulb). The light bulb also helped to provide a higher temperature for the compost of 41.5 °C and 39.9 °C by day 1 for 10 days composting.

**Keywords** Heat source, Vegetable-fruit waste, Composting, Intermittent aeration, Low aeration rate

[SOMChE2020.232]

# Study of Forced Aeration System for Fruit and Vegetable Waste Composting

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## Abstract

This study aimed to determine the effects of aeration rate (AR) and aeration method (AM) on forced aeration composting of fruit and vegetable waste (FVW) to supply an optimum aeration condition for a successful composting process. To achieve this aim, FVW and rice husk as bulking agents were composted for seven days. The effects of various aeration rates (0.3, 0.6, and 0.9 L $min^{-1)}$ and methods (continuous and intermittent) on composting were assessed. Process parameters, including temperature, moisture content, pH, and carbon-to-nitrogen (C/N) ratio, were monitored throughout the experiment. The result showed that forced aeration accelerated the degradation process, and both the aeration rate and method significantly affected the process. Low AR resulted in a high degradation rate, corresponding to a high initial temperature increasing rate and peak temperature. These were also found to be higher when intermittent aeration was used. Low AR resulted in minimal moisture loss in the composting material. Under similar AR, intermittent aeration had an average of 17.15 % of moisture loss, which was less than continuous aeration. Besides, pH also varied with aeration conditions where low AR and intermittent aeration resulted in higher peak pH, corresponding to their temperature profile. Lower AR and intermittent aeration resulted in a larger difference between initial and final C/N ratio, in which the largest C/N reduction was found in 0.3 L $min^{-1}$ with intermittent aeration. Based on the result, AR of 0.3 and 0.6 L $min^{-1}$ under intermittent aeration had the top two performance compared to the other. Further optimization was then carried out with 0.1 L $min^{-1}$, 0.2 L $min^{-1,}$ and 0.4 L $min^{-1}$. The result showed that AR of 0.2 L $min^{-1}$ with intermittent aeration performed better than the other.

**Keywords** Forced aeration, Vegetable-fruit waste, Composting, Intermittent aeration

# Material Science and Engineering

**[SOMChE2020.025]**

# Impact of Heavy Hydrocarbon Impurities on PTFE Membrane Stability

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## Abstract

Membrane contactor technology has attained considerable attention as a promising technology to reduce $CO_2$ content in natural gas. In this study, the main objective is to investigate the effect of heavy hydrocarbons impurities, often present in natural gas, on polytetrafluoroethylene (PTFE) hollow fibre membrane. The membranes were immersed for months in n-heptane, 1-decene, benzene and toluene, and analysed periodically through its surface morphology, composition, functional groups, hydrophobicity and thermal stability. The characteristics of PTFE fibres remained unchanged even after long term exposure with heavy hydrocarbons. This study provides a better understanding of the robustness of using PTFE membrane fibre for $CO_2$ removal in membrane contactor system.

**Keywords** Polytetrafluoroethylene (PTFE), Membrane, Heavies

[SOMChE2020.084]

# Grease Formulation and Characterization from Waste Automotive Engine Oil with The Use of Complex Thickener

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## Abstract

Waste engine oil one of the most abundant wastes in Malaysia, and through the reutilization of waste automotive engine oil helps to create a sustainable environment. The objective of this research is to develop the best formulation of lithium complex grease derived from waste automotive engine oil as base oil. The main focused parameter in this study is the different formulation ratio of base oil, thickener and co-thickener. Lithium 12-hydroxystearate is mixed with azelaic acid to produce lithium complex 12-hydroxystearate. Two different type of base oils, i.e. fresh automotive engine oil (FAO) and waste automotive engine oil (WEO) are used to formulate Li-complex grease. The grease derived from FAO is used to compare the physical properties derived from WEO. The texture of the formulation of base oil higher than 82 weight percentage was very fluid. The formulation of grease is carried out by differencing the ratio of the waste automotive engine oil, lithium complex 12-hydroxystearate and azelaic acid, which are 82:18, 80:20 and 70:30. The properties of the grease formulated is conducted through several tests, such as ASTM approach, Fourier Transform Infrared Spectroscopy (FTIR) characterization, oil separation and thermogravimetric analysis (TGA). Such interesting properties included consistency, chemical compound of the grease, oil separation and thermal stability. Based on the finding, the best formulated Li-complex grease is $WG_3$, classified NLGI 3. The significant peak derived from FAO and WEO to observe is 1710 $cm^{-1}$ as this peak indicated the oxidation stability. From the result, the intensity of carboxylic acid is weak that ranged 1709 – 1711 $cm^{-1}$. Hence, this indicated the grease formulated exhibited better oxidation stability. Furthermore, the formulated grease was thermally stable as the onset temperature was 250.09 °C. In conclusion, the formulation of Li-complex from WEO can be used as an alternative source of base oil in the grease industry, due to the good properties exhibition and preserving the environment as well as the increment of fossil fuel's demand and cost.

**Keywords** Grease, Waste automotive engine oil, Lithium 12-HAS, FTIR analysis

[SOMChE2020.085]

# Studies on The Modification of Fly Ash structure with Alkaline Pre-treatment as a Green Composite Flame Retardant Filler

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## Abstract

A green composite made up of renewable and recyclable materials has become one of the advanced material's attractive topics. The smooth fly ash surface used in the green composite for flame retardancy enhancement are hard to bind with hydrophobic polymer. Thus, the surface modification of this filler is needed to increase its surface roughness and pore size to be more compatible with its polymer matrix. In this research study, the alkaline pre-treatment of fly ash has been performed by using sodium hydroxide solution (NaOH) with various concentrations (5 w/w%, 10 w/w%, 15 w/w%, 20 w/w%). For pore size and morphological of the filler's evaluation, few analyses such as Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDX), Barret-Joyner-Halenda (BJH) and Brunauer-Emmett-Teller (BET) pore size and volume analysis were conducted. Treated fly ash with 20 w/w% sodium hydroxide concentration gives the better morphological structure in terms of pore diameter, volume, area and high composition of aluminium, silicon with lower calcium and sulphur contents compared to others. Hence, the potential of the physiochemical properties of the green composite produced by using this modified filler will be improved as the adhesiveness of the filler with its matrix increased.

**Keywords** Fly ash, Modified fly ash, Alkaline pre-treatment, Pore size, Adhesiveness, Flame retardant, Green composite

[SOMChE2020.086]

# The Impact of The Mulberry (*Morus nigra* L.) Leaf Extract on The Physicochemical Properties of Poly(vinyl alcohol) Blend Films

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## Abstract

In this work, mulberry (*Morus nigra* L.) leaf extract was added in poly(vinyl alcohol) (PVA)-based films and its impact on the film's properties was evaluated. In addition, HCl and glycerol were studied for their use as additives to prepare PVA-based films. The results showed that HCl and glycerol have minimal impacts on the films' appearance, while mulberry leaf extract imparted green colour to the films produced, mainly due to the presence of green pigments. Moreover, the results suggested that a significant interaction has occurred between the polymer matrix and leaf extract, contributing to a more compact and uniform film morphology. The tensile strengths of the films increased from 21.38 MPa to 28.28 MPa after the addition of mulberry leaf extract. Additionally, the films were tested for their application as food wrapping films. Overall, the results showed that PVA-based films incorporated with mulberry leaf extract have higher capability to preserve the freshness of food when compared to commercial cling wraps from brands such as Diamond and Glad. Appropriate proportions of additives (mulberry leaf extract, HCl and glycerol) used in the formulation of P-GH-M20 films showed improvement in its mechanical properties and food preservation capability.

**Keywords** Poly(vinyl alcohol), Mulberry leave extract, Film solubility, Food preservation

[SOMChE2020.122]

# Fabrication and Characterization of Chitosan-Titanium Oxide Nanotubes Scaffolds Reinforced with Tiger Milk Mushroom

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## Abstract

Chitosan-based scaffolds have been reported to promote cellular activities but lack mechanical strength which is much sought after for bone regeneration. The current research work aided to reinforce chitosan-based scaffolds with tiger milk mushroom (TMM) powder, a naturally occurring polysaccharide. Scaffolds of chitosan-titanium oxide nanotubes (TNTs) reinforced with tiger milk mushroom (TMM-CTNTs) were fabricated via direct-blending and freeze-drying methods. Prior to that, TNTs were hydrothermally synthesized and blended with chitosan solution and TMM powder at 1-5 weight percent (wt %). The pore size, microstructure, porosity, swelling, degradation, compressive modulus and functional groups of resultant scaffolds were characterized. These cylindrical scaffolds of TMM-CTNTs showed pore size of 48 – 68 µm. The addition of TMM from 3 wt% to 5 wt% in scaffolds reduced the porosity from 81.7% to 79.9%. The compressive modulus of 3 wt%-5 wt% TMM-CTNTs scaffolds increased from 0.013 MPa – 0.038 MPa. The incorporation of TMM influenced the swelling property of scaffolds. The swelling percentage of TMM-CTNTs reduced from 400% to 373% as TMM powder was introduced from 1 wt% to 5 wt%. The degradation ratio increased from 0.959% to 2.385% as TMM powder was introduced from 1 wt% to 5 wt%. The Fourier-Transform Infrared (FTIR) spectra of TMM-CTNTs scaffolds revealed the presence of β-glucan which verified that the processing methods in this study preserved the medicinal property of TMM. A preliminary *in vitro* test, MTT assay, was used to study proliferation rate of MG63 (osteoblast-like cells) cultured on TMM-CTNTs scaffolds with different weight percent of TMM. Notably, the cells proliferation of MG63 showed high biocompatibility at 3 days of culture.

**Keywords** Titanium oxide nanotubes, Tiger milk mushroom, Chitosan

[SOMChE2020.125]

# Iodide-based Ionic Liquid Impregnated on High Surface Area Porous Solid as Adsorbent for Mercury Uptake from Produced Water

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## Abstract

The production of produced water from the oil and gas industry has increased over time due to enhanced oil recovery activities. Several types of mercury such as organic, ionic, elemental and particulate mercury and other impurities are present in produced water. Due to its hazards to human health, environment and process equipment components, various mercury removal technologies such as adsorption, ion exchange, chemical injection *etc*. have been developed all over the world. Adsorption is widely utilised in the industry because of its simplicity and ease of handling. In this study, an adsorbent consists of iodide-based ionic liquid, impregnated on high surface-area porous solid support was prepared and evaluated for mercury uptake from produced water. The presence of iodide in the adsorbent was confirmed by energy-dispersive X-ray (EDX) analysis and inductively coupled plasma - optical emission spectrometry (ICP-OES). The results on mercury uptake showed the adsorbent is capable to remove mercury in the range of 80 to 95% within designated testing hours at various inlet concentrations, and simultaneously outperformed tested commercial adsorbents available in the market. The adsorbent capacity is also superior due to its finely dispersed active sites available to capture the mercury in the produced water.

**Keywords** Mercury, Produced water, Iodide-based ionic liquid

[SOMChE2020.131]

# Comparison of Chemically Surface Treated Luffa Cylindrica Using Scanning Electron Microscopy (SEM)

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## Abstract

The world as we probably know is currently facing a big difficulty referred as environmental pollution. Researchers from around the globe have been working on biodegradable materials in order to reduce the overall consequences due to environmental pollution. Furthermore, biodegradable composites also known as green composites made using natural fibers are highly considered over non-green synthetic fiber composites. Additionally, natural fibers are low in cost, have good mechanical properties, biodegradability and require less production energy. Focus of this research paper was on one of the natural fibers, luffa cylindrica (LC). There are plenty of surface treatments available including chemical and mechanical surface treatments. However, the focus of this paper was on chemical surface treatments. Sodium hydroxide, silane and acetylation chemical surface treatments were utilized. Chemically surface treated LC was compared with untreated LC with the help of Scanning Electron Microscopy (SEM). With the help of SEM, it was observed that all of the chemical surface treatments were effective. Furthermore, it was also noticed that each of the chemical surface treatment affected LC differently. However, sodium hydroxide surface treated LC samples showed the best outcome by removing waxy impurities as well as voids from the surface of LC.

**Keywords** Luffa cylindrica, Scanning electron microscopy (SEM), Composites, Fiber surface modification

[SOMChE2020.166]

# Extraction of Magnesium from Salt Pond Waste with Low Lithium Grade Using Sodium Silicate Reagent

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## Abstract

Nowadays, Indonesia's salt production process has shifted from a traditional salt pond process to a salt pond with a geomembrane tarpaulin system. This system has the advantage of producing a faster salting process and a better salt quality and producing a thick yellow liquid waste known as bittern. The waste produced has not been fully utilized, even though the waste contains valuable elements, namely magnesium, lithium, and others. This paper investigates the potential utilization of bittern by extracting magnesium from by-product salt pond using sodium silicate reagent with various concentrations of 125 g/l - 250 g/l. The bittern used in this experiment had the chemical composition as follows: 33,184 ppm magnesium (Mg), 23,787 ppm sodium (Na), 6.1 ppm lithium (Li), 5,491 ppm potassium (K), 617 ppm calcium (Ca), 152 ppm boron (B). The highest removal of magnesium ion by addition of sodium silicate of 250 g/l was about 96.2%. The results showed that the solid products were magnesium silicate precipitates without containing asbestos compounds. The magnesium silicate precipitate product can be applied as talc raw material for the pharmaceutical industry.

**Keywords** Magnesium, Bittern, Extraction, Talc, Lithium

[SOMChE2020.167]

# Synthesis and Characterization of Perovskite-Supported CoNi Catalyst for CO Oxidation via Exsolution

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## Abstract

The introduction of perovskite oxide as catalysts alternative has increased the interest worldwide due to its advantages such as its versatility to accommodate different transition metals. This study set out to evaluate the catalytic activity of CO oxidative perovskite catalysts (LCCNTO), fabricated via solid-state method and reduced under various reducing condition for the exsolution of the active metals, in this case is the Cobalt-Nickel (CoNi). The effect of reducing duration towards the catalytic activity was discussed in terms of CO conversion and $CO_2$ production rate of the fabricated LCCNTO. Through the light-off test, sample that was reduced the longest ($S_2T_{10}H_6$-$R_5H_5$) showed the highest CO conversion of 45.45% and $CO_2$ production rate of 0.1409 x $10^{-4}$ mol $s^{-1}g^{-1}$ at the temperature of 500 °C. Not only that, it was discovered that by controlling the reducing duration, the starting temperature for the reaction to occur could be reduced from 360 °C ($S_2T_{10}H_6$-$R_5H_3$) enabling the reaction to occur at lower temperature to 280 °C in $S_2T_{10}H_6$-$R_5H_5$. Under the same reducing temperature, the $CO_2$ production of sample reduced for 200 minutes ($S_2T_{10}H_6$-$R_5H_3$) started at 360 °C but as the reducing duration increased to 300 minutes ($S_2T_{10}H_6$-$R_5H_5$), the CO oxidation occurred at a much lower temperature of 280 °C. Although LCCNTO catalyst still suffer from similar deterioration as the other reported base metal catalyst, but it was clear that by just tuning the reducing duration, it could greatly affect the initiation temperature of the reaction to occur.

**Keywords** Perovskites, Base metal, Exsolution, CO oxidation

[SOMChE2020.180]

# Influence of pH on Corrosion Resistance of Electrodeposited LDH Composite Films on Mg Alloys WE43

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## Abstract

Layered double hydroxide (LDH) is widely studied as a protective coating for magnesium (Mg) alloys due to their nano-lamellar structure and anion-exchange ability. The two common approaches in synthesising LDH films on Mg alloys are co-precipitation and hydrothermal treatment. Recently, electrodeposition has drawn more interest as a potential synthesis approach due to the low cost, ease of control, one-step method, and ability to create a compact film. In this work, Mg-Fe LDH film was synthesised on magnesium hydroxide, $Mg(OH)_2$ layer formed on Mg alloy WE43 by electrodeposition approach. The effect of pH of the solution (3.0, 5.0 and 7.0) on the formation of LDH films was examined using Field Emission Scanning Electron Microscopy (FESEM), and the surface functional groups of the film were obtained by Fourier Transform Infrared Spectrometer (FTIR). Electrochemical tests in Hank's Balanced salt solution (HBSS) revealed that all the LDH composite films synthesised at different pH values promote corrosion resistance of WE43 with the LDH film synthesised at pH 3.0 provided the highest inhibition efficiency (I.E) of 94.48% and resistance polarisation value of 3559. 07$\Omega cm^2$ .

**Keywords** Magnesium alloys, layered double hydroxide, surface modification, corrosion, coatings

[SOMChE2020.202]

# Effect of Open Pore and Pore Interconnectivity in The Ni-SDC Cermet Anode Microstructure on The Performance of Solid Oxide Fuel Cells

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## Abstract

In nickel-samarium-doped ceria (Ni-SDC) cermet anode layers, the open pores and interconnected pores in the microstructure are the main factors that affect the mechanical and electrical properties. In this work, porous Ni-SDC cermet anode layers are fabricated using various quantities of potato starch (0 to 25 wt.%) as pore former in the anode powders. The properties of the Ni-SDC cermet anode layers were characterized by FESEM-BSE microscopy, Archimedes method for density measurement, Vickers hardness, flexural strength, and DC four-point electrical conductivity. The results showed that the different content of potato starch greatly affected the percentage of porosity and pore interconnectivity in the microstructure and consequently altered the mechanical and electrical properties of the Ni-SDC cermet anode. The degree of shrinkage, relative density, mechanical strength and electrical conductivity of the Ni-SDC cermet anodes decreased as their pore former content increased. Furthermore, the research shows that the large porosity (> 40%) in the Ni-SDC cermet anode microstructure affected the continuity of Ni-Ni, SDC and Ni-SDC phases and thereby affected the mechanical and electrical properties. The Ni-SDC cermet anode with 10 wt.% exhibited sufficient porosity, Vickers hardness, flexural strength and electrical conductivity of 34%, 48 MPa, 72 MPa and 2028 S/cm (at 800 °C), respectively. Therefore, optimization of porosity in the Ni-SDC cermet anode microstructure strongly contributes to the well-connected pore channels for the rapid diffusion of hydrogen for oxidation and mechanical strength.

**Keywords** Solid oxide fuel cells, Anode, Porosity, Mechanical properties, Electrical conductivity

[SOMChE2020.214]

# Synthesis and Characterization of (3-Aminopropyl) triethoxysilane (APTES) Functionalized Zeolite AlPO-18

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## Abstract

Over the years, functionalization of zeolite is gaining popularity among researchers to further modify the properties of the zeolite for wide applications. The procedure of functionalization is crucial to ensure that the framework and structure of the zeolite would not be destroyed by the functionalization process. In this work, zeolite AlPO-18 was synthesized via hydrothermal synthesis method and functionalized by (3-Aminopropyl) triethoxysilane (APTES). The effect of the APTES functionalization on zeolite AlPO-18 was investigated in this work. Both unfunctionalized and silane-functionalized zeolite AlPO-18 were characterized using Fourier-transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), and Thermogravimetric analysis (TGA) for their properties. The morphology and the composition of the elements present in zeolite AlPO-18 and zeolite $NH_2$-AlPO-18 were examined using Field Emission Scanning Electron Microscopy (FESEM) and Energy-Dispersive spectroscopy (EDX) respectively. The XRD pattern of $NH_2$-AlPO-18 was similar to that of zeolite AlPO-18, however, the intensity of the peaks was lower compared to zeolite AlPO-18. Based on the FTIR spectra, the presence of N-H stretching and bending vibration band of aminosilane were observed in the $NH_2$-AlPO-18 sample. According to FESEM images, the morphology of $NH_2$-AlPO-18 was comparable to that of zeolite AlPO-18 even after functionalization, proving that functionalization of aminosilane on zeolite does not affect on the zeolite structure. Besides that, EDX proves the presence of 3.02% of element N in the $NH_2$-AlPO-18 sample which is absent in the zeolite AlPO-18 sample. All of the characterizations evinced the presence of aminosilane, APTES in the $NH_2$-AlPO-18 sample.

**Keywords** Zeolite AlPO-18, Hydrothermal synthesis, Functionalized zeolite AlPO-18, APTES

[SOMChE2020.219]

# Functionalization of Polylactic Acid Thin Films via Polydopamine-Assisted Chelation of Copper (II) Ions for Antibacterial Applications

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## Abstract

Polylactic acid (PLA) is a biodegradable polymer, which has been widely investigated for use in biomedical and packaging applications due to its excellent biodegradability, biocompatibility, non-toxicity, low cost, good stability, and thermal processability. In this work, PLA was functionalized to improve the membrane's hydrophilicity and impart antimicrobial activity by simultaneously depositing polydopamine (PDA) and chelating $Cu^{2+}$ metal ions on the membrane surface. Pristine PLA films were modified via one-pot dip coating method using dopamine-copper (II) solution at different coating times (6, 12, 24 h). FTIR analysis confirmed the deposition of PDA on the modified membranes (PLA/PDA/Cu) as indicated by the presence of catechol and amine moieties on the samples. TGA results revealed the degradation of the same functional groups on PLA/PDA/Cu. The hydropilicity of PLA was significantly reduced upon coating with PDA as indicated by the decrease in the membrane's contact angle from 96.5 ± 5.3° to 56.2 ± 4.7°. SEM images and EDS results clearly showed that copper particles were deposited on the PLA/PDA/Cu membranes (atomic % ~ up to 0.88) and coating with PDA did not alter the porous structure of the pristine PLA film. Results also demonstrated that the concentration of copper immobilized on the modified membranes increased with longer coating; thus, offering a way of tailoring the metal concentration on the membrane for its specific use. PLA/PDA/Cu membranes showed antibacterial property against the *B. subtilis*, which could be attributed to the chelation of $Cu^{2+}$ ions with the catechol moiety of the PDA coating.

**Keywords** Polydopamine, Polylactic acid, Antibacterial coating, Copper chelation

[SOMChE2020.222]

# Photocatalytic Degradation of Anthracene By Biochar-Based Graphitic Carbon Nitride

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## Abstract

Polycyclic aromatic hydrocarbons (PAHs) are major organic pollutants in water system, which are persistent and toxic to living organism which can be considered as carcinogenic, mutagenic and teratogenic pollutants. In this study, a green photocatalyst of biochar-based graphitic carbon nitride (BC/g-$C_3N_4$-M) is derived from sugarcane bagasse (SB) and melamine were developed as a promising material for the degradation of PAHs. BC(SB)/g-$C_3N_4$-M prepared with different ratio of melamine to SB and different synthesis temperature were characterized by FTIR, BET and UV-DRS. The performance of the catalyst for the degradation of anthracene were further investigated in terms of its efficiency at different pH medium, catalyst dosage and initial concentration of anthracene. Experimental results revealed that g-$C_3N_4$ showed better degradation efficiency to anthracene than BC(SB)/g-$C_3N_4$-M. Additionally, the best degradation efficiency of anthracene by g-$C_3N_4$ and BC/g-$C_3N_4$-M75% composites were found at pH 3 with 1.0 g/L dosage at 2 ppm and 1 ppm initial concentration, respectively. The catalysts were also found reusable for five cycles with slightly reduction in photocatalytic degradation. This present work may provide a promising approach in water and wastewater treatment by utilization of agricultural biomass waste.

**Keywords** Biochar, Graphitic carbon nitride, Thermal polycondensation, Photocatalytic degradation, Melamine

[SOMChE2020.224]

# Fundamental Study of Colloidal Stability and Dispersion of Novel Nanosized Conductive Polyaniline (PANI)/ Natural Rubber Latex (NRL) Film for Antimicrobial Applications

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## Abstract

A smart material possessed enhanced conductivity integrated in natural rubber latex (NRL) film produced throughout this work. Also recognizing the synthesis route of PANI was vast and vary, choosing suitable method was great importance corresponding to the aim of study. PANI was prepared through chemical oxidative polymerization of aniline carried out in aqueous solution which aniline dissolved in strong acidic solution (1 M HCl) with the presence of Ammonium Persulphate (APS) as the oxidizing agent and Sodium Dodecyl Sulphate (SDS) as surfactant. However, PANI was readily in acidic condition while NRL in basic and consequently creates immiscibility upon mixing. Upon realizing the barrier factor, PANI formed then mixed with 0.1 – 0.5 % KOH via homogenizer to increase the pH and secure the homogeneity as well as dispersion to be combine with NRL. Various studies on PANI synthesis and incorporation with latex had been reported but very limited in focusing the colloidal and dispersion stability of the mixture. In this work, zeta potential measurements revealed an effective dispersion and the colloidal stability as the pH of PANI increases. Analysis of mechanical performance using Universal testing Machine revealed that addition of PANI improves greatly in novel film tensile strength and Young's Modulus by 109% and 230% respectively. Prepared novel PANI/NRL film was characterized by scanning electron microscopy (SEM), turbiscan, rheometer, zeta potentiometer, thermogravimetric analysis (TGA), FTIR spectra and Transmission electron microscopy (TEM).

**Keywords** Electrical conductive latex, Polyaniline, Colloidal stability

[SOMChE2020.226]

# Membrane Pervaporation Performance Applied for Brackish Water Prepared By Vacuum Impregnation Method

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## Abstract

Coating method and number of membrane layer are crucial factors that will affect toward membrane performance. Sol gel process is one process or step to create an inorganic polymer or ceramic layers from a solution through the transformation from a liquid precursor to sol. Through a vacuum impregnation method allows this sols solution uniformly fill into membrane support which has large pore, and it is required only less solution. The aim of this study is to apply vacuum impregnation method through vacuum calcination and air calcination during fabrication of silica membranes and to investigate the effect of layer variations (2 - 3 layers) on the performance of silica membranes applied for water desalination using brackish water as a feed. The sol solution was made from a mixture of silica precursor TEOS, ethanol solvent and dual catalysts (citric acid + ammonia). Alumina membrane support was coated with the sol-gel solution by vacuum impregnation method. And it is then calcined via air and vacuum conditions. The FTIR spectra was applied to investigate the functional groups. The results of this study indicates that both pure silica membranes calcined in air and vacuum calcination have siloxane (Si-O-Si) and silanol (Si-OH) groups. All the silica membranes prepared through the vacuum impregnation obtained smoother surface and silica membrane calcined via vacuum calcination show water flux and salt rejection are 22.01 $kg.m^{-2}.h^{-1}$ and 98.98%. If compare to silica membranes calcined in air, the water flux and salt rejection are 19.11 $kg.m^{-2}.h^{-1}$ and 98.75%. It is also found that the two layers silica membrane is better than three layers for the membrane performance result.

**Keywords** Air Calcination, Flux Permeate, Pervaporation, Salt Rejection, Vacuum Calcination

[SOMChE2020.228]

# Chemical Cleaning to Evaluate The Performance of Silica-Pectin Membrane on Acid Mine Drainage Desalination

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## Abstract

Pervaporation process is an excellent and potential way applied for desalting acid mine drainage water. Nevertheless, the water flux was reduced gradually due to the issue of membrane fouling. To resolve this problem, cleaning process was chosen to maintain the water flux of silica-pectin membranes. This study aims to recover the water flux and salt rejection of the silica-pectin membranes via chemical cleaning process applied for acid mine drainage water desalination with various temperature of feed water (25-60°C). Silica-pectin membrane was formulated by employing TEOS functioning as silica precursor and pectin as carbon template from banana peels. Chemical cleaning of the membrane carried out by employing $TiO_2$ solution + UV light radiation for an hour. Performance of the silica-pectin membrane was evaluated via pervaporation process under dead-end system. The performance of silica-pectin banana peels membrane found flux recovery from 10.6 $kg.m^{-2}.h^{-1}$ and flux recovery of 17.54 $kg.m^{-2}.h^{-1}$. It shows that flux recovery higher than before backwashing process. Also, silica-pectin membrane results in all of the salt rejection <99%. It is concluded that the chemical backwashing process is important to apply to recover the water flux of membrane, also, this process considers to save and reduce the operational costs.

**Keywords** Backwashing, Chemical cleaning, Silica-pectin membrane, Acid mine drainage water

[SOMChE2020.235]

# Extraction of Cellulose from Oil Palm Empty Fruit Bunch (OPEFB) Using Eco-Friendly Reagent and Preparation of Transparent Cellulose Thin Film

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## Abstract

The purpose of this research is to extract the cellulose using eco-friendly reagents, which are hydrogen peroxide and formic acid at 10% and 20% concentration respectively and determine the optimum reaction time for delignification process. Transparent thin film were then prepared from the extracted cellulose and characterised using FTIR, TGA, PSA and tensile test. The percentage yield of extracted cellulose were calculated and the highest yield were found to be 65.78% at reaction time 120 min. The FTIR spectral studies confirms the removal of lignin from the delignified cellulose at peak 1613 $cm^{-1}$ and the TGA result shows the thermal degradation of extracted cellulose at 329.04, 329.92 and 330.99°C for delignified cellulose at 60, 90 and 120 minute. The PSA studies provided the evidence of extracted particle size of the cellulose become finer as the reaction time increase. The particle size observed for delignified cellulose at 60, 90 and 120 minute are 68.4, 64.6 and 57.3µm. The extraction of cellulose and characterization to determine the optimum reaction time were able to obtain. From the result obtained, it can be concluded that the longer the reaction time, the higher the percentage yield of cellulose extracted. Film formation was later carried out using the extracted cellulose and MCC as control.

**Keywords** Transparent thin film, Extraction, Eco-friendly reagent

# Green and Sustainable Processing

**[SOMChE2020.004]**

# Lipid Yields in Algae Dried in an Enhanced Solar Chimney

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## Abstract

This work focuses on the lipid yield of algae dried using an enhanced solar chimney dryer for the purpose of production of biodiesel without high energy consumption or loss of quality. Jaworski's medium was chosen for the cultivation in this research project as it can provide enough nutrients to green algae of type *Chlorella. Sp*. Centrifugation is an effective method to harvest the algae from its medium prior to a drying process. In this project, the methods used for drying were oven drying, open-sun drying and an enhanced solar chimney drying. The moisture content was determined where the average moisture content were 82.5% for oven drying method, 81.6% for open sun drying and 82.2% for solar chimney drying. Methods affect differently the properties in algae where the lipid yield and mineral content data have been collected. The lipid yields of oven drying were 23.7%, 20.6% for open sun drying and 24.4% for enhanced solar chimney drying. While the oven drying was found to be the fastest way to dry the algae, the solar chimney drying proved best in energy saving while producing the same amount or more algae lipid within reasonable drying times.

**Keywords** Lipid, Algae, Drying, Solar chimney, Duration

[SOMChE2020.006]

# Reduction of Tar from Biomass Gasification Using a Dielectric Barrier Discharge Reactor

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## Abstract

A non-thermal plasma reactor was used to investigate its effectiveness in reducing the by-products from biomass gasification. Biomass is used for generating heat and power through gasification, which is a process of converting solid fuel to gaseous fuel at temperatures of 700 to 900 °C by operating a reactor in sub-stoichiometric conditions. This gas mixture can be utilized for liquid fuel synthesis or for fuel cells. However, the by-product of gasification consists of tar, which consists of oxygenates, ringed-aromatics, phenolic compounds, and polyaromatic hydrocarbons (PAH). Depending on the composition, the condensation temperature can be as high as 450 °C, fouling downstream equipment. In this study, a dielectric barrier discharge (DBD) reactor with a coil as the inner electrode was used to reduce toluene, a model tar compound. Toluene was injected into a mixing chamber that was heated to 900 °C, evaporating the toluene, and is entrained by nitrogen into the DBD reactor. High voltage is injected into the DBD reactor to initiate ionization, decomposing the toluene into lighter hydrocarbons. A sampling bottle submerged in an ice bath collects the residual toluene, and the resulting decomposition rate is as high as 70%.

**Keywords** Tar, Biomass, Gasification, Non-thermal plasma, Dielectric barrier discharge

[SOMChE2020.020]

# Prediction of Solvation Properties of Low Transition Temperature Mixtures (LTTMs) Using COSMO-RS and NMR Approach

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## Abstract

The concept of sustainable and green solvent has always highlighted in the field of energy and environmental science. The synthesis and application of natural-based Low Transition Temperature Mixture (LTTM) as a novel and green solvent for the lignocellulose biomass pre-treatment such as delignification of Oil-Palm Empty Fruit Bunch (EFB) have been greatly emphasized. In this present work, the investigation of LTTM efficiency as green solvent in delignification process was conducted using both theoretical and experimental studies. Initially, screening of solvation properties of different types of hydrogen bond acceptor (HBA) and predicted hydrogen bond donor (HBD) for synthesis of LTTMs was conducted using conductor-like screening model (COSMO-RS) software and formation of hydrogen bonding was evidenced using NMR spectroscopy analysis. Three types of HBA namely sucrose, choline chloride and monosodium glutamate were mixed with malic acids as HBD and their charge density distribution on the surface was determined through sigma profile (σ). The COSMO-RS results determined the σ profile of pure component malic acid to be 11.42, sucrose to be 25.37 and the total value of σ profile for mixtures is 14.19 as the best combination of LTTM composition compared to LTTM from choline chloride and monosodium glutamate (MSG). The reliability of the COSMO-RS predictions data was correlated with Nuclear Magnetic Resonance (NMR) analysis through determination of peaks with chemical shifts hydrogen bonding that suggested existence of potential interaction between malic acids and sucrose has occurred.

**Keywords** Solvation properties, Low Transition Temperature Mixture (LTTM), COSMO-RS, Hydrogen bond acceptor (HBA), NMR

[SOMChE2020.054]

# Hydrogenation of $CO_2$ to Methanol Using Cu-based Catalyst Supported on Oxide Pellets

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## Abstract

Hydrogenation of $CO_2$ into methanol is one of the most economical process to reduce $CO_2$ concentration in the atmosphere. Since methanol is an industrial commodity used in chemical products as well as transportation fuel, this process has gained considerable interest, which enables the effective utilization of $CO_2$. Nevertheless, the efficiency of direct $CO_2$ hydrogenation to produce methanol is strongly reliant on the activity of the catalyst. In this regard, the present work highlights the synthesis of methanol, catalytic evaluation and characterization of catalysts Cu/ZnO supported on $Al_2O_3$ and SBA-15 pellets with the addition of group IV, V and VII metal oxides mixture as promoters. The catalysts were systematically prepared *via* impregnation technique with fixed Cu:Zn and promoter ratio from group VII:V:IV. The synthesized catalysts were characterized by $H_2$- temperature-programmed reduction ($H_2$-TPR), field emission scanning electron microscopy (FESEM), X-ray fluorescence (XRF), $N_2$ adsorption-desorption and $N_2O$ pulse chemisorption method. The crushing strength of the pellets were also tested. Catalytic performances were evaluated for methanol synthesis from $CO_2$ hydrogenation in a tubular, stainless steel fixed-bed reactor at 250°C, 2 MPa, gas hourly space velocity (GHSV) 4000 ml/g.h and $H_2/CO_2$ ratio of 3:1. The tri-promoted Cu/ZnO supported on $Al_2O_3$ pellet resulted in $CO_2$ conversion of 13.3% compared to 11.61 % from that of SBA-15–supported catalyst. However, the catalyst supported on SBA-15 pellet exhibited 54.59% methanol selectivity, whereas $Al_2O_3$ -supported catalyst only resulted in 46.73 % methanol selectivity.

**Keywords** $CO_2$ hydrogenation, Methanol, Utilization of $CO_2$, Pellets

[SOMChE2020.070]

# Simulation of Ozonolysis of Volatile Organic Compounds: Effect on Flue Gas Composition

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## Abstract

This study shows that the reaction of ozone with various volatile organic compounds (VOC) yields different flue gas composition in terms of the carbon dioxide, oxygen and moisture contents. Steam production and thermal output requirements from a combustion system (i.e., a boiler) may dictate the range of operating conditions, such as the air to fuel mass flow rates. To improve the combustion efficiency in these operating conditions, low temperature plasmas have been used to ionize air and generate ozone as an oxidant for ozonolysis with the VOC. Therefore, this study simulates the reaction mechanism of the ozonolysis of VOC and the effect on the flue gas composition, which affects the combustion efficiency. Simulation results show that residual oxygen in the flue gas reduces, reducing the excess air. Thus, the corresponding efficiency loss through dry flue gas would be reduced. Literature data shows that emissions of alkanes, alkynes and alkenes per unit mass of solid fuel is evident for both coal and biomass, and thus ozonolysis of these VOC would reduce the excess air, improving the combustion efficiency.

**Keywords** Volatile organic compounds, Non-thermal plasma, Ozonolysis, Biomass, Coal

[SOMChE2020.073]

# Continuous Desalting Concept on Ionic Liquid-Mediated De-acidification Process of Crude Oil: A Pilot Study

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## Abstract

Desalting process concept was tested using methyltrimethylammonium methylcarbonate [N4441][$MeCO_3$] treated Pyrenees crude oil (initial Total Acid Number (TAN) of 1.6 mg KOH/g oil) with the aim to gain empirical evidences on the effectiveness of in-line water washing and electrostatic aided phase separation as mean to recover the naphthenic acid derivatives for recycling. The treated crude oil (final TAN value of less than 0.3 mg KOH/g oil) was subjected to typical operating scheme such as single stage desalting and effects of water wash volumes. The novelty of the work comes from the utilisation of ionic liquids to neutralise acid components of the crude oil. Furthermore, the work is also able to test the hypothesis of whether naphthenate salts behave as is its inorganic counterpart and quantify the solubility behaviour in water as extraction medium. The effectiveness of such scheme will be measured against naphthenic acids derivative percent recovery in the wash water. The results indicate the electrostatic conditions can facilitate the recovery of the naphthenate salts post neutralization with high recovery rate of average of 70.6% with 30% water wash volume in a single-stage contact, observed over 12 hours steady-state operation. The water wash weight was observed to increase post separation which indicate hydrocarbon carry-over in the heavy phase due to formation of tight water – oil emulsion. The technique is viable should the amount of water required is available and the process water can be recycled safely into the desalter again without causing tripping to the desalter. Ionic liquid can be used in conjunction with desalter and the presence of electrostatic field did hasten the separation of the phases, however the amount of water used may hinder the viability of the solution.

**Keywords** Ionic liquids, Naphthenates, Desalting

[SOMChE2020.094]

# Comparative Laboratory Cost Analysis of Various Activated Carbon Activation Process

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## Abstract

Activated carbon (AC) is an established adsorbent for organic pollutants reduction, metal removal, and liquid and gas adsorption. Cost analysis corresponds to determining the best approach for AC production depending on activation techniques with different degrees of activation is still minimal in literature. A cost estimation of AC production in laboratory scale using different conventional activation and post-activation surface modification process is performed in this study. This study attempts to develop a cost-friendly selection of activation process from laboratory scale prices. Chemicals and utility costs were acquired from vendor quotes (i.e., Sigma-Aldrich and Fisher Scientific) and Sarawak industrial electricity tariffs based on 100 g production. Oil palm-based ACs produced from five different activation or surface modification methods were compared to ascertain the least expensive production approach in terms of estimated production cost. Of the five methods investigated, method that quoted the least expensive production cost is chemical activation using potassium hydroxide (KOH) with minimum estimated cost of $7.30 whereas the most expensive production cost involves surface modification by polyethyleneimine (PEI) impregnation with cost of $873.00. Therefore, the estimated production cost for KOH activation is the minimum at $0.073 $g^{-1}$ while the maximum is $8.73 $g^{-1}$ for PEI impregnation.

**Keywords** Oil palm-based activated carbon, Laboratory scale, Activated carbon production, Production cost, Cost-friendly activation process

[SOMChE2020.111]

# Development of Poly(ethylene Glycol) Diacrylate Membrane for Facilitated $CO_2/N_2$ Separation

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## Abstract

Carbon dioxide ($CO_2$) is responsible for approximately 80% of greenhouse gases emission that is the main source to global climate change causing notable environmental impacts. Poly (ethylene glycol) diacrylate (PEGDA) have polar PEG repeating units, which provide a strong affinity towards carbon dioxide ($CO_2$) molecules has been blended with 3-aminopropyltrimethoxysilane (APTMS) to synthesize membrane for $CO_2$ /nitrogen ($N_2$) separation. The new synthesized membrane is studied for potential applications in gas separation and to be implemented in control $CO_2$ emission. APTMS is also used to delay the diffusion between polymer and solvent. In this study, concentration of polymer of PEGDA and casting solvent of APTMS in terms of mol ratio from a range of 0.9:1.1 to 1.3:0.7 is discussed. Based on the results, PEGDA membrane shows best gas separation performance at mol ratio of PEGDA to APTMS of 1:1 where the permeance for both $CO_2/N_2$, and $CO_2/N_2$ selectivity are 75.21±0.15 GPU, 22.95±0.05 GPU and 3.28±0.12, respectively. An optimal aminosilane/polymer reaction ratio benefits the gas separation performance of the membrane due to the affinity of the membrane towards $CO_2$ and formation of different membrane surface morphology.

**Keywords** Membrane technology, Poly (ethylene glycol) diacrylate, 3-aminopropyltrimethoxysilane, $CO_2/N_2$ Separation

[SOMChE2020.115]

# Lipids Extraction from Moringa Oleifera Seeds for Biodiesel Production

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## Abstract

This paper explore the mechanism of lipid extraction efficiency on Moringa Oleifera seeds using Soxhlet extraction method. This present study essential to determine the effect of particle size of the sample, extraction time and type of solvent applied towards the efficiency in extracting the lipids from the material. Soxhlet extraction method utilizing Buchi B118 was use in this study and response surface method was applied to analysed the data and determine the optimum parameter condition to obtain the highest yield of Moringa oil extraction. Moringa oil derived from Moringa Oleifera seeds was converted into biodiesel (FAME) via Transesterification process. Conversion of Moringa FAME was observed using three different alcohol oil to molar ratio by based-catalysed. This study shows significant strong correlations between particle size of the sample, extraction time and type of solvent use towards extraction yield. Particle size ranging between ≥ 1.0 mm to ≤ 2.0 mm with 3 hours extraction time using hexane was the optimum condition in order to get the highest yield of lipids extract from both Moringa Oleifera samples.

**Keywords** Moringa Oleifera, Soxhlet extraction, Lipids, FAME

[SOMChE2020.137]

# Techno-Economic Evaluation of Microalgae-Based Supply Chain: Review on Recent Approaches

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## Abstract

Third generation biomass-derived products such as biofuel has been garnering attention as a viable alternative energy source recently as it does not necessarily require fresh water and vast land for cultivation as compared to first-generation and second-generation biomass. However, extensive studies have to go into the feasibility evaluation for third generation biomass utilization prior to upscaling the process to commercial level. Other than comprehensive technical evaluation such as experimental studies to understand the microalgae productivity, economic evaluation of the utilization of third-generation biomass is also critical specifically in the perspective of supply chain. Therefore, the objective of this review is to lay out an overall picture to the readers the various option of approaches or methods utilized in feasibility evaluation of the microalgae-based supply chain. The outcome of the review paper indicated that approximately 58 % of the papers reviewed opted for mathematical modeling with optimization whereas the remaining 42 % opted for mathematical modeling without optimization.

**Keywords** Stochastic, Deterministic, Optimisation

[SOMChE2020.161]

# Evaluation and Characterisation of Candidate Prebiotics Extracted from Coconut Husk by Ultrasound-Assisted Extraction Technique

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## Abstract

Oligosaccharides are carbohydrates containing between three to ten sugar moieties. Certain oligosaccharides such as inulin and fructo-oligosaccharides are known as prebiotics that promote the growth of beneficial bacteria in the human gastrointestinal tract. This study began by comparing the efficiency of two different solvents (distilled water and 10% w/v sodium hydroxide) in extracting oligosaccharides from the coconut husk by ultrasound-assisted extraction (UAE). Following that, the coconut husk extract (CHE) extract was subjected to a series of prebiotic evaluation tests. The findings indicated that a significantly high extraction yield (40.51 ± 6.00%) could be achieved with 10% w/v NaOH treatment. The in vitro enzymatic digestion study found that there was 43.70 ± 0.15% of hydrolysis at pH 8 after five hours of incubation. For the in vitro gastric juice digestion, 29.21 ± 0.71% of hydrolysis was recorded at pH 1 after four hours of incubation. The extract was able to stimulate the growth of selected beneficial bacterial strains. FTIR and NMR analysis of the CHE revealed that the extract has a similar structure to the well-known prebiotic inulin.

**Keywords** Oligosaccharides, Prebiotics, Coconut husk, Ultrasound-assisted extraction

[SOMChE2020.168]

# Simultaneous Degumming and Deacidification of Crude Palm Oil Using Mixed Matrix PVDF Membrane

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## Abstract

The research work aimed to investigate the compatibility of polyvinylidene difluoride (PVDF) membrane embedded with various inorganic adsorbents for producing a mixed matrix membrane (MMM) and to examine the capability of mixed matrix PVDF membrane (PVDF- MMM) for simultaneous degumming and deacidification of crude palm oil (CPO). Four different adsorbent were tested which includes calcium silicate (CaS), magnesium silicate (MagS), ZSM-zeolite (ZSM) and activated carbon (AC). The in-house made PVDF-MMM was fabricated according to the dry-jet wet spinning method. The performances of these PVDF-MMMs were assessed with respect to the removals of phosphorus, FFA and colour. Based on finding showed that the combination of 18PVDF embedded with 3wt% MagS showed the most compatible polymer-inorganic hybrid MMM to perform pre-treatment of CPO. Increasing the MagS concentration from 3 to 8wt% in the polymer matrix recorded the highest removals of FFA at 16.51%, phospholipid at 93.31% and colour at 18.8%, respectively. Nevertheless, high amount of MagS added to the polymer matrix affected the spinnability and reproducibility performance of MMM. Future work, surface modifications of inorganic adsorbent can be evaluated to facilitate good dispersion of filler in polymer matrix during membrane fabrication to maintain good membrane reproducibility.

**Keywords** Mixed Matrix Membrane, Degumming, Deacidification, Crude Palm Oil

[SOMChE2020.178]

# Effect of GDE Structure on Selectivity and Flooding Control Performances in Electrochemical $CO_2$ Reduction to CO

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## Abstract

Understanding the structure-performance relationship is a crucial initiative prior to developing the required gas diffusion electrode (GDE) in electrochemical $CO_2$ reduction reaction ($CO_2$RR). We investigated the effect of the thickness of the microporous layer (MPL) of the GDE on the performance of $CO_2$RR based on silver nanoparticles (AgNPs) as the catalyst in a flow cell electrolyser. It is highlighted that MPL is of essential importance to maintain the high selectivity for desired products especially during high current density (CD), thanks to which is excellent at catalyst supporting and prevention of flooding. The flooding rate was measured by weighting the mass differentiation of the seeping catholyte for the first time. Furthermore, there is a trade-off between gas transfer and flooding prevention of GDEs composed of different thickens of MPL: thick MPL performs better on high CD (>100 mA $cm^{-2}$), owing to superb flooding resistance but inferior on low CD due to deficient $CO_2$ transfer. The apprehension of the functions of the GDE structure paves the way to the realization of adequate stability at operating currents needed for industrial applications.

**Keywords** Electrochemical $CO_2$ reduction, Gas diffusion electrode, Thickness, Flooding rate

**[SOMChE2020.204]**

# Eggshell Waste as a Catalyst for Biodiesel Production: A Preliminary Study

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## Abstract

This research aims to observe the usability of waste eggshells as a heterogeneous CaO-based catalyst to produce biodiesel via the transesterification process. The waste eggshell contains CaO and serves as a heterogeneous catalyst that can be extracted using a simple heat treatment technique. The catalyst loading used in this study were 1% wt, 2% wt, 3% wt, 4% wt, and 5% wt. The biodiesel yield affects the variables of the reaction, including the amount of catalyst used. According to the findings in this work, the low-weight catalyst produced more biodiesel (64% of yield) than other catalysts in the studies. Using the same CaO catalyst with a 1 wt% catalyst, previous studies showed a biodiesel yield of 56.64%. Outcomes revealed that waste eggshells could be used as an effective catalyst to transform waste cooking oil into biodiesel, thereby significantly lowering biodiesel costs and improving product yield and fuel properties.

**Keywords** Biodiesel, Calcium oxide, Renewable energy, Transesterification, Waste cooking oil

[SOMChE2020.206]

# Numerical Simulation and Experimental Study on Hematite Production By Oxidation of Mill Scale

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## Abstract

Mill scale is a waste product from steel hot rolling processes and containing a high amount of FeO and $Fe_3O_4$. It is crucial to recycle and reuse this waste for the recovery into a metallic iron or its single oxide derivative. One of the end products of mill scale oxidation is hematite which has multitude of uses in various application. In this present study, mill scale is converted to hematite by roasting a mixture of mill scale at a specific set of conditions at 900°C for a varied time under ambient air environment by addition of pelletized limestone as a heat storage media. In this work, the Dimensionless Degree of Oxidation Prediction Model (DDOPM) has been constructed to gain hematite purity approach in the resulting powder by using Matlab. The Buckingham Pi Theorem is used to find dimensionless parameters considering the effect of different parameters including the geometric factor of tubular horizontal furnace used, characteristic of mill scale, ambient air factor, and thermal characteristics of limestone. The degree of oxidation from experimental result was obtained from XRF analysis and compared to the result of DDOPM to show the correlation between the experimental and numerical.

**Keywords** Mill scale, Hematite, DDOPM, Buckingham Pi Theorem, Matlab

[SOMChE2020.217]

# Optimising of Vacuum Distillation Units Using Surrogate Models

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## Abstract

Crude oil blending is an important step for the operation of crude distillation systems in the refinery to improve the yield and profitability of the products. The product's yield and quality are strongly dependent on the properties of the crude oil. However, the products of crude distillation units, especially the vacuum distillation unit (VDU) need to satisfy the yield and quality requirements of the downstream process units in the refinery. Otherwise, the performance of downstream processes will be affected, and loss of profitability in the refinery. Hence, it is important to optimise the performance of the VDU to ensure the optimum operation of VDU. This work covers the process simulation of VDU, surrogate modelling and mathematical optimisation model. The objective of the developed optimisation model is to determine an optimal for maximum high vacuum gas oil (HVGO) yield and minimum total annualised cost (TAC) respectively. To do this, crude oil blending ratio, column temperature, column pressure, stripping steam flowrate, pump-around flowrate in the VDU are optimised. Based on the optimised result, the heavy-light crude blend achieves higher HVGO yield and lower TAC as compared to the heavy-medium crude blend and heavy-medium-light crude blend. The optimised results can provide insight into the optimal process conditions of VDU for the refiners. With this insight, effective operating strategies can be developed to overcome the limitations present in real VDU operations.

**Keywords** Vacuum distillation unit, Surrogate model, Mathematical optimisation, Process simulation

[SOMChE2020.223]

# Utilization of Supercritical Carbon Dioxide (SC-$CO_2$) in Lipids Extraction from Sewage Sludge Cake: A Preliminary Study

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## Abstract

Sewage sludge containing a large number of lipids that can be recovered and utilised as a promising raw material in the production of biodiesel. Studies have been conducted to extract lipids from sludge using conventional solvent methods. However, all these conventional methods have some limitations such as extensive product separation and long extraction time (between 4 to 8 hours), which lead to high energy consumption. Supercritical carbon dioxide extraction (SFE) which utilises carbon dioxide ($CO_2$) gas at its critical condition as solvent has been studied extensively in various fields for oil extraction especially for plant and vegetative. This is due to the shorter extraction time and the lipids can be easily separated from the extraction system. The present research has undertaken a comparison study of supercritical carbon dioxide (SC-$CO_2$) utilisation in the extraction of lipids from sewage sludge against conventional soxhlet extraction of methanol and ethanol as solvent. The extraction of lipids from sewage sludge utilising SC-$CO_2$ extraction was successfully being conducted with lipids yield of 0.69 % within 0.5 hours at the operating temperature of 50 °C and pressure of 20 MPa. The lipids were easily separated subsequently from the SFE system when $CO_2$ is being released in gas form through the outlet valve during lipids collection. Whilst soxhlet extraction using methanol and ethanol as solvent (sludge: solvent ratio of 1:10) managed to extract 1.95 % and 2.81 % within 4 hours of extraction time at 60 °C, with the additional time needed to separate the lipids from solvent by evaporation.

**Keywords** Supercritical carbon dioxide, Lipids extraction, Sewage sludge, Engineering

**[SOMChE2020.239]**

# Innovation and Commercialization – Success stories of UMS

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## Abstract

The workloads of the lecturers have now been doubled; on top of publication in high impact journals, the academia have been expected to produce innovation and commercialization. This happens because the lecturers, especially in the universities, serve two stakeholders. The first stakeholder is the Ministry of Higher Education Malaysia (MOHE). MOHE sets the key performance index of the universities in terms of publication, particularly in high impact journals. Whereas the second stakeholder is the State Governments. The State Governments often expect universities to conduct research that are directly beneficial and useable by local industries and communities. The issue of lack of meaning and application of the publication is not uncommon. In order for the academia to meet these two expectations, a new paradigm shift in conducting research and development is warranted. The traditional mindset typically separates publication and commercialization, believing that those two have different pathways and cannot be achieved simultaneously in a research project. In contrast, the new mindset requires the alignment of publication and commercialization into a single pathway when conducting a research and development project. In this talk, the commercialization successes of six research products are presented. It will elucidate the strategy to carry out a project that delivers both publications and commercialization. The talk is relevant not only to the lecturers but also to all researchers who aspire to achieve publications and commercialization in their research projects.

**Keywords** Commercialization, Innovation, Key performance index, Research, Publication

# Energy

[SOMChE2020.017]

# Combustion Temperature Analysis in a Fluidized-Bed Reactor By Utilizing Palm Oil Biomass for a Renewable Energy

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## Abstract

Biomass from palm oil is a renewable energy source that can be utilized and has very promising availability. Biomass energy is a renewable and sustainable energy that can replace conventional (fossil) fuels. The main objective of the experiment in this article is to analyze the combustion temperature, emissions, and efficiency of palm oil biomass fuel to use and applied in rural/remote areas. The palm oil biomass used in this study is palm kernel shells, empty fruit bunches, oil palm midrib, and oil palm fibers. The experiments in the research carried out in a fluidized-bed combustion chamber designed explicitly with capacities of up to 5 kg of biomass. The results of operations on fluidized-bed when the valve is open 100%, 75%, and 50% with overall palm oil biomass show a high combustion temperature. The highest combustion temperature was recorded in the TC test for 100% open valves with 3 kg biomass of 943°C. While the minimum combustion temperature obtained on TF2 at 50% open valve with 1 kg biomass of 619°C, overall combustion temperatures in this experiment showed high results. The maximum emission for $O_2$ is 20.4% which is obtained at 50% open valve, while for $CO_2$ the maximum emission is produced when 100% open valve is 19.9% with a biomass weight of 1 kg and 3 kg, respectively. The yield for maximum combustion efficiency when using 1 kg of biomass recorded at 50% open valve was 94.9%. While the minimum efficiency of 87.7% is obtained when the valve is 100% open with biomass of 2 kg. As the biomass fuel used in fluidized-bed increases, the combustion temperature also increases significantly.

**Keywords** Combustion analysis, Fluidized-bed, Utilization biomass, Renewable energy, Ash deposit

[SOMChE2020.063]

# Thermogravimetric Kinetic Analysis of In-Situ Catalytic Pyrolysis of Palm Oil Wastes with the Presence of Palm Oil Wastes Ash Catalyst

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## Abstract

The thermal degradation and kinetic analysis for palm oil wastes such as oil palm frond (OPF) and oil palm trunk (OPT) with its ashes are investigated using thermogravimetric approach (TGA). OPF ash, OPT ash and its mixtures are used as a natural source of catalysts in the pyrolytic conversion of the palm oil wastes to bioenergy. The TGA experiments are conducted in different heating rates of 10-100 K/min from the temperature of 323K to 1173 K. Coats-Redfern model is applied in this study to evaluate the activation energy ($E_A$) and pre-exponential factor ($A$). The average $E_A$ values ranged 24.27-32.36 kJ.mol$^{-1}$ and 41.42-46.10 kJ.mol$^{-1}$ for pyrolysis of OPF and OPT respectively. Meanwhile, the average $E_A$ values ranged 24.27-31.06 kJ.mol$^{-1}$ and 31.77-43.45 kJ.mol$^{-1}$ for catalytic pyrolysis of OPF and OPT respectively. Based on $E_A$ calculated, the degradation results were found with the following conclusion: OPF-OPF/OPT ash > OPF-OPF ash > OPF > OPT-OPT ash > OPT-OPF/OPT ash > OPT. It is proven that OPF/OPT ash is suitable for OPF pyrolysis and OPT ash is suitable for OPT pyrolysis process for an effective energy-efficient bioenergy production.

**Keywords** Kinetic analysis, Thermogravimetric, Palm oil wastes, Pyrolysis, Ash

[SOMChE2020.064]

# Inter-entities Symbiotic Relationships with The Use of Multi-Period Methodology in Energy Planning

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## Abstract

The deficiency of natural resources and serious climate change have driven the global community to optimize energy planning using various process integration approaches. The inter-entities energy planning that allows internal sharing of resources poses a great potential to enhance energy planning. It is believed that the effective management of such relationships is crucial to gaining collaborative synergies, which provide economic benefits and minimize environmental impact. The developed inter-collaborated energy sharing model gives a handy lens to evaluate the effectiveness of the suggested inter-entities collaboration and how it provides economic benefits for the involved "players". To demonstrate the economic viability of the inter-entities' energy planning, an energy sharing model is developed and applied to an illustrative case study that involved two entities. The results show that, when energy sharing is enabled, the involved entities can reduce their monthly electricity bill by 16.72% (MYR 14940.73) for entity 1 and 14.29 % (MYR 14218.50) for entity 2, with a 20 % carbon emission constraint limit.

**Keywords** P2P energy sharing, Multi-period energy planning, Optimization, Mixed-integer linear programming

[SOMChE2020.121]

# High Gravity Cryogenic Distillation for Bulk $CO_2$ Removal

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## Abstract

Hydrocarbon resources with ultra-high $CO_2$ content of more than 50 mol% remained undeveloped in South East Asia due to lack of economic incentive to monetize the field. An innovative total solution is required to overcome this barrier to develop ultra-high $CO_2$ gas fields in improvement of power requirement, weight and space reduction, in order to meet project economics.

High gravity cryogenic distillation technology is a process intensification of conventional distillation. The technology utilizes a rotating packed bed (RPB), driven by a motor, to separate $CO_2$ from natural gas. The rotation in the packing will increase flooding limit and mass transfer performance, leading to two-fold effect of operation at higher superficial velocity without the risk of flooding and reduction of height equivalent to a theoretical plate (HETP). This ultimately results in significant reduction in column diameter and column height. Additional power required for rotation of the RPB is minimal.

The technology for bulk $CO_2$ removal at offshore has significant advantage due to $CO_2$ product is in liquid form, making it suitable for pumping for $CO_2$ sequestration – less power is required to pump $CO_2$ as liquid than to compress as gas phase. Additionally, this technology is a solvent-less $CO_2$ separation process, thus resulting low energy requirement due to no solvent regeneration process and no regeneration column. In comparison with other $CO_2$ separation technology, the technology has better product purity and less hydrocarbon (methane) loss in $CO_2$ product stream.

Technology prototype was tested for high $CO_2$ content (60 to 80 mol%) at high pressure of up to 50 bar. Feed flow rate is varied from 1 to 3 kg/hr and consists of binary component of methane and carbon dioxide. The feed gas is cooled down before entering a rotating packed bed with variable rotational speed (up to 1000 rpm).

Testing results showed that the technology can separate bulk $CO_2$ to obtain down to 20% mol as top vapour product stream and almost pure liquid $CO_2$ product stream with minimal methane loss. Separation performance were in line with thermodynamic vapor-liquid equilibrium (VLE) prediction and validated with gas chromatography data. Motor reliability test was conducted for more than 30 hours non-stop with vibration measurements within acceptable range. The technology is ready for up-scaling and testing with other contaminants.

**Keywords** $CO_2$, High gravity, Rotating packed bed, Distillation, Process intensification

[SOMChE2020.135]

# Organic Acid-assisted Catalytic Wet Torrefaction of Oil Palm Trunks (OPT)

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## Abstract

Oil palm trunks (OPT) are attractive bio-fuel sources given their abundant availability. Nonetheless, the inherent properties of these biomass can lead to their inefficient use as bio-fuel directly. This work utilizes four organic acids (i.e., acetic, formic, levulinic, and citric acid) as catalyst in wet torrefaction to enhance the fuel properties of OPT hydrochar. In this study, the effects of different catalyst, catalyst concentration, and residence time on the fuel properties of OPT hydrochar were analyzed. To study the effects of residence time, 0.2M of acid concentration were used for all four acids at 220 °C for 3 hr and 24 hr. Meanwhile, study on the effect of catalyst concentrations were performed at 220 °C for 24 hr at 0.2M and 1.0M for all four acids. Increasing the residence time decreases the solid yield of OPT hydrochar treated in deionized water, acetic, formic, and levulinic acid, while wet torrefaction in citric acid results in close solid yield value in both residence time. The energy yield was observed to decrease in all liquid medium with increasing residence time except formic acid and citric acid. On the other hand, the increasing the acid concentration increases the OPT hydrochar solid yield in all acid except formic acid and highest energy yield of 77.08% was obtained from wet torrefaction in 1.0M of citric acid at 220 °C for 24 hr. In summary, citric acid is an environmentally friendly acid to be use as catalyst to enhance the fuel properties of OPT hydrochar. Further study on the reaction mechanisms that governs such fuel properties enhancement with citric acid is necessary.

**Keywords** Wet torrefaction, Oil palm biomass, Hydrochar, Catalytic wet torrefaction, Organic acids

[SOMChE2020.171]

# Production of Phenolic Compounds by Pyrolysis of Empty Fruit Bunches

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## Abstract

Oil palm biomass is an agricultural waste which has potential to be utilized as a feedstock for bio-oil production. One of many processes to convert the oil palm biomass into bio-oil is pyrolysis. Bio-oil contains a lot of organic components which are derivatives of lignin such as phenols, alcohols, organic acids and carbonyl such as ketones, aldehydes and esters. Of these, phenolics are the major compounds in the bio-oil. Phenol has an economic value that can be used as disinfectants, resins, pesticides, explosives, drugs and dyes. In this study, empty fruit bunches (EFB) was processed via pyrolysis using fluidised bed reactor at different temperature (400, 500, 600 and 700 °C), heating rate of 30 °C $min^{-1}$ and particle size of 91 – 106 µm. The pyrolysis products i.e. bio-oil, bio-char and gas were recovered and analysed. The influence of temperature on the yield of phenols was investigated and analysed using GC-MS. The maximum bio-oil yield was 35.4 wt.% while that of phenolic compounds was 30.4 area, % when EFB was pyrolyzed at temperature of 500 °C. Hence, EFB can be a potential renewable source for biochemical production.

**Keywords** Pyrolysis, Bio-oil, Phenolic compounds, Oil palm biomass

[SOMChE2020.174]

# The Effect of Process Parameters on Catalytic Direct $CO_2$ Hydrogenation to Methanol

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## Abstract

The direct $CO_2$ hydrogenation to methanol is an attractive route to actively remove $CO_2$ and to promote sustainable development. Herein, the performance of Cu-Zn-Mn catalyst supported on mesoporous silica KIT-6 (hereafter, CZM/KIT-6) for methanol synthesis by direct $CO_2$ hydrogenation reaction was investigated by varying the process parameters, which included the weight-hourly space velocity, reaction temperature and reaction pressure. The $CO_2$ conversion was found to decrease with the increase of WHSV. On the other hand, $CO_2$ conversion increased with reaction temperature and pressure. Meanwhile, the methanol selectivity increased with WHSV and reaction pressure but decreased with the increase of reaction temperature. The apparent activation energy of methanol production at low reaction temperature (160-220°C) was 10 kcal/mol. Non-Arrhenius behaviour of methanol formation was observed at high reaction temperature (220-260°C). The performance of CZM/KIT-6 was maintained at high level, with the average methanol yield of 24.4%, throughout the stability experiment (120-hour time-on-stream). In post-reaction XRD analysis, the copper crystallite growth was found to be 53.5%, thus, resulting in 35.3% loss of copper surface area.

**Keywords** Process parameters, $CO_2$ hydrogenation, Methanol, Apparent activation energy, Stability

[SOMChE2020.183]

# Towards Zero Carbon Dioxide Concentration in Sweet Natural Gas Product from Amine Sweetening Plant

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## Abstract

This work presents a two-step method to reduce $CO_2$ concentration of sweet natural gas product from amine sweetening plant *via* amine blending (Step 1) followed by minor process modification (Step 2). In Step 1, an industrial natural gas sweetening plant was simulated using Aspen HYSYS and the simulation results were validated against the plant data. Afterwards, different blends of methyl diethanolamine and monoethanolamine (MDEA-MEA) and methyl diethanolamine and diethanolamine (MDEA-DEA) were investigated. Then the optimum amine blend of 28 wt.% MDEA and 10 wt.% MEA was reported. The optimum amine blend achieved a significant reduction in $CO_2$ concentration of sweet natural gas of 99.9% compared to the base case (plant data). In Step 2, two types of amine stream splits, i.e., lean amine stream split and semi-lean amine stream split were studied. The study covered split stream amount, absorber recycle stage, and regenerator stage withdrawal. Both types of stream splits attained a significant reduction in $CO_2$ concentration of sweet natural gas product and amine circulation rate compared to Step 1. However, the semi-lean amine stream split was superior to lean amine split with 69.1% and 63.6% reduction in $CO_2$ concentration of sweet natural gas and lean amine circulation rate, respectively.

**Keywords** Natural gas; Gas sweetening; Amine solvents; Process simulation

[SOMChE2020.194]

# Performance Enhancement of a Baffle-type Solar Heat Collector Through CFD Simulation Study

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## Abstract

The application of solar energy conversion has been extensively utilized as an alternative energy source to generate heat. This approach would be a step towards sustainable energy development particularly in the manufacturing industry with energy-intensive process. In this paper, thermal enhancement on the key component of a solar energy device – solar heat collector (SHC), has been evaluated by proposing a baffle-type SHC with various geometric configuration in the air passage namely longitudinal baffle and transversal baffle. The performance of SHC is evaluated in term of efficiency, temperature distribution, airflow pattern and pressure drop across the collector outlet through Computational Fluid Dynamic (CFD) investigation. It was observed that maximum collector efficiency was achieved in the Longitudinal-SHC (L-SHC), with a value of 46.2% followed by Transversal-SHC (T-SHC) and without baffles. Maximum drying temperature at the collector outlet was 332.43 K for L-SHC, showing temperature rise of 0.35% and 4.21% from T-SHC and without baffles, respectively. The velocity vector indicated that turbulence flow was created in the T-SHC which consequently improved the heat transfer. Whereas in L-SHC, enhancement was achieved through the prolonged heating time in the passage. Considering the thermo-hydraulic performance factor evaluated, these enhancement features had diminished the effect of pressure drop.

**Keywords** Solar heat collector, Numerical simulation, Performance enhancement

[SOMChE2020.200]

# Critical Review of The Effect Of Electrode Surface Wettability on Electrochemical $CO_2$ Reduction

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## Abstract

Various strategies and technologies have been developed to mitigate carbon dioxide ($CO_2$) emissions from various sources. In particular, electrochemical $CO_2$ reduction reaction ($CO_2RR$) coupled with renewable electricity from solar, wind, or hydro has become a versatile approach for $CO_2$ reduction technology while still creating economic value through producing fuel and chemical feedstock (CO, HCOOH, $CH_4$, $C_2H_5OH$, and $C_3H_7OH$). However, $CO_2RR$ still have several challenges before it can achieve an industrial level application. Sluggish $CO_2$ mass transfer to catalyst has proven to be contributing to insufficient $CO_2RR$ activity, selectivity and stability. Many strategies have been placed to overcome the mass transfer limitation. One consistency was observed from all the employed strategies, as most of the strategies involved altering the surface wettability of either gas diffusion layer, catalyst layer or both. In this critical review, we investigate the key factors which influence surface wettability in $CO_2RR$ system. We also summaries recent strategies in controlling surface wettability to enhance $CO_2RR$ performance.

**Keywords** Electrochemical $CO_2$ reduction, Wettability, Gas diffusion layer

**[SOMChE2020.208]**

# Sustainable Energy Planning via Negative Emission Technologies

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## Abstract

Drastic mitigation actions are required to manage the impacts of climate change. According to the United Nations Environment Programme, countries must now make annual emission cuts as much as 2.7% and 7.6% to limit global warming by 2°C and 1.5°C respectively above the pre-industrial level since mitigation actions did not commence in year 2010. Presently, renewable energy sources offer the least cost option in terms of new power generation. Aside from the early closure of existing coal power plants, the declining cost of power generation via solar power photovoltaic systems and onshore wind turbines resulted in renewable energy electricity generation to be cost-competitive against existing coal plants. It is projected that the decarbonisation of the power generation grid is expected to result in a reduction of GHG emissions by 8.1 Gt $CO_2$-eq. Nevertheless, according to the IPCC, limiting global warming to 1.5°C requires the deployment of *Carbon Dioxide Removal* (CDR) in the range of 100 to 1,000 Gt $CO_2$ throughout the 21st century. CDR is typically achieved using *negative emission technologies* (NETs), to reduce the atmospheric concentration of GHG. NETs allow the removal of historical $CO_2$ emissions, aside from offsetting emissions originating from sectors that are almost impossible to mitigate such as the transportation and agricultural sectors. While the *direct capture* techniques such as direct air capture (DAC), ocean liming etc. make use of chemical reactions for $CO_2$ removal from the air, the *indirect capture* techniques such as bioenergy with Carbon Capture and Storage (BECCS) and biochar relies on plants in the form of biomass for $CO_2$ removal. NETs can be categorised as either energy-producing NET (EP-NET) or energy-consuming NET (EC-NET). Therefore, the interface of NETs with the background energy system is an important consideration in their deployment. In this paper, the adoption of NETs is demonstrated for *carbon-constrained energy planning* CCEP via an algebraic targeting technique. It identifies the various network targets (e.g. minimum deployment of EP-NET and EC-NET and extent of CCS retrofit) and identifying trade-offs in implementing NETs and CCS technologies.

**Keywords** Carbon dioxide removal (CDR), $CO_2$ capture and storage (CCS), Carbon emissions pinch analysis (CEPA), Bioenergy with carbon capture and storage (BECCS), Direct air capture (DAC), Process integration

# Bioprocessing and Biotechnology

[SOMChE2020.087]

# Synthesis of Symmetrical Structured Triglycerides via a Bottom-up Process

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## Abstract

The synthesis of symmetrical structured triglycerides (STG) through a bottom-up approach was previously shown to produce 1,3-dioleoyl-2-palmitoyl glycerol in significant quantities. This solvent-free lipase-catalyzed process, consisting of a low-temperature (40 °C) esterification step with glycerol dosing followed by a high-temperature (60 °C) esterification step, was further investigated in the production of symmetrical medium-and-long-chain triglycerides (MLCT). By replacing oleic acid with capric acid in the first step or the palmitic acid by either capric acid or lauric acid in the second step, the effects of free fatty chain length and sequence of fatty acid addition on STG production were established. These produced 1,3-dicaproyl-2-oleoyl glycerol, 1,3-dioleoyl-2-caproyl glycerol, and 1,3-dioleoyl-2-lauroyl glycerol at concentrations of 36.98 g, 36.77 g, and 37.08 g per 100 g of triglycerides respectively after 72 h at an overall FFA1:FFA2:Glycerol of 2:1:1 and 4 g Novozyme 435 per 100 g reactants, without the purification of intermediates and products. The sequence of fatty acid addition had the most significant effect as purer STG products can be obtained when the medium chain fatty acid is introduced in the first step. As the process was carried out without solvents, the STG produced are appropriate for functional food or nutraceutical applications.

**Keywords** Symmetrical structured triglycerides, Bottom-up process, Lipase-catalyzed, Functional food application

[SOMChE2020.172]

# Effect of Neutralizing Agents in The Preparation of Succinic Acid from Oil Palm Trunk

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## Abstract

Neutralization is an important process to maintain the pH required for enzymatic saccharification of pretreated biomass followed by fermentation for biochemical conversion. In this study, the production of succinic acid as a potential C4 building block was investigated by utilizing lignocellulosic biomass in the form of oil palm trunk (OPT). The effect of different neutralizing agents (NaOH, KOH and $NH_4OH$) on the enzymatic saccharification of oxalic acid-pretreated OPT and subsequent succinic acid fermentation by *Actinobacillus succinogenes* ATCC 55618 was investigated. The results showed that all neutralizing agents tested were able to assist in the recovery of fermentable sugars with concentrations ranging from 38.1 to 39.6 g/L. However, during succinic acid fermentation, it was found that the soluble $NH_4$-oxalate salt formed severely inhibited succinic acid fermentation compared to Na and K, thereby decreasing the succinic acid production from 14.0 g/L (using NaOH) to 1.0 g/L (using $NH_4OH$). In particular, Na- and K-oxalate did not show apparent inhibition for both the saccharification and fermentation processes. Hence, the selection of suitable neutralizing reagent is essential to avoid process inhibition in succinic acid production from lignocellulosic biomass.

**Keywords** Oil palm biomass, Alkaline neutralizer, Enzymatic hydrolysis, Succinic acid

[SOMChE2020.173]

# Modelling the Kinetics of Microwave Drying of Shallot (*Allium cepa*) Slices

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## Abstract

Convective drying is typically used to dry shallot (*Allium cepa*) commercially. However, a long drying time with a relatively low efficiency has led to the pursuit of new and improved drying methods. Microwave drying was chosen to be used due to its numerous advantages such as improved drying time, high drying efficiency and better product quality. In this research, three microwave power (180 W, 300 W, 450 W) and convective drying at 100°C were used. Results showed that drying kinetics (moisture content and drying rates) decreased the fastest at higher microwave power and the slowest using convective drying. In order to determine the best model to describe the thin-layer drying kinetics, four semi-empirical models were used namely Newton, Page, Logarithmic and Two-term models. Page model was found to be the best in describing the thin-layer microwave drying kinetics. Effective diffusivity values increased with higher microwave power and were found to be in the range of $6.62 \times 10^{-6}$ $m^2/s$ to $3.69 \times 10^{-5}$ $m^2/s$ with convective drying being the lowest ($6.62 \times 10^{-6}$ $m^2/s$) and 450W being the highest ($3.69 \times 10^{-5}$ $m^2/s$). Microwave drying is therefore able to improve drying kinetics compared to convective drying.

**Keywords** Drying, Diffusivity, Kinetics, Microwave, Modelling

**[SOMChE2020.182]**

# Modelling, Optimization and Control of Continuous Two-Stage Cephalosporin C Production

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## Abstract

Cephalosporin is one of the most consumed antibiotics for its effectiveness against a wide variety of infections. Most cephalosporin products are the semi-derivatives of Cephalosporin C (CPC), a metabolite of the fungus *Acremonium chrysogenum*. Since naturally the desired metabolite is not produced in a large amount by the fungus, an innovative operational strategy is required to increase its yield for the production of the antibiotic to be economically feasible. One way to increase the cephalosporin productivity is by increasing the concentration of thin hyphae cell in the bioreactor, but this will lead to a higher blower power requirement for providing adequate availability of oxygen in the fermentation broth. Lack of oxygen will retard the growth rate and reduce the productivity. Conversely, excessive aeration of the fermentation broth will lead to high shear stress that can kill the cells. The present work investigates through dynamic simulation the effectiveness of a continuous two-stage aerobic fermentation for the CPC production. The operating conditions are optimized to determine an optimal trade-off between the cephalosporin productivity and blower power. An increase of the dissolved oxygen in the first bioreactor from 10% to 20% can increase CPC productivity by 75.5% from 24.42 mg/L.hr to 42.86 mg/L.hr.

**Keywords** Antibiotic, Cephalosporin C, Modelling, Fermentation control

[SOMChE2020.193]

# Fractionation of Phycocyanin and Carbohydrate from *Spirulina platensis* Using Ionic Liquid-based Aqueous Two-phase System

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## Abstract

Microalgae have gained considerable attention due to their high-value biomolecules and potential applications in the pharmaceutical, food, medical and cosmeceutical field. However, the conventional biorefinery process of microalgae are costly, energy-intensive and time-consuming. Aqueous two-phase system (ATPS) has emerged as a potential technique for the separation and fractionation of biomolecules in the biorefinery field. This study proposed the application of ionic liquid (IL) based ATPS for the fractionation of high-value phycocyanin and carbohydrates from a crude extract of *Spirulina platensis*. The biomass was first lysed by a high-speed homogenization with a solid to liquid ratio (S/L) of 1:10 and an operation time of 5 min to achieve optimum yields of multiple products. Next, the feasibility of several IL-based ATPS with phosphate/citrate buffer was evaluated by investigating the effects of cation, anion and alkyl chain's length of ILs. Among the IL-based ATPS, the system comprising of 1-butyl-1-methylpyrrolidinium dicyanamide and citrate buffer demonstrated the optimum phycocyanin extraction efficiency of 83.260.05% at the top phase and a concurrent recovery of 73.890.06% carbohydrate at the bottom phase. In this work, the IL-based ATPS performed better than conventional polymer-based ATPS. This work suggests that IL-based ATPS allows efficient fractionation of phycocyanin and carbohydrates.

**Keywords** Phycocyanin, Carbohydrates, Aqueous two-phase system, Spirulina Platensis, Ionic liquid, Fractionation

[SOMChE2020.201]

# Chitosan-$TiO_2$ Nanotubes Scaffolds for Proliferation and Early Differentiation of MG63 By Functionalization with Fetal Bovine Serum

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## Abstract

Scaffolds have been used as an alternative biomaterial to overcome physiological bone disorders. Production of ideal scaffolds has been challenging to fulfil the following criteria; biodegradability, mechanical sustainability and biocompatibility. For cellular interaction, protein adsorbed on scaffold surface is important for enhancing osteoblastic activities. This study aimed to functionalize chitosan-$TiO_2$ nanotubes for scaffolds with fetal bovine serum and to investigate in vitro efficacy of chitosan-$TiO_2$ nanotubes scaffolds with fetal bovine serum. Chitosan-$TiO_2$ nanotubes scaffolds were first prepared via direct blending and freeze drying. Subsequently, the resultant scaffolds were functionalized with fetal bovine serum via adsorption for 4, 8, 12 and 24 h. The in vitro efficacy of the functionalized scaffolds was evaluated using MG63 osteoblast-like cells in terms of adhesion, proliferation and early differentiation. It was observed that the adsorption of fetal bovine serum onto chitosan-$TiO_2$ nanotubes scaffolds was complex where saturation of adsorption was hardly attained within the duration tested. The in vitro efficacy of scaffolds with adsorbed fetal bovine serum was much higher than that of those without fetal bovine serum by promoting better osteoblastic functions. Notably, the scaffolds functionalized for 4 h enhanced cell adhesion as well as proliferation on 7 day suggesting good regulation of osteoblastic binding and proliferation. Interestingly, ALP protein was expressed on 26 day in all functionalized scaffolds. Chitosan-$TiO_2$ nanotubes scaffolds functionalized with adsorbed fetal bovine serum can be a potential regenerative material for bone regeneration.

**Keywords** Adsorption affinity, Fibronectin, Adhesion, Protein expression, Desorption


# Sponsored Poster

**[SP-01]**

# Assessment of Novel Catalysts for Green Hydrogen Production *via* Dry Methane Reforming: Economic and Environmental Analyses

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## Abstract

Hydrogen demand has been escalating lately which serves as a notable green energy carrier for the future. Most of the energy is produced using fossil fuels in which resulting in massive carbon footprint. To mitigate this issue, dry methane reforming process is proposed to valorize the palm oil mill effluent (POME)-derived biogas which mainly consists of methane and carbon dioxide, to produce higher value-added products, i.e., hydrogen. This indeed reduces global carbon emissions, at the same time, benefiting the nation economically. The problem faced by the conventional nickel-based catalysts are the sintering and carbon deposition issues. Therefore, novel catalysts, i.e., single atom catalyst (SAC) and metal organic framework (MOF), were proposed to replace the nickel-alumina catalysts that are being utilized in the industry. The benefits of novel catalysts include high specific surface area, catalytic activity, thermal stability and tailored cavity structure. In addition, the novel catalysts pose a longer lifespan, and therefore, leads to lower regeneration cost and carbon emissions. Another key feature of this work is the consideration of 3D printing technology for bulk scale synthesis of these novel catalysts. As a result, 3D printed catalysts offer better economic and environmental performances as compared to the conventional synthesis method. Furthermore, sensitivity analysis was performed to identify the key parameters that will significantly affect the overall sustainability performance of the DRM process. It serves as a crucial guide in upscaling and commercialize the usage of novel catalysts in production of hydrogen. It can be concluded that 3D-printed novel catalysts are potentially providing a great breakthrough for dry methane reforming process in the future.

**Keywords** Dry methane reforming, Green hydrogen, Single atom catalysts, Metal organic framework, Techno-economic analysis, Environmental analysis

[SP-02]

# Oil Palm Trunk Derived Activated Carbon for Liquid Phase Adsorption Removal of 2,4-dichlorophenoxyacetic Acid Herbicide

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## Abstract

Environmental pollution due to agricultural activities is one of the biggest problems faced around the world. The efficient removal of pollutants from water bodies, namely pesticides and herbicides which are toxic to the environment and humans remains a challenging task. There are numerous methods for the removal of herbicides from water bodies where one of the methods is adsorption. Activated carbon has been proven from numerous previous studies to be an effective and low-cost adsorbent. This study investigates the liquid phase adsorption of 2,4- dichlorophenoxyacetic acid (2,4-D) herbicide by using oil palm trunk derived activated carbon (OPT-AC). Firstly, the effect of solution pH on the removal efficiency (%) was investigated. The adsorption was carried out at pHs of 2, 4, 6 and 8. It was found that as the pH increased, the removal efficiency decreased where pH 2 exhibited the highest removal efficiency of 93.24%. The removal efficiency was then measured at varying time intervals of 1, 5, 15, 30, 45, 60, 120, 240 and 1440 min to explore the effect of contact time between adsorbate and adsorbent on the removal efficiency. The longer the contact time, the higher the removal of 2,4- D from the solution whereby a plateau can be seen at contact time of 240 min. Finally, the effect of initial adsorbate concentration was studied by carrying out adsorption with varying initial concentrations of 2,4-D of 50, 100, 150, 300 and 400 mg/L. The results indicate that OPT-AC is a promising adsorbent which is suitable for the efficient and low-cost liquid phase removal of 2,4-D.

**Keywords** 2,4-dichlorophenoxyacetic acid, Activated carbon, Liquid phase adsorption, Oil palm trunk, Herbicides

**[SP-03]**

# Pure Oxygen Separation from Air Using Dual-Phase SDC-SCFZ Disc Membrane: A Modelling Approach

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## Abstract

Novel $Ce_{0.8}Sm_{0.2}O_{1.9}$-$SrCo_{0.4}Fe_{0.55}Zr_{0.05}O_{3-\delta}$ (SDC-SCFZ) disc membranes consist of 25 wt.% SDC fluorite ionic conducting phase and 75 wt.% SCFZ perovskite mixed conducting phase, which is more promising than perovskite oxide SCFZ single-phase membrane in terms of the oxygen permeation flux. This work features a modelling approach to simulate the oxygen permeation fluxes of the SDC-SCFZ membrane. Simplified model equations from the Zhu model and Xu-Thomson model based on the limiting cases of surface exchange reactions and bulk diffusion are compared. The Zhu model is found to be more applicable for the membranes with overall good correlation and low sum of squared error. Furthermore, modelling studies revealed that the oxygen transport is limited by surface exchange reactions from 700 to 850 °C and a mixture of both limiting cases above 850 up to 950 °C. It is concluded that the membranes exhibit high oxygen permeation flux of up to $2\times10^{-6}$ mol s-1 cm-2 at 950 °C with Pair of 5 atm and PO2IIof 0.005 atm. The optimum range of operating conditions of the membrane are found to be at 950 °C with minimum Pair of 1 atm and PO2II lower than 0.025 atm.

**Keywords** Modelling, Oxygen permeation, Dual-phase membrane, Surface exchange reaction, Bulk diffusion

[SP-04]

# Techno-economic Evaluation of Tri-ethylene Glycol Sales Gas as a Potential Stripping Agent in the context of Conventional Dehydration Process

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## Abstract

Natural gas from underground reservoir is saturated with water vapor, which causes serious problems such as pipeline corrosion, hydrate f\ormation, and lowering heating value of natural gas. The removal of water vapor via conventional dehydration process is common in the industry. However, this process requires large amount of glycol (i.e., tri-ethylene glycol (TEG)) given the purity of the regenerated TEG, which cannot exceed 98.9%. Thus, this project aims to improve the regenerated TEG purity and hence reduce its circulation rate via injecting a portion of the sale gas in the reboiler of the regeneration column, i.e., stripping gas injection technique. Therefore, an insight on the technical and economic performance of stripping gas dehydration process using sale gas which will be able to improve sale gas water dew point is provided. Both the conventional and stripping natural gas dehydration processes have been simulated in Aspen HYSYS and validated against available literature. Then, several process parameters have been analyzed to reveal the effect of reboiler temperature of conventional regenerator, TEG feed rate and amount of stripping gas on water content in dry gas, reboiler duty, raw material losses and TEG purity. This is followed by an economic analysis which reveals that although the equipment cost in stripping gas method is higher, the increase in fixed capital investment (FCI) is considered insignificant as the difference was only 2.34%. Therefore, it can be concluded that stripping gas injection using sale gas is an effective method in enhancing the entire dehydration plant performance and TEG purity.

**Keywords** Natural gas dehydration, stripping gas injection, tri-ethylene glycol, parametric analysis, economic analysis, Aspen HYSYS

**[SP-05]**

# Preparation of Porous Starch-Acrylic Acid Complex Hydrogels for Dye Removal Purposes

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## Abstract

Dye colorants is an essential synthetic organic compound used in various industries especially textiles. These dyes are often found to be harmful to human health and environment. In this research, starch grafted acrylic acid (AA) hydrogels was demonstrated as an efficient adsorbent for cationic dyes removal of methylene blue (MB), a commonly used industrial dye. The graft copolymerization of AA onto starch was synthesized by using N,N'methlenebisacrylamide (NMBA) and cerium ammonium nitrate (CAN) as the crosslinker and initiator respectively. These hybrid hydrogels were synthesized by varying the amount of monomer AA to starch weight ratio (1.0, 1.5 and 2.0). The effect of monomer concentration has been evaluated in the terms of grafting parameters such as %GE and %Add-on. The maximum water absorbance capacity of the hydrogels is 19.68 g $H_2O$/g hydrogel. The lower the AA concentration, the higher the absorbance capacity. Meanwhile, the adsorption capacity of MB was found to be 25.11 mg $g^{-1}$, 24.06 mg $g^{-1}$ and 20.71 mg $g^{-1}$ for monomer to starch weight ratio of 1.0, 1.5 and 2.0 respectively. These results were achieved in MB solutions with an initial concentration of 100 mg $L^{-1}$ by using 0.4 g dosage of hydrogels adsorbent. Lastly, the maximum removal efficiency of MB was found to be approximately 97%.

**Keywords** Starch, Acrylic acid, Hydrogel, Methylene blue

**[SP-06]**

# Thermal Performance Analysis of Graphene Heat Pipe: Parametric Study

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## Abstract

Heat pipes are heat transfer devices, which use phase-change of working fluid to transfer heat from a heat source to a heat sink and capitalises on the capillary forces that are generated in the wick structure to circulate the working fluid. As we move to an IT era, electronic cooling is mandatory in power electronics. Heat pipes are usually made of copper or aluminium but has reached its heat transmission capacity. Application of graphene in heat pipes may solve this issue, which is considered to be world's thinnest, strongest and most conductive material of heat. In this study, the heat distribution in heat pipes is examined by conducting a steady-state thermal analysis using Ansys. The report presents the review of simulation and modelling of a heat pipe using stainless steel as solid and sodium as working fluid for high temperature application, which was utilised in modelling and simulating copper and graphene heat pipes. Boundary conditions and dimensions of heat pipe were defined. Method for calculations of effective thermal conductivity and finite model expressions are discussed in the report. In this research paper, the study focuses on the temperature distribution of both copper and graphene heat pipes when subjected to parametric changes. The research focuses on five different cases, where case one is performed to validate the result of Ansys simulation. The other cases focus on the thermal distribution of a sintered wicked heat pipe for parametric changes of heat load, porosity of wick, wick thickness and heat pipe length. It is found that graphene heat pipes were able to operate twice the heat load of the first case, while copper heat pipes experienced evaporator dry-out. It is also found that reducing porosity of sintered wick and reducing wick thickness results in better performance of heat pipe. The boiling limits are calculated for both the heat pipes to ensure that the high heat load applied does not exceed boiling limit. The simulation results show that graphene heat pipes are capable of operating at high heat fluxes than copper heat pipe in all the cases of the parametric study conducted.

**Keywords** Steady-state, Ansys, Graphene, Copper, Heat pipe, Porosity

**[SP-07]**

# Modelling of Temperature Profile in a Self-heating Composting Reactor

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## Abstract

Composting is a sustainable solution to landfilling disposal. The complexity of composting process is marked by the dynamic changes of environmental variables due to the underlying biological and physiochemical mechanisms driving the composting process. To address this complexity, the mathematical model of composting process is governed by three components which are substrate degradation with microbial kinetics (first-order, Monod-type), energy balance (biological heat generation, conduction) and mass balance. Energy and mass balances are linked to substrate degradation through heat generation and production or consumption of components such as water due to microbial activities, indicating the significance of substrate degradation kinetics in predicting the composting behaviour. Based on previous studies, there is a lack of literatures comparing the accuracies between first-order and Monod-type kinetics in in-vessel systems and insufficient modellers who develop model for in-vessel composting systems with intermittent aeration modes. Hence, mathematical models based on continuous aeration and both first-order and Monod-type kinetics for substrate degradation were adopted and modified to predict temperature variations in a self-heating composting reactor with intermittent aeration. MATLAB was employed to numerically solve the spatial non-linear equations, generating temperature profiles to study the composting behaviour in a self-heating reactor. Comparison between simulation results and experimental data for temperature profiles showed that the model has good predictions with relative root mean square (rRMSE) values lower than 10%. The results showed that the prediction performance of model based on Monod-type kinetics is slightly higher than first-order kinetics.

**Keywords** Composting, Mathematical model, Temperature profile, Self-heating composting reactor

**[SP-08]**

# Accelerated Weathering of Limestone $CO_2$ Capture for Utilization in Bicarbonate Lime Mortar Developed with Cement Kiln Dust and Fly Ash

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## Abstract

Besides being carbon intensive, the cement manufacturing and power generating industry generate large amount of industrial wastes, namely the cement kiln dust (CKD) and fly ash (FA). Any unused amount of these wastes will result in it being discarded into the landfill – which is not a desirable long-term solution as production are expected to increase for years to come. This research aims to develop an alternative sustainable construction material to capture and utilize $CO_2$ from ambient air and industrial wastes from these industries. Firstly, in the making of lime mortar (LM), water is part of the composition besides lime (CaO) and sand. In this research, a process called Accelerated Weathering of Limestone (AWL) is used to replace water to produce bicarbonate lime mortar (BLM). Secondly, CKD will be added in replacement of lime while FA is added as additional cementitious material. Bicarbonate solution from AWL is injected into sand-CKD-FA mixture to produce bicarbonate lime mortar with CKD and FA (BLM-CKD-FA). The mixing ratios for each component are obtained from Design Expert with two experimental variables input (mass of CaO in CKD, mass of FA) with one response (compressive strength of BLM). The aim is to determine the optimum amount of CKD and FA to produce highest mortar strength. Compressive strength test is performed after the BLM samples were cured for 14 days. The results show that, there are improvement in BLM strength as the amount of CKD increases. BLM- 46.83 g CaO in CKD- 8.28 g FA have strength of 0.3240 MPa when comparing to BLM- 0.17 g CaO in CKD- 12.18 g FA which have strength of only 0.2640 MPa. Comparing to previous researches, BLM- 40 g CaO-FA strength at 14 days reaches 0.6256 MPa, while BLM- 11.21 g CaO in CKD has highest strength of 0.312 MPa. Based on the optimization model from Design Expert, it shows that the optimum amount of CaO in CKD and FA are 81.14 g and 9.90 g respectively, with desirability of 0.8470 which will obtain strength of 0.3050 MPa. The model accuracy based on the ANOVA analysis shows the model's lack of fit is 0.5427, which is not significant. Besides that, the adjusted $R^2$ is 0.8973 while predicted $R^2$ is 0.582, proving the model is in a reasonable agreement as the difference is less than 0.2. Hence, in this research, it shows that industrial wastes can be utilized as value added component in development of alternative sustainable construction materials like mortar, which can certainly benefit the environment.

**Keywords** Accelerated weathering of limestone, Bicarbonate lime mortar, Cement kiln dust, Fly ash

**[SP-09]**

# Physicochemical Properties of Choline Chloride based Green Solvents in Water

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## Abstract

Green technology and sustainable development goals acquired unprecedented global attention over the past decades. The intensive use of conventional solvents in the industries raises environmental concern, therefore urges for green alternatives to substitute these conventional solvents. This lead to the emergence of a new class of designer solvents that is relatively cheap and environmentally benign, initially introduced as Deep Eutectic Solvents (DES), and further coined as Low Transition Temperature Mixtures (LTTM). The versatility of LTTMs is one of its main attraction, given that the physicochemical properties of LTTMs are highly tunable by varying its composition or constituents. This research project investigated the effect of water on the physicochemical properties of Choline chloride/Malic acid (CCMA) and Choline Chloride/Lactic acid (CCLA) LTTMs since the solvents are often much likely to be exposed to water during its application, either by purpose or otherwise. A total of 12 compatible LTTMs with different water content were synthesized and characterized. The addition of water modulated the density and electrical conductivity of the green solvents by decreasing density and increasing electrical conductivity with higher water content. FTIR characterization found the broadened OH stretching within the range 3700 $cm^{-1}$ to 2500 $cm^{-1}$, the diminished choline chloride characteristic peak associated with its OH group at 3221 $cm^{-1}$, and the bathochromic shift of the C=O stretch associated with carboxylic acids within 1680 $cm^{-1}$ to 1725 $cm^{-1}$ which evidenced the hydrogen bond formation between the hydrogen bond acceptor and hydrogen bond donor, as the prerequisite for LTTM formation. Water addition also demonstrated significant effect on biopolymer solubility despite the retention of original DES structure when subjected to water addition. CCLA demonstrated highest lignin solubility at 6.32wt% and further hydration results in weakened DES structure causing degradation in dissolution performance. CCMA reported slight improvement on lignin selectivity and solubility with water addition at which the maximum solubility was recorded at 3.67wt% with 40wt% water content. Both CCMA and CCLA green solvents demonstrated potential to be used in biomass valorization and addition of water to LTTMs to modulate the physicochemical properties were proven feasible.

**Keywords** Green solvents, Deep eutectic solvents, Choline chloride, Biomass pretreatment

[SP-10]

# Kinetics Modelling of Green Solvents Delignified Oil Palm Empty Fruit Bunch Pyrolysis via Thermogravimetric Analysis

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## Abstract

The urge to seek for green alternatives in replacement of conventional pretreatment methods has led to the disclosure of a new class of designer solvents termed Low-Transition-Temperature-Mixtures (LTTMs) as a prospective green pretreatment method. Correspondingly, a kinetic study on the pyrolysis process of sucrose-based LTTMs pretreated oil palm empty fruit bunch (EFB) was carried out by using thermogravimetric analysis (TGA) equipment at various heating rates of 10, 30, 50 and 70 °C/min. The present research project focused on the thermal degradation and determination of kinetic parameters such as the activation energy and frequency factor by means of three model-free methods namely Kissinger model, Kissinger-Akahira-Sunose (KAS) model and Flynn-Wall-Ozawa (FWO) model. The results derived from TGA showed that three stages of thermal decomposition of oil palm EFB were identified such as dehydration, devolatilisation and degradation. In addition, the weight loss curves indicated that the pyrolysis of untreated and delignified EFB took place mainly in the range of 200 °C to 400 °C. Moreover, the peaks of the differential thermogravimetry (DTG) curves which represent maximum degradation tended to shift slightly towards the right at higher temperature when the heating rates were being increased. The results showed that the values of kinetic parameters evaluated from model-free methods were compatible with each other whether it be untreated EFB or the delignified EFB. Furthermore, there was an increase in the activation energies after the process of pretreatment. Specifically, the activation energies increased from 129.40 kJ/mol to 188.83 kJ/mol for Kissinger model; 167.87 kJ/mol to 194.93 kJ/mol for KAS model; 167.22 kJ/mol to 190.09 kJ/mol for FWO model. The findings were then used to correlate with scale-up purposes.

**Keywords** Biomass pyrolysis, Kinetic parameters, Model-free methods, Thermal decomposition, Thermogravimetric analysis

[SP-11]

# Influence of Laser Treated Aluminium Reinforced with Silica Carbide and Rice Husk Ash on Morphological Properties

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## Abstract

The research is focused on the influence of laser treatment of hybrid aluminium matrix composite (AMC) reinforced with silica carbide (SiC) and rice husk ash (RHA) on morphological structure properties. AMC can be a primary material for structural parts of aircrafts, automobiles and other engineering application. By combining desired characteristics of ceramics to a ductile metal like aluminium, it can produce a composite that possess the properties in between matrix alloy and that of a ceramic reinforcement, which highly demand in industries. SiC has an excellent compatibility with aluminium composite. Recent studies have shown that agro-waste particularly RHA, is a promising secondary reinforcement for enhanced materials. Agro-waste produces low-cost by-products, reduces the overall cost of AMC, cost efficient and readily available, and possess density that are lower than that of most technical ceramics. However, the study of agro-waste as reinforcements is limited especially in the field of laser treated hybrid AMC. In this study, powder metallurgy and sintering process are methods used to procure Al/SiC/RHA composite and $CO_2$ laser type at low power will be employed and performed onto its surface to obtain potential enhanced structures through a morphological properties' analysis. Hence, the research aims to investigate the influence of laser surface treatment onto the morphology of Al/SiC/RHA. SEM analysis have shown that imaging of Al/SiC/RHA before and after laser treatment, a surface change was notable as pores were diminished and melted matrix interacted with the reinforcements. This could be a potential application towards microelectronic packaging.

**Keywords** Aluminium matrix composite, Agro-waste, Rice husk ash, Laser surface treatment

**[SP-12]**

# Effects of Double Calcined Potassium Sodium Niobate (KNN) Lead-Free Piezoelectric

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## Abstract

The research focuses on the effects of double calcination of potassium sodium niobate (KNN) lead-free piezoelectric that helps to achieve better homogeneity and led to higher densification. In reaction to an applied power or force or inducing mechanical-based activity when exposed to field of electrical, piezoelectric components consist the functionality of creating an electrical potential. Such smart materials, particularly in the fields of information and communication, diagnostics medical, automation industry etc., have become important for modern society. While piezoelectricity is present in many types of natural materials, polycrystalline ceramics are used in most modern devices and it is easy to be manufactured and moulded at a lower cost. Due to their outstanding properties and versatility in terms of modifying composition, lead zirconate titanate (PZT) ceramics have been dominating the industry for decades. However, owing to safety issues and federal restrictions against dangerous chemicals, the vast volume of lead used in PZT products has increased a big number of interest over the past decade. Therefore, significant attempts have also been made to produce competitive lead-free equivalents, and specially KNN material. KNN is chosen to be studied due to its outstanding performance based on KNN lead-free piezoelectric. SEM analysis have shown the grains from double calcination process were visibly observed in better densification and less porosity compared to the single calcination process. Therefore, the preliminary SEM results have visibly confirmed that double calcination process led to better homogeneity and higher densification.

**Keywords** Potassium sodium niobate, Lead-free piezoelectric, Double calcined

**[SP-13]**

## Characterisation and Optimisation of Extracted Pectin from Fruit Peels

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### Abstract

Pectin is a complex carbohydrate molecule that is used in numerous food applications as gelling agents, thickeners, stabilisers, and emulsifiers. Currently, the global source for pectin production is primarily from citrus fruits causing a rise in the cost and demand of citrus fruits in the global market. Moreover, fruit processing industries generate fruit wastes comprising of peels and seeds, liquid waste of juice, and wash water. Since the peels of fruits are often discarded as waste, it would be an advantage to convert them into a value-added product such as pectin. A central composite design was used to determine effects of temperature (40-90°C), extraction time (1-3 hours) and acid concentration pH (1.0–3.0 on the yield of pectin from unripe banana and mango peels. The pectin extracted was characterised in terms of moisture content, equivalent weight and methoxyl content. The fitted mathematical model allowed to plot response surfaces and to determine optimal extraction conditions for both fruit peels. It was found that acid concentration was the most important parameter influencing the yield. A maximum yield of 78.64% was obtained for the unripe banana peels at optimum conditions of 90°C, 1 hour and pH 1.0 whereas a maximum yield of 23.69% was extracted for mango peels at 90°C, 2 hours and pH 2.0. The moisture content, equivalent weight and methoxyl content for the unripe banana peels were 16.10%, 1503.16 and 5.25% respectively whereas, for the mango peels were 26.5%, 943 and 9.77% respectively.

**Keywords** Pectin, Characterisation, Yield, Optimisation

**[SP-14]**

# Fabrication of Essential Oil Blended Soaps

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## Abstract

Soaps have high demand due to its continuous usage in maintaining cleanliness. Soap molecules consists of hydrophilic end which is also known as polar head and hydrophobic end which is also known as non-polar hydrocarbon tail. Hydrophilic end binds with the water while hydrophobic end binds with the oil. Soap making process is known as saponification. Saponification is a process where triglycerides react with base to produce soap and glycerol. In this research, the base that was used as lye in soap making is sodium hydroxide whereas the essential oils that were used are castor oil, coconut oil and olive oil. In order to produce soap, all these three oils were blended in different ratios for each set of experiments. The saponification value of oil blend 1, oil blend 2 and oil blend 3 are 208.46, 221.09 and 198.75 while the iodine values are 61.90, 47.10 and 70.00 respectively. The blended oils were used in soap making by cold process. The moisture content of the three soaps ranges between 6.70% to 8.74%. Total fatty matter of the soaps is 63.18%, 96.06% and 88.32% whereas total alkali content is 2.29%, 1.18% and 2.42% respectively. All three soaps have pH ranging from 9.23 to 9.33 which is safe for the skin. Oil blend ratio that yields soap of the best properties is oil blend 2. This soap has lowest moisture content, highest total fatty matter, lowest total alkali content and pH that is in the range of good quality soaps.

**Keywords** Saponification, Sodium hydroxide, Essential oils, Soap, Quality

**[SP-15]**

# Locally Weighted Kernel Partial Least Square Model for Nonlinear Processes: A Case Study

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## Abstract

A soft sensor, namely locally weighted partial least squares (LW-PLS) cannot cope with the nonlinearity of process data. To address this limitation, Kernel functions are integrated into LW-PLS to form locally weighted Kernel partial least squares (LW-KPLS). In this study, the different Kernel functions are used in the LW-KPLS model. Then, the predictive performance of these Kernel functions in LW-KPLS is accessed by employing a nonlinear case study and the analysis of the obtained results is then compared. It was found that the predictive performance of using Exponential Kernel in LW-KPLS are better than other Kernel functions. The values of root-mean-square errors (RMSE) for the training and testing dataset by utilizing this Kernel function are the lowest in the case study, which are 44.54% lower for RMSEs values.

**Keywords** Soft sensors, Locally weighted partial least square, Nonlinearity, Kernel functions

**[SP-16]**

# A Literature Review on Fish Feeds Using Different Protein Sources

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## Abstract

An increase in the production of fish in the aquaculture sector leads to the rising demand for fish feeds. Moreover, the sources used to produce fish feeds are the main protein sources that have high proteins, essential amino acids, and nutrient digestibility. However, the fish feeds made from the different protein-rich plant sources such as soybean meal, corn gluten meal and wheat meal have different optimum protein sources. Notice that a limited review study has been done on the fish feeds. Hence, the aim of this research study is to provide a literature review on fish feeds from different sources. It was found that plant protein sources have great potential in the future development and sustainability in aquaculture. Moreover, it is recommended to further study the fermented fish feeds because fermentation improved the feed nutritional value and reduce the anti-nutritional factors which resulted in increased feed efficiency.

**Keywords** Fish meals, Proteins sources, Aquaculture, Fish feeds, Fermentation

**[SP-17]**

# Techno-Economic Analysis of Biofuel Production through Pyrolysis of Palm Oil Wastes in Malaysia

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## Abstract

Renewable energy sources particularly in biomass energy had drew attention from public to researchers and scientists recently in seeking alternative solution to resolve the arising issues associated to climate change, unequal distribution of fossil fuels and fluctuation of fossil fuels prices faced globally. This study investigates the thermodynamic analysis and techno-economic feasibility of pyrolysis process for palm oil wastes in Malaysia. Empty fruit bunches (EFB), palm kernel shell (PKS), and palm mesocarp fibre (PMF) have been selected as the biomass feedstock in this current study. The model was developed by using ASPEN Plus V10. The production of the biofuels includes the bio-char, bio-oil, and syngas. The operating conditions of the pyrolysis process involved and assessed in this study are as follows: Temperature (300-1,000°C), Pressure (1-10 bar) and carrier gas $N_2$/biomass ratio (0.3-1.0). To assess the economic viability, there were four economic indicators used in the analysis which are project capital cost, operating cost, raw material cost and product sales. Fluctuation of biomass price was considered as a sensitivity study of economic analysis. Payback period was estimated and compared for pyrolysis of EFB, PKS and PMF, via using cumulative cash flow diagram.

**Keywords** Biofuels, Thermodynamic analysis, Techno-economic analysis, Pyrolysis, Palm oil biomass, Malaysia

**[SP-18]**

# A Literature Review on Colour Measurements

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## Abstract

Colour is an organoleptic characteristic, which influences the consumer's choice and preferences. Also, colour is an important quality attribute in product manufacturing industries including chemicals, foods, beverages, and agriculture industries. Traditionally, colour measurement is done via visual evaluation using human eyes. However, the visual acuity of the human eyes could be inaccurate as every human perceives colour differently and the capacity of the brain in memorising the similar colour is poor. Hence, with technological advances, colour measurement instruments including colorimeter, and spectrophotometer are indeed critical in quality control and assurance by assessing a product's colour consistency and follows the standard specifications to be marketed to customers. However, it is noticed that a limited review study related to the colour measurements has been done. Thus, the aim of this research study is to provide a literature review on colour measurements. It was found that colour measurement instruments are usually expensive whilst require frequent servicing or maintenances, repairs, and calibrations which incur additional costs. Furthermore, these instruments are incapable in delivering a direct colour index. Upon addressing such issue, it was discovered that with the advancements in computer vision, colour index can be calculated via a simulation model which requires little to no additional calibration or maintenance rather than those extortionate colour measurement instruments listed previously.

**Keywords** Colour, Algorithm, Measurement, Mathematical model, Review

**[SP-19]**

# Effect of Jicama (*Pachyrhizus erosus*) and Chinese Water Chestnut (*Eleocharis dulcis*) on the Growth of *Lactobacillus* and *E.coli*

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## Abstract

Jicama and Chinese water chestnut (CWC) are legume crop usually found in the local climate condition of Southeast Asia. Studies reported that jicama is a functional food, which contained component such as inulin, a source of prebiotic. While, CWC (*Eleocharis dulcis*) and its tuberous edible-part is a traditional remedy besides of their fresh taste. It brings health benefits such as antibacterial activity, anti-cancer compounds, laxative compounds, diuretic properties, and as respiratory disease treatment. Both jicama and CWC is physiological similar in terms of texture, alkaline-soluble pectin, water-soluble and chelator-soluble, yet vary in the hemicellulose, molecular weight and neutral sugar structure. This leads to the research question of CWC as a functional food, particularly as a prebiotic ingredient. To date, there is no study of the CWC related to prebiotic. Therefore, this study aimed to preliminary assess and compare the prebiotic potential of jicama and CWC in terms of probiotic growth stimulation as well as pathogen inhibition. Through *in vitro* monoculture fermentation by *Lactobacillus* spp. and *Escherichia coli*, the stimulation effect of jicama and CWC were determined. This study may contribute to increase the value of both crops as a functional food.

**Keywords** Jicama, Chinese water chestnut, *Lactobacillus*, *E.coli*, Probiotic

**[SP-20]**

# A Preliminary Assessment of Melinjau (*Gnetum gnemon*) as a Prebiotic Potential Ingredient through The Stimulation of *Lactobacillus* growth

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## Abstract

*Melinjau* (*Gnetum gnemon*) is consumed as a traditional medicine or herbs by the ethnical people in many places especially Borneo areas. Previously, studies reported that derivatives of *Melinjau* seeds, leaves and roots possess various sakes for human health, such as antioxidant, anti-microbial and anti-inflammatory effect. However, as a food ingredient, the prebiotic potential of *Melinjau* leaves and fruits is yet to be explored. Therefore, *Melinjau* is chosen as test subjects for a preliminary prebiotic study through *in vitro* probiotic fermentation. The *Melinjau* was inoculated with *Lactobacillus* for 24 hours and its growth was monitored using optical density (OD) as a precursor indication for the prebiotic potential of *Melinjau*. The study showed that *both Melinjau* leaves and fruits contributes to noticeable increase of *Lactobacillus* similar to inulin, the known prebiotic control. Conclusively, this study suggested that *Melinjau* showed potential as prebiotic ingredient.

**Keywords** Prebiotics, *Melinjau*, *In vitro* batch culture fermentation, Gut microbiota, Lactobacilli

**[SP-21]**

# Microbial Pigment as Sustainable Alternative for Synthetic Colorant

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## Abstract

Synthetic colorant and dyes are preferably used in industries such as textiles, food and cosmetics, due to its cost and reliable supply compared to natural alternative. However, long term application of these synthetic products results in toxicity and environmental issues. Unlike synthetic colorant, natural colorant and dyes are environmental-friendly and may come with extra benefits such as antioxidant and antimicrobial properties. Among natural dyes, microbial pigments have gradually become a research hotspot on account of their rich species, short production cycle and high productivity. A locally isolated fungus, *Ramichloridium* sp. was found to convert fermentation broth into intense "carmine and cherry red" solution. The coloration produced by this fungus has not been described to date. Therefore, the aim of this study is to isolate the red pigment, characterise its biochemical properties and identify the compound. Two red pigments (ACO7174_01 and ACO7174_02) were successfully isolated, and the pH, light and temperature stability of the pigments were determined. AC07174_02 pigment showed good stability upon exposure to light at pH 1 – pH 9 for 30 days. It is also remained stable when heated up to 100°C for 2 hours. Further studies on the toxicity and chemical structure of the isolated pigments will be carried out to characterize the pigments.

**Keywords** Natural colorant, *Ramichlorodium* sp., Stability, Pigment, Dyes

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*Business Events Planners Incentivised Packages* provide business events planners with additional support and benefits when hosting all types of business events in Sarawak.

## Incentivised Package & Criteria For National and International Events

### Tribe Acceleration

- For business events held in Sarawak until December 2022
- **Supports hybrid events**
- Suitable for new and current applicants
- For business events with **149 or less** national and international delegates*
- Extra claimable items included
- Value booster included
- Application may be submitted 4 months prior to event date

### Tribe Elevation

- For business events held in Sarawak until December 2022
- **Supports hybrid events**
- Suitable for new and current applicants
- For business events with **150 or more** national and international delegates*
- Extra claimable items included
- Value booster included
- Application may be submitted 4 months prior to event date

### Tribe Generation

- **Seed fund for inaugural business events** (first edition) held in Sarawak until December 2022.
- Seed fund is applicable for any event, **inclusive of hybrid events**, under *Tribe Acceleration* or *Tribe Elevation* under the condition that the event is inaugural
- Application may be submitted 4 months prior to event date

To apply or enquire about organising conventions and exhibitions, contact:
Donny Tan (donny@sarawakcb.com) at +6016 866 9553
Serena Sa-or (serena@sarawakcb.com) at +6013 823 8487

To apply or enquire about organising corporate meetings or corporate incentives, contact
Crystal Phang (crystal@sarawakcb.com) at +6019 822 7795
Gloria Pahang (gloria@sarawakcb.com) at +6017 851 1351

Learn what other support and programmes are available by visiting www.businesseventssarawak.com.

* Minimum and maximum capacity is subject to the Standard Operating Procedures as stipulated by the Ministry of Tourism, Arts and Culture Sarawak and Sarawak State Disaster Management Committee.

# Hazards AsiaPacific2022

## The 6th Hazards Asia Pacific Symposium

22-23 March 2022,
Virtual

**Sustainable Process Safety - Thriving in the new norm**

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

# Call for abstracts

This year's conference theme "**Sustainable Process Safety – Thriving in the new norm**", brings these issues together. For many businesses late 2020 and throughout 2021 will have been about survival, but the intent of this conference is to look beyond survival and discuss how we can thrive in the new environment. Of interest is the link between Process Safety and Sustainability and how companies are managing this.

## Main topics and sub-themes

### Digitalization, New technology and Remote Interventions

- How have we applied digitalization, new technology and remote interventions to manage our operations safely?

### Success stories on implementing Process Safety during Covid-19

- What have we done to comply with process safety demands under the new resource and travel constraints?

### Sustainability and Process Safety

- How are we implementing sustainable development and environmental requirements whilst ensuring process safety targets are achieved?
- What does the future of Process Safety leadership and culture look like?

### Asset Integrity

- Why is management of operational risk and maintaining asset integrity key to achieving strong process safety compliance during the pandemic?

### Partnership and collaborations

- Has there been a role for new partnerships and collaborations? What are the lessons learned from strategic partnerships and collaborations in terms of promoting process safety and operational excellence?

## Abstract guidelines

Abstract should be submitted in NOT more than 500 words, including purpose, method and conclusion
The author's biography (in NOT more than 200 words) should accompany the abstract submission.

*Abstract submission deadline: Friday, October 15, 2021 to hazardsap@icheme.org*

For further information, registration & sponsorship opportunities, please visit www.hazardsap.org

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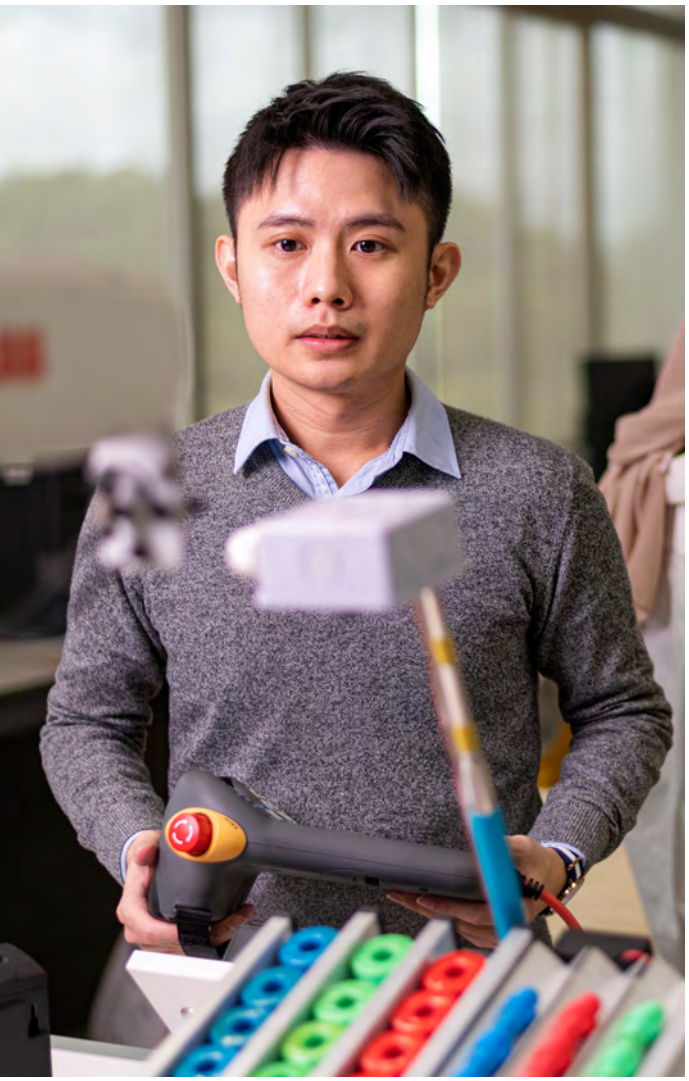

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