Department of Chemical Engineering
De La Salle University-Manila

29th Regional Symposium on Chemical Engineering

Building a Resilient Future: Engineering Solutions for Global Uncertainties

October 29-30, 2025
Dusit Thani Hotel
Makati, Philippines

Book of Abstracts

29th Regional Symposium on Chemical Engineering

Building a Resilient Future: Engineering Solutions for Global Uncertainties

Department of Chemical Engineering
Gokongwei College of Engineering
De La Salle University
2401 Taft Ave, Malate, Manila, Philippines 1004
Tel: +632 8536-0257 | +632 8524-4611 loc. 218
Email: rsce@dlsu.edu.ph
URL: https://www.dlsu.edu.ph/conferences/rsce/rsce-2025/

OBJECTIVES

1. To share recent research trends, the most updated technology, and experiences among academicians, industry, community, and policy makers on the role of Chemical Engineering for Sustainable Cities and Communities,
2. To facilitate an avenue for knowledge exchange by publicizing research progress and outputs of collaborative research to attain sustainable Cities and Communities,
3. To extend and strengthen the research network among industry, community, and policymakers.

SCOPE OF CONFERENCE

Recent Developments in the Knowledge Domain

Separation Processes (SEP)
Reaction Engineering and Catalysis (REC)
Thermodynamics (THR)
Transport Phenomena (TRA)
Process Safety (PRS)
Particulate Technology (PAR)

Environmental Protection and Sustainable Development

Water and Wastewater Engineering (WWE)
Energy and Climate Change (ECC)
Air Pollution Control (APC)
Solid Environment and Waste Management (SWM)
Environmental site assessment and rehabilitation (EAR)
Circular Economy in Engineering (CEE)
Policies and Partnerships for Sustainable Development (PSD)

Post-Pandemic Education

Teaching engineering, new strategies, opportunities (TEO)
Jobs in engineering (JIE)

Innovation in New Materials

Nanotechnology (NNT)
Fuel Cells and Electrochemistry (FCE)
Polymer Science and Engineering (PSE)
Surface Chemistry (SCM)
3D Printing Technology (3DP)

Design, Modelling and Simulation of Processes

Design, Modelling and Simulation of Processes (DMS)
Process Integration, Intensification and Optimization (PIO)
Artificial Intelligence for Engineering (AIE)

Advancements in Life Systems

Bioenergy and Biofuels (BAB)
Biochemical Engineering (BCE)
Biomaterials (BMT)

A Message from the President of De La Salle University

A warm Lasallian welcome to all delegates, esteemed guests, and participants of the 29th Regional Symposium on Chemical Engineering!

It is with immense pride that De La Salle University embraces this opportunity to gather the brightest minds in the field. This symposium has long been a vital platform for innovation and collaboration, and its 29th iteration is a testament to the enduring passion for knowledge that drives our community forward. As chemical engineers, you stand at the forefront of transformation, turning raw potential into tangible solutions that shape our world—from pioneering new processes and sustainable energies to ensuring clean water for all.

At De La Salle University, we are guided by the mission to be achievers for God and country. This mission is lived by our core Lasallian values of Faith, Service, and Communion which are principles that we believe are deeply intertwined with the noble profession of chemical engineering.

Our value of Faith calls us to be engineers with a conscience. It is the ethical compass that guides our research and practice, compelling us to create technologies that uphold human dignity and protect our shared home. The value of Service is the very heart of your calling; it is the zeal to apply your technical expertise to address society's most pressing challenges and uplift the lives of others, especially the last, the lost, and the least. Finally, the value of Communion is embodied in this very symposium that is a gathering built on collaboration, mutual respect, and a shared commitment to working together for the common good.

As you engage in the discussions, presentations, and networking opportunities over the next few days, I challenge you to look beyond the complexities of the processes and equations. I encourage you to see the human faces your work will impact and the better world you are empowered to build. May this symposium not only sharpen your minds but also ignite your spirits to become catalysts for positive change.

We are honored to be part of your journey. May you have a fruitful, inspiring, and transformative experience.

Animo La Salle!

Sincerely,

Br. Bernard S. Oca FSC

President, De La Salle University

International Scientific Committee

Prof. Sanggono Adisasmito	Institut Teknologi Bandung, *Indonesia*
Prof. Mohammad Fahrurrozi	Gadjah Mada University, *Indonesia*
Prof. Yasunori Okano	Osaka University, *Japan*
Prof. Hidetoshi Sekiguchi	Institute of Science Tokyo, *Japan*
Prof. Wan Ramli Wan Daud	Universiti Kebangsaan Malaysia, *Malaysia*
Prof. Mohamed Azlan Hussain	Universiti Malaya, *Malaysia*
Prof. Maria Natalia R. Dimaano	University of Sto. Tomas, *Philippines*
Prof. Aileen H. Orbecido	De La Salle University, *Philippines*
Prof. Susan A. Roces	De La Salle University, *Philippines*
Prof. Tawatchai Charinpanitkul	Chulalongkorn University, *Thailand*
Prof. Anchaleeporn Lothungkum	King Mongkut's Institute of Technology, *Thailand*
Dr. Nguyen Quang Long	Ho Chi Minh University, *Vietnam*

Organizing Committee

Conference Chair	**Prof. Aileen H. Orbecido**
Co-chairs	Prof. Arnel B. Beltran
	Dr. Vergel C. Bungay
Secretariat Committee	**Prof. Rhoda B. Leron**
Members	Dr. Cynthia F. Madrazo
	Engr. Jacob Louies Rohi W. Paulo
	Engr. Johara D. Capingian
	Engr. Theresa G. Carrera
	Ms. Maria Jennifer I. Gacutan
	Ms. Kyla Bianca S. Tuaño
Program Committee	**Dr. Vergel C. Bungay**
Members	Dr. Joseph R. Ortenero
	Prof. Lawrence R. Belo
	Engr. Mia Patricia P. Manalo
	Engr. James Bryan C. Cagas
	Engr. Jacob Louies Rohi W. Paulo
	Engr. Joshua P. Pocaan
	Ms. Kyla Bianca S. Tuaño

Logistics Committee	**Prof. Allan N. Soriano**
Members	Prof. Angelo Earvin S. Choi
	Engr. Dennis N. Yu
	Engr. Gerianne Mae G. Arada
	Engr. Lemuel B. Agonoy
	Engr. Michelle Airah N. Pablo
	Engr. Kim Ahmed N. Sadol
Technical and Publications Committee	**Prof. John Frederick D. Tapia**
Members	Prof. Joseph L. Auresenia
	Prof. Kathleen B. Aviso
	Dr. Carla Mae J. Pausta
	Engr. Mia Patricia P. Manalo
	Engr. James Bryan C. Cagas
	Engr. Jacob Louies Rohi W. Paulo
	Ms. Kyla Bianca S. Tuaño
Website Committee	**Dr. Gian Paolo O. Bernardo**
Members	Prof. Michael Angelo B. Promentilla
Financials Committee	**Prof. Aileen H. Orbecido**
Members	Prof. Nathaniel P. Dugos
	Prof. Joey D. Ocon
	Prof. Raymond Tan
	Engr. Theresa G. Carrera

PROGRAMME

Day 1: October 29, 2025 (Wednesday)

7:30 AM – 8:30 AM	**Registration**	*Mayuree 1 Hall*
Main Session Venue:	***Mayuree 1 Hall***	
8:30 AM – 8:45 AM	**Opening Ceremonies** **National Anthem** **Prayer** **Welcome Remarks**	 **Prof. Aileen Orbecido** Chair, RSCE 2025 De La Salle University, Philippines
	Opening Remarks	**Prof. Raymond Tan** Vice President for Research and Innovation De La Salle University, Philippines
8:45 AM – 9:15 AM	**Plenary Lecture 1**	**Prof. Tawatchai Charinpanitkul** Department of Chemical Engineering Chulalongkorn University, Thailand
9:15 AM – 9:45 AM	**Plenary Lecture 2**	**Dr. Pablo Brito-Parada** Earth Science and Engineering Imperial College London, United Kingdom
9:45 AM – 10:15 AM	**Plenary Lecture 3**	**Prof. Rigoberto Advincula** Department of Chemical and Biochemical Engineering University of Tennessee Knoxville , United States of America
10:15 AM – 10:45 AM	**Panel Discussion and Q&A**	**Prof. Michael Angelo Promentilla** Moderator De La Salle University, Philippines
10:45 AM – 11:00 AM	**Morning Break**	

Prof. Kathleen Aviso & Prof. Ramon Christian Eusebio
Masters of Ceremonies

PROGRAMME

Day 1: October 29, 2025 (Wednesday) – *continuation*

11:00 AM - 12:30 PM	**Parallel Technical Sessions**	**Session A1 –** *Mayuree 1 Hall* **Session B1 –** *Molave Room* **Session C1 –** *Narra Room*
12:30 PM – 1:30 PM	**Lunch Break**	
1:30 PM – 3:30 PM	**Parallel Technical Sessions**	**Session A2 –** *Mayuree 1 Hall* **Session B2 –** *Molave Room* **Session C2 –** *Narra Room*
3:30 PM – 4:00 PM	**Afternoon Break and Poster Session**	
4:00 PM – 5:30 PM	**Parallel Technical Sessions**	**Session A3 –** *Mayuree 1 Hall* **Session B3 –** *Molave Room* **Session C3 –** *Narra Room*
Main Session Venue:	***Mayuree 1 Hall***	
6:00 PM – 10:00 PM	**Fellowship Night**	

PROGRAMME

Day 2: October 30, 2025 (Thursday)

8:00 AM – 8:30 AM	**Registration**	*Mayuree 1 Hall*
Main Session Venue:	***Mayuree 1 Hall***	
8:30 AM – 8:45 AM	**National Anthem** **Prayer**	
	Opening Remarks and Synthesis of Day 1	**Prof. Allan Soriano** Chair, Department of Chemical Engineering De La Salle University, Philippines
8:45 AM – 9:15 AM	**Plenary Lecture 4**	**Prof. Antoine Venault** Department of Chemical Engineering Chung Yuan Christian University, Taiwan
9:15 AM – 9:45 AM	**Plenary Lecture 5**	**Prof. Joey Ocon** Nascent Technologies Corporation Department of Chemical Engineering De La Salle University, Philippines
9:45 AM – 10:15 AM	**Panel Discussion and Q&A**	**Prof. Michael Francis Benjamin** Moderator University of Santo Tomas, Philippines
10:15 AM – 10:30 AM	**Morning Break**	
10:30 AM – 12:30 PM	**Parallel Technical Sessions**	**Session D1 –** *Mayuree 1 Hall* **Session E1 –** *Molave Room* **Session F1 –** *Narra Room*

Dr. Cynthia Madrazo & Prof. Michael Francis Benjamin
Masters of Ceremonies

P R O G R A M M E

Day 2: October 30, 2025 (Thursday) – *continuation*

12:30 PM – 1:30 PM	**Lunch Break**	
1:30 PM – 3:30 PM	**Parallel Technical Sessions**	**Session D2 –** *Mayuree 1 Hall* **Session E2 –** *Molave Room* **Session F2 –** *Narra Room*
3:30 PM – 4:00 PM	**Afternoon Break and Poster Presentation**	
4:00 PM – 5:00 PM	**Parallel Technical Sessions**	**Session D3 –** *Mayuree 1 Hall* **Session E3 –** *Molave Room* **Session F3 –** *Narra Room*
Main Session Venue:	***Mayuree 1 Hall***	
5:00 PM – 6:00 PM	**Synthesis of Day 2**	**Prof. Lawrence Belo** Department of Chemical Engineering De La Salle University, Philippines
	Awarding Ceremony for Outstanding Student Presentations	**Dr. Joseph Ortenero** **Prof. Angelo Earvin Choi** Department of Chemical Engineering De La Salle University, Philippines
	Closing Remarks	**Prof. Arnel Beltran** Co-chair, RSCE 2025 Department of Chemical Engineering De La Salle University, Philippines

RSCE 2025 SPONSORS

GOLD SPONSORS

PETRON

dlsu science foundation, inc.

SILVER SPONSORS

NASCENT TECHNOLOGIES CORP.

1995 BIHIS-MAALA BASICS "DELIVERING GLOBAL QUALITY STANDARDS"

BRONZE SPONSORS

bpit

CEXCI

KRYPTON INTERNATIONAL RESOURCES, INC.

SPi POWER

ARC AUXESIS REVIEW CENTER

15 ALVTECHNOLOGIES PHILIPPINES INCORPORATED YEARS OF PROVIDING ONE-STOP TOTAL SOLUTIONS

SHIMADZU Excellence in Science

TABLE OF CONTENTS

LIST OF ABSTRACTS

Plenary Lecture Abstracts

PLENARY LECTURE 1

A Challenge to Build a Resilient Carbon-Neutral Future by Developing Quaternary Layered Double Hydroxide (LDH) Catalysts for Low-Temperature CO_2 Methanation

Haftu G. Gebreegziabher[1], Mani Sivakumar[2], Naphaphan Kunthakudee[2], Noriaki Sano[3], Sakhon Ratchahat[2], and Tawatchai Charinpanitkul[1]*

[1]Center of Excellence on Particle and Material Processing Technology, Faculty of Engineering, Chulalongkorn University, Thailand
[2]Department of Chemical Engineering, Faculty of Engineering, Mahidol University, Thailand
[3]Department of Chemical Engineering, Faculty of Engineering, Kyoto University, Japan

To build a sustainable and resilient future for a carbon-neutral society, an increasing number of research attempts have been conducted to convert CO_2 to reutilizable compounds, such as CH_4, CH_3OH, and others. CO_2 methanation is one of the promising technologies to achieve the net-zero target. However, the remaining issue for CO_2 methanation is operating conditions at high temperature to compensate for its limited kinetic conversion. Recently, our multi-lateral collaborating research team has set up a challenge to develop Ni-based catalysts derived from layered double hydroxides (LDHs) for low-temperature CO_2 methanation. Such LDHs can provide high Ni loading and structural tunability through the incorporation of specific metallic promoter species. In this work, a series of binary NiAl, ternary NiAlCe, and quaternary NiAlCeLa LDH-derived catalysts have been developed via a facile one-pot hydrothermal method by varying metallic species ratios (Ni/Al = 1.0 – 5.0, Ce/Al = 0.2 - 1.0, and La/Ce = 0.025 -1.000). Among all the developed LDH-derived catalysts, the quaternary NiAlCeLa LDH-derived catalyst can provide remarkably high activity on 85% CO_2 conversion and 100% CH_4 selectivity at 180 °C. To examine the role of each species in the developed LDH-derived catalysts, systematic characterization revealed that oxygen vacancies, basic sites, and metal-support interaction play a dominant role in governing the rate of CO_2 methanation at low temperature.

Keywords: CO_2 methanation; LDH; Low temperature; Oxygen vacancy; Basic site

*Corresponding author: Tawatchai.C@chula.ac.th

PLENARY LECTURE 2

A New Spin on Separation Technology: Solving Industrial and Environmental Challenges with Miniaturized Hydrocyclones

Pablo R. Brito-Parada*

Imperial College London, United Kingdom

This talk presents a comprehensive research programme on optimising and applying mini-hydrocyclones to address complex multiphase separation challenges. By integrating Computational Fluid Dynamics (CFD) with advanced 3D printing techniques, a rapid design–test–validate framework has been developed for creating and evaluating non-conventional mini-hydrocyclone geometries, such as parabolic-walled designs. These innovations have demonstrated significant improvements in solids recovery and concentration efficiency. Validated CFD models for both liquid-liquid and solid-liquid separations have deepened our understanding of the underlying fluid dynamics, enabling solutions for a diverse range of applications — from demulsifying stable microemulsions and separating microplastics from water, to algae concentration and novel medical separations. This integrated design and modelling approach not only advances separation science but also offers critical implications for industrial processes and environmental remediation strategies. The talk will conclude with insights into current progress, remaining challenges, and future opportunities for optimising mini-hydrocyclones to solve some of today's most pressing separation problems.

Keywords: Hydrocyclone; Multiphase separation; Design Optimisation; 3D printing; Computational Fluid Dynamics

*Corresponding author: p.brito-parada@imperial.ac.uk

PLENARY LECTURE 3

AI/ML in Additive Manufacturing and Advanced Polymer Materials

Rigoberto Advincula*

Oak Ridge National Laboratory, University of Tennessee

Creating and curating new data appends the way we approach materials science. In additive manufacturing (AM), the fabrication of parts and objects with high complexity and high performance is advantageous over other methods. Using nanocomposites enables highly improved properties even with “commodity polymers” that do not need to undergo high-temperature processes or extensive reformulation. With artificial intelligence and machine learning (AI/ML), optimizing the formulation and manufacturing methods is possible. Using sensors capable of a feedback loop mechanism and the ability to use simulation to create digital twins, optimizing properties in record time is possible. Statistical and logic-derived design, including regression analysis, are starting points for designing experiments (DOE) or principal component analysis (PCA) in optimization and analysis vs trial-and-error approaches when working with polymer materials. In this talk, we demonstrate the approaches toward understanding Nanostructuring in composites and hierarchical approaches in optimization via AI/ML and other training/learning sets for specific properties and applications, such as 3D printing and flow chemistry reactions. Introducing more sensors (monitoring instruments) in AM processes and real-time ML with online monitoring allows a feedback loop and deep learning (DL) for autonomous fabrication and data analytics.

*Corresponding author: rca41@case.edu

PLENARY LECTURE 4

LIPS and VIPS Membranes for Advanced Water and Wastewater Treatment

Antoine Venault*, Irish Valerie Maggay, and Yung Chang

Chung Yuan Christian University, Taiwan

Porous membranes fabricated from traditional polymers such as polyvinylidene fluoride (PVDF) are commonly produced using phase inversion techniques, notably liquid-induced phase separation (LIPS) and vapor-induced phase separation (VIPS). These methods lead to membranes with distinct pore structures, morphologies, and application ranges. We begin by reviewing the fundamental principles underlying membrane formation via LIPS and VIPS. Next, we highlight a series of studies where PVDF membranes prepared by LIPS were functionalized with catalytic nanoparticles to address the removal of antibiotics from water. In the third section, we demonstrate that membranes formed via VIPS serve as ideal matrices for direct contact membrane distillation, not only for desalination but also for the removal of perfluorooctanoic acid (PFOA) and related substances. Finally, we explore the use of both LIPS- and VIPS-derived membranes for the filtration and inactivation of bacterial species, as well as for microalgae harvesting. Overall, this presentation aims to showcase the potential of membrane technology to tackle complex separation challenges in water and wastewater treatment, thereby contributing to a more sustainable future.

Keywords: LIPS, VIPS, antibiotics, PFOA, bacteria, microalgae harvesting

*Corresponding author: avenault@cycu.edu.tw

PLENARY LECTURE 5

Open Models, Real Systems: From Off-Grid Research to National Energy Planning

Joey D. Ocon

Chemical Engineering Department, De La Salle University, Manila, Philippines
Nascent Technologies Corporation, Philippines

Energy transitions in the Philippines face the dual challenge of universal electrification and climate resilience. Our decade-long research on hybrid renewable systems and mini-grids across more than 600 islands highlights both the opportunities and barriers in reducing diesel dependence while meeting rising demand. Building on this foundation, we developed PyPSA-Pilipinas, the first open-source national model of the Philippine grid, which features 28-node, hourly resolution analysis that integrates technical constraints and regulatory realities (e.g. coal moratorium). Open energy modelling and planning provide a pathway for more transparent and participatory decision-making, bridging academic research with government policy and industry practice. Beyond modelling, I will share how innovation translates into action: at Nascent Batteries, where we advance sodium-ion technologies for tropical and emerging market contexts; at Forum for the Future, where the Responsible Energy Initiative embeds circularity, equity, and resilience into renewable energy value chains; and at the Center for Energy Research and Policy, where I help shape national energy discourse. Together, these efforts demonstrate how chemical engineers can design inclusive and sustainable energy futures.

Keywords: Open energy modelling; Off-grid electrification; Energy transition; Sodium-on batteries; Sustainable energy planning

*Corresponding author: joey.ocon@dlsu.edu.ph

Keynote Abstracts

KEYNOTE 1

Mechanism of Electrically Responsive Graphene-Based Membranes for Simultaneous Steam and Power Generation

Wei-Song Hung*

Graduate Institute of Applied Science and Technology, Advanced Membrane Materials Research Center, National Taiwan University of Science and Technology, Taipei, 10607, Taiwan

Water and electricity shortages constitute a global energy crisis that cannot be ignored. The sun is an unlimited source of energy, and oceans provide abundant water and renewable energy resources. In this study, poly(vinylidene fluoride) (PVDF)/graphene solar evaporator membranes are fabricated for simultaneous freshwater production and power generation. Graphene addition transformed the PVDF crystal from the α-phase to the piezoelectric self-assembly β-phase. The resulting membrane is used to convert the mechanical energy of waves to electrical energy. The membrane has an output voltage of 2.6 V (±1.3 V) and an energy density of 2.11 Wm^{-2} for 1 Hz simulated waves, which are higher than values reported in the literature. The stacked graphene and polymer formed a wood-lumens-like mesoporous structure with a photothermal effect. Under one sun illumination, the water production rate is 1.2 kg m^{-2} h^{-1}, and the solar-thermal energy conversion efficiency is 84%. Finally, a prototype is built to prove a single evaporator's feasibility that can simultaneously obtain freshwater and generate electricity. Thus, this membrane serves as an ocean wave power generation device that can provide all-weather energy generation, convert stored electrical energy into thermal energy at night and on cloudy days, and continuously provide safe drinking water.

Keywords: Graphene; Membranes; Solar evaporator; Power Generation

*Corresponding author: wshung@mail.ntust.edu.tw

KEYNOTE 2

Asymmetric PES Membranes with Perm-Selectivity for Nitrate Ions and Their Applications in Electrochemical Nitrate Reduction

Jenn Fang Su*

Department of Chemical and Materials Engineering, Center for Sustainability and Energy Technologies, Chang Gung University, Taoyuan, Taiwan

In this presentation, a series of asymmetric polyethersulfone (PES) membranes are introduced for the wastewater treatment applications. Firstly, the effects of different additives during membrane preparation on the morphologies and physical properties of fabricated membranes are discussed. It is found that the asymmetric membranes with three-dimensional pore networks in PES matrix without the presence of macrovoids can be achieved under optimal loading of water or polyvinylpyrrolidone (PVP) additives using non-solvent induced phase separation (NIPS) process. The resulted PES membranes exhibit a remarkable water permeation flux and a BSA rejection, which are suitable for ultrafiltration. Secondly, the synthesized PES membranes can be utilized as ion-selective membranes to concentrate the nitrate ions in water. Our results demonstrated that the high selectivity of nitrate ions over fluoride ions and sulfate ions can be obtained at low applied potential less than 3 V. The collected nitrate ions in water are further converted to ammonia through electrochemical reduction process, offering a promising avenue to address the environmental impacts associated with nitrate-containing wastewater and reduce the energy intensity as well as the carbon footprint linked to the traditional Haber-Bosch method for producing ammonia.

Keywords: polyethersulfone; ion-selective membrane; nitrate; polyvinylpyrrolidone

*Corresponding author: jennfangsu@mail.cgu.edu.tw

KEYNOTE 3

Advanced Materials Design and Closed-Loop Recovery Strategies Toward Sustainable Lithium Batteries

Wei-Fan Kuan*

Chang Gung University, Taiwan

The advancement of next-generation lithium-ion batteries requires innovations in both performance and sustainability. Lithium-metal anodes offer exceptional theoretical capacity, but their commercialization is hindered by dendritic growth, parasitic reactions, and safety risks. Anode-free lithium-metal batteries (AFLMBs), which eliminate the use of excess lithium metal and rely solely on lithium from the cathode, offer improved energy density and simplified manufacturing. However, issues such as lithium dendrite formation and the accumulation of inactive "dead lithium" remain critical barriers. To address these challenges, we developed a lithiophilic composite polymer coating on copper current collectors, which regulates lithium-ion flux and promotes uniform nucleation. This surface-engineered interface is designed to enhance interfacial compatibility and improve the cycling stability of AFLMBs, making it a promising strategy for advancing safe and efficient lithium-metal batteries. On the other end of the battery lifecycle, we address the urgent need for sustainable recycling methods, particularly for lithium iron phosphate ($LiFePO_4$, LFP), a cathode material valued for its safety and long cycle life. Traditional recycling techniques, such as pyrometallurgy and hydrometallurgy, are highly energy-consuming and involve complex chemical processes with significant environmental impact. In contrast, we investigate a direct regeneration approach that restores the electrochemical performance of spent LFP through relithiation and structural repair, preserving the material's original crystal framework. By integrating interface engineering and regenerative recycling, this work aims to contribute to the development of both high-performance and environmentally responsible lithium-ion battery systems.

Keywords: Lithium battery; Anode-free design; Recycling; Bio-based polymer; Energy

*Corresponding author: weifankuan@mail.cgu.edu.tw

Technical Session Abstracts

SEPARATION PROCESSES (SEP)

SEP-001

Application of Superhydrophobic Membranes in Gravity-Driven Emulsion Separation and Enantiopure Drug Recovery

Irish Valerie Maggay, Antoine Venault, and Yung Chang*

Chung Yuan Christian University, Taiwan

Membrane separation has long been employed for oil–water emulsion treatment, though typically limited to model systems with little relevance to pharmaceutical applications. This study demonstrates the use of porous superhydrophobic SiO_2/poly(vinylidene difluoride) (PVDF) composite membranes for separating emulsions and recovering S(+)-ibuprofen ester following the enzyme-catalyzed kinetic resolution of racemic ibuprofen by Candida rugosa lipase. The membranes were fabricated by blending 0.5–2.0 wt% SiO_2 aerogel—synthesized from methyltrimethoxysilane (MTMS)—into the PVDF casting solution. The membranes exhibited high porosity (>70%) and large pore sizes (>0.5 μm), enabling fast gravity-driven filtration. The optimal SiO_2 loading was found to be 1.0 wt%, balancing permeability and selectivity. This membrane delivered high oil-phase purities of >98.7% (toluene), 99.78% (n-hexane), and >99.51% (isooctane). Although a slight reduction in flux was observed due to increased solid content and induced β-phase crystallinity, the composite membrane exhibited superior emulsion-breaking efficiency. Importantly, the recovered organic phase showed an absorbance of 0.12—closely matching the control (0.10)—and no residual enzymatic activity, indicating successful recovery of the S(+)-enantiomer. This work investigates a new direction for membrane technology in the pharmaceutical field, offering an effective and economical route for separating and recovering enantiopure drug compounds from emulsified systems.

Keywords: Wastewater; Emulsion; Membrane; Gravity-driven filtration

*Corresponding author: ychang@cycu.edu.tw

SEP-002

Optimization of Choline-Acetate Catalyzed Glycolysis of PET in Polycotton Fabric

Luis Cabatingan* and Ramelito Agapay

University of San Carlos, Philippines

Technologies for recycling of waste textiles are enabling towards a circular textile economy. Research on processing of polycotton fabric has accordingly grown in recent years with the end view of separating and recycling the monomer or polymer components of fabrics back to the textile production chain. One technique for separating the polyethylene terephthalate (PET) and cellulose in polycotton fabric is through selective degradation of PET. In this work, PET in polycotton is broken down to the bis(2-hydroxyethyl) terephthalate (BHET) monomer by reacting it with large excess of ethylene glycol (EG) using choline acetate, an ionic liquid, as catalyst. At fixed EG:PET ratio of 8.1 g/g, the optimum process conditions were determined through response surface methodology which employed a Box-Behnken design of experiments. It was found that maximum yield of BHET can be obtained at reaction temperature of 195 °C, reaction time of 135 min, and catalyst-to-PET load of 9 wt.%. The process is further evaluated using green metric criteria. It is discussed that the BHET product can be used in PET production, the residual EG can be reused after distillation, and the cotton (cellulose) residue may be used in man-made cellulosic fiber production. Also discussed is the outlook regarding process scalability.

Keywords: polycotton; textile waste; PET glycolysis; choline acetate; response surface methodology

*Corresponding author: lkcabatingan@usc.edu.ph

SEP-003

Enhancement of Oil-Water Emulsion Ultrafiltration Performance and Antifouling Properties of Cellulose Acetate Tubular Membrane Incorporated with Zwitterionic Carbon Quantum Dots

John Paul Arcilla[1]*, Rhoda Leron[2], Hong-Li Yang[3], Hsin-Yi Lin[3], Pei-Chen Chen[3], Hui-An Tsai[3], and Kuier-Rarn Lee[3]

[1]*School of Chemical, Biological and Materials Engineering and Sciences, Mapúa University, Philippines*
[2]Department of Chemical Engineering, Gokongwei College of Engineering, De La Salle University, Philippines
[3]R&D Center for Membrane Technology, Department of Chemical Engineering, Chung Yuan Christian University, Taiwan

The use of polymeric membranes has gained considerable attention as promising approach for addressing complex wastewater that continuously threatens human health and the environment. This research focuses on utilizing membrane technology in treating oily wastewater through enhancing the ultrafiltration performance and improving the antifouling properties of cellulose acetate (CA) tubular membranes by integrating zwitterionic carbon quantum dots (ZQDs). The morphology and physical properties of the modified membrane was characterized through SEM-EDX, ATR-FTIR, XPS, and AFM analyses and water contact angle measurements. Furthermore, membrane performance was evaluated by measuring its pure water flux, permeation, oil rejection efficiency, and fouling resistance. The modified membrane (CA/ZQDs-DO) displayed improved hydrophilicity with WCA of 53.1 ± 0.4° and pure water flux of 695.47 ± 19.15 LMH/bar. The CA/ZQDs-DO membrane also exhibited improved permeance for oil-water emulsion of 477.23 ± 26.25 LMH/bar compared to the pristine CA membrane (293.13 ± 7.04 LMH/bar). It also showed an excellent oil rejection rate of >99% and enhanced fouling resistance (flux recovery: 94.39%, reversible fouling ratio: 32.90%, and irreversible fouling ratio:5.61%). Furthermore, CA/ZQDs-DO exhibited good chemical and mechanical long-term stability after 6 cycles of oil-water separation test. In conclusion, the incorporation of ZQDs to CA membrane provides an effective platform for oily wastewater treatment.

Keywords: Zwitterionic carbon quantum dots; Cellulose acetate; Tubular membrane; Oil-water separation; Antifouling

*Corresponding author: jp.arcilla.dm@gmail.com

SEP-004

Preliminary Study of Microplastic Removal from Artificially River Sand Using Agglomeration-Micro-Flotation

Palot Srichonphaisarn[1], Carlito Baltazar Tabelin[2], and Theerayut Phengsaart[1]*

[1]*Chulalongkorn University, Thailand*
[2]*Mindanao State University - Iligan Institute of Technology, Philippines*

Microplastics (MPs), plastic particles ranging from 1 μm to 5 mm, are increasingly recognized as hazardous emerging pollutants due to their small size, low density, and hydrophobic surface, which facilitate widespread dispersion in the environment. In river systems, sediments—particularly coarse-grained matrices like river sand—act as major sinks for MPs, presenting long-term risks to aquatic ecosystems and human health. Although various separation techniques have been proposed for MP removal, their efficacy in sandy sediments remain challenging due to particle embedding and the heterogeneity of the matrix. This study investigates the potential of agglomeration-micro-flotation for MP removal from artificially contaminated river sand. This method exploits the hydrophobicity of MPs by enhancing agglomeration with kerosene as a bridging liquid, promoting effective attachment to air bubbles. Six common types of plastics—polypropylene (PP), polyethylene (PE), acrylonitrile butadiene styrene (ABS), polystyrene (PS), polyethylene terephthalate (PET), and polyvinyl chloride (PVC)—with sizes ranging from 100 μm to 1 mmwere tested. The study systematically examined the effects of kerosene dosage and solid-to-liquid ratio (S/L) on MP removal efficiency. By focusing on river sand as a sediment model, this work aims to support the development of practical and scalable flotation-based techniques tailored for real-world contaminated riverine environments.

Keywords: Agglomeration; Microplastics; River Sand; Flotation; Environmental Remediation

*Corresponding author: theerayut.p@chula.ac.th

SEP-005

Utilization of Supercritical Carbon Dioxide Extraction for Contaminant Removal from Semiconductor Manufacturing Equipment Components and Modeling of Extraction Behavior

Takuma Matsuoka[1], Mitsuru Sasaki[2], and Yukio Kiba[3]*

[1]*Kumamoto University, Japan*
[2]*Institute of Industrial Nanomaterials, Japan*
[3]*Tokyo Electron Kyushu Ltd, Japan*

Supercritical carbon dioxide ($scCO_2$), due to its low polarity, is widely used for extracting active compounds. In this study, we applied this extraction technique to investigate the separation of organic contaminants from components used in semiconductor manufacturing equipment. Compounds A and B which are commonly found as residues in production environments, were applied as model contaminants to PTFE substrates. Extractions were performed at temperatures ranging from 60 to 80 °C and pressures from 20 to 30 MPa. The effectiveness of $scCO_2$ in removing these substances was evaluated through high-performance liquid chromatography and liquid chromatography–mass spectrometry to determine both the extracted and residual amounts of contaminants. Additionally, to interpret and predict extraction behavior, two modeling approaches were employed: an equilibrium partitioning model and a first-order kinetic model. The solubility of each solute in $scCO_2$ was also correlated using five density-based models, and assessed by mean absolute percentage error. The results demonstrated extracted amounts exceeding 99% of the applied contaminants under all conditions, with residual levels below 0.5%, indicating excellent cleaning performance. Higher pressure, which increases CO_2 density, significantly enhanced both solubility and extraction rates. Among the models tested, Chrastil model provided the best predictive accuracy. These findings contribute to the development of safer, solvent-free cleaning processes for advanced semiconductor manufacturing.

Keywords: Supercritical carbon dioxide; Semiconductor; Separation; Extraction

*Corresponding author: yukio.kiba@tel.com

SEP-006

Thin-Film Composite Membrane from Cellulose Acetate–Polycaprolactone Incorporated with Banana Peel-Derived Carbon Quantum Dots for Forward Osmosis Desalination

Chrizzle Mae Domingo*, Catherine Losito, Ramon Christian Eusebio, Mart Merwin Magboo, Butch Bataller, and Michael Vincent Laurio

University of the Philippines Los Baños, Philippines

The study explores the incorporation of CQDs from banana peels into CA-PCL matrix for the fabrication of FO membranes for desalination. Banana peel-derived CQDs were synthesized via hydrothermal method, producing nanoparticles with an average size of 10.4 nm. Analysis revealed the presence of functional groups and exhibited blue fluorescence under UV light. Different CQD concentrations were incorporated into the casting solution which were formed through phase inversion, followed by interfacial polymerization to form a polyamide layer. The membranes were characterized by their functional groups, porosity, mean pore radius, and hydrophilicity, while the performance was evaluated based on water flux, reverse salt flux, and salt rejection. The pristine membrane exhibited a water flux of 1.58 LMH, reverse salt flux of 87.90 GMH, and salt rejection of 51.89%. The membrane containing 0.05 wt.% CQDs demonstrated the best performance (6.87 LMH, 64.97 GMH, and 91.10%). This membrane also displayed enhanced porosity (59.26%), pore size (4.43 nm), and reduced contact angle (76.49°). The commonly observed permeability-selectivity trade-off was not evident at the lowest loading (CPC-0.01), but higher CQD concentrations began to display this effect. Overall, these results show the potential of banana peel-derived CQDs for enhancing the properties and performance of CA-based FO membranes.

Keywords: Forward Osmosis Membrane; Cellulose Acetate; Polycaprolactone; Carbon Quantum Dots; Banana Peels

*Corresponding author: cdomingo@up.edu.ph

SEP-007

Sustainable Fabrication of Modified PVDF Membrane Using Green Solvent Incorporated with Dolomite for Water Separation

Mujaroh Khotimah[1], Mohd Azlan Hussain[2], Mohd Usman Mohd Junaidi[2], and Yusuf Wibisono[3]*

[1]*Universiti Malaya, Malaysia*
[2]*Department of Chemical Engineering, Faculty of Engineering, Universiti Malaysia, 50603 Kuala Lumpur, Malaysia*
[3]*Department of Bioprocess Engineering, Brawijaya University, 65145, Malang, Indonesia*

Global concerns over water scarcity and inadequate access to clean water have intensified due to rapid industrialization and urban growth. Driven by the pursuit of optimal performance, membrane development has accelerated in recent years. However, the widespread use of toxic solvents still limits broader adoption. This study aims to develop environmentally friendly modified polyvinylidene fluoride (PVDF) by incorporating modified dolomite as a natural bio-filler and using Cyrene™ as a green solvent. Firstly, dolomite is calcinated to remove impurities, reduce the particle size to nano size, modified using fatty acid (steric acid), then blended with PVDF, and varying modified dolomite loadings (0–0.75 wt.%) to prepare the dope solution. Flat-sheet membranes (~0.20 mm thick) are fabricated via phase inversion. Characterization includes surface morphology (SEM), functional group (FTIR), water contact angle (WCA), liquid entry pressure (LEP), and tensile strength analyses. The membrane performance is evaluated through water flux and salt rejection via membrane distillation (MD) using synthetic saline water. The novelty lies in the synergistic use of Cyrene™, PVDF, and modified dolomite (an unexplored formulation) to achieve high membrane performance and enhanced environmental sustainability. The expected outcome is a robust hydrophobic membrane with improved water purification and supporting sustainable water separation via MD.

Keywords: PVDF; Cyrene; Dolomite; Hydrophobic membrane; Membrane Distillation

*Corresponding author: y_wibisono@ub.ac.id

SEP-008

Enhancing Water Recovery and Salt Rejection in Brackish Water Treatment Using Ultra Low Pressure RO Membranes

Azizullah Hanif, Muhammad Nur Fazley Roslan, Mohd Azlan Hussain, and Azman Ariffin*

Universiti Malaya, Malaysia

Water scarcity remains a critical global challenge, particularly in regions with limited access to safe drinking water. Brackish water, characterized by moderate salinity, presents a viable alternative source; however, its treatment demands efficient and accessible purification technologies. Conventional reverse osmosis (RO) systems operate at high pressures (17 - 27 bar), making them unsuitable for low resource or decentralized settings. This study investigates the performance of Ultra Low Pressure Reverse Osmosis (ULPRO) membranes as an energy efficient solution, operating effectively below 5 bars. Two commercial Vontron ULPRO modules a lightweight and a heavyweight type were evaluated using synthetic brackish water under both single pass and recycle flow configurations. Results indicated that both salt rejection and water recovery rates improved with increasing feed pressure and decreasing salinity. For a 500-ppm feed solution, salt rejection increased from 25% to 44% in single pass mode and from 27% to 56% in recycle mode across a pressure range of 1-3 bar. The lightweight membrane consistently outperformed the heavyweight module in terms of efficiency. These findings underscore the potential of ULPRO membranes for brackish water treatment, with performance influenced by membrane type, feed concentration, and operating pressure.

Keywords: Water Purification; Ultra Low Pressure Reverse Osmosis; Brackish Water

*Corresponding author: 17013783@siswa.um.edu.my

SEP-009

Influence of Solvent Concentration on Liquid-Liquid Extraction of Carotenoids from Crude Palm Oil

Anita Kusuma Wardani*, Daniel Pramudita, Jenny Rizkiana, Jonathan Martin Wibawa, and Muhammad Izzan

Institut Teknologi Bandung, Indonesia

Crude palm oil (CPO) is a prevalent commodity and is the most produced and traded vegetable oil worldwide. Carotenoid, a component of CPO, is distinguished for its health advantages, acting as a provitamin A source and an antioxidant. Carotenoid is susceptible to deterioration during the CPO refining process because of its low heat stability. An eco-friendly process is necessary for carotenoid extraction before refining. This research examines the extraction of carotenoids from crude palm oil using liquid-liquid extraction with a green solvent blend of ethanol and isopropanol. The extraction utilized diverse ethanol-to-isopropyl alcohol ratios (1:0, 3:1, 1:1, 1:3, 0:1) and distinct CPO-to-solvent ratios (3:7, 4:6, 5:5, 11:9, 6:4). The results indicated that solvent composition markedly influenced extraction yield in a parabolic manner and greatly impacted separation parameters, with lowered ethanol concentration in the solvent diminishing separation efficiency. Furthermore, reducing the CPO-to-solvent ratio improved extraction yield without significantly affecting separation characteristics. The ideal extraction condition was attained using an ethanol-to-isopropyl alcohol ratio of 1:0 and a CPO-to-solvent input ratio of 4:6.

Keywords: carotenoid; crude palm oil; green solvent; liquid-liquid extraction

*Corresponding author: anita.kw@itb.ac.id

REACTION ENGINEERING AND CATALYSIS (REC)

REC-002

Kinetics of Electro-Fenton Process in Degradation of Ciprofloxacin in Nickel-Zinc Selenide on Nickel Foam

Victor Timothy Garcia[1], Aldrin Jelo Tobias[1], Naomi De Leon[1], Leahchim Emerlinda Edwards[1], Joseph Ortenero[1,2], Kim Ahmed Sadol[1,2], Gerianne Mae Arada[1,2], Brian Gerald Bueno[1,5], Johara Capingian[1,2], Lemuel Agonoy[2], Aileen Orbecido[1,2], Carla Mae Pausta[1,2], Michael Angelo Promentilla[1,2], Liza Bautista-Patacsil[3], Joel Cornista[4], and Arnel Beltran[1,2]*

[1]Department of Chemical Engineering, De La Salle University, Philippines
[2]Center for Engineering and Sustainable Development Research, De La Salle University, Philippines
[3]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[4]Department of Biology, University of the Philippines Manila, Philippines
[5]Kubota Kasui Philippines Corp., Philippines

The release of untreated antibiotics into wastewater poses a critical threat, as conventional treatment techniques fail to degrade these persistent pollutants effectively. Electro-Fenton (EF), recognized for its high efficiency and environmental compatibility, operates through the in situ generation of hydroxyl radicals to degrade the complex and recalcitrant nature of antibiotics. With an appropriate electrode, its potency is enhanced with boosted catalytic performance, improved stability, and cost-effectiveness. This study uses electrodeposited NiZnSe, drop-cast on nickel foam, as a cathode in a three-electrode undivided system for EF degradation of ciprofloxacin (CIP). The identified optimum condition of 1 mM initial concentration of Fe^{2+} and 350 mA applied current is used to investigate the kinetics of CIP degradation. Various kinetic models are fitted to the kinetics data of CIP degradation, and results show that it obeys a pseudo-first-order model with R^2 = 0.9437 and an observed rate constant of kapp = (-3.549 ± 0.085) x 10-2 $M^{-1}{\cdot}min^{-1}$. The kinetic Findings reveal that the degradation rate decreases over time due to the low concentration of CIP and the formation of Fe^{3+} sludge.

Keywords: NiZnSe/NF electrode; electro-Fenton; ciprofloxacin; degradation; kinetics; rate constant

*Corresponding author: arnel.beltran@dlsu.edu.ph

REC-003

Homogeneous Photo-Fenton Degradation of Multiple Antibiotics in Aqueous Solution: Kinetics Study and Parameter Optimization

Gerianne Mae Arada[1,3], Brian Gerald Bueno[2,3], Kim Ahmed Sadol[1,3], Lemuel Agonoy[1], Johara Capingian[1,3], Aileen Orbecido[1,3], Joseph Ortenero[1,3], Carla Mae Pausta[1,3], Michael Angelo Promentilla[1,3], Liza Bautista-Patacsil[4], Joel Cornista[5], and Arnel Beltran[1,3]*

[1]Center for Engineering and Sustainable Development Research, De La Salle University Manila, Philippines
[2]Kubota Kasui Philippines Corp., Philippines
[3]Department of Chemical Engineering, De La Salle University, Philippines
[4]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[5]Department of Biology, University of the Philippines Manila, Philippines

Antibiotics such as ciprofloxacin and metronidazole are among the most frequently detected pharmaceutical contaminants in wastewater due to their extensive medical use and high environmental persistence. These compounds are known to resist conventional wastewater treatment processes and contribute to the spread of antimicrobial resistance. This study investigated the simultaneous degradation of ciprofloxacin and metronidazole in aqueous solution using the homogeneous photo-Fenton process, an advanced oxidation technology that combines hydrogen peroxide and ferrous ions under ultraviolet irradiation to generate highly reactive hydroxyl radicals. Experiments were conducted in a reactor containing 2.5 L of aqueous solution with initial antibiotic concentrations of 10 ppm each, an Fe^{2+} concentration of 0.5 mM, and a UV lamp intensity of 11 W. The effects of solution pH (3 and 7) and hydrogen peroxide dosage (with and without H_2O_2) were examined to determine their influence on degradation efficiency. Kinetic analysis showed pseudo-first-order behavior: ciprofloxacin exhibited a degradation rate constant of 0.226 min^{-1} individually but decreased to 0.048 min^{-1} in the mixture, while metronidazole increased from 0.238 to 1.501 min^{-1}. Under optimized conditions, the process achieved over 95% removal of both antibiotics, demonstrating the strong potential of the photo-Fenton process for efficient, sustainable antibiotic degradation in aquatic systems.

Keywords: photo-Fenton; degradation; kinetics; multiple antibiotics

*Corresponding author: arnel.beltran@dlsu.edu.ph

REC-004

Simultaneous Degradation of Multiple Antibiotics by Pt-Pt Electro Fenton in an Aqueous Pharmaceutical Mixture

Kim Ahmed Sadol[1,2], Brian Gerald Bueno[2,5], Lemuel Agonoy[1], Gerianne Mae Arada[1,2], Johara Capingian[1,2], Aileen Orbecido[1,2], Joseph Ortenero[1,2], Carla Mae Pausta[1,2], Michael Angelo Promentilla[1,2], Liza Bautista-Patacsil[3], Joel Cornista[4], and Arnel Beltran[1,2]*

[1]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2]*Department of Chemical Engineering, De La Salle University, Philippines*
[3]*Department of Engineering Science, University of the Philippines Los Baños, Philippines*
[4]*Department of Biology, University of the Philippines Manila, Philippines*
[5]*Kubota Kasui Philippines Corp., Philippines*

The discharge of antibiotics to the environmental waters through industrial, domestic and hospital wastewater pathways has elevated its status to becoming a contaminant of emerging concern (CEC). Ciprofloxacin, a fluoroquinolone antibiotic, and metronidazole, a nitroimidazole, are among the top-dispensed antibiotics in hospitals in the Philippines. Their environmental presence may cause enhanced development of antibiotic resistance in bacteria. Electro Fenton is an Advanced Oxidation Process that uses current to enhance the mineralization capability of Fenton oxidation, a reaction that takes place more efficiently in acidic conditions. Hence, in this experiment, the removal of ciprofloxacin in synthetic wastewater via electro Fenton with similar platinum-coated titanium electrodes was first optimized. The effects of current density, initial pH, and initial concentration were observed using response surface methodology. The optimized conditions were then applied to the simultaneous removal of ciprofloxacin, clindamycin and metronidazole in a three-component pharmaceutical water. The kinetics of this process was evaluated.

Keywords: electro Fenton; antibiotic residue; contaminant of emerging concern; optimization; HPLC

*Corresponding author: arnel.beltran@dlsu.edu.ph

REC-005

Degradation and Kinetic Behavior of Multiple Antibiotics in Synthetic Wastewater by Homogeneous Photoelectro–Fenton Process

Lemuel Agonoy[1], Kim Ahmed Sadol[1,2], Brian Gerald Bueno[2,5], Gerianne Mae Arada[1,2], Johara Capingian[1,2], Aileen Orbecido[1,2], Joseph Ortenero[1,2], Carla Mae Pausta[1,2], Liza Bautista-Patacsil[3], Joel Cornista[4], Michael Angelo Promentilla[1,2], and Arnel Beltran[1,2]*

[1]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2]*Department of Chemical Engineering, De La Salle University Manila, Philippines*
[3]*Department of Engineering Science, University of the Philippines Los Baños, Philippines*
[4]*Department of Biology, College of Arts and Science, University of the Philippines Manila, Philippines*
[5]*Kubota Kasui Philippines Corp., Philippines*

Pharmaceutical waste has become a critical global concern due to its detrimental effects on both public health and the environment. Among these contaminants, antibiotics such as ciprofloxacin, metronidazole, and clindamycin are of particular concern because of their persistence in aquatic environments and their contribution to the development of antimicrobial resistance. Conventional wastewater treatment systems are often unable to effectively remove these compounds, especially at trace concentrations, resulting in their continuous release into natural water bodies. This study investigates the potential of the homogeneous photoelectro-Fenton (PEF) process as an advanced oxidation technique for the degradation of ciprofloxacin, metronidazole, and clindamycin in synthetic wastewater. Using the optimal parameters from a Box-Behnken design, the effects of initial contaminant concentration, solution pH, and applied current were evaluated while maintaining a constant iron catalyst concentration of 2 mM. The kinetics experiments were conducted under continuous irradiation from an 11 W UVC lamp for 120 minutes. Residual antibiotic concentrations were quantified using the UV-Vis spectrophotometer. Furthermore, kinetic analyses were performed to determine degradation rate constants and interpret the reaction pathways governing the PEF degradation of each antibiotic.

Keywords: photoelectro-Fenton; wastewater treatment; multiple antibiotics degradation; advanced oxidation process; kinetics behavior

*Corresponding author: arnel.beltran@dlsu.edu.ph

REC-006

Impact of Ethanol Impurities on Catalytic Performance and Stability of Modified HZSM-5 in Ethanol Dehydration to Ethylene

Muhammad Dimas[1]*, Teguh Ariyanto[1], Imam Prasetyo[1], Rochmadi[1], and Hardaning Pranamuda[2]

[1]Universitas Gadjah Mada, Indonesia
[2]PT Harapan Interaksi Swadaya (Greenhope), Indonesia

Catalytic dehydration of bioethanol is recognized as a sustainable route for producing bioethylene, a fundamental building block in the chemical industry. However, the demand for high-purity bioethanol significantly increases production costs, while the presence of impurities may impair catalyst performance. This study investigates the performance of a 1%W-HZSM-5 catalyst under varying water and methanol impurities, and its comparison with a conventional HZSM-5 catalyst. The product gases were determined by gas chromatography analysis. Post-reaction coke deposition was characterized by thermal gravimetric analysis (TGA) to distinguish between light and heavy coke species and N_2-sorption analysis was employed to pore structure changes. Catalytic performance was evaluated in terms of ethanol conversion and ethylene selectivity, while catalyst stability was determined based on time on stream. The results reveal that the 1%W-HZSM-5 catalyst exhibits improved stability and ethylene selectivity at lower ethanol concentrations, although the introduction of methanol moderately diminishes its selectivity efficiency.

Keywords: Bioethylene; Catalysis; Heterogeneous catalyst; HZSM

*Corresponding author: nurstiadimas@mail.ugm.ac.id

REC-007

Sulfur-Modified Palm Kernel Shell-Derived Porous Carbon for Ethyl Levulinate Synthesis from Ethanol and Levulinic Acid

Dimas Agung Pramudikto[1], Rochim Bakti Cahyono[1], Ahmad Tawfiqurrahman Yuliansyah[1], Imam Prasetyo[1], and Teguh Ariyanto[2]*

[1]*Universitas Gadjah Mada, Indonesia*
[2]*Gadjah Mada University, Indonesia*

Biodiesel replacement for diesel is one of the viable solutions to achieving net zero emission, particularly in the energy sector. One of key point that hinders the wide use of biodiesel is regarding its cloud point and pour point. Ethyl levulinate, a derivative of levulinic acid, is an additive to improve biodiesel properties. Aqueous acid catalysts prove to be a highly effective and low cost for esterification, but difficult to reuse and separate. Its high reactivity also demands the use of noncorrosive materials of reactors and pipes, which are typically expensive. In this work, sulfur-modified porous carbon was prepared and utilized as heterogeneous catalyst for ethyl levulinate synthesis. The porous carbon was produced from an abundance palm kernel shell and sulfur functional group was introduced by an oxidation process using sulfuric acid. The characterizations (FTIR, TGA, EDX and titration analysis) showed that sulfur functional groups can be anchored in the porous carbon with acidity up to 0.36 mmol/g. Under mild operating conditions of batch reaction, sulfur-modified porous carbon achieves 75% conversion after 120 hours and recyclability without significant losses to its effectiveness.

Keywords: Biofuel; Esterification; Heterogeneous catalyst; Porous carbon

*Corresponding author: teguh.ariyanto@ugm.ac.id

REC-009

Photocatalytic Reactive Ceramic Membrane for Removing Trance Organic Chemicals in Wastewater

Haruka Takeuchi*

Kyoto University, Japan

Residual trace organic chemicals (TrOCs) can be ecotoxic and may contribute to the emergence of antibiotic-resistant bacteria, posing serious risks to public health. Photocatalytic membrane treatment is a promising technology for controlling TrOCs in wastewater with lower chemical and energy demands. This study investigated the removal characteristics of 11 TrOCs with varying photodegradability and radical reactivity using a titanium dioxide-based photocatalytic membrane system. In pure water, all compounds except tris(2-chloroethyl) phosphate (TCEP) showed removal rates above 72%, indicating effective degradation via radical reactions. In tap and wastewater samples, removal rates significantly decreased, particularly due to radical scavenging by dissolved organic matter, nitrite, and bicarbonate ions. To enhance degradation efficiency in such complex matrices, UV irradiation conditions were optimized. Under irradiation at 365 nm and 100.08 mW/cm^2, removal rates exceeded 78% for all compounds except TCEP. This suggests that high-intensity UV-LED irradiation can compensate for radical loss in wastewater samples, achieving effective pollutant degradation. Additionally, increased radical production under higher UV intensity contributed to suppress membrane fouling. These findings highlight the potential of UV-LED-driven photocatalytic membrane systems for advanced water treatment applications. This work was supported by JSPS KAKENHI Grant Number JP22K18043 and JST NEXUS Japan Grant Number JPMJNX24A1.

Keywords: Photocatalytic membrane; titanium oxide; Water treatment; Trace organic chemicals; UV-LED

*Corresponding author: takeuchi.haruka.6m@kyoto-u.ac.jp

REC-010

In-situ and Operando Analysis of Methanol Electrooxidation with Nickel Foam as Electrocatalyst

Liezle Agasino, Matt Justin Young, Gabrielle Marie Segui, Glennise Faye Mejica, Airon Rae Asuncion, Hannah Joy Drapisa, Jan Goran Tomacruz, and Joey Ocon*

Laboratory of Electrochemical Engineering, University of the Philippines Diliman, Philippines

Fossil fuel combustion drives rising greenhouse gas emissions, demanding cleaner alternatives. Hydrogen, a clean fuel with high specific energy, offers a promising solution. Electrochemical reforming, such as the methanol electrooxidation reaction (MEOR), can produce hydrogen efficiently. This study investigates MEOR using nickel foam as an electrocatalyst. Electrochemical analyses were performed in 1 M KOH + 1 M methanol using an AUTOLAB potentiostat with a three-electrode setup. This includes cyclic voltammetry (CV), linear sweep voltammetry (LSV), and chronoamperometry (CA), followed by DEMS analysis. UV-Vis spectroscopy and Tollen's test further confirmed the results. MEOR was observed to initiate at 0.9 V, with cyclic voltammetry (CV) having a reduction peak at 1 V attributed to $Ni(OH)_2$ reduction. Chronoamperometry (CA) results showed a declining current, suggesting continuous $Ni(OH)_2$ reduction and possible catalyst instability. DEMS detected formaldehyde and formic acid and confirmed via Tollen's test and UV-Vis (223 nm), respectively. These findings collectively support a detailed reaction mechanism for MEOR on nickel foam, with multiple trials confirming electrocatalyst stability. To further strengthen this understanding, future work could apply additional confirmatory tests such as X-ray photoelectron spectroscopy (XPS), Fourier-transform infrared spectroscopy (FTIR), gas chromatography–mass spectrometry (GC–MS), high-performance liquid chromatography (HPLC), and scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM–EDX) to verify intermediate ionic species and surface states.

Keywords: methanol electrooxidation; nickel electrocatalysts; reaction mechanism; differential electrochemical mass spectroscopy

*Corresponding author: jdocon@up.edu.ph

REC-011

Ammonia Synthesis using Dielectric Barrier Discharge under Cryogenic Conditions

Ryogo Serizawa, Satoshi Kodama, and Hidetoshi Sekiguchi*

School of Materials and Chemical Technology, Institute of Science Tokyo, Japan

Few studies have been carried out on plasma-assisted synthesis processes under cryogenic conditions (-60 to -80 °C), however such environments may have potential to provide novel reaction fields and separation processes. This study investigates ammonia (NH_3) synthesis using dielectric barrier discharge (DBD) as a model synthetic process under cryogenic conditions. The DBD was generated by a high-voltage power supply (4.8 kV ,17.6 kHz) between a tungsten rod (φ1 mm) coaxially inserted into a quartz tube (I.D. 6 mm) and an aluminum sheet with a width of 30 mm wrapped around the outer surface of the quartz tube. Nitrogen (75 mL/min) and hydrogen (25 mL/min) were supplied to the discharge, and the experiment was conducted for 2 hours at temperatures of 25 °C, –60 °C, –70 °C, and –80 °C. The outlet gas was bubbled into water, and the NH_3 concentration was determined by titration with dilute hydrochloric acid to calculate the production rate. The results showed that there was no significant difference between the production rate of NH_3 at cryogenic temperatures and that at room temperature, indicating that DBD maintains its reactivity under such cold conditions. This study suggests the high potential for developing novel processes by utilizing plasma in cryogenic environments.

Keywords: cryogenic conditions; plasma; ammonia synthesis; dielectric barrier discharge

*Corresponding author: hsekiguc@chemeng.titech.ac.jp

REC-012

Kinetic Parameter Estimator for Reaction Systems: A Dynamic Regressor Extension and Mixing Procedure Approach

Thanh Sang Nguyen[1], Ngoc Ha Hoang[2], and Mohd Azlan Bin Hussain[3]*

[1]Faculty of Chemical and Food Technology, HCMC University of Technology and Education, Vietnam
[2]Institute of Research Development, Duy Tan University, 550000 Da Nang, Vietnam
[3]Department of Chemical Engineering, Faculty of Engineering, Universiti Malaya, 50603 Kuala Lumpur, Malaysia

This paper aims to design a globally convergent estimator for estimating kinetic parameters of reaction rates, namely activation energies and kinetic constants, using a dynamic regressor extension and mixing (DREM) procedure approach. It is important to note that the appearance of activation energies in exponential terms from the modelling viewpoint of Arrhenius law causes non-separable nonlinearities, thereby limiting the applicability of standard gradient descent (SGD) estimator. To derive a solution for this challenging issue, we first propose an overparameterized linear regression equation, where reaction rates are computed from the extent-based reactor model. The DREM procedure with a second-order differential operator is then applied to this equation for designing a modified GD (MGD) estimator. Interestingly, all kinetic parameters can be estimated simultaneously under an interval exciting condition, which is weaker than the persistency exciting condition. Simulations for the reaction system that synthesizes glycerol from the hydration of 2-3-epoxy-1-propanol in a non-isothermal continuous stirred stank reactor illustrate the proposed MGD estimator.

Keywords: chemical reactor; vessel extent; gradient-descent estimator; system identification; linear regression model

*Corresponding author: mohd_azlan@um.edu.my

REC-013

Translating Science into Impact: University–Industry Co-Creation of the PKTB-Z10SZ Desulfurizer

Carolus Borromeus Rasrendra[1]*, Melia Laniwati[2], Granprix T.M. Kadja[3], Igbn Makertihartha[4], Subagjo Subagjo[2], Althafa Muntaqin[2], Achmad Rois[5], Mustanginah[5], Chairunissa[5], and Insyiah Meida[5]

[1]Chemical Engineering Department, Faculty of Industrial Technology, Institut Teknologi Bandung, Indonesia
[2]Center for Catalysis Engineering, Institut Teknologi Bandung, Bandung, Indonesia
[3]Division of Inorganic and Physical Chemistry, Faculty of Mathematics and Natural Sciences, ITB, Indonesia
[4]Chemical Engineering Department, Faculty of Industrial Technology, ITB, Indonesia
[5]PT Pupuk Kalimantan, Bontang, Kalimantan Timur, Indonesia

The co-creation of the PKTB-Z10SZ desulfurizer exemplifies how research–industry partnerships can accelerate technological breakthroughs into impactful industrial solutions. Through the Merah-Putih innovation initiative, PT Pupuk Kalimantan Timur (PKT) collaborated with the Center for Catalysis Engineering ITB (PRK-ITB) and PT Rekayasa Inovasi ITB (RII) to design, scale, and implement a zinc oxide–based adsorbent for hydrogen sulfide removal. Development was carried out in successive stages: laboratory formulation of 1 kg samples with comprehensive physicochemical characterization; pilot production of a 15 kg prototype, validated against commercial benchmarks; and full commercial deployment of a 12 m^3 batch in natural gas purification units. Across these stages, adsorption performance consistently matched or surpassed imported materials, with long-term operation maintaining H_2S concentrations below 0.05 ppm—well within specification limits. The results highlight not only the technical reliability of the PKTB-Z10SZ adsorbent but also the strategic importance of structured university–industry collaboration in strengthening Indonesia's technological independence.

Keywords: University–industry co-creation; PKTB-Z10SZ; Zinc oxide adsorbent; Hydrogen sulfide removal; Pilot-to-commercial scale-up; Merah-Putih innovation

*Corresponding author: cbr@itb.ac.id

THERMODYNAMICS (THR)

THR-001

Numerical Simulation for Heat Generation Process in a Rice Husk Ash-Synthesized Zeolite-Water Adsorption Heat Pump

Maria Patrichia Oliva* and Ma. Natalia Roxas-Dimaano

University of Santo Tomas, Philippines

Adsorption heat pumps (AHPs) are currently on the rise for providing energy using waste heat from a particular adsorbent-adsorbate pair's adsorption and desorption process. The zeolite-water system is one of the most commonly used adsorbent-adsorbate pair in adsorption heat pumps. In this study, Zeolite synthesized from rice husk ash will be used as an adsorbent to have a more environmentally-friendly approach. This adsorbent will be used in this study due to its raw material availability and low-cost criteria. The study will cover the numerical simulation of an adsorption heat pump using zeolite synthesized from rice husk ash and water as an adsorbent-adsorbate pair, using ANSYS software. The pretext of the study relies on the initial thermodynamic study, which will be done before the numerical simulation of the entire adsorption pump, that determines whether the pair can generate waste heat on par with the existing pairs used in adsorption heat pumps, as reflected in previous studies. This will then be studied for its efficiency and briefly compared with the current range of coefficients of performance (COP) for vapor compression pumps and other existing adsorption heat pump systems previously studied by other researchers. Moreover, this study aims to provide more in-depth knowledge on sustainable energy transmission and contribute to the knowledge pool on heat pumps and their viable materials by providing comprehensible numerical modeling of an adsorption heat pump when used within a manufacturing plant setting. The study, however, will not cover the usage of other adsorbent-adsorbate pairs, nor the study for the optimization of the entire adsorption heat pump system, since the study focuses solely on the viability of an adsorption heat pump employing rice husk ash and water as its adsorbent-adsorbate pair.

Keywords: adsorption; rice husk ash; zeolite; adsorption heat pump; thermodynamic study; numerical simulation

*Corresponding author: mariapatrichia.oliva.gs@ust.edu.ph

TRANSPORT PHENOMENA (TRA)

TRA-001

Evaluation of Infinite Dilution Diffusion Coefficients in Water of Different Brands of Analgesics containing Naproxen as Active Ingredient using Conductance Method

Allan Soriano[1]*, G Bundalian[2], and Gynjere Normanflor Yu[2]

[1]*Department of Chemical Engineering, Gokongwei College of Engineering, De La Salle University, Philippines*
[2]*School of Chemical, Biological, and Materials Engineering and Sciences, Mapúa University, Philippines*

Diffusion is a mixing process on a microscopic scale that is caused by the molecular motion of the particles. Diffusion can be the rate and determining step in many mass transfer operations, such as distillation, and extraction. Moreover, information of diffusion coefficient rates is important for the design of process equipment and for the fate and transport analysis of substances. In this present work the infinite dilution diffusion coefficients in water of pharmaceutical products that contain the active ingredient, Naproxen, were evaluated using the conductance method. The infinite dilution diffusion coefficients were determined from the measured electrolytic conductivities. The temperature and compositional dependency of the conductivity data were also correlated using the Kohlrausch equation and Modified Robinson-Stokes equation. The obtained conductivities were then used to determine the diffusion coefficients and some of its molecular parameters using the Nernst-Haskell, Nernst-Einstein, and Stokes-Einstein equations. The results of the present work will be beneficial to future investigations involving the scale-up analysis of the fate and transport of naproxen in the natural environment.

Keywords: analgesics; conductance method; diffusion coefficient; infinite dilution; naproxen

*Corresponding author: allan.soriano@dlsu.edu.ph

TRA-002

Determination of Effective Moisture Diffusivity Model from Thin Layer Drying of Philippine Medicinal Leaves

Michelle Airah Pablo[1,2], Robby Andre Ching[2], Joshua Nibre[2], John Frederick Tapia[1,2], Kathleen Aviso[2,3], and Allan Soriano[2]*

[1]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2]*Department of Chemical Engineering, De La Salle University, Philippines*
[3]*Gokongwei College of Engineering, De La Salle University, Philippines*

In establishing the drying characteristics of solid food materials, calculation of the transport property effective moisture diffusivity (EMD) is essential. This property provides the possible mass transfer mechanism involved during the drying process which includes surface diffusion, vapor diffusion, liquid diffusion, hydrodynamic flow, and capillary flow. EMD primarily depends on the moisture content, temperature, and physical structure of the material. In this study, the EMD of *Costus igneus* (Insulin Plant), *Lagerstroemia speciosa* (Banaba), and *Blumea balsamifera* (Sambong) were obtained based on the results of thin-layer drying experiments. The EMD values for all the plant systems range from 10^{-12} to 10^{-6} m^2/s. Liquid diffusion was determined to be the main moisture transport mechanism at the earlier stage of drying whereas vapor diffusion takes place at the latter stage. The activation energy for all the plant systems ranges from 49.3 to 80.7 kJ/mol. Correlation model focusing on effective moisture diffusivity, temperature, and moisture content will then be established. This model will be critical in predicting the effective moisture diffusivity when drying medicinal leaves at an upscaled drying process.

Keywords: drying; effective moisture diffusivity; diffusion; moisture transport; medicinal leaves

*Corresponding author: allan.soriano@dlsu.edu.ph

TRA-003

Drying Kinetics Study of *Morus rubra* var. Australian and Illinois Everbearing

Jasper Izak Samson*, Allan Soriano, Mary Therese Necio, Tiffany Lei Po, and Mirra Alessi Santos

Department of Chemical Engineering, Gokongwei College of Engineering, De La Salle University, Manila, Philippines

Mulberry leaves were studied to compare the drying behavior of the Australian and Illinois Everbearing varieties of *Morus rubra*. Drying was conducted using a convective air tray dryer at 45 °C, 50 °C, and 55 °C with an air velocity of 1 m/s. The Australian variety, with an initial moisture content of 247%, dried faster than the Illinois Everbearing variety, which had an initial moisture content of 203%. The faster drying of the Australian variety was attributed to its higher stomatal density of 14.27 stomata/mm^2 and size of 68.45 by 59.52 µm, compared to 9.88 stomata/mm^2 and 29.76 by 20.83 µm for the Illinois Everbearing variety. At 55°C, the equilibrium moisture content for the Australian variety was 8.17%, compared to 2.80% for the Illinois Everbearing variety. The Midilli model provided the best fit for the drying kinetics based on highest average coefficient of determination of 0.9787 and 0.9753, and lowest average root mean square error of 0.04016 and 0.03918 for the Australian and Illinois Everbearing varieties, respectively. Understanding the drying behavior of different mulberry varieties is essential in preservation and can enhance processing efficiency in the food, pharmaceutical, and herbal industries, leading to improved product stability and quality.

Keywords: Drying kinetics; Convective drying; Mulberry leaves; Midilli model

*Corresponding author: jasperizaksamson@gmail.com

TRA-004

Development and Characterization of Geopolymerized Perlite as Potential Packing Material in Packed-Columns

Lola Domnina Pestaño[1], Paul Matthew Gomez[2], Ma. Angela Mendoza[2], and Ryu Ohira[2]*

[1]University of Santo Tomas - Research Center for the Natural Sciences and Applied Sciences, Philippines
[2]University of Santo Tomas, Philippines

Perlite is a naturally occurring volcanic glass that expands significantly when heated, transforming into lightweight material with diverse applications in construction, horticulture, and potentially as a packing material in gas absorbers. In the Philippines, particularly in regions such as Lamba, Albay, Bicol, perlite is abundant and valued for its insulating properties. This research aims to develop and characterize an improved geopolymerized perlite with 25%, 35%, and 45% by weight of sodium silicate (Na_2SiO_3) as a potential packing material in packed-columns. The procedure includes (1) procurement of perlite, (2) geopolymerization of perlite, (3) analysis of geopolymerized perlite for thermal stability, compressive strength, and chemical resistance, and (4) comparison of stability and strength with other geopolymers and potential packing materials. FTIR analysis on the developed material exhibited characteristic peaks corresponding to Si–O, Si–O–M, and O–H vibrations, consistent with aluminosilicate-based geopolymers, confirming successful geopolymerization. Geopolymerized perlite with 25% Na2SiO3 cured at 60°C exhibited the least weight loss, with the highest compressive strength and highest retained mass in the ASTM D 543-21 chemical resistance test, making this geopolymerized perlite a potential packing material. The developed geopolymerized perlite is comparable to other geopolymers in terms of stability and strength.

Keywords: Perlite; Geopolymerization; packing material; packed-column; gas absorption

*Corresponding author: ohira.ryu@gmail.com

TRA-005

Multiphysics Modeling of Sodium-ion Batteries with 3D Interdigitated Electrodes

Ryean Joshua Garcia, Michael Castro, Jan Goran Tomacruz, and Joey Ocon*

Laboratory of Electrochemical Engineering, Department of Chemical Engineering, University of the Philippines – Diliman, Philippines

Sodium-ion batteries (SIBs) offer a sustainable and cost-effective alternative to lithium-ion batteries (LIBs), leveraging abundant sodium resources and similar manufacturing. However, conventional planar electrodes face a trade-off between energy density and power output due to limitations in ion transport and active material utilization. Novel three-dimensional (3D) electrode configurations address this by enabling lateral ion transport, which reduces the ion transport distances regardless of electrode thickness. Despite this potential, 3D designs in SIBs are largely unexplored through multiphysics modeling. This research bridges that gap by modeling and evaluating the discharge curves, energy density, and electrode utilization of SIBs with 3D interdigitated electrodes and comparing it with conventional planar designs. The SIB was simulated via the Doyle-Newman-Fuller model, and parameters for the model were obtained from published literature, where they were experimentally validated. These validated parameters were then applied to simulate 125 µm-thick 3D interdigitated electrodes and compared to 50 µm and 125 µm-thick planar configurations. Performance metrics like discharge curves, energy density, and electrode utilization across 0.5, 1.0, and 2.0 C-rates were then analyzed. Preliminary results show that the 3D interdigitated achieves higher energy density with thicker electrodes while maintaining high power, attributed to the uniform ion transport.

Keywords: Sodium-ion batteries; 3D interdigitated electrodes; Multiphysics modeling; COMSOL simulation

*Corresponding author: joey.ocon@gmail.com

TRA-006

Evaluation and Mathematical Modeling of Drying Kinetics of Microwave-Pretreated, White-Fleshed Taro (*Colocasia esculenta*) Slices with Varying Drying Parameters

Ana Katrina Dumduman[1,2]*, Dinah Jane Martinez[2], Aliah Gianna Ramos[2], Kyra Marie Tuazon[2], Rugi Vicente Rubi[2,3], Jarlie Clemeña[2], Francis Dominic Lavilles[2], Denvert Pangayao[1,2], Allan Soriano[4], and Marianito Margarito[1]

[1]*Department of Science and Technology—Industrial Technology Development Institute, Philippines*
[2]*Pamantasan ng Lungsod ng Maynila, Philippines*
[3]*Adamson University, Philippines*
[4]*De La Salle University, Philippines*

Colocasia esculenta, or taro, is the third most produced tuber and an essential food source in the Philippines. Drying is employed to preserve agricultural products like taro by reducing moisture content through heat and mass transfer to prevent changes caused by microbial spoilage. To enhance drying efficiency, various influencing factors and microwave pretreatment were considered. In this study, the effects of microwave pretreatment and drying parameters such as slice thickness, drying air velocity, and drying air temperature, on the values of effective moisture diffusivity, activation energy, and color change of taro were highlighted. Researchers found that microwave pretreatment enables a faster drying time by reducing the moisture content of the taro samples before the drying process. Researchers concluded that the dried taro slices with a thickness of 3 mm, using a drying air velocity of 1.5 m/s and a drying air temperature of 70°C, yielded the best parameter for higher diffusivity values. Additionally, observations indicate that both microwave pretreatment and drying parameters contributed to shrinkage and induced a significant color change on the surface of the taro samples. Among the five mathematical models utilized, the model by Midilli et al. provided the best fit for the experimental run drying curves.

Keywords: Drying kinetics; White-fleshed Taro; Mathematical Modeling; Microwave Pretreatment; Drying parameters

*Corresponding author: akldumduman.itdi@gmail.com

TRA-007

Stability Improvement of Atmospheric-Pressure Reactive Microwave Plasma

Wataru Fukumoto, Satoshi Kodama, and Hidetoshi Sekiguchi*

Institute of Science Tokyo, School of Materials and Chemical Technology, Japan

Atmospheric-pressure microwave plasma (APMP) is an effective method of gas-phase processing due to its high reactivity and moderate temperatures of several thousand Kelvin. However, stable APMP generation is often affected by flow conditions. In this study, we investigated the operational stability of APMP using argon as a carrier gas and nitrogen, hydrogen and methane as process gases. Two additional measures, including flow modification and an auxiliary plasma jet, were implemented. Atmospheric-pressure microwave plasma was generated at 2.45 GHz using a waveguide applicator equipped with a nozzle that introduced gas as a swirling flow through two ports. The results showed that inserting a quartz tube coaxially into the swirl nozzle at the upstream region of the microwave plasma column achieved an expanded range of discharge-sustaining conditions because it maintained swirl flow in the downstream region. Furthermore, the introduction of an auxiliary argon plasma jet, generated by a dielectric barrier discharge (DBD) through the coaxially inserted quartz tube, contributed to further stabilization and extended the operational range of the APMP.

Keywords: Microwave plasma; Dielectric barrier discharge; Atmospheric pressure plasma; Plasma stability

*Corresponding author: hsekiguc@chemeng.titech.ac.jp

PROCESS SAFETY (PRS)

PRS-001

The Longstanding Application of Quantitative Risk Assessment in Process Industries: A State-of-the-Art Review on Its Quality

Darmawan Ahmad Mukharror[1], Henry Susilo[2], and Heri Hermansyah[3]*

[1]*Chemical Engineering, Universitas Indonesia*
[2]*Honeywell Indonesia*
[3]*Universitas Indonesia*

Quantitative Risk Assessment (QRA) has been in development for over 70 years, initially pioneered by the nuclear industry in the early 1950s following the expansion of nuclear power plants in the United States. Despite its long-standing application, concerns regarding the quality, validity, and reliability of QRA persist. Numerous scholars and practitioners continue to explore unresolved and open questions related to its effectiveness and methodological robustness. This paper aims to review a representative body of scientific literature to analyze trends in QRA quality attributes and measurement approaches. Additionally, it seeks to assess whether past and ongoing efforts to enhance QRA methodologies have effectively addressed the critiques and evaluations found in the literature. The reviewed studies have been systematically evaluated based on key factors, including topics, authorship, sources, and trends concerning fundamental QRA quality attributes such as validity and reliability, along with other dimensions including trustworthiness, usefulness, relevance, compliance, comprehensibility (completeness), resilience, and maturity. The findings provide a comprehensive overview of the current state of QRA quality characteristics and offer insights into defining key performance indicators (KPIs) and key result indicators (KRIs) for evaluating and improving QRA methodologies across various attributes

Keywords: QRA; validity; reliability; key performance indicator; key result indicator

*Corresponding author: heri.hermansyah@ui.ac.id

PARTICULATE TECHNOLOGY (PAR)

PAR-001

Sorption Interactions Between Oxidized Microplastics and Pharmaceutical and Personal Care Products (PPCPs): A Comprehensive Review of Oxidation Processes, Mechanisms, and Influencing Factors

Dale Jason Gamorot and Angelo Earvin Choi*

Department of Chemical Engineering, De La Salle University, Philippines

Microplastics (MPs) have emerged as significant environmental pollutants, raising concerns due to their persistence, widespread distribution, and potential impacts on ecological and human health. Beyond their intrinsic risks, MPs can serve as vectors for other contaminants, notably pharmaceuticals and personal care products (PPCPs). Oxidative processes—whether naturally occurring or engineered—can enhance the sorptive capacity of MPs by introducing oxygen-containing functional groups and increasing surface roughness and area. This review systematically examines the adsorption behavior of PPCPs onto oxidized MPs, focusing on the underlying mechanisms, including hydrophobic interactions, hydrogen bonding, and electrostatic forces. The role of oxidation in modifying the surface chemistry of MPs is explored, as well as the impact of environmental variables such as pH, salinity, and aging. Hydrophilic PPCPs exhibit stronger sorption onto aged or oxidized MPs due to improved surface compatibility and interaction sites. Conversely, shifts in pH and salinity can hinder adsorption by altering surface charge dynamics and reducing electrostatic attraction. This review provides a detailed understanding of the complex interplay between oxidized MPs and PPCPs, highlighting the importance of accounting for physicochemical and environmental variables when assessing the environmental fate and risks of such contaminants.

Keywords: Oxidized microplastics; Environmental contaminants; Adsorption; Surface oxidation

*Corresponding author: angelo.choi@dlsu.edu.ph

PAR-002

Development of Microwave Plasma-Driven Powder Particle Spouted Bed for Fine Particle Treatment

Kazuki Nishimura, Satoshi Kodama, and Hidetoshi Sekiguchi*

School of Materials and Chemical Technology, Institute of Science Tokyo, Japan

A novel fine particle treatment process was studied using a microwave plasma-driven powder particle spouted bed (PPSB) under atmospheric pressure. Aluminum hydroxide particles with diameters of several micrometers were treated with coarse medium particles of brown fused alumina with diameters of several hundred micrometers in the microwave plasma-driven PPSB. First, the stability of the microwave plasma-driven PPSB was investigated by examining reactor configurations such as the distance between the plasma zone and the spouted bed inlet as well as by varying operating conditions such as electric discharge power of microwave, gas flow rate, diameters of coarse particles, and the amount of fine particles introduced. After determining the stable operating conditions, the pyrolysis behavior of aluminum hydroxide was evaluated using thermogravimetry and X-ray diffraction of the treated fine particles. The results showed that the aluminum hydroxide was thermally decomposed and converted into alumina, suggesting the high potential of the microwave plasma-driven PPSB for fine particle treatment.

Keywords: Microwave plasma; Powder particle spouted bed(PPSB); Fine particle; Pyrolysis

*Corresponding author: hsekiguc@chemeng.titech.ac.jp

PAR-003

Mathematical Modeling of Particle Solidification in a Urea Prilling Tower

Tuan-Anh Nguyen*, Van Han Dang, and Quoc Lan Nguyen

Ho Chi Minh City University of Technology, Vietnam

In the manufacturing of granular urea, the technique of prilling is utilized rather frequently because of the low operational cost. In the process, the liquid droplets that are produced fall along the tower to the ground and become solid due to the removal of heat by the cooling air, which flows in the opposite direction of the stream. Generally, mathematical modeling studies of this process considered three sequential thermal intervals for the solidification of urea droplets: the cooling of liquid drops, solidification at the freezing temperature of the liquid phase, and cooling of complete solid particles. This consideration is not reasonable due to the continuous nature of the process. In this study, the solidification of the urea droplets was considered as a two-phase Stefan problem with a convective flux boundary condition rather than dividing the whole process into three sequential steps. The heat transfer problem was solved numerically using the enthalpy method. The mathematical modeling also includes mass and momentum transfer. The system of partial differential equation was solved simultanously and the computaional results are validated with real plant data.

Keywords: Prilling; urea; mathematical modeling; simulation; Stefan problem; free boundary problem

*Corresponding author: anh.nguyen@hcmut.edu.vn

WATER AND WASTEWATER ENGINEERING (WWE)

WWE-002

Photo-Fenton for Treatment of Metronidazole in Wastewater

Tomas Emilio Custodio[1], Justine Hamada[1], Jacob Alexander Lai[1], Justin Ryan Pamintuan[1], Gerianne Mae Arada[1,4], Kim Ahmed Sadol[1,4], Lemuel Agonoy[4], Johara Capingian[1,4], Denvert Pangayao[1], Aileen Orbecido[1,4], Joseph Ortenero[1,4], Carla Mae Pausta[1,4], Michael Angelo Promentilla, Liza Bautista-Patacsil[2], Joel Cornista[3], and Arnel Beltran[1,4]*

[1]Department of Chemical Engineering, De La Salle University, Manila, Philippines
[2]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[3]Department of Biology, University of the Philippines Manila, Philippines
[4]Center for Engineering and Sustainable Development Research, De La Salle University, Manila, Philippines

Public health is at risk due to the presence of trace amounts of antibiotics in aquatic systems, including drinking water, playing a significant role in the widespread of antimicrobial resistance. Metronidazole (MET), frequently detected in wastewater due to incomplete metabolism in the human body and improper disposal practices further highlights this issue. This study explores the degradation of 50 mg/L MET in a synthetic wastewater using the Photo-Fenton process within a 2.5 L batch reactor. A 2k factorial design of the experiment was utilized to evaluate the influence of three factors: hydrogen peroxide at 2 mM and 5 mM, ferrous sulfate at 2 mM and 5 mM, and ultraviolet (UV) light intensity at 11 W and 36 W. MET removal rate was determined using a UV-visible spectrophotometer. The resulting optimal condition–2 mM ferrous sulfate, 5 mM hydrogen peroxide, and 11 W UV intensity–achieved a complete (100%) removal of MET. Comparing the parameters, the concentration of hydrogen peroxide had a significant effect on the MET removal rate. Kinetics analysis under optimal conditions indicated that MET degradation followed a pseudo-first-order kinetics model.

Keywords: Photo-Fenton process; Antimicrobial Resistance; Metronidazole; Optimization; Kinetics

*Corresponding author: arnel.beltran@dlsu.edu.ph

WWE-003

Photo-Fenton for Treatment of Ciprofloxacin in Wastewater

Tomas Emilio Custodio[1], Justine Hamada[1], Jacob Alexander Lai[1], Justin Ryan Pamintuan[1], Gerianne Mae Arada[1,4], Kim Ahmed Sadol[1,4], Lemuel Agonoy[4], Johara Capingian[1,4], Denvert Pangayao[1], Aileen Orbecido[1,4], Joseph Ortenero[1,4], Carla Mae Pausta[1,4], Michael Angelo Promentilla[1,4], Liza Bautista-Patacsil[2], Joel Cornista[3], and Arnel Beltran[1,4]*

[1]*Department of Chemical Engineering, De La Salle University, Manila, Philippines*
[2]*Department of Engineering Science, University of the Philippines Los Baños, Philippines*
[3]*Department of Biology, University of the Philippines Manila, Philippines*
[4]*Center for Engineering and Sustainable Development Research, De La Salle University, Manila, Philippines*

The low-concentration presence of antibiotics in different water environments, including drinking water, contributes to the growing issue of antimicrobial resistance, posing a high risk to public health. Ciprofloxacin (CIP), commonly found in wastewater effluent due to the human body not fully metabolizing antibiotics and improper disposal, exemplifies this risk. This study investigates the Photo-Fenton process to degrade 50 mg/L CIP in a synthetic wastewater solution with a batch reactor volume of 2.5 L. A 2k factorial experiment design was employed to assess the effects of three variables: hydrogen peroxide (2 mM and 5 mM), ferrous sulfate (2 mM and 5 mM), and ultraviolet (UV) light intensity (11 W and 36 W). CIP removal rate was analyzed through a UV-visible (UV-Vis) spectrophotometer. Results showed an optimal parameter of 2 mM ferrous sulfate, 5 mM hydrogen peroxide, and 11 W UV intensity achieving a removal rate of 97.67%. Among the variables, it was seen that the concentration of hydrogen peroxide had a significant effect on the CIP removal rate. The kinetics were measured based on the optimal parameters revealing that the CIP degradation followed a pseudo-first-order kinetics model.

Keywords: Photo-Fenton process; Antimicrobial Resistance; Ciprofloxacin; Optimization; Kinetics

*Corresponding author: arnel.beltran@dlsu.edu.ph

WWE-004

Degradation of Ciprofloxacin in Nickel-Zinc Selenide on Nickel Foam using the Electro-Fenton Process

Victor Timothy Garcia[1], Aldrin Jelo Tobias[1], Naomi De Leon[1], Leahchim Emerlinda Edwards[1], Joseph Ortenero[1,2], Kim Ahmed Sadol[1,2], Gerianne Mae Arada[1,2], Brian Gerald Bueno[1], Johara Capingian[1,2], Lemuel Agonoy[2], Aileen Orbecido[1,2], Carla Mae Pausta[1,2], Michael Angelo Promentilla[1,2], Liza Bautista-Patacsil[3], Joel Cornista[4], and Arnel Beltran[1,2]*

[1]Department of Chemical Engineering, De La Salle University, Manila, Philippines
[2]Center for Engineering and Sustainable Development Research, De La Salle University, Manila, Philippines
[3]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[4]Department of Biology, University of the Philippines Manila, Philippines

Untreated antibiotics in wastewater present a tremendous global health concern, contributing to the escalating threat of antibiotic resistance. Due to its recalcitrant nature, these emerging contaminants resist conventional treatment techniques. Electro-Fenton (EF) is a promising technology for efficient and environmentally compatible antibiotic degradation, relying on in situ hydroxyl radical generation. Electrode material selection can boost EF efficiency through enhanced catalytic performance, stability, and cost-effectiveness. In this work, NiZnSe synthesized through electrodeposition is drop-cast on nickel foam and used as an electro-Fenton cathode in a three-electrode undivided cell to degrade ciprofloxacin (CIP). CIP concentration is measured using ultraviolet-visible (UV-Vis) spectrophotometry before and after the 60-minute run. The optimum process condition is determined using central composite design (CCD) by varying initial Fe^{2+} concentration (1, 2, 3 mM) and applied current (200, 300, 350 mA). SEM and TEM micrographs of NiZnSe deposits show an urchin–like and irregular surface morphology, suggesting high porosity and, subsequently, a high catalytic activity. CIP degradation of 57.89% is the calculated maximum for an aqueous solution of 50 ppm CIP with an optimum Fe^{2+} initial concentration of 1 mM and an applied current of 350 mA. Results show that high applied current and low initial concentration of Fe^{2+} promote greater CIP degradation.

Keywords: NiZnSe/NF electrode; electro-Fenton; degradation; ciprofloxacin; optimization

*Corresponding author: arnel.beltran@dlsu.edu.ph

WWE-005

Water Quality Monitoring Method with High Spatial Resolution in Coastal Area for Seasonal Operation of Sewage Treatment Plants

Akira Umehara[1], Ryoji Hamawaki[2], Feng Wang[1], Satoshi Nakai[3], and Wataru Nishijima[1]*

[1]*Environmental Research and Management Center, Hiroshima University, Japan*
[2]*Public Health and Environment Center, Hiroshima Prefectural Technology Research Institute, Japan*
[3]*Graduate School of Advanced Science and Engineering, Hiroshima University, Japan*

The Seto Inland Sea is the largest semi-enclosed sea in Japan. The Total Pollutant Load Control System was implemented in 1979 due to eutrophication and have successfully reduced anthropogenic nutrient loading from the land. However, nutrient concentrations of the water and total fish catch in the Seto Inland Sea has declined. Therefore, seasonal operation of sewage treatment plants was implemented to increase the nutrient concentrations in the sea during the cold season. In this study, we investigated a water quality monitoring method with high spatial resolution in the coastal area and clarified changes in nutrient concentrations in Hiro Bay before and after seasonal operation. The line observation was able to take 20 times more surface data than the fixed-point observation, and the drone observation was able to produce a high-resolution maps of surface Chl.a concentration in the coastal zone. This research was performed by the Environment Research and Technology Development Fund (JPMEERF20225002) of the Environmental Restoration and Conservation Agency provided by Ministry of the Environment of Japan. A part of this work was supported by JST NEXUS, Japan Grant Number JPMJNX24A1.

Keywords: Hiro bay; Line observation; Nutrient supply; Sewage plant; UAV

*Corresponding author: wataru@hiroshima-u.ac.jp

WWE-006

Development of Efficient Decomposition Conditions for Dibutyl Phosphate Using Interfacial Pulsed Arc Discharge

Mone Tanaka[1], Kiyoshi Anzai[2], Takeshi Tsukada[2], and Mitsuru Sasaki[1]*

[1]*Kumamoto University, Japan*
[2]*Japan Nuclear Fuel Limited, Japan*

Dibutyl phosphate (DBP), generated in the reprocessing of spent fuel, forms complexes with metal ions in high-level radioactive liquid waste, causing pipe blockages and foaming during vitrification. While UV degradation has been studied, it suffers from low throughput and limited scalability. To address this, we investigated DBP decomposition using an interfacial pulsed arc discharge in alkaline liquid waste. A simulated waste solution containing 5 g/L DBP in 1 mol/L Na_2CO_3, $NaNO_3$, and $NaNO_2$ was used. Batch tests with various electrode materials showed that tungsten doped with 2% lanthanum had the highest reaction efficiency and the least degradation per energy unit. Based on these results, continuous flow experiments were performed using a prototype reactor equipped with a peristaltic pump and constant liquid level control. Elemental analysis of Inconel 600 electrodes is ongoing, and both materials are being tested under circulation to assess their suitability for long-term use. This work contributes to the development of an efficient and scalable DBP decomposition process, enhancing the safety and sustainability of vitrification systems. This work was performed as a part of the basic research programs of vitrification technology for waste volume reduction（JPJ010599）supported by the Ministry of Economy, Trade and Industry, Japan.

Keywords: Interfacial pulsed arc discharge; Dibutyl phosphate; Electrodes; Hydrolysis UAV

*Corresponding author: msasaki@kumamoto-u.ac.jp

WWE-007

PBA-Coated Ti_3C_2 Nanocomposite for Capacitive Deionination of Cationic Species

Nai-Ying Wang and Ruey-An Doong*

National Tsing Hua University, Taiwan

The increase in population as well as climate change worldwide has caused water shortage severely. The development of electrochemical method for ion removal has received consideration attention on water and wastewater treatment. Capacitive deionization (CDI) is a promising electrochemical technology in ion removal at different water bodies. In this study, a novel nanomaterial was developed by coating Prussian blue analogue (PBA) material, NiHCF, onto the Ti_3C_2 MXene nanosheets, a newly developed 2-D material prepared by the in-situ HF method. The surface area increases upon the increase in the added amount of NiHCF from 20 to 40 wt%, and a high specific surface area of 189 m^2 g^{-1} is achieved at 40 wt% PBA@MXN. After using the 40 wt% PBA@MXN as the electrode materials, a specific electrosorption capacity (SEC) of 55 mg g^{-1} is obtained for CDI system in 2000 mg L^{-1} NaCl solution at 1.2 V. Addition of cation and anion exchange membranes significantly enhances the SEC to 77 mg-Na^+/g. In addition, a 2-fold increase in charge efficiency is also observed in the presence of membrane, presumably attributed to the reduction of co-ion repulsion effect. Results clearly show that PBA can provide a vast ion storage site in the lattice structure while MXN offers excellent conductivity and structure tunability, highlighting the promise of PBA@MXN nanocomposite to effectively remove ions in water and wastewater treatment.

Keywords: capacitive deionization; Ti_3C_2 MXene; Prussian blue analogues (PBA); specific electrosorption capacity (SEC); intercalation

*Corresponding author: radoong@mx.nthu.edu.tw

WWE-008

Reaction Kinetics of Ciprofloxacin Removal from Synthetic Wastewater via Electro-Photo-Fenton Treatment

Jan Aubrey Valdez[1], Lio Josepat Domingo[1], Bjorn Joenrique Schen Gerona[1], Lemuel Agonoy[4], Kim Ahmed Sadol[1,4], Brian Gerald Bueno[1], Gerianne Mae Arada[1,4], Johara Capingian[1,4], Denvert Pangayao[1], Aileen Orbecido[1,4], Joseph Ortenero[1,4], Carla Mae Pausta[1,4], Liza Bautista-Patacsil[2], Joel Cornista[3], Michael Angelo Promentilla[1,4], and Arnel Beltran[1,4]*

[1]Department of Chemical Engineering, De La Salle University, Manila, Philippines
[2]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[3]Department of Biology, University of the Philippines Manila, Philippines
[4]Center for Engineering and Sustainable Development Research, De La Salle University, Philippines

Electro-Photo-Fenton (EPF) treatment is an Advanced Oxidation Process that combines the Electro-Fenton and Photo-Fenton processes to improve the efficiency of the treatment. A 2.5-liter EPF reactor was used to determine the optimal conditions degradation of Ciprofloxacin in terms of pH levels and initial concentration. The results indicated better degradation at a low pH of 2.0 The kinetic model of the EPF treatment of Ciprofloxacin under this condition was done with a low and a high initial concentration, done in duplicate. The samples were collected before the treatment, after 1, 3, 5, 10, 15, 30, 60, and 120 minutes have elapsed since the beginning of the treatment. The determined degradation at pH 2 and 10 ppm initial concentration after 120 minutes was 46%, while the pH 2 and 50 ppm initial concentration exhibited a 37% degradation after 120 minutes. Using the integrated rate laws, the reaction follows a Pseudo-First Order Reaction with an R2 value of 0.9959 for pH 2 and 10 ppm initial concentration and 0.9603 for pH 2 and 50 ppm initial concentration.

Keywords: Advanced Oxidation Processes; Electro-Photo-Fenton treatment; Antibiotics; Ciprofloxacin; Reaction Kinetics; Synthesized Wastewater

*Corresponding author: arnel.beltran@dlsu.edu.ph

WWE-009

Electrocoagulation Process for Post-Treatment of Fats, Oils, and Grease (FOG) in Wastewater Using Recycled Aluminum Electrodes

E'Lyssa Rodica*, Frances Alivoso, and Adrian Oblena

Technological Institute of the Philippines, Quezon City, Philippines

The quick service restaurant industry, commonly known as fast food chains, is an expanding industry in the country with a market size of $4.6 billion in 2018 and is projected to reach $7.9 billion by 2026. Wastewater from this nature of business is highly rich in organic materials such as fats, oils, and greases (FOG), mainly due to food product preparation and serving. Integrating grease traps is one of the most common solutions for fast food chains to handle high FOG in their wastewater. However, studies revealed that these technologies do not entirely eliminate FOG, especially in high flow rates. Additionally, emulsification of FOG due to activities such as dishwashing and high-temperature water increases its risk of escaping grease traps. FOG in wastewater poses the problem of constricting sewer lines and causing blockages if not properly handled and treated. Electrocoagulation is an environmentally conscious technology that efficiently treats wastewater with minimal secondary pollutants and without additional chemicals. This treatment utilizes electrodes, which can generate in-situ coagulants when combined with electricity, that can trap and separate pollutants from the water. Particularly, electrocoagulation is effective in destabilization of oil-in-water emulsions. This study employed recycled aluminum electrodes from soda cans since aluminum is one of the most common electrode choices in electrocoagulation. XRF analysis pre-electrocoagulation identified 98.02 wt% Al in the recycled cans. SEM-EDS determined the morphology and elemental composition of the anode post-electrocoagulation. FTIR analysis of the flocs determined the presence of chemical bonds and functional groups in the sample. Process variables current, electrolysis time, and salt (NaCl) concentration were optimized using the Box-Behnken Design under response surface methodology. Two targets were set for the optimization. First, the model predicted maximum FOG removal at 0.614A, 52 min, and 3.23 g/L NaCl. Second, the model predicted standard FOG concentration (5 mg/L) at 0.475A, 20 min, and 2.32 g/L NaCl. Kinetics of the FOG removal were also identified through first-order kinetics. The corrosion rate was determined by quantifying the mass loss of the anode. Lastly, a cost analysis was performed concerning the energy, electrode, and salt consumption of the electrocoagulation setup at optimum conditions.

Keywords: FOG; fast food; electrocoagulation; recycled aluminum cans; optimization; removal kinetics; corrosion rate; cost analysis

*Corresponding author: qerrodica@tip.edu.ph

WWE-011

Electrocoagulation for Sustainable Palm Oil Mill Management: A Comprehensive Review of Recent Advances

Vyvyen Zena Cabrera, Markus Biehn Sorilla, Sophia Tercenio, Angelo Earvin Choi, and Joseph Ortenero*

Department of Chemical Engineering, De La Salle University, Manila, Philippines

Palm oil mill effluent (POME) poses a risk to the environment as it contains organic matter. Its raw effluent necessitates treatment before it is released to reduce possible toxic compounds impermissible to the allowed threshold value. Several technologies have been adopted for POME treatment. Most fall short of effectively addressing simultaneously the efficiency and cost-effectiveness of the treatment. Electrocoagulation (EC) directly applies current to sacrificial electrodes submerged in an aqueous solution. It has been a subject of interest for its rapid efficiency and cost-effectiveness. This review examines the integration of electrocoagulation for POME treatment. This covers an assessment of its efficiency, key operational parameters, and leverage against other present technologies. This paper condenses principal findings from recent studies regarding EC for POME treatment. This encompasses the optimum parameters and conditions of EC that improve the efficiency and reduce the cost of its process. Comparative studies revealed that EC is a more efficient and cost-effective treatment for POME in comparison with ponding system, membrane anaerobic systems (MAS), microbial fuel cells (MFC), and supercritical water gasification (SWCG).

Keywords: electrocoagulation; organic matter; palm oil mill effluent; palm oil industry; treatment technologies

*Corresponding author: joseph.ortenero@dlsu.edu.ph

WWE-012

Ciprofloxacin and Metronidazole Removal in Wastewater Using Submerged Membrane Bioreactor

Lemuel Joshua Ubiña[1]*, Erica Mai Cabuyao[2], Nathaniel John Cruz[2], Shaughn Dominic Padon[2], Rowlan Joseph Guia[1], Christian Laurence Aquino[1], Lester Raj Somera[1], Sheryl Lozel Arreola[3], Ramon Christian Eusebio[4], Arnel Beltran[5], Joel Cornista[2], and Liza Bautista-Patacsil[1]

[1]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[2]Department of Biology, University of the Philippines Manila, Philippines
[3]Institute of Chemistry, University of the Philippines Los Baños, Philippines
[4]Department of Chemical Engineering, University of the Philippines Los Baños, Philippines
[5]Department of Chemical Engineering, De La Salle University, Philippines

Antibiotics are recognized as an emerging contaminant of concern, presenting a significant threat in wastewater due to their role in promoting antimicrobial resistance (AMR), which is acknowledged as a significant global health challenge. A submerged membrane bioreactor (SMBR) is an advanced biological wastewater treatment method that employs microorganisms to degrade pollutants coupled with membrane filtration set-up. This study evaluated the removal of ciprofloxacin (CIP) and metronidazole (MET) using biodegrading bacteria in a laboratory-scale SMBR in relation to the acquisition of resistance genes, considering both the time of exposure and the initial concentration of the antibiotics. The removal efficiency for wastewater containing a single antibiotic component was found to be higher than that of wastewater with a double antibiotic component under identical parameters: an initial antibiotic concentration of 5 mg/L, a solids retention time (SRT) of 2 weeks, and a hydraulic retention time (HRT) of 24 hours, conducted in semi-batch mode within the SMBR. The antibiogram results suggested that, although the bacteria were susceptible to acquiring resistance, the conditions over the 2-week period and the initial concentration of 5 mg/L were insufficient to induce any resistance.

Keywords: Emerging Contaminants; Antibiotics; Antimicrobial Resistance; Membrane Reactor; Biodegradation

*Corresponding author: lbubina@up.edu.ph

WWE-013

Adsorption of Ciprofloxacin in a Packed Bed Column using 3D-Printed Sorbent made with H_3PO_4-Activated Biochar derived from Sugarcane Bagasse

Rowlan Joseph Guia[1]*, Lemuel Joshua Ubiña[1], Edward Paul Marasigan[2], Christian Laurence Aquino[1], Lester Raj Somera[1], Mary Donnabelle Balela[3], Arnel Beltran[4], Joel Cornista[5], and Liza Bautista-Patacsil[1]

[1]University of the Philippines Los Baños, Philippines
[2]Department of Science and Technology - Forest Products Research and Development Institute, Philippines
[3]University of the Philippines Diliman, Philippines
[4]De La Salle University Manila, Philippines
[5]University of the Philippines Manila, Philippines

Antibiotics such as ciprofloxacin (CIP) in wastewater pose a significant and pressing concern as an emerging contaminant. Several methods have been tested for the removal of CIP-rich effluents, including Fenton's oxidation, PhotoFenton oxidation, photochemical degradation, ozonation, and adsorption. Adsorption is considered an attractive process due to its ease of operation, lower energy consumption, and no by-products. This study investigated the performance for removing CIP from synthetic wastewater through adsorption using 3D-printed sorbent made with phosphoric acid (H_3PO_4) activated biochar derived from sugarcane bagasse. The adsorbent was synthesized using a 90:10 weight ratio of bentonite clay to activated carbon. The maximum saturation capacity was obtained using the wastewater flow rate of 3.0 mL/min and 10 mg/L as the initial concentration of the effluent. The breakthrough curve data adequately fit in Thomas and Yoon-Nelson models. H_2O_2 and thermal treatment are possible ways for adsorbent regeneration.

Keywords: Emerging Contaminants of Concern; Ciprofloxacin; Continuous adsorption studies; Adsorption; Kinetic modeling; Adsorbent Regeneration

*Corresponding author: raguia@up.edu.ph

WWE-014

Study on the Effect of pH on the Simultaneous Recovery of Lead and Zinc from Simulated Lead Acid Battery Industry Wastewater by Fluidized Bed Homogeneous Granulation Process

Roselle Mamuad[1,2]*, Angelo Earvin Choi[2], and Ming Chun Lu[3]

[1]*Mariano Marcos State University, Philippines*
[2]*De La Salle University, Philippines*
[3]*National Chung Hsing University, Taiwan*

The increasing contamination of water bodies by heavy metals, particularly lead (Pb) and zinc (Zn), poses a significant threat to human health and the environment. This study explores an innovative approach for effectively removing Pb and Zn from simulated lead-acid battery industry wastewater (LABIW) using a fluidized bed homogeneous granulation (FBHG) process. This method involves forming granules within a fluidized bed reactor, presenting a unique and promising technique for enhancing the recovery of metal ions. The study systematically examines the impact of pH on the FBHG process. The study revealed that FBHG can achieve exceptionally high Pb and Zn total removal efficiencies, consistently exceeding 99% at pH of 9.5, 10 and 10.5. Highest granulation efficiency was obtained at pH 10.5 both for Pb and Zn. FTIR results confirmed that the granules recovered are in the form of carbonate compounds in all pH ranges while hydroxide is present in pH 10.5. XRD results identified that the granules were specifically in the form of ZnCO3, Cerrusite (PbCO3) and Hydrocerrusite (Pb3 (CO3)2(OH)2). The FBHG process demonstrates significant potential for efficient Pb and Zn removal from wastewater. This makes it a promising solution for treating LABIW wastewater and other water treatment applications.

Keywords: homogeneous crystallization; lead; zinc

*Corresponding author: roselle_mamuad@dlsu.edu.ph

ENERGY AND CLIMATE CHANGE (ECC)

ECC-001

Selection and Evaluation of Geological Reservoirs for CO_2 Storage using Neutrosophic Data Envelopment Analysis (NDEA)

John Frederick Tapia*

De La Salle University – Manila, Philippines

Carbon capture, utilization, and storage (CCUS) is an important technology for climate change mitigation. It enables the use of fossil fuel-based power plants by capturing CO_2 from its flue gas. The captured CO_2 is then transported through pipelines and either utilize it for high-value products or inject it into the underground reservoir for long-term storage. The greenhouse gas reduction of CCUS is mainly attributed to storage. Estimating the characteristics of underground reservoirs for CO_2 storage involves uncertainties due to the complex properties of the geological formation. These uncertainties may pose risks of incurring additional storage costs. This study addresses the need to manage these risks by applying a neutrosophic data envelopment analysis (NDEA) model to evaluate and select CO_2 storage options under uncertainty. The model uses input and output parameters expressed as range with values characterized with membership, non-membership, and indeterminacy values. A case study is used to illustrate the model.

Keywords: multi-criteria decision analysis; optimization; data envelopment analysis; neutrosophic sets

*Corresponding author: john.frederick.tapia@dlsu.edu.ph

ECC-003

PyPSA-Pilipinas: A 28-Node Spatial and 8760-h Temporal Resolution of Electricity-Only Open-Source Philippine Power Grid Model for Scenario Analysis

Eugene Jr. Esparcia[1], Giancarlo Dominador Sanglay[1], Anthony John Santos[1], Kevin Lester Lobo[1,2], Sophia Bernadette Lunor[1], Czarina Ann Espera[1], Genev Yesiree Garcia[1,3], Arizeo Salac[1], and Joey Ocon[1]*

[1]University of the Philippines – Diliman, Philippines
[2]University of Santo Tomas, Philippines
[3]University of the Philippines – Los Baños, Philippines

Energy modelling tools are used to quantitatively analyze different energy scenarios for planning the national energy system of a particular country. For the Philippines, most of the energy models so far are limited and usually comprise of single to few nodes which do not capture the nuances of the power grid. This work introduces the PyPSA-Pilipinas model, which consist of 28 nodes and 8760-h resolution. The model also incorporates transformers, and line and transformer losses to better simulate the power network. The model incorporates transmission and distribution marginal costs, and some relevant regulations in the Philippines, such as the 2021 greenfield coal power plant moratorium. The model is solved using rolling horizon optimization to reduce memory requirement and to simulate uncertainty handling. Modeling results generally show no substantial additional installations beyond DOE listing for 2030, suggesting the Philippine Energy Plan (PEP) is on-track. For 2035 and beyond, substantial additional installations are needed with most coming from renewable energy generators to compensate for retirement and higher load demand while being align with the increasing renewable portfolio standard requirement.

Keywords: Philippines; energy systems; PyPSA; modelling

*Corresponding author: jdocon@up.edu.ph

ECC-004

Integration and Evaluation of Carbon Budgeting and Pricing in a PyPSA-Based Philippine Energy System Model

Justine Anne Aguilar, Rod Vincent Morada, Karylle Ingrid Mazo, Eugene Esparcia Jr., Giancarlo Dominador Sanglay, Jan Goran Tomacruz, and Joey Ocon*

Laboratory of Electrochemical Engineering, University of the Philippines Diliman, Philippines

The Philippines must consider decarbonization strategies for the energy sector to comply with the Paris Agreement. Carbon pricing has been gaining momentum as a greenhouse gas (GHG) mitigation strategy but there is currently no implementation in the Philippines and the integration of carbon budgets and taxes in local energy system models remains limited. This study utilizes a Python for Power System Analysis (PyPSA) model of the Philippine energy system to develop and evaluate localized scenarios involving carbon pricing. The model was able to simulate carbon budgets and taxes through added constraints. Results from CO_2 emission constraints shifted the energy mix in favor of high-output, low emission generators and renewable energy. A carbon taxation scheme resulted in a minimized cost of energy considering price equivalences for emissions, especially for generators with a high CO_2 output, and significant reduction in GHG emissions. The results indicate that the introduction of carbon pricing can decarbonize the power sector and pave the way towards a low-carbon future for the Philippines.

Keywords: Philippines; energy systems modeling; PyPSA; carbon pricing; carbon budgets

*Corresponding author: jdocon@up.edu.ph

ECC-005

Magnetic Solid Support Strategies: Advancing Polyoxometalate (POM)-Based Catalysts in Oxidative Desulfurization

Andrey Clarice Gelogo[1], Angelo Earvin Choi[1]*, Nathaniel Dugos[1], and Meng-Wei Wan[2]

[1]*De La Salle University – Manila, Philippines*
[2]*Chia Nan University of Pharmacy and Science, Taiwan*

High sulfur levels in liquid fuels lead to increased emissions of sulfur oxides during combustion, exacerbating environmental and health risks. Desulfurization is a critical process in fuel refining processes to reduce sulfur content. Among various techniques, oxidative desulfurization (ODS) has become increasingly recognized due to its mild operating conditions and efficiency in the removal of refractory sulfur compounds, such as dibenzothiophene (DBT) and benzothiophene (BT), from fuels. The efficiency of sulfur removal via ODS is influenced by several key parameters: reaction duration, operating temperature, the type and concentration of oxidant, and the nature and dosage of the catalyst. Although polyoxometalates (POMs) exhibit excellent catalytic activity in ODS processes, their homogeneous nature and poor recoverability hinder their application. Recent advancements have focused on improving POM performance through heterogeneous supports to overcome these limitations. The encapsulation of POMs in magnetic particles has been demonstrated to enhance their structural stability and accessibility to active sites, contributing to sustained catalytic performance. Additionally, the magnetic properties facilitate a simpler catalyst recovery and reuse through magnetic separation, eliminating the need for complex and energy-intensive processes. This review highlights the recent advancements in using magnetic particles as heterogeneous support for POM catalysts, emphasizing their role in stabilizing POM catalysts while improving the sustainability of the ODS process.

Keywords: magnetic support; oxidative desulfurization; polyoxometalate catalyst

*Corresponding author: angelo.choi@dlsu.edu.ph

ECC-007

Sizing and Siting of the Short- and Long- Duration Energy Storage Requirements in the Philippine Clean Energy Future Scenarios

Giancarlo Dominador Sanglay, Czarina Ann Espera, Eugene Jr. Esparcia, and Joey Ocon*

University of the Philippines – Diliman, Philippines

The Philippine Energy Plan (PEP) 2023–2050 targets 35% renewable energy (RE) share by 2030 and 50% by 2040. 19,190.02 MW of committed power projects have been approved, including 11,684.28 MW of RE and 1,934.00 MW of Battery Energy Storage Systems (BESS), set for operation by 2030. However, the increasing share of variable renewable energy (VRE) challenges grid reliability. With Python for Power Systems Analysis (PyPSA), this study optimized the sizing and siting of additional lithium-ion BESS with discharge durations of 1, 1.5, 4, 6, and 8 hours across the country. It also aims to explore the impact of pumped hydro energy storage (PHES) integration into the grid, in light of the recent awarding of 2 GW of PHES projects under the DOE's Green Energy Auction Program. The work provides a BESS expansion plan using the PyPSA-Pilipinas model, a high-resolution model of the Philippine grid with 28 nodes and 8760-hour resolution. Additional BESS and generators are unfavorable by 2030. By 2040, short-duration BESS for frequency regulation and longer-duration BESS were added to the network due to power plant retirements and higher RE targets. Results provide insights for grid and energy storage planners in the Philippines.

Keywords: Philippines; energy systems modelling; PyPSA; BESS; discharge durations; PHES

*Corresponding author: joeyocon@gmail.com

ECC-008

Effect of Temperature on PdCu Catalyst for Formic Acid Electro-Oxidation

Jeraldine Raymundo, Zailah Elaine Guanco, Lery Jeremiah Gallos, Daniel Eldrei Loresca, Jan Goran Tomacruz, and Julie Anne Paraggua*

Laboratory of Electrochemical Engineering, University of the Philippines Diliman, Philippines

The shift toward net zero emissions has spurred interest in greener energy technologies like direct formic acid fuel cells (DFAFCs), which offer high efficiency and favorable oxidation kinetics due to their direct electro-oxidation pathway that minimizes CO poisoning. Palladium (Pd) is widely used as a catalyst for formic acid electro-oxidation (FAEO), but alloying it with copper (Cu) enhances stability and reduces cost. Despite practical DFAFC operation occurring at elevated temperatures (60–80°C), most mechanistic studies are limited to room temperature. This study explores the performance of a PdCu catalyst at 25°C, 60°C, and 80°C. The catalyst was synthesized via a one-pot method and will be characterized using SEM-EDX, cyclic voltammetry (CV), Raman, and FTIR spectroscopy. FAEO activity and stability were evaluated through CV, linear sweep voltammetry (LSV), and chronoamperometry (CA). Preliminary results show uniform spherical morphology and the successful incorporation of Pd and Cu. CV results indicate both direct and indirect FAEO pathways are active. Optimal FAEO kinetics were observed at 80°C, while greater catalyst stability occurred at 25°C, highlighting a trade-off between activity and degradation. Future work will involve in-situ techniques such as DEMS and computational studies like DFT to better understand the reaction mechanisms.

Keywords: formic acid; electrocatalysis; electro-oxidation; temperature effects; fuel cells

*Corresponding author: jddelrosario2@up.edu.ph

ECC-009

Feasibility Analysis of Commercial PV-Battery Microgrids in the Philippines with SAM-Based Financial Modeling

Ma Cristina Joyce Manalo[1,2]*, Meryll Hannah Bautista[1], and Maria Natalia Dimaano[1]

[1]*University of Santo Tomas, Philippines*
[2]*Far Eastern University - Institute of Technology, Philippines*

This study investigates the techno-economic feasibility of PV-battery energy storage systems in the Philippine context using the National Renewable Energy Laboratory's System Advisor Model (SAM). The research specifically evaluates the performance and financial viability of integrating Vanadium Redox Flow Batteries (VRFB) into grid-connected PV systems across varying configurations and capacities. The study applies a distributed commercial ownership model, simulating battery sizes ranging from 50 kW to 1 MW, which are suitable for microgrid applications in rural and island settings. Using location-specific data from New Clark City, Pampanga, the simulations incorporate local weather patterns, solar irradiance, electricity rates, and load demand for a 100-household community. Technical parameters include PV array size, inverter specifications, battery configuration, and energy dispatch strategies. Financial models assess installation and operating costs, loan terms, taxes, inflation, and other economic assumptions relevant to the Philippines. The key performance indicators used include net present value (NPV), levelized cost of energy (LCOE), internal rate of return (IRR), and payback period. Three system configurations were simulated: (1) an 80 kWdc PV system with an optimized VRFB capacity, (2) an 80 kWdc PV system with a 100 kW / 400 kWh battery, and (3) a 150 kWdc PV system with the same battery size. The results reveal distinct trade-offs between system size, capital cost, energy yield, and financial performance. While the third configuration achieved the highest energy savings and lowest LCOE at 14.66 ¢/kWh, it also incurred the highest capital cost and yielded the lowest NPV, making it less attractive from an investment standpoint. In contrast, the second configuration offered the best balance, with a shorter payback period (9.5 years), higher NPV ($85,617), and increased grid independence. This study concludes that PV-battery hybrid systems are financially and technically viable in the Philippine setting, particularly for commercial microgrid applications. The commercial ownership model proves effective in balancing investment feasibility and operational efficiency. The use of SAM provides a robust framework for evaluating such systems, allowing for optimization based on site-specific conditions and financial assumptions. These findings support policy and investment decisions aimed at accelerating the deployment of decentralized renewable energy systems in underserved communities across the Philippines.

Keywords: PV-Battery System; Vanadium Redox Flow Battery; Microgid Energy Storage

*Corresponding author: macristinajoyce.mps@gmail.com

AIR POLLUTION CONTROL (APC)

APC-001

Advancements in Ultrasound-Assisted Oxidative Desulfurization of Dibenzothiophene Using Novel Catalytic Systems

James Bryan Cagas[1], Gian Paolo Bernardo[1,2], Angelo Earvin Choi[1,2]*, and Joseph Ortenero[1,2]

[1]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2]*Department of Chemical Engineering, De La Salle University, Philippines*

Dibenzothiophene (DBT) is a dominant sulfur-containing compound in fossil fuels known for its resistance to conventional hydrodesulfurization (HDS) techniques. In recent years, ultrasound-assisted oxidative desulfurization (UAOD) has emerged as a highly effective, energy-efficient, and selective method for DBT removal under mild conditions. This review addresses the research gap on the lack of systematic comparisons of catalysts for DBT removal, specifically analyzing UAOD studies published from 2022 to 2025. Eight (8) peer-reviewed articles were screened based on their focus on DBT as the target sulfur compound. Advanced catalytic materials reviewed include ionic liquids, deep eutectic solvents, supported polyoxometalates, phosphonium salts, and geopolymer composites. These systems typically employ hydrogen peroxide as the oxidant, and ultrasonic irradiation, which enhances reaction kinetics through cavitation phenomena. Six (6) out of 8 catalysts assessed delivered 92-98.71% DBT removal within 2-49 min under ultrasonic frequencies ranging from 20-40 kHz. Key operational parameters such as temperature, oxidant-to-sulfur ratio, catalyst dosage, and ultrasound amplitude were found to significantly impact desulfurization efficiency. Furthermore, three (3) catalysts demonstrated high reusability which maintained performance over 5-6 cycles with minimal loss of activity. Collectively, these findings underscore UAOD as a scalable and sustainable alternative for deep desulfurization of liquid fuels, contributing to the development of cleaner energy technologies.

Keywords: catalyst systems; deep desulfurization; dibenzothiophene; recyclability; ultrasound-assisted

*Corresponding author: angelo.choi@dlsu.edu.ph

Progress and Perspectives in Mixing-Assisted Oxidative Desulfurization for Dibenzothiophene and Benzothiophene Removal

Mia Patricia Manalo[1,2], Angelo Earvin Choi[1,2]*, and Cary Albert Chan[1,2]

[1]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2]*Department of Chemical Engineering, De La Salle University, Philippines*

Sulfur emissions resulting from fuel combustion are among the primary contributors to environmental pollution. To comply with increasingly stringent sulfur regulations, hydrodesulfurization (HDS) has been extensively employed to reduce sulfur content in fuels. However, HDS operates under severe conditions and is often ineffective in removing refractory sulfur compounds such as dibenzothiophene (DBT) and benzothiophene (BT). Oxidative desulfurization (ODS) has emerged as a promising alternative as it offers deep desulfurization under relatively mild conditions. A process-intensified variant, mixing-assisted oxidative desulfurization (MAOD), enhances mass transfer efficiency between immiscible phases by utilizing high-shear mixing. As a relatively novel technique, MAOD continues to be the subject of ongoing research and optimization. This work highlights recent developments in MAOD for DBT and BT removal, focusing on the effectiveness of various oxidant–catalyst systems and key process parameters such as mixing speed, mixing duration, catalyst dosage, oxidant concentration, and reaction temperature. High sulfur conversion efficiencies—up to 100%—have been reported, particularly with the use of hydrogen peroxide as an oxidant and phosphotungstic acid as a catalyst. Ferrate (VI) has also shown potential in non-catalytic MAOD systems. Further research is needed on the reusability and stability of heterogeneous catalysts, as well as on the scale-up and industrial application of the MAOD process. The continued optimization of this technique holds significant promise for cleaner fuel production and environmental sustainability.

Keywords: benzothiophene; dibenzothiophene; high shear mixing; oxidative desulfurization; process optimization; sulfur conversion

*Corresponding author: angelo.choi@dlsu.edu.ph

SOLID ENVIRONMENT AND WASTE MANAGEMENT (SWM)

SWM-001

Production of Polyunsaturated Fatty Acids by Culturing a Thraustochytrid on Hydrolysate of a Brown Alga

Miki Hatanaka[1], Satoshi Nakai[1]*, Nhat A. Tran[1], Toshikazu Suenaga[1], Takehiko Gotoh[1], Wataru Nishijima[1], and Hiromichi Suzuki[2]

[1]Hiroshima University, Japan
[2]DOWA LINE Co., LTD., Japan

Stranding of the brown seaweed *Sargassum* has caused serious problems. This study investigated usability of Sargassum as a substrate for a thraustochytrid *Aurantiochytrium sp*. strain L3W that produces useful polyunsaturated fatty acids such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA). As a model *Sargassum*, *Sargassum fusiforme* was used. The strain L3W grew and produced DHA and EPA on the hydrolysate of *S. fusiform*. The results implied that hydrolysates of *Sargassum* may be useful as a good substrate for thraustochytrids to produce PUFAs such as DHA and EPA.

Keywords: Aurantiochytrium sp.; docosahexaenoic acid; eicosapentaenoic acid; hydrolysates; Sargassum

*Corresponding author: sn4247621@hiroshima-u.ac.jp

SWM-002

Immobilization of Dredged Material from Tullahan-Tinajeros River System as a Partial Substitute for the Production of Concrete

Denvert Pangayao*, Maria Christine Latosa, and Bernard Jude Gutierrez

Industrial Technology Development Institute - Department of Science and Technology, Philippines

The Tullahan-Tinajeros River System is considered as one of the most polluted waterways in Metro Manila and a major water tributary of Manila Bay. To determine the current status of the river system, dredged materials were examined. Dredged material is composed of sediments and soil that may contain inorganic and organic contaminants. Based on the particle size distribution, dredged material is classified as coarse sand to medium sand which is suitable as partial substitute to sand in a concrete mix. Also, the dredged material contains heavy metals such as cadmium, lead, antimony and zinc and inorganic contaminants such as sulfate, sulfide, phosphate and ammonia. Moreover, XRD and XRF analysis shows the presence of quartz, plagioclase, iron, aluminum and silicon dioxide. On the other hand, volatile organic compound, polychlorinated biphenyl and dioxin and furans were not detected. According to the Toxicity Characterization Leaching Procedure (TCLP), heavy metal may leach out in the environment without proper treatment or disposal. Through immobilization technique, optimized concreted mixture was determined. After 28 days of curing time, the optimized concrete mix was 10% dredged material and 90% sand by weight with a compressive strength of 22.70 MPa. Likewise, after TCLP of the concrete cylinder shows that the heavy metal is below the detection limit.

Keywords: immobilization; dredge material; partial substitute; Tullahan-Tinajeros; concrete

*Corresponding author: dcpangayao@itdi.dost.gov.ph

SWM-003

Carbon Sequestration Potential of Phosphogypsum via Indirect Mineral Carbonation

Michelle Airah Pablo[1,2], Joshua Pocaan[1,2], Jacob Louies Rohi Paulo[1,2], Arnel Beltran[1,2], Carla Mae Pausta[1,2], John Frederick Tapia[1,2], Michael Angelo Promentilla[1,2], Marish Madlangbayan[3], Botvinnik Palattao[4], Jennyvi Ramirez[4], Carlito Tabelin[5], Vannie Joy Resabal[5], and Aileen Orbecido[1,2]*

[1]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*
[2]*Department of Chemical Engineering, De La Salle University, Philippines*
[3]*College of Engineering and Agro-Industrial Technology, University of the Philippines – Los Baños, Philippines*
[4]*Philippine Nuclear Research Institute, Department of Science and Technology, Philippines*
[5]*Department of Materials Resource Engineering Technology, Mindanao State University-Iligan Institute of Technology, Philippines*

Carbon dioxide (CO_2) emissions have been steadily increasing in recent years, underscoring the need to develop sustainable carbon capture, utilization, and storage (CCUS) solutions. Mineral carbonation (MC) has emerged as a promising technology for permanent CO_2 sequestration along with the valorization of Ca- and Mg-rich industrial byproducts and wastes. In indirect MC, Ca- and Mg-rich solid wastes or minerals react with strong inorganic acids to extract Ca^{2+} and Mg^{2+} ions followed by the carbonation of Ca- or Mg-rich leachate to form stable carbonates. This study explores the use of Phosphogypsum, a waste by-product from phosphoric acid and phosphate fertilizer production, as Ca-rich feedstock for CO_2 sequestration through indirect mineral carbonation. Calcium extraction efficiency using HCl and NaCl as leaching agents were optimized considering leaching agent concentration, contact time, temperature, and liquid-to-solid ratio. For HCl leaching, the optimized parameters are 2.3 M HCl, 62 °C, 60 min, and 26 L/S ratio with a predicted Ca extraction efficiency of 93.0% and a theoretical CO_2 sequestration capacity of 0.67 Mt CO_2/year. For NaCl leaching, the predicted optimal Ca extraction efficiency is 19.1% at 2.5 M NaCl, 38 °C, 60 min, and 26 L/S ratio with a theoretical CO_2 sequestration capacity of 0.14 Mt/year.

Keywords: Indirect mineral carbonation; CO_2 emissions; Phosphogypsum; calcium extraction

*Corresponding author: aileen.orbecido@dlsu.edu.ph

SWM-004

Green Material Development: Phosphogypsum (PG) as Filler Material for Alkali- Activated Coal Fly Ash (CFA) Geopolymer

Christian Gabonada[1], Peter Joseph Visto[1], Joshua Pocaan[2,3], Michelle Airah Pablo[2,3], Jacob Louies Rohi Paulo[2,3], Michael Angelo Promentilla[2,3], Arnel Beltran[2,3], Carla Mae Pausta[2,3], John Frederick Tapia[2,3], Carlito Tabelin[1], Vannie Joy Resabal[1], Jennyvi Ramirez[4], Botvinnik Palattao[4], Marish Madlangbayan[5], and Aileen Orbecido[2,3]*

[1]Mindanao State University–Iligan Institute of Technology, Philippines
[2]Center for Engineering and Sustainable Development Research, De La Salle University, Philippines
[3]Department of Chemical Engineering, De La Salle University, Philippines
[4]Philippine Nuclear Research Institute, Philippines
[5]University of the Philippines Los Baños, Philippines

Phosphogypsum (PG), a by-product of fertilizer production, has a problem of being stockpiled and take up large areas of land due to its limited utilization routes. With its radioactive nature and the presence of rare earth elements (REEs) as its component, it poses a serious threat to health and environment. On the other hand, coal fly ash (CFA) has been proven for application as a building material through geopolymerization. This study explores the use of PG as a filler material in the synthesis of alkali-activated CFA geopolymer. Factors such as PG to CFA composition (4-96, 8-92, 12-88, 16-84, and 20-80), activator-to-precursor (A/P) ratio (0.8, 0.9, 1, 1.1, and 1.2), and curing time (7 days and 28 days) were considered. The significance of the said factors on the synthesis was determined using a 3k factorial design of experiment. A total of 100 samples were synthesized. The highest unconfined compressive strength (UCS) was achieved using a mix ratio of 20-80 PG:CFA, A/P of 0.8, and a curing time of 28 days. As a viable pathway for PG valorization and immobilization of pollutants such as REE and other heavy metals (As, Ba, Cd, Cr, Pb, Se, and Ag), a toxicity characteristic leaching procedure (TCLP) were conducted following the protocol of the United States Environmental Protection Agency (US EPA). Immobilization of the pollutants from both CFA and PG through geopolymerization were effective, providing an alternative pathway for these materials for reuse in engineering applications.

Keywords: geopolymerization; phosphogypsum; coal fly ash; TCLP; rare earth elements; green material

*Corresponding author: aileen.orbecido@dlsu.edu.ph

SWM-005

Leaching Process Optimization of Phosphogypsum Tailings Using Sodium Gluconate

Wayne Flossien De Silva[1], Neena Mikaela Ang[1], Rei Natalie Sta. Maria[1], Decar John Capadiso[1], Michelle Airah Pablo[1,2], Joshua Pocaan[1,2], Jacob Louies Rohi Paulo[1,2], Piolo Gabriel Gervacio[1], John Frederick Tapia[1,2], and Aileen Orbecido[1,2]*

[1]*Department of Chemical Engineering, De La Salle University – Manila, Philippines*
[2]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*

Phosphogypsum (PG), a byproduct of phosphoric acid production, contains a high amount of calcium, making it a potential secondary resource. This study explores calcium and magnesium recovery from phosphogypsum using sodium gluconate (SG), a biodegradable and recyclable chelating agent, under various conditions. PG characterizations such as XRD and XRF verified gypsum as the primary phase, with the measured calcium oxide content at 43.207% while no Mg was detected. The best results were achieved at 20 minutes of leaching, with an SG:Ca molar ratio of 2:1 and an L/S ratio of 54.25 mL/g. These conditions resulted in a Ca leaching efficiency of 82.36% and a theoretical carbon dioxide sequestration capacity of 273.05 mg CO_2/g PG. Precipitation was observed at 60 minutes with a molar ratio of 3.5 and an L/S ratio of 25 mL/g, and at 43 minutes with a molar ratio of 3 and L/S of 25 mL/g. XRD and SEM-EDX analyses confirmed the formation of calcium gluconate in the precipitated runs. With such results, future studies should explore alkaline conditions and adjust reaction time and reagent concentration for enhanced results. Exploring alternative solvents and applying direct carbonation strategies are also recommended to enhance both calcium extraction and carbon sequestration.

Keywords: Phosphogypsum; Sodium gluconate; Calcium recovery; Leaching; CO_2 sequestration

*Corresponding author: aileen.orbecido@dlsu.edu.ph

SWM-006

Effect of Hydrolysis Duration on the Dimension and Crystallinity of Pineapple Crown Leaf-Derived Cellulose Nanocrystals for Additive Manufacturing Application

John Lemuel Untalasco*, Queenie Tuazon, and Marianito Margarito

Department of Science and Technology – Industrial Technology Development Institute, Philippines

Cellulose nanocrystals (CNCs) have emerged as promising nanomaterials for reinforcing polymer nanocomposites due to their positive mechanical properties and biodegradability. One sustainable source of CNCs is the pineapple crown leaf, an agricultural waste product that offers a renewable and eco-friendly raw material. In this study, CNCs were extracted from pineapple crown leaves (PCL) through sequential chemical treatments including alkaline, bleaching, and acid hydrolysis. The effect of varying hydrolysis durations (30 minutes, 1 hour, 2 hours, and 3 hours) on the dimensions and crystallinity of the resulting CNCs was investigated to assess their potential as reinforcements in photopolymer resin for additive manufacturing applications. Fourier Transform Infrared Spectroscopy (FTIR) was utilized to verify the effective removal of the non-cellulosic components. Scanning Electron Microscopy (SEM) was used to visualize changes in morphology and physical properties of the extracted cellulose fibers. X-ray Diffraction (XRD) analysis was performed to verify the removal of amorphous regions in hydrolyzed cellulose fibers, leaving mostly CNCs, by measurement of the crystallinity index. Furthermore, the size reduction of CNCs in terms of diameter and length was inspected using Transmission Electron Microscopy (TEM). The extracted CNCs were successfully integrated into PMMA resin at three (3) wt% using a homogenizer mixer. The dimensional characteristics and degree of crystallinity of CNCs significantly affect their interfacial interactions within the polymer matrix, directly impacting their dispersion quality and the resulting structural homogeneity of the nanocomposite system.

Keywords: Cellulose Nanocrystals; Pineapple Crown Leaf; Nanocomposites; Acid Hydrolysis; Additive Manufacturing

*Corresponding author: lemuel.untalasco@gmail.com

SWM-007

Synthesis of Aluminum-Iron Bimetallic Materials from Aluminum Scrap Using a Two-Stage Mechanical-Chemical Method

Carlito Tabelin[1]*, Vannie Joy Resabal[1], Ilhwan Park[2], Mary Grace Villanueva[1], Mylah Villacorte-Tabelin[1], Aileen Orbecido[3], Richard Alorro[4], Sanghee Jeon[5], Mayumi Ito[2], and Naoki Hiroyoshi[2]

[1]Mindanao State University-Iligan Institute of Technology, Philippines
[2]Hokkaido University, Japan
[3]De La Salle University, Philippines
[4]Curtin University, Australia
[5]Akita University, Japan

Bimetallic materials are well-known for their catalytic properties and are increasingly becoming popular as catalysts in chemical industries and green technologies, including tools for clean-up/remediation of polluted systems. Another promising application of bimetallic materials is to recover battery/critical elements from waste streams for resources conservation and decontamination. However, their synthesis has been limited to the use of pure monometallic elements. In this study, we proposed a two-stage mechanical-chemical method to synthesized bimetallic material from aluminum scrap (Al-scrap). The first stage involves the removal of protective coatings by polishing followed by etching-cementation for zero-valent iron (ZVI) deposition. The removal of anodized/organic protective coating on Al-scrap was effective but an Al-oxyhydroxide/oxide film composed of corundum, bayerite, and boehmite was rapidly formed on the exposed Al^{0}. This Al-oxyhydroxide/oxide layer was removed using NaCl-HCl and Fe^{3+} was deposited on corrosion pits on Al^{0} in the second etching-cementation stage. Synthesized products in 1.0 M Fe^{3+} exhibited strong magnetic susceptibility and the deposition of ZVI on Al-scrap was confirmed by SEM-EDS and XPS analyses. The results also showed two potential pathways for Fe^{3+} reduction to ZVI (Fe^{0}): (i) direct cementation (Fe^{3+} ▪ Fe^{0}), and (ii) sequential reduction (Fe^{3+} ▪ Fe^{2+} ▪ Fe^{0}).

Keywords: Bimetallic materials; Zero-valent iron; Aluminum scrap; Repurposing; Cementation

*Corresponding author: carlito.tabelin@g.msuiit.edu.ph

SWM-008

Dual-Step NaOH-HCl Leaching of Fly Ash: Process Optimization and Coagulant Performance Evaluation

Iwan Setiyawan[1], Joko Wintoko[2], and Chandra Wahyu Purnomo[2]*

[1]PT. Petrokimia Gresik, Indonesia
[2]Gadjah Mada University, Indonesia

This study aims to optimize the extraction of aluminum (Al) and iron (Fe) from fly ash using NaOH and HCl leaching. Fly ash, rich in Al_2O_3 (21.17%) and Fe_2O_3 (14.16%), was processed through a dual-step extraction: alkaline leaching (NaOH) followed by acid leaching (HCl). The Response Surface Method (RSM) was employed to optimize three key variables—temperature (60–110°C), solvent concentration (NaOH: 25–48%; HCl: 5–25%), and solid-liquid ratio (1:6 to 5:10)—with extraction efficiency as the response parameter. Optimal conditions: Highest Al/Fe recovery (Al: 4.47%, Fe: 2.43%) was achieved at 110°C, 29.7% HCl, and a 3:10 solid-liquid ratio. NaOH extraction yielded lower efficiencies (Al: 0.28%, Fe: 0.018%) at 85°C and 36.5% NaOH. The combination of high temperature, optimal HCl concentration, and optimum solid:liquid ratio maximized Al and Fe extraction efficiency. This study provides operational guidelines for producing fly ash-based coagulants with improved metal recovery.

Keywords: Fly Ash; Al-Fe Extraction; Coagulant; Sodium Hydroxide; Hydrochloric Acid

*Corresponding author: chandra.purnomo@ugm.ac.id

ENVIRONMENTAL SITE ASSESSMENT AND REHABILITATION (EAR)

EAR-001

Evaluation of Pre-Processing Methods for Improved Microplastic Detection Using Nile Red Staining Method

Lesly Ann Pauline Manaoat, Melanie Lagmay*, and Marianito Margarito

Department of Science and Technology – Industrial Technology Development Institute, Philippines

Microplastic (MP) pollution has become an emerging concern in drinking water treatment systems with potential consequences for both ecosystem and human health. To accurately detect and quantify microplastics, water samples require careful preparation before analysis. Nile Red staining, a fluorescence based technique, selectively binds to hydrophobic plastic polymers, making them visible for analysis. However, improper pre-treatment can lead to co-staining; where non-polymeric substances also absorb the dye, resulting in false positives and decreased detection accuracy. This study focused on the preprocessing methods for water samples ensuring reliable results with minimal interference from organic and inorganic matter. Experimental results indicated that the samples pretreated with 10 mg/L NaOCl for 3 hrs and 25% H_2O_2 for 21 hrs showed a 92.07% decrease in organic and inorganic material compared to an 89.07% reduction using only 25% H_2O_2 for 24 hrs. The Raman spectroscopy analysis of collected environmental water samples further confirmed that the combination of NaOCl and H_2O_2 treatment effectively reduced the fluorescent interference on MP detection caused by the non-MP presence in the samples. The preprocessing method developed in this study may serve as a reference if MPs are to be detected in drinking water treatment plants (DWTPs).

Keywords: Microplastics; Nile Red; DWTP; Hydrogen peroxide; Sodium hypochlorite

*Corresponding author: melaniesapitolalagmay@gmail.com

EAR-002

Audit of Heavy Metal Pollution and Rhizosphere Bacterial Communities from *Saccharum spontaneum* L. in a Rehabilitated Nickel-Laterite Mine in the Philippines

Sheila Mainit[1], Carlito Tabelin[1], Florifern Paglinawan[1], Jaime Guihawan[1], Alissa Jane Mondejar[1], Vannie Joy Resabal[1], Ma. Reina Suzette Madamba[1], Dennis Alonzo[2], Aileen Orbecido[5], Michael Angelo Promentilla[5], Joshua Zoleta[1], Dayle Tranz Daño[3], Ilhwan Park[3], Mayumi Ito[3], Takahiko Arima[3], Theerayut Phengsaart[4], and Mylah Villacorte-Tabelin[1]*

[1]*Mindanao State University-Iligan Institute of Technology, Philippines*
[2]*University of New South Wales, Australia*
[3]*Hokkaido University, Japan*
[4]*Chulalongkorn, Thailand*
[5]*Department of Chemical Engineering, De La Salle University, Philippines*

To better understand heavy metal pollution and soil bacterial communities in a rehabilitated nickel (Ni) laterite mine, we audited soil pollutants and examined the effects of revegetation on bacterial communities using 16s rRNA sequencing in post-mining sites rehabilitated in 2015, 2017, and 2019. Our results showed that rehabilitated soils were low in moisture content, available phosphorus, and total nitrogen; exhibited low to medium exchangeable potassiun; and had organic matter and organic carbon ranging from extremely low to high. X-ray diffraction analysis identified iron oxyhydroxides, silicates, and clays as major soil components. Pollution load index and contamination degree, the 2015A and 2015B sites were classified as “pristine” and had a “low degree of pollution”, while the remaining sites were considered “moderately contaminated” with heavy metals such as Ni, chromium, Co, lead, zinc, and Cu. Proteobacteria were particularly dominant in the oldest rehabilitated site (2015), followed by the earliest rehabilitated site (2019). Meanwhile, the most abundant genera found in Control and rehabilitated sites were Ralstonia, with relative abundance ranging from 29.1% to 38.3%. The findings of this study indicate that while rehabilitation efforts by the mining company are showing progress, full restoration of microbial diversity and structure may require additional time.

Keywords: Heavy metal pollution; 16s rRNA gene marker; rehabilitation; soil microbial ecology; metagenomic analysis; bacterial indicators

*Corresponding author: mylah.tabelin@g.msuiit.edu.ph

EAR-003

Leaching of Chromium and Lead in Surface Sediments from Meycauayan River Using Oxalic Acid and N,N-bis(carboxymethyl)-L-Glutamic Acid Tetrasodium Salt

Jezreel Cardinales[1], Jayvee Del Rosario[1], James Japhet Jerota[1], Arjem Llido[1], Denvert Pangayao[2]*, and Peniel Jean Gildo[1]

[1]Pamantasan ng Lungsod ng Maynila (University of the City of Manila), Philippines
[2]Environment and Biotechnology Division, Industrial Technology Development Institute, Department of Science and Technology, Philippines

Heavy metals pose significant threats to soil, air, and water systems. Their presence in surface sediments, particularly in the Meycauayan River in the Philippines, is alarming due to their toxicity, persistence, and tendency to accumulate in organisms. Lead (Pb) and chromium (Cr) are particularly prevalent in this river. Thus, this study aims to leach Pb and Cr from surface sediments using a mixture of GLDA and oxalic acid. The surface sediments obtained along the Meycauayan River contained 89.6 mg/kg Pb, 54.1 mg/kg Cr, 0.53 mg/kg Cd, 2.3 mg/kg As, and 0.1 mg/kg Hg. After the chemical leaching experiments, the maximum metal leached is 6.31% for Cr and 27.21% for Pb. The optimum parameters were determined to be 20% GLDA-80% OA ratio in the leaching solution, 5:10 S/L ratio, and 120 minutes of leaching time, with an optimum yield of 6.24% Cr and 27.01% Pb. Among these parameters, it was revealed that the ratio of GLDA and OA in the leaching solution has the highest effect on heavy metal leaching. However, the leaching solution was not effective for lead and chromium removal due to the low percentages of metals leached. Thus, further research is recommended to explore other parameters and acids combined with GLDA to potentially improve the leaching efficiency for these heavy metals in the Meycauayan River's surface sediments.

Keywords: Leaching; Lead; Chromium; Oxalic Acid; GLDA

*Corresponding author: dcpangayao@itdi.dost.gov.ph

EAR-004

Assessment on Limestone-Based Passive Treatment System for Acid Mine Drainage (AMD) Impacted Waters in the Philippines

Hue Aldrich Fenix[1], Analyn Cai[1], Aleksandra Sofiya Mari Sy[1], Joshua Pocaan[1,2], Brian Gerald Bueno[1], Jaica Mae Pagaduan[2], Johara Capingian[1,2], Michelle Airah Pablo[1,2], Jacob Louies Rohi Paulo[1,2], Arnel Beltran[1,2], Aileen Orbecido[1,2], Renan Ma. Tanhueco[1], and Michael Angelo Promentilla[1,2]*

[1]*De La Salle University, Philippines*
[2]*Center for Engineering and Sustainable Development Research, Philippines*

Acid mine drainage (AMD) is an acidic waste product that forms when surface water reacts with acidic heavy metals. This can cause damage to water sources due to their acidic nature, threatening local communities. This study aims to analyze and measure the performance of a deployed limestone passive treatment system in the Philippines. The samples were collected and analyzed using atomic absorption spectroscopy (AAS) for heavy metal concentrations of the sample. ORP, conductivity, and pH would also be used to determine the effectiveness of the deployed treatment system by comparing it with the DAO 2016-08 guidelines on Class C waters. Geochemical modeling, particularly PHREEQC, was used to determine the precipitates formed in the sample. The system neutralized AMD from a pH of 4.79 to 6.21, making the quality within the effluent standards. Blue stains were observed on the surface of the limestone, indicating the occurrence of Cu-armoring due to the high concentration of Cu in AMD. PHREEQC modeling results showed that cuprous ferrite ($CuFeO_2$) and magnetite (Fe_3O_4) were the precipitates that most likely formed in both the influent and effluent stream samples. Results also showed that the system is not effective at treating and neutralizing the AMD due to the increased metal concentrations and stagnation of pH, ORP, and conductivity values. To improve it in terms of efficiency and longevity, limestone should be changed every two weeks, and the addition of other media, such as gravel and sandstone to limit the heavy metal armoring on the limestone surface.

Keywords: Passive Treatment; Geochemical Modelling; DAO 2016-08 guidelines; Copper-induced armoring

*Corresponding author: michael.promentilla@dlsu.edu.ph

EAR-005

Water Quality Assessment of Mananga River Using Principal Component Analysis

Mary Julia Mercado[1], Wesly Cai[1], Cybelle Concepcion Futalan[2], Mayzonee Ligaray[3], and Angelo Earvin Choi[1]*

[1]Department of Chemical Engineering, De La Salle University, Manila, Philippines
[2]Institute of Civil Engineering, University of the Philippines Diliman, Philippines
[3]Institute of Environmental Science Meteorology, University of the Philippines Diliman, Philippines

The Mananga River in the Philippines was classified as a class A river in 1997; however, the river has significantly degraded due to pollution. The water quality of Mananga River was evaluated using the principal component analysis (PCA). The effects of weather conditions on water quality and significant relationships between the water quality parameters and water quality of each sampling station were determined. Data of the three water quality parameters, namely dissolved oxygen (DO), biological oxygen demand (BOD), and total suspended solids (TSS), were obtained from the Department of Environmental and Natural Resources - Environmental Management Bureau Region 7. Significant correlations were observed, such as DO and BOD are negatively correlated, while a positive correlation exists between DO to RH and wind speed, BOD to temperature, and TSS to wind speed. Furthermore, negative correlations are observed between DO to temperature and wind direction, BOD to rainfall, and TSS to wind direction and rainfall. In the overall analysis of the results, the heavier the influence of a variable, the more likely it is to contribute in affecting the water quality. Results of the present work will be used in environmental monitoring, environmental management, and assistance for the rehabilitation of Mananga river using PCA.

Keywords: Cebu City; Mananga River; Principal component analysis; water quality; weather

*Corresponding author: angelo.choi@dlsu.edu.ph

EAR-006

Antimicrobial Resistance Control in a Tertiary-Level Hospital Wastewater Treatment System in Laguna through Insights from Whole-Genome Sequence Analyses of Multidrug-Resistant Bacteria

Shaughn Dominic Padon, Erica Mai Cabuyao, Nathaniel John Cruz, Kiara Nicole Rodriguez, Leslie Michelle Dalmacio, and Joel Cornista*

University of the Philippines Manila, Philippines

Hospital wastewater treatment (WWT) systems have emerged as critical interfaces in the evolution and dissemination of antimicrobial resistance (AMR), requiring a comprehensive understanding of the dynamic interplay between antibiotic-resistant bacteria (ARBs) and genes (ARGs), and mobile genetic elements (MGEs). Through antibiotic susceptibility testing (AST) and comparative whole-genome sequence analyses, this study determined the prevalence and mobility of ARGs and MGEs across different stages (influent, sludge, treated effluent) of WWT in a tertiary-level hospital in Laguna, Philippines. Results showed that highly pathogenic *Escherichia coli* ST453 O23:H16 from influent harbored massive and highly diverse AMR load, utilizing diverse metabolic pathways with predominance of transfer-related MGEs. Potentially pathogenic *Bacillus cereus* ST177 from sludge revealed this treatment stage as a potential AMR hotspot due to a dramatic shift in resistance determinants, like disinfection RGs, despite overall MGE reduction. Lastly, *Bacillus licheniformis* ST26, from effluent, displayed residual risk of critical ARGs by the persistence of glycopeptide RGs and shift in HGT dominance to transduction events. Insights into the metabolic and survival capabilities of bacteria in WWT systems provide site-specific recommendations to improve AMR control, primarily through limiting the mobility of resistance determinants and decreasing the adaptive capacity of ARBs in response to selection pressure.

Keywords: multidrug efflux; glycopeptide resistance; disinfection resistance determinants; cellular metabolic compound salvage; wastewater treatment selection pressure; antimicrobial resistance control

*Corresponding author: jccornista@up.edu.ph

CIRCULAR ECONOMY IN ENGINEERING (CEE)

CEE-001

Driving Plastic Waste Management (PWM) Towards Circular Economy in the Philippines: A Hybrid Approach using Weighted DEMATEL and TOPSIS/VIKOR

Kyla Bianca Tuaño and Michael Angelo Promentilla*

Department of Chemical Engineering, De La Salle University, Philippines

Plastic waste management (PWM) remains a critical environmental challenge in the Philippines, with high plastic consumption, limited recycling facilities, and inadequate waste management infrastructure. While current initiatives present promising interventions, decision-makers often lack a structured and comparative evaluation method to prioritize the most effective strategies. This study applies a hybrid Multi-Criteria Decision Analysis (MCDA) model that integrates the Decision-Making Trial and Evaluation Laboratory (DEMATEL), Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), and Vlsekriterijumska Optimizacija I Kompromisno Resenje (VIKOR). Eight criteria were used to evaluate PWM strategies: land use, air pollution, energy requirement, cost, employment, technical feasibility, product value, and social impact. DEMATEL was used to identify cause-effect relationships and to determine the criteria weights based on stakeholder input. TOPSIS and VIKOR were employed to rank PWM alternatives. The model aims to provide a systematic approach for supporting decision-making in PWM. Results highlight the importance of socially inclusive and technically viable strategies in advancing circular economy (CE) practices in the Philippines. Sensitivity analysis using rank reversal tests affirmed the robustness of the model. Future research should incorporate life cycle assessment and broader stakeholder engagement to enhance the adaptability and long-term effectiveness of PWM strategies in developing countries.

Keywords: Plastic waste management; Multi-Criteria Decision Analysis; Circular Economy; Weighted DEMATEL; TOPSIS; VIKOR

*Corresponding author: michael.promentilla@dlsu.edu.ph

CEE-002

Fabrication of Chitosan-Coated Slag for Acid Mine Drainage: Adsorption in Passive Treatment Systems

Casey Oliver Turingan[1]*, Takahiko Arima[2], Naoki Hiroyoshi[2], and Tsutomu Sato[2]

[1]*Division of Sustainable Resources Engineering, Graduate School of Engineering, Hokkaido University, Japan*

[2]*Division of Sustainable Resources Engineering, Faculty of Engineering, Hokkaido University, Japan*

Acid mine drainage (AMD) treatment after mine closure is an issue for local stakeholders due to its centuries-long generation. Passive treatment systems have been developed to minimize treatment costs and manpower, using neutralization steps supplemented with constructed wetlands and other technologies. However, these techniques are limited by the area topography, strict operating conditions, or long retention time. Using adsorption, more treatment options can be considered for passive systems. This study explores the use of chitosan mounted on slag as a secondary step to deal with persistent metals (i.e. Mn, Ni, and Zn) at circumneutral pH. Adsorption tests were conducted to compare metal removal efficiency using glass beads, ferrous, and non-ferrous slags coated with a polyacrylic acid-crosslinked chitosan hydrogel. Metals removal significantly improved when coated materials were subjected to a 1M NaOH bath. Mn, Ni, and Zn removal increased from 18.11%, 27.80%, 27.20% to 35.88%, 49.14%, 56.51%, respectively, using ferrous slag. On the other hand, the removal efficiency of non-ferrous slag increased from 5.83%, 4.33%, 9.27% to 41.40%, 68.62%, 76.53%, respectively. Thus, chitosan-coated slag is a promising adsorbent in AMD passive treatment systems. The recovery of adsorbed metals should also be considered to reduce the overall cost of the system.

Keywords: heavy metals; slag; chitosan; adsorption; acid mine drainage; passive treatment

*Corresponding author: casey.turingan@gmail.com

CEE-003

Beyond the Lab: Embedding Social Sciences in Engineering and Environmental Interventions for Sustainable Mine Rehabilitation

Dennis Alonzo[1], Mylah Villacorte-Tabelin[2], Aileen Orbecido[3], Arnel Beltran[3], Michael Angelo Promentilla[3], Richard Herrington[4], Robin Armstrong[4], Anne Jungblut[4], Ana Santos[4], Paul Schofield[4], Pablo Brito-Parada[5], Yves Plancenerel[5], Marlon Suelto[6], Vannie Joy Resabal[2], Carlito Tabelin[2], and Irish Mae Dalona[2]*

[1]The University of New South Wales, Australia
[2]Mindanao State University-Iligan Institute of Technology, Philippines
[3]De La Salle University Manila, Philippines
[4]Natural History Museum, London, United Kingdom
[5]Imperial College London, United Kingdom
[6]University of the Philippines, Los Banos, Philippines

Conventional efforts to rehabilitate legacy mine sites often fail due to the exclusion of local communities. Without their participation, even the most advanced technical solutions lack social legitimacy, face resistance, and risk long-term failure. This presentation introduces the Bio+Mine Project, which exemplifies an integrated, multidisciplinary approach to mine rehabilitation, combining chemical engineering, geological and environmental sciences, biotechnology, drone and data sciences, and social science. We used the abandoned Sto. Niño copper mine site in Tublay, Benguet (Philippines) as our natural laboratory. Through mineralogical, geochemical, hydrological, and remote sensing analyses, we co-designed site-specific strategies with the community to mitigate environmental degradation, recover critical minerals from waste, and restore ecological integrity. A key feature of our approach is the recognition of local communities as co-engineers of a resilient environment. Our social scientists conducted in-depth interviews and surveys to understand community perceptions, rehabilitation knowledge practices, governance structure, historical narratives, livelihood patterns, and aspirations. These insights guided the co-design of culturally appropriate and economically viable interventions. The community-informed strategies, e.g., using hyperaccumulator plants, earthworms for soil regeneration, microbial bioremediation of water sources, and various socio-economic activities, support circular resource use, enhance natural capital, and ensure social legitimacy. The co-design approach transforms the local community from passive beneficiaries into co-creators of solutions. In addressing the global uncertainty of mineral resource scarcity and environmental degradation, Bio+Mine offers a replicable model of socially embedded scientific and engineering interventions. It affirms that sustainable mining futures are possible when technical innovation is matched with socio-cultural insight, ensuring long-term resilience for both people and ecosystems.

Keywords: legacy mine; rehabilitation; local community; engineering and environmental solutions

*Corresponding author: irishmae.fernandez@g.msuiit.edu.ph

CEE-004

Effects of Ferric and Cobalt Ions on the Recovery of Neodymium via Ion Flotation

Theerayut Phengsaart[1]*, Worada Kwathichak[1], Thanakornkan Limlertchareonwanit[1], Palot Srichonphaisarn[1], and Carlito Baltazar Tabelin[2]

[1]Chulalongkorn University, Thailand
[2]Mindanao State University - Iligan Institute of Technology, Philippines

Neodymium (Nd^{3+}), a key component of Nd–Fe–B permanent magnets, is critical to renewable energy and clean storage technologies. Unfortunately, the abundance of Nd-bearing ores is limited globally, so the recovery of this element from secondary resources is important. This study investigated the effects of ferric (Fe^{3+}) and cobalt (Co^{2+}) ions, major components of Nd–Fe–B permanent magnets, on the ion flotation of Nd^{3+} using sodium dodecyl sulfate (SDS) as a surfactant. Experiments were performed using a Hallimond tube under optimized conditions (0.01% Nd^{3+}, Nd^{3+}:HNO_3 molar ratio of 1:5, and flotation time of 5 minutes), with Fe^{3+} and Co^{2+} present at 10–20% molar ratios relative to Nd^{3+}. Results showed that both Fe^{3+} and Co^{2+} interfered with Nd^{3+} recovery. Co^{2+} likely suppressed recovery through direct competition for SDS binding, while Fe^{3+} promoted chemical disruptions by forming non-floatable complexes and sequestering SDS. In ternary systems, the lowest Nd^{3+} recovery (~45%) was observed at 1 mol SDS with 20% Fe^{3+} and Co^{2+} present. However, recovery improved to ~75% at 3 mol SDS, indicating that sufficient collector dosage mitigates coexisting ion interferences. These findings underscore the importance of managing coexisting ions and optimizing flotation conditions to enhance selective rare earth recovery from complex leachates.

Keywords: Neodymium; Ion flotation; Rare earth; Ferric ion; Cobalt ion

*Corresponding author: theerayut.p@chula.ac.th

CEE-005

Indirect Mineral Carbonation of Calcium Extracted from Acid Leaching: A Life Cycle Approach on the Management of Philippine Phosphogypsum

Jacob Louies Rohi Paulo[1], Michelle Airah Pablo[1], Joshua Pocaan[1], Michael Angelo Promentilla[1], Arnel Beltran[1], Marish Madlangbayan[2], Botvinnik Palattao[3], Jennyvi Ramirez[3], Carlito Tabelin[4], Vannie Joy Resabal[4], Aileen Orbecido[1], John Frederick Tapia[1], and Carla Mae Pausta[1]*

[1]De La Salle University, Philippines
[2]University of the Philippines Los Baños, Philippines
[3]Philippine Nuclear Research Institute, Philippines
[4]Mindanao State University - Iligan Institute of Technology, Philippines

Phosphogypsum (PG) is a byproduct of phosphoric acid production used for P-rich fertilizers. Accruing at a rate of 175 Mt annually, the global accumulation of PG poses environmental issues if left unmanaged. Recent trends of PG management explored its applications in soil enrichment, construction and building materials, and carbon sequestration. It has been investigated to be effective at mitigating greenhouse gas emissions due to its ability to form carbonates using indirect mineral carbonation (IMC) with an acid-leaching step. An ex-ante life cycle assessment was conducted to evaluate the impact of repurposing via IMC using IMPACT World+ 2022. Cradle-to-grave inventory analysis was performed from raw material acquisition, PG production, cement production using PG, calcium extraction, and mineral carbonation. Long-term climate change effect (CC-LT), fossil and nuclear energy use (FNEU), mineral resources use (MRU), land transformation (LT), and water scarcity (WS) were identified as the most relevant life cycle impact indicators and were calculated. The proposed indirect mineral carbonation process proved to be environmentally beneficial in terms of MRU, LTB, WS while adverse effects were observed for CC-LT and FNEU. The results provide insight into the actual environmental impacts of IMC shaping industrial MC standards and policy recommendations for PG reuse.

Keywords: circular economy; solid waste management; impact assessment

*Corresponding author: carla.pausta@dlsu.edu.ph

CEE-007

Enhancing the Sulfur Filtration Process: Transitioning from Diatomaceous Earth to Silica Waste Derived from Aluminium Fluoride Production as Filter Aid in Molten Sulfur Filtration

Anggi A. Nasution[1], Damar S. Ismoro[1], Jawad Farisi[1], Iwan Setiyawan[1], Alex Z. Fanani[1], Galih Yudhaprawira[1], Faizal Alianto[1], Bambang Ariwibowo[1], Himawan T. M. B. Petrus[2], Ade Kurniawan[2], and Teguh Ariyanto[2]*

[1]*PT. Petrokimia Gresik, Indonesia*
[2]*Gadjah Mada University, Indonesia*

In sulphuric acid production from sulphur burning process, the filtration process of molten sulphur is critical for ensuring molten sulphur purity and operational efficiency. Traditionally, diatomaceous earth has been employed as filter aid due to its high porosity and filtration efficiency. However, with recent development in global uncertainties of supply chain and import-export regulation, as well as raising environmental concerns and costs associated with diatomaceous earth, an exploration of alternative materials is required. This paper investigates the feasibility of replacing diatomaceous earth with silica waste generated from the aluminium fluoride manufacturing process. Early analysis revealed that silica waste has higher SiO_2 purity compared to diatomaceous earth (±89.0% vs ±94.5%). The experiments were carried out using two industrial sulphur filtrations equipment equipment to evaluate the performance of material. The results indicated that silica waste yielded typical performance with diatomaceous earth in term of molten sulphur purity and ash content in filtration product. However, silica waste showed lower required consumption ratio up to 0.88 of initial to achieve such performance. Both Sulphuric Acid and Aluminium Fluoride units (in which the silica waste are derived from) are within Petrokimia Gresik Industrial Park, thus promoting not only waste utilization of unused silica but also product integration, limiting external factors that global uncertainties may poses to come.

Keywords: waste utilization.; product integration.; silica waste.; Molten sulphur filtration.; global uncertainties of supply chain

*Corresponding author: teguh.ariyanto@ugm.ac.id

CEE-008

Repurposing of Coal Fly Ash into Secondary Raw Material of Rare Earth Elements and Ceramic Materials Applications

Vannie Joy Resabal, Carlito Tabelin, Joshua Zoleta, Mona Lisa Pacaña-Pongcol, Argel Mugot, Vivien Bless Sullaga, Liberty Lumasag, Fel Jane Echavez, Jefrey Gadapan, Myra Cabatingan, Raymond V. Rivera Virtudazo, Rojellyn Baldago, and Edison Limbaga*

Mindanao State University-Iligan Institute of Technology

With the Philippines generating approximately 2.78 metric tons of coal fly ash (CFA) annually from coal-fired power plants, effective utilization of this industrial waste remains a critical challenge. Given its untapped potential as a secondary resource for rare earth elements (REEs), this study demonstrates the sustainable valorization of Philippine CFA through REE extraction by acid leaching and conversion of the acidified residue into thermal insulating materials. The CFA obtained from a circulating fluidized bed combustion (CFBC) coal-fired power plant was leached using hydrochloric acid to recover REEs. Results showed optimal leaching conditions at 3M HCl, 65 °C, and 270 minutes, yielding high extraction rates for Nd (70.8%), Er (76.34%), Eu (88.02%), Tb (90.01%), and Dy (73.38%). The acidified solid residue, rich in silica and alumina, was repurposed into non-firing ceramic tiles for construction applications through alkali activation using Kapatagan diatomaceous earth (DE) and alkaline solutions. The optimal composition obtained at 20% acidified CFA residue and 80% DE produced a 152x152x10 mm tile. with a thermal conductivity of 0.344 W/m·K and porosity of 89.17%, indicating promising thermal insulation properties. The recovery of critical REEs while producing insulation materials for sustainable construction applications highlights a circular and eco-efficient pathway for CFA management.

Keywords: Coal Fly Ash; Rare Earth Elements; Thermal Insulating Material; Alkali activation; Circular Economy

*Corresponding author: edison.limbaga@g.msuiit.edu.ph

CEE-008

Essential-Oil and Polyphenol Extraction from Hydrous and Immature Japanese Bitter-Orange Peels Using Supercritical Carbon Dioxide

Yuri Fukagusa[1]*, Asa Kudoh[1], Mitsuru Sasaki[1], Cinthya Issasi[2], and Hiroyuki Mizukami[3]

[1]*Kumamoto University, Japan*
[2]*Universidad Autonoma de Nuevo Leon, Mexico*
[3]*Kumamoto Industrial Research Institute, Japan*

In this study, we investigated the extraction of essential oils from immature Japanese bitter-orange peels using supercritical CO_2 (SCO_2) and compared it to the traditional Soxhlet extraction with hexane and ethanol. Higher temperatures during SCO_2 extraction led to greater oil yields, despite the decrease in\ SCO_2 density, because of the increase of diffusion coefficient and solute vapor pressure due to higher temperatures. At constant temperatures, increased pressure enhanced the SCO_2 density and solubility, further improving the extraction yields. SCO_2 extraction at high temperatures and pressures outperformed the Soxhlet method in terms of essential oil yield, though the efficiency could be improved with better raw-material processing. Furthermore, we explored selective extraction using SCO_2 by analyzing the polyphenol content and antioxidant properties of different fractions. SCO_2 extraction was found to suppress the extraction of monoterpenes compared to Soxhlet extraction. Additionally, the composition of the SCO_2 extract varied depending on the extraction conditions, suggesting that selective extraction is possible. The Soxhlet extract contained the highest polyphenol content, while the SCO_2 extract obtained at a high temperature and pressure demonstrated the strongest antioxidant properties.

Keywords: Supercritical carbon dioxide; immature Japanese bitter-orange peel; essential oil; polyphenols

*Corresponding author: 242d8778@st.kumamoto-u.ac.jp

CEE-010

The Role of Semiconductive Property on the Selective Cementation Mechanism of Iron Oxides to Gold in Galvanic Interaction with Zero-Valent Aluminum from Gold-Copper Ammoniacal Thiosulfate Solutions

Joshua Zoleta*, Carlito Tabelin, and Vannie Joy Resabal

Mindanao State University-Iligan Institute of Technology, Philippines

Iron oxides (Hematite, Fe_2O_3 and Magnetite, Fe_3O_4), previously used as an electron mediator in the galvanic system with zero-valent aluminum (ZVAl), have been shown to recover Au upon cementation in Au-Cu ammoniacal thiosulfate medium selectively, and this warrants further investigation. This research is focused on investigating the role of semiconductive properties of metal oxides by conducting a cementation experiment by mixing 0.15 g of electron mediators (Fe_3O_4, Fe_2O_3, TiO_2 (anatase and rutile)) and 0.15 g of zero-valent aluminum powder as an electron donor, and various electrochemical experiments. The results revealed that upon cementation experiment, synthetic Fe_2O_3 and Fe_3O_4 were consistently able to selectively recover Au at around 90% and Cu at around 20%. Compared to activated carbon (AC), TiO_2, in anatase and rutile form, obtained selective recovery for gold but was utterly insignificant compared to iron oxides, obtaining an average of 93% Au-63% Cu recovery. The electrochemical and surface analysis support the results obtained upon the cementation process, where TiO_2, upon cyclic voltammetry (CV), obtained two (2) reduction peaks centered at -1.0 V and -0.5 V assigned to reducing Au and Cu ions, respectively. Furthermore, various electrochemical impedance spectroscopic analyses revealed that the flat band potential obtained in the Mott-Schottky plot is around -1.0 V and -0.2 V for iron oxides and titanium oxides, respectively, suggesting that the electrons travel from semiconductor interface to electrolyte interface and electrons are accessible only to Au ions in electrolyte interface (reduction band edge around -1.0 V). The determination of this selective cementation mechanism is one of a kind. It has been proposed that the semiconductive properties of Fe_2O_3 and Fe_3O_4 can be configured by configuring their relative energy band diagram; the travel of electrons from iron oxide-electrolyte interface facilitates the selective cementation towards $Au(S_2O_3)_2^{3+}$ ions in gold-copper ammoniacal thiosulfate solutions.

Keywords: Galvanic Interaction; Thiosulfate; Gold; Flat-band potential; Energy Band Gap; Reductive Precipitation

*Corresponding author: joshua.zoleta@g.msuiit.edu.ph

POLICIES AND PARTNERSHIPS FOR SUSTAINABLE DEVELOPMENT (PSD)

PSD-001

Policy Framework for Managing Antibiotic Pollution and Antimicrobial Resistance (AMR) in the Philippine Water Environment in the Lens of One Health Approach

Johara Capingian[1,5], Carla Mae Pausta[1,5], Miguel Antonio Salazar[2], Kim Ahmed Sadol[1,5], Gerianne Mae Arada[1,5], Lemuel Agonoy[1], Aileen Orbecido[1,5], Joseph Ortenero[1,5], Michael Angelo Promentilla[1,5], Liza Bautista-Patacsil[3], Joel Cornista[4], and Arnel Beltran[1,5]*

[1]*Department of Chemical Engineering, De La Salle University, Philippines*
[2]*Alliance for Improving Health Outcomes, Philippines*
[3]*University of the Philippines Los Baños, Philippines*
[4]*University of the Philippines Manila, Philippines*
[5]*Center for Engineering and Sustainable Development Research, De La Salle University, Philippines*

Like other countries, the Philippines faces a disparity of efforts to combat growing concerns of antibiotic pollution in the environmental sector compared to the other sector in the One Health context. Particularly, enough evidence has highlighted the crucial role of water matrix on the spread and transmission of AMR in the environment. The integration of the environmental dimension is a crucial step to abate and control the adverse effects of antibiotic pollution and development of AMR. The United Nations Environment Programme (2022) highlights key priority areas for managing AMR environmentally, including inter-agency coordination, reducing contaminant release, financing, innovation, capacity development, and enhanced environmental monitoring. As such, this study created a framework tailored at providing targeted policies and standards is crucial. A policy analysis for the management of antibiotics and AMR in the Philippine water environment was conducted through systematic policy and literature review. This is followed by consultations and focused group discussion, involving selected stakeholders across all relevant sectors in the lens of one health. This study highlights a national water quality guideline policy warranting a more comprehensive and targeted approach to fill in the gaps of the current Water Quality Guidelines (WQG) and General Effluent Standards (GES) and align with the efforts and initiatives of the current global and local legal framework to combat antibiotic pollution and spread of AMR in the water environment.

Keywords: Antibiotic Pollution; AMR (Antimicrobial Resistance); Water Environment; Policy Analysis; One Health

*Corresponding author: arnel.beltran@dlsu.edu.ph

PSD-002

Evaluating Corporate ESG Performance of ASEAN-5 Companies Using Data Envelopment Analysis (DEA) and Entropy-TOPSIS: A Case of the Extractives Industry

Chalmer Belaro and Michael Angelo Promentilla*

De La Salle University, Philippines

Climate financing is expected to continue increasing, particularly in developing economic regions such as the ASEAN-5, where natural resource extraction plays a vital role in meeting climate goals. In a global investment environment that integrates environmental, social, and governance (ESG) considerations to align sustainability with business performance, this study proposes a framework to evaluate corporate sustainability performance through ESG materiality scores, which may influence investment decisions and serve as peer benchmarks. Financial efficiency is assessed using Data Envelopment Analysis (DEA) on companies from the ASEAN-5, and ESG materiality scores are determined for the efficient firms using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), with entropy weights derived from ESG indicators based on materiality topics developed by the Sustainability Accounting Standards Board (SASB) and sourced from the Refinitiv database. ESG factors under each pillar that significantly influence the scores are identified, and the resulting scores are used to highlight top-performing companies. These ESG materiality scores differ from standard Refinitiv scores by offering enterprise managers insights into financially efficient and sustainable peers, along with prioritized ESG factors to enhance their own practices. The findings provide valuable guidance for investors and policymakers in promoting informed investment decisions and advancing ESG adoption in the region

Keywords: Corporate Sustainability; ESG Materiality; MCDA; Company Ranking

*Corresponding author: michael.promentilla@dlsu.edu.ph

PSD-003

A Review of Sustainability Assessments for Wastewater Management Systems in Developing Countries: Towards a Contextualized Framework for the Philippines

Theresa Carrera[1], Regina Damalerio[2,3], Carla Mae Pausta[1,4], Michael Angelo Promentilla[1,4], Aileen Orbecido[1,4], Renan Ma. Tanhueco[1,5], Kathleen Aviso[4,6], Ador Torneo[7], and Arnel Beltran[1,4]*

[1]Center for Engineering and Sustainable Development Research, De La Salle University, Philippines
[2]Lucerne University of Applied Sciences and Arts, Switzerland
[3]University of Geneva, Switzerland
[4]Department of Chemical Engineering, De La Salle University, Philippines
[5]Department of Civil Engineering, De La Salle University, Philippines
[6]Gokongwei College of Engineering, De La Salle University-Manila, Philippines
[7]Department of Political Science and Development Studies, De La Salle University, Philippines

Water demand in the Philippines continues to rise while water resource quality steadily deteriorates. Majority of municipalities lack functional wastewater systems due to limited financial and technical capacities, and weak regulatory incentives and enforcement. Decentralized wastewater management systems (WMS) are viable alternatives in areas not served by centralized systems due to lower costs, smaller land requirements, adaptability to varying conditions, and greater resilience. This study presents existing decentralized WMS in the Philippines through a systematic literature review. It assesses their performance and explores the challenges affecting their implementation. Existing studies highlight the potential of anaerobic treatment technologies and nature-based solutions and the significance of the physical, demographic, and socio-economic parameters in assessing the appropriate degree of centralization. Despite these approaches and numerous policies, WMS in the country remains constrained by inadequate infrastructure and inconsistent regulatory enforcement. Challenges stem from the fragmented governance structure of policymaking and the implementation, regulation, financing, and social aspects. The social, political, technological, and economic interdependence is emphasized in achieving successful WMS deployment. Insights from the study aim to inform strategies for scaling decentralized systems by utilizing a toolkit and policy guidelines manual developed from a systematic review that FGDs supplemented to guide decision-makers in selecting the appropriate WMS and technologies to be implemented.

Keywords: wastewater management systems; systematic literature review; degree of centralization; implementation challenges; decentralized wastewater management

*Corresponding author: arnel.beltran@dlsu.edu.ph

PSD-004

Go Green: Implementing the Zero Waste to Landfill Approach in Sustainable FPC Manufacturing

Ivy Alintanahin and Kimberly Matedios*

First Sumiden Circuits Inc., Philippines

The Zero Waste to Landfill (ZWTL) Program presents a proactive approach to sustainable Flexible Printed Circuit (FPC) production. This study evaluates the structured methods adopted by First Sumiden Circuits, Inc. – the Philippines' sole FPC manufacturer - in minimizing environmental impact and improving operational sustainability. The program integrates key environmental practices such as detailed waste stream analysis, waste segregation, continuous waste tracking, employee education, life cycle assessment and collaboration with certified waste management providers. Since its implementation in 2022, the facility has diverted 96.39% of total waste away from landfills with the residuals being directed to material and thermal recycling process. Ongoing monitoring and continuous improvement efforts position the facility to achieve full waste diversion by the first quarter of 2026. This evaluation provides a replicable framework for similar industries seeking to align with circular economy principles.

Keywords: waste diversion; flexible printed circuit; lifecycle assessment; waste management

*Corresponding author: matedioskim@gmail.com

PSD-005

Reduction of Oil and Grease Concentration in Domestic Wastewater through Physical Remediation Methods in a Dry Manufacturing Process

Ivy Alintanahin, Kimberly Matedios, Micaela Angela Derramas, and Shairish Mei Lamaroza*

First Sumiden Circuits Inc., Philippines

Maintaining the quality of wastewater generated in industrial areas is critical to preventing the contamination of nearby tributaries leading to Laguna de Bay - the primary water source for CALABARZON and Metro Manila. However, the fluctuating behavior of oil and grease in effluent from dry manufacturing processes poses a significant challenge in maintaining compliance with the interconnected industrial park (LISP 1) effluent requirements and consequently with EMB DAO 2016-08 standards. This study evaluates the effectiveness of physical remediation techniques in reducing the oil and grease level in the domestic wastewater discharges of First Sumiden Circuits, Inc. (FSCI) – Plant 3, a dry manufacturing facility in Cabuyao City, Laguna. The methodology integrates process mapping, regular wastewater sampling, implementation of engineering and administrative controls and establishment of standardized operational procedures. The assessment demonstrated a substantial improvement in the reduction of oil and grease concentration by 89.64% using an automatic grease trap compared to 35.29% removal rate of the existing passive or conventional grease traps. This research provides a scalable framework for similar industrial and commercial sectors facing effluent compliance challenges. Future studies may explore chemical and biological remediation methods that are beyond the scope of this research.

Keywords: oil and grease; dry manufacturing process; domestic wastewater; effluent standards; grease trap

*Corresponding author: splamaroza@fsci.sei.co.jp

NANOTECHNOLOGY (NNT)

NNT-001

Investigation of Graphene Oxide Functionalized with Natural Deep Eutectic Solvent for Pervaporation Desalination

Gabriel Carballo* and Wei-Song Hung

National Taiwan University of Science and Technology, Taiwan

Global water scarcity, affecting over half the population due to limited freshwater availability (less than 1%), demands innovative desalination solutions. This study aimed to enhance pervaporation desalination efficiency by functionalizing graphene oxide (GO) with natural deep eutectic solvents (NADES). NADES, known for their biocompatibility and tunable properties, were used to modify GO, enhancing its hydrophilicity and selective transport characteristics. The resulting GO-NADES composite membranes were characterized using various techniques, including water contact angle, X-ray diffraction, Fourier-transform infrared spectroscopy, and scanning electron microscopy, to confirm successful functionalization and morphological changes. Pervaporation performance, including water flux and salt rejection, under different conditions was evaluated. Incorporating NADES significantly improved the membrane's water selectivity and flux compared to pristine GO membranes. This enhanced performance can be attributed to the increased hydrophilicity and the formation of selective pathways facilitated by the NADES within the GO matrix. The findings demonstrate the potential of GO-NADES composite membranes as a promising material for efficient and sustainable seawater desalination, offering a pathway to address global water scarcity.

Keywords: Deep eutectic solvent; Lamellar membranes; Graphene oxide; Pervaporation desalination; Salt removal

*Corresponding author: gabrielvcarballo@gmail.com

NNT-002

Molecular Dynamics Simulation of Effect of Temperature on Interfacial Structure and Interaction between Alkylphosphonic Acid-Modified TiO_2 and Organic Solvent

Ronald[1], Hiroto Sawauchi[1], Yuto Sato[1], Takamasa Saito[1], Shohei Yamashita[2], Yohei Okada[2], Eita Shoji[3], and Masaki Kubo[1]*

[1]Department of Chemical Engineering, Tohoku University, Japan
[2]Department of Applied Biological Science, Tokyo University of Agriculture and Technology, Japan
[3]Department of Mechanical Systems Engineering, Tohoku University, Japan

Titanium dioxide (TiO_2) nanoparticles have a wide range of applications, including in electronic devices and biomedical materials. Due to their tendency to aggregate, it is essential to control their dispersibility by surface modification with organic ligands. Understanding the relationship between the interfacial structure and interaction between surface-modified nanoparticles and organic solvents is crucial for the design and optimization of ligands. In this study, the effect of temperature on interfacial structure between surface-modified TiO_2 and organic solvents was investigated using all-atom molecular dynamics simulations. The simulation system consisted of a toluene solvent film placed on surface-modified TiO_2 anatase (101) slab. The ligand was alkylphosphonic acid with varying alkyl chain lengths, achieved by changing the number of carbon atoms. Surface coverage was 2.56 molecules/nm^2. Simulations were conducted at temperatures of 278 K, 298 K, and 328 K, under a constant pressure of 1 atm. At lower temperature, shorter ligand chains exhibited less ordered structures, allowing solvent to penetrate into the ligand layer. It resulted in strong interaction between ligands and solvent. In contrast, longer ligand chains exhibited more ordered structures. At higher temperature, ordered structures in longer ligand chains became less ordered, leading to enhanced solvent penetration.

Keywords: nanoparticles; surface modification; interfacial structure; molecular dynamics simulation

*Corresponding author: m.kubo@tohoku.ac.jp

NNT-004

Selective Silane-based Polyketone/Nylon-6 Adsorptive Filtration Membrane for Heavy Metal Removal

Jao Jancen Ruiz[1]*, Joy Thomas[2], Rhoda Leron[3], and Robert Tang Chang Chang[2]

[1]*Mapua University, Philippines*
[2]*National Ilan University, Taiwan*
[3]*De La Salle University Manila, Philippines*

In this study, electrospun polyketone/nylon-6 (PKxNYz) nanofibrous composite membranes were modified using 3-aminopropyltriethoxysilane(APTES) for selective removal of Cr, Pb, Hg, Ag, Cu, Fe, Zn, Co, and Ni from aqueous solutions. The pristine and surface-modified membranes were characterized using Fourier transform infrared spectroscopy, scanning electron microscopy, and water contact angle measurement. The pure water flux of the pristine PKxNYz increased from 12,260.12±923.27 to 20,895±2,585.15 $Lm^{-2}h^{-1}$ (LMH) as the nylon-6 content increased to 50wt%. The pristine PKxNYz was modified via spin coating method using a 25% APTES solution at 250 rpm spin coating speed. The modified membrane exhibited 100% rejection rates for Pb and Hg, >80% for Ag and Cu, and 80% for Fe, Zn, Ni, and Co. For Cr removal, the highest rejection rate obtained was 87.90±1.38% with a permeate flux of 7,914±391.69 LMH. Reusability tests showed that the modified PKxNYz still achieved rejection rates of 100% and 66.08% for PB and Cr, respectively, while the corresponding permeate flux decreased to 394.50 LMH and 836.94 LMH. It can be concluded that the APTES-surface modified PKxNYz could selectively adsorb the heavy metals Pb, Hg, and Cr from aqueous solutions.

Keywords: heavy metal removal; APTES; polymer blending; electrospinning

*Corresponding author: jaoruiz07@gmail.com

NNT-005

Hydrogen Storage by Carbon Nanohorns Enhanced by Hydrogen Spillover Effect

Noriaki Sano*

Kyoto University, Japan

We have been studying the synthesis and application of carbon nanohorns. Carbon nanohorns are nanotube-like material, and they can be synthesized by an arc discharge technique at high purity easily. We have found that carbon nanomaterials dispersed with metallic nanoparticles can store hydrogen by softly-dissociative adsorption of hydrogen, and their hydrogen storage capacity is higher than pure carbon materials. This enhancement is reported to be contributed by so-called hydrogen spillover. The present study reports that carbon nanohorns synthesized by arc discharge in water with gas-injection can be dispersed with various metallic nanoparticles when the electrode in the arc discharge system contains carbon and metallic species. Also, it reports that the metal-dispersed carbon nanohorns can exhibit significantly higher hydrogen storing capacity than ordinal carbon nanohorns and the metal species and its amount dispersed in carbon nanohorns essentially affects the hydrogen storage capacity. It is observed that titanium is the appropriate metallic species and there is an optimized amount of it in carbon nanohorns. In addition, chemical modification on metal-dispersed carbon nanohorns can exhibit high hydrogen storage capacity. By a theoretically using a semi-empirical molecular orbital calculation, the metal dispersion on carbon nanohorns can reduce activation energy to dissociate hydrogen molecule in hydrogen spillover scheme.

Keywords: carbon nanohorn; hydrogen storage; spillover effect; arc discharge

*Corresponding author: sano@cheme.kyoto-u.ac.jp

NNT-007

One-Pot Strategy to Valorize Underutilized Biomass into Metal–Embedded Porous Carbon for Environmental Remediation

Dung Van Nguyen*, Hung Minh Nguyen, Long Quang Nguyen, and Tuyet-Mai Tran-Thuy

Ho Chi Minh City University of Technology (HCMUT), VNU-HCM, Vietnam

The sustainable valorization of underutilized biomass into high-performance functional materials provides an eco-friendly pathway for environmental remediation. Herein, we introduce a novel one-pot strategy to directly valorize biomass to metal-embedded porous carbon (M/PC) composites. In this approach, biomass is preloaded with metal precursors and activating agents, followed by one-pot pyrolysis at 600–700 °C under a nitrogen atmosphere. This integrated process enables simultaneous carbonization, activation, and in situ formation of metal (Fe, Co, Cu) or metal oxide (MnO, Fe_3O_4) nanoparticles within the porous carbon framework. The resulting M/PC materials exhibit high specific surface areas, large total pore volumes, hierarchical porosity, and uniformly dispersed metal nanoparticles, providing abundant active sites for catalytic reactions. Their effectiveness is demonstrated through the activation of multiple oxidants, including peroxydisulfate, peroxymonosulfate, hydrogen peroxide, and percarbonate to degrade organic pollutants. Overall, this one-pot strategy provides a scalable, green, and cost-effective route for fabricating advanced carbon-based catalysts from biomass for wastewater treatment and other environmental applications.

Keywords: one-pot strategy; biomass valorization; metal nanoparticle; porous carbon; organic pollutant; environmental remediation

*Corresponding author: nvdung@hcmut.edu.vn

FUEL CELLS AND ELECTROCHEMISTRY (FCE)

FCE-001

Modified Synthesis of Cotton Cellulose for Nano-sized Cellulose Whisker for Hybrid Membrane as Sustainable Membrane Filler

Jo Maria Opeña* and Ronaldo Parreño Jr.

Department of Science and Technology – Industrial Technology Development Institute, Philippines

Cellulose whisker (CW) has been studied as energy material because of its unique properties which makes it a sustainable filler in hybrid membrane for polymer exchange membrane fuel cells (PEMFCs) due to their mechanical strength and electrochemical performance. This study investigated the effect of modified synthesis method in producing CW with nano-sized structure that could have potential application as sustainable filler. Cotton CW was successfully synthesized with primary modifications on acid concentration (44%), temperature (35 °C) and reaction time (3 hours) in accordance with the principles of Green Chemistry by applying less hazardous chemical syntheses and the use of renewable feedstock. Characterization results showed that these modifications have beneficial effects on the microstructure of the CW by making it a nano-sized material. SEM images showed that the original CW had dimensions of 5.28 µm, and the modified synthesis successfully reduced the CW to nanoscale dimensions of 7.53 nm, showing a size reduction of 99.85%, Fourier-transform infrared spectroscopy with attenuated total reflectance (FTIR-ATR) confirmed the $-SO_3$ present in the CW and a CrI of 93% was determined using X-ray diffraction (XRD), while optical tensiometer showed a contact of angle of 35.7◦, indicating that it is hydrophilic. This modified method proved to be effective in reducing the size of CW, thereby, improving compatibility with the membrane material.

Keywords: Cotton cellulose; cellulose whiskers; hybrid membrane; nanostructure; fuel cell

*Corresponding author: openajomaria@gmail.com

FCE-002

Evaluation of the Improvised MEA Former as a Cost-Effective and Sustainable Alternative to Hot Pressing for Fuel Cell Assembly

Kurt Yvhan Garganta, Ronaldo Parreño Jr., Rica Glen Marchan, Jowin Rama, Jo Maria Opeña, Aeron Vincent Austria, Claire Ann Chua, and Jhim Carl Layug*

Department of Science and Technology, Philippines

A major drawback in fuel cell manufacturing is the high cost of materials, primarily due to the amount of catalyst integrated in the electrodes. Furthermore, several instruments utilized in the development of fuel cells are expensive and energy intensive, one such equipment is the hot press. This study aims to address these challenges by developing an improvised MEA former that is cheap and easy to fabricate as a substitute to hot pressing. To further reduce production costs, biomass-derived waste materials were used in synthesizing the individual components. Qualitative tests simulating stack operation, such as boiling and oxidation tests demonstrated that the MEA could withstand high temperatures and oxidative environments without affecting the interfacial adhesion. Voltage output of the MEA was also identified. It was determined that the MEA had a maximum voltage of 0.958 V, 0.540 V, and 0.053 for the commercial MEA, commercial membrane combined with the sample electrode, and commercial electrode with the sample membrane respectively. Results indicate that incorporating the sample electrode/membrane leads to a lower voltage output, suggesting the need for further optimization of the components. Nevertheless, the improvised MEA former was shown to induce good interfacial adhesion of the components.

Keywords: Hot press; improvised MEA former; boiling test; oxidation test; interfacial adhesion; voltage output

*Corresponding author: jhimcarllayug25@gmail.com

FCE-003

Statistical Approach on Determining the Effects of Membrane Resistance for Fuel Cell Using Electrochemical Impedance Spectrometer (EIS)

Aeron Vincent Austria, Ronaldo Parreño Jr., Rica Glen Marchan, Jowin Rama, Jo Maria Opeña, Kurt Yvhan Garganta, Claire Ann Chua, and Jhim Carl Layug*

Department of Science and Technology, Philippines

Galvanostatic Electrochemical Impedance Spectroscopy (GEIS) is a powerful technique used to evaluate the electrochemical behavior of materials by measuring their frequency-dependent impedance. In fuel cell applications, impedance data, particularly from Nyquist plots, can reveal critical information about membrane resistance and interfacial characteristics. This study investigates the effects of membrane resistance using GEIS on perfluorosulfonic acid (PFSA) membranes through a statistical approach. A typical three-electrode setup was used for all tests. For the second batch, membranes were presoaked in H_2SO_4 for one hour prior to measurement to assess the impact of preconditioning. Results showed that data inconsistencies and measurement noise were more prevalent in the low-frequency region (300 Hz), while mid (300–4000 Hz) and high-frequency (>4000 Hz) regions exhibited clearer impedance features related to charge transfer and ohmic membrane resistance. Further analysis revealed no statistically significant difference in the average real impedance (Z′) between the batch using a single membrane and the batch using three different membranes, indicating consistent bulk resistance. However, a significant difference was observed in the average imaginary impedance (Z″), suggesting variability in capacitive or interfacial behavior. These findings highlight the importance of membrane preparation, frequency selection, and statistical validation when interpreting EIS data for fuel cell diagnostics.

Keywords: Galvanostatic Electrochemical Impedance Spectroscopy; PFSA Membrane; Fuel Cell; Membrane resistance; Nyquist plot

*Corresponding author: jhimcarllayug25@gmail.com

FCE-004

In-situ and Operando Studies on Glycerol Electrooxidation Using a Nickel Foam Electrocatalyst

Gabrielle Marie Segui, Liezle Agasino, Matt Justin Young, Airon Rae Asuncion, Rosela Mae Lazaro, Glennise Faye Mejica, Jan Goran Tomacruz, and Joey Ocon*

Laboratory of Electrochemical Engineering, University of the Philippines Diliman, Philippines

The rising global energy demand and shift toward sustainable fuels have accelerated biodiesel production, leading to excess glycerol as a major byproduct commonly present in wastewater. Glycerol electrooxidation reaction (GEOR) offers a viable pathway for valorizing this surplus, particularly in direct alcohol fuel cells, but remains hindered by sluggish kinetics and an incomplete understanding of its catalytic mechanism. This study examines nickel foam, an inexpensive, non-noble electrocatalyst, to provide mechanistic insight into GEOR. Using a three-electrode potentiostat setup, electrochemical tests were conducted with pretreated nickel foam. Cyclic voltammetry confirmed its electrochemical activity, while linear sweep voltammetry identified 0.4504 V vs. Ag/AgCl as the effective potential for GEOR. This potential was applied in chronoamperometry, which showed stable current at 0.01 mA. Differential electrochemical mass spectrometry (DEMS) during five hours of chronoamperometry detected ethylene glycol and methanol as intermediates, and acetic acid and hydrogen as gaseous products. UV-Visible spectroscopy revealed a peak at 223 nm, and functional group tests confirmed aldehydes and carbonate, while eliminating carboxylic acids, oxalate, and reducing sugars. These findings support established pathways and propose a reaction mechanism. The study demonstrates that nickel foam can serve as a selective and efficient electrocatalyst for GEOR, advancing the development of sustainable fuel and chemical conversion technologies.

Keywords: glycerol electrooxidation; nickel foam; non-noble metal electrocatalyst; differential electrochemical mass spectrometry

*Corresponding author: jdocon@up.edu.ph

FCE-005

In-Situ and Operando Mechanistic Study of Ni Foam Catalyzed Electrooxidation of Isopropyl Alcohol

Matt Justin Young, Gabrielle Marie Segui, Liezle Agasino, Hannah Joy Drapisa, Airon Rae Asuncion, Glennise Faye Mejica, Jan Goran Tomacruz, and Joey Ocon*

Laboratory of Electrochemical Engineering, University of the Philippines-Diliman, Philippines

Traditional acetone production, largely from petroleum via the cumene process, generates harmful waste. A potential alternative is through the electrooxidation of isopropanol (IPA) using nickel foam (NiF) as catalyst. Nickel-based electrocatalysts are of interest as potential sustainable and cost-effective alternatives to noble metal based electrocatalysts in alcohol electrooxidation. To advance commercialization, understanding the reaction mechanism of NiF-catalyzed IPA electrooxidation is crucial. This study utilized a combination of potentiometric methods with ex-situ and in-situ techniques to gain insights on its possible reaction mechanism. Additionally, samples from 2-hour chronoamperometry were tested using UV-Vis spectrometry and differential electrochemical mass spectrometry (DEMS). Cyclic voltammetry results show separate potentials of NiOOH oxidation (0.46V vs Ag/Ag/Cl) and $Ni(OH)_2$ reduction (0.28V vs Ag/Ag/Cl), IPA oxidation (0.575V vs Ag/Ag/Cl). UV-Vis spectra did not show acetone's characteristic absorbance. Instead, DEMS results indicate the formation of a species with a 44 mass-to-charge ratio. These findings imply a potential-dependent mechanism, possibly with multiple concurrent pathways. Future work using techniques like high-performance liquid chromatography (HPLC) and in-situ Fourier transform infrared (FTIR) spectrometry could further refine understanding of these complex reaction pathways.

Keywords: isopropanol electrooxidation; nickel catalyst; mechanistic study; differential electrochemical mass spectrometry

*Corresponding author: jdocon@up.edu.ph

FCE-006

Sonochemical Synthesis of Copper-based Metal–Organic Framework for Modification of Screen-Printed Carbon Electrode toward Ciprofloxacin Detection

Vincent Paul P. Laguardia*, Caren R. Tumambing, Glenson R. Panghulan, Felix Rey C. Bueta, Ian Lorenzo E. Gonzaga, Liza Bautista-Patacsil, and Resmond L. Reaño

College of Engineering and Agro-industrial Technology, University of the Philippines Los Baños, Philippines

Rapid and on-site monitoring of antibiotics in food samples, aquatic environment, and wastewater effluents is critical in mitigating antimicrobial resistance (AMR). Among the various monitoring tools, electrochemical sensors are increasingly recognized as a cost-effective, simple, yet versatile alternative to conventional analytical techniques. Their wide range of applications is amplified through surface modification and functionalization with polymers and nanomaterials, which improve sensitivity and detection capabilities. In this study, a facile sonication method was employed to synthesize and integrate copper(II)-benzene-1,3,5-tricarboxylate (Cu-BTC) metal–organic framework onto a screen-printed carbon electrode (SPCE). The bare and Cu-BTC/SPCE were compared through their electrochemical performance and applied for the detection of ciprofloxacin (CIP). Cyclic voltammetry showed that upon modification, peak-to-peak separation (ΔEp) of the redox probe decreased by 81% while both the anodic (Ipa) and cathodic (Ipc) peak currents increased five-fold. Meanwhile, electrochemical impedance spectroscopy confirmed that Cu-BTC/SPCE exhibited a 98% reduction in charge transfer resistance. Both tests established that the addition of Cu-BTC significantly enhanced the electrode's electrocatalytic activity. Electrochemical sensing analysis revealed that CIP's mass transport involved an irreversible oxidation and adsorption-controlled process, and that Cu-BTC/SPCE had a good linear response to CIP in the range of 0.5–20 μM.

Keywords: sonochemical synthesis; metal–organic framework; electrochemical detection; ciprofloxacin

*Corresponding author: vplaguardia@up.edu.ph

FCE-007

Optimization of a Sodium-Ion Battery Architecture Combining Multi-Phase $Na_{0.84}Ni_{0.3}Fe_{0.1}Mn_{0.5}Mg_{0.1}O_2$ Cathode and Coal-Derived Hard Carbon Anode

John Christian Quillope[1], Mecaelah Palaganas[1], Maricor Divinagracia-Luzadas[1], and Joey Ocon[1,2]*

[1]Nascent Technologies Corporation, Philippines
[2]De La Salle University, Philippines

Sodium-ion batteries (SIBs) are viewed as cost-effective, sustainable complement to lithium-ion batteries (LIBs) in expediting the integration of variable renewable energy into the power grid. Still, commercialization remains limited by the gap between lab-scale research and scalable full cell integration. In this study, a scalable cell architecture consisting of a mixed-phase layered transition metal oxide cathode (P^{2-}, O^{3-}, and P3-type $Na_{0.84}Ni_{0.3}Fe_{0.1}Mn_{0.5}Mg_{0.1}O_2$) paired with a coal-derived hard carbon anode is presented, where the electrode materials were synthesized through facile annealing (cathode material) and pyrolysis (anode material) techniques. The P2 and O3 phases of the cathode material deliver long-term cycling stability and high Na^+ inventory, respectively. Meanwhile, the anode material offers superior charge-discharge capacity. The effect of variations in presodiation technique and electrolytes used were analysed. Presodiated coin cells via direct contact yielded competitive specific capacity (84 mAh g^{-1} at 1C) along with superior energy densities of 280–320 Wh kg^{-1} under fast charge-discharge conditions at a wide potential range (2.0 – 4.2 V, 0.5C and 1C). Two electrolyte formulations (1 M $NaPF_6$ in PC + 5% FEC and 1 M $NaPF_6$ in 1:1 DEC:PC + 5% FEC) achieved the highest capacity retentions (~80% over 1250 cycles at 1C). These results demonstrate the feasibility of high-performance, long-life sodium-ion batteries and offer valuable insights into scalable approaches for SIB commercialization from material synthesis to full cell assembly.

Keywords: sodium-ion batteries; full cells; cathode materials; layered oxides; anode materials; hard carbon

*Corresponding author: joey.ocon@dlsu.edu.ph

FCE-008

Enhancing $NaCrO_2$ Cathodes for High-Performance, Thermally Stable Sodium-Ion Full Cells

Anna Karenina Dalabajan, Maricor Divinagracia-Luzadas, and Joey Ocon*

Nascent Technologies Corporation, Philippines

Lithium-ion batteries (LIBs) face not only supply chain and sustainability challenges but also safety concerns, with multiple reported cases of thermal runaway and explosions. Sodium-ion batteries (SIBs) present a viable alternative, offering abundant raw materials, compatibility with existing LIB infrastructure, and enhanced safety. Among SIB cathodes, layered sodium chromium oxide ($NaCrO_2$) stands out for its high rate capability and excellent thermal stability, remaining structurally stable at temperatures up to 573.15 K (300 °C). In this study, $NaCrO_2$ was synthesized via solid-state reaction at 1173.15 K (900 °C) under an inert atmosphere. The electrochemical performance demonstrated a reversible capacity of 107.2 mAh g^{-1} between 2.0 – 3.6 V at 0.5C, with 91.0% capacity retention over 50 cycles. Full cell assembly using in-house coal-derived hard carbon anode delivered a discharge capacity of 93.0 mAh g^{-1}, with an equivalent energy density of 277.0 Wh kg^{-1} (1.8 – 3.6 V at 0.5C). The initial electrochemical results underscore the potential of $NaCrO_2$ as a high-performance cathode for practical sodium-ion full cell applications. Future work will focus on carbon coating and elemental doping of $NaCrO_2$ to improve capacity retention and increase specific capacity (targeting up to 125 mAh g^{-1}), as well as conducting TGA-DSC analysis to confirm its thermal stability.

Keywords: sodium-ion batteries; $NaCrO_2$; thermal stability; cell development

*Corresponding author: joey.ocon@dlsu.edu.ph

FCE-009

High-Performance Hard Carbon Anodes for Sodium-Ion Batteries Derived from Locally Sourced Coal: Effects of Pyrolysis Conditions and Pre-Treatment Protocols

Joshua Jr Santiago[1], Mecaelah Palaganas[1], Maricor Divinagracia-Luzadas[1], and Joey Ocon[1,2]*

[1]*Nascent Technologies Corporation, Philippines*
[2]*Chemical Engineering Department, De La Salle University, Philippines*

Sodium-ion batteries (SIBs) are gaining traction amid supply-chain risk and cost pressure, yet a shortage of low-cost, high-performance anodes from local resources limits deployment. In this study, hard carbon (HC) anodes were synthesized from Semirara coal and the effects of precursor heating value (HV), pyrolysis temperature, and pre-treatment methods on the structure and performance were determined. Results show that the 5300 HV sample (HV: ~5300 kcal kg^{-1},) delivered the highest capacity (>280 mAh g^{-1} at 0.1C) and retention (>100% after 180 cycles), outperforming both lower (5100) and higher (5600) HV coals. Pre-pyrolysis acid washing with 5M HCl enhanced discharge capacities, particularly at 1C, by removing mineral impurities. Brunauer–Emmett–Teller (BET) surface area analysis, Raman spectroscopy, and Fourier-transform infrared spectroscopy (FTIR) confirmed that low surface area, balanced graphitic disorder (ID/IG = ~0.9–1.0), and minimal oxygen-containing functional groups correlate with high-performance coal-derived anodes. Benchmarking against a commercial HC tested under identical protocols, the optimized coal-derived HC delivered a higher initial capacity (~321 mAh g^{-1} vs. ~294–299 mAh g^{-1} at 0.1C) and superior cycling stability. This work establishes how local feedstocks and tailored synthesis protocols can enable efficient, robust, low-cost SIB anodes, contributing to a resilient, decarbonized future.

Keywords: Sodium-ion batteries; anode; coal-derived hard carbon

*Corresponding author: joey.ocon@dlsu.edu.ph

POLYMER SCIENCE AND ENGINEERING (PSE)

PSE-001

Comparison of Gamma and Electron Beam Irradiation on Biofilm Carriers for Wastewater Treatment

Maegan Gwyneth Alcaraz*, Ace Albert Angeles, and John Paolo Lazarte

Philippine Nuclear Research Institute, Philippines

A moving bed biofilm reactor is a wastewater treatment technology that uses biofilm carriers as a medium for microorganisms. It relies on bacterial communities to treat organic matter and reduce nutrient content in wastewater. Various procedures can be done to modify the characteristics of these carriers and improve their performance. Radiation processing is performed on polymers to modify their physical and chemical properties such as mechanical strength and thermal stability. Gamma and electron beam radiation differ in multiple aspects, one of which is their penetration depth. Photons from gamma rays penetrate deeper into materials, while electrons are more effective for surface level treatments. The present study investigates the comparison of gamma and electron beam irradiation on the characteristics of biofilm carriers and biofilm attachment. Commercial biofilm carriers were separately subjected to gamma and electron beam radiation and tested in a pilot-scale MBBR module. The attached biofilm on the carriers was measured and the carriers were characterized using FTIR, AFM, and contact angle analysis. The results of this study can be helpful in the continuous improvement of MBBR technologies as more environmentally friendly processing techniques can be applied to increase efficiency.

Keywords: gamma irradiation; electron beam irradiation; wastewater treatment; moving bed biofilm reactor; biofilm carriers

*Corresponding author: maeganalcaraz99@gmail.com

PSE-002

Fuzzy Optimization of Production of Cassava Starch-Based Biodegradable Plastic for Enhanced Tensile Strength and Cost Efficiency

Ralph Emmanuel Manlulu, Gamille Marie Silva, Alijaeh Joshua Go, Jose Antonio Calero, Kathleen Aviso, and Angelo Earvin Choi*

Department of Chemical Engineering, De La Salle University, Manila, Philippines

The persistent buildup of synthetic plastics has heightened environmental concerns, necessitating sustainable alternatives. Biodegradable plastics present an eco-friendly solution due to their compostability, yet balancing mechanical performance and cost remains a challenge. Unlike Response Surface Methodology (RSM), this study employs fuzzy optimization to simultaneously enhance tensile strength and minimize material expenses in biodegradable plastic production. By evaluating both factors, the method identifies optimal conditions at 1.5 g chitosan, 5.0 g starch, and 3.0 g PVA. This yields a tensile strength of 22.89 kPa at a cost of 1,365.46 USD/kg. Using a max-min aggregation approach, the fuzzy model maximizes satisfaction, ranging from 0 (unsatisfied) to 1 (satisfied). This resolved the trade-offs between mechanical performance and affordability. Although the tensile strength was 13.26% lower than RSM-derived results, the approach reduced costs by 51.48%, highlighting its economic viability. This research demonstrates that fuzzy optimization can produce cost-effective biodegradable plastics without significantly compromising mechanical properties, offering a practical pathway for sustainable manufacturing. The findings highlight the potential for scalable, affordable solutions, particularly in packaging.

Keywords: biodegradable plastic; tensile strength; material cost; fuzzy optimization; Pareto

*Corresponding author: angelo.choi@dlsu.edu.ph

SURFACE CHEMISTRY (SCM)

SCM-001

Biofilm Carrier Enhancement: Investigating the Impact of Irradiation Media on Biofilm Attachment

Ace Albert Angeles*, Maegan Gwyneth Alcaraz, and John Paolo Lazarte

Philippine Nuclear Research Institute, Philippines

Gamma irradiation is a well-established technique for modifying polymers; however, the effect of irradiation media particularly in the modification of biofilm carriers for wastewater treatment has not been explored. This study focuses on the modification of biofilm carrier surface by irradiating them while submerged in various media—air, water, activated sludge, and sodium acetate. The ionizing radiation, carrier material and these environments may interact to alter the surface properties of biofilm carriers and promote faster biofilm attachment. The irradiated carriers, along with a control group, were subjected to a 28-day acclimatization period during which a comparative analysis is conducted to evaluate the effects of these irradiation conditions on carrier surface characteristics and biofilm attachment. Biofilm attachment was assessed weekly through the dry weight method to monitor growth rates. Carrier surface modifications were characterized via contact angle measurements to assess wettability and Fourier-transform infrared spectroscopy (FTIR) to identify chemical changes. This study presents a less chemical-intensive approach in modifying biofilm carriers, potentially accelerating biofilm formation and improving the efficiency of biological wastewater treatment systems.

Keywords: Gamma irradiation; Biofilm attachment; Biofilm carriers; Irradiation media; Surface modification

*Corresponding author: agangeles@pnri.dost.gov.ph

SCM-002

Energetics Analysis of Electrocatalytic Formic Acid Oxidation over Pd_7Cu Catalysts: A DFT Study

Benedick D. Feliciano[1], Jan Goran T. Tomacruz[1], Allan Abraham B. Padama[2], and Joey D. Ocon[1]*

[1]*University of the Philippines Diliman, Philippines*
[2]*University of the Philippines Los Baños, Philippines*

Developing cheaper, safer, and portable fuel cells extend their potential use in applications ranging from transportation to compact electronic devices. Among these, the direct formic acid fuel cell (DFAFC) stands out due to its higher energy density and easier storage compared to traditional hydrogen fuel cells. While experimental and computational studies have looked into more affordable and better-performing catalysts like PdCu, the reasons behind their improved performance are still yet to be fully understood. To address this, Density Functional Theory (DFT) calculations were carried out using Quantum ESPRESSO to study the formic acid oxidation reaction on a PdCu (111) with literature-derived Cu/Pd alloy ratio of 0.15 ± 0.02. Adsorption energies of adsorbates and intermediates were calculated to develop free energy diagrams for different reaction pathways. The density of states (DOS) was also analyzed to understand the electronic structure, charge transfer behavior, and orbital interactions involved in the reaction. These energetics indicators were essential in elucidating foundational understanding of the activity and selectivity behavior of PdCu catalysts. The findings may validate experimental trends and can guide further improvements in catalyst design and operating conditions to enhance DFAFC performance and cost-efficiency.

Keywords: direct formic acid fuel cell; electrocatalytic formic acid oxidation; palladium-copper catalyst; density functional theory

*Corresponding author: jdocon@up.edu.ph

3D PRINTING TECHNOLOGY (3DP)

3DP-001

Optimizing Internal Curing Efficiency in Concrete Using Superabsorbent Polymers: A Comparative Study of Dry and Pre-Wetting Techniques

Lesly Ann Pauline Manaoat, Melanie Lagmay*, John Lemuel Untalasco, Ian Valiente, and Marianito Margarito

Department of Science and Technology – Industrial Technology Development Institute, Philippines

Superabsorbent polymers (SAPs) play a crucial role in optimizing internal curing efficiency in concrete by improving hydration and reducing shrinkage-related issues. This study explores two methods of incorporating SAP—dry mixing and pre-wetting—to determine the most effective approach for improving concrete performance. In the dry mixing method, SAP is added in its original form, absorbing excess water and gradually releasing it during hydration. This controlled water release helps refine the pore structure and enhances long-term durability. On the other hand, pre-wetted SAP is soaked before mixing, ensuring immediate hydration benefits and minimizing early-age shrinkage. However, this approach can affect workability, requiring adjustments in mix design. Low, medium, and high compressive strength concrete cured for 7, 14, and 28 days were utilized in this study. Results showed that pre-wetted SAP boosts early hydration and reduces shrinkage, while dry SAP improves long-term durability and pore distribution. Workability assessments indicate that pre-wetted SAP enhances flowability but requires adjustments to maintain mix stability. Furthermore, results confirmed that SAP influences hydration control, mechanical integrity, and pore distribution. By optimizing the use of SAP, stronger and more resilient concrete can be developed. This study provides valuable insights into maximizing SAP's potential in high-performance infrastructure applications.

Keywords: Superabsorbent polymers; internal curing efficiency; shrinkage; dry and pre-wetting mixing; compressive strength

*Corresponding author: melaniesapitolalagmay@gmail.com

3DP-002

Effect of Cellulose Nanocrystal Loading on the Mechanical and Morphological Properties of 3D-Printed PMMA Nanocomposites

John Lemuel Untalasco*, Queennie Tuazon, Jenny Lyn Alfeche, Ian Valiente, Marco Rodriguez, and Marianito Margarito

Industrial Technology Development Institute, Department of Science and Technology, Philippines

Cellulose Nanocrystals (CNCs), derived from sustainable biomass sources, offer a high aspect ratio, excellent mechanical strength, and biocompatibility, making them a promising reinforcement agent for polymer matrices. In this study, the influence of CNC loading on the mechanical and morphological properties of polymethyl methacrylate (PMMA)-based nanocomposites developed through stereolithography (SLA) 3D printing was examined. The CNCs employed in the composites were extracted from pineapple crown leaves through an acid hydrolysis process. Varying concentrations of CNCs with 0, 1.50, and 3.00 weight % were incorporated into the PMMA matrix using a homogenizer mixer to ensure uniform dispersion. The resulting composite was processed using an SLA 3D printer. Tensile, flexural, and compression tests were done to reveal improvements in the mechanical performance of the composite at different CNC loadings. Fracture surfaces were examined using optical and scanning electron microscopy (SEM) to assess the failure mechanisms and microstructural features. These findings demonstrate that controlled incorporation of CNC enhances the structural integrity and sustainability of 3D-printed PMMA nanocomposites.

Keywords: Cellulose Nanocrystals; Acid Hydrolysis; Additive Manufacturing; Nanocomposites

*Corresponding author: lemuel.untalasco@gmail.com

3DP-003

Preliminary Investigation of the Thermally Induced Shape Memory Behavior of 3D-Printed Recycled Polyamide-6/Thermoplastic Polyurethane Blends

Queennie Tuazon*, John Lemuel Untalasco, Shaun Angelo Arañez, Mar Christian Que, Jethroe Jr. Napay, and Marianito Margarito

Industrial Technology Development Institute, Department of Science and Technology, Philippines

4D printing introduces dynamic functionality to otherwise static 3D-printed structures by incorporating shape memory polymers (SMPs) that change shape over time in response to external stimuli such as heat. Polymer blending offers a strategy to enhance SMP performance and develop novel shape memory materials. In this study, the thermomechanical properties and shape memory behavior of polymer blends composed of recycled polyamide-6 (rPA6), derived from discarded fishing nets, and thermoplastic polyurethane (TPU) were investigated. rPA6/TPU blends with varying weight ratios (90/10, 80/20, 70/30, 60/40, and 50/50) were pelletized and extruded into filaments for fused deposition modeling (FDM). The chemical structure of the blends was analyzed using Fourier Transform Infrared Spectroscopy (FTIR), while their thermal and mechanical properties were compared to those of neat rPA6 and TPU. The thermally induced shape memory behavior was evaluated for neat and blended samples via Dynamic Mechanical Analysis (DMA) under cyclic loading. The study highlights the potential of rPA6/TPU blends as sustainable, thermoresponsive materials for 4D printing applications.

Keywords: 4D printing; shape memory polymers (SMPs); recycled polyamide-6 (rPA6); thermoplastic polyurethane (TPU); polymer blending; fused deposition modeling (FDM)

*Corresponding author: queennietuazon@gmail.com

3DP-004

Recycling PET Waste into 3D Printing Filaments: A Comparative Mechanical Analysis of Pultrusion and Extrusion Methods

Claire Ann Gagelonia*, Alvin Kim Collera, Anthony Al Aquiro, John Lemuel Untalasco, Jethroe Napay, Ian Valiente, Marianito Margarito, Zamantha Nadir Martin, and Shaun Angelo Aranez

Industrial Technology Development Institute, Department of Science and Technology, Philippines

Polyethylene terephthalate (PET) is widely used in packaging due to its durability and low production cost. However, the overproduction of PET products has led to significant environmental challenges, including plastic waste accumulation and inefficient recycling systems, particularly for PET bottles. This study investigates the feasibility of recycling PET, sourced from used bottles and shredded post-consumer waste, for use in developing 3D printing filaments via two manufacturing techniques: pultrusion and extrusion. In the pultrusion process, PET bottles were sorted and turned into strips, which were then thermally drawn through a heated die. For extrusion, shredded PET bottle waste was processed using a filament extruder. The resulting filaments were used to 3D print standardized test specimens via fused deposition modelling (FDM). Mechanical testing and optical microscopy were conducted to evaluate filament quality, cross-section morphology, and mechanical performance. Both filament types demonstrated compatibility with FDM, and this work supports sustainable 3D printing practices, highlighting the potential for closed-loop recycling to mitigate plastic waste.

Keywords: recycled PET; mechanical analysis; 3D printing; pultrusion; extrusion; PET waste

*Corresponding author: camgage.itdi@gmail.com

3DP-005

Dimensional Compensation of 3D-Printed Ti_6Al_4V-PA12 Lattice Structured Composites via Selective Laser Sintering During Debinding and Sintering for Biomedical Applications

Anthony Al Aquiro, Lean Mae Cagujas, Alvin Kim Collera, Ana Katrina Dumduman, Zamantha Nadir Martin, Mar Que, and Marianito Margarito*

Industrial Technology Development Institute, Department of Science and Technology, Philippines

Biomedical applications of 3D-printed metallic materials like Ti_6Al_4V offer advantages for patient specific solutions and complex geometries like lattice structures. The following thermal post-processing steps affect the final material properties but would impose substantial dimensional changes (shrinkage) that compromises quality and fit. This project focuses on different lattice structure models for titanium alloy, printed through selective laser sintering (SLS), using PA12 as a binder during printing. This study compensated the dimensional accuracy of 3D-printed material during their debinding and sintering cycles through design adjustments. Characterization approaches were employed to compare and examine causes of malformation, as well as determining the shrinkage for all lattice structures. Optical microscopy was conducted to analyze the PA12 binder distribution within the printed parts before processing and to observe microstructural changes post-sintering. Dimensional measurements were conducted at each stage (post printed, debound, sintered), quantifying total linear shrinkage and volumetric shrinkage. Scanning Electron Microscopy (SEM) for elemental analysis confirmed the presence of minimal residual carbon and oxygen, ensuring high material purity after sintering in a vacuum furnace. Furthermore, 3D-CT X-ray provided an assessment of the internal porosity distribution. By correlating the initial binder distribution and optimized thermal processing parameters, the study managed the resultant shrinkage, porosity, and carbon content. This establishes the debinding and sintering profiles that demonstrate minimal dimensional changes. These findings provide insights for predicting precise dimensions in 3D-printed Ti_6Al_4V for bone implants application, and advancing clinical applicability of additively manufactured medical devices.

Keywords: Additive manufacturing; shrinkage; thermal- post processing; selective laser sintering; lattice structures; Ti_6Al_4V-PA12 composites

*Corresponding author: mtmargarito@itdi.dost.gov.ph

3DP-006

Impact of Printing Process Parameter Variations on the Performance of 3D Printed Samples using Mechanically Mixed Irregular-Shaped Ti_6Al_4V and Nylon 12 Composite Powders

Ana Katrina Dumduman*, Lean Mae Cagujas, Anthony Al Aquiro, John Lemuel Untalasco, Alvin Kim Collera, Mar Christian Que, Sharyjel Gelilang, Zamantha Nadir Martin, Claire Ann Gagelonia, Queennie Tuazon, Melanie Lagmay, Lesly Ann Pauline Manaoat, and Marianito Margarito

Industrial Technology Development Institute, Department of Science and Technology, Philippines

Selective laser sintering (SLS) is an additive manufacturing process that utilizes a CO_2 laser to fuse powder materials layer by layer without melting it. While different models of SLS printers offer predefined printing parameters for polymer powder feed, these parameters often require variation when printing composite powders to achieve accurate part geometry, print quality, and desired mechanical properties. In this study, the combined effect of varying different printing parameters – laser power ratio (LP ratio), energy scales, and layer height – on the printability and final part quality of mechanically mixed irregular-shaped Ti_6Al_4V (Ti64) and Nylon 12 (PA12) composite powder were investigated. Pieces of cuboid samples per batch were printed under the stock printing parameters set for PA12 in the Sinterit Lisa Pro SLS 3D printer and under varying laser power ratios, layer heights, and energy scale. The printed parts were initially evaluated based on surface morphology through visual inspection, optical microscopy and 3D-CT X Ray scanning, and dimensional accuracy by measuring shrinkage.

Keywords: Additive Manufacturing; Indirect Selective Laser Sintering; Process Printing Parameters; Polymer-metal Composite Powder

*Corresponding author: akldumduman.itdi@gmail.com

DESIGN, MODELLING AND SIMULATION OF PROCESSES (DMS)

DMS-001

Modelling and Experimental Study for an Interfacial Solar Vapour Generation System for Seawater Purification

Azree Azhar Awi, Mohd Usman Mohd Junaidi, and Mohamed Azlan Hussain*

University Malaya, Malaysia

Pure water scarcity is a particularly severe challenge in the coming future globally. While a substantial amount of water is present in the form of seawater on the earth structure, harvesting this water by state-of-the-art purification technology can be extremely energy intensive and impractical. The usage of solar vapor generation system for seawater purification has long been researched as it saves electricity and uses only the sun radiation. In this study, the idea of optimizing the flow rate and absorption into absorber has led to the development of enhanced interfacial solar vapor generation system that is not only electricity-free, but also deemed to produce the highest clean water volume per day. The seawater is put through an evaporator at a slanted angle to control the flow rate while undergoing effective evaporation and condensation processes in the evaporator. Performance evaluation, including evaporation and condensation rate, water quality, and energy conversion efficiency, will be conducted under various environmental conditions. The end quality of clean water produced will be analysed to meet the global drink water standards. The findings of this research are expected to contribute to the development of sustainable and scalable solutions for addressing global clean water scarcity challenges. However, optimum technology in creating the best methodology of solar vapor generation system has always been the way forward for the future.

Keywords: separation; solar vapour; seawater; evaporation; condensation

*Corresponding author: mohd_azlan@um.edu.my

DMS-002

Development of an Industrial-Scale Operator Training Simulator for Phosphoric Acid Plants

Maulana Gilar Nugraha[1], Iwan Setiyawan[2], Jawad Farisi[2], Ridho Azwar[2]*, and Muslikhin Hidayat[1]

[1]*Department of Chemical Engineering, Universitas Gadjah Mada, Indonesia*
[2]*Department of Plant Operation III B, PT Petrokimia Gresik, Indonesia*

This study presents a modular Operator Training Simulator (OTS) specifically designed for phosphoric acid production, integrating Python-based dynamic simulation, OPC UA communication, and Aveva InTouch HMI. The simulator includes key process scenarios, such as control valve regulation and cooling tower operation, to evaluate its responsiveness and realism. The control module incorporates PID logic with both manual and automatic modes, while the cooling tower submodel captures thermal dynamics influenced by air blower operation. An embedded interlock system and a Field Operator Station (FOS) interface further enhance realism by allowing simulated emergency shutdowns and manual field-level operations. Real-time data synchronization is achieved via OPC UA, ensuring seamless interaction between the simulation engine and the HMI. The simulator delivers high computational efficiency, completing the full plant simulation cycle in under one second. Validation against actual process data from PT Petrokimia Gresik, Indonesia, confirms the model's accuracy in representing system dynamics and control behavior. The OTS enables users to monitor process variables, manipulate control settings, and evaluate plant responses under diverse operational scenarios, without risk to physical assets. This scalable and cost-effective platform significantly improves operator competency, supports safety training, and strengthens process understanding in both industrial and educational settings.

Keywords: Operator Training Simulator; Dynamic Process Simulation; Python Modeling; OPC UA Communication; Human-Machine Interface (HMI); Phosphoric Acid

*Corresponding author: ridhoazwar@petrokimia-gresik.com

DMS-005

Planning and Management of Power Supply Augmentation in Metro Manila through Biogas Production from Anaerobic Digestion of Sewage Sludge via an Integrated P-graph and Analytic Hierarchy Process Framework

Claire Ann Gagelonia[1]*, Deanne Rosselini Acosta[2], Kristine Camille Billen[2], Ianne Claudine Brito[2], Vince Harvey Alano[2], Jarlie Rosario Clemena[2], Rugi Vicente Rubi[2], Francis Dominic Lavilles[2], Peniel Jean Gildo[2], and Marianito Margarito[1]

[1] *Industrial Technology Development Institute, Department of Science and Technology, Philippines*
[2]*University of the City of Manila, Philippines*

Wastewater treatment plants are greenhouse gas emitters, despite sewage sludge being considered waste. Nevertheless, this sludge can be an energy source, driving interest in Waste-to-Energy (WtE) technologies. With countries facing high energy demands and power outages, finding solutions to aid this in cities is crucial. This study proposes a decision-making framework to explore the possibility of generating biogas through the anaerobic digestion of sewage sludge in Metro Manila, augmenting the power supply. The approach combines P-graph Simulation and Analytical Hierarchy Process (AHP) to evaluate technical data from STPs and determine the best conditions for biogas production. The study identifies Technical, Social, and Environmental criteria for a centralized facility, comparing them pairwise using AHP. Results show environmental factors as most critical, followed by social and technical, with weights of 0.5434, 0.2985, and 0.1581, respectively. P-graph provides optimal and near-optimal solutions by combining different STPs as a sludge source. An optimal combination of STPs - Pasay, Paranaque, Makati South Marikina North, and Poblacion - can produce 100 MW at 248 km. The study emphasizes better planning and sustainability accounting for implementing projects that meet power demands. The proposed decision-making framework offers a promising solution for powering cities with eco-friendly WtE technology.

Keywords: waste to energy; analytical hierarchy process; p-graph simulation; power supply augmentation; sewage treatment plant

*Corresponding author: camgage.itdi@gmail.com

DMS-007

Enforced Thermodynamic Consistency for The Soave and Mathias-Copeman Alpha Functions Applied to Soave-Redlich-Kwong, Peng-Robinson, and Almajose-Dalida Equations of State

Allan Paolo Almajose[1]* and Ariel Hernandez[2]

[1]*University of Santo Tomas, Philippines*
[2]*Universidad de las Américas, Chile*

Polynomial alpha functions are widely used in cubic equations of state (EoS) due to their simplicity and effectiveness in modeling vapor pressure behavior. However, their non-vanishing nature at high temperatures often leads to thermodynamic inconsistencies, particularly in the temperature derivatives of the attractive term. This study addresses this issue by introducing an upper temperature limit of 2000 K in the optimization of polynomial alpha functions, specifically the Soave and Mathias–Copeman form, to enforce thermodynamic consistency without greatly compromising accuracy in the subcritical region. Limit testing was conducted using both the Soave–Redlich–Kwong (SRK), Peng–Robinson (PR), and Almajose-Dalida (AD) equations of state using the Soave function across a representative set of 100 compounds, evaluating the tradeoff between error growth and temperature upper limit applicability. Comparative analysis of three alpha function formulations: the default Soave function, the Mathias–Copeman function with parameters derived in this study, and those provided by ChemSep—was performed using the SRK equation of state, and it is shown that the constants generated from this study are thermodynamically consistent up to 2000 K. Given the structural similarity of SRK and PR as two-parameter cubic equations, and the functional similarity of the three-parameter AD equation of state, similar behavior is anticipated for both polynomial-based alpha functions. Soave and Mathias–Copeman alpha constants for 100 compounds commonly used in process simulations are provided in the Appendix, developed using SRK, PR, and AD equations valid up to 2000 K. A complete dataset for 1100 compounds is available upon request or through the corresponding author's academic repository.

Keywords: thermodynamic consistency; Mathias-Copeman; equation of state; vapor pressure; Soave-Redlich-Kwong; Peng-Robinson; Almajose-Dalida

*Corresponding author: alalmajose@ust.edu.ph

PROCESS INTEGRATION, INTENSIFICATION AND OPTIMIZATION (PIO)

PIO-001

A Power Index and P-graph Method for Criticality Analysis in Integrated Biorefineries

Michael Francis Benjamin[1]*, Karen Hong[2], Bing Shen How[3], Viknesh Andiappan[3], and Raymond Tan[4]

[1]*University of Santo Tomas, Philippines*
[2]*Zhejiang University, China*
[3]*Swinburne University of Technology, Malaysia*
[4]*De La Salle University, Philippines*

The utilization of agricultural waste in integrated biorefineries (IBRs) can meet local bioenergy demands, such as bioethanol production. An IBR is a facility that converts biomass into various bio-based products using biological, chemical, and thermochemical pathways. The design of IBRs should account for potential disruptions or inoperability of process units, as these can lead to operational losses (e.g., reduced production output). Criticality analysis is a method used to identify the most crucial process unit in an IBR by assessing its impact when disrupted. Power indices, such as the Shapley-Shubik Index (SSI), help to determine how pivotal or significant a unit is within the IBR. The SSI is computed by evaluating the frequency of a process unit being critical across all possible sequences of equipment disruption. A process unit is deemed critical when a predetermined parameter (e.g., profit loss) is exceeded upon the unit's addition to a disruption sequence. The P-graph method, commonly used for process network synthesis, can be applied to calculate this predetermined parameter for all coalitions. In this study, a method integrating Shapley-Shubik power index and P-graph is developed for criticality analysis in IBRs. The proposed method is demonstrated using an IBR that processes rice waste (i.e., straw, husk, and bran) as raw materials into value-added products.

Keywords: Shapley-Shubik power index; Optimal profit; Pivotal process unit; Sequential coalitions

*Corresponding author: mdbenjamin@ust.edu.ph

PIO-002

Multi-Objective Optimization of Cetane Number and Cost of Biodiesel Blends Using ε -Constraint Method

Francis Allen Foronda*, Kathleen Claire Capule, Jacinta Marta Mosquito, Joaquin Manuel Fortun, Kathleen Aviso, and Luis Razon

De La Salle University, Philippines

Biodiesel is a promising alternative to petroleum-based diesel to aid in the global energy crisis and reduce harmful emissions. With biodiesel performance relying heavily on feedstock composition, finding the optimal biodiesel blend proportions are necessary to achieve a desirable, cost-effective, and energy-efficient fuel. There is a gap in the current knowledge on biodiesel blend optimization. Existing literature on manufacturing biodiesel do not account for the optimization of multiple criteria for blending various feedstocks. This work utilized correlations for predicting biodiesel properties from fatty acid profiles and applied the ε-constraint method to determine Pareto optimal solutions which maximize cetane number (CN) and minimize costs. Two biodiesel blend case studies were considered: Case 1 considered six feedstock oils (coconut, palm, canola, soybean, rapeseed, and waste cooking oil (WCO)), while Case 2 excluded WCO. A blend of palm, coconut, and WCO was determined to be optimal for Case 1, while palm, soybean, and coconut oil was optimal for Case 2. Pareto front analyses indicated that including WCO results in a steeper tradeoff over a wider CN-Cost range. Future research can explore the addition of a life cycle assessment to account for environmental impact categories as part of the optimization criteria for the blends.

Keywords: Biodiesel; Multi-objective optimization; ε-constraint method; Waste cooking oil; Sustainability

*Corresponding author: for.francisallen@gmail.com

PIO-003

Optimization of Biomass Production of an Indigenous Thraustochytrid Isolate in Distillery Wastewater using Response Surface Methodology

Nathaniel Arogante[1]*, Joshua Ignacio[1], Zander Karl Herrera[1], Jerico Alcantara[1], Mart Merwin Magboo[1], Francisco Elegado[2], and Jewel Capunitan[1]

[1]*University of the Philippines Los Baños, Department of Chemical Engineering, Philippines*
[2]*University of the Philippines Los Baños, BIOTECH, Philippines*

Thraustochytrids are marine protists known for their high lipid content, including omega-3 polyunsaturated fatty acids (PUFAs) such as Eicosatetraenoic acid (EPA) and Docosahexaenoic acid (DHA). These fatty acids have significant applications on aquaculture sustainability and aquaculture industries. Ergo, this study investigates the efficacy of an indigenous thraustochytrid isolate cultivating in distillery wastewater and concurrently producing a nutrient-rich biomass, by employing Response Surface Methodology (RSM) to optimize the following cultivation parameters; pH, salinity, Carbon-to-Nitrogen (C:N) ratio. Parametric experiment proved that pH has the highest effect on biomass yield, together with salinity, and the interaction of pH and salinity. Mathematical model was made to relate the different parameters, pH, salinity, and C:N ratio, to the response, biomass yield. Optimum conditions to maximize biomass yield were obtained at pH 9, salinity 27, and C:N 20, which was statistically validated at 95% confidence intervals. The predicted response at the optimum conditions shows a biomass yield of 9.16 g/L and the resulting data mean obtained was 9.06 g/L. Experimental verification of the predicted response was considered to be successful.

Keywords: Thraustochytrids; Distillery Wastewater; Biomass Production; Response Surface Methodology; Optimization

*Corresponding author: ndarogante@up.edu.ph

PIO-004

Fuzzy Optimization of Biodegradable Plastic Production: Balancing Elongation and Cost Using Cassava Starch, Chitosan, PVA, and Crude Glycerol

Alijaeh Joshua Go, Jose Antonio Calero, Gamille Marie Silva, Ralph Emmanuel Manlulu, Kathleen Aviso, and Angelo Earvin Choi*

Department of Chemical Engineering, De La Salle University, Philippines

The increasing buildup of synthetic plastics has intensified the demand for eco-friendly alternatives. Biodegradable plastics present a viable solution, as their compostable nature helps mitigate environmental harm. However, balancing mechanical strength with low production costs remains a key obstacle. This study explores fuzzy optimization to develop cost-effective biodegradable plastics using cassava starch, chitosan, PVA, and crude glycerol. The method optimizes both elongation and material cost, resolving the conflict between performance and affordability. By assessing efficiency on a scale of 0 to 1, fuzzy optimization determines the best material compositions, achieving an overall satisfaction level of 0.5587. The optimal formulation consists of 2.4 g chitosan, 5.0 g starch, and 3.0 g PVA, yielding 54.52 % elongation with a 4.54 % uncertainty error. Although this elongation is 37.09 % lower than Response Surface Methodology (RSM)-based results, it reduces costs by 41.81 %. The research uniquely addresses the trade-off between cost efficiency and mechanical properties, offering a fresh perspective compared to prior studies. The substantial cost savings highlight the economic feasibility of producing biodegradable plastics, marking a significant step toward sustainable large-scale applications, particularly in packaging. This work advances the development of affordable, high-performance biodegradable materials.

Keywords: Biodegradable Plastic; Elongation; Cost; Pareto

*Corresponding author: angelo.choi@dlsu.edu.ph

PIO-006

Optimization of Electro-Photo-Fenton Process Parameters for Ciprofloxacin Degradation in Synthetic Wastewater

Bjorn Joenrique Schen Gerona[1], Lio Josepat Domingo[1], Jan Aubrey Valdez[1], Lemuel Agonoy[4], Kim Ahmed Sadol[4], Brian Gerald Bueno[1], Gerianne Mae Arada[4], Johara Capingian[1], Denvert Pangayao[1], Aileen Orbecido[1], Joseph Ortenero[1], Carla Mae Pausta[1], Liza Bautista-Patacsil[2], Joel Cornista[3], Michael Angelo Promentilla[1], and Arnel Beltran[1]*

[1]Department of Chemical Engineering, De La Salle University, Philippines
[2]Department of Engineering Science, University of the Philippines Los Baños, Philippines
[3]Department of Biology, University of the Philippines Manila, Philippines
[4]Center for Engineering and Sustainable Development Research, De La Salle University, Philippines

Various methods are used to reduce the presence of antibiotics in wastewater, such as membrane filtration, bioremediation, and oxidation processes. Advanced Oxidation Processes (AOPs), which include Electro-Photo-Fenton (EPF) treatment, are considered promising technologies for wastewater treatment. EPF treatment combines Photo-Fenton and Electro-Fenton to increase the efficiency of the treatment. This study aimed to investigate the effectiveness of EPF treatment against Ciprofloxacin in synthesized wastewater when done in a 2.5-liter setup under different pH conditions and antibiotic concentrations. The experimental runs were conducted with an 11-Watt UV lamp and initial concentrations of 2 mM ferrous sulfate and 0.1 M sodium sulfate. Treatment done at pH 2 with lower initial contaminant concentrations showed superior degradation, achieving a maximum removal of 55.97% after 60 minutes. This supports existing literature indicating optimal EPF reactor performance under acidic conditions. The other experimental runs at the same pH level also showed relatively high removal percentages (23.32% - 46.77%), with one run having a final removal percentage lower than 20%. The optimal conditions were determined to be at pH 2 and 10 ppm initial concentration of Ciprofloxacin which achieved a maximum removal of 55.97% and an average removal of 51.37%.

Keywords: Advanced Oxidation Processes; Electro-Photo-Fenton treatment; Antibiotics; Ciprofloxacin; Synthetic Wastewater

*Corresponding author: arnel.beltran@dlsu.edu.ph

PIO-007

A Fuzzy-Based Optimization Approach to Electrocoagulation for Sustainable Color Reduction in POME Treatment

Vyvyen Zena Cabrera, Markus Biehn Sorilla, Sophia Tercenio, Angelo Earvin Choi*, and Joseph Ortenero

De La Salle University, Philippines

The palm oil mill industry produces a massive amount of wastewater that causes environmental issues due to improper treatment. Palm oil mill effluent (POME) is a wastewater characterized by significant amounts of oil and grease, which poses a risk to the environment. Various technologies have been developed to treat POME. Electrocoagulation (EC) has gained traction due to its lower operating costs and good efficiency. Previous studies focused on optimizing EC parameters but often did not consider cost. This study examined how EC could be improved in terms of color reduction. A multi-objective fuzzy optimization (MOFO) model was used to obtain optimal values. Total operating cost was considered to assess economic viability. Objective functions were derived from the response surface methodology (RSM) of Rakhmania et al. (2021). The Pareto front was generated using the ε-constraint method, and a max-min operator determined the overall satisfaction level. Results showed 68.41% color reduction with an operating cost of 0.46 USD/unit-color. Satisfaction levels were 68% for removal efficiency and 79% for cost. Optimal conditions were 18.69 V, 1 h electrolysis time, and 13.30 g/L electrolyte. The model presented a potential solution to the problem of optimizing the EC process for POME treatment and its economic feasibility.

Keywords: electrocoagulation; color reduction; organic matter; palm oil mill effluent; palm oil industry

*Corresponding author: vyvyen_cabrera@dlsu.edu.ph

ARTIFICAL INTELLIGENCE FOR ENGINEERING (AIE)

AIE-001

A Rough Set-Based Model for Predicting Adsorption Efficiency of Biochar for the Removal of Heavy Metals in Wastewater

Jose Andrew Oracion[1], Bea Angela Reyes[1], Mario Jr. Rapisura[1], and Beatriz Belmonte[1,2]*

[1]*Department of Chemical Engineering, University of Santo Tomas, Philippines*
[2]*Research Center for the Natural and Applied Sciences, University of Santo Tomas, Philippines*

Urbanization and industrialization has been beneficial to the environment. However, it has also damaged the environment via contamination of water and soil with heavy metals. Toxicity with heavy metals is detrimental to human health. Efficient removal of heavy metals is therefore imperative. Biochar, as a low-cost heavy metal adsorbent, has attracted research in the field of wastewater treatment. However, the adsorption efficiency of biochar on heavy metals in wastewater varies depending on the biochar characteristics based on biochar production, environmental and application condition, and the desired metal type. It is necessary to identify the effective combination of parameters to achieve maximum adsorption efficiency. This study developed a rule-based model with the aid of rough set-based machine learning (RSML). Three top-performing if-then rules were accepted correlating the biomass feedstock type, pyrolysis temperature, cation exchange capacity of biochar, pH of solution, initial concentration ratio of heavy metals over biochar, and metal type to the adsorption efficiency of biochar. The coverage of Rules 1, 2 and 3 in the training set are 18 %, 18 %, and 19 % respectively. While the coverage in the validation set are 33 %, 33 % and 20 %. The three top performing rules achieved 100 % accuracy on both sets. To further validate the ability of the model to predict the adsorption efficiency of biochar, a 10-fold cross validation was done. The findings show that these condition attributes greatly affect the adsorption efficiency of biochar on heavy metals in wastewater. This study is beneficial in maximizing the efficiency of biochar in the treatment of heavy metals in wastewater.

Keywords: Biochar; Rough Set-based Machine Learning; Heavy Metals; Rule-based Model; Adsorption Efficiency; Wastewater

*Corresponding author: babelmonte@ust.edu.ph

AIE-002

Streamlining AI for Low-Carbon Concrete: Ablation and Sensitivity-Based Feature Selection

Ma. Christine Jaucian and Michael Angelo Promentilla*

De La Salle University, Philippines

As reducing embodied carbon becomes a growing priority in construction, geopolymers are increasingly recognized for their low-carbon potential. While Artificial Intelligence (AI) accelerates the development of mix designs, the lack of standardization in input feature selection across studies hinders reproducibility, generalizability, and meaningful comparison of model results. To address this, Support Vector Regression (SVR), Multi-layer Perceptron Neural Network (MLPNN), and Random Forest (RF) models were trained on an 855-sample fly ash–slag geopolymer database using 26 commonly cited features. Inputs were grouped into tiers based on typical data availability and progressively ablated to evaluate the impact on prediction accuracy for compressive strength, slump flow, and embodied carbon. Despite differences in model architecture, a consistent trend was observed where a reduced input tier maintained strong predictive accuracy, suggesting its potential as a lean, transferable baseline for multi-target modeling. To validate this lean set, Hoffman Gardner's one-at-a-time sensitivity analysis confirmed the retained features were the primary drivers of predictive accuracy. This approach results in a reproducible, evidence-based input selection protocol and eliminates arbitrary feature choices, supporting more reliable, comparable, and efficient AI models in designing resilient, sustainable construction materials in a carbon-constrained future.

Keywords: Geopolymers; feature selection; Multi-output modeling; sensitivity analysis; Artificial Intelligence

*Corresponding author: michael.promentilla@dlsu.edu.ph

AIE-003

Machine Learning Prediction of Hydrogen Solubility in Pure Solvents Using Quantum Mechanics-9 (QM-9) Data and Molecular Fingerprints

Yuiichi Nakano[1,2]*, Raphael Alampay[1], and Alvin Caparanga[3]

[1]*Ateneo de Manila University, Philippines*
[2] *Chevron Inc., Philippines*
[3]*Mapua University, Philippines*

Accurate prediction of hydrogen solubility in pure solvents is essential for improving the efficiency of gas-liquid processes. This study explores the use of machine learning (ML) models to predict hydrogen solubility in 100 pure solvents, using experimental data compiled by Foroughizadeh et al. (2024). Four algorithms—Support Vector Regression (SVR), Extreme Gradient Boosting (XGB), Random Forest (RF), and Multi-Layer Perceptron (MLP)—were evaluated based on features derived from critical properties, acentric factors, quantum chemical descriptors (QM-9), and molecular fingerprints generated via RDKit. All models were trained using 4-fold cross-validation, with performance assessed through RMSE. Among the models, XGB consistently yielded the highest predictive accuracy, with RMSE as low as 0.0177 and R^2 up to 0.9255. It is noted that models relying solely on critical properties performed nearly as well as those with more complex feature sets, suggesting that simpler thermodynamic descriptors may often suffice. Adding molecular fingerprints and quantum descriptors slightly improved robustness but made the models more computationally complex. One-way ANOVA revealed that dataset grouping significantly affected model performance across all algorithms, while only SVR showed a statistically significant sensitivity to fingerprint type—implying that XGB, RF, and MLP were largely unaffected by the choice of molecular representation. These findings highlight the importance of selecting appropriate features and algorithms based on the available molecular data and desired trade-off between model complexity and performance.

Keywords: hydrogen; solubility; machine learning (ML); molecular fingerprinting; quantum mechanics-9 (QM-9); artificial intelligence (AI)

*Corresponding author: nakano.yuiichi@gmail.com

AIE-004

Predicting Fuel Pump Price Volatility in the Philippines: A Machine Learning Approach Integrating Geopolitical and Pandemic Effects Post COVID-19 Outbreak

Chryss Anika C. Bersabal, Sophia Bernadette R. Lunor, Jan Goran T. Tomacruz, and Joey D. Ocon*

Laboratory of Electrochemical Engineering, University of the Philippines Diliman, Philippines

The Philippines confronts a challenge in securing its energy future due to it being a net oil-importing country. The nonlinear and dynamic nature of oil prices necessitates data-driven machine learning (ML) for market price analysis and prediction. Our previous work established a correlation between the COVID-19 pandemic, the Russia-Ukraine War, and oil pump prices in the Philippines up to July 2022. This study extends past these initial crisis periods and the effects of key factors on seven fuel product prices in Metro Manila, Philippines, from December 2019 through August 2024. Multiple Linear Regression (MLR), Support Vector Regression (SVR), Random Forest Regression (RFR), and Artificial Neural Networks (ANN) were the primary machine learning regression models used. The factors examined were drawn from related literature and processed using p-value testing and Principal Component Analysis. In addition, permutation feature importance (PFI) determined the rank of the feature contributions and directional trends. Models were trained, evaluated, and refined through hyperparameter optimization, with prediction accuracy assessed using Mean Absolute Percent Error (MAPE). Future work, based on this study's scope limitations, could explore the use of deep learning and hybrid models, along with the effects of geographic location and newly-identified period-specific features on pump prices.

Keywords: machine learning; multiple linear regression; support vector regression; random forest regression; artificial neural networks; permutation feature importance; fuel pump price; pandemic; russia-ukraine war; principal component analysis

*Corresponding author: jdocon@up.edu.ph

TEACHING ENGINEERING, NEW STRATEGIES, OPPORTUNITIES (TEO)

TEO-001

Reforming the Philippine Chemical Engineering Curriculum: A Benchmarking with Course 10 of the Massachusetts Institute of Technology

Jaymar Adante[1]* and Jed Bellen[2]

[1]*Bicol University, Philippines*
[2]*De La Salle University, Philippines*

Chemical engineering integrates chemical, physical, and biological systems to design processes for producing materials and products that benefit society. Chemical engineers work on technologies central to modern life, with a strong focus on industrial processes and applications. In the Philippines, chemical engineering programs emphasize chemical and physical principles for industries such as chemicals, drugs, food, textiles, and cement. These programs prepare students for both large and small-scale plant design, troubleshooting, and formal research. The Philippine Chemical Engineering Undergraduate Curriculum is governed by the Commission on Higher Education Memorandum Order No. 91, which shifted to outcomes-based education in 2018. While the curriculum is updated, it has been seven years since the last major revision. As the field of chemical engineering evolves, particularly with the rise of new technologies, there is a need to reassess the curriculum to ensure students are prepared for the changing landscape of the profession. To effectively accomplish this, benchmarking with the curriculum of the world's top Chemical Engineering Program is imperative. As such, the curriculum of the Massachusetts Institute of Technology's (MIT) Course 10 was chosen for the said benchmarking. MIT offers a diverse and specialized chemical engineering program, including various tracks such as Course 10 (traditional chemical engineering), Course 10B (biochemical and biomedical), Course 10-ENG (flexible engineering), and Course 10C (interdisciplinary studies). MIT's program focuses on foundational knowledge in chemistry, biology, physics, and mathematics, with an emphasis on cutting-edge areas like energy, nanotechnology, and biotechnology. MIT also encourages hands-on research through its Undergraduate Research Opportunities Program (UROP). The primary goal of this paper is to propose curriculum improvements for the Philippine Chemical Engineering Program by comparing it to MIT's Course 10 Curriculum. Recommendations include integrating specialized topics early, expanding electives to cover emerging technologies, and fostering stronger industry collaboration. These changes aim to better equip graduates to meet global challenges and drive high-level innovations in chemical engineering.

Keywords: Curriculum; Chemical Engineering Pedagogy; Industry-Relevant; Bioprocessing; Sustainability; Massachusetts Institute of Technology

*Corresponding author: jaymarbricenio.adante@bicol-u.edu.ph

JOBS IN ENGINEERING (JIE)

JIE-001

The Post-Pandemic Rise of AI Use and Curricular Transition Lag: A Gap Analysis of Philippine State Universities and Colleges (SUC) Offering Chemical Engineering Programs

John Raymond Barajas[1]* and Chien Hwa Chong[2]

[1]*College of Engineering, Architecture, and Fine Arts, Batangas State University, Philippines*
[2]*Department of Chemical and Environmental Engineering, Faculty of Science and Engineering, University of Nottingham, Malaysia*

The post-pandemic rise of Artificial Intelligence (AI) has triggered major transformations across global industries, including Chemical Engineering. This study explored whether Philippine State Universities and Colleges (SUCs) offering Chemical Engineering programs have responded through meaningful curricular updates. Specifically, this work evaluated the presence and extent of AI integration within these programs following the pandemic-driven acceleration of AI use in education and industry. A gap analysis was conducted by systematically reviewing program curricula, objectives, course descriptions, and course learning outcomes from 10 publicly accessible SUC websites. When key documents were unavailable, official definitions from the Commission on Higher Education (CHED) were used. The textual data were normalized and analyzed using unigram and bigram models to detect AI-relevant terminology. Findings revealed that although terms such as "data analysis" appear sporadically, more advanced AI-related terms—such as "artificial intelligence," "machine learning," "AI tools," and "generative AI"—were largely absent. This strongly indicated a lag in curricular transition despite the global momentum. To address this, the study recommends embedding AI-centered modules into core and elective courses, offering standalone AI courses tailored for Chemical Engineering, and using flexible formats such as summer or online learning to align curricula with current industry expectations.

Keywords: Artificial Intelligence; Chemical Engineering Curriculum; Data Analysis; Machine Learning; Generative AI

*Corresponding author: jrbarajas12@gmail.com

BIOENERGY AND BIOFUELS (BAB)

BAB-002

Synthesis of CuO/CaO from Kuhol Shells as Catalyst for the Production of Biodiesel from Selected Waste Cooking Oils

Rejie Magnaye*, Carmela Fritz Briones, William Ross Fillartos, Maika Otsuki, and Francis Rada

Batangas State University - The National Engineering University, Philippines

Biodiesel can be produced in the presence of a catalyst by transesterification of animal fat or vegetable oil with alcohol. This study focuses on synthesizing CuO/CaO nanoparticles from Kuhol (*Sulcospira*) shells to serve as a catalyst in converting waste cooking oil (WCO) into biodiesel. Additionally, the CuO/CaO nanocatalyst was characterized through SEM, EDX, FTIR, and XRD Analysis, wherein these nanoparticles appeared to agglomerate with a mean particle size of 150.894 nm and were uniformly distributed in nanosizing at a 1:1 atomic ratio. Moreover, the EDX Analysis result showed that the sample contains elemental atomic percentages of 61.56% Oxygen, 19.23% Calcium, and 19.21% Copper. This type of metal nanoparticle plays an important role in catalysis applications due to its large surface area and more active sites, which facilitate faster reactions and increase product yield. Optimal conditions illustrated that higher catalyst concentration and longer reaction time significantly increase biodiesel yield, highlighting the impact of these parameters on biodiesel conversion. The ANOVA model for palm, vegetable, and coconut parameters and biodiesel yield resulted in p-values of 0.0003, 0.0010, and 0.02216, implying that all models are significant. For the catalyst reusability, the biodiesel conversion gradually decreases on each run. On the 9th run, the biodiesel yield went below the 50-percent baseline which indicates that the reusability of CuO/CaO nanocatalyst can be carried out for up to 8 cycles only, with high stability under the process' optimal conditions.

Keywords: Biodiesel; Catalyst; Calcium oxide (CaO); Copper oxide (CuO); Kuhol shells

*Corresponding author: rmagnaye635@gmail.com

BAB-004

Low-Voltage Hydrogen Production using Metal Ions Reduced by Biomass Waste

Yihan Xiu, Kento Suzuki, Ryuichi Ashida*, and Motoaki Kawase

Kyoto University, Japan

The authors have been developing a novel process to efficiently extract the chemical energy contained in lignite and biomass in the form of hydrogen. In this process, hydrogen is produced by electrochemically oxidizing vanadium ions, previously reduced by lignite or biomass, using surplus electric power. This method requires a lower theoretical voltage than conventional water electrolysis. In this study, we investigated the conditions that promote hydrogen production, focusing on the improvement in current density. Experiments were conducted using different electrode materials and flow field designs on the anode side. Carbon paper, titanium sponge, and platinum-coated titanium were used as electrode materials, among which the platinum-coated titanium exhibited the highest current density. Three types of flow fields were tested: a diffusion-based serpentine flow field and two forced-convection-based flow field, flat and interdigitated ones. The interdigitated flow field achieved the highest current density. This result suggests that forced convection is more effective than diffusion for the transport of vanadium ions. Furthermore, compared to the flat flow field, the interdigitated design may offer more uniform flow distribution across the electrode surface.

Keywords: biomass; hydrogen; highly efficient energy conversion; redox reaction; electrode material; flow field design

*Corresponding author: ashida@cheme.kyoto-u.ac.jp

BAB-005

Effect of Reaction Temperature and Time on the Oil Yield and Properties of Bio-Oil from Hydrothermal Liquefaction of *Spirulina* (*Arthrospira*) *platensis* (Gomont) Geitler (Cyanobacteria) after Protein Extraction

Daniel Gary Gabuat, Rowena Carpio*, Monet Concepcion Detras, and Manolito Bambase Jr.

University of the Philippines Los Baños, Philippines

The growing demand for sustainable energy has focused research into biofuels, with microalgae such as *Arthrospira platensis*, commonly known as *Spirulina* emerging as a potential feedstock due to its fast growth and carbon capture capabilities. However, its high protein content contributes to elevated nitrogen levels in bio-oil, lowering fuel quality and releasing harmful nitrous oxide emissions. This study investigated the effect of temperature (290 °C, 320 °C, 350 °C) and time (15 minutes, 30 minutes, 45 minutes) on the hydrothermal liquefaction (HTL) of *Spirulina* residue after protein extraction using 3^k full factorial experiment. The main effects as well as their interaction had been observed to have significant effect on the oil yield and the pooled aqueous and gas phase yield, while only temperature had a significant effect on the solid residue yield. The highest yield of 29.58% was obtained at 320 °C and 45 minutes. Results also show that HTL oil yield decreased by 5% when using protein extracted residue compared to the original biomass. FTIR analysis detected a decrease in nitrogenous compounds in the biocrude oil product, but ultimate analysis reported an increase in oxygen to carbon ratio of the product. Energy recovery of protein-extracted Spirulina residue was reported to be at 46.67%. Nitrogen content of the biocrude oil (4.69%) was still significantly higher than commercial diesel and gasoline levels, indicating a need for subsequent upgrading of biofuel for future studies.

Keywords: Hydrothermal liquefaction; Spirulina; protein extraction; bio-oil

*Corresponding author: rbcarpio@up.edu.ph

BAB-006

Evaluating the Effect of Calcination Temperature on the Performance of Sulfated Tin (IV) Oxide Catalyst for Fatty Ester Isomerization

Yano Surya Pradana[1], Alif Kembara Alam[2], Antonius Indarto[3], I Gusti Bagus Ngurah Makertihartha[3]*, Tirto Prakoso[3], and Tatang Hernas Soerawidjaja[4]

[1]*Department of Chemical Engineering, Faculty of Engineering, Universitas Gadjah Mada, Indonesia*
[2]*Master Program of Chemical Engineering, Faculty of Industrial Technology, Institut Teknologi Bandung, Indonesia*
[3]*Department of Chemical Engineering, Faculty of Industrial Engineering, Institut Teknologi Bandung, Indonesia*
[4]*Department of Bioenergy Engineering and Chemurgy, Faculty of Industrial Technology, Institut Teknologi Bandung, Indonesia*

Biodiesel, also known as fatty esters, has emerged as a promising alternative diesel fuel due to its renewability, biodegradability, abundant availability, and cleanliness in combustion. However, the application of this cleaner-burning fuel in high percentage is hampered by low levels of cold flow properties. Primarily, the constraints on these physical properties are led by the elevated content of saturated fatty esters. Reducing the saturation degree of biodiesel is a potential improvement, but it has an adverse impact on oxidation stability. Later, isomerization technique was proposed to enhance cold flow properties without alleviating the saturation level of biodiesel. In this study, the isomerization reaction was conducted using sulfated tin(IV) oxide solid catalyst under nitrogen flow at temperature of 200°C, atmospheric pressure, and catalyst loading of 10 wt%. The effect of calcination temperature (400–600°C) on the catalyst characteristics and reaction performance was investigated with varying residence time. The highest yield (20.4%) was observed at calcination temperature of 500°C and residence time of 12 h. The isomerization yield declined at higher calcination temperature because a reduced amount of acid sites. Meanwhile, the isomerization reaction was significantly limited when using the catalyst calcined at 400°C, despite having the highest number of acid sites. This phenomenon was due to the restricted pore diameter and surface area, obstructing molecule mass transfer and reaction.

Keywords: biodiesel; cold flow properties; oxidation stability; isomerization; sulfated tin(IV) oxide; calcination temperature

*Corresponding author: makertia@itb.ac.id

BAB-007

A Conceptual Mathematical Model of a Simultaneous Extraction and Transesterification Reaction on the Production of Fatty Acid Ethyl Esters from Wet Mahogany (*Swietenia macrophylla*) Seed

Juvyneil Cartel[1] and Joseph Auresenia[2]*
[1]*Eastern Visayas State University, Philippines*
[2]*De La Salle University, Philippines*

Reducing the production cost of biodiesel remains a key barrier to its competitiveness against petroleum diesel. This study addresses the issue through a novel approach that integrates mathematical modeling with a simultaneous extraction–transesterification process using *Swietenia macrophylla* (Mahogany) seed oil. The innovation lies in the in-situ generation of carbonic acid and the use of a carbon dioxide-expanded ethanol-water system, which removes the need for energy-intensive seed drying and relies on low-cost, eco-friendly solvents like azeotropic ethanol and recyclable CO_2. Although initial conversion rates were low, the development of a comprehensive mathematical model offers insights into optimizing reaction conditions and improving yield. The model captures the dynamics of reactive extraction in a wet solid–liquid heterogeneous medium and supports both steady- and unsteady-state analyses. Simulations explore the interactions within the CO_2-ethanol-water system and evaluate key parameters such as temperature and reactor configuration. This predictive modeling approach guides process optimization and design, particularly for supercritical fluid (SCF) reactors, offering potential reductions in cost and processing time. As no prior studies have tackled this integrated method, the work presents original contributions with strong scientific relevance and potential industrial application.

Keywords: Mahogany; transesterification; modelling; simulation; supercritical fluid

*Corresponding author: joseph.auresenia@dlsu.edu.ph

BIOCHEMICAL ENGINEERING (BCE)

BCE-001

Optimization of Culture Conditions for Enhanced Biomass Production of an Indigenous *Aurantiochytrium* sp. Strain in Bioethanol Distillery Wastewater

Bien Binamera[1]*, Joshua Ignacio[1], Zander Herrera[1], Jewel Capunitan[1], Francisco Elegado[2], Veronica Migo[1], and Catalino Alfafara[1]

[1]*Department of Chemical Engineering, University of the Philippines Los Baños, Philippines*
[2]*National Institute of Molecular Biology and Biotechnology (BIOTECH), Philippines*

Thraustochytrid biomass is a promising alternative for aquaculture fish feed due to its high polyunsaturated fatty acid (PUFA) content, but commercial production is limited by high media costs. This problem was addressed in this study, by utilizing bioethanol distillery wastewater (DWW) as a low-cost medium for biomass production of a local *Aurantiochytrium* sp. strain. Furthermore, Response Surface Methodology was used to optimize its fermentation conditions. A factorial design identified that near-neutral initial pH and low C/N ratio significantly enhanced biomass yield. The salinity effect was identified to be insignificant. Response surface modeling using a central composite design produced a significant quadratic model that was validated by ANOVA (p 0.0001). Numerical optimization predicted maximum biomass yield (8.676 g/L) at initial pH 6.897, C/N ratio 5, and inherent DWW salinity of 18 ppt. Experimental validation yielded 9.538 ± 0.99 g/L, closely matching predictions. Preliminary cost analysis of shake flask results showed that the optimized DWW media reduced biomass production cost by over 99% as compared to the traditional synthetic media. The study supported the feasibility of valorizing locally-sourced DWW for low-cost thraustochytrid cultivation.

Keywords: Thraustochytrids; bioethanol distillery wastewater; response surface methodology; numerical optimization; biomass production

*Corresponding author: bebinamera@up.edu.ph

BCE-002

Optimization of Surfactant-Assisted Extraction of Polyphenols from Cacao Bean Shells

Jennivee Chua, Lawrence Belo*, and Cynthia Madrazo

De La Salle University, Philippines

Surfactant-assisted extraction is a potential green process for obtaining polyphenols from agricultural waste. The cacao bean shell (CBS) has been shown to possess antioxidant polyphenols. SAE using Tween 80 was optimized to maximize the total phenolic content (TPC), total flavonoid content (TFC), and antioxidant activity (AOA) from CBS. The parameters investigated were pH (4 – 8), surfactant concentration (0.5% to 1.5%), and solid-to-liquid ratio (0.02 – 0.08 g/mL). The TPC, TFC, and AOA were optimized individually and verified to obtain actual values of 24.995 mg GAE/g, 22.304 mg CE/g, and 50.126 micromol $FeCl_2$/g, respectively. The optimum extraction parameters were 1.500% Tween 80 and 0.020 g/mL ratio for TPC,1.211% Tween 80 and 0.020 g/mL for TFC, and 1.500% Tween 80 and 0.0497 g/mL ratio. The optimum pH for all responses is pH 8.000. Simultaneous optimization of all responses achieved TPC, TFC, and AOA of 21.889 mg GAE/g, 20.350 mg CE/g, and 45.453 micromol $FeCl_2$/g, respectively, at extraction parameters of pH 8.000, 1.240% Tween 80, and 0.0330 g/mL ratio. All regression models have p 0.0001. The results of this study show that SAE is an effective method to obtain antioxidant polyphenols from CBS and is a viable alternative to organic extraction.

Keywords: Cacao bean shell; Agri-waste valorization; Optimization; Green extraction; Antioxidant

*Corresponding author: lawrence.belo@dlsu.edu.ph

BCE-002

Color Stabilization of Phycocyanin Using Sodium Lauryl Sulfoacetate Under Varying pH and Temperature Conditions

John Ray Estrellado[1], Aldrin Bonto[2], and Cynthia Madrazo[1]*

[1]Department of Chemical Engineering, De La Salle University, Philippines
[2]Department of Chemistry, De La Salle University, Philippines

One of the main limitations of phycocyanin as a natural antioxidant is its susceptibility to denaturation due to changes in pH and temperature, and presence of huge surfactant concentrations in cosmetic or food formulations. This study investigates the stabilizing potential of sulfate-free anionic surfactant sodium lauryl sulfoacetate (SLSa) on phycocyanin under varying pH and temperature. SLSa was evaluated at sub-micellar, near-critical micelle concentration (CMC), and above-micellar levels to determine its effect on color retention and protein stability. Samples were subjected to varying pH (4–8) and temperature (25–50 °C) conditions, with stability assessed via ΔE color difference and UV-Vis absorbance spectra over time. Results show that at optimized micellar concentrations and near-neutral pH, SLSa reduced color degradation and maintained the spectral integrity of phycocyanin. In contrast, higher temperatures and lower pH accelerated pigment loss, especially at sub-micellar surfactant levels. These findings suggest that SLSa, when properly dosed and buffered, can mitigate phycocyanin degradation by providing micellar encapsulation and interface stabilization. The use of sulfate-free surfactants like SLSa also aligns with the demand for low-irritancy and clean-label formulations in cosmetic and pharmaceutical applications involving sensitive bioactives.

Keywords: phycocyanin; sodium lauryl sulfoacetate; surfactant; micelle; color retention

*Corresponding author: cynthia.madrazo@dlsu.edu.ph

BCE-004

Biuret Protein Quantification and Turbidity Kinetics Evaluation of Digested Total and Soluble Decellularized Porcine Skin Extracellular Matrix

John Ray Estrellado[1], Charlize Dawn Batin[2], Sarah Miguelle Garcia[2], Catherine Anne Sy[2], Tosha Mae Manalastas[1], Mariquit Delos Reyes[3], and Joseph Rey Sta. Agueda[2]*

[1]Department of Chemical Engineering, De La Salle University, Philippines
[2]Department of Manufacturing Engineering and Management, De La Salle University, Philippines
[3]Department of Biology, De La Salle University, Philippines

Porcine skin extracellular matrix (ECM) is a biologically rich scaffold with emerging use for biomedical applications. This study investigates the protein yield and colloidal behavior of sodium dodecyl sulfate (SDS)-decellularized ECM digests. The decellularized ECM was digested with pepsin, and the resulting mixtures were analyzed as total digests and soluble fractions (post-centrifugation). Protein concentration was quantified via the Biuret assay, targeting peptide bonds in both fractions. Simultaneously, turbidity kinetics were assessed at 600 nm over digestion periods of 4, 8, 12, and 24 hours at 37 °C to evaluate aggregation behavior. Results showed increasing protein concentration over time in both fractions, with total digests consistently yielding higher values. However, total digests also demonstrated faster and greater turbidity development, indicating aggregation of partially solubilized ECM fragments. Soluble fractions showed delayed turbidity onset and lower final absorbance, suggesting enhanced dispersion stability. These findings highlight the influence of digestion time and fractionation on the physical and biochemical characteristics of ECM suspensions. The combination of Biuret protein quantification and turbidity profiling provides a simple yet informative approach to optimizing ECM-based formulations for tissue engineering and injectable biomaterial applications.

Keywords: Biuret assay; decellularization; extracellular matrix; gelation; turbidity; protein

*Corresponding author: joseph.staagueda@dlsu.edu.ph

BCE-005

Development of Hydrogel Using Cellulose Nanofiber from *Cladophora rupestris* and Glycogens from Lagkitan Corn (*Zea mays var. Ceratina*) or Golden Apple Snail (*Pomacea canaliculata*) Meat

Mary Rose Persincula[1,2] and Cynthia Madrazo[2]*
[1]*Batangas State University, Philippines*
[2]*De La Salle University Manila, Philippines*

A hydrogel was developed utilizing cellulose nanofiber (CNF) derived from *Cladophora rupestri*s, glycerol and glycogen extracted from golden apple snail (*Pomacea canaliculate*) meat or phytoglycogen from Lagkitan corn (*Zea mays var. ceratina*). The CNF derived *Cladophora rupestris* possessed high crystallinity, webbed surface morphology, nanoparticle size, and functional groups confirming cellulose presence. It was found that the glycogen from golden apple snail meat was comparable with that of the standard in comparison with that of the phytoglycogen. The glycogen extraction was modified by varying citric acid concentration, and temperature for the glycogen extraction, varying drying methods (vacuum drying and freeze-drying), and washing (ethanol and water). Results indicate that a 1:2 CNF:glycogen ratio exhibited good water retention and swelling properties compared to that with phytoglycogen. Both hydrogels demonstrated good water uptake, making these good candidates for wound dressing applications.

Keywords: Glycogen; Phytoglycogen; Hydrogel; Cellulose nanofiber

*Corresponding author: cynthia.madrazo@dlsu.edu.ph

BCE-006

Design Self-Organized Nano Carriers for Drug Delivery

Hiroshi Umakoshi* and Nozomi Watanabe
The University of Osaka, Japan

A "Biomembrane" is a highly-organized self-assembly of biomolecule (i.e. lipid, protein etc.) and a key interface for the survival of biological cell. The "Membranome" can be defined as the interfacial properties of "self-organizing system" (i.e. vesicle, liposome, bicelle, cubosome, nano carriers, etc.), which arise from the molecular assembly of amphiphilic molecules, focusing on "emergent properties" which are not present in the individual components, and is gradually recognized as an important research methodology to investigate the potential functions of the above self-organizing systems and to apply them for nano medicine in DDS and/or nano-capsule for food engineering. As for potent application to design and development of nano medicine and/or food engineering, nanostructured lipid carriers (NLCs) are a new generation of lipid vectors for drug delivery systems (DDSs), which are composed of solid and liquid lipids dispersed throughout the inner lipid matrix. In this presentation, a systematic method to characterize the "interface" of various NLCs will be introduced by selecting some case studies, such as (i) standard vesicles, (ii) model biomembranes, (iii) cubosomes, (iv) cataniosomes, and (v) covid19-carrier (DSPC/cholesterol/cationic lipid (SM102)). The method includes the (1) conventional physical characterization methods (i.e. DLS, SANS, etc) and (2) (our original) physicochemical ones (i.e. multi-probes fluorescence spectroscopy, time-resolved / decay-associated fluorescence spectroscopy, (surface enhanced) Raman spectroxcopy etc). These systematic results can be used to clarify the design space of the NLC composition to show the drug delivery.

Keywords: Bio-Inspired Chemical Engineering; Liposome (Vesicle); Drug Delivery System

*Corresponding author: umakoshi.hiroshi.es@osaka-u.ac.jp

BCE-007

ARABITECT: Microwave-Assisted Green Synthesis of Graphene Oxide Quantum Dots from *Coffea arabica* L. as Fluorescent Probe with Cytotoxic Effects for Selective and Sensitive Detection of HCT116 Human Colon Adenocarcinoma

Gared Arthur Tribunalo, Mari Angeline Dejucos, Myer Angela Gulayan, Jasper Clint Parasdas, and Reyna Claire Dizon*

Science and Technology Education Leaders in Learning and Research, Philippines

This study explored the potential of Graphene Oxide Quantum Dots (GOQDs) derived from *Coffea arabica* L. black carbon as a fluorescent probe with cytotoxic effects for the selective and sensitive detection of HCT116 human colon adenocarcinoma cells. Baseline characterization using UV/Vis and FTIR spectroscopy revealed that GOQDs exhibit optimal excitation within the UV-B spectrum and contain hydroxyl and carboxyl groups. Further analysis, conducted at Chulalongkorn University in Bangkok, Thailand, using XRD, TEM, EDX, and FESEM, confirmed the successful synthesis of GOQDs. The GOQDs' potential for detecting the HCT116 cell line was validated through fluorescence measurements, where GOQD-HCT116 samples demonstrated 26.30% fluorescence in blue at an 80% concentration, compared to 7.50% for healthy cells with GOQDs. Additionally, in vivo analyses using Drosophila melanogaster in three standardized tests (oral, direct-smash, and homogenization) corroborated the in vitro results, showing that cancer-induced flies exhibited the highest fluorescence. Cytotoxicity assessment via the MTT assay revealed that GOQDs had an IC50 value of 3.26 µg/mL, and could still inhibit 97.33% of cancer cells at 7.5 µg/mL. Consequently, EPR spectroscopy identified that GOQDs exhibit unpaired electrons, which generate reactive oxygen species (ROS) that contribute to cancer cell inhibition. The marketability of GOQDs was also evaluated, showing a production cost reduction of 37,579 times, an 82.5-fold increase in diagnostic speed, and a 12,240-fold reduction in retrieval time. This study confirms that GOQDs synthesized from *Coffea arabica* L. provide a selective and sensitive method for detecting the HCT116 cell line, while also exhibiting cytotoxic activity.

Keywords: GOQDs; Coffea arabica L.; HCT166 human colon adenocarcinoma; Drosophila melanogaster

*Corresponding author: stemazingdranhs@gmail.com

BIOMATERIALS (BMT)

BMT-002

Sequential Extraction Strategies for High-Purity Chitin and In Situ Chitosan Production from Black Soldier Fly Puparia

Judy Retti Bhawaningrum Witono, Daniel Tan*, Mika Fernando, Herry Santoso, and Arry Miryanti

Department of Chemical Engineering, Parahyangan Catholic University, Indonesia

Chitin, a biodegradable biopolymer with excellent physical and chemical properties, is widely used across biomedical, agricultural, and industrial sectors. Its derivative, chitosan, offers even greater versatility due to its enhanced solubility and reactivity. Traditionally extracted from crustacean shells, chitin extraction is now shifting toward alternative, more sustainable sources to mitigate environmental and supply concerns. In this study, we investigate black soldier fly (BSF, *Hermetia illucens*) puparia, a typically discarded byproduct, as an emerging feedstock for chitin extraction. By systematically evaluating different extraction protocols, we identify an optimized sequence of demineralization, deproteination, and depigmentation that yields highly purified chitin with residual ash, lipid, and protein contents of 1.01%, 1.99%, and 3.01%, respectively. This process achieves demineralization and deproteination efficiencies of 94.77% and 92.24%, resulting in a chitin purity of 93.98%. Notably, an alternative treatment sequence, demineralization followed by combined deproteination and depigmentation, facilitates partial in situ conversion to chitosan, achieving a degree of deacetylation of 65.90%. These findings demonstrate the potential of the BSF puparium as a viable source for both chitin and direct chitosan production, offering a practical and sustainable approach that supports circular bioeconomy initiatives.

Keywords: black soldier fly; chitin; chitosan; puparia-BSF

*Corresponding author: daniel.tan@unpar.ac.id

BMT-005

Development and Optimization of Chicken Feather Keratin Extraction and 3D Bioprinting of Composite Scaffolds

Beatrisse Anne Bustamante, Andre Leopold Nidoy, Nathaniel Dugos*, Vergel Bungay, and Renato Ong
De La Salle University, Philippines

The poultry industry generates vast amounts of chicken feather waste annually, posing environmental challenges despite feathers being rich in keratin–a durable, biocompatible protein with biomedical potential. This study developed a sustainable method for keratin extraction from chicken feathers using a deep eutectic solvent (DES) composed of L-cysteine and lactic acid. Process optimization via Response Surface Methodology (Box-Behnken Design) examined the effects of L-cysteine mass, temperature, and dissolution time on keratin yield. Optimal conditions (2.3g L-cysteine, 108 °C, 6h) produced a maximum yield of 85.98%, with strong model predictability (R2 = 0.979). FTIR confirmed preservation of key amide functional groups, indicating minimal protein degradation. The extracted keratin was incorporated into a polyvinyl alcohol (PVA)-gelatin matrix to fabricate 3D-bioprinted scaffolds. Characterization revealed improved tensile strength, surface morphology, and chemical integration compared to controls. This demonstrates the potential of L-cysteine/lactic acid DES as an eco-friendly extraction system and highlights the feasibility of converting feather waste into functional biomaterials. The approach supports circular bioeconomy principles and offers a scalable pathway for sustainable scaffold fabrication in tissue engineering and regenerative medicine

Keywords: chicken feather keratin; deep eutectic solvent; L-cysteine; lactic acid; 3D bioprinting

*Corresponding author: nathaniel.dugos@dlsu.edu.ph

BMT-006

Optimization of Sonication–Perfusion Parameters for Rapid Decellularization of Porcine Urinary Bladder Scaffolds

Jeffrey Joy Berizo, Ricielle Abby Magno, Andre Leopold Nidoy, Kevin Victor Espiritu, Nathaniel Dugos*, Vergel Bungay, and Renato Ong

De La Salle University, Philippines

This study aimed to optimize the decellularization parameters for developing an extracellular matrix (ECM) scaffold derived from porcine bladder using a combination of perfusion and sonication methods. Sodium dodecyl sulfate (SDS) concentration, flow rate, and sonication power were selected as the key parameters due to their significant influence on cellular removal efficiency and processing duration. A face-centered central composite design (FCC) was employed under the response surface methodology (RSM) framework to determine their individual and interactive effects on decellularization time. The progression of decellularization was monitored based on tissue color changes from pink to translucent white, while histological validation using hematoxylin and eosin staining confirmed the absence of cells in decellularized samples. Results indicated that higher SDS concentration, greater flowrate, and increased sonication power significantly reduced decellularization time. The shortest complete decellularization was achieved within 2.5 hours at 1%(w/v) SDS, 120 mL/min flow rate, and 120 W sonication power, compared to 16 hours under the lowest settings. These findings demonstrate that the combined sonication-perfusion system efficiently enhances decellularization while minimizing process duration, proving a promising approach for rapid and effective bladder ECM preparation.

Keywords: Porcine bladder; decellularization; extracellular matrix (ECM); sonication; perfusion

*Corresponding author: nathaniel.dugos@dlsu.edu.ph

BMT-007

Development of an Antibiotic–Antimycotic-Based Sterilization Protocol for Decellularized Urinary Tract Scaffolds

Andre Leopold Nidoy, Kevin Victor Espiritu, Jan Joshua Cruz, and Nathaniel Dugos*
De La Salle University, Philippines

Sterilization of decellularized scaffolds is a critical step in ensuring their biosafety and suitability for tissue engineering applications. Residual microbial contamination can compromise scaffold integrity, trigger inflammatory responses, and affect the performance of subsequent recellularization or biological assays. This study focuses on the development of a novel antibiotic-antimycotic-based sterilization protocol (AAE-based) intended as a cost-effective and accessible alternative to conventional sterilization methods. The protocol incorporates sequential soaking steps involving a high-dose antimicrobial treatment, ethanol immersion, and a final phosphate-buffered saline (PBS) displacement soak to remove residual agents while maintaining the extracellular matrix (ECM) architecture. Controlled contamination using representative bacterial and fungal strains is employed to simulate potential bioburden within decellularized urinary scaffolds. Sterilization efficiency is evaluated through enrichment cultures in tryptic soy broth (TSB) and surface plating on tryptic soy agar (TSA) to assess microbial recovery. The outcomes of this work aim to establish an optimized framework for validating antimicrobial-based sterilization strategies for decellularized tissues, contributing toward safer and more sustainable scaffold preparation techniques for regenerative medicine.

Keywords: decellularized scaffold sterilization protocol antibiotics-antimycotics extracellular matrix tissue engineering

*Corresponding author: nathaniel.dugos@dlsu.edu.ph


The Petron Bataan Refinery is the only remaining refinery in the country and one of the most advanced facilities in the region.
Through this, we are capable of supplying around 40% of the Philippines' total fuel requirements.
PETRON

NASCENT
TECHNOLOGIES CORP.

ABOUT NASCENT

We engineer sodium-ion battery systems built for tropical performance—safer and longer-lasting than lead-acid, simpler than lithium-ion.

From our headquarters in Metro Manila, Philippines, **Nascent** is leading Southeast Asia's shift to smart, sustainable energy with sodium-ion innovation.

ELECTRO-CHEMISTRY

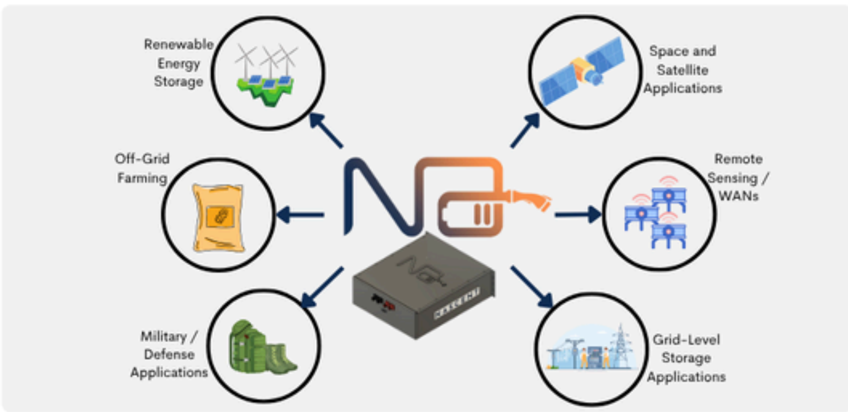
- Coin and pouch cell prototyping
- Electrochemical performance testing
- Custom R&D outsourcing & reporting

APPLICATIONS ENGINEERING

- NOVA SLI packs (Automotive)
- 5 kWh modular rack-mounted battery
- Dual-chemistry BMS (Li-ion & Na-ion)
- Enclosure, rack, and integration design

ESS SOLUTIONS & SERVICES

- Site feasibility and load analysis
- ESS design and integration strategy
- Energy systems software solutions
- Supplier matchmaking and system design



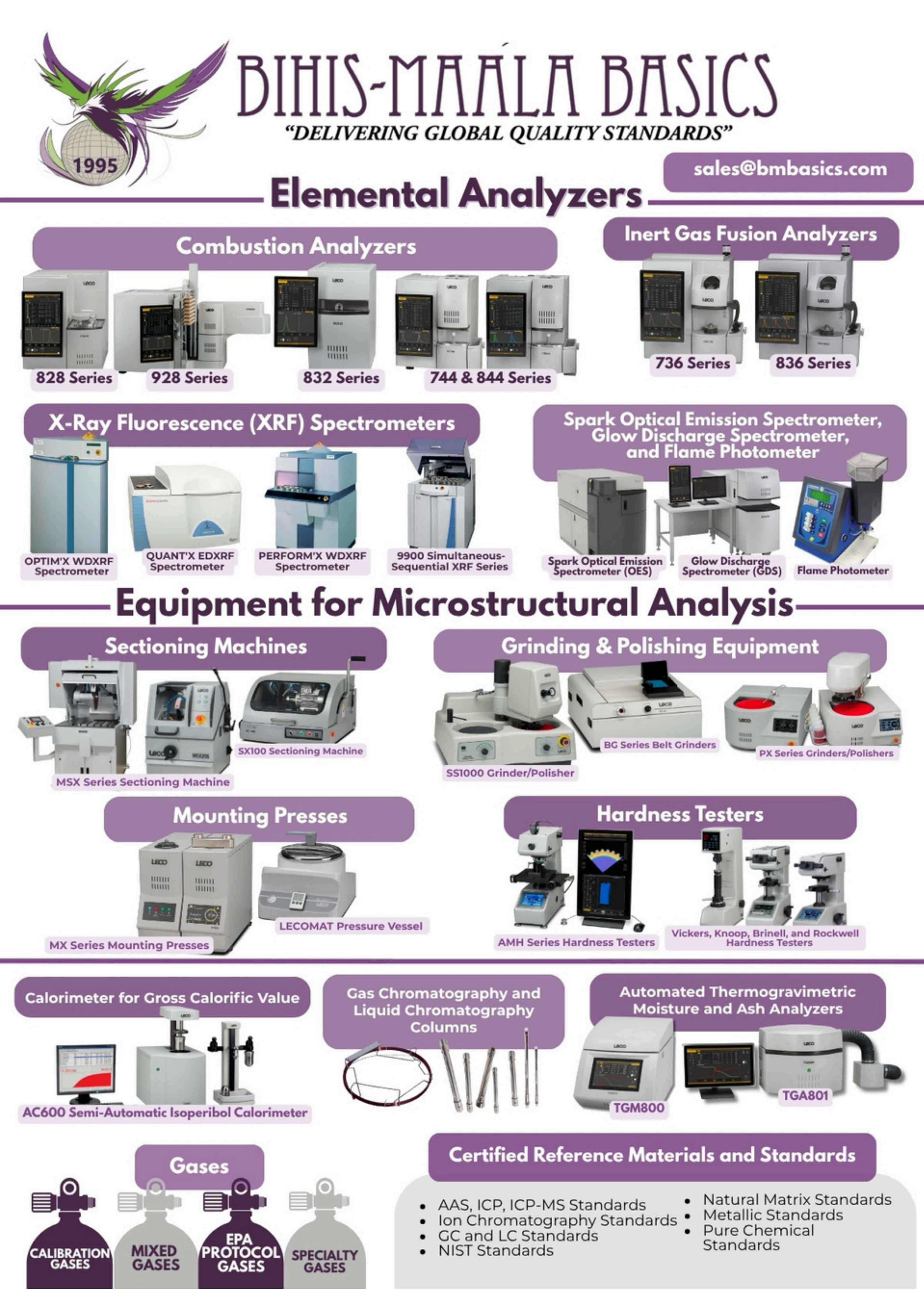
Partner with us!
We're open to collaborations in R&D, pack design, cell sourcing, and system deployment.

*Let us engineer the future of energy—**together**.*

Contact Us (Viber/WhatsApp)
+63 917 500 3934

Visit our website
www.nascentbatteries.com

Email Us
jssantiagojr@nascentbatteries.com


BIHIS-MAÁLA BASICS
"DELIVERING GLOBAL QUALITY STANDARDS"
1995
sales@bmbasics.com
Elemental Analyzers
Combustion Analyzers
828 Series
928 Series
832 Series
744 & 844 Series
Inert Gas Fusion Analyzers
736 Series
836 Series
X-Ray Fluorescence (XRF) Spectrometers
OPTIM'X WDXRF Spectrometer
QUANT'X EDXRF Spectrometer
PERFORM'X WDXRF Spectrometer
9900 Simultaneous-Sequential XRF Series
Spark Optical Emission Spectrometer, Glow Discharge Spectrometer, and Flame Photometer
Spark Optical Emission Spectrometer (OES)
Glow Discharge Spectrometer (GDS)
Flame Photometer
Equipment for Microstructural Analysis
Sectioning Machines
SX100 Sectioning Machine
MSX Series Sectioning Machine
Grinding & Polishing Equipment
BG Series Belt Grinders
PX Series Grinders/Polishers
SS1000 Grinder/Polisher
Mounting Presses
LECOMAT Pressure Vessel
MX Series Mounting Presses
Hardness Testers
AMH Series Hardness Testers
Vickers, Knoop, Brinell, and Rockwell Hardness Testers
Calorimeter for Gross Calorific Value
AC600 Semi-Automatic Isoperibol Calorimeter
Gas Chromatography and Liquid Chromatography Columns
Automated Thermogravimetric Moisture and Ash Analyzers
TGM800
TGA801
Gases
CALIBRATION GASES
MIXED GASES
EPA PROTOCOL GASES
SPECIALTY GASES
Certified Reference Materials and Standards
• AAS, ICP, ICP-MS Standards
• Ion Chromatography Standards
• GC and LC Standards
• NIST Standards
• Natural Matrix Standards
• Metallic Standards
• Pure Chemical Standards

ALVTECHNOLOGIES PHILIPPINES INCORPORATED

15 YEARS OF PROVIDING ONE-STOP TOTAL SOLUTIONS

HORIBA Scientific

Raman Spectrometer, Fluorescence Spectrometer, Ellipsometer, ICP-OES, GD-OES, Optical Spectroscopy Components

MODULESCI

Table-top and Floor type Scanning Electron Microscope Entry Level FE-SEM

BioLogic

Electrochemistry, Potentiostat, Galvanostat, EIS, Battery Cycler, Quartz Crystal Microbalance

inovenso

Electrosppining Machine and Syringe Pump System

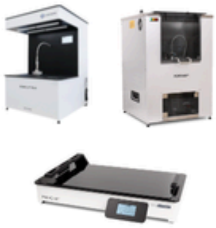
KYOWA Leading to answers

Contact Angle Meter   Force Tensiometer

Starna scientific

Cuvettes and Certified Reference Materials

porometer



Gas-Liquid Porometer, Liquid-Liquid Porometer, Membrane Casting System

For the development of scientific technologies
Yamato Scientific Co., Ltd.

Oven, Furnace, Laboratory Stirrer and Hotplate, Incubator, Laboratory Shaker, Autoclave/Sterilizer, Spray Dryer, Freeze Dryer, Water Purifier, Water Bath, Rotary Evaporator

OXFORD INSTRUMENTS
ASYLUM RESEARCH

Atomic Force Microscope

VISIT OUR WEBSITE

CONTACT US FOR MORE INFORMATION

sales@alvtechnologies.com.ph   www.alvtechnologies.com.ph   (632) 8 638 2317 - 19