ICPPCT

2026

4th International Conference on Pollution Prevention and Clean Technologies

7th – 9th
September 2026

al. Adama Mickiewicza 30,
30-059 Kraków,, Poland

AGH University of Krakow

AGH

https://icppct.com/

Contents

Welcome Message

The "4th International Conference on Pollution Prevention and Clean Technologies" event is scheduled for the 07-09th, 2026 in AGH university, Krakow, Poland. The event will bring together renowned researchers, scholars, delegates, d key speakers, who will discuss more about using tech on minimizing the impact of economic activities on the planet and environment.

The International Conference on Pollution Prevention and Clean Technologies will also offer a platform for unpublished papers focused on new and innovative clean technologies. The event will be chaired and co-chaired by **Various insightful researchers around the world**.

"AGH university is extremely proud of being associated with the 4th International Conference on Pollution Prevention and Clean Technologies. While economic development activities are necessary, this event will bring **a platform to discuss innovative clean technologies that can mitigate the waste and risks** related to such activities. From discussing the shift to sustainable resources to improving energy efficiency and design sustainable manufacturing systems, the event will allow a perfect international platform for discussing possible solutions. We also hope that the event will offer an insight on how **global carbon footprint** can be minimized strategically".

ICPPCT would be the first event of its kind that would rely on tech & innovations to create solutions that would address serious environmental concerns. Key speakers and researchers will also offer insight into how innovative clean technologies can be expanded cross manufacturing, industrial, and other sectors to reduce the impact on climate and the planet while considering various aspects of pollution prevention technologies. Scholars and researchers can also interact directly with one another on key pointers like the production of carbon-neutral products and finding new pioneering financial models to support new visions.

"At a time when we are discussing aspects like climate change and increasing pollution levels, ICPPCT would be a great opportunity for the world to explore new ideas and innovations. The event will also offer room to discuss Sustainable Environmental Management System (SEMS) designs and environmental economics, along with waste management and multi-criterion decision-making models for sustainability. We hope ICPPCT will pave the path for determining innovative environmental policies for the world". We hope you enjoy the event, and the scientific discussions will bring new insights to make the environment sustainable and Greener in Future.

Sincerely,

ICPPCT-team

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Cracow University of Technology, Poland

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National ILan University, Taiwan

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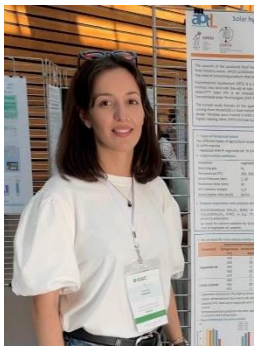

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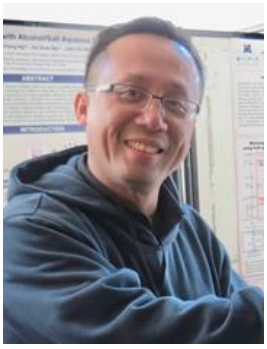

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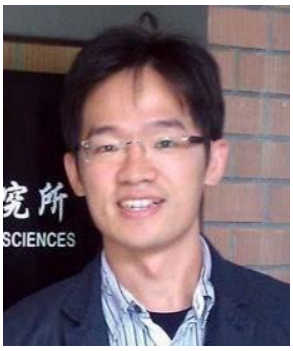
Southern Taiwan University of Science and Technology, Taiwan



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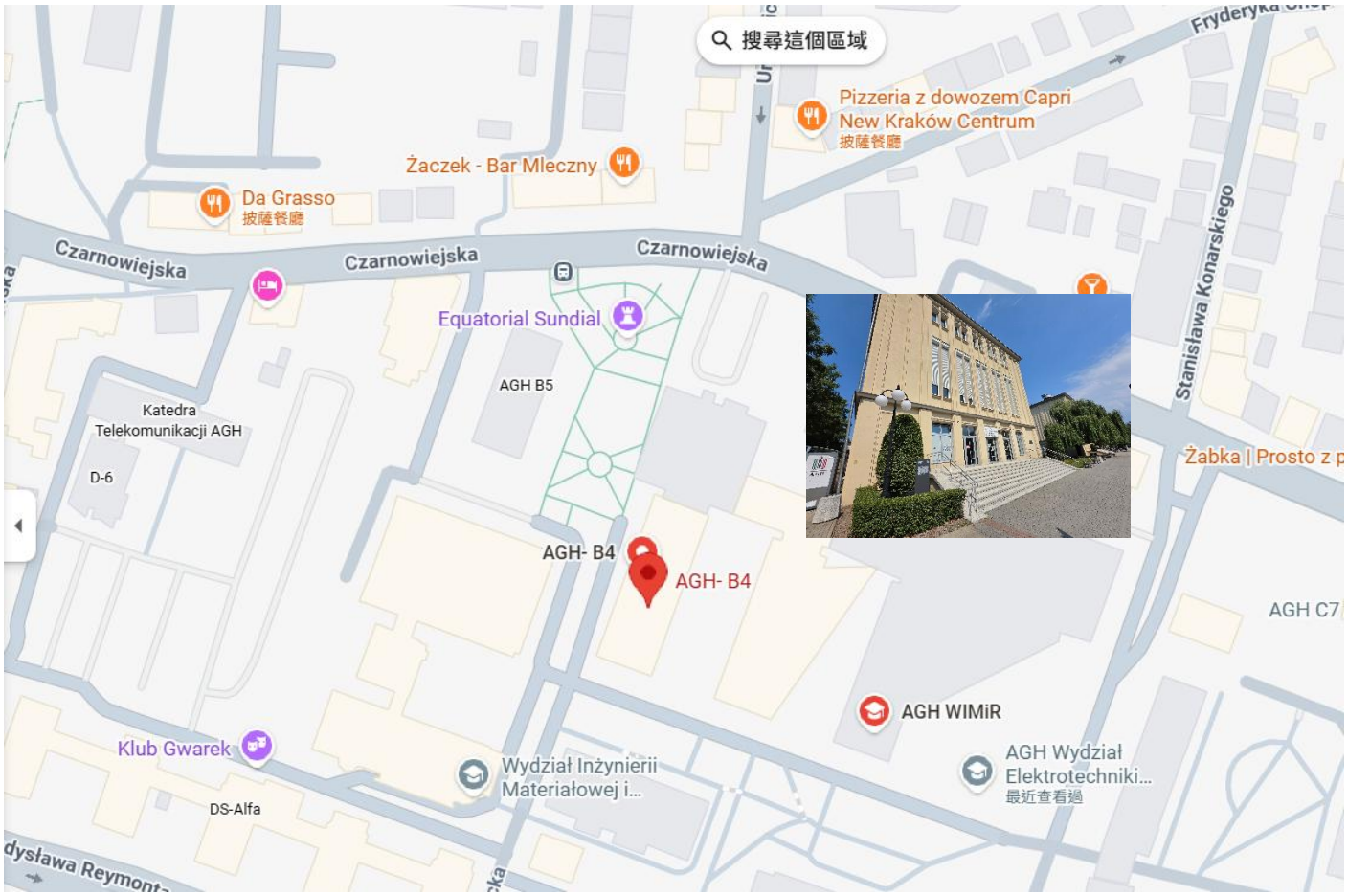

Programme

4th International Conference on Pollution Prevention and Clean Technologies
Date: September 7 – 9, 2026
Venue: AGH University of Krakow, Krakow, Poland

Date	Sept. 7th Monday		Sept. 8th Tuesday	Sept. 9th Wednesday
08:30-09:00	Registration			On-site Visiting and Specific topic Workshop
09:00-09:30	Opening Ceremony Group Photo		Industrial partner Section	
09:30-10:30	Keynote Speakers Session I			
10:30-11:00	Coffee Break		Coffee Break	
11:00-12:00	Keynote Speakers Session II		Green engineering Session	
12:00-13:30	Lunch		Lunch	
13:30-15:00	Sustainable Environment Session	Circular economic Session	Circular economy and AI in Environmental and Eco System Session	
15:00-15:20	Coffee Break		Coffee Break	
15:30-17:05	Green Social Impact Session	Green engineering Session	Taiwan–India–Japan–Thailand Forum on Bioelectrochemical Engineering and Space Sustainability	
17:30-20:00	Welcome drink		Closing Ceremony	

Day 1: Monday, September 7, 2026		
08:30-09:00	**Registration**	**Committee**
Opening ceremony		**Venue: Room 118**
09:00-09:30	**Opening Ceremony** **Group Photo**	**Prof. Agnieszka Kopia** AGH University of Krakow, Poland **Prof. Damian Kasperczyk,** CEO – Ekoinwentyka Ltd.
Keynote Section I **Session Chair: Dr. Gopalakrishnan Kumar**		**Venue: Room 118**
09:30-10:00	From Agricultural and Food Waste to Clean Hydrogen Energy: An Integrated Biorefinery Pathway for the Circular Bioeconomy	**Prof. Dr. Alissara Reungsang** Khon Kaen University, Thailand
10:00-10:30	Socio-Economic, Technological, and Environmental Opportunities and Challenges for Renewable Energy Generation from Residual Biomass: A Case Study of Biogas Production in Brazilian Amazon	**Prof. Moura A. G. L.** Federal University of Maranhao, Brazil
10:30-11:00	Coffee Break	
Keynote Section II **Session Chair: Dr. Gopalakrishnan Kumar**		**Venue: Room 118**
11:00-11:30	Bioreactors in the fight for clean air. Innovations for air protection - in the aspect of energy transformation	**Prof. Damian Kasperczyk**, CEO – Ekoinwentyka Ltd.
11:30-12:00	Microplastic Pollution Mitigation in Sewage Sludge via Hydrothermal Carbonization	**Prof. Małgorzata Wilk** AGH University, Krakow, Poland
12:00-13:00	Lunch (Poster Session)	
Sustainable Environment **Session Chair: Dr. Eldon R Rene**		**Venue: Room 118**
13:00-13.15	Valorizing Agricultural Waste into Advanced Materials: A Coconut Shell-Derived Activated Carbon-Silver Nanocomposite for Wound-Healing Soap Formulation (O55)	**Helen Rose,** Christ University, India
13:15-13.30	Sustainable Electrochemical Technologies for Nitrate Remediation and Ammonia Generation (O56)	**Misheal Merlin V S**, Christ University, India
13:30-13:50	**Invited speaker** The assessment of hydrogen production with spark plug system in automobiles	**Prof. Jer-Huan Jang** Ming Chi University of Technology, Taiwan
13:50-14:10	**Invited speaker** Synergetic Enhancement of Photo-fermentative Biohydrogen Production by Rhodobacter sphaeroides KKU-PS1 by Application of Hydrothermally Synthesized Carbon Dots	**Assoc. Prof. Peer Mohamed** Universiti Kebangsaan Malaysia, Malaysia

14:10-14:30	**Invited speaker** Overexpression of *pckA* alleviates combined lactic acid and p-coumaric acid inhibition of succinic acid production from brewery mashing wastewater hydrolysate (O62)	**Prof. Rajendra Prasad Singh** Southeast University, China
14:30-14:45	Enhanced Aromatic Hydrocarbon Production from Catalytic Pyrolysis of Ginkgo biloba Waste over Zeolite Beta catalyst (O01)	**Haneul Shim** Seoul National University, Republic of Korea
14:45-15:00	Reductive catalytic fractionation of pinecone biomass over transition metal-modified activated carbon catalysts (O02)	**Avnish Kumar** University of Seoul, Republic of Korea
15:00-15:20	Coffee Break	
Circular Economy **Session Chair:**		**Venue: Room II**
13:30-13:50	**Invited speaker** From Agricultural and Food Waste to Clean Hydrogen Energy: An Integrated Biorefinery Pathway for the Circular Bioeconomy	**Assoc. Prof. Sureewan Sittijunda** Mahidol University, Thailand
13:50-14:10	**Invited speaker** From Waste to Spatial Systems: Reimagining Architecture through Bio-Based and Geopolymer Materials	**Assist. Prof. Bo Sheng Liu** Feng Chia University, Taiwan
14:10-14:30	**Invited speaker** Ammonia fermentation for enhanced ammonia recovery	**Prof. Dong Hoon Kim** Inha University, Republic of Korea
14:30-14:45	Enhanced production of transportation fuel and naphthalene enriched bio-oil through catalytic pyrolysis of pine sawdust: Tuning of the catalyst pore size and pyrolysis medium (O03)	**Behzad Valizadeh** University of Seoul, Republic of Korea
14:45-15:00	Hydrogen production from waste cigarette filters via steam gasification over waste-derived Ni/MFe_2O_4 spinel catalysts synthesized from acid mine sludge effluent (O04)	**Fatemeh Khani-Aghesmaeili** University of Seoul, Republic of Korea
15:00-15:20	Coffee Break	
Green Social Environment **Session Chair:**		**Venue: Room 118**
15:20-15:40	**Invited speaker** From Stone Weirs to Modern Renewables: Energy, Land, and Community in the Making	**Assist. Prof. Hui-Tzu Huang** Feng Chia University, Taiwan

15:40-16:00	**Invited speaker** Advanced biorefinery and Technoeconomic Assessments	**Dr. Abdullah Bilal Öztürk** Brno University of Technology, Czech Republic
16:00-16:20	**Invited speaker** Integrated analytical strategies in the study of contaminants of emerging concern (CECs): from wastewater treatment systems to wastewater-based epidemiology and population risk assessment	**Prof. Katarzyna Styszko** AGH university, Poland
16:20-16:35	Steam Gasification of Waste Coffee-Mix Packaging over a Red-Mud-Derived Ni/$AlFe_2O_4$ Catalyst (O05)	**Hoesuk Yim** National University, Republic of Korea
16:35-16:50	Catalytic Pyrolysis of Waste Plastics over Zeolite Catalystsfor the Production of Light Olefins (O07)	**Jihyeon Seo** Korea Advanced Institute of Science and Technology, Republic of Korea
16:50-17:05	Enhanced Hydrogen Production via Catalytic Steam Gasification of Waste Plastic Pyrolysis-Derived Wax over Ni/LaxZr1-xO2 Catalysts (O08)	**Negar Ataei** University of Seoul, Republic of Korea
17.05-17.20	From Nutrient-Rich Wastewater to Valuable Resources: Electrocoagulation for Clean Treatment and Nutrient Recovery in Hydroponic Agriculture	**Khalid Bani-Melhem**, Qatar University, Qatar
Green Engineering **Session Chair:**		**Venue: Room II**
15:20-15:40	Development of Electrospun Microtube Array Membrane for Anode Application in the Microbial Fuel Cell (O33)	**Prof. Yung-Chin Yang** National Taipei University of Technology, Taiwan
15:40-16:00	Calcined cobalt-intercalated polyaniline-rGO composites as cathode catalysts for anion-exchanged membrane fuel cells (O34)	**Prof. Tzi-Yi Wu** National Yunlin University of Science and Technology, Taiwan
16:00-16:20	Evaluation of untreated spent coffee grounds for hydrogen production by *Clostridium beijerinckii* DSM791: Effects of initial pH, substrate and co-fermentation (O61)	**Liana Vanyan** Yerevan State University, Armenia
16:20-16:35	Recovering Vietnam's Rainwater Culture: A Review of the Evidence and Implications for Community-Based Drinking Water Systems (O26)	**Do Dieu Khue** Seoul National University, Republic of Korea
16:35-16:50	Gas-phase bioreactors for methane mitigation: A comprehensive review of microbial ecology, conventional bioreactors, and next-generation technologies (O100)	**Damian Kasperczyk,** Ekoinwentyka Ltd, Poland
16:50-17:05	From Nutrient-Rich Wastewater to Valuable Resources: Electrocoagulation for Clean Treatment and Nutrient Recovery in Hydroponic Agriculture (O102)	**Khalid Bani-Melhem**, Qatar University, Qatar

18:00-20:00	**Welcome drink party** Venue: AGH University

Day 2: Tuesday, September 8, 2026		
Industrial partner Section **Session Chair: Dr inż. Damian Kasperczyk**		**Venue: Room 118**
09:00-09:20	Sustainable Polymers for Commodity, Engineering and Medical Applications	**Prof. Vimal Katiyar** IIT Guwahati, India
09:20-09:40	International Specialist – Energy, Water & Sustainability	**UV Krishna Mohan Rao** ITiFY Energy Services
09:40-10:00	E-Titanium: Building Policy, Technology and Implementation for a circular future	**Manager Candy Cheng** E-Titanium International Ltd., Taiwan
Green Engineering **Session Chair**		**Venue: Room 118**
10:00-10:15	Upcycling Alkali Lignin to Monomeric Phenols over Red Mud-derived Catalysts (O09)	**Reeta Rani** University of Seoul, Republic of Korea
10:15-10:30	Aromatic hydrocarbon production from printer-derived e-waste via catalytic pyrolysis (O10)	**Sumin Pyo** Korea Advanced Institute of Science and Technology, Republic of Korea
10:30-10:45	Co-hydrothermal liquefaction of LDPE and pinecone biomass over Nickel and Cobalt loaded alumina (O6)	**Im Hack Lee** University of Seoul, Republic of Korea
10:45-11:00	Continuous biohydrogen production by sequential bioaugmentation using exogenous *Clostridium* species during reduction of hydraulic retention time (HRT) (O15)	**Dr. Young-Bo Sim** Yonsei University, Republic of Korea
Green Engineering **Session Chair**		**Venue: Room II**
10:00-10:15	Circular economy as a pathway for greener agricultural production: Results from pilot models in six farming systems in the Vietnamese Mekong Delta (O54)	**Nguyen Minh Tu** Vietnam National University, Vietnam
10:15-10:30	Redox Thermodynamics and Oxygen Vacancy Formation in Calcium based Perovskites for High-Temperature Thermochemical Energy Storage (O67)	**Rahul R. Bhosale** University of Tennessee at Chattanooga, USA
10:30-10:45	Closing the loop in a fast-growing renewable-energy market: Circular-economy adoption and photovoltaic recycling economics in Vietnam (O71)	**Nguyen Huy Manh** Vietnam National University, Vietnam

10:45-11:00	Effect of nitrogen supply on Methylocystis hirsuta growth in high-load reactors (O73)	**Elisa Leonor García-Cruz** University of Valladolid, Spain
11:00-11:30	Coffee Break	
Circular Economy **Session Chair:**		**Venue: Room 118**
11:30-11:50	**Invited speaker** Integrated analytical strategies in the study of contaminants of emerging concern (CECs): from wastewater treatment systems to wastewater-based epidemiology and population risk assessment	**Katarzyna Styszko** AGH University of Krakow, Poland
11:50-12:10	**Invited speaker** Turn Waste to Wealth: Global Possibilities of Valorization of Agricultural Side streams within circular economy	**Hysen Bytyqi** University of Prishtina, Kosovo
12:10-12:25	Bridging the Simulation-Reality Gap in Biogas Biorefineries: A Pilot-Scale Life Cycle Assessment (O36)	**Stanley Zheng** Feng Chia University, Taiwan
12:25-12:40	Recombinant Production and In Vitro Bioactivity of the Peptide in *Escherichia coli* (O45)	**Yi-Ru Wu** Da-Yet University, Taiwan
Circular Economy **Session Chair:**		**Venue: Room II**
11:30-11:50	**Invited speaker** Recyclable CO_2-Derived Carbamate Ionic Liquids as Tunable Green Solvents for Microalgal Biomass Extraction toward SAF Biorefineries	**Prof. John Chi-Wei Lan** Yuan Ze University, Taiwan
11:50-12:10	**Invited speaker** Biodegradation of gas-phase styrene using fungal and bacterial cultures in different bioreactor configurations	**Prof. Eldon R. Rene** IHE Delft Institute for Water Education, The Netherlands
12:10-12:25	Effect of HZSM-5 Catalysis on BTX Formation during Co-Pyrolysis of Biomass and Plastic (O11)	**Sejin Hwang** University of Seoul, Republic of Korea
12:25-12:40	Enhanced Semi-Dry Anaerobic Digestion of Dewatered Sludge by Thermal Pretreatment (O22)	**Dr. Gi-Beom Kim** Yonsei University, Republic of Korea
12:40-13:20	Lunch (Poster Session)	
Circular Economy **Session Chair:**		**Venue: Room 118**
13:20-13:35	Effects of Increasing Solubilized PLA Loading on Process Performance and Microbial Dynamics during Mesophilic Co-Digestion with Food Waste Leachate (O18)	**Danniswara Andreas** Yonsei University, Republic of Korea

13:35-13:50	Rainwater-for-drinking as a clean decentralised water technology: governance architecture of the Rain School Network in the Mekong subregion (O27)	**Dr. Nguyen Duc Canh** Vietnam National University Ho Chi Minh City, Vietnam
13:50-14:05	Deep Eutectic Solvent-Assisted Anaerobic Digestion of Paddy Straw: Enhanced Biomethane Production with Integrated Techno-economic Analysis and Life Cycle Assessment (O52)	**Dr. Anuradha** Sardar Swaran Singh National Institute of Bioenergy, India
14:05-14:20	Food Quality Monitoring through Digital Colorimetric Analysis (O58)	**Prof. Vinod T. P.** CHRIST University, India
14:20-14:35	Economic and Environmental Assessment of Thermoelectric Generators for Industrial Waste Heat Recovery (O59)	**Piotr Górszczak** AGH University of Krakow, Poland
Circular Economy **Session Chair:**		**Venue: Room II**
13:20-13:35	Interactions of hydroxylated polycyclic aromatic hydrocarbons with environmentally aged tire rubber (O60)	**Dominika Uchmanowicz** AGH University of Krakow, Poland
13:35-13:50	Rational Design of a Spherical Ternary NiCoMn@Ionic Liquid Nanocomposite for Enhanced Electrochemical Vanillin Sensing (O87)	**Prof. Suvardhan Kanchi** CHRIST University, India
13:50-14:05	Comprehensive Assessment of Sewage Sludge Quality, Contaminants and Pathogens for Sustainable Agricultural Application (O89)	**Prof. Kanmani Sellappa** Anna University, India
14:05-14:20	Fe/Ni Co-Doped Carbon Dots from Molasses and Spent Yeast Synergistically Enhance Dark Fermentative Biohydrogen via CD-Mediated Metal Delivery (O90)	**Nantharat Wongfaed** Khon Kaen University, Thailand
14:05-14:20	Phytoremediated Multi-Metal Biochar/Polyaniline Composite for High-Performance Supercapacitor (O57)	**Prof. Sreeja P.B.** CHRIST University, India
14:20-14:35	Multi-functional NiWO4 Microrobots for Water Treatment: Towards Synergistic Visible- Light Photocatalysis and Impedimetric Sensing Platform (O37)	**Arathy B R**, CHRIST University, India
15:00-15:20	Coffee Break	
Taiwan–India–Japan–Thailand Forum on Bioelectrochemical Engineering and Space Sustainability **Session Chair: Prof. Chin-Tsan Wang**		**Venue: Room 118**
15:20-15:25	Opening	**Prof. Chin-Tsan Wang** National I Lan University, Taiwan
15:25-15:40	Microbial fuel cells in Space: From Fundamental Bioelectrochemistry to Energy and Life-Support Functions	**Dr. Vasumathi K** National I Lan University, Taiwan

15:40-15:55	AI and Digital Twins for Autonomous Energy Systems in Space	**Professor Arun Kumar Sangaiah** National Yunlin University of Science and Technology, Taiwan
15:55-16:10	Possible effect of microgravity and moon soil simulant on plant microbial fuel cell	**Prof. Chairat Treesubsuntorn** King Mongkut's University of Technology Thonburi, Thailand
16:30-16:45	**Closing Ceremony**	**Venue: Room I**

Day 3: Wednesday, September 9 2026

Green Technologies - AGH University and Ekoinwentyka

Biofilter systems – Site visit

Poster Session

No.	Topic	Authors
1	Influence of Biochar bed Temperature and Steam Injection on Ammonia Production from Sewage Sludge Gasification (P12)	Bo Sung Kang, Jeong Hyeon Park, Young-Kwon Park*
2	Solar-driven electrochemical advanced oxidation process using photocathode and mechanism analysis using isotope (P14)	Juwon Lee, Hyoung-il Kim*
3	Enhancement of continuous bio-H_2 production by magnetite addition in a dynamic membrane bioreactor (P16)	Hwan-Hong Joo, Young-Bo Sim, Do-yeon Kim, Hee-won Cho, Sang-Hyoun Kim*
4	Integrated Acidogenic Fermentation and Vivianite Crystallization for Concurrent Phosphorus and Organic Acid Recovery (P17)	Doyoung Kweon, Sang-Hyoun Kim*
5	Effect of starch concentration and operating temperature on batch biohydrogen production (P19)	Sujin An, Hwan-Hong Joo, Nahyun Kwon, Sang-Hyoun Kim*
6	Electro-Fermentation Coupled Dynamic Membrane Bioreactor: Voltage-Dependent Shifts in Metabolic Flux and Hydrogen Yield (P23)	Eunseo Cho, Eunjin Kim, Yerim Lee, Jiho Jeon, Junseo Song, Ju-Hyeong Jung*
7	Enhanced Methane production through DES- Thermal Pretreatment of *Sargassum horneri* (P24)	Yerim Lee, Eunjin Kim, Eunseo Cho, Jiho Jeon, Junseo Song, Ju-Hyeong Jung*
8	Enhanced Dark Fermentative Biohydrogen Production through Granular Activated Carbon Addition and Bioaugmentation (P25)	Eunjin Kim, Yerim Lee, Eunseo Cho, Jiho Jeon, Junseo Song, Ju-Hyeong Jung*
9	From seaweed to sustainable bioplastics: A microbial biorefinery approach (P28)	Shashi Kant Bhatia*, Yung-Hun Yang
10	A facile strategy for constructing porous N-doped carbon nanosheets integrated with Co/CoO nanoparticles to promote efficient activation of peroxymonosulfate (P29)	Jinglin Wen, Hyoung-il Kim*
11	Optimal Design of a Passive Fluid Oscillating Mixer in a Recirculating Microbial Fuel Cell (P30)	Wei-Hsin Kao, Chin-Tsan Wang*
12	Effect of surfactant pretreatment for diesel pollutant remediation in a floating PVB-TiO_2 microbial fuel cell (P31)	Chyi-How Lay*, Ya-Yun Tsai, Yu-An Weng
13	Optimizing cultivation conditions for a novel enrichment method for marine biosurfactant consortium producers (P32)	Chyi-How Lay*, Bedeny E. Wahby, Chin-Chao Chen, Chiu-Yue Lin, Fatin Nurliyana Asrin, Peer Mohamed Abdul
14	A Stepwise Deployment Framework for Industrial Effluent Resource Recovery (P35)	Chin-Chao Chen*, Idowu Afeez, Chyi-How Lay, Chiu-Yue Lin
15	Rapid SOC Estimation for the Sorting and Reuse of Used Primary Zinc–Carbon Batteries Using Short-Duration Feature Fusion and Random Forest Regression (P37)	Shih-Hsien Hsu*, Jhih-Siang Wang

No.	Topic	Authors
16	Integrating Grey Relational Analysis and Machine Learning Algorithms for Predicting Anaerobic Hydrogen Production Rates (P38)	Hsi-Min Chen*, Hoang-Thanh Duong, Chyi-How Lay, Chiu-Yue Lin
17	Using social return on investment to evaluate the impact of a green synergy ecofarm in a social enterprise (P39)	Chyi-How Lay, Yu Chen Wu*, Ying Ju Chen, Tzu Yun Chan
18	An Interdisciplinary Smart Campus Platform for Integrated Energy–Carbon–Finance–Governance Management toward Net-Zero Transformation (P40)	Hui-Tzu Lee, Shu-Hsien Lin, Chun-Wei Huang*, Yu-Wei Chang, Chien-Wei Chen, Yi-Ling Shi, Yi-Xuan Lin, Pei-Yu Huang
19	Development of Antibacterial Biochar Modified with Metal-Based Compounds (P41)	Tsai Tung Huang, Hoang Jyh Leu*
20	Development of Composite Biochar by Recycle PET and Spent Coffee Grounds (P42)	Dang Hoang Nam, Hoang Jyh Leu
21	Direct seawater electrolysis by bamboo biochar modified electrode for green hydrogen production (P43)	Nguyen Ly Anh Thy, Hoang Jyh Leu*
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Abstract book

Keynote speakers

Keynote I:

From Agricultural and Food Waste to Clean Hydrogen Energy: An Integrated Biorefinery Pathway for the Circular Bioeconomy

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Abstract
Sustainable hydrogen production from biomass remains constrained by lignocellulosic recalcitrance, poor catalyst reusability, and the gap between laboratory promise and pilot-scale reality. This keynote presents an integrated research programme at Khon Kaen University that addresses these constraints through four complementary strategies for converting abundant Thai agricultural and food-waste streams into clean hydrogen and value-added bioproducts. First, a dual-matrix immobilization system combining sodium alginate with activated carbon was developed for the cellulolytic consortium KKU-MC1 and applied to untreated Napier grass and oil palm frond, achieving a maximum yield of 119.9 ± 10.5 mL-H_2/g-VS and retaining 83.8 % of initial performance over four reuse cycles — without any energy-intensive pretreatment. Second, sugarcane bagasse and leaves were upcycled into iron- and nickel-modified biochars that act as both trace-nutrient source and electron-transfer mediator, selectively enriching *Clostridium sensu stricto* 1 and *Paraclostridium* sp. to deliver 108.77 mL-H_2/g-glucose, a 58.8 % gain over control. Third, these lab-scale advances were translated to a 4.4 m^3 pilot-scale two-stage anaerobic digester producing biohythane from hydrothermally pretreated Napier grass and *Chlorella* microalgae, delivering 473.5 L-biogas/m^3·d (54.2 % CH_4, 2.9 % H_2) over 98 days of operation. Finally, an anaerobic-membrane bioreactor coupled with *Candida tropicalis* cultivation co-produced hydrogen, volatile fatty acids, and microbial oil from food waste, with 94.2 % VFA utilization on the recovered permeate. Together, these results outline a coherent pathway in which pollution prevention, clean fuel production, and the circular bioeconomy converge.

Keynote II:

Influence of animal feed composition on methanogenic biogas potential of anaerobic swine manure treatment: an amazon periphery case study

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Abstract:
Anaerobic treatment is the low maintenance technology most used by small farmers worldwide to simultaneously provide sanitation and bioenergy production. Especially for swine manure release, the anaerobic digestion process reduces more than one third of greenhouse gas emissions, i.e., biodigester represents an instrument for low carbon livestock development. In this context, volatile solids (VS) content of the residue is especially crucial to determine efficiency and biogas yield of its treatment. This study assessed the swine feed composition influence on swine manure methanogenic potential comparing the supplementation of two amazon periphery typical ingredients: (i) Mango pulp (Mangifera indica) and (ii) Babaçu meal (Attalea speciosa). Mango pulp addition resulted in 24.6% of VS (82.1±2.5 g/L) on swine manure, meanwhile 83.5% of VS (309.5±20.9 gVS/L) was observed on swine manure after animal feeding composed with Babaçu meal. Probably, lignocellulosic composition of Babaçu fiber is resilient to swine digestion, consequently converting to residues with higher organic matter content. Additionally, swine manure obtained after Mango and Babaçu meal was fed into 20 m³ full-scales biodigesters operated with 30 days of hydraulic retention time and presented 50% and 86% of CH4 composition on biogas, respectively. It is important to notice that literature review reported volatile matter percentages between 50-60% for swine manure, with 60-70% of methanogenic percentage on biogas. Thus, Babaçu portion used on animal feed composition resulted in significantly higher volatile matter percentage and ensured disruptive methanogenic potential on swine manure biodigestion processes located in Amazon periphery.

Keywords: Biogas; Methanogenic potential; Low carbon livestock; Babaçu; Circular economy.

Keynote III:

Sustainable Polymers for Commodity, Engineering and Medical Applications

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Abstract:
This presentation highlights the use of available bio-resources for value added sustainable polymeric products for food packaging applications. Biopolymers can be extracted from renewable feedstock such as plants, marine animals, insects, etc. It is noteworthy to mention that so far biopolymers extracted from these sources have limited applications in large scale plastic production. Among the available bio-based plastics, polylactic acid (PLA), poly (caprolactone), Polyhydroxyalkanoates, have made its own place due to its biodegradability and have a potential to replace some of the conventional fossil based plastics. It is noteworthy to mention that properties such as melting point, stiffness, heat stability temperature and gas barrier properties limit its use in high temperature commodity and engineering applications. In relation with PLA, such limitations can be overcome by developing new class of high molecular weight stereocomplex PLA (sc-PLA). In this context, sc/sb-PLA and its sc/sb-PLA-bionanocomposites by using different biobased nanofillers which includes cellulose nanocrystals, silk nanocrystals, modified chitosan, etc. The formation of stereocomplex crystallites is confirmed by the XRD analysis. The melting point of the composite is increased even higher than 225°C which suggests the formation of stereocomplex crystallites and the Heat Deflection temperature is enhanced upto ~140°C at optimum bionanofiller loading. Due to the presence of various bionanofillers, ultimate tensile strength is enhanced significantly. Based on the studies, it is concluded that bionanofillers are good candidates for enhancing the stereocomplexation in the PLA. In this talk, fabrication strategies for synthesis of stereocomplex-PLA-bionanocomposites and evaluation of their properties along with possible applications will be discussed. This talk will also focus on fabrication of bionano-fillers, edible food packaging, processing of bionanocomposites caste films, injection molded products and 3D printing for biomedical and also its uses in energy applications. This presentation will also be focused towards utilization of other bio-based plastics and their formulations in the area of agriculture, food packaging. Further, translational research at IIT Guwahati on sustainable Plastics based packaging products will also be highlighted during the presentation.

Keywords: Bioplastics; Polymer processing, Composting, large-scale production of bioplastics.

Keynote IV:

Microplastic Pollution Mitigation in Sewage Sludge via Hydrothermal Carbonization

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Abstract:
The fate and transformation of microplastics (MPs) during hydrothermal carbonization (HTC) require more systematic investigation before the HTC process can be recommended as a sustainable strategy for microplastic mitigation in sewage sludge. In this study, MPs were isolated from raw sewage sludge and from hydrochars, a solid product produced under various HTC operating conditions, using a specifically dedicated extraction protocol. The isolated particles were subsequently characterized by multiple analytical techniques, including optical microscopy, Fourier-transform infrared (FTIR) spectroscopy, and Raman microspectroscopy, and laser direct infrared imaging (LDIR). HTC induced extensive fragmentation and pronounced morphological modifications of MPs, manifested by particle darkening, severe surface degradation, and partial carbonization. Raman spectra of untreated MPs generally preserved discernible polymer-specific fingerprint regions, permitting their attribution to weathered polymer-derived materials. By contrast, MPs recovered from hydrochar display markedly altered spectral features, including elevated fluorescence backgrounds, broadened Raman bands, attenuation or loss of characteristic fingerprint regions, and increasingly aromatic or carbon-rich spectral profiles. These findings indicate that HTC can substantially transform and reduce MPs in sewage sludge, suggesting it is a sustainable sewage sludge management strategy that being in line with the concept of circular economy.

Keywords: microplastics; sewage sludge; hydrothermal carbonization; sustainable sewage sludge management; circular economy.

Invited speakers

Invited I:

Turn Waste to Wealth: Global Possibilities of Valorization of Agricultural Side Streams within a Circular economy

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Abstract:
Agriculture production throughout the globe leads to generation of substantial quantities of biomass surpluses and side streams in the phases of growth, harvest, separation, storage, processing, and agriculture operations. Despite being rich in biological and nutritional qualities, these side streams are often left behind in farms, disposed off, underutilized in ways that have little or no value due to low quality, mechanical damage, unevenness in size, pest attacks and diseases, methods of harvest, and market values among others. Poor management of agricultural side streams may lead to pollution, generation of greenhouse gases, nutrient loss, and inefficiency in the use of land, water and other inputs in the production process. On the contrary, agricultural side streams provide possibilities to move from traditional waste management practices to pollution prevention and circular production. The international prospect of the utilization of agricultural side-streams to biological resources via the approach of a circular economy requires a comprehensive and multidisciplinary perspective. In addition, this abstract examines the technical, economic, environmental, food/feed safety, regulatory, and market barriers that exist to large scale side-stream application at the moment. Among others, life-cycle thinking, resource efficiency, industrial symbiosis, digitalization, and better integration between primary producers, processors, technology providers, research community, policy makers, and consumers are the critical components of biological and material loop closure. Therefore, switching from waste management to side-stream utilization may imply some implications concerning pollution prevention, cleaner production, reduced reliance on resources, climate change adaptation, and finally efficient resource-based food and agricultural systems across the globe.

Keywords: Agricultural productions; side-stream management; biological resources; pollution prevention; circular production.

Invited II:

Advanced biorefineries and techno-economic-assessments

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Abstract:
Biorefineries offer a sustainable platform for converting renewable feedstocks—including plant biomass, agricultural residues, organic waste, and algae—into value-added products to replace fossil-based alternatives. Among the most promising conversion technologies are two-stage anaerobic digestion, two-stage fermentation, and syngas fermentation, owing to their environmental benefits and economic potential. These processes can produce biohydrogen, biomethane, bioethanol, biobutanol, polyhydroxyalkanoates (PHAs), and volatile fatty acids (VFAs), depending on the microbial strain used. However, syngas fermentation with purple bacteria warrants particular discussion. It can also be classified as bioenergy with carbon capture and storage (BECCS), a widely recognized critical carbon-negative technology within the broader framework of carbon capture, utilization, and storage (CCUS) processes for achieving global climate targets. The primary focus of the BECCS system is to integrate a gasification process with appropriate microbial pathways to convert this greenhouse gas into high-value bioproducts. In this regard, purple photosynthetic bacteria (PPBs) are attractive for their metabolic versatility, which enables both efficient CO_2 fixation and the production of a wide range of high-value chemicals. Accordingly, this study evaluated alternative biorefinery pathways using lab-scale results to show scaling-up scenarios that produce bioproducts from varied carbon sources and presented a techno-economic evaluation. Finally, a comparative evaluation, key process bottlenecks, and prospects for sustainable implementation were discussed comprehensively.

Keywords: Biorefineries, purple bacteria, biopolymer; biofuels, process simulation, techno-economic assessment

Invited III:

Synergetic Enhancement of Photo-fermentative Biohydrogen Production by *Rhodobacter sphaeroides* KKU-PS1 by Application of Hydrothermally Synthesized Carbon Dots

Ming Foong Tiang[1], Ee Jo Tan[1], Abdullah Amru Indera Luthfi[1,2], Wan Nor Roslam Wan Ishak[1,2], Mohd Shaiful Sajab[1,2], Alissara Reungsang[3], Peer Mohamed Abdul[1,2,*]

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Abstract:
Previous studies reported that heavy-metal-doped quantum dots show photonic enhancements in biohydrogen (bio-H_2) production by efficiently increasing the light conversion efficiency (LCE) of photosynthetic purple non-sulphur bacteria for bio-H_2 production via photo-fermentation. However, the risks of heavy metal leaching and uneconomic at scale have become the drawbacks of large-scale application of heavy-metal-doped quantum dots. Hence, green carbon dots (CDs) with similar photoluminescence properties were synthesized and further applied to the photo-fermentation system in this study. CDs were synthesized from citric acid and urea with the addition of ethanol and dimethylformamide as solvents to tune their emissive spectra, from green (g-CDs) to red (r-CDs), respectively, via hydrothermal reaction at 180 °C for 8 hours. During photo-fermentation, photoheterotrophic *Rhodobacter sphaeroides* KKU-PS1 cultivated at 30 °C and 150 rpm under light illumination at 15 klux with the addition of g-CDs and r-CDs was investigated. The experimental results revealed that the application of CDs has augmented photo-fermentative bio-H_2 production without significant effects on biomass accumulation, and LCE by g-CDs and r-CDs was calculated at 171% and 121%, respectively, which were higher than that of the control. Conversely, the cumulative bio-H_2 production with the addition of g-CDs is 473.8±9.2 ml H_2/L culture, which is the highest compared to the control and r-CDs. This is because g-CDs and r-CDs have converted unusable light wavelengths into the green and red-light spectra, respectively, which are absorbable by the accumulated bacteriochlorophylls and carotenoids within *R. sphaeroides* KKU-PS1 to generate more ATP energy for photoheterotrophic growth and photo-fermentative bio-H_2 production.

Keywords: Biohydrogen; carbon dots; *Rhodobacter sphaeroides*; photo-fermentation; photoluminescence
Acknowledgement: We would like to thank the Government of Malaysia and Universiti Kebangsaan Malaysia. We also gratefully acknowledge the financial support from Ministry of Higher Education through Fundamental Research Grant Scheme (FRGS/1/2023/TK08/UKM/02/4).

Invited IV:

Recyclable CO_2-Derived Carbamate Ionic Liquids as Tunable Green Solvents for Microalgal Biomass Extraction toward SAF Biorefineries

Nguyen The Duc Hanh[1], Liang-Chin Chen[1], Adityas Agung Ramandani[2], Kuan Shiong Khoo[2], John Chi-Wei Lan[1*]

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Abstract

Microalgae are promising renewable feedstocks for sustainable aviation fuel (SAF) because of their rapid growth, high areal productivity, and capacity to accumulate lipids. However, downstream recovery remains a major barrier to commercialization, as conventional extraction commonly relies on volatile organic solvents associated with toxicity, energy-intensive recovery, and environmental burdens. This study therefore developed recyclable CO_2-derived carbamate ionic liquids (ILs) as low-volatility, tunable solvents for microalgal biomass processing.

Dry ice was used as a safe and convenient CO_2 source and reacted with three secondary amines—diallylamine (DA), dibutylamine (DB), and dipropylamine (DP)—to generate the corresponding carbamate IL systems. Fourier-transform infrared spectroscopy and nuclear magnetic resonance spectroscopy confirmed carbamate formation. The effects of amine structure and amine-to-CO_2 molar ratio were systematically examined, and the synthesized ILs were subsequently applied to Chlorella biomass extraction. Extract profiles were evaluated by gas chromatography–mass spectrometry (GC–MS).

All three amines successfully formed CO_2-derived carbamate ILs, while molecular structure and reactant stoichiometry markedly affected conversion behavior. The optimal amine-to-CO_2 molar ratios were 2:1 for DA, 1.7:1 for DB, and 2:1 for DP. GC–MS analysis revealed distinct extraction profiles among the IL systems, demonstrating that solvent structure and composition can be tuned to influence the recovery of biomass-associated compounds.

These findings establish a circular solvent platform that integrates CO_2 utilization, ionic-liquid synthesis, and microalgal biomass valorisation. Although further work is required to quantify lipid yield and selectivity, verify solvent recyclability over repeated cycles, and assess process scale-up, CO_2-derived carbamate ILs show promise as greener extraction media for SAF-oriented microalgal biorefineries.

Invited V:

Integrated analytical strategies in the study of contaminants of emerging concern (CECs): from wastewater treatment systems to wastewater-based epidemiology and population risk assessment

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Abstract:
Contaminants of emerging concern (CECs) represent one of the most significant challenges in modern environmental analytical chemistry. Their presence in municipal wastewater, sewage sludge, and receiving waters is associated with ecotoxicological risks, the potential for microbial resistance selection, and population exposure to chronic doses of biologically active compounds. This paper presents an integrated analytical approach encompassing the development and validation of chromatographic-spectrometric methods for determining CECs and their metabolites in complex environmental matrices. The obtained data is utilized to assess the environmental fate of these compounds, the safety of products derived from sludge management, and population exposure. Advanced instrumental techniques, including LC-MS/MS, GC-MS/MS, and GC-ITQ-MS, were applied, enabling selective and sensitive determination of analytes in wastewater, surface waters, sewage sludge, and fertilizers produced from them.

Keywords: Contaminants of emerging concern (CECs); wastewater-based epidemiology; environmental risk assessment; analytical chemistry; chromatographic methods.

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Invited VI:

Gas-phase bioreactors for methane mitigation: A comprehensive review of microbial ecology, conventional bioreactors, and next-generation technologies

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Abstract:
Biological gas-phase reactors are among the most promising technologies for mitigating dilute methane emissions from landfills, coal mines, wastewater treatment plants, livestock facilities, and other industrial sources. However, their broader application remains constrained by poor methane solubility, gas-liquid mass-transfer resistance, slow microbial kinetics, and biofilm related transport limitations. Despite the many advances done in microbial ecology and reactor engineering, a comprehensive assessment that combines both disciplines for next generation gas-phase bio reactors is still lacking. This review provides an integrated assessment of methane-oxidizing microorganisms, biofilm development, factors affecting reactor performance, and more recent developments made in biofilters, bioscrubbers, biotrickling filters, and two-phase partitioning bioreactors. Reported methane removal efficiencies exceeded 90% for biofilters, 35% for bioscrubbers, and 78% for biotrickling filters. In two phase partitioning bioreactors, addition of 10% (v/v) silicone oil increased methane elimination capacity by up to 131% by improving methane transfer. The review further highlights recent advances in novel packing materials, microbial enrichment and bioaugmentation, reactor intensification, and hybrid biological systems, demonstrating that integrating microbial ecology with reactor engineering is key to developing scalable, high-performance methane mitigation technologies for carbon-neutral industries.

Key words: Biological methane oxidation, Next-generation technologies, Methanotrophs, Two-phase partitioning bioreactors, Reactor intensification, Hybrid biological systems

Invited VII:

Ammonia fermentation for enhanced ammonia recovery

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Abstract:
Ammonia (NH_3) is one of the world's most widely produced chemicals, with a current global output exceeding 200 million tons per year. While its dominant use remains in fertilizers, emerging applications—particularly as a carbon-free maritime fuel and hydrogen carrier—are driving renewed interest in sustainable NH_3 production routes. Conventional Haber-Bosch synthesis accounts for most of today's NH_3 output but contributes significantly to global fossil energy consumption and greenhouse gas emissions. To enable low-carbon NH_3 systems, this work investigates NH_3 fermentation (AF) as a biological pathway for generating high-concentration NH_3 directly from protein-rich waste streams. A series of continuous and sequencing batch reactors were operated using gelatin as the nitrogen source to evaluate AF performance, microbial dynamics, and rate-limiting steps. AF achieved unprecedented NH_3 concentrations of 12 to 14 g TAN-N/L, surpassing previously reported inhibition thresholds. However, deamination efficiency declined at high NH_3 loadings, indicating biochemical inhibition and osmotic stress as key bottlenecks. Introducing the compatible solute ectoine mitigated osmotic stress, reshaped the microbial community, and enabled NH_3 accumulation up to 18-19 g TAN-N/L with conversion efficiencies approaching 80- 90%. Energy analyses showed significantly reduced stripping requirements at higher NH_3 concentrations, underscoring the advantage of biological pre-concentration.

Keywords: Ammonia fermentation; High-concentration ammonia; Protein-rich waste; Osmotic stress; Ectoine

Invited VIII:

From Waste to Spatial Systems: Reimagining Architecture through Bio-Based and Geopolymer Materials

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Abstract:
The Architecture, Engineering, and Construction (AEC) industry is a major contributor to global carbon emissions, driven by both embodied carbon from construction materials and operational energy consumed throughout a building's service life. Reducing these impacts requires more than simply replacing conventional materials with lower-carbon alternatives. A more comprehensive strategy is to reconsider how architectural form, material selection, building envelopes, and fabrication processes can work together to reduce carbon across the entire building system.

This invited talk explores an integrated approach to low-carbon architecture through four interconnected directions. First, architectural form and structural geometry can be optimized to reduce unnecessary material consumption while maintaining required performance. In parallel, geopolymer materials provide an alternative to conventional Portland cement-based systems and offer opportunities to further reduce embodied carbon. Together, material-efficient geometry and lower-carbon binders can significantly reduce the environmental burden of structural systems.

Second, reducing operational energy requires improved thermal performance of the building envelope. Mycelium-based materials offer lightweight, bio-based, and thermally insulating characteristics that can contribute to reducing heat gain. Hybrid systems combining mycelium with geopolymer materials may further integrate thermal insulation with structural integrity, durability, and protective performance, creating multifunctional low-carbon envelope systems.

Finally, the talk reconsiders current approaches to digital fabrication. While large-scale additive manufacturing has increasingly focused on direct concrete printing, printing concrete does not inherently guarantee lower material consumption or lower carbon emissions. An alternative approach is to use digital fabrication to produce reusable or removable formwork for casting concrete or geopolymer materials. This strategy enables complex and materially efficient geometries while maintaining the reliability of conventional casting and improving the potential for formwork reuse.

By integrating architectural geometry, geopolymer materials, mycelium-based thermal envelopes, and reusable digitally fabricated formwork, this work proposes a broader framework for decarbonized construction. Rather than focusing solely on creating "greener" materials, the future of low-carbon architecture may depend on simultaneously redesigning the material, form, envelope, and fabrication process as one interconnected system.

Invited IX:

Microplastic contaminated anaerobic digestion effluent in hydroponic green cos lettuce: growth, oxidative stress and the rhizosphere

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Abstract:
Biogas plants generate large volumes of nutrient-rich effluent, and this effluent increasingly carries plastic particles. Reusing it as liquid fertilizer therefore reintroduces those particles into cultivation. Green cos lettuce (*Lactuca sativa* L. var. *longifolia*) was grown hydroponically on diluted anaerobic digestion effluent to establish a usable concentration range. Screening of seeds and seedlings set a ceiling of 4.5% (v/v). Six treatments were subsequently maintained for 31 days: five effluent dilutions between EC 0.7 and 1.8 mS/cm, and a commercial AB mix solution at EC 1.6 mS/cm. Biomass at EC 1.3–1.5 mS/cm was equivalent to that obtained with the commercial solution. Leaf protein content and catalase and ascorbate peroxidase activities were greater than in the commercial treatment. Performance declined at EC 1.8 mS/cm, whereas the commercial control of comparable conductivity was unaffected, indicating a cause other than ionic strength. Electron microscopy of the roots corroborated this interpretation. Tissue remained sound at EC 1.5 mS/cm; at EC 1.8 mS/cm, cell walls were breached and plastic-like particles were detected in the vascular tissue. Microbial and metabolite profiling of the same plants located the transition at an identical concentration. Reuse is feasible within the lower range, provided that particle input is restricted at the digester.

Keywords: Plant growth, stress response, metabolomics, rhizosphere microorganism, microplastics

Invited X:

The assessment of hydrogen production with spark plug system in automobiles

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Abstract:
In this study, an experimental study was performed to investigate the performance of a spark ignition (SI) internal combustion engine using syngas containing hydrogen as auxiliary fuel has been performed in detailed. The syngas containing hydrogen was produced from a spark plug plasma reformer system, which included supersonic atomization devices, spark plugs, and controlling devices. The SI engine is an electronic fuel injection motorcycle engine with 4-stroke air-cooled 125 c.c. cylinder. Syngas containing hydrogen was mixed with unleaded gasoline and delivered into the SI engine for measurements. The SI engine was tested in 4000, 5000, and 6000 rpm with throttle opening of 20%, 30%, 40% and 50%, respectively. Fuel consumption and output torque of the SI engine are measured, as well as the emission. Results show that the torque increases with gasoline mixed with syngas containing hydrogen for 14%, 17.89% and 21.92% with respect to the engine rotational speed of 4000, 5000, and 6000 rpm, respectively. It is also found that the output torque increases and fuel consumption decreases with gasoline mixed with syngas. Besides, the emission of HC and CO decreases with gasoline mixed with syngas containing hydrogen.

Invited XI:

From Stone Weirs to Modern Renewables: Energy, Land, and Community in the Making

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Abstract:
Renewable energy technologies are often presented as technical solutions to climate change and regional development. Yet their social impacts are shaped not only by technological design, but also by how they encounter local histories, land relations, community needs, and existing understandings of energy. This presentation examines how the meanings and social organization of energy evolve as communities move from traditional forms of water and land use toward contemporary renewable energy systems.

Drawing on qualitative fieldwork in rural and Indigenous communities in Taiwan, the presentation focuses on two cases. In Ershui, Changhua County, a proposal for micro-hydropower builds upon long-established irrigation practices and traditional stone-based water infrastructure. The project illustrates how a seemingly modern technology must negotiate existing relationships among water, agriculture, land, and local institutions. In the Taromak Indigenous community in Taitung, the transition from hydropower infrastructure introduced during the Japanese colonial period to community-based solar energy raises questions concerning energy autonomy, collective ownership, Indigenous territory, and local capacity building.

The comparison demonstrates that energy transitions are never merely replacements of one technology by another. From the initial imagination of how energy should be used and who should own its facilities, communities must subsequently confront practical questions of employment, local development, leadership, benefit distribution, interdepartmental coordination, and state implementation mechanisms. Technologies are therefore continually interpreted, negotiated, and reshaped through their encounters with local society.

By tracing the movement from traditional water infrastructure to micro-hydropower and community solar power, this presentation argues that the social impact of technology depends on whether energy projects can connect with locally grounded knowledge, institutional relationships, and development priorities. A socially meaningful energy transition requires not only technological innovation, but also the capacity to recognize communities as active participants in the making of energy futures.

Invited XII:

Biodegradation of gas-phase styrene using fungal and bacterial cultures in different bioreactor configurations

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Abstract:
Styrene is a prevalent Volatile Organic Compound (VOC) found in plastics and rubbers; it is also associated with health hazards such as irritation, vertigo, and neurological problems resulting from brief exposure. The primary sources of styrene emissions include the manufacturing of plastics, fiberglass, coatings, rubber, and related products. For the remediation of VOCs, biofiltration (BF) has been recognized as a versatile gas treatment method capable of effectively managing emissions at high gas flow rates and low VOC concentrations. To enable the utilization of BF in industrial applications, it is crucial to undertake research focused on the removal of individual compounds and VOC mixtures under varying inlet loading conditions. In this presentation, the efficacy of the following laboratory-scale biological filters will be discussed: (i) perlite biofilter inoculated with a mixed culture, (ii) fungal biofilter, and (iii) monolith bioreactor. Furthermore, the utilization of neural networks as a predictive modeling method will be presented, illustrating the relationship among flow rate (FR), pressure drop (PD), inlet concentration (C), and removal efficiency (RE) of a BF treating mixture of VOCs.

Keywords: Volatile organic compounds, biofiltration, styrene, neural networks, performance evaluation, elimination capacity

Oral section

[O01]

Enhanced Aromatic Hydrocarbon Production from Catalytic Pyrolysis of *Ginkgo biloba* Waste over Zeolite Beta catalyst

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Abstract:
The increasing generation of agricultural and forestry residues has intensified the need for efficient thermochemical valorization strategies that convert waste biomass into value-added chemicals. *Ginkgo biloba* waste is a promising biomass resource, although its pyrolysis produces substantial amounts of heavy alkylphenols derived from ginkgolic acid-related structures in the sarcotesta and lignin-derived components in the nutshell. This study investigated the catalytic pyrolysis of *Ginkgo biloba* waste over commercial zeolites and synthesized nano-sized zeolite Beta catalysts to enhance aromatic hydrocarbon production while suppressing heavy alkylphenol formation. Non-catalytic pyrolysis predominantly produced phenolic compounds, with heavy alkylphenols as the major products. Among the commercial catalysts, HZSM-5 achieved the highest BTEX selectivity of 24.8% because of its shape-selective MFI structure. In contrast, commercial HBeta more effectively decomposed bulky alkylphenolic intermediates owing to its large-pore framework. The synthesized nano-sized zeolite Beta catalysts further reduced heavy alkylphenol selectivity to below 1.0%. In particular, SB-7, with a Si/Al ratio of 7, exhibited the highest total aromatic hydrocarbon selectivity of 44.9%. Its superior performance was attributed to the favorable balance among external surface accessibility, well-developed Beta microporosity, and abundant acid sites, which promoted the cracking and dealkylation of bulky intermediates followed by secondary aromatization. Increasing the catalyst-to-feedstock ratio from 0.5:1 to 2:1 further increased total aromatic hydrocarbon selectivity from 31.2% to 48.4% while decreasing heavy alkylphenol selectivity from 16.3% to 0.4%. These findings demonstrate the potential of nano-sized zeolite Beta for converting *Ginkgo biloba* waste into value-added aromatic hydrocarbons.

Keywords: *Ginkgo biloba*; Catalytic pyrolysis, Nano-sized zeolite Beta, Aromatic hydrocarbons, Biomass valorization.

Acknowledgement:
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[O02]

Reductive catalytic fractionation of pinecone biomass over transition metal-modified activated carbon catalysts

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Abstract:
Reductive Catalytic Fractionation (RCF) is an advanced lignin-first biorefinery strategy that enables the efficient valorization of lignin into value-added aromatic chemicals. This approach facilitates the depolymerization of lignin into a monomer-rich lignin oil using a polar protic solvent, an appropriate catalyst, and a hydrogen source under controlled reaction conditions. By selectively cleaving ether linkages (e.g., β–O–4) while preserving the aromatic ring structure, RCF provides a high-yield and selective pathway for lignin valorization, while largely retaining the carbohydrate fraction in the solid residue. Owing to these advantages, RCF has attracted considerable attention as a means of improving the sustainability of lignocellulosic biorefineries. In this study, a series of transition-metal-modified Ru-loaded activated carbon catalysts (Ru/AC), incorporating Ce, Zr, Mo, and Nb promoters, was investigated for the RCF of pinecone biomass. The results demonstrated efficient fractionation of pinecone into a guaiacyl-phenolic monomer-enriched lignin oil. Notably, a high yield of 2-methoxy-4-propylphenol was obtained over the Ru/Ce–AC catalyst, indicating effective hydrogenation of 2-methoxy-4-(1-propenyl) phenol formed during lignin depolymerization. The incorporation of transition-metal promoters introduced additional acidic and/or redox-active sites that play a crucial role in suppressing lignin repolymerization and facilitating hydrogenation pathways, thereby enhancing monomer yield and selectivity. The results indicated a key role for activated carbon modification in the biorefinery.

Keywords: RCF; Pinecone; Ru/AC; Phenol-2-methoxy-4-propyl; Guaiacyl phenol

Acknowledgement:
This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (RS-2024-00341143).

[O03]

Enhanced production of transportation fuel and naphthalene enriched bio-oil through catalytic pyrolysis of pine sawdust: Tuning of the catalyst pore size and pyrolysis medium

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Abstract:
The ever- growing consumption of transportation fuel (i.e., biogasoline, bio- aviation, and biodiesel) and valuable chemicals (i.e., naphthalene) derived from non- renewable resources has raised economic and environmental concerns. This study investigates the production of transportation fuels and naphthalene through catalytic pyrolysis of pine sawdust (PW) using hierarchical zeolite beta catalysts under N_2, CH_4, and CO_2 media. To this aim, alkaline-treated beta zeolites at different concentrations (NaOH: 0. 2, 0. 0.4, and 0. 6 Molar) were fabricated and tested during the catalytic pyrolysis of PW at 500 ° C. Among all catalysts, beta zeolite treated with a 0. 4 molar alkaline agent (4N-Hbeta) significantly enhanced the selectivity of jet fuel range (65. 1%), diesel range hydrocarbons (53. 5%), and naphthalenes (43. 9%). This is attributed to its optimal pore size and acidity of the modified catalyst, which were confirmed by a wide range of catalyst characterization techniques. Furthermore, using different pyrolysis media significantly influenced the proportion of transportation fuels and naphthalenes. However, a series of stability tests conducted over four consecutive cycles using 4 N-Hbeta showed that catalyst stability substantially varies under different pyrolysis media. This is ascribed to notable changes in the catalyst structure, which were evident from examination of spent catalysts under each environment. Overall, this study offers a promising technology for the production of transportation fuel and naphthalene-enriched bio-oil through catalytic pyrolysis of PW. Furthermore, a systematic investigation of catalyst deactivation under different environments makes a substantial contribution to the field of biomass and bioenergy.
Keywords: Transportation fuel, pine sawdust, hierarchical zeolites, catalytic pyrolysis, pyrolysis medium, catalyst deactivation

Acknowledgement:
This work was supported by the Technology Innovation Program (or Industrial Strategic Technology Development Program) (No, RS-2025–10152975, Development of advanced technology for simultaneous conversion of woody biomass and waste plastic mixtures for carbon-circulated BTX production) funded by the Ministry of Trade, Industry and Resources (MOTIR, Korea).

[O04]

Hydrogen production from waste cigarette filters via steam gasification over waste-derived Ni/MFe_2O_4 spinel catalysts synthesized from acid mine sludge effluent

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Abstract:
Cigarette filters (CF) are generated in large quantities worldwide, while current treatment methods face challenges in managing this hazardous waste. This study aimed to produce H_2-enriched gas through catalytic steam gasification of CF using iron-based spinel-type oxide-supported Ni catalysts synthesized from iron extracted from hazardous acid mine sludge. Nickel-loaded spinel supported catalyst, with the general formula Ni/MFe_2O_4 (M = Co, Mg, Zn, and Mn), were evaluated in the steam gasification of CF. All catalysts outperformed commercial Ni/Al_2O_3, with Ni/$MnFe_2O_4$ showing the highest gas yield, H_2 concentration, and lowest coke formation (93.9 wt%, 53.0 vol%, and 0.1 wt%, respectively). This superior performance was attributed to well-dispersed metallic Ni sites and the synergistic redox properties of Mn and Fe, which enhanced reforming and water-gas shift reactions. Reducing the catalyst/feedstock ratio from 1/10 to 1/20 slightly decreased gas yield and H_2 concentration. Notably, Ni/$MnFe_2O_4$ maintained satisfactory performance over three consecutive cycles without regeneration, with gas yield and H_2 concentration decreasing to 83.9 wt% and 47.2 vol%, respectively. Additionally, catalytic steam gasification of waste cigarette filters (WCF) achieved a gas yield of 91.7 wt% and an H_2 concentration of 51.1 vol%, demonstrating the potential of this technology. Overall, this study presents a feasible approach for converting hazardous waste into valuable H_2-enriched gas while addressing environmental concerns.

Keywords: Steam *gasification; Acid mine sludge; Spinel catalysts; Cigarette Butts.*

Acknowledgement:
This work was supported by the Technology Innovation Program (or Industrial Strategic Technology Development Program) (No, RS-2025–10152975, Development of advanced technology for simultaneous conversion of woody biomass and waste plastic mixtures for carbon-circulated BTX production) funded by the Ministry of Trade, Industry and Resources (MOTIR, Korea).

[O05]

Steam Gasification of Waste Coffee-Mix Packaging over a Red-Mud-Derived $Ni/AlFe_2O_4$ Catalyst

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Abstract:
Multilayer packaging for coffee-mix is challenging to mechanically recycle due to the presence of a mixture of polymers and metals. This study aimed to consider steam gasification as a thermochemical process to produce hydrogen-rich gas from waste coffee-mix packaging. $AlFe_2O_4$ prepared from alumina industry by-product, red mud, was used to prepare $Ni/AlFe_2O_4$ catalyst and catalytic performance of the prepared $Ni/AlFe_2O_4$ catalyst was compared with commercial Ni/Al_2O_3 catalyst and synthesized Ni/Al_2O_3 catalyst, bare $AlFe_2O_4$, and non-catalytic condition.

Steam gasification experiments were carried out in a fixed-bed reactor, and product yields and gas composition of the products were analyzed. The $Ni/AlFe_2O_4$ catalyst showed the highest gas yield, between 47–48 wt% and the lowest yield of condensable tar (30 wt%). It also yielded the highest H_2 concentration (about 47 vol %), lower concentrations of CH_4 and C2–C4 hydrocarbons than the other catalysts. Based on these results, it can be inferred that the $Ni/AlFe_2O_4$ catalyst is effective in cracking and steam reforming the condensable hydrocarbons and light hydrocarbon intermediates, respectively.

The gasification performance of $Ni/AlFe_2O_4$ catalyst is better, although its specific surface area is smaller than that of Ni/Al_2O_3 catalysts. This increased activity could be due to the large pore size of the $AlFe_2O_4$ support, which allowed diffusion and reaction of bulky tar molecules, and perhaps some interaction between Ni and Fe-containing species. However, when the Ni support was replaced with $AlFe_2O_4$, gas production was increased with respect to the non-catalytic case, but the activity for hydrogen production was found to be low, which was ascribed to the catalytic activity of Ni active sites.

The results indicate that the $Ni/AlFe_2O_4$ catalyst fabricated by red-mud is a promising catalyst for production of hydrogen-rich gas from multilayer plastic packaging which is difficult to recycle. The proposed method allows avoiding waste plastic valorization and beneficially utilization of the red mud as a catalyst precursor.

Keywords: Steam gasification, Coffee-mix packaging waste, $Ni/AlFe_2O_4$ catalyst, Hydrogen-rich syngas, Red mud

Acknowledgment:
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[O06]

Co-hydrothermal liquefaction of LDPE and pinecone biomass over Nickel and Cobalt loaded alumina

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Abstract:
The Co-hydrothermal liquefaction (co-HTL) of polyolefins and lignocellulosic biomass offers a promising route for the production of a high-quality oil yield. Herein, we studied the co-HTL liquefaction potential of pinecone (PC) and low-density polyethylene (LD) biomass in a high-pressure batch reactor, which provide a sustainable solution of forestry biomass and most abundant plastic waste. The effect of different blending was systematically evaluated at 320 °C/ 0.5h using methanol solvent under atmospheric N_2. The results revealed a 20% synergy in oil yield production for PC-LD (1:2) ratio for non-catalytic condition. Furthermore, the effect of 10 wt%, Ni and Co loaded γ-Al_2O_3 catalysts were also systematically examined using for two preparation methods; wetness and urea assisted impregnation. The urea assisted impregnation showed a superior performance toward the liquefaction compared to wetness method, enhancing the oil yield significantly (10.2 wt%) over 10Co/Al-UR.

Keywords: Co-HTL; Pinecone; LDPE; Ni/Alumina; Co/Alumina

Acknowledgement:
This work was supported by the National Research Foundation of Korea(NRF) grant funded by the Korea government(MSIT) (RS-2025-23902969).

[O07]

Catalytic Pyrolysis of Waste Plastics over Zeolite Catalysts for the Production of Light Olefins

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Abstract:

The continuous generation and accumulation of waste plastics cause environmental pollution and inefficient use of carbon resources. Polyolefin-based plastics, such as polyethylene and polypropylene, contain high levels of carbon and hydrogen and can therefore serve as alternative feedstocks for producing value-added hydrocarbons. This study investigated the production of light olefins, including ethylene, propylene, and butene, through waste plastic pyrolysis followed by zeolite-catalyzed upgrading. Dried and ground waste plastics were characterized by FT-IR, proximate analysis, ultimate analysis, and thermogravimetric analysis.

Zeolite catalysts with different Si/Al ratios, acidities, pore structures, and modification conditions were evaluated. Their physicochemical properties were analyzed using XRD, nitrogen adsorption–desorption, NH_3-TPD, SEM, and TGA. Catalytic pyrolysis was performed in a fixed-bed reactor under nitrogen, while reaction temperature and catalyst-to-feedstock ratio were varied. Gaseous products were analyzed by GC-TCD and GC-FID, and liquid products and coke were also quantified.

During pyrolysis, zeolite catalysts enhanced light olefin production by promoting the secondary cracking of long-chain hydrocarbons and wax-like intermediates. Light olefin selectivity increased with increasing reaction temperature and catalyst-to-feedstock ratio owing to enhanced cracking activity, a greater number of available acid sites, and improved contact between the pyrolysis vapors and the catalyst. However, excessive catalyst acidity or loading may promote undesirable secondary reactions, including hydrogen transfer, aromatization, and coke formation. Overall, zeolite-catalyzed pyrolysis is a promising approach for converting waste plastics into value-added light olefins, thereby contributing to sustainable chemical recycling and a circular carbon economy.

Keywords: Waste plastics; Catalytic pyrolysis; Zeolite catalysts; Light olefins; Chemical recycling

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[O08]

Enhanced Hydrogen Production via Catalytic Steam Gasification of Waste Plastic Pyrolysis-Derived Wax over $Ni/La_xZr_{1-x}O_2$ Catalysts

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Abstract:
Catalytic steam gasification of waste plastic pyrolysis-derived wax offers a promising route for sustainable hydrogen production. In this study, Ni-loaded La-Zr composite oxide catalysts ($Ni/La_xZr_{1-x}O_2$, x = 0.2, 0.5, and 0.8) were synthesized and evaluated for hydrogen-rich gas production, with Ni/La_2O_3, Ni/ZrO_2, and conventional Ni/Al_2O_3 used for comparison. Among the catalysts, $Ni/La_{0.5}Zr_{0.5}O_2$ exhibited the best performance, achieving a gas yield of 91.9 wt% and H_2 selectivity of 56.4 vol%, outperforming the conventional Ni/Al_2O_3 catalyst. Moreover, coke deposition was significantly suppressed over $Ni/La_{0.5}Zr_{0.5}O_2$, resulting in excellent catalytic stability during prolonged operation. The superior activity was attributed to highly dispersed Ni particles and the enhanced redox properties of the La-Zr mixed oxide support, which facilitated tar cracking, steam and dry methane reforming, and the water-gas shift reaction. These results demonstrate that $Ni/La_{0.5}Zr_{0.5}O_2$ is a highly effective catalyst for converting waste plastic-derived wax into hydrogen-rich gas, providing a promising approach for simultaneous plastic waste valorization and clean hydrogen production.

Keywords: Thermocatalytic conversion; Hydrogen generation; Plastic pyrolysis wax; Composite catalysts; Waste to energy.

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[O09]

Upcycling Alkali Lignin to Monomeric Phenols over Red Mud-derived Catalysts

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Abstract:
Lignin, a major byproduct of biorefinery processes, represents a promising renewable resource for producing phenolic compounds, offering a sustainable alternative to petrochemical-derived chemicals. This study investigated the effects of transition-metal-loaded industrial-waste red mud (RM)-derived catalysts (Co/RM, Cu/RM, and Ni/RM) on the hydrothermal liquefaction of alkali lignin. The results revealed effective lignin breakdown using the Co/RM catalyst, yielding the highest bio-oil production (20.7 wt.%) at 250 °C for 15 min. The maximum conversion (40.3%) was achieved with the Cu/RM catalyst, yielding a high gas yield (26.6 wt.%). GC-MS analysis revealed that catalyst use promoted demethoxylation, as evidenced by a significant decrease in selectivity for methoxy phenols. The high HHV (31.8 MJ kg^{-1}) of the catalytic bio-oil (Co/RM-250) indicates lignin upgradation into a high-calorific bio-oil. The utilization of byproduct char (Co-RM-250) for the adsorption of pharmaceutical pollutants, such as tetracycline, was also examined, which showed a maximum adsorption of 23% without any further pretreatment of the Co/RM-immobilized char.

Keyword: Hydrothermal liquefaction (HTL); Red-mud (RM); Alkali lignin; 2-Methoxy-phenol

Acknowledgement:
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[O10]

Aromatic hydrocarbon production from printer-derived e-waste via catalytic pyrolysis

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Abstract:
Printer-derived electronic waste has become an increasingly important environmental issue owing to the widespread use of laser printing devices and the limited recycling options for toner-containing materials. Rich in polymeric organic components, this waste offers significant potential as a carbon-rich feedstock for producing value-added chemicals through thermochemical conversion. Among various catalysts, HZSM-5 is widely employed for aromatic hydrocarbon production because of its strong Brønsted acidity and shape-selective microporous structure. However, its narrow micropores restrict the diffusion of bulky pyrolysis intermediates, leading to inefficient utilization of active sites and severe coke deposition. Introducing mesoporosity into the zeolite framework can overcome these mass-transfer limitations while preserving the intrinsic catalytic properties of HZSM-5. In this study, the catalytic pyrolysis of printer-derived electronic waste was investigated using hierarchical HZSM-5 catalysts for the selective production of benzene, toluene, ethylbenzene, and xylene (BTEX). The feedstock, mainly composed of styrene-acrylate resin, exhibited high volatile matter and carbon contents, indicating excellent suitability for catalytic upgrading. Hierarchical HZSM-5 catalysts exhibited superior BTEX production compared with the parent HZSM-5 by facilitating the diffusion of bulky intermediates, improving accessibility to acidic active sites. The best-performing hierarchical catalyst was subsequently evaluated under CO_2, and CH_4 atmospheres to examine the influence of gaseous environments on catalytic performance. CO_2 effectively improved catalyst stability by reducing carbon deposition, whereas CH_4 enhanced alkylbenzene formation, increasing selectivity toward toluene and xylenes. These findings demonstrate that hierarchical HZSM-5 combined with appropriate reaction atmospheres provides an effective strategy for upgrading printer-derived electronic waste into valuable aromatic hydrocarbons.

Keywords: Printer-derived electronic waste, Hierarchical HZSM-5, Catalytic pyrolysis, Aromatic hydrocarbons, Reaction atmosphere

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[O11]

Effect of HZSM-5 Catalysis on BTX Formation during Co-Pyrolysis of Biomass and Plastic

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Abstract:
The depletion of fossil resources and increasing environmental concerns have intensified interest in biomass as a renewable carbon source for the production of fuels and value-added chemicals. However, bio-oil obtained from biomass pyrolysis typically contains a high proportion of oxygenated compounds, resulting in low heating value, poor chemical stability, and limited applicability. Catalytic co-pyrolysis of biomass and plastic has been proposed as an effective strategy to overcome these limitations. Because plastics possess a relatively high hydrogen-to-carbon ratio, they can act as hydrogen-rich co-feeds and facilitate the conversion of biomass-derived oxygenates into hydrocarbons. In this study, the formation of benzene, toluene, and xylenes (BTX) during the catalytic co-pyrolysis of biomass and plastic was investigated using HZSM-5. The acidic and shape-selective properties of HZSM-5 promoted cracking, deoxygenation, and aromatization reactions, thereby enhancing the formation of aromatic hydrocarbons. In addition, interactions between biomass- and plastic-derived intermediates produced a synergistic effect during co-pyrolysis. The resulting product distribution differed from the calculated additive values based on the individual pyrolysis of each feedstock, with increased formation of aromatic compounds, including BTX. These results indicate that HZSM-5-catalyzed co-pyrolysis is an effective approach for upgrading mixed biomass and plastic feedstocks into high-value aromatic chemicals.

Keywords: Catalytic co-pyrolysis, Biomass–plastic synergy, BTX, HZSM-5, Aromatic hydrocarbons

Acknowledgement:
This work was supported by the Technology Innovation Program (or Industrial Strategic Technology Development Program) (No, RS-2025–10152975, Development of advanced technology for simultaneous conversion of woody biomass and waste plastic mixtures for carbon-circulated BTX production) funded by the Ministry of Trade, Industry and Resources (MOTIR, Korea).

[O15]

Continuous biohydrogen production by sequential bioaugmentation using exogenous *Clostridium* species during reduction of hydraulic retention time (HRT)

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Abstract:
This study investigated continuous biohydrogen production from glucose using a dynamic membrane bioreactor (DMBR) under stepwise hydraulic retention time (HRT) reduction from 2.0 to 1.5 h with sequential bioaugmentation of *Clostridium pasteurianum*. The DMBR maintained stable biohydrogen production at HRTs of 2.0 and 1.8 h, achieving hydrogen production rates (HPRs) of 61.29 ± 2.71 and 70.42 ± 1.98 L H_2/L-d, respectively, with comparable hydrogen yields (HYs) of 2.05 ± 0.09 and 2.12 ± 0.06 mol H_2/mol $hexose_{added}$. However, further reduction of the HRT to 1.5 h significantly deteriorated hydrogen production performance, decreasing the HPR and HY to 56.37 ± 2.17 L H_2/L-d and 1.42 ± 0.05 mol H_2/mol $hexose_{added}$, respectively. This deterioration occurred despite the highest volatile suspended solids (VSS) concentration and solid retention time (SRT), indicating that biomass retention alone was insufficient to sustain efficient biohydrogen production. Granule size distribution shifted toward larger granules, accompanied by a transition from polysaccharide-rich to protein-rich extracellular polymeric substances (EPS). Stoichiometric metabolic flux analysis revealed increased homoacetogenic flux at HRT 1.5 h, while microbial community analysis showed enrichment of *Selenomonas bovis* and a marked decrease in the relative abundance of *Clostridium pasteurianum*. These findings demonstrate that hydrogen production stability under intensified short-HRT operation depends not only on biomass retention but also on maintaining favorable granule structure, EPS characteristics, and microbial metabolic pathways.

Keywords: Bio-H_2; Dynamic membrane bioreactor (DMBR); Hydraulic retention time (HRT); Bioaugmentation; *Clostridium pasteurianum*

[O18]

Effects of Increasing Solubilized PLA Loading on Process Performance and Microbial Dynamics during Mesophilic Co-Digestion with Food Waste Leachate

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Abstract:
Detection of polylactic acid-based bioplastics in municipal food waste is increasing, yet how much of it an anaerobic digestion (AD) system can tolerate without process failure remains poorly defined. This study evaluated the effect of increasing solubilized polylactic acid (sPLA) loading on process performance and microbial dynamics during mesophilic co-digestion with food waste leachate (FWL). Four duplicate mesophilic reactors co-digested FWL (52 g COD/L) with sPLA at 0, 10, 20, and 30 g COD/L (Reactors A-D), semi-continuously fed at an HRT of 30 d; substrate stocks were pH-buffered to 5–5.5 to limit feed acidification. CH_4 yield was unaffected by sPLA dose (218.5 ± 3.9 mL CH_4/g COD_{added} across reactors), while production rate rose with loading (0.37 ± 0.1 to 0.58 ± 0.0 L/L/d, A to D), reflecting higher substrate input, not improved conversion efficiency. Loading caused temporary stress: propionate, the main VFA, rose from 0.55 ± 0.0 g/L in A to 4.1 ± 0.3 g/L in D (7.5-fold), while the lowest pH reached in each reactor ranged from 7.3 ± 0.0 (A) to 7.1 ± 0.0 (D). pH recovered to 7.5 within 5 d in A versus 12 d in D, and VFA reduced within 4–17 d, with no further accumulation over the 90-day run. No lactic acid accumulated. Mesophilic FWL digesters can accommodate sPLA loading up to 30 g COD/L with only short-term, self-recovering imbalance and no yield loss, offering a practical loading benchmark for bioplastic-contaminated waste. Full microbial and statistical data will be presented at the conference.

Keywords: Polylactic acid (PLA); anaerobic co-digestion; propionate accumulation; process stability; CH_4 yield.

[O22]

Enhanced Semi-Dry Anaerobic Digestion of Dewatered Sludge by Thermal Pretreatment

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Abstract:
Anaerobic digestion (AD) of dewatered sludge at high solids concentrations can reduce reactor volume and energy requirements while recovering renewable energy. However, increasing solids concentration and organic loading rate (OLR) may adversely affect substrate degradation and process stability. This study investigated the effects of low-temperature thermal pretreatment on semi-dry AD of dewatered sludge under increasing solids concentrations.

Two 20-L horizontal anaerobic digesters were continuously operated under mesophilic conditions using untreated (UT) and thermally pretreated (PT; 60 °C for 3 h) dewatered sludge. The feed total solids concentration was progressively increased from approximately 10% to 15%, corresponding to OLRs of approximately 4.4–6.5 g VS/L·d. Thermal pretreatment enhanced methane production, with its effect becoming more pronounced as the OLR increased. Methane yields ranged from 138.9 to 193.8 mL CH_4/g VS for PT and from 114.4 to 157.9 mL CH_4/g VS for UT. The maximum volumetric methane production rates were 1.10 and 0.88 L CH_4/L·d for PT and UT, respectively. Microbial community analysis showed an increased relative abundance of Clostridia with increasing OLR, together with a shift toward hydrogenotrophic methanogens. These results indicate that low-temperature thermal pretreatment can improve methane recovery and support stable semi-dry AD of dewatered sludge under elevated solids and organic loading conditions.

Keywords: Anaerobic digestion; Dewatered sludge; Thermal pretreatment; Semi-dry digestion; Methane production

[O26]

Recovering Vietnam's Rainwater Culture: A Review of the Evidence and Implications for Community-Based Drinking Water Systems

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Abstract:
Vietnam ranks among the most rainfall-abundant countries in Southeast Asia yet faces a mounting freshwater crisis. Community-based rainwater drinking systems are technically proven and cost-competitive, but uptake remains constrained by low trust, inadequate storage, and weak community ownership. This study argues that these barriers are substantially cultural: they reflect the erosion, over the course of the twentieth century, of a tradition in which rainwater was understood as cosmologically privileged, linguistically central, and materially sophisticated. Drawing on Vietnamese ethnographic, linguistic, historical, and water-sector literature, the paper maps three registers of this tradition — ritual, linguistic, and material — and traces the institutional process through which it was marginalized. Four implications for programme design follow: reframing rainwater harvesting as cultural recovery rather than new technology; embedding community ownership through beneficiary contribution; activating residual cultural preference to address storage resistance; and resolving the regulatory gap that prevents decentralized rainwater plants from scaling. Vietnam's rainwater culture was not always invisible. Understanding how it was marginalized, and how it can be made visible again, is a prerequisite for sustainable community-based water provision.

Keywords: rainwater harvesting; drinking water; water culture; community-based water supply; technology acceptance; Vietnam

[O27]

Rainwater-for-drinking as a clean decentralised water technology: governance architecture of the Rain School Network in the Mekong subregion

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Abstract:
Rural schools across the Mekong subregion depend on groundwater of uncertain quality, trucked supply, or purchased bottled water — an arrangement that is costly, energy-intensive, and plastic-generating. Rainwater-for-drinking (RFD) offers a decentralised alternative that treats precipitation as a resource at the point of use rather than as runoff to be discharged. Its persistence, however, depends less on hardware than on governance: externally funded school water systems routinely perform at commissioning and fail after project closure.

This paper presents the Rain School Network, a Mekong–Republic of Korea Cooperation Fund initiative that installed multi-barrier RFD systems at schools in Cambodia, Lao PDR, Myanmar, Thailand and Vietnam between 2022 and 2023, pairing each system with two locally constituted governance bodies: a BiTS (Bi Teacher and Student) team responsible for weekly water-quality monitoring, rainfall measurement and tank-level data, and a Skywater Committee joining school authority, parents, technical experts and local officials. At the first site — Nguyen Binh Khiem School, Ha Long City, Vietnam — a ten-month evaluation recorded a 53% rainwater utilisation ratio, no supply interruption, and compliance with all 26 parameters of the national drinking-water standard across more than 40 student-led monitoring sessions.

The network's distinguishing feature is horizontal: cross-border peer learning among school-level actors, which addresses single-site fragility, donor-exit vulnerability and cultural isolation in ways bilateral technology transfer does not. Three testable conditions for survival beyond the funding cycle are proposed — curriculum embedding, local-government co-ownership, and self-sustaining peer exchange — offering a transferable governance template for decentralised clean-water technology.

Keywords: rainwater harvesting; decentralised drinking water; water circular economy; network governance; school WASH; Mekong subregion

[O33]

Development of Electrospun Microtube Array Membrane for Anode Application in the Microbial Fuel Cell

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Abstract:
Microbial fuel cell (MFC) is a novel technique can solve the waste water problem and generate electricity. This study focuses on the anode material. Using co-axial electrospinning method to fabricate polylactic acid (PLLA) microtube array membrane (MTAM). These MTAM not only have high specific area but also enhance the microbial adhesion ability. The addictive, multi-walled carbon nanotubes (MWCNT), increase the conductivity that can improve the efficiency of MFC. Furthermore, the effects of different numbers of electrospun fiber membrane placed in the anode of dual-chamber MFC on electrical performances are analyzed. The scanning electron microscopy (SEM) images show that MTAM have thin walls and contain pores on its surface which is beneficial for fast mass transport. During acclimation, bacteria regularly accumulate on the surface and formed a lamellar structure. However the bacteria in the inner structure tend to group into individual block. The growth of biofilm obviously affected the electrical performance of the cell. In the acclimation process, more electrospun fiber membranes in the anode raise voltage rapidly due to better electron transfer ability. The use of MTAM as the anode in MFC is beneficial for attaching bacteria in shorter acclimation time. The MFC of 11 MTAMs has a maximum power density of 2.94 mW/m2 and a minimum resistance of 833 Ω. Compared to sealing MTAM, hollow MTAM demonstrate better electrical performance.

Keywords: MFC, Co-axial electrospinning, Acclimation, Biofilm, Power density.

[O34]

Calcined cobalt-intercalated polyaniline-rGO composites as cathode catalysts for anion-exchanged membrane fuel cells

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Abstract:
Poly(aniline-co-2-aminobenzenesulfonic acid) (P(ANI-co-SANI)), cobalt(II) chloride, and graphene oxide (GO) are calcined as non-precious metal catalysts (NPMCs) for anion exchanged membrane fuel cells (AEMFC). P(ANI-co-SANI)s were copolymerized by various molar feed ratios of ANI/SANI. Functional groups of copolyanilines are analyzed using Fourier transform infrared (FT-IR) spectroscopy. The crystalline behavior and morphology of CoNxSyC/rGO are characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM), respectively. SEM characterization reveals that CoN4S1C/rGO (ANI/SANI=4:1) catalysts possess porous morphologies. X-ray photoelectron spectroscopy (XPS) analysis showed that nitrogen-doped carbon, namely pyridine nitrogen and graphitic nitrogen, is the active species in oxygen reduction reaction (ORR) catalysts. N2 adsorption–desorption isotherm analysis shows that CoN4S1C/rGO catalyst exhibited a mesoporous structure, with a Brunauer-Emmett-Teller (BET) surface area of 822 m2/g. Electrochemical investigations were carried out for the CoN4S1C/rGO catalyst using a rotating disk electrode method. Following the investigations, a high oxygen reduction reaction activity (−5.96 mA cm−2) in KOH(aq) was observed. The membrane electrode assemblies prepared using the CoN4S1C/rGO cathode achieved a peak power density of 206.1 mW cm−2 at 60 °C.

Keywords: Cobalt, non-precious metal, catalysts, oxygen reduction reaction, anion exchanged membrane fuel cell.

[O36]

Bridging the Simulation-Reality Gap in Biogas Biorefineries: A Pilot-Scale Life Cycle Assessment

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Abstract:
This study presents a systematic cradle-to-gate Life Cycle Assessment (LCA) of a 3.1m³ three-stage integrated biogas pilot plant (comprising dark fermentation, anaerobic digestion, and microalgae carbon capture) to bridge the "reality gap" between thermodynamic simulations and actual operations. Four scenarios were evaluated: S1 (EST, optimized split-feeding with heat recovery), S2 (CSF, conventional mixed feeding with high heat loss), S3 (SAD, industrial single-stage digestion baseline), and S4 (TDL, idealized thermodynamic simulation). Using 1,000kg of organic feed solution as the Functional Unit (FU), a 100% mass-balanced Life Cycle Inventory was constructed. Thermodynamic simulation (S4) underestimated environmental burdens, showing extremely low electricity (1.91 kWh) and heat (42.69 MJ) demands. In contrast, the real pilot plant exhibited a constant electrical baseline of 45.45 kWh/FU. However, upgrading from CSF (S2) to the proposed EST (S1) system successfully locked the glucose equivalent from 2.5 kg/FU to 20.3 kg/FU. This split-feeding design doubled biohydrogen and methane yields to 0.137 kg/FU and 15.52 kg/FU, respectively, achieving a superior Net Energy Ratio (NER) of 0.23. The surge in biofuel production effectively diluted the fixed electrical overhead, while thermal integration reduced steam demand by 54.5%, leading to an exponential decline in net greenhouse gas (GHG) emissions. Nutrient balance analysis revealed that S1 successfully recycled 55.3% of liquid-phase nitrogen and phosphorus back to the microalgae unit. This study demonstrates that engineering interventions and thermal integration are pivotal in mitigating real-world energy overheads and achieving true decarbonization in early-stage biorefineries.

Keywords: Green Hydrogen; Life Cycle Assessment; Circular economy; Resource recovery; Net Energy Ratio; Biogas pilot plant

[O37]

Multi-functional $NiWO_4$ Microrobots for Water Treatment: Towards Synergistic Visible- Light Photocatalysis and Impedimetric Sensing Platform

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Abstract:
Light-actuated micro-/nanorobots are intelligent systems designed to achieve propulsion and multifunctionality under light irradiation, enabling them to carry out diverse tasks in the medium. Here, we introduce a single-component $NiWO_4$ microrobot that exhibits visible-light-driven actuation in a fuel-free medium. These photocatalytic $NiWO_4$ microrobots show locomotion and multifunctionality. The actuation of particles was validated using mathematical models, including mean-square displacement analysis and Active Brownian Particle modelling. The photoresponsive microrobots function as a motile photocatalyst for the capture and degradation of bisphenol A, an emerging endocrine disruptor. Further, owing to their capture ability, we developed an impedimetric platform for the detection of bisphenol A in an aquatic medium. The sensor showed a detection limit of 5.6 nM, and as proof of concept, the applicability in real environmental matrices was established with respect to the resistance change. Moreover, these pave the way towards strategy development of an integrated degradation and detection platform from single-component microrobots towards aquatic contaminants. Further advancing its translation potential towards mitigation strategies in water treatment.

Keywords: light actuation, particle modelling, bisphenol A degradation, Brownian motion, impedimetric sensing

[O45]

Recombinant Production and In Vitro Bioactivity of the Peptide in *Escherichia coli*

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Abstract:
This study evaluated the feasibility of producing a recombinant peptide, designated Ω76, in a genetically engineered *Escherichia coli* expression system and assessed its in vitro bioactivities. Expression plasmids pT7-Ω76 and pTOL03F-Ω76 were constructed and transformed into *E. coli* BL21(DE3). The effects of isopropyl β-D-1-thiogalactopyranoside (IPTG) concentration on peptide production were subsequently examined. Among the tested conditions, BL21(DE3)/pT7-Ω76 induced with 15 μM IPTG produced the highest peptide yield. Following purification, approximately 10.5 mg/L of Ω76 was obtained. High performance liquid chromatography analysis indicated a purity of approximately 97%, and mass spectrometry showed a molecular mass of approximately 2.3 kDa, consistent with the expected peptide product. In antimicrobial assays, Ω76 produced inhibition zones of 5 mm against *Escherichia coli* and 3 mm against *Staphylococcus aureus* under the tested conditions. At 1.6 mg/mL, Ω76 exhibited approximately 40% ABTS radical-scavenging activity, a FRAP value of 0.1 mM, and approximately 25% ferrous-ion-chelating activity. In tyrosinase inhibition assays, Ω76 showed inhibition rates of approximately 95% and 85% when tyrosine and *L*-DOPA were used as substrates, respectively, at the same concentration. These findings demonstrate the feasibility of recombinant Ω76 production in *E. coli* and indicate that the purified peptide possesses in vitro antioxidant and tyrosinase inhibitory activities. Further studies on production optimization, activity validation, safety, and underlying mechanisms are warranted to evaluate its potential as a bioactive ingredient for cosmeceutical applications.

Keywords: Recombinant peptide; *Escherichia coli*; peptide purification; antioxidant activity; tyrosinase inhibition

[O52]

Deep Eutectic Solvent-Assisted Anaerobic Digestion of Paddy Straw: Enhanced Biomethane Production with Integrated Techno-economic Analysis and Life Cycle Assessment

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Abstract:
Lignocellulosic biomass represents an abundant renewable feedstock for biogas production; however, its efficient conversion through anaerobic digestion is constrained by the recalcitrant structure of lignin and the complex association of cellulose, hemicellulose, and lignin. In the present study, a choline chloride (ChCl)–urea deep eutectic solvent (DES) was investigated as a pretreatment approach to improve the anaerobic digestibility of lignocellulosic biomass and enhance biogas and biomethane production. The ChCl–urea DES was selected because of its simple preparation, relatively low volatility, and potential to modify the lignocellulosic matrix and increase the accessibility of structural carbohydrates. The effects of DES pretreatment on substrate characteristics and subsequent anaerobic digestion performance were evaluated by comparing pretreated biomass with untreated biomass. Biogas production, methane content, cumulative biomethane yield, and volatile-solids degradation were used to assess the effectiveness of the pretreatment.
The DES pretreatment promoted structural disruption of the biomass and increased the accessibility of biodegradable organic fractions, thereby facilitating hydrolysis and subsequent microbial conversion during anaerobic digestion. Enhanced biogas and methane production following ChCl–urea pretreatment demonstrated the potential of DES technology for overcoming biomass recalcitrance. The study provides a basis for integrating deep eutectic solvent pretreatment with anaerobic digestion for improved renewable methane recovery from lignocellulosic biomass. The optimized ChCl–urea pretreatment was further evaluated through techno-economic analysis (TEA) and life cycle assessment (LCA) to assess its economic viability, environmental performance, and potential for scale-up, providing an integrated evaluation of the technical, economic, and environmental feasibility of the proposed process.

Keywords: Lignocellulosic biomass, Deep eutectic solvent, Anaerobic digestion, Biomethane

[O54]

Circular economy as a pathway for greener agricultural production: Results from pilot models in six farming systems in the Vietnamese Mekong Delta

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Abstract:

Agricultural production is the primary source of income for millions of local people in the Vietnamese Mekong Delta (VMD), accounting for more than 56% of Vietnam's total rice output and 72% of its aquaculture production in 2023. However, agricultural systems in the VMD depend heavily on external inputs such as chemical fertilizers, pesticides, and commercial feed, while generating substantial volumes of waste and crop residues that contribute to soil and water pollution. Circular agriculture offers a promising approach to mitigating pollution and improving resource efficiency in these farming systems by minimizing input use, circulating nutrients and resources within and across farming systems, and recovering and valorizing production waste and by-products. This study implemented pilot circular economy models across six farming systems, including coconut, chicken, cattle, rice-shrimp, mango, and saltwater shrimp, in the VMD during 2024-2025. The circular practices included composting agricultural residues and trash fish for use as solid and liquid fertilizers, applying bio-bedding in animal husbandry (i.e., chicken and cattle), intercropping coconut with cash crops, and valorizing crop residues for silage and biochar production. The results indicate that the application of these circular economy practices have potential to increase economic benefits and improve the environmental performance of the pilot systems. Based on these pilot results, the study proposes solutions and recommendations for scaling up suitable circular economy models in agricultural production in the VMD.

Keywords: Circular economy; agricultural production; resource efficiency; pilot models; Vietnamese Mekong Delta

[O55]

Valorizing Agricultural Waste into Advanced Materials: A Coconut Shell-Derived Activated Carbon-Silver Nanocomposite for Wound-Healing Soap Formulation

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Abstract:
Turning agricultural waste into high-value materials is the heart of circular economy practice, providing a greener alternative than relying on conventional raw materials for consumer product manufacturing. Among diverse waste materials, coconut shells remain as one of the most abundant agricultural wastes. In this work, activated carbon was synthesised from these agricultural wastes, emphasising a green engineering technology that converts move discarded biomass into a usable material. To enhance functional properties of activated carbon, nanoparticles were incorporated by an in-situ reduction method to obtain a dual-functional material, exhibiting combined adsorption properties of activated carbon and those of the incorporated nanoparticles. BET analysis revealed that the pristine activated carbon had a surface area of about 480.12 m^2g^{-1} while on incorporation of the nanoparticle, it decreased to 318.87 m^2g^{-1}. Further, the presence of nanoparticles was confirmed using XPS analysis as well as TEM analysis. The safety of the nanocomposite was determined using in vitro biological analysis. Antibacterial assay revealed that, on comparison with pristine activated carbon, the nanocomposite showed enhanced inhibition of bacterial growth and high biocompatibility with more than 85% cell viability when exposed to even higher concentrations. By reusing low-value waste materials into sustainable, multifunctional, safe ingredients for personal-care formulations with good antibacterial and wound healing properties, this work shows a kind of scalable, waste-to-value pathway.

Keywords: Activated carbon, nanoparticle, nanocomposite, cosmetic application.

[O56]

Sustainable Electrochemical Technologies for Nitrate Remediation and Ammonia Generation

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Abstract:
Green ammonia has been researched as a carbon-free energy vector and a hydrogen carrier for sustainable energy systems. Electrochemical nitrate reduction (NO_3RR) is a sustainable method for NH3 synthesis and water remediation via the reduction of nitrate-contaminated wastewater into a valuable resource. However, low-cost electrocatalysts with high activity, selectivity, and stability are a significant challenge. Herein, a solvent-free mechanochemical synthesis of g C_3N_4@Fe_2O_3 heterostructure supported on nickel foam for efficient NO_3RR under ambient conditions has been developed. The synergistic interaction between graphitic carbon nitride and iron oxide is employed to enhance charge transfer, increase active sites, promote nitrate adsorption, and suppress the competing hydrogen evolution reaction.
The engineered catalyst exhibited a low onset potential of -0.06 V versus RHE and achieved a faradaic efficiency (FE) of 85% with an NH_3 yield rate of 0.397 mg h-1 cm-2 at -0.4 V in 0.1 M nitrate concentration. When the nitrate concentration was increased to 0.5 M, an FE of 90.6% and an NH_3 yield rate of 0.8083 mg h^{-1} cm^{-2} were achieved, with stable operation over 12 h. Isotopic ^{15}N-labelling experiments and UV-Vis spectroscopic methods confirmed that the produced NH_3 originated exclusively from nitrate reduction.

Keywords: Electrochemical reduction, nitrate remediation, g-C_3N_4@Fe_2O_3 heterostructure, green ammonia synthesis

[O57]

Phytoremediated Multi-Metal Biochar/Polyaniline Composite for High-Performance Supercapacitor

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Abstract:
The uncontrolled proliferation of water hyacinth (*Eichhornia crassipes*) in tropical and subtropical aquatic ecosystems poses a significant ecological threat. This hyperaccumulator weed can be converted to value-added biomass feedstock. This study presents a phytoremediation-assisted waste-to-wealth approach that converts multi-metal-enriched biomass into a high-performance energy storage material. Water hyacinth was grown in a controlled environment containing metals such as Mn, Fe, Co, and Ni. This biomass was converted into high-surface-area multi-metal biochar by KOH activation followed by pyrolysis. The presence of all targeted metals was successfully confirmed using XRD, SEM, TEM, and XPS. The biochar then underwent in situ oxidative polymerization with aniline to form a biochar-polyaniline (WhB/PANI) composite. The surface modification with PANI, along with the presence of the metals, enhanced the redox activity and charge transport kinetics. Electrochemical analysis of the WhB/PANI electrode in 3 M KOH revealed a specific capacitance of 303.33 F g^{-1} at 0.5 A g^{-1}, with an energy density of 24.27 Wh kg^{-1} and a power density of 3200 W kg^{-1}. The electrode further exhibited excellent cyclic stability, retaining 91% of its initial capacitance after 2000 charge-discharge cycles. Collectively, this work presents a scalable and circular approach that integrates phytoremediation, biomass valorization, and conductive polymer engineering to develop a low-cost, sustainable electrode material for supercapacitor applications.

Keywords: Phytoremediation, Biochar, Waste-to-Wealth, Sustainable, Energy storage, Supercapacitor

[O58]

Food Quality Monitoring through Digital Colorimetric Analysis

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Abstract:
Digital colorimetric analysis represents an innovative and promising approach for monitoring food quality, combining the simplicity, cost-effectiveness, and visual readouts of colorimetric sensors with the accessibility of smartphones. This technique relies on capturing and analyzing color changes in food products to assess their freshness, quality, and safety. The presentation will introduce the principles of Digital Image Colorimetry (DIC), the color models employed in DIC, and the integration of smartphone technology into this methodology. An overview of the foundations of these techniques and their applications across different food systems will be provided, with emphasis on their utility in food safety assurance, process monitoring, and remote quality assessment. Future challenges, including the need for standardization and integration with advanced technologies, will also be addressed. In addition, highlights of the research conducted by the presenter's group will be showcased, such as freshness sensors prepared from natural anthocyanin sources like red cabbage and hibiscus, applied through rub-coating on paper and delignified jute substrates for visual detection of fish and milk spoilage. Collectively, these studies demonstrate sustainable, low-cost platforms for real-time monitoring of food freshness, which will be discussed in detail during the talk.

[O59]

Economic and Environmental Assessment of Thermoelectric Generators for Industrial Waste Heat Recovery

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Abstract:
Waste heat recovery in high-temperature processes is crucial for improving energy efficiency. Applying thermoelectric generators (TEGs) utilising the Seebeck effect is a promising method for reducing the carbon footprint. This study presents a comprehensive environmental and economic assessment of a heat recovery system. The experimental setup comprised a steel heating plate and a TEG assembly. This included a copper heat-receiving plate, five commercial thermoelectric modules connected in series, and copper coolers through which water flowed with a volumetric flow rate of 260 l/h. In the first phase, the system was analysed in a transient state. The heat source, previously heated to a specific temperature, cooled down naturally, transferring thermal energy to the TEG, which allowed for parameter recording over time. The second phase involved steady-state measurements with the heat source stabilised at 450 °C. The maximum useful electrical power output was determined to be 19.29 W. Assuming 8000 hours of continuous operation per year, electricity production reached 154.32 kWh. Using an emission factor of 0.553 kg/kWh, the annual CO_2 reduction was calculated at 85.34 kg. The economic analysis was based on Commercial Tariff C pricing (2.09 PLN/kWh). Annual financial savings were estimated at 322.53 PLN, which, against capital expenditures (CAPEX) of 3000 PLN, yielded a simple payback time (SPBT) of 9.3 years. This result is dictated by fixed prototyping costs and the low efficiency of current TEG modules. Improving profitability depends on scaling up the installation and achieving higher conversion efficiency, which is the subject of ongoing research.

Keywords: thermoelectric generators, waste heat recovery, CO_2 emission reduction, SPBT, Seebeck effect.

[O60]

Interactions of hydroxylated polycyclic aromatic hydrocarbons with environmentally aged tire rubber

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Abstract:
Tire wear particles (TWPs) are recognized as one of the major sources of microplastic pollution originating from road transport. Owing to their sorption properties, they may act as vectors of environmental contaminants. This study investigated the adsorption of selected hydroxylated polycyclic aromatic hydrocarbons (OH-PAHs) onto environmentally aged tire rubber under batch conditions. Adsorption experiments were performed using intact and mechanically fragmented tire rubber. Adsorption capacity (qt) and removal efficiency (R) were determined after 24 h of contact, which corresponded to adsorption equilibrium for most of the investigated compounds.

The highest adsorption performance was observed for 2-OH-NAP, reaching qt = 27.49 µg g^{-1} with a removal efficiency of 92.11%. Similarly, 4-OH-PHEN exhibited high adsorption, with qt = 26.00 µg g^{-1} and R = 95.41%, while 2-,3-,9-OH-FLU reached qt = 22.87 µg g^{-1} and R = 75.36%. For most investigated OH-PAHs, mechanically fragmented tire rubber showed higher adsorption capacities and removal efficiencies than intact material, indicating that particle fragmentation enhanced the adsorption process by increasing the availability of active sorption sites.

The obtained results demonstrate the strong affinity of environmentally aged tire rubber toward selected OH-PAHs and highlight the potential role of TWPs as vectors of environmental micropollutants. Such interactions may enhance the transport, persistence and bioavailability of hazardous organic contaminants, thereby increasing their environmental dispersion and potential ecological risk. Furthermore, the results indicate that environmental fragmentation of tire-derived materials may further increase their capacity to accumulate organic pollutants, emphasizing the importance of considering aged tire rubber in environmental risk assessment.

Keywords: tire-derived microplastics; tire rubber; OH-PAHs; adsorption; environmental micropollutants; environmental fate

[O61]

Evaluation of untreated spent coffee grounds for hydrogen production by *Clostridium beijerinckii* DSM791: Effects of initial pH, substrate and co-fermentation

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Abstract:
Spent coffee grounds (SCG) represent an abundant lignocellulosic waste with significant potential for biohydrogen production within circular bioeconomy frameworks. In this study, hydrogen production by *Clostridium beijerinckii* DSM791 using untreated SCG as a sole substrate and in combination with glucose as a co-substrate during dark fermentation was evaluated. Experiments were conducted at substrate loadings of 2–10% (w/v) under two initial pH conditions (5.5 and 7.5), both in SCG-only systems and in SCG supplemented with glucose (0.8 %). Untreated SCG supported measurable H_2 production reaching maximum yields of 4.5–4.9 NmL H_2 g^{-1} SCG and up to 9.56 NmL H_2 g^{-1} VS in sole-substrate systems. H_2 standard volume (NmL) production was consistently higher at initial pH 7.5 than at pH 5.5, with up to 1.6-fold greater cumulative production under near-neutral conditions. Glucose supplementation enhanced H_2 generation, resulting in cumulative production of 1755–2045 NmL per reactor (900 mL) and significantly higher conversion efficiencies. The highest VS-normalized yield obtained was 264.5 mL H_2 g^{-1} VS (culture media containing glucose: as control, pH 7.5), while SCG-containing systems reached up to 125.6 NmL H_2 g^{-1} VS under co-fermentation conditions. Although co-fermentation substantially improved H_2 yields, increasing SCG concentration reduced conversion efficiency, because a larger proportion of the substrate consisted of recalcitrant lignocellulosic material, which limited carbohydrate availability, together with potential inhibitory compounds present in SCG. These findings demonstrate that *C. beijerinckii* can directly utilize untreated SCG under simplified process conditions, glucose co-fermentation and the selection of initial pH significantly improved H_2 production.

Keywords: Anaerobic bioconversion; Biohydrogen; Circular bioeconomy; Spent Coffee Grounds; Lignocellulosic waste

[O62]

Overexpression of *pckA* alleviates combined lactic acid and p-coumaric acid inhibition of succinic acid production from brewery mashing wastewater hydrolysate

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Abstract:
Brewery mashing wastewater (BMW), rich in carbohydrates and nutrients, is a promising feedstock for succinic acid (SA) production by *Actinobacillus succinogenes*. However, inhibitors in pectinase-treated BMW hydrolysate impaired fermentation by the wild-type (WT) strain, limiting SA titer to 10.49 ± 0.36 g/L. Inhibitor profiling identified ferulic acid, *p*-coumaric acid (*p*-CA), furfuryl alcohol, and lactic acid (LA) as candidate inhibitors. Individual and combined inhibition assays showed that LA and *p*-CA were the main inhibitors acting in combination to limit SA production. Further transcriptomic and regression analyses identified the downregulated reductive C4 branch genes *pckA*, *fumC*, and *frdA* as candidate bottleneck genes; their reduced expression strongly correlated with reduced SA titer ($R^2 > 0.97$). Among these targets, *pckA* overexpression most effectively alleviated inhibition, increasing SA titer to 16.32 ± 0.58 g/L, 55.6% higher than that of the WT strain in BMW hydrolysate and comparable to the WT titer obtained in tryptic soy broth. Together with reduced byproduct accumulation, these results suggest that *pckA* overexpression reinforced the ATP-generating carboxylation of phosphoenolpyruvate to oxaloacetate and favored carbon conversion toward SA biosynthesis. This study provides mechanistic insight and a promising genetic strategy for the direct production of SA from non-detoxified BMW hydrolysate.

Keywords: Brewery mashing wastewater; Hydrolysate; Succinic acid production; *Actinobacillus succinogenes*; Inhibitors; Transcriptomic and regression analyses

[O67]

Redox Thermodynamics and Oxygen Vacancy Formation in Calcium based Perovskites for High-Temperature Thermochemical Energy Storage

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Abstract:
Perovskite oxides are promising redox materials for high-temperature thermochemical energy storage (TCES) because of their reversible oxygen exchange, compositional flexibility, and potential integration with concentrated solar power systems. This study investigates the redox thermodynamics of calcium cobalt perovskite ($CaCoO_3$) by examining the effects of reduction temperature and oxygen partial pressure on oxygen release and oxygen non-stoichiometry. Thermodynamic equilibrium calculations were performed over reduction temperatures of 1073–1473 K and oxygen partial pressures ranging from 0.01 to 0.0001 atm. The results demonstrate that oxygen release increases consistently with increasing reduction temperature and decreasing oxygen partial pressure, indicating enhanced formation of oxygen vacancies under more reducing conditions. Correspondingly, the oxygen non-stoichiometry (δ) increases from 0.00276 to 0.06360 over the investigated temperature range at 0.01 atm. A substantially greater reduction extent is obtained at 0.0001 atm, where δ reaches 0.52320 at 1473 K. The equilibrium oxygen content decreases, accordingly, confirming progressive formation of oxygen-deficient $CaCoO_{3-\delta}$ under high-temperature, low-oxygen conditions. Overall, the thermodynamic trends demonstrate the strong dependence of $CaCoO_3$ redox behavior on operating conditions and identify temperature and oxygen partial pressure as key parameters controlling its oxygen exchange capacity. These findings support the potential of $CaCoO_3$ as a redox material for high-temperature thermochemical energy storage applications.

Keywords: $CaCoO_3$, thermochemical energy storage, redox materials, thermodynamics, solar energy, high temperature processes

[O71]

Closing the loop in a fast-growing renewable-energy market: Circular-economy adoption and photovoltaic recycling economics in Vietnam

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Abstract:
Rapid renewable-energy deployment reduces operational emissions but shifts environmental pressures toward material extraction and end-of-life management. This study examines circular-economy (CE) adoption among renewable-energy organizations in Vietnam, its alignment with narrow, slow and close resource loops, and the role of photovoltaic (PV) waste throughput in prospective recycling economics. An integrated lifecycle-loop-business model framework combines the 10R hierarchy, lifecycle stages, circularity objects and circular business-model mechanisms. Empirically, a non-probability, sector-targeted survey of 59 organizations across solar PV, wind power, battery energy storage systems and waste-to-energy, conducted from March to June 2025, is integrated with Weibull PV-waste cohort scenarios and an accounting model based on a licensed waste-treatment company. Results show that CE adoption among respondents is concentrated in maintenance and life extension, while reuse remains limited and no respondent reported operational commercial-scale recycling for PV modules, wind-turbine blades or lithium batteries. Under the stated assumptions, cumulative PV waste reaches 4.62 million tonnes in the regular-loss scenario and 6.77 million tonnes in the early-loss scenario by 2050. The modeled recycling activity is loss-making at 24 tonnes per year (benefit-cost ratio = 0.63) and marginally positive at 52 tonnes per year (1.03); these are scenario-dependent screening results, not universal thresholds or an investment appraisal. The study contributes a framework that distinguishes operational circularity from systemic material-loop closure and shows that throughput aggregation alone is insufficient without take-back arrangements, quality standards, reverse logistics and verified recovery markets. The findings support an anticipatory transition combining life extension with institution-building for closed-loop recovery.

Keywords: circular economy; renewable energy; photovoltaic waste; recycling economics; circular business models; Vietnam; battery storage; wind power

[O73]

Effect of nitrogen supply on *Methylocystis hirsuta* growth in high-load reactors

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Abstract:
An alternative to reduce the use of single-use fossil plastics are polyhydroxyalkanoates (PHA), biopolymers characterized by their biodegradability and biocompatibility. *Methylocystis hirsuta* (methanotroph) is capable of producing PHA under conditions of nitrogen limitation and excess of a carbon source, such as methane. However, inhibition of the process has been reported in reactors operated with high CH_4 loads, associated with the accumulation of NO^{2-} [1]. Consequently, it is necessary to develop operational strategies that allow avoiding inhibition and promoting the growth of methanotrophic bacteria in high mass transfer bioreactors.

Batch cultures of *M. hirsuta* were carried out in 10 L bubble columns with internal gas recirculation, operated under high CH_4 load and different sources and concentrations (130 & 160 mg NL^{-1}) of nitrogen such as KNO_3 and $(NH_4)_2SO_4$. Subsequently, a daily nitrogen supplementation of 10 mg/L/day from these sources was evaluated.

The use of NO^{3-} as a nitrogen source supported higher cell densities compared to NH^{4+}, but at 260 mg N L^{-1} inhibited *M. hirsuta* growth. The daily nitrogen supplementation of 10 mg N L^{-1} d^{-1} in the form of KNO_3 allowed to sustain the greatest bacterial growth, demonstrating that the source and strategy of nitrogen supply is critical to maintain the growth of *M. hirsuta* under high methane loading ratres

Keywords: Supplementation of nitrogen, PHA, methanotrophs inhibition.

[1] Rodríguez, Y., Firmino, P. I. M., Pérez, V., Lebrero, R., & Muñoz, R. Biogas valorization via continuous polyhydroxybutyrate production by Methylocystis hirsuta in a bubble column bioreactor, 113, 395–403 (2020).

[O87]

Rational Design of a Spherical Ternary NiCoMn@Ionic Liquid Nanocomposite for Enhanced Electrochemical Vanillin Sensing

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Abstract:

Rational design of nanostructured electrochemical interfaces is essential for sensitive, selective detection of food-related bioactive compounds. This study reports a spherical ternary NiCoMn metal–organic framework (MOF) integrated with the ionic liquid [BMIM][$MeSO_4$] to fabricate a GCE/IL/NiCoMn-MOF sensor for vanillin detection. Sensing performance was benchmarked against Co-MOF and NiCo-MOF analogues, revealing a clear synergistic enhancement in electrochemical activity arising from the three metal centers. Cyclic voltammetry showed an electroactive surface area roughly eight times greater (0.5911 cm^2) for the ternary NiCoMn-MOF electrode than for bare GCE (0.071 cm^2), while EIS confirmed improved charge-transfer characteristics at the ionic-liquid-modified interface. The optimized GCE/IL/NiCoMn-MOF platform displayed a strong oxidative response toward vanillin at 0.73V. Square-wave voltammetry (SWV) enabled sensitive quantification, yielding R^2 = 0.998, LOD of 0.649 nM, and LOQ of 2.161 nM, with a sensitivity of 10.55 µA μM^{-1} cm^{-2} and recovery of 98–102% in real samples. The GCE/IL/NiCoMn-MOF sensor offers a low-cost, energy-efficient alternative to solvent-intensive chromatographic methods, supporting green engineering principles for sustainable food quality control.

Keywords: Ternary metal–organic framework; ionic liquid; electrochemical sensor; vanillin; square-wave voltammetry; food analysis; electroactive surface area; nanocomposite.

[O89]

Comprehensive Assessment of Sewage Sludge Quality, Contaminants and Pathogens for Sustainable Agricultural Application

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Abstract:
Rapid urbanization has resulted in increased wastewater generation, consequently leading to a substantial increase in sewage sludge generation. Sewage sludge characterization was conducted at 14 sewage treatment plants (STPs) during two different seasons in two metropolitan cities of Tamil Nadu, India. Digested and dewatered sludge samples were collected from the operational STPs and characterized for physicochemical properties, nutrients, heavy metals, and pathogens. The sludge exhibited a slightly alkaline nature, with pH ranging from 7.07 to 8.70, and had a high moisture content. Heavy metal concentrations were within the permissible limits prescribed by the Fertilizer (Control) Order (FCO), except for Ni and Hg at one STP. The nutrient concentrations were lower than the minimum requirements specified by the FCO. Pathogenic microorganisms, including faecal coliforms (27–28,000 MPN/g TS), helminth eggs (10–130 eggs/4g TS), and Salmonella sp., were detected at concentrations exceeding the permissible limits of the FCO, United States Environmental Protection Agency (USEPA) Class A, and Central Public Health and Environmental Engineering Organisation (CPHEEO) standards. However, the faecal coliform concentrations complied with USEPA Class B and CPHEEO biosolid requirements. The Fertilizing Index (FI) and Cleanliness Index (CI) were evaluated to assess sludge quality and determine its suitability for agricultural application. The FI ranged from 1.0 to 2.4, while the CI ranged from 4.7 to 5.0. Based on these indices, the sludge was classified as Class D, indicating limited suitability for direct agricultural application. Therefore, appropriate pre-treatment is required, particularly heat-based treatments such as thermal or synergistic treatments such as thermo-chemical treatment, to effectively reduce pathogens and achieve USEPA Class A biosolid standards. Such treatment can also improve sludge biodegradability and enhance biogas production compared with conventional anaerobic digestion. Following effective pathogen reduction and stabilization, the treated and dewatered digested sludge could be safely utilized in agricultural applications rather than being disposed of through landfilling, thereby promoting resource recovery and supporting a circular economy approach to sustainable sewage sludge management.

Keywords: Sewage Sludge, Sewage Treatment Plants, Heavy Metals, Pathogens, Nutrients

[O90]

Fe/Ni Co-Doped Carbon Dots from Molasses and Spent Yeast Synergistically Enhance Dark Fermentative Biohydrogen via CD-Mediated Metal Delivery

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Abstract:
Dark fermentation rarely achieves its theoretical hydrogen yield (HY). Iron and nickel are essential cofactors for [FeFe]- and [NiFe]-hydrogenases, but no study has systematically delivered these metals through biocompatible nanocarriers. We developed metal-doped carbon dots (CDs) from spent brewer's yeast (SY) and sugarcane molasses (MO) using central composite design-optimized microwave synthesis, single-metal dark fermentation screening, multi-modal characterization, and 16S rRNA-based microbial profiling with PICRUSt2 functional prediction. Screening established Fe at 100 mg/L and Ni at 1.0 mg/L as optimal single-metal precursor concentrations. Combining both metals at a 100:1 ratio (Fe/Ni@SY-CDs) raised HY to 165.4 ± 5.2 mL H_2/g-glucose 182.3% and 144.3% higher than the corresponding Fe- and Ni-only formulations, exceeding the additive expectation and confirming genuine synergism. Ionic controls receiving equivalent free Fe/Ni doses yielded only 58.9 ± 5.8 mL H_2/g-glucose, 2.8-fold lower than the CD-bound formulation, indicating that the benefit arises from CD-mediated metal delivery rather than metal dose alone. The 100:1 ratio marked a clear interior optimum, with yield declining at both 50:1 and 200:1 (ratio effect, MO: p = 0.019; SY: p = 0.006). Fourier Transform Infrared Spectroscopy, X-Ray Diffraction, and Transmission Electron Microscopy/Energy-Dispersive X-ray Spectroscopy confirmed molecular-level Fe incorporation within the amorphous carbon matrix, with no crystalline metal-oxide phases detected. Microbial analysis showed dramatic enrichment of *Clostridium* sp. (1.9 → 31.8%) and emergence of *Caproiciproducens* sp. (0.13 → 21.3%), accompanied by PICRUSt2-predicted enrichment of the hypA-F gene cluster governing [NiFe]-hydrogenase maturation. These results position waste-derived metal-doped CDs as a promising platform for sustainable bio-H_2 enhancement.

Keywords: Carbon dots; metal doping; dark fermentation; biohydrogen; agro-industrial waste valorization; microbial community

[O102]

From Nutrient-Rich Wastewater to Valuable Resources: Electrocoagulation for Clean Treatment and Nutrient Recovery in Hydroponic Agriculture

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Abstract:
Hydroponic cultivation has emerged as an important component of modern sustainable agriculture because it enables crop production without soil while providing precise control over water and nutrient supply. However, continuous recirculation and periodic replacement of nutrient solutions generate a considerable amount of hydroponic wastewater solution (HWS), which contains substantial concentrations of dissolved nutrients that are not completely taken up by plants. Consequently, the direct discharge of such rich-nutrient solution can introduce considerable nitrogen and phosphorus and contribute to eutrophication and deterioration of water quality. This study evaluates the removal of major nutrient, including nitrate (NO_3^-), ammonium (NH_4^+), phosphorus (P), potassium (K), magnesium (Mg), and calcium (Ca) from HWS by electrocoagulation (EC) technique using aluminum electrodes in a batch reactor system. The Box–Behnken design was utilized to optimize EC operating conditions and the effects of four key independent factors, including applied current (X_1: 0.033-0.133 A), EC time (X_2: 3-60 min), initial pH (X_3: 4-10), and electrodes distance (X_4: 1,1.5,2) were investigated. The EC process achieved a complete removal of phosphorus (100%) within EC treatment time less than 10 min at moderate applied current. However, the removals efficiencies of ammonium nitrogen and nitrate were 68.5 % and 55.5% at an optimum operating conditions (X_1=0.133 A, X_2= 30.1 min, X_3=8.85, X_4= 1cm). These findings indicate that further treatment steps may be required to achieve comprehensive nutrient removal. The study also investigated the potential for resource valorization. Characterization of the EC-generated sludge confirmed the presence of a spectrum of micro and macro nutrients that can be recovered, suggesting EC treatment as a potential clean technology for nutrients recovery from agriculture wastewater solution. Thus, EC offers a dual benefit by simultaneously treating HWS and recovering valuable nutrients from the generated sludge. The presentation will further address the effects of key operating parameters on energy consumption.

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Keywords: Electrocoagulation; hydroponic Wastewater, resource recovery; removal efficiency, aluminum electrodes.

Poster section

[P12]

Influence of Biochar bed Temperature and Steam Injection on Ammonia Production from Sewage Sludge Gasification

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Abstract:
Ammonia is a promising hydrogen carrier because of the high hydrogen storage capacity that enables efficient hydrogen storage. Ammonia is also an essential nutrient for plant growth and is produced and consumed in large quantities worldwide every year. The Haber-Bosch process is the predominant industrial route for ammonia production. However, the process requires high-temperature and high-pressure operating conditions and results in significant greenhouse gas emissions. Accordingly, this study explored the direct production of ammonia from nitrogen-rich biomass such as sewage sludge, through gasification as a sustainable alternative to the conventional Haber-Bosch process. Biochar derived from the pyrolysis of lignocellulose biomass was employed as an additive for tar removal during biomass gasification replacing the conventional catalysts typically used in gasification process. In addition, steam was introduced to enhance hydrogen production. The gasification of sewage sludge was conducted at an equivalence ratio(ER) of 0.2 and a fixed temperature of 800℃, while the temperature of the biochar bed was varied from 600 to 800℃. Hydrogen production increased with increasing biochar bed temperature, whereas ammonia production reached a maximum at 700℃ before decreasing at higher temperatures. Steam was introduced in amounts of 5,10, and 15ml. Increasing the steam injection amount promoted hydrogen production but resulted in a gradual decrease in the concentration of gaseous ammonia.

Keywords: Green Ammonia, Green Hydrogen, Sewage Sludge, Biochar, Gasification

Acknowledgement
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[P14]

Solar-driven electrochemical advanced oxidation process using photocathode and mechanism analysis using isotope

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Abstract:
In this study, we designed a new durable photocathode for the solar-driven electrochemical advanced oxidation process (SEAOP) to efficiently generate hydroxyl radicals (●OH) from O_2 under 1 sun irradiation conditions. The CuO-$CuFeO_2$ heterojunction photocathode exhibited rapid ●OH formation, enabling the degradation of various organic pollutants. However, the photocathode faced challenges with low ●OH conversion efficiency and poor stability due to H_2O_2 consumption and morphological breakdown. To overcome these limitations, a thin protective layer was applied to the CuO-$CuFeO_2$ photocathode, providing two key benefits: (1) enhancing the stability of the photocathode by protecting the CuO-$CuFeO_2$ layer, and (2) improving the ●OH generation efficiency and charge separation through the formation of a heterojunction between CuO-$CuFeO_2$ and protective layer. This modification increased the H_2O_2 to ●OH conversion efficiency by blocking the reaction between Cu(I) and H_2O_2, enabling O_2 conversion to ●OH without the need for costly chemicals or secondary treatment. The proposed SEAOP system was analyzed using $^{18}O_2$ isotope. We elucidated the ●OH generation mechanism from O_2 reduction and other reactions. This study provides a novel method for generating ●OH from in situ formed H_2O_2 without using chemical reagents, presenting a sustainable and environmentally friendly approach to wastewater treatment.

Keywords: Solar-driven photoelectrochemical advanced oxidation process, CuO-$CuFeO_2$ photocathode, TiO_2 overlayer, $^{18}O_2$ isotope labeling, micropollutant degradation

[P16]

Enhancement of continuous bio-H_2 production by magnetite addition in a dynamic membrane bioreactor

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Abstract:
This study evaluated the enhancement of continuous bio-H_2 production following magnetite addition to a mixed-culture dynamic membrane bioreactor (DMBR). The reactor was fed 20 g/L glucose and operated at 37 °C and pH 5.5–6.0, while the hydraulic retention time (HRT) was sequentially shortened from 6 to 3 and 2 h. The hydrogen production rates (HPRs) at HRTs of 6, 3, and 2 h were 9.79 ± 0.18, 20.54 ± 0.24, and 28.04 ± 1.09 L H_2/L-d, respectively, whereas the hydrogen yield (HY) remained near 1.0 mol H_2/mol hexose. After pseudo-steady-state operation at an HRT of 2 h, 10 g/L magnetite was added without changing other conditions. Following magnetite addition, the HPR increased from 28.04 ± 1.09 to 50.79 ± 0.39 L H_2/L-d and the HY from 0.94 ± 0.04 to 1.70 ± 0.01 mol H_2/mol hexose, representing increases of 81.1% and 80.9%, respectively. Electron transport system activity increased from 5.60 to 8.62 μg/mL/min (53.9%). Hydrogen-producing bacteria increased from 85.25% to 91.44%, whereas hydrogen-consuming bacteria decreased from 1.27% to 0.76%. *Clostridium pasteurianum* remained dominant and was further enriched. PICRUSt2-based predictions indicated greater potentials for pyruvate oxidation, hydrogen evolution, acetate and butyrate formation, and electron transfer. The predicted abundances of the acetate pathway, menaquinone biosynthesis, and Rnf/Rsx complex-related functions were 2.68, 2.32, and 1.83 times their pre-addition levels, respectively. These findings suggest that magnetite promoted hydrogen-producing bacteria and redox-related metabolic potential, thereby improving continuous dark fermentation performance at a short HRT.
Keywords: Dark fermentation; Dynamic membrane bioreactor; Magnetite; Biohydrogen production; PICRUSt2

[P17]

Integrated Acidogenic Fermentation and Vivianite Crystallization for Concurrent Phosphorus and Organic Acid Recovery

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Abstract:

Recovering phosphorus and value-added organics from waste streams can reduce reliance on phosphate rock while mitigating nutrient discharge. This study investigated an integrated acidogenic fermentation-vivianite crystallization process for concurrent phosphorus capture and organic acid production from protein-rich waste. Central composite design batch tests evaluated pH, influent Fe/P molar ratio, and mixing speed. The highest vivianite purity (37.53%) was obtained at pH 8.2, Fe/P 2.5 mol/mol, and 400 rpm, indicating that pH and iron availability were the dominant factors governing mineral formation. Continuous operation was then assessed in a 2 L anaerobic CSTR fed with casein at an HRT of 10 d. At an influent Fe/P ratio of 2.5, vivianite purity reached 39% and inorganic phosphorus precipitation increased to 71%. Meanwhile, 62.19 g COD/L of organic acids was recovered from 75 g COD/L of feed COD, corresponding to an organic acid recovery of 82.91%. Biological reduction converted 67.33 ± 0.1% of Fe(III) to Fe(II), accompanied by enrichment of iron-reducing bacteria. These findings show that acidogenesis can supply both organic acid products and biologically generated Fe(II) for vivianite formation. The integrated process therefore offers a promising clean-technology route for magnetic phosphorus separation and resource recovery from organic waste.

Keywords: Acidogenic fermentation; Biological iron reduction; Circular economy; Organic acid recovery; Phosphorus recovery; Vivianite crystallization

[P19]

Effect of starch concentration and operating temperature on batch biohydrogen production

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Abstract:
Carbohydrate-rich organic wastes containing starch can be converted into hydrogen through dark fermentation. In this study, the effects of substrate concentration and temperature on hydrogen production performance were evaluated in batch experiments. The substrate (starch) concentration was tested over a range of 5–40 g/L under mesophilic (35°C) and thermophilic (55°C) conditions. As a result, the highest hydrogen production performance was observed at a substrate concentration of 20 g/L under both mesophilic and thermophilic conditions. Under mesophilic conditions, a substrate concentration of 20 g/L resulted in a hydrogen yield of 2.60 ± 0.08 mol H_2/mol hexose $_{added}$, cumulative hydrogen production of 652.49 ± 4.24 mL H_2, and a hydrogen production rate of 55.23 ± 2.84 mL H_2/h. At the same substrate concentration under thermophilic conditions, the hydrogen yield and cumulative hydrogen production were 2.29 ± 0.99 mol H_2/mol hexose $_{added}$ and 585.29 ± 6.28 mL H_2, respectively. As the substrate concentration increased above 20 g/L, hydrogen yield decreased while residual substrate increased at both temperatures, indicating incomplete substrate consumption at higher concentrations. These results suggest that substrate concentration is an important factor affecting starch-based biohydrogen production and that 20 g/L could provide a reference condition for future continuous hydrogen production studies.

Keywords: Biohydrogen, Starch, Dark fermentation, Substrate concentration, Mesophilic, Thermophilic

[P23]

Electro-Fermentation Coupled Dynamic Membrane Bioreactor: Voltage-Dependent Shifts in Metabolic Flux and Hydrogen Yield

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Abstract:
To improve hydrogen recovery in continuous dark fermentation, this study coupled electro-fermentation (EF) with a dynamic membrane bioreactor (DMBR-EF) and examined how applied voltage governs metabolic flux and hydrogen yield. The combined system was operated for 59 days under glucose feeding, with voltages applied sequentially at 0 (control), 0.2, 0.4, 0.6, 0.8, and 1.0 V to trace the voltage-dependent regulation of fermentative metabolism. Among the tested conditions, 0.2 V yielded the best performance, achieving a hydrogen production rate (HPR) of 15.35 ± 0.48 L H_2/L/d and a hydrogen yield (HY) of 1.54 ± 0.05 mol H_2/mol $glucose_{added}$, which were 33.71% and 33.91% higher than those of the unpowered control, respectively. This optimal condition was accompanied by near-complete glucose consumption, reduced effluent volatile suspended solids (VSS), a shift toward butyric acid-type fermentation (HBu), and suppression of lactic acid (HLa) accumulation. When voltage exceeded 0.4 V, however, hydrogen recovery declined as metabolic flux was progressively diverted toward HLa, propionic acid (HPr), formic acid (HFo), and homoacetogenesis, indicating that excessive electrochemical input favors non-hydrogenic or hydrogen-consuming pathways. Microbial community analysis confirmed Clostridium as the dominant genus across all voltage conditions, while applied voltage reshaped the relative abundance and metabolic contribution of individual Clostridium-associated amplicon sequence variants (ASVs). Overall, these findings demonstrate that a mild voltage of 0.2 V provides the most favorable electrochemical environment for continuous hydrogen production in DMBR-EF systems by enhancing butyric acid fermentation, limiting lactic acid buildup, and minimizing hydrogen loss to competing pathways, whereas higher voltages progressively undermine hydrogen recovery by redirecting metabolic flux toward less hydrogen productive routes.

Keywords: Biohydrogen production, dynamic membrane bioreactor, electro-fermentation, applied voltage, metabolic flux, *Clostridium*.

[P24]

Enhanced Methane production through DES- Thermal Pretreatment of *Sargassum horneri*_

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Abstract:
Sargassum horneri(S.horneri), a brown algae responsible for recurrent golden-tide events, has considerable bioenergy potential. However, its rigid polysaccharide-rich cell wall limits biodegradability during anaerobic digestion (AD), resulting in low methane yields. In this study, a deep eutectic solvent (DES)-assisted thermal pretreatment based on choline chloride and ethylene glycol (ChCl-EG) was applied to improve methane production from *S.horneri.* The effects of pretreatment temperature (70-150℃), reaction time(1-12h), and ChCl:EG molar ratio (1:1-1:3) were systematically evaluated and optimized using a face-centered central composite design (FCCCD) and response surface methodology (RSM). The optimal pretreatment condition was identified as 110℃ for 1h with a ChCl:EG molar ratio of 1:1, achieving the highest methane yield of 279.2mL CH_4/g COD. The enhanced performance was attributed to improved organic matter solubilization and substrate accessibility. These results demonstrate that DES-assisted thermal pretreatment is an effective strategy for enhancing AD performance and promoting the sustainable valorization of marine biomass.

Keywords:
Brown algae, Deep eutectic solvents, Pretreatment, Anaerobic digestion, Microbial analysis

Acknowledgment
This research was supported by the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (MSIT) (RS-2024-00345011 and RS-2024-00408787).

[P25]

Enhanced Dark Fermentative Biohydrogen Production through Granular Activated Carbon Addition and Bioaugmentation

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Abstract:
This study was conducted to enhance biohydrogen production and maintain stable hydrogen generation under shortened hydraulic retention time (HRT) conditions in a dark fermentative process using an upflow anaerobic sludge blanket (UASB) reactor. To achieve this, activated carbon (AC) was introduced to improve microbial attachment and electron transfer efficiency, while bioaugmentation with *Clostridium pasteurianum* was applied to promote the dominance of hydrogen-producing bacteria. As a result, the maximum hydrogen production rate (HPR) and hydrogen yield (HY) reached 83.08 ± 2.34 L /L·d and 1.91 ± 0.04 mol H_2/mol glucose $_{consumed}$, respectively. Notably, stable hydrogen production was maintained even at the shortest HRT of 1 h, with an HY of 1.39 ± 0.04 mol H_2/mol glucose $_{consumed}$. These improvements were attributed to enhanced microbial retention by AC and the enrichment of functional hydrogen-producing microorganisms through bioaugmentation, which effectively mitigated biomass washout. Organic acid analysis revealed that butyrate-type fermentation remained the dominant metabolic pathway. Microbial community analysis further showed that the relative abundance of *C. pasteurianum* increased to 85.6% following bioaugmentation. These results indicate that metabolic flux was directed toward hydrogen production, thereby improving process stability and biohydrogen productivity. Furthermore, the combined application of activated carbon and bioaugmentation improved reactor stability under shortened HRT conditions by enhancing biomass retention and maintaining the activity of hydrogen-producing microorganisms.

Acknowledgment
This work was supported by the National Research Foundation of Korea (NRF) funded by the Ministry of Science and ICT (MSIT), Republic of Korea (RS-2024-00345011 and RS-2024-00408787).

Keywords: Biohydrogen, UASB, Dark fermentation, biofilm carrier, Bioaugmentation

[P28]

From seaweed to sustainable bioplastics: A microbial biorefinery approach

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Abstract:
Macroalgae (seaweed) has emerged as a promising renewable feedstock for sustainable polyhydroxyalkanoate (PHA) production because of its high biomass productivity, rapid growth, and minimal requirement for arable land and freshwater. This study explores the use of the halophilic bacterium *Halomonas* sp. YLGW01 for poly(3-hydroxybutyrate) (PHB) production from seaweed-derived sugars. The development of sustainable bioplastics is increasingly important as global plastic production is projected to reach 1.8 billion tons by 2050, while conventional plastics continue to accumulate in the environment and generate persistent microplastic pollution. PHAs are biodegradable and biocompatible microbial polyesters synthesized under carbon-rich and nutrient-limited conditions and represent an attractive alternative to petroleum-based plastics. However, their widespread commercialization is hindered by high production costs. Macroalgae offers an economical substrate owing to its high carbohydrate content, low lignin composition, and limited pretreatment requirements. In this study, the red macroalga *Eucheuma spinosum* was hydrolyzed using acid and enzymatic pretreatment to generate fermentable sugars. The hydrolysate was detoxified using biochar derived from *E. spinosum*, removing 87.9% of aromatic inhibitors while preserving fermentable sugars. Among the inhibitors examined, furfural exhibited the strongest inhibitory effect on microbial growth. Using detoxified, unsterilized hydrolysate, *Halomonas* sp. YLGW01 produced 3.88 ± 0.04 g/L PHB with a cell dry biomass of 6.32 ± 0.16 g/L. These findings demonstrate the potential of integrating macroalgal biomass, biochar-based detoxification, and halophilic microbial fermentation to establish cost-effective, non-sterile microbial biorefineries for sustainable bioplastic production.

Keywords: Macroalgae; seaweed; polyhydroxyalkanoate; *Halomonas* sp.

[P29]

A facile strategy for constructing porous N-doped carbon nanosheets integrated with Co/CoO nanoparticles to promote efficient activation of peroxymonosulfate

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Abstract:
Persistent organic contaminants in aquatic environments remain difficult to eliminate using conventional treatment processes, highlighting the need for more efficient oxidation technologies. Peroxymonosulfate (PMS)-based advanced oxidation processes have attracted considerable attention because PMS can be activated to generate highly reactive species capable of rapidly oxidizing refractory pollutants. In particular, cobalt-based catalysts are promising PMS activators owing to the favorable redox properties of Co species.

Herein, a porous Co/CoO nanoparticle-decorated N-doped carbon nanosheet composite (Co/CoO-NC) was prepared through a simple one-pot thermal reduction method. The integration of Co/CoO nanoparticles with the N-doped carbon framework promoted efficient PMS activation and resulted in rapid degradation of 4-chlorophenol (4-CP). Complete removal of 4-CP was achieved within 30 min even at a low catalyst dosage. The Co/CoO-NC catalyst also maintained effective degradation performance over a broad pH range. In addition, its magnetic characteristics facilitated straightforward recovery from aqueous solution, while repeated-cycle tests demonstrated favorable catalytic stability.

Electron paramagnetic resonance (EPR) spectroscopy together with radical-quenching experiments was employed to elucidate the oxidation mechanism. The results confirmed the simultaneous generation of sulfate radicals ($SO_4^{\bullet-}$) and hydroxyl radicals (•OH), with $SO_4^{\bullet-}$ serving as the predominant reactive species responsible for 4-CP degradation.
These findings demonstrate that coupling Co/CoO nanoparticles with porous N-doped carbon nanosheets provides an effective strategy for enhancing PMS activation and offers a promising catalyst design for the treatment of refractory organic contaminants.

Keywords: PMS activation; Cobalt oxide; Persistent organic pollutants; Advanced oxidation process; Free radicals

[P30]

Optimal Design of a Passive Fluid Oscillating Mixer in a Recirculating Microbial Fuel Cell

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Abstract:
This study introduces a passive fluid-oscillating mixer integrated into the anode chamber to address bottlenecks in concentration-difference polarization and mass transfer during the scale-up of circulating microbial fuel cells (MFCs). Using two-dimensional transient computational fluid dynamics (CFD) and verification of battery electrical properties, the study systematically investigates how geometric variables affect mixing efficiency and the flow field. At a fixed Reynolds number of Re=2500, the R10 circular chamber without a distributor plate exhibits optimal vortex dissipation and global chaotic convection. Electrical verification shows that the fluid-oscillator mixer configured with a parallel flow rate of 40 ml/min (FO40) achieves a maximum power density of 0.391 W/m2, 5.4 times that of the control group without an oscillator, and the ultimate current density reaches 7.24 A/m2. Microscopic micrographs confirm that this optimized flow field promotes the formation of a dense, mature biofilm network of Shiwacellia, expanding the contact area for extracellular electron transport. This study demonstrates the complete causal chain of 'flow field geometry—chaotic mass transfer—biofilm morphology—electrical gain,' providing a key hydraulic control solution for the next generation of MFC industrial scale-ups with low energy consumption and high mass transfer.

Keywords: microbial fuel cells, fluid oscillators, passive mixing, Conda effect, *Shivattella bacteria*

[P31]

Effect of surfactant pretreatment for diesel pollutant remediation in a floating PVB-TiO_2 microbial fuel cell

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Abstract:
To address the critical issue of marine crude oil spills and simulate realistic ocean environments, this study integrates multiple key variables, including oil spill concentration, water matrices (freshwater and natural seawater), and the emulsification process induced by ocean currents. In the experiment, diesel solution (500 mg/L) was first emulsified using the pure soy lecithin (5-20 g/L) and biodegradable dishwashing liquid (BDL) (20-40 g/L). The results show that the peak emulsified efficiency was occurred at pure soy lecithin 20 g/L and biodegradable dishwashing liquid 30 g/L. Subsequently, a thin-film gel was fabricated by combining titanium dioxide (TiO_2) photocatalysts with sodium alginate. Upon assembling these components, ultraviolet (UV) irradiation for 4 h was applied to initiate primary photocatalytic decomposition, followed by a secondary decomposition stage utilizing a Microbial Fuel Cell (MFC) to compare the degradation efficiencies of emulsified and non-emulsified diesel. The anodic chamber was fed with a mixture of anaerobic digestate, photodegraded diesel solution, and Endo nutrient formula under freshwater and seawater, respectively. Concurrently, the cathodic chamber was supplied with 50 mM $K_3Fe(CN)_6$. The MFC was subsequently operated in a sequencing batch mode at 37 °C with an initial pH of 7.0. The results show that peak voltages were generated at 31.04 mV while using BDL 0 g/L in freshwater and 37.21 mV while using BDL 40 g/L in seawater, respectively. This comprehensive model successfully replicates the multi-variable environmental conditions encountered by diesel in the ocean, significantly enhancing the applicability and authenticity of the experimental design. The results demonstrate that hydrogen-producing bacteria were successfully cultivated, proving their capability to degrade emulsified diesel within a seawater matrix.

Keywords: Microbial Fuel Cell (MFC), diesel emulsification, surfactant, seawater matrix.

[P32]

Optimizing cultivation conditions for a novel enrichment method for marine biosurfactant consortium producers

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Abstract:
Biosurfactant are green and environmentally friendly molecules, which can disperse hydrocarbons into tiny droplets, reducing surface tension and increasing their availability for microbes. One of the pathways involve in production of biosurfactant to break the hydrocarbons into smaller units for the accessibility and bioavailability of microbes. The cultivation of biosurfactant producers is the main factor in order to achieve the high quality of biosurfactant. The chemical structures, surface tension reduction, emulsion stabilizing of bio-surfactant, and the microbial community structures were observed to elucidate the enrichment performances. In this study, the enrichment was done with three different substrate which is diesel, mixture of diesel and sodium lactate and mixture of diesel with glucose. As a results, the highest yield of biosurfactant is the mix culture that cultivate using mixture of diesel and glucose with 7.6 g/L of the crude biosurfactant concentration, the highest reducing surface tension of 29.27 mN/m. The temperature and pH of the cultivation were optimized using response surface methodology (RSM) to evaluate the surface tension and biosurfactant concentration. As a results, the optimum pH and temperature was at pH 4 and 45 °C that yield the highest biosurfactant concentration of 28.75 g/L and lowest surface tension of 57.32 mN/m.

Keywords: Diesel pollutant, biosurfactant, nitrogen source, RSM.

[P35]

A Stepwise Deployment Framework for Industrial Effluent Resource Recovery

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Abstract:
The strategic management of industrial effluent represents a key foundation of circular sustainability, integrating water recycling and reuse, energy generation, and nutrient recovery. However, a significant gap exists between the laboratory-proven performance of advanced treatment technologies and their real-world operational viability, particularly when deployed in resource-constrained, developing regions. This study evaluates the implementation of four key water resource recovery pathways—water reuse, nutrient reclamation (via struvite precipitation and biological nutrient removal), anaerobic digestion (AD), and membrane bioreactor (MBR) systems—with a specific focus on the food, beverage, and textile sectors. A central finding of this study is the "MBR Paradox": while MBR systems deliver exceptional effluent quality under stable operating conditions in high-income countries, their deployment in developing economies is severely obstructed by high setup costs, high energy demands, grid instability, and a lack of a specialized maintenance workforce. To address these infrastructural and financial bottlenecks, we introduce the Stepwise Feasibility Deployment Framework (SFDF). The framework sequences technology adoption according to local infrastructure readiness and policy and regulatory intensity—prioritizing low-CAPEX, stable technologies like AD and struvite precipitation in the short term, transitioning to biological nutrient removal in the medium term, and establishing advanced membrane filtration as a long-term goal. By aligning technological options with regional capacity, this study provides a realistic roadmap to reduce global wastewater disparities, where low-income nations currently treat less than ten percent of industrial effluents. Ultimately, this framework guides policy-makers and industries transitioning from linear waste disposal to circular resource recovery.

Keywords: Circular economy; Industrial effluent; Water reuse; Resource recovery; Membrane bioreactor; Stepwise Feasibility Deployment Framework (SFDF); Textile industry; Techno-economic viability

[P37]

Rapid SOC Estimation for the Sorting and Reuse of Used Primary Zinc–Carbon Batteries Using Short-Duration Feature Fusion and Random Forest Regression

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Abstract:
The extensive use of primary batteries has increased the need for efficient sorting and potential reuse of used batteries. Rapid and accurate estimation of state of charge (SOC) is important for improving recycling efficiency, reducing unnecessary disposal, and supporting circular use of battery resources. However, zinc-carbon primary batteries exhibit voltage recovery after discharge. This behavior causes the measured terminal voltage to deviate from the actual SOC and reduces the accuracy of conventional methods based on open circuit voltage. This study presents a rapid SOC estimation method for used zinc-carbon primary batteries using short duration feature fusion and random forest regression (RFR). The total measurement duration is two seconds, with one second under open circuit conditions and one second under load. Five physical features are obtained, including open circuit voltage, loaded voltage, load current, voltage difference, and DC internal resistance. These features are combined into a multidimensional input vector, and the RFR model is used to establish the nonlinear relationship between the measured features and SOC. Experiments were conducted using Panasonic AA zinc-carbon batteries under different rest periods. The results indicate that the fusion of multiple electrical features reduces SOC estimation errors associated with voltage recovery and polarization while maintaining satisfactory accuracy within the short measurement period. The proposed method may support automated sorting of used primary batteries and improve battery recovery, resource reuse, and pollution prevention.

Keywords: Primary battery, state of charge, used battery sorting, feature fusion, random forest regression

[P38]

Integrating Grey Relational Analysis and Machine Learning Algorithms for Predicting Anaerobic Hydrogen Production Rates

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Abstract

The hydrogen production rate (HPR) in anaerobic fermentation systems is influenced by complex biochemical parameters, and its non-linear nature increases the difficulty of precise prediction. This study aims to integrate grey relational analysis (GRA) with machine learning (ML) algorithms across various operating conditions. The research utilizes a dataset consisting of 197 samples and 11 input features, including critical indicators such as pH, volatile fatty acids (VFA), volatile suspended solids (VSS), organic acids (acetate, butyrate, etc.), and oxidation-reduction potential (ORP) from a biohydrogen-producing CSTR (continuously stirred-tank reactor) using sucrose as feedstock. The methodology follows a systematic five step pipeline: (1) data cleaning and MinMax normalization; (2) ranking features by their grey relational grade with HPR using GRA; (3) incremental feature addition based on these rankings; (4) benchmarking five regression models (SVM, DT, RF, KNN, and XGBoost); and (5) providing model interpretability through SHAP (Shapley Additive Explanations) values and correlation heatmaps. Experimental results demonstrate that with all 11 features, the K-Nearest Neighbors (KNN) model outperformed others, achieving a coefficient of determination (R^2) of 0.817 and the lowest prediction error (RMSE=0.113). Furthermore, feature subset selection revealed that KNN reached peak performance (R^2 ≈0.822) using only the top eight features (e.g., pH, VFA, and VSS), suggesting significant potential for simplifying sensor configurations in industrial settings. Regarding interpretability, SHAP analysis indicated that the lower-range ORP (ORP_Low) and butyrate concentration were the most influential contributors to the prediction. This finding aligns with established biochemical mechanisms where a strongly reductive environment favors hydrogenase activity, confirming that the model has captured scientifically sound correlations. This study emphasizes the necessity of "transferring the analytical pipeline rather than just the single best model," providing a robust data-driven solution for the monitoring and optimization of biohydrogen production.

Keywords: Anaerobic Hydrogen Production, Grey Relational Analysis, Machine Learning, Hydrogen Production Rates.

[P39]

Using social return on investment to evaluate the impact of a green synergy eco-farm in a social enterprise

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Abstract
Yu-Ren Garden, operated by the Chang Hsiu-Chiu Foundation, initiated a poultry farming program with 500 hens to enhance the foundation's financial sustainability. However, this model also introduced critical environmental challenges, including poultry odors, chicken manure accumulation, and carbon emissions. To address these ecological issues, this innovative project integrated green technology with social welfare, engaging 20 vulnerable placement youths as primary participants to foster their career transition skills and psychological resilience. Adhering to international SVI standards, this study applied an evaluative Social Return on Investment (SROI) methodology. The team established a cross-disciplinary welfare-technology partnership; deployed an on-site modular anaerobic biogas digester under professional technical guidance; and trained youths to manage the hens while conducting five consecutive monthly egg sales to internalize their financial literacy. Furthermore, deadweight, displacement, attribution, and drop-off factors were rigorously calculated and deducted to prevent overestimation of the project's impact. With an investment of NT$1,384,765.00, the project achieved a conservative SROI of 2.80:1 (every NT$1 invested returned NT$2.80 of social impact value), aiming to become a pioneering social enterprise model for self-sustaining micro-livestock farms. While this short 4.5-month evaluation underrepresents the long-term, non-quantifiable progress of youth psychological rehabilitation, the ecological impact was immediate: 1.2 tons of manure were converted into 7.4 m3 of biogas and 3,475 kg of bio-fertilizer. Socially, youth life satisfaction surged from 2.8 to 7.0. Although cross-disciplinary synergy is verified, youth psychological rehabilitation fluctuations demand long-term tracking, which was restricted by the 4.5-month project duration, leading to a conservative valuation. Future initiatives should establish grid-connected power generation infrastructure and transition to active impact management by implementing rolling three-stage assessments and digitalized growth profiles for multi-year tracking.

Keywords: Social Return on Investment (SROI), Cross-disciplinary Collaboration, Circular Economy, Social Enterprise, SDGs

[P40]

An Interdisciplinary Smart Campus Platform for Integrated Energy–Carbon–Finance–Governance Management toward Net-Zero Transformation

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Abstract
Driven by the increasing demands for intelligent campus operations and net-zero transformation, real-time monitoring of equipment conditions and energy performance has become essential for operational reliability, carbon emission mitigation, and accountable sustainability governance. This study proposes an interdisciplinary smart campus platform for integrated energy–carbon–finance–governance management. The proposed framework combines YOLO-based object detection, wavelet transform denoising, long short-term memory forecasting, and a physics-informed temperature–power–carbon mapping mechanism to establish a traceable relationship among equipment conditions, energy losses, carbon emissions, financial impacts, and governance indicators. An IoT-enabled infrastructure acquires thermographic, electrical, equipment-status, and environmental data at granular temporal and spatial resolutions. The platform localizes campus equipment and detects abnormal thermal patterns, while wavelet denoising suppresses environmental interference and preserves dominant signal characteristics. The extracted multivariate features are processed by an LSTM-based forecasting model to estimate equipment energy dissipation, carbon-emission dynamics, and emerging operational risks. Energy consumption and carbon-emission records are translated into measurable cost, asset-performance, maintenance-risk, and sustainability metrics, thereby creating a verifiable data lineage from physical operation to financial assessment and governance disclosure. Experimental evaluations demonstrate the proposed system achieves superior accuracy and stability, with a mean absolute percentage error (MAPE) below 5%. In addition to accurate anomaly detection and trend forecasting, the framework supports proactive maintenance, real-time alarming, carbon allocation, evidence-based sustainability reporting, and data-driven decision-making for low-carbon campus operations and long-term net-zero transformation.

Keywords: energy-carbon aware management; financial performance, governance accountability; circular economy.

[P41]

Development of Antibacterial Biochar Modified with Metal-Based Compounds

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Abstract:
In this study, biomass wastes from bamboo and branches were used as raw materials. The materials were cut, weighed, combusted with the fuel of alcohol, quenched with water, and oven-dried to prepare biochar. The prepared biochar was then immersed in a 1% metal nitrate solution for 5 h. After centrifugation, the recovered solid material was treated with a 5% reduction agent for 1 h to obtain wet metal-contained biochar. The bacterial suspension experiment was conducted using LB medium. The absorbance of each sample was measured at a wavelength of 600 nm, and the result was expressed as OD600 values. These measurements were used to compare changes in turbidity and bacterial growth trends among the different metals.

The results showed that the biochar yields varied with the different of biomass resources. This variation may have been affected by differences in material properties. In the bacterial suspension experiment, the OD600 value of the silver-contained biochar group were lower than the other of the bacterial suspension control group and the biochar group at most measurement times. These results suggest that the silver-containing biochar may have inhibited bacterial growth trends or reduced the turbidity of the bacterial suspension.

In addition, a life cycle inventory framework was established for the preparation of biochar and silver-contained biochar. The inventory includes waste biomass materials, combustion aids, silver nitrate, reduction agent, and water were used, equipment energy consumption, transportation, and wastewater generation. This framework was served as the basis for subsequent product carbon footprint estimation. Overall, this study established an experimental procedure for biochar production from biomass waste, silver ion reduction treatment, and OD600 measurement of bacterial suspensions. The silver-contained biochar showed preliminary inhibitory potential toward bacterial growth trends with a lower carbon emission.

Keywords: biochar, silver, life cycle inventory, antibacterial, OD600 measurement.

[P42]

Development of Composite Biochar by Recycle PET and Spent Coffee Grounds

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Abstract:
Spent coffee grounds (SCG) and Polyethylene terephthalate (PET) are widely generated food and plastic wastes that contribute to environmental pollution. This study investigates the co-pyrolysis of SCG and PET across various mixing ratios, focusing on product distribution, synergistic interactions, pyrolysis kinetics, and the potential of maximal biochar for value-added applications. The maximum biochar yield (45 wt%) was obtained at a 70:30 SCG:PET ratio, where synergistic effects enhanced carbon content and reduced hydrocarbon compounds in the biochar. The resulting biochar showed improved carbon content and heating value, making it a potential alternative to green fuel. Kinetic analysis indicated that first-order kinetics and diffusion models best described the degradation behavior of SCG, PET, and their blends. The addition of PET also improved biochar properties by promoting higher surface area and carbon content while minimizing oxygen and sulfur levels, making it suitable for soil remediation and carbon sequestration. These results demonstrate that SCG–PET co-pyrolysis is an effective waste-to-energy strategy, producing high-quality biofuels and biochar.

Keywords: spent coffee grounds, polyethylene terephthalate, biochar, co-pyrolysis, green fuel.

[P43]

Direct seawater electrolysis by bamboo biochar modified electrode for green hydrogen production

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Abstract:
Direct seawater electrolysis (DSE) is vital for sustainable green hydrogen production but is severely hindered by extreme salinity and mineral scaling. This study evaluates the catalytic performance and structural durability of carbon conductive ink-modified bamboo biochar electrodes against bare graphite in high-concentration (3.5M) simulated seawater (KCl, NaCl, $MgCl_2$, and $CaCl_2$). Chronopotentiometric assessments demonstrate that the porous architecture and superior conductivity of biochar-graphite consistently yield higher hydrogen evolution rates and optimize gas detachment through a dynamic microscopic bubble traffic system. While monovalent systems exhibit stable, Arrhenius-driven kinetics, divalent systems suffer from severe "dynamic deactivation" induced by mineral scaling. However, the carbonaceous layer serves as a robust, solidophobic protective framework that preserves catalyst integrity and significantly delays performance decay. Furthermore, bulk pH analysis reveals a unique "buffering effect" in divalent media, where cathodic hydroxyl species are stoichiometrically trapped by insoluble $Mg(OH)_2$ and $Ca(OH)_2$ precipitates. Ultimately, these findings underscore the strategic role of carbon-supported matrices in enhancing catalyst longevity and resilience for viable marine-based hydrogen production.

Keywords: direct seawater electrolysis, bamboo biochar, chronopotentiometry, Arrhenius-driven kinetics, hydrogen production.

[P44]

Effects of Light Source and Photoperiod on Germination Rate and Antioxidant Activity of Off-Grade Mixed-Variety Rice

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Abstract:
Off-grade rice (broken, defective, and mixed-variety grains) accounts for up to 44% of paddy processed at a commercial Taiwanese rice mill, yet remains an underutilized low-value byproduct despite its nutritional potential. This study valorized mixed-variety off-grade rice via germination, evaluating light source, intensity, and photoperiod effects on germination rate and resulting bioactive properties for food and cosmetic applications. Germination trials were conducted under seven light conditions at three intensities and two photoperiods. Germinated grains were water-extracted and analyzed for protein, polysaccharide, total phenolic, flavonoid, and γ-aminobutyric acid (GABA) content, antioxidant capacity (DPPH, ABTS, reducing power, ferrous chelating, FRAP, SOD-like), and tyrosinase inhibition for whitening potential. The optimal condition was purple light at 223 μmol/m^2 under a 24 h photoperiod for 72 h, achieving 92% germination. Under this condition, GABA rose sharply from trace levels to 27.52 mg/100 g, while protein, polysaccharide, phenolic, and flavonoid contents changed minimally. At an extract concentration of 68.25 mg/mL, germinated rice extract showed strong antioxidant activity (DPPH 80%, ferrous chelating 79%, SOD-like 78%) and notable tyrosinase inhibition. These results demonstrate that light-modulated germination effectively converts discarded off-grade rice into a GABA-enriched, antioxidant-rich functional ingredient with promising applications in functional foods and cosmeceuticals, supporting circular economy valorization of agricultural byproducts.

Keywords: Off-grade rice; germination; γ-aminobutyric acid (GABA); antioxidant activity; circular economy; agricultural waste valorization

[P46]

Eco-Friendly Electrochemical Fabrication of Fe–Mn Phosphate Composite Coatings for Sustainable Corrosion Protection of Steel in Chloride-Contaminated Concrete Environments.

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Abstract:
Phosphate conversion coating has been recommended as a possible means to improve the corrosion performance of steel reinforcement bars. It served as a physical barrier, preventing the permeation of moisture and aggressive chloride ions and delays the onset of corrosion. However, the thickness of the conventional chemical conversion phosphate coatings (< 10 µm) is not sufficient enough to provide the desired corrosion resistance in aggressive environments. Further, growing environmental concerns have driven the development of sustainable, low-toxicity phosphate coating processes that enhance coating performance while reducing environmental impact. In this study, a facile cathodic electrochemical deposition process was employed to fabricate iron – manganese phosphate composite coatings on steel substrates as a sustainable corrosion protection strategy. Deposition parameters, including current density (2-5 $mA.cm^{-2}$) and treatment time (10-60), were systematically optimized to obtain high-performance protective coatings. The deposited coatings were characterized using Fourier-transform infrared (FT-IR) and Raman spectroscopy, scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), and X-ray diffraction (XRD) to investigate their chemical composition, morphology, elemental distribution, and phase constituents. The corrosion performance of the coated steel was evaluated by potentiodynamic polarization and electrochemical impedance spectroscopy (EIS) after immersion for 1, 24, 72, and 168 h in a simulated concrete pore solution containing 3.5 wt.% NaCl, representing aggressive chloride exposure conditions. The findings of the study indicate that composite coatings produced at 5 mA/cm^2 for 30 min provided the highest corrosion resistance that accounts to ~85% enhancement in barrier protection relative to uncoated steel.

Keywords: Steel, cathodic electrochemical deposition, Fe-Mn phosphate composite coating, simulated pore solution, corrosion resistance

[P47]

Chrome-Free Tartaric Acid Anodization with Inhibitor Sealing: A Sustainable Approach for Corrosion Protection of Aerospace Aluminium Alloys

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Abstract:
Chromic acid anodization (CAA) is widely used to enhance the corrosion resistance of aerospace-grade aluminium alloys, but the environmental toxicity and carcinogenic hazards of hexavalent chromium necessitate non-toxic, compliant alternatives. This study presents a sustainable, chrome-free surface engineering strategy integrating tartaric acid anodization (TAA) with an eco-friendly organic corrosion inhibitor sealing treatment. The TAA process generates a structured porous oxide film, while the subsequent inhibitor sealing promotes effective pore filling and forms an aggressive barrier layer, eliminating the need for hazardous chromium-based post-treatments.
The electrochemical performance and surface characteristics of the treated aluminium alloy were systematically evaluated using electrochemical impedance spectroscopy (EIS), potentiodynamic polarization (PDP), and microstructural characterization techniques. Electrochemical analysis revealed that the inhibitor-sealed TAA coating provided superior barrier protection over unsealed anodized surfaces, marked by a substantial increase in polarization resistance (Rp), a elevated charge-transfer resistance (Rct), and a lower corrosion current density (icorr). Surface analysis confirmed successful inhibitor entrapment within the porous anodic matrix, directly contributing to enhanced film integrity and durability under corrosive environments.
By substituting toxic hexavalent chromium with a tartaric acid and organic inhibitor system, this approach delivers a high-performance, environmentally responsible solution that meets aerospace durability standards. This work demonstrates a scalable pathway for clean manufacturing and pollution prevention in next-generation sustainable corrosion protection.

Keywords: Anodization; Corrosion; Inhibitors; Environmental Pollution; Sustainable technology.

[P48]

Bioelectrochemical Systems for Sustainable Treatment of Antibiotic- and Emerging Contaminant-Laden Wastewaters

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Abstract:
The extensive use of antibiotics worldwide has led to their accumulation in aquatic environments, posing serious concerns related to antibiotic resistance, genotoxicity, and ecological disruption. The persistence of active antibiotics in sewage can alter microbial communities and promote the proliferation of drug-resistant bacteria, highlighting the need for efficient and sustainable treatment technologies. Microbial fuel cells (MFCs) offer a promising approach for wastewater treatment coupled with bioelectricity generation. In this study, a single-chamber multi-electrode microbial fuel cell (MEMFC) with three electrode assemblies was evaluated for the bioelectrochemical degradation of amoxicillin (AMX) over a 7-day hydraulic retention time using a mixed microbial consortium derived from a sewage treatment plant. The AMX degradation profile, microbial community, and potential degradation mechanisms were investigated. The MEMFC achieved a maximum current output of 330 mA with an open-circuit voltage of 589 mV and 78% AMX degradation in the absence of sewage. COD removal reached 83.5% with sewage, 75% with glucose supplementation (3 g/L), and 65% with sewage plus glucose. The enhanced performance of MEMFCs can be attributed to electroactive biofilm formation, microbial metabolism, extracellular electron transfer, and electrochemical reactions occurring at the electrodes. Overall, MEMFCs demonstrate considerable potential for scalable, reliable, and energy-generating treatment of pharmaceutical-contaminated wastewater. Bioelectrochemical systems hold significant promise as next-generation wastewater treatment platforms, with future advances in reactor design, microbial engineering, and scale-up expected to enable efficient removal of emerging contaminants while simultaneously recovering renewable energy.

Keywords: Amoxicillin degradation, Antibiotic wastewater, Pharmaceutical wastewater, Bioelectricity, Emergent contaminants

[P50]
Integrated Biorefinery Approach for Scalable Cultivation of *Haematococcus pluvialis* for Downstream Recovery of Natural Astaxanthin for valuable Applications

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Abstract:
The rising global demand for sustainable bioactive compounds has positioned microalgae as essential drivers in modern bio-refinery frameworks. Haematococcus pluvialis is widely recognized as the richest natural source of astaxanthin, a potent keto-carotenoid exhibiting antioxidant capacity far exceeding the alpha tocopherol and beta carotene. Despite extensive commercial potential in nutraceuticals, cosmetics, pharmaceuticals, and aquaculture, industrial expansion is hindered by high production costs, environmental sensitivity, and downstream processing bottlenecks.
This study presents an integrated, sustainable bioprocessing strategy to optimize H. pluvialis cultivation and streamline astaxanthin extraction. Upstream parameters include light intensity, photoperiod, temperature, pH, and nutrient composition were systematically optimized within a custom, eco-friendly bioreactor system to maximize biomass yield and carotenogenic. For downstream recovery, various solvent systems (acetone, ethanol, methanol, heptane, and petroleum ether) were screened, establishing 96% food-grade ethanol and acetone as safe, highly efficient extraction media. To prevent oxidative degradation during processing, alpha and beta carotene 0.02% (w/v) butylated hydroxytoluene (BHT) were evaluated as protective antioxidants. Astaxanthin content was quantified using UV-Vis spectrophotometry and HPLC (470–480 nm), while residual biomass (wet and dried) and oleoresin fractions were characterized by FTIR spectroscopy to facilitate complete biomass valorization.
The optimized protocol demonstrates high reproducibility, operational feasibility, and environmental sustainability, directly addressing critical scale-up barriers. By combining eco-friendly bioreactor cultivation with holistic co-product recovery, this work provides an economically viable, green roadmap for high-purity natural astaxanthin production tailored to global nutraceutical and cosmetic industries.

Keywords: Haematococcus pluvialis, Astaxanthin, Microalgae Biorefinery, Photobioreactor Optimization, Downstream Extraction, Biomass production.

[P51]

Pretreatment of liquid anerobic digestate using chitosan and zeolite for enhanced spirulina platensis cultivation

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Abstract:
Liquid anaerobic digestate (LAD) is nutrient rich by-product of anaerobic digestion that can cause significant environment challenge if discharge without adequate treatment. However, due to its high nutrient it can be use as alternative culture medium for sustainable *spirulina platensis* cultivation. *Spirulina* utilize essential nutrient like ammonia, nitrate and phosphate for their growth. However, high ammonia concentration and intense colour of LAD can adversely affect *spirulina* growth by causing ammonia toxicity and reducing light penetration thereby reducing Photosynthetic activity. Therefore, appropriate pretreatment of LAD is necessary to reduce ammonia and colour while retaining sufficient nutrient for effective *spirulina* cultivation. In this study LAD was pretreated using chitosan and zeolite to reduce ammonia and colour before its application for *spirulina* cultivation. Chitosan and zeolite were evaluated at different concentration, followed by cultivation of *spirulina* in the treated LAD. The optimized pretreatment achieved 46% colour removal and 96.5% ammonia removal substantially sustaining nitrate and phosphate in the LAD. Following pretreatment *spirulina* demonstrated successful growth and achieved a maximum biomass concentration of 1.53g/l . Overall, the integration of LAD pretreatment with microalgal cultivation provides a promising strategy for LAD remediation nutrient recovery waste valorisations and sustainable *spirulina* biomass production. contributing to a circular bioeconomy.

Keywords: Liquid anaerobic digestate, chitosan and zeolite, colour removal, ammonia removal, *spirulina platensis,* circular bioeconomy, microalgal cultivation

[P68]
Oxygen-Vacancy Screening of Perovskite Oxides for Thermochemical Energy Storage Using an Automated First-Principles Workflow

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Abstract:
Computational screening of redox-active perovskite oxides can accelerate the identification of materials with favorable oxygen exchange properties for high-temperature thermochemical energy storage (TCES). However, systematic first-principles investigations of these materials require numerous calculations involving structure preparation, defect generation, structural relaxation, convergence verification, and data analysis. This work presents an automated density functional theory (DFT) workflow for investigating oxygen-vacancy formation in perovskite oxides for TCES applications. The computational framework integrates Quantum ESPRESSO for electronic structure calculations, AiiDA for workflow management and provenance tracking, Python-based tools for structural preparation and post-processing, and high-performance computing resources for scalable execution. Crystal structures are automatically processed for supercell construction and crystallographic symmetry analysis, allowing symmetrically distinct oxygen sites to be identified and redundant defect calculations to be minimized. Oxygen-deficient structures are subsequently generated by removing oxygen atoms from unique lattice sites and subjected to standardized structural relaxation and electronic convergence procedures. Automated job submission, monitoring, error detection, restart procedures, and data extraction reduce manual intervention and improve consistency across large numbers of calculations. Calculated energies, optimized structures, convergence information, and associated workflow metadata are systematically archived with complete computational provenance. The modular architecture enables the same computational protocol to be applied across different perovskite compositions and oxygen-vacancy configurations while providing flexibility for future integration of additional computational methods. Overall, the developed framework establishes a reproducible and scalable platform for oxygen-vacancy formation energy calculations and future high-throughput screening of redox-active perovskite oxides for thermochemical energy storage and related energy-conversion applications.

Keywords: Density functional theory; Perovskite oxides; Oxygen-vacancy formation energy; Workflow automation; Thermochemical energy storage; High-throughput screening

[P69]

Performance, Emission and Stability Assessment of Commercial Gasoline Fuels for a Single-Cylinder Engine on a Chassis Dynamometer

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Abstract:
Almost all nations in the world currently use fuels that are non-renewable and whose prices rise year over year. These fuels are produced from fossil or living material that existed during an earlier geologic period. Because of this, the use of alternative fuels for internal combustion engines, whether diesel or petrol, has gained popularity all over the world. The other cause is the tight enforcement of laws relating to the regulation of automobile exhaust gas emissions. Everyone is aware that utilizing fossil fuels for transportation and power generation contributes to the current high levels of air pollution. This research work will help us to identify which fuel is ecofriendly to nature by evaluating the performance and emission characteristics of a spark ignition engine using different fuels. A further objective of the study was to investigate the effect of ethanol content on the performance and emissions of a spark ignition vehicle during various misfire conditions, since combustion instability strongly influences the pollutants that leave the tailpipe.

Nine commercially available gasoline fuels obtained from various Indian fuel suppliers, designated Fuel A through Fuel I, were taken for testing on a single cylinder, four stroke, fuel injected spark ignition two-wheeler engine of the 200-cc class mounted on a two-wheeler chassis dynamometer. Before the engine testing, each fuel was characterized for its Research Octane Number, density, kinematic viscosity, calorific value and injector delivery rate. Misfire was then induced systematically using a misfire generator at six different schedules, namely 100-4, 100-3, 100-2, 1001, 50-1 and 10-001, alongside a clean no misfire baseline. The individual fuels were tested for their performance and emissions during which these various misfires were induced, so that every fuel could be judged at its best as well as at its worst. At every condition, HC, CO, CO_2, NOx, O_2 and lambda were recorded from the tailpipe using an exhaust gas analyzer, and Brake Specific Fuel Consumption (BSFC) was derived from an in-line fuel flow meter. All the runs were repeated at identical throttle and load settings so that the fuel itself remained the only variable in the comparison.

Fuels with higher octane ratings and higher calorific values held up noticeably better as the misfire frequency climbed. Their HC and CO excursions were smaller and combustion in the firing cycles remained more complete, which indicates a greater tolerance to disturbed ignition. The oxygen concentration in the exhaust rose steadily with the number of skipped firing events, which confirms that a large share of the unburnt charge was passing straight through the cylinder. NOx, on the other hand, tracked the air fuel equivalence ratio much more closely than it tracked octane number, and its response to misfire was non-monotonic across the fuel set. BSFC worsened with misfire severity for every fuel, although the penalty was smallest for the higher-grade blends. The results confirmed the best fuel to be used for better performance and lower emissions from the vehicle, and the dataset offers a practical benchmark for evaluating E10-blended and premium gasoline quality in the Indian market context.

Keywords: Spark ignition engine; commercial gasoline; ethanol blend (E10); misfire; chassis dynamometer; exhaust emissions; brake specific fuel consumption.

[P70]

Experimental Investigation of Hydrogen-Enriched Waste Tyre Oil–Diesel Blends in a CI Engine: Combustion, Performance, and Emission Characteristics

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Abstract:
Waste tyre oil (WTO) has shown potential as an alternative fuel for diesel engines due to its similar properties to conventional diesel. However, the high sulfur content and low cetane number of WTO can lead to increased emissions and reduced engine performance. This study aims to investigate the use of WTO along with induction of hydrogen at 3 LPM, 6 LPM, 9 LPM and 12 LPM respectively under dual fuel mode of operation where hydrogen inducted via air intake manifold was used to improve the fuel quality of WTO. The test was conducted in a single cylinder DI diesel engine at various load conditions. The test results were compared with neat diesel fuel and WTO B80 fuel at maximum loading conditions to evaluate the performance, combustion and emission characteristics which include brake thermal efficiency, cylinder pressure, heat release rate and emission characteristics of hydro-carbon, carbon monoxide and oxides of nitrogen by varying the induction rate of hydrogen. The results indicate that the optimal WTO B80 + 12 LPM of hydrogen achieved highest BTE of 33.87% with a peak HRR of 60.7 J/deg CA and maximum in-cylinder pressure of 76.52 bar. Emission analysis revealed reductions in HC, CO and smoke emission by 40%, 30% and 23.5% respectively and marginal increase in NO emission were observed for WTO B80 + 12 LPM hydrogen induction which concludes it as a suitable fuel for diesel engine compared to other test fuels without any major engine modifications.

Key words: Waste tyre oil, Hydrogen fuel, Efficiency, Pyrolysis, Dual fuel engine, Exhaust Emissions.

[P72]

Multifunctional high-entropy FeCoNiMoW-WO3 sensor for solar-driven sensing volatile organic compounds

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Abstract:

High-entropy materials, as emerging advanced functional materials, have shown great potential in the field of sensing technology in recent years. This study focuses on the application of multifunctional high-entropy photocatalysts in sensors and develops gas-phase sensing technology for volatile organic compounds (VOCs). This study synthesizing high-entropy materials and oxides by a CTAB (C19H42BrN)-assisted non-hydro sol-gel method and the sensor developed in this study, used for detecting changes in resistance in the gas phase, involves adding high-entropy powder to isopropanol (IPA), stirring, drop-coating it onto an electrode substrate, connecting it to a sensing instrument, and then performing variable modulation and analysis. The FeCoNiMo-WO3 and FeCoNiMoW-WO3 composite sensor exhibited enhanced acetone sensing performance, achieving significant response toward 10~1000 ppm acetone with excellent concentration sensitivity, stability, temperature control and selectivity over other VOCs sensor. The synergistic effect of high-entropy nanoparticles improved the catalytic activity and gas-sensing properties of WO3, demonstrating its potential as a low-cost, highly sensitive material for non-invasive disease diagnosis. This study shows that WO3 modified with high-entropy materials exhibit excellent repeatability and sensitivity for noninvasive disease diagnosis and industrial gas-sensing applications.

Keywords: High entropy materials; sensor; solar-driven; non-invasive diagnosis; acetone

[P74]

Co-Hydrothermal Liquefaction of Spirulina platensis with Date and Palm Biomass: Yield Trends Across Blend Compositions

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Abstract:
Reducing the carbon footprint of energy and industrial processes requires technologies that convert existing waste streams into usable fuels, rather than technologies that depend on new, resource-intensive feedstock production. Hydrothermal liquefaction (HTL) of microalgae is a promising route to renewable biocrude, but the cost and land/water footprint of dedicated algal cultivation constrain its standalone viability as a clean-energy technology. Co-liquefaction with agricultural residues, which are otherwise landfilled or burned, generating their own carbon and air-quality costs, offers a way to lower feedstock costs and waste-disposal emissions simultaneously, making HTL a more deployable decarbonization technology for regions with established date and palm agriculture.
This study investigates co-HTL of Spirulina platensis with date (seed and flesh) powder and palm leaf powder, across pure-feedstock controls and binary blends, to determine how co-substrate selection governs product distribution. Biocrude was recovered via dichloromethane extraction and biochar quantified gravimetrically. Across all runs, biocrude yields ranged from 0.7–46 wt% and biochar yields from 0.2–77 wt%. Pure-feedstock controls showed the widest yield ranges (biocrude 0.7–41 wt%; biochar 0.5–77 wt%). Date blends produced the highest biocrude yields observed (up to 46 wt%) with a similarly broad biochar range (0.2–71 wt%), indicating a favorable interaction between algal and date-derived intermediates during liquefaction. Palm leaf blends, by contrast, gave markedly narrower and lower yields for both products (biocrude 4.5–10 wt%; biochar 7–26 wt%), consistent with the more recalcitrant, lignin-rich character of palm leaf biomass limiting liquefaction efficiency.

These findings identify co-substrate selection as a first-order lever for tuning HTL product distribution and demonstrate that date residues are a more effective co-feedstock than palm leaves for maximizing biocrude recovery. The results support co-HTL as a scalable, low-carbon-footprint waste valorization strategy for regions where algal cultivation and date/palm agriculture coexist, contributing directly to reducing the carbon intensity of biofuel and biomaterial production.

Key words: hydrothermal liquefaction; microalgae; co-liquefaction; waste valorization; carbon footprint reduction; biocrude; date and palm biomass

[P75]

Application of economical pretreatment methods for liquefaction of marine macroalgae (*Ulva intestinalis*) for biohydrogen production

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Abstract
Marine macroalgae represent an abundant and renewable biomass resource with considerable potential for sustainable biohydrogen production. Biohydrogen is a clean energy carrier that can contribute to decarbonization and support circular bioeconomy approaches through the conversion of marine biomass into value-added energy. This study investigated economical physical pretreatment strategies, namely disperser and microwave pretreatment, to enhance the solubilization of marine macroalgal biomass and improve its suitability for dark-fermentative biohydrogen production. Disperser pretreatment was evaluated at 4000–12,000 rpm for 0–60 min, while microwave treatment was conducted at 0.1–0.5 kW using progressively shorter treatment durations at higher power levels. The optimal disperser condition was 8000 rpm for 40 min, resulting in a soluble chemical oxygen demand (sCOD) release of 1920 mg/L, together with carbohydrate and protein releases of 365 mg/L and 591 mg/L, respectively. Microwave pretreatment achieved substantially higher solubilization at 0.2 kW for 8 min, releasing 3200 mg/L sCOD, 1020 mg/L carbohydrate, and 529 mg/L protein. Furthermore, dark fermentation of disperser-pretreated algal biomass using camel dung as an anaerobic inoculum produced a maximum biohydrogen yield of 128 mL/g COD. These findings demonstrate that low-cost physical pretreatment can effectively improve substrate accessibility and enhance biohydrogen generation from marine macroalgae. The study also exhibited the dominance of *Clostridium* as the dominant strain, which potently accelerated the biohydrogen production during dark fermentation process. The proposed approach provides a promising pathway for integrating marine biomass valorization, renewable hydrogen production, waste-derived inoculum utilization, and circular-economy principles.

Keywords: Macroalgae, Biohydrogen, Solubilization, Bioenergy, Biomass, Dark fermentation

[P76]

Extraction and characterization of bio-diesel from *Botryococcus braunii* using heterogeneous Zn-MOFs catalyst

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Abstract:
Due to the overuse of fossil fuels, during various developmental activities in the field of automobiles, industries, and transportation, there has been an increase in the concentration of CO_2 levels into the green atmosphere. At the same time, there has been a significant increase in fuel costs due to the rapid depletion of fossil fuel resources. The green global habitats will quickly disappear, as a result. Currently, the most popular substitute for fossil fuel resources is biodiesel, made from different biomasses / microalgae species. In this study, a microalgal species namely *Botryococcus braunii* (Bb) was chosen for the potentiality to produce biodiesel via the trans-esterification path in the presence of Zn/H_2 heterogeneous catalytic medium, supported by a hexa-coordinated hetero Zn-MOF (2–aminobenzamide–*L*–histidine) as catalyst. The chemical composition profile of the isolated lipids was analyzed using proximate, elemental, and different spectral approaches viz. FT–IR, UV–*vis*., GC–Mass, ^{1}H and ^{13}C NMR. Additionally, SEM analysis was used to examine the microalgal structure and the results reveal that the surface morphology changed before and after the lipid extraction. The extracted bio-diesel were characterized. The engine characteristics of biodiesel blends B10, B20 and B50 were studied for their engine torque, BTE (ηbth), as well as BSFC, and outcomes were compared to the petro-diesel. The emissions analyses of specific exhausted GHG constituents, including HCs, CO, CO_2, $(NO)_x$, O_2, and smoke particulates, conducted after the combustion of the biodiesel blends B10, B20, and B50 at a minimum engine speed of 1000rpm, indicate that the emissions are negligible in comparison to those of B100 fuel, with the exception of $(NO)_x$ release. Additionally, the bio-diesel from the microalgae *B. braunii* (Bb) exhibits notable DNA and *in vitro* antimicrobial activities.

Key words: Zn(II)-MOF catalyst; *Botryococcus braunii*, Bio-diesel; Spectral; Engine characteristics; DNA and *in vitro* antimicrobial.

[P77]

Production of bio-diesel from *Chlorella* species using Ni(II)-Schiff base MOF: Engine performance and emission characteristics

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Abstract:
Microalgae biomasses represent the modern sustainable alternative bioenergy sources due to their enhanced lipid production relative to both edible and non-edible biomass. The unique genus *Chlorella*, among the microalgae species, has garnered considerable interest for biofuel production due to its higher lipid content, and the lipid yield can be enhanced by incorporating $FeCl_3$ during cultivation. The Ni / H_2 catalytically assisted transesterification, using a N(II)-Schiff base MOF chelate was used to extract bio-oil from three microalgal species, namely C_1 (*Chlorella vulgaris*), C_2 (*Chlorella* sp.), and C_3 *(Chlorella protothecoides*). After the extraction process, the produced bio-oil with a low viscosity of about 92% was tested systematically to determine the molecular constituents of the lipid molecule via various analytical evaluations viz. proximate, elemental, FT-IR, UV-*vis*, GC-Mass, ^{1}H NMR, and ^{13}C NMR. Further, thermogravimetry (TG / DTA) was used to evaluate its thermal characteristics. To determine the microalgae structure, SEM pictograms were taken both before and after the removal of lipid molecules. The bio-diesel fuel qualities were evaluated and compared to the predetermined standards. Additionally, different fuel blends C_1 B10, C_2 B10, C_3 B10 & C_1 B20, C_2 B20, C_3 B20 and C_1 B40, C_2 B40, C_3 B40 were used to assess the engine performance, further compared to petro-derived diesel B100. Besides, the emission analyses were carried out for CO_2, $(NO)_x$, exhaust, and smoke. The findings indicate that the BSFC of the C_1B10 blend was significantly lower than that of the other blends, aa a result of its diminished heating value and elevated viscosity. The improved brake specific fuel consumption (BSFC) of C_2B50 fuel at 1500 and 2000 rpm were found to be 4–5% and 3–4%, respectively as compared to the petro-diesel (B100).

Keywords: *Chlorella* species; N(II)-Schiff base MOF catalyst; Spectral; TG/DTA; Engine efficiency; SEM

[P78]

Physico-chemical, Engine Performance, Emission and Bioactivities of Rice bran derived biodiesel

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Abstract:
The rice bran (RB) constitutes 16–20% of crude rice bran oil (RBO) by weight, this study investigates the characteristics of biodiesel, produced from RBO via a heterogeneous basic catalytic transesterification process. The performance and emission characteristics of biodiesel blends derived were analyzed when a four-stroke, single-cylinder, direct-injection engine operated at 1500 rpm. The results indicate that a 20% biodiesel mixture lowers ignition delay at high loads, hence quickening gasoline vaporization owing to its higher cetane number. Due to its high oxygen levels, this fuel mixture exhibits a maximum in-cylinder peak pressure and heat release rate (HRR) during the pre-mixed combustion phase of rapid combustion, around 73.1 bar and 70.427 J/ºCA, respectively. It possesses a maximum brake thermal efficiency (BTE), enhancing the overall combustion, notwithstanding its high viscosity. The exhaust gas temperature (EGT: 7.8222%) increases with load. Furthermore, when the load increases, the emissions of hydrocarbons, carbon oxides, and nitrogen oxides reduce due to an enhanced fuel atomization promoting combustion, hence decreasing the amount of unburned biodiesel constituents. The opacity of the smoke has diminished by approximately 22.02% under full load. Due to the occurrence of some bioactive components in the rice bran generated biodiesel, the rice bran oil and the blend samples (20, 30, and 40%: B20, B30, and B40) were tested for their substantial *in vitro* microbial, antioxidant, and nuclease bioactivities. The effective transformation of RBO into biodiesel, alongside fulfilling 60–70% of our diesel requirements, would enhance the ecological sustainability.

Keywords: RBO, Physico-chemical, Spectral, Engine characteristics; Emissions; *In vitro* bioactivities

[P79]

Production, Characterization and Stability Studies on *Hevea brasiliensis* rubber seed oil-derived Biodiesel

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Abstract:
Hevea brasiliensis rubber seeds were collected, and bio-oil was extracted using a Soxhlet extractor with *n*-hexane as the solvent at a constant temperature (set at the boiling point of the solvent as 67 °C). The physio-chemical and thermal characteristics were identified for the extracted semi-drying oil via FT–IR, UV–*vis*., GC–Mass, ^{1}H and ^{13}C NMR analyses. Vibrational analyzes of the oil reveal the distinctive significant absorption for the –C=O and –C=C– groups at 1742 and 1645 cm^{-1}, respectively. Triacylglycerol groups were present in both saturated and unsaturated forms, according to the ^{1}H NMR and ^{13}C NMR spectral analyses. The extracted oil was thermally characterized using the photo pyroelectric technique (PPE). The extracted oil was transesterified to produce biodiesel and physico-chemically characterized. One of the most important concerns with the commercialization of biodiesel into the worldwide gasoline market is fuel stability. The oxidation process deteriorates the properties of biodiesel, which lowers engine performance. The impact of adding artificial antioxidants to make the biodiesel more stable at various doses on fuel stability has been studied recently. This study involves rubber seed oil derived biodiesel, as a low-cost feedstock. To improve the fuel stability, doping of three synthetic antioxidants to the biodiesel samples namely butylated hydroxytoluene: BHT, pyrogallol: PY and *tert*-butylhydrooquinone: TBHQ were added to biodiesel at varying quantities, ranging from 375, 750, 1000, 1125, and 1500ppm, respectively. The stability of the samples was then evaluated using DSC, and Fourier Transform Infrared Spectroscopy: FT-IR. The results of this investigation demonstrated that both the FT-IR and DSC are suitable methods for evaluating the stabilized products quality. It has been revealed that the best way to improve the stability of the rubber seed oil biodiesel is to dope with TBHQ at 1125ppm. Besides, the per-oxdidative pathway for the doped antioxidants was explained.

Keywords: *Hevea brasiliensis* oil biodiesel; Physico-chemical; Spectral; Thermal; Antioxidants; Per-oxdidative pathway

[P80]

Extraction, Characterization, Anticorrosion and bioactivities of *Sargassum muticum* derived lipids for biorefineries

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Abstract:
The global demand for energy has rapidly been increasing. In this context, aquatic biomass emerges as a highly promising renewable energy source for producing biodiesel, which is biodegradable and improves the lubricating properties of petro-derived diesel. Utilizing microalgae biodiesel in a conventional petro-based gasoline engine markedly decreases the greenhouse gas emissions (GHGs). This biodiesel has been attracted much more attention recently because of its reduced CO_2 emissions. It is considered as a promising feedstock for bio-refineries in the future due to their ability to facilitate the decarbonisation process, thereby benefiting the environment. The lipids derived from microalgae biomass can be converted into high quality biodiesel in the presence of Co-MOF (cobalt-metal organic framework) as catalyst. Furthermore, this research demonstrates the extraction of lipids and production of biodiesel by transesterification with Co-MOF / H_2 catalytical system from freshwater *Sargassum muticum* microalgal species specifically. The extracted bio-lipids and produced biodiesel were analyzed via physicochemical and spectroscopical methods (FT–IR, UV–*vis*., GC–Mass, ^{1}H and ^{13}C NMR). Further, the anticorrosion measurements were carried out for the biodiesel to find the percentage inhibition efficiency ($\eta\%$). The *in vitro* biological activity of the lipids were tested against the bacteria, fungus and yeast such as: *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Streptococcus species, Proteus species, Klebsiella species, Enterobacter species, Pastruella species, Candida species, Aspergillus species* and *Mucor* species by well-diffusion method. Furthermore, the *in-vitro* antioxidant properties (free radical scavenging capacity) and CT-DNA bioactivities were examined via both DNA cleavage and binding techniques. The results indicate that absorption and gel electrophoresis experiments on the interaction of the extracted lipids with CT-DNA suggest that the lipid molecules can bind to DNA by intercalation between chromophores and DNA base pairs.

Keywords: *Sargassum muticum* lipids; Biodiesel; Physico-chemical; Spectral; Anticorrosion; Bioactivities

[P81]

Engine characteristics, Corrosion and antioxidant studies of bio-diesel from *Scenedesmus* species

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Abstract:
This research investigates micro elemental and spectral analytical techniques viz. FT-IR, UV-vis, GC-Mass, ^{1}H NMR, and ^{13}C NMR to confirm the composition of the extracted low viscosity and corrosion-resistant algal bio-oil, derived from *Scenedesmus* species, a microalga. The transesterification processes of *Scenedesmus* species microalgal bio-oil in the presence of Zn–Schiff base (MOF) / H_2 as catalyst were carried out together with the assessment of the engine and emission characteristics of the bio-oil–diesel blends. The measurements were taken for engine characteristics, including brake-specific fuel consumption, brake thermal efficiency, and volumetric fuel injection / stroke. Besides, various emissions of CO_2, NO_x, and HCs, across three fuel samples: diesel (B100), a 20% micro algal bio-oil blend (SB20), and a 50% micro algal bio-oil blend (SB50). Moreover, *in vitro* microbial and antioxidant tests were carried out to assess the biocidal activities. The presence of electron-withdrawing carboxyl (–COO) and carbonyl (–C=O) side chains is pivotal for the exceptional performance of nuclease activities when exposed to H_2O_2 oxidant. The nuclease and biological processes substantiate that contaminants are circumvented. The ability of algal bio-oil to stop the corrosion is illustrated by weight loss measurements, vibrational assessments, and morphological (SEM) examinations of stainless steel. It has been found that the activity of the inhibitor enhances, when the concentration of algal bio-oil increases, owing to the availability of free electron pairs on nitrogen and oxygen atoms, along with π-electrons in the organic constituents of the lipid fraction.

Keywords: *Scenedesmus* species; Zn(II)–Schiff base MOF; Spectral; Corrosion resistance; Engine performance; Biocidal

[P83]

Explainable Edge-AI for Low-Resource Crop Disease Diagnosis: MobileNetV3 with Grad-CAM and MC-Dropout Uncertainty

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Abstract:
Early and reliable crop disease diagnosis is essential for reducing agricultural losses and supporting sustainable farming practices. However, many existing deep-learning approaches require substantial computational resources and continuous internet connectivity, limiting their deployment in low-resource agricultural environments. This paper presents an explainable edge-AI framework for crop disease diagnosis using MobileNetV3, Grad-CAM, and Monte Carlo Dropout (MC-Dropout) uncertainty estimation. MobileNetV3 is employed as a lightweight image classification model suitable for resource-constrained edge devices such as smartphones and low-power computing platforms. Grad-CAM provides visual explanations by identifying image regions that contribute most strongly to the predicted disease class, improving interpretability for farmers and agricultural practitioners. In addition, MC-Dropout is integrated to estimate predictive uncertainty and identify low-confidence cases where the system should avoid making potentially unreliable diagnoses. The proposed framework supports offline inference, reducing dependence on cloud infrastructure and enabling deployment in regions with limited connectivity. Experimental evaluation will consider classification accuracy, precision, recall, F1-score, inference efficiency, calibration, and uncertainty-based rejection performance using publicly available crop disease datasets. The proposed approach aims to provide an efficient, interpretable, and trustworthy AI-assisted solution for sustainable crop health monitoring and early disease management.

Keywords: Crop disease; Edge AI; MobileNetV3; Grad-CAM; uncertainty estimation; sustainable agriculture

[P84]

Lightweight Drift Detection for Environmental IoT: Entropy-Based Sensor Data Integrity Monitoring

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Abstract:
Environmental Internet of Things (IoT) networks continuously collect pollution and environmental measurements that support monitoring, regulatory compliance, and scientific analysis. However, compromised, faulty, or gradually drifting sensors can introduce abnormal patterns and corrupt downstream environmental datasets. This paper proposes a lightweight entropy-based framework for detecting data integrity anomalies and distribution drift in environmental IoT sensor streams. The approach adapts Shannon entropy scoring to characterize changes in the statistical behavior of sensor observations and employs Welford's online algorithm for memory-efficient computation of streaming statistics. By operating directly on incoming sensor data, the framework can identify sudden changes, persistent deviations, and potentially manipulated measurements without requiring complete historical datasets. The proposed method is designed for resource-constrained edge environments and supports continuous monitoring across large-scale distributed sensor networks. A streaming detection architecture is developed to maintain compact statistical representations while minimizing computational and memory overhead. Experimental evaluation on publicly available air-quality and water-quality datasets will investigate anomaly detection performance under simulated sensor faults, gradual drift, abrupt distribution changes, and data manipulation scenarios. Performance will be assessed using precision, recall, F1-score, detection latency, memory consumption, and computational overhead. The proposed framework provides a lightweight approach for improving the reliability and integrity of environmental sensing infrastructures.

Keywords: Environmental IoT; sensor integrity; drift detection; Shannon entropy; Welford algorithm; anomaly detection

[P85]

Sustainable Energy Transition through Torrefied Biomass Pellets: Opportunities and Challenges

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Abstract:
The transition toward renewable energy has intensified the search for sustainable alternatives to fossil fuels, with biomass emerging as a promising energy resource because of its renewable nature, carbon-neutral potential, and dispatchability. However, agricultural residues generally exhibit high moisture content (10-50%), low bulk density (40-250 Kg/m^3), poor grindability, hydrophilic behavior, and relatively low heating value (14-18 MJ/Kg), limiting their direct application as solid fuels. This review evaluates torrefaction and pelletization as integrated upgraded technologies for converting agricultural residues into high-quality solid biofuels. Torrefaction, typically conducted at 200-300^{0}C under oxygen-deficient conditions, enhances fuel quality by increasing carbon content to approximately 50-60%, increasing the higher heating value to 20-25 MJ/Kg, reducing moisture content to 1-5%, improving the hydrophobicity, grindability, and energy density to 12-20 GJ/m^3 and can achieve mechanical durability of about 97.5%, meeting the requirements of several international solid-biofuel standards. From a techno-economic perspective, integrated torrefaction-pelletization systems can achieve internal rates of return of approximately 22-34% and payback periods of 4-7 years, although feedstock cost remains a major determinant of profitability. Life-cycle assessments further indicate potential greenhouse-gas emission reductions of 65-93% compared with coal. Despite these advantages, large capital requirements, variability in feedstock characteristics, feedstock availability, product durability, and supply-chain constraints remain important barriers to commercialization. This review therefore highlights the technological, economic, environmental, and supply-chain aspects of torrefied biomass pellets and identifies key research priorities required for their large-scale deployment as sustainable solid fuels.

Keywords: Agricultural residues; biomass pellets; torrefaction; pelletization; bioenergy; sustainable fuels; techno-economic analysis; life-cycle assessment

[P86]

Maximizing Resource Recovery from Food Waste by Coupling Acidogenic Fermentation and Microbial Lipid Production

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Abstract:
Oleaginous yeasts are promising candidates for lipid biosynthesis, as they can accumulate over 20% of their cell weight as intracellular lipids. While sugar-based carbon sources are typically used for this purpose due to their well-documented yields and metabolic pathways, volatile fatty acids (VFAs) derived from acidogenic fermentation offer a low-cost alternative. Utilizing VFAs as feedstock provides higher conversion efficiency toward lipid production, thereby enabling a sustainable bioeconomy. In this study, acidogenic fermentation of food waste was conducted in a semi-continuous anaerobic membrane bioreactor (AnMBR) to allow *in-situ* membrane separation of VFAs. Subsequently, the mixed VFA solution, which was majorly composed of acetate and butyrate, was used as a carbon source for lipid biosynthesis by the isolated yeast strain ARY3 (genetically identified as *Candida tropicalis*) in batch cultivation. During the acidogenic fermentation stage, a maximum VFA concentration of 6.70 ± 0.19 g-COD/L and a VFA productivity of 1.68 ± 0.15 g-COD/L·d were attained at an organic loading rate (OLR) of 3.3 g-volatile solids (VS)/L·d. In the microbial lipid production stage, biomass and lipid yields reached 0.47 and 0.15 g/g-VFA consumed, respectively, resulting in a maximum lipid accumulation of 31.2% w/w. Analysis of VFA consumption showed that acetate was completely assimilated within 72 h, while only 14.2% of butyrate remained after 96 h. Although propionate and lactate were present in negligible concentrations in the mixed VFA solution, they were completely assimilated within 72 h. Ultimately, this simultaneous food waste utilization and microbial lipid production provides a green strategy for future food waste biorefineries.

Keywords: Acidogenic fermentation, *Candida tropicalis*, waste valorization, oleaginous yeast, membrane separation.

[P88]

EcoMind: A Self-Evolving AI Ecosystem for Autonomous Model Adaptation, Collaboration, and Resource-Aware Intelligence

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Abstract:

Artificial intelligence systems are increasingly deployed in environments where tasks, data distributions, and computational resources continuously change. However, most existing AI architectures rely on fixed models or predefined collections of agents, limiting their ability to respond effectively when new requirements or unexpected situations emerge. This paper proposes EcoMind, a self-evolving AI ecosystem that dynamically manages a population of specialized AI models according to changing environmental conditions. Inspired by the adaptive behavior of biological ecosystems, EcoMind enables AI models to collaborate, compete for computational resources, transfer useful capabilities, and undergo autonomous creation or retirement. A central AI Evolution Engine evaluates individual models using multiple factors, including predictive performance, adaptability, computational cost, latency, energy consumption, and task relevance. When an emerging task cannot be adequately handled by the existing model population, the framework identifies complementary capabilities and enables the formation of a specialized model. Models that become redundant, inefficient, or unreliable can subsequently be retired to reduce unnecessary computational overhead. The proposed ecosystem will be evaluated under dynamically changing environments involving distribution shifts, emerging tasks, resource constraints, model failures, and unexpected events. Its performance will be compared with conventional single-model and static multi-agent architectures using metrics such as accuracy, adaptation time, computational efficiency, energy consumption, resilience, and recovery capability. The study aims to demonstrate that treating AI models as evolving members of an intelligent ecosystem can provide a more adaptive, resilient, and resource-aware approach to developing next-generation AI systems.

Keywords: Artificial Intelligence Ecosystem; Self-Evolving AI; Autonomous Model Adaptation; Multi-Agent AI; Evolutionary AI; Continual Learning; Model Collaboration; Dynamic Model Selection; Resource-Aware AI; Adaptive Intelligence; AI Model Lifecycle; Computational Efficiency

[P91]

Magnetite-Assisted Degumming of Crude Palm Oil for Biodiesel Production: Comparative Phosphorus Removal Using Acid–Activated Carbon Treatments

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Abstract:
Crude palm oil (CPO) is one of the main raw materials used for biodiesel production in Thailand. It should be degummed properly because the presence of phosphatides in CPO can cause problems such as sticking in transesterification reactions, inactivating catalysts, causing the formation of emulsions, and affecting the quality and stability of the biodiesel product. The four phosphor removal strategies compared here were (i) 0.05% (w/w) phosphoric acid followed by 1% (w/w) activated carbon and 1% (w/w) water, (ii) an equivalent treatment using 0.05% (w/w) citric acid, (iii) 0.05% (w/w) phosphoric acid followed by 1% (w/w) activated carbon, and (iv) 0.05% (w/w) phosphoric acid followed by 1% (w/w) co-precipitated magnetite (Fe_3O_4) nanoparticles. The collected solid phase was separated by centrifugation at 2,500 rpm for 5 min and then ashed at 800–900 °C for 2 h before measuring the phosphorus concentration in triplicate using the UV–visible spectrophotometric method with the phosphovanadomolybdate method. The calibration curve was linear over the range of 4–20 µg L^{-1} ($A = 0.0106C$; $R^2 = 0.9779$). Untreated CPO had a phosphorus concentration of 36.09 µg L^{1}. Finally, the phosphoric acid + activated carbon, citric acid + activated carbon, and acid-coated activated carbon technologies reduced the phosphorus (P) concentration to 28.58, 25.90, and 29.62 µg/L and removal efficiencies of 20.8%, 28.3%, and 17.9%, respectively. A comparison of the different treatments showed that the Fe_3O_4 treatment achieved a 51.6% reduction in phosphorus concentration (18.61 µg L^{-1}). When the dosage was between 0.1 and 0.4 g for each 70 g of oil, 0.3 g was found to be the best dosage, yielding a maximum phosphorus removal rate of 67.7% and a minimum residual concentration of 11.64 µg L^{-1}. The possible aggregation of nanoparticles and inadequate solid–oil separation at higher doses of magnetite were suggested as explanations for the decrease in performance with increasing magnetite dose. The results show that magnetite-assisted degumming is significantly superior to all acid–activated carbon treatments investigated and is a promising pretreatment technique that can be recovered for further enhancement of the quality of CPO before biodiesel production. Future research efforts should focus on improving free fatty acid measurement, decreasing the bleachability index, oil recovery, regeneration of nanoparticles, process cost, and subsequent transesterification performance.

Keywords: Crude palm oil, Acid degumming, Activated carbon, Magnetite nanoparticles, Biodiesel production, Phosphorus removal

[P92]

Enhancing Methane Yield from High-Nitrogen Broiler Chicken Manure via Mesophilic Semi-Continuous Digestion with Fe–GAC and Optimized Hydraulic Retention Time

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Abstract
This study aimed to improve methane yield and stability during semi-continuous anaerobic digestion (AD) of nitrogen-rich broiler chicken manure (BCM) by varying the hydraulic retention time (HRT), the impact of Fe–granular activated carbon (Fe–GAC) (5 mg L^{-1}) addition, and mesophilic (35 °C) versus thermophilic (55 °C) operation, in addition to a techno-economic analysis of the optimal condition. Four identical 20-L CSTRs (150 rpm) inoculated from a stable mesophilic livestock-manure biogas plant were operated at: R1 (control) mesophilic, HRT 60 d, no additive, OLR 2 kg COD m^{-3}; R2 mesophilic, HRT 30 d, no additive, OLR 1 kg COD m^{-3}; R3 mesophilic, HRT 15 d, Fe-GAC, OLR 1 kg COD m^{-3}; and R4 thermophilic, HRT 15 d, no additive, OLR 1 kg COD m^{-3}. Lowering HRTs from 60 to 30 days boosted productivity but caused instability in methane production and pH. Fe-GAC with a 15-day HRT in the R3 system led to the highest methane yield (around 70%) and a stable pH range (6.8-8.2). Increased buffering and ammonia reduction were due to enhanced electron transport, trace metal release, and adsorption of inhibitory compounds. Thermophilic digestion enhanced gas production but was unstable, with varying ammonia and pH. Fe-GAC resulted in a higher biogas energy value (7.00-9.80 THB m^{-3}) whose net value was 2.29 THB m^{-3} (adding Fe-GAC cost: 0.51 THB m^{-3}). Semi-continuous mesophilic digestion at 15 days HRT and 5 mg L^{-1} Fe-GAC addition is scalable, stable, and has economic potential for BCM biogas production, and should be verified in pilot-scale, optimal Fe dosing tested, microbial studies on DIET mechanisms, and life-cycle costing.

Keywords: Broiler chicken manure; Anaerobic digestion; Fe–GAC; Hydraulic retention time; Methane yield; Renewable energy

[P93]

Heat-Recirculating Solar Drying of Semi-Dried Nile Tilapia Using the "HLANG TAO Model"

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Abstract:
This study developed and evaluated the performance of the "HLANG TAO Model," a solar drying cabinet incorporating an internal heat-recirculation system to enhance drying efficiency for community-scale food processing. The dryer measured 172 cm × 200 cm × 180 cm (W × L × H) and was equipped with eight drying shelves designed to promote uniform heat distribution. Drying experiments were conducted using 30.4 kg of deboned Nile tilapia fillets (*Oreochromis niloticus*) for 5 h under an average solar irradiance of 844.09 W/m². During drying, the cabinet maintained an average internal temperature of 54.16 °C and a relative humidity of 75.3%. The product weight decreased from 30.4 to 24.7 kg, corresponding to an 18.75% reduction in mass. The semi-dried tilapia exhibited L*, a*, and b* values of 44.35, −1.36, and 8.24, respectively, with a water activity (aw) of 0.981 and a pH of 6.56. Proximate analysis showed moisture, ash, protein, lipid, and fiber contents of 74.61%, 3.42%, 20.34%, 0.46%, and 0.97%, respectively. The results demonstrate that the HLANG TAO Model can maintain suitable and relatively stable drying conditions for the production of semi-dried fish. Its internal heat-recirculation configuration offers potential for improving energy utilization and supporting community-scale processing of fish and other agricultural products, thereby contributing to more energy-efficient and sustainable food processing.

Keywords: HLANG TAO Model; solar drying; heat recirculation; Nile tilapia; semi-dried fish; community-scale food processing; sustainable food processing

[P94]

Electric-Field-Assisted Intensification of Cottonseed Oil Transesterification over Waste Eggshell-Derived CaO Catalyst

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Abstract:
An innovative method for accelerating the transesterification process is gaining interest for improving biodiesel preparation. In this study, the transesterification of cottonseed oil with calcined eggshell (ES) as a heterogeneous catalyst using an electric field (E-Field) was investigated. The prepared catalyst was characterized using X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM) to determine the microstructure and properties of the catalyst, and BET analysis was applied to determine the surface area. The ES powder was then calcined in a muffle furnace at 1,000 °C for 2 h. The obtained CaO (>94%) was used as ~~a~~ heterogeneous catalyst for the transesterification of cottonseed oil under an electric field. Simultaneously, to explicitly determine the E-field for acceleration in biodiesel production, experiments were conducted at voltages of 0-15 kV. Transesterification was accelerated by the application of a coaxial cylinder electrode by creating an E-field. The optimal reaction conditions were a catalyst amount of 4 wt. %, a methanol-to-oil molar ratio of 12:1, a reaction temperature of 60 °C, with a reaction time of 30 min, under an electric field of 5 kV, which gave a biodiesel yield of 94.65%. The reused catalyst yielded a conversion level above 80% after three uses. In addition, high-speed photography was used to capture the deformation, distribution, sedimentation, and coalescence of charged polar glycerol droplets in the nonpolar biodiesel phase.

Keywords: Biodiesel; Cottonseed oil; Electric field; Process intensification; Waste eggshell-derived CaO; Heterogeneous catalysis

[P95]

Photovoltaic Performance of Dye-Sensitized Solar Cells Using Natural Pigments from Ornamental Plants

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Abstract

Natural pigments are an alternative dye-sensitized solar cell (DSSC) sensitizer that is cheap, renewable, and environmentally friendly. In this study, ethanolic pigment extracts from gerbera leaves, red gerbera flowers, pink aglaonema leaves, and red oak leaves were extracted and compared when used as sensitizers in DSSCs. The photoanode was prepared by depositing each natural extract on TiO2-coated fluorine-doped tin oxide glass. The cells were made using a carbon counter electrode, a polyethylene membrane and an iodide electrolyte. They were tested for their current voltage characteristics under controlled illumination to determine the maximum current, maximum voltage, maximum power, fill factor, and power-conversion efficiency. The highest conversion efficiency (0.182%) with a maximum current of 0.105 mA, maximum voltage of 0.107 V, maximum power of 0.015 mW, and fill factor of 43.010% was obtained using red gerbera flower extract as a sensitizer. Red oak leaf extract gave the maximum current value of 0.108 mA, the maximum voltage value of 0.108 V, the highest fill factor of 49.203 %, and the lowest conversion efficiency of 0.062 %. The maximum current generated by the gerbera leaf-sensitized cells was 0.055 mA, with a maximum voltage of 0.057 V, maximum power of 0.004 mW, fill factor of 44.308%, and conversion efficiency of 0.048%. The performance of the pink aglaonema leaf extract was the lowest among all the extracts, with a maximum current of 0.035 mA, maximum voltage of 0.034 V, maximum power of 0.001 mW, fill factor of 22.620%, and efficiency of 0.023%. The results suggest that the choice of pigment source plays an important role in the performance of the DSSC, and red gerbera flowers are the best natural sensitizer when compared with other plant materials. The photovoltaic performance of these low-cost, bio-based solar cells can be further optimized by optimizing the extraction of pigments, sensitization of the photoanode, electrolyte composition, and cell assembly.

Keywords: dye-sensitized solar cell; natural sensitizer; ornamental plant pigments; photovoltaic performance; red gerbera; titanium dioxide; renewable energy

[P96]

Hospital Wastewater and Antimicrobial Resistance: Regulatory Gaps, Facility-Level Evidence, and a Source-Separated Treatment Framework

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Abstract
Hospital wastewater regulation was written for conventional pollutants and has not been revised for antimicrobial resistance (AMR). This paper asks what that omission costs in practice, and what a workable correction would look like in a middle-income setting. Discharge rules for hospitals in six jurisdictions — Italy, Spain, China, In-dia, Brazil and Thailand — were compared across two regulatory pathways, discharge to sewer and discharge to surface water, alongside the guidance instruments of WHO, US EPA, IAEA and ICRP. Not one of the six regu-lates an antibiotic residue, a resistance gene or a resistant organism. Thailand is the weakest case: hospitals are governed by the generic Type A building standard (BOD ≤ 20, TSS ≤ 30, TDS ≤ 500, sulfide ≤ 1.0, settleable solids ≤ 0.5, FOG ≤ 20, TKN ≤ 35 mg L-1, pH 5–9) with two coliform limits appended by hospital accreditation, and no discharge-to-sewer standard exists because hospitals must treat on site. The consequences were traced at a 700-bed regional hospital. The plant met bulk parameters yet released sulfonamide residues and multidrug-resistant ESKAPEE organisms, including carbapenem-resistant Escherichia coli; it exceeded the dissolved-solids limit because a renal-therapy stream the law neither names nor separates; and antibiotic mass reappeared as prod-ucts on a drying bed outside the boundary. Three defects emerge: compliance is measured at a discharge point, not the facility; sampling is allowed although flow is intermittent; and no parameter links the standard to the haz-ard managed. A source-separated framework is proposed, with segregated soil, urinal, washing and medical-activity stacks, activity-specific pre-treatment, and pipes. A three-tier pathway is set out; advanced polishing would cost 6.2–9.1 THB (0.19–0.28 USD) per bed per day, or 0.7–1.1 thousand THB for a 120-bed hospital. The barrier to regulating hospital effluent for AMR is not cost but the absence of a parameter, boundary and sampling protocol to detect the problem.

Keywords: hospital wastewater; effluent standards; antimicrobial resistance; sanitary design; source separation; environmen-tal policy

[P97]

Green Hydrogen Production via High-Entropy Metal Glycerate Catalysts

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Abstract:
As a cornerstone of zero-emission energy systems, green hydrogen production via water electrolysis offers a sustainable path toward carbon neutrality. However, widespread adoption is hindered by the high cost and environmental footprint of precious metal catalysts. This study presents a cost-effective, noble-metal-free alternative: a highly efficient sulfurized high-entropy metal glycerate catalyst for the hydrogen evolution reaction (HER). Vanadium (V)-doped CoMoFeMnNi multi-metal glycerate was successfully anchored onto graphite felt using a scalable solvothermal process, followed by secondary sulfurization. To minimize energy and material consumption, manufacturing parameters, including reaction temperature, holding time, and sulfur dosage, were systematically optimized. Structural characterization via SEM and TEM confirmed the formation of robust, highly active catalytic sites. Electrocatalytic evaluations revealed that the optimized catalyst (synthesized at 160 °C for 12 h with 5 mL sulfur source) achieved a low overpotential of 302 mV and a Tafel slope of 69.41 $mV \cdot dec^{-1}$. Crucially, the catalyst demonstrated exceptional long-term electrochemical stability and high faradaic efficiency. By eliminating reliance on scarce precious metals and lowering the kinetic barrier for water splitting, this work highlights the transformative potential of high-entropy alloys to accelerate affordable, large-scale clean energy conversion technologies.

Keywords: Hydrogen production, High-Entropy, Catalysts, Hydrogen evolution reaction

[P98]

Upcycling Biochar in High-Performance Carbon Fiber Composites for Carbon-Negative Material Design

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Abstract:
While Carbon Fiber Reinforced Polymers (CFRPs) are known for their impressive strength-to-weight ratio. The researchers in this work set out to address these shortcomings head-on by developing a state-of-the-art composite with an epoxy-phenolic resin matrix. Our system's high-performance foundation is this complex matrix, which outperforms traditional epoxies in terms of heat stability, chemical resistance, and toughness. For a longer-lasting composite, it's best to start with a thicker matrix. Biochar, a sustainable and practical filler made from wood, is being used to improve this system. In this study, we look at how the three main parts-the biochar, the long-lasting epoxy-phenolic matrix, and the reinforcing carbon fibers- interact with one another. Our research involves carefully controlled pyrolysis to produce high-quality biochar, and we analyze its impact on the interfacial dynamics and overall performance of the composite in detail. This research aims to demonstrate the potential of biochar, when combined with a well-selected epoxy-phenolic matrix, to replace industrial carbon black. Our aim is to create high-performance composites that are both environmentally benign and functionally advanced, with the hope of contributing to the achievement of carbon-emission reduction targets.

Keywords: Biochar, Carbon Fiber Reinforced Polymer (CFRP), Epoxy-Phenolic Resin, Multi-functional Filler, Interface, Sustainable Materials

[P99]

Quantum Dot-Modulated Microalgal Growth and Carbohydrate Accumulation: A Feedstock Strategy for Fermentation-Based Bioplastic Production

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Abstract:
Microalgae are promising biological resources for sustainable biotechnology because of their capacity to assimilate carbon dioxide and accumulate valuable macromolecules that can serve as feedstocks for bio-based products. Nanomaterial-assisted cultivation has emerged as a potential strategy for enhancing microalgal productivity and modifying biochemical composition; however, responses vary considerably with nanomaterial type and concentration. This study evaluated the effects of quantum dots (QDs) synthesized from zinc (Zn), magnesium (Mg), copper (Cu), and carbon (C) sources on microalgal growth, carbohydrate accumulation, and protein production. Cultures were cultivated in BG-11 medium for 28 days under continuous illumination with intermittent CO_2 supplementation. Two concentrations of each QD type were tested, alongside untreated controls. Growth was monitored by optical density at 680 nm (OD_{680}), while carbohydrate and protein concentrations were quantified using anthrone and modified Lowry assays, respectively.

Distinct physiological responses were observed among treatments. Mg-QDs at 100 mg/L promoted the strongest growth among QD-treated cultures, reaching an OD_{680} of approximately 1.92 on Day 28 and yielding the highest protein concentration (1.439 mg/mL). In contrast, Cu-QD treatments exhibited reduced growth and earlier culture decline but enhanced carbohydrate accumulation. Cu-QDs at 50 mg/L achieved the highest carbohydrate concentration among QD treatments (3.910 mg/mL), slightly exceeding the control (3.741 mg/mL) and representing a substantial increase from the initial concentration (0.903 mg/mL). Zn- and C-based QDs generally showed limited benefits for biomass growth or macromolecule production. These findings demonstrate that QD composition can differentially regulate microalgal growth and metabolite accumulation. In particular, Cu-QDs at 50 mg/L represent a promising cultivation condition for producing carbohydrate-rich microalgal biomass, supporting the development of sustainable microalgae-based bioplastic feedstocks and integrated algae-to-biopolymer production systems.

Keywords: Microalgae; Quantum dots; Carbohydrate accumulation; Nanomaterials; Sustainable biotechnology

[P100]

The effect of temperature of hydrothermal carbonization of agricultural digestate on wastewater pollution indicators in process water

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Abstract:
Agricultural digestate is, along with biogas, the product of methanogenic fermentation occurring in a biogas plant. Digestate is characterized by a high content of organic and inorganic compounds but its exact composition depends on the type of feedstock used in the biogas plant and the process parameters applied. In this study, agricultural digestate was subjected to the hydrothermal carbonization process (HTC). This process is applied as a treatment of biomass and sewage sludge with high moisture content. As a result, the mixture of solid and liquid phases is obtained and small amounts of gaseous CO_2. The mixture is separated into solid hydrochar and liquid process water. In this investigation, the temperature of the HTC process was 190 and 210°C and the residence time 0.5 and 2 h. The produced process water was then analyzed to determine the content of phosphorus, nitrogen, ammonia, COD and phenol compounds. In addition, the pH and conductivity were tested. The results showed that lower temperature and shorter residence time affect the production of process water with higher phosphorus and nitrogen content whereas the COD content is lower for longer residence time of HTC.

Keywords: Biomass, biogas plant, agricultural digestate, hydrothermal carbonization, process water

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