ICBS 2026

The 4th International Conference on Bioprocess and Sustainability

Abstract Book

June 22–23, 2026

Hong Kong

Contents

Keynote Speech

Dr. Bing Li is an associate professor at Tsinghua Shenzhen International Graduate School, Tsinghua University, China. His research focuses on applying multi-omics to investigate antibiotic resistance in environments and biotransformation of emerging pollutants. He has published over 170 papers in prestigious journals including Nature Water, Environmental Science & Technology, and Water Research, etc. with total citations over 17300 and an H-index of 61. He serves as Associate Editor for the JCR Q1 SCI journal-Applied Microbiology and Biotechnology, and the Conference Chairman for 2027 12th IWA MEWE Conference. Recognized as a Clarivate Highly Cited Researcher and listed in Stanford's "World's Top 2% Scientists", he also contributes as a public consultation expert for WHO and UNEP.

K-1 - Microbial Risks Triggered by Oral Administration of Antibiotics in Fish Aquaculture Persist Long after the Legally Mandated Antibiotic Withdrawal Time

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Abstract: Industrial aquaculture relies on antibiotics such as florfenicol to combat disease and maintain production, but microbial risks, particularly concerning antibiotic resistance genes (ARGs) after the mandated withdrawal time, are poorly understood. To address this, we simulated standard and prolonged florfenicol treatments in common carp (*Cyprinus carpio*) and performed metagenomic analyses of the gut resistome, mobilome and microbiome. Here we show that florfenicol administration caused significant resistome shifts. While ARG abundance decreased during post-treatment times, it remained elevated above control levels even after the mandated withdrawal time. Integrons and a composite transposon harbouring *floR* facilitated ARG dissemination during florfenicol treatments. Following withdrawal, gut microbiota of fish subjected to prolonged treatments harboured more diverse ARG-carrying plasmids than controls. Although the dominant microbiota showed resilience, some ARG-carrying bacteria remained enriched. Of the enriched potential pathogens, 47.1% harboured ARGs identical to those on plasmids. Crucially, the high similarity between plasmid and chromosomal ARG-flanking sequences underscores a key role of plasmid in ARG transfer. Overall, florfenicol treatment increased both the abundance and the mobility of ARGs in the carp

gut. The resistome and mobilome profiles did not return to baseline after the mandated withdrawal time, indicating that this period is insufficient to mitigate the ARG transmission risk.

Keywords: Antibiotic Resistance; Antibiotic Withdrawal Time; Aquaculture; Metagenomics; Mobile Genetic Elements

Prof. Carol Sze Ki Lin received her Ph.D. in Biochemical Engineering from the University of Manchester after completing her Bachelor's degree in Chemical and Materials Engineering with first-class honours at the University of Auckland. She conducted postdoctoral research at Ghent University, Belgium, and later served as Visiting Assistant Professor at the Hong Kong University of Science and Technology. She is currently a Full Professor in the School of Energy and Environment at City University of Hong Kong. Her research focuses on circular waste-based biorefinery technologies for the sustainable production of chemicals, materials, and fuels, including the valorization of agricultural residues, food, beverage, plastic, and textile wastes. She has secured more than HK$33 million in research funding, led over 35 research projects, and published more than 270 peer-reviewed journal articles in leading journals. She has been recognized among the world's top 2% scientists by Stanford University and became a Fellow of the Royal Society of Chemistry in 2024.

K-2 - Circular Biorefinery of Food and Yard Waste for the Production of Sustainable Chemicals, Materials and Fuels

○Carol Sze Ki Lin[*, 1], Di Wu[1], Ziyao Liu[1], Anda Fridrihsone[2], Mikelis Kirpluks[2], Charles Chunbao Xu[3], Molly M.-J. Li[4], Song Cheng[5], Duu-Jong Lee[6], Ben Shao Yuan Leu[3]

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Abstract: In food waste bioconversion, research has largely focused on recovering fermentable sugars, while the lipid fraction remains underutilized. This talk first explores the valorization of food waste lipids as a promising feedstock for bioplastic production, particularly polyurethane (PU) resin, offering a sustainable route to reduce plastic pollution. Our previous work demonstrated the successful replacement of fossil-based polyols with food-waste-derived polyols in PU production. However, the continued reliance on toxic isocyanates presents environmental and health concerns, underscoring the need for greener approaches to develop fully bio-based non-isocyanate polyurethane. The second part of the talk addresses sustainable aviation fuel (SAF) production from lignocellulosic biomass. Pretreated biomass undergoes enzymatic hydrolysis to generate C6 and C5 sugars for microbial fermentation, producing 2,3-butanediol (2,3-BDO) as a key intermediate for iso-alkane synthesis. An in-situ fibrous bed bioreactor (*is*FBB) enhances 2,3-BDO production by immobilizing cells on low-cost agricultural residues, improving process stability, yield, and durability. Sugarcane bagasse was identified as an effective *is*FBB material for Klebsiella pneumoniae PM2 and applied in a 2.5 L bioreactor. The resulting 2,3-BDO was upgraded via dehydration, catalytic conversion, oligomerization, hydrogenation, and distillation to produce SAF-range hydrocarbons.

Keywords: 2,3-butanediol; in-situ fibrous bed fermentation; *Klebsiella pneumoniae*; Sustainable aviation fuel; Yard waste; Waste biorefinery

Prof. Fabrizio Adani graduated in Agricultural Sciences from the University of Milan (1988) and obtained a Ph.D. in Environmental Protection from the University of Basilicata (1993). He worked as a researcher at the A. Natta Institute of Industrial Chemistry, Polytechnic of Milan (1994–1995), and since 1996 has been with the University of Milan, where he is currently Full Professor. He teaches “Biomass and Waste Recycling Promoting the Circular Economy” in the MSc Biotechnology for the Bioeconomy. He is also Adjunct Professor at iBEST, China Agricultural University, Beijing. His research focuses on sustainable biotechnologies, circular bioeconomy, and the valorization of biomass and waste into bio-based products. He has authored over 273 Scopus-indexed publications (h-index 69; 13197 citations). Ranked among the top 2% of scientists worldwide (Stanford University, 2025), he is internationally recognized for his contributions to bioenergy and environmental biotechnology.

K-3 - A New Generation of Biofertilizers: Trichoderma-Driven Bioactivation of Organic Matrices

○Elisa Clagnan[1], Giuliana D’Imporzano[1], Marco Ovani[2], Marco Pierpaolo Pina[2], Fabrizio Adani[*, 1]

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Abstract: This study explores next-generation biofertilizers based on the microbial activation of organic matrices such as digestates and manure-derived products. While bio-based fertilizers (BBFs) already contribute to nutrient recycling, their agronomic performance can be significantly enhanced through the inoculation of beneficial microorganisms, particularly *Trichoderma* spp. Recent evidence demonstrates that *Trichoderma*-enriched BBFs can achieve crop yields comparable to, or higher than, those obtained with conventional mineral fertilization. Trials on horticultural crops, such as tomato, have shown increases in biomass production and improvements in fruit quality, including higher carotenoid and lycopene content. Microbial analyses indicate that *Trichoderma* plays a central role in shaping rhizosphere communities and driving plant growth responses, while bacterial contributions appear more limited in the early stages following application. The effectiveness of this approach is linked to the multifunctional nature of Trichoderma, which promotes nutrient availability, enhances root development, improves tolerance to abiotic stress, and provides biocontrol against soil-borne pathogens. Additionally, the incorporation of microbial inoculants into stabilized organic matrices improves their survival and persistence in soil, addressing key limitations of traditional biofertilizers. From a technological perspective, the development of granulated and industrially processed bioactivated products represents a crucial step toward large-scale application. This strategy supports circular economy principles by valorizing organic residues and reducing dependence on synthetic inputs. Overall, *Trichoderma*-based bioactivation defines a new generation of efficient and sustainable biofertilizers, contributing to the transition toward regenerative and climate-smart agricultural systems.

Keywords: *Trichoderma* spp.; Bioactivated digestates; *Trichoderma* spp.; Bioactivated digestates; Rhizosphere microbiome

Prof. Feng Xiao earned his BEng and MEng from Xi'an Jiaotong University in 2002 and 2005, and his PhD from the University of Hong Kong in 2009. He served as Assistant and Associate Researcher at the Research Center for Eco-Environmental Sciences, CAS from 2010 to 2019. He was promoted to Professor and Doctoral Supervisor at North China Electric Power University in 2019 and is a Young Affiliate of TWAS.

His research covers water, environment and energy. He has led over 70 research projects. He has published more than 100 high-level papers and secured over 10 invention patents. His achievements have been widely applied industrially. He received the First Prize of Beijing Science and Technology Progress

Award in 2023, the Second Prize of Qinghai Science and Technology Progress Award in 2024.

K-4 - Apparent DOC Loss Underestimates Source-dependent Autochthonous DOM Turnover under Intense Summer Irradiation in an Urban River

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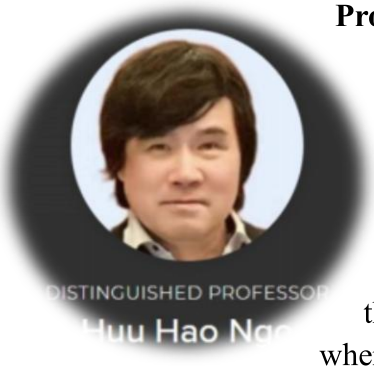
Abstract: Autochthonous dissolved organic matter (DOM) may become an important internal driver of eutrophication in urban rivers under intense summer irradiation, because its photochemical-microbial reworking can sustain nutrient regeneration within the system. Yet how this irradiation-driven process varies among different autochthonous DOM pools remain unclear, as these pools are highly heterogeneous and conventional bulk indicators cannot effectively capture internal molecular turnover. Using an urban river in Beijing as a representative system, we selected water-derived DOM (W-DOM), sediment-derived DOM (S-DOM), and intracellular and extracellular Microcystis derived DOM (I-DOM and E-DOM) as representative autochthonous DOM pools. A 7 day microbial incubation was conducted under cyclic light-dark (LD) and continuous dark (D) conditions. The LD treatment enhanced DOC loss in I-DOM and S-DOM by 23.22% and 19.08%, respectively, and was accompanied by stronger microbial respiration, preferential removal of CHO molecules and lipid- and protein-like components, as well as enhanced dehydration, dehydroxylation, and demethylation pathways. FT-ICR-MS further showed that actual DOC turnover rates under the LD condition reached 0.02, 0.08, 0.21, and 0.26 d-1 for W-DOM, E-DOM, I-DOM, and S-DOM, respectively, all substantially higher than the corresponding apparent rates, with the largest discrepancy observed in I-DOM and S-DOM. Although apparent DOC loss already reflected the promoting effect of irradiation, actual turnover showed that this effect was substantially stronger than indicated by bulk DOC change alone. These results suggest that intense summer irradiation strengthens the internal cycling of autochthonous DOM and may provide a plausible mechanistic explanation for bloom persistence in urban rivers despite limited apparent DOM accumulation.

Keywords: Autochthonous dissolved organic matter; Intense summer irradiation; FT ICR-MS; Actual DOC turnover; Bloom persistence



Prof. Huu Hao Ngo is a world-leading scholar in Environmental Engineering and Biotechnology, recognized globally for his pioneering contributions to sustainable water and waste management, environmental biotechnology, and circular-economy green technologies. He currently holds the title of Distinguished Professor (the highest academic rank) at the University of Technology Sydney (UTS), Australia, where he works as Deputy Director of the Centre for Technology in Water and Wastewater and Co-Director of the Joint Research Centre for Environmental Green Bioprocess in the Faculty of Engineering and IT. He also serves as Founder and Executive Coordinator of the Australasia Practical Net Zero Emission Society and Vice Chairman of the IETI Biomass and Green Energy Committee. Ngo holds the distinguished titles of Fellow of the International Water Association (FIWA)and the Fellow of the International Bioprocess Association (D/FIBA).

He has been repeatedly recognised as a Clarivate Highly Cited Researcher (Web of Science) across multiple disciplines, including Environment and Ecology, Biology & Biochemistry, and Cross-Field, placing him among the top 1% most cited scientists worldwide. Global research analytics consistently rank Professor Ngo among the world's leading experts in environmental engineering and wastewater technologies. According to SciVal (Elsevier) global rankings (2015–2024), he is ranked #1 worldwide in Waste Management and Disposal, #2 in Environmental Engineering, and #8 in Bioengineering. Based on Scholar GPS global rankings (past five years), he is ranked #2 worldwide in Wastewater, #6 in Wastewater Treatment, and #7 in Bioreactors. The AUSTRALIAN Scholar Rankings recognized him as a National Leader in Biotechnology and Environmental Science (2021, 2023), Environmental Science (2020), and Biotechnology (2019).

Professor Ngo has authored over 800 scholarly publications, including 16 books and 54 book chapters, accumulating more than 73,000 citations with an h-index of 134 (Google Scholar, March 2026).

K-5 - Microalgae Assisted Membrane Bioreactors for Fouling Control

○Huu Hao Ngo[1]

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Abstract: Membrane bioreactors (MBRs) have emerged as a promising technology for advanced wastewater treatment; however, their widespread application is significantly constrained by persistent membrane fouling. Recent studies suggest that integrating microalgae with bacterial consortia offers a sustainable strategy to mitigate fouling while

enhancing nutrient removal and reducing energy demand. Microalgae inoculation can influence sludge characteristics and reduce the production and accumulation of extracellular polymeric substances (EPS), which are key contributors to fouling formation. This presentation provides the first comprehensive assessment of the role of microalgae in controlling membrane fouling in MBR systems. It begins with an overview of the development and unique features of microalgae-based MBRs, followed by a critical evaluation of their treatment performance. Furthermore, this identifies current limitations, including operational complexity, light requirements, and system stability, and highlights future research directions to advance the practical implementation of microalgae-assisted fouling control.

Prof. Fengting Li leads an internationally renowned interdisciplinary research team that specializes in the molecular design of environmental functional materials. The group systematically bridges fundamental chemical research with industrial applications to address critical environmental challenges. Their innovative approach combines molecular engineering with technological standardization to deliver sustainable solutions across multiple industrial sectors.

Professor Li's research has generated significant scientific and industrial impact. Since 2000, he has led over 60 major research projects funded by China's Ministry of Science and Technology, UNEP, UN-Habitat, and industrial partners. His team's technologies have been adopted by more than 60 Chinese companies, with their iron salt coagulants capturing over 50% of the national market. The group's intellectual contributions include 400+ peer-reviewed publications and 150 patents in China and the U.S.

The quality and relevance of this work have been recognized through prestigious awards, including the United Nations Special Contribution Award for South-South Cooperation, two First Prizes for Shanghai Technological Invention, and two National Teaching Achievement Awards. These accomplishments underscore the group's ability to transform molecular innovations into scalable environmental solutions while maintaining scientific rigor and global relevance.

K-6 - Red Mud Valorization: From Waste Management to Metal Resource Recovery in the Circular Economy

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Abstract: Red mud (bauxite residue) represents a critical dual challenge for the aluminum industry: massive, hazardous alkaline waste and a potential secondary resource for valuable metals. This review systematically deconstructs the limitations of conventional metal-specific recovery pathways, which are fundamentally constrained by a process trilemma—the inescapable trade-off among high efficiency, selective recovery, and sustainable process intensity. We argue that transcending this trilemma requires a paradigm shift from discrete technological optimization to the integration of systemic processes. Through a critical analysis of individual recovery routes for Fe, Al, Ti, and REEs), we demonstrate how their inherent limitations necessitate integrated solutions. Building on this analysis, the review synthesizes emerging integrated flowsheets and proposes a novel "Sequential Decoupling-Synergistic Recovery-Circular Metabolism" framework. This framework prioritizes the stepwise restructuring of the red mud matrix to enable efficient multi-metal recovery while designing for the closure of material loops (e.g., alkali and CO_2) and the valorization of final residues into construction materials. We conclude that the future of red mud valorization lies not in discovering new unit processes, but in the predictive design of resilient industrial ecosystems. This transition demands advancements in digital system modeling, circular product design, and policies that incentivize industrial symbiosis, ultimately positioning red mud as a cornerstone for a circular, low-carbon metallurgy.

Keywords: Red mud; Metal recovery; Process integration; Circular economy; Sustainable metallurgy

Dr. Li Li, Professor, formerly served as Director of the Experimental Center and Deputy Director of the National Experimental Teaching Demonstration Center at the College of Environment and Ecology, Chongqing University. She has led six research projects, including those under the National Key R&D Program of China, the National Natural Science Foundation of China, and provincial/ministerial-level funding, and participated in three additional National Key R&D Program projects. She has published over 50 research papers in renowned domestic and international journals and holds 17 authorized patents. As a nationally certified engineer (water supply and drainage), she has led the design of more than one hundred urban wastewater treatment facilities. She has received three science and technology awards, including the Special Prize of the Hua Xia Construction Science and Technology Award and the First Prize of Chongqing Science and Technology Progress Award. She has directed one key provincial/ministerial-level teaching reform project and three university-level teaching reform projects, and published one textbook. She has developed one National First-Class Undergraduate Course and two provincial/ministerial-level First-Class Courses and Model Courses for Ideological and Political Education.

K-7 - Process-dependent Transformation Behaviors and Conserved Reaction Networks in a Full-scale Textile Dyeing Wastewater Treatment Train

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Abstract: Understanding contaminant transformation during wastewater treatment is essential for pollution control, yet the highly diverse molecular composition arising from industrial sources challenges the elucidation of underlying reactions. Here we performed nontargeted analysis, molecular networking (GNPS), and paired mass distance (PMD) analysis across the entire treatment train (hydrolysis acidification, aeration, coagulation, ozonation, BAF) of a textile dyeing plant. PMD analysis revealed a clear dichotomy: biological units (hydrolysis, aeration, BAF) favored mass loss (common shifts: 14.016, 28.032, 44.026, 2.016 Da), whereas physicochemical units (coagulation, ozonation) favored mass gain. This explains why aeration and BAF were the primary removal units, while coagulation was inefficient. Consistently, hydrolysis acidification and ozonation increased feature diversity by converting large molecules into smaller, bioavailable intermediates, enabling subsequent biological removal. ESI^+ features decreased sharply from influent to effluent, but ESI^- showed only moderate reduction with more newly generated features, indicating persistence of acidic/oxygenated/halogenated compounds. Chemical subclass annotation revealed that amino acids, peptides, and analogues (AAPAs) dominated, and transformation networks were centered on AAPAs, involving process-specific partners such as ethers (hydrolysis) or amines and carbohydrates (ozonation). Nevertheless, only ~10% net subclass reduction occurred after whole treatment, suggesting extensive interconversion rather than mineralization. This study provides molecular-scale insight into process-dependent transformation patterns, benefiting targeted process enhancement for recalcitrant compounds.

Keywords: Contaminants composition; Molecular networking; Non-targeted analysis; Pairwise mass distance; Textile dyeing wastewater; Transformation pathways

Dr. Hongbo Liu (male, Han Chinese, b. 1979) is a tenured professor at the School of Environment and Architecture, University of Shanghai for Science and Technology, and an adjunct researcher at Tongji University. He is a National Certified Environmental Protection Engineer in China.

He has led or significantly contributed to over ten major projects, including those funded by the National Natural Science Foundation of China, the National Key R&D Program, the National Water Pollution Control S&T Major Projects (11th & 12th Five-Year Plans), and the Bill & Melinda Gates Foundation's Reinvent the Toilet Challenge. He serves as Director of the Carbon Neutrality Research and Industry Promotion Center (Yangtze River Delta Smart City Area) and Vice President of Shanghai Yangtze River Delta Smart City Development Research Institute. He holds multiple committee memberships in national professional societies and editorial roles in journals such as Frontiers in Environmental Science and Applied Sciences.

His main academic achievements focus on three areas: microbial electrochemical-assisted deep denitrification for low C/N wastewater, microbial weak-electricity driven high-value conversion of organic wet wastes (e.g., livestock manure), and resource-recovering ecological toilets with low-carbon self-sustaining operation. For these innovations, he has received several provincial/ministerial science and technology awards, including the Shanghai Technological Progress Award and the Shanghai Technological Invention Award.

K-8 - Exploration of the Control and Resource Utilization Pathways of Enteromorpha

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Abstract: Massive green tides of Enteromorpha in the Yellow Sea impose severe ecological pressure, while the harvested biomass presents substantial logistical challenges due to its high moisture content (>90%) and high viscosity, compounded by the low value addition of existing utilization pathways. Employing collected Enteromorpha as feedstock, this study established an integrated technology chain involving high-solids dewatering, targeted subcritical hydrothermal conversion, extraction and separation of functional components, and formulation of small-molecule organic fertilizer. A dedicated dewatering system designed for highly viscous algal biomass reduced the moisture content of fresh Enteromorpha from over 90% to below 60%. A continuous subcritical hydrothermal reactor with a treatment capacity of 10 t/d (wet basis) was developed to

stably convert proteins and polysaccharides into bioactive small-molecule products, including oligosaccharides and amino acids. Rapid extraction and separation methods for proteins, oligosaccharides, and polysaccharides were further developed. The resulting integrated process offers an engineering pathway for coastal green-tide mitigation, high-value utilization of marine biomass, and the development of green agricultural inputs.

Keywords: Enteromorpha; Green tide control; Organic fertilizer; Resource utilization; Subcritical hydrothermal treatment

Dr. Yu Liu is a Chair Professor in College of Environmental Science and Engineering, Nankai University, China. Prior to that, he had been a tenured professor in School of Civil and Environmental Engineering, Nanyang Technological University of Singapore for 25 years. His research primarily focuses on innovative technologies for municipal wastewater reclamation and biosolids management. Dr Liu has published more than 400 journal papers, with the total citation of more than 43000 and h-index of 106 by Google Scholar, and he has 9 books published by Elsevier, Wiley, IWA Publishing etc. In recognition of his contributions to research and administration, Dr Liu was awarded The Singapore Public Administration Medal in 2014, The Singapore Minister for National Development's R&D Award in 2013 and Singapore National Technology Award in 2003.

K-9 - Critical Issues Toward Carbon-Neutral Municipal Wastewater Treatment

○Yu Liu[1]

[1]*College of Environmental Science and Engineering, Nankai University, Tianjin, China*

Abstract: The current WWTPs are predominantly designed according to biological redox principles, which require substantial energy inputs while generating GHGs. As a result, WWTPs are recognized as significant contributors to global carbon emissions. Despite considerable progress in developing carbon-neutral wastewater treatment technologies, several critical issues still remain debatable. In such a context, this talk aims to provide new insights into these key challenges. It is expected that the discussion will be useful for developing a robust technological roadmap toward carbon-neutral municipal wastewater treatment.

Dr. Yue-Qin Tang earned her doctoral degree from Kumamoto University in Japan. She served as an Assistant Professor at Kumamoto University from 2006 to 2008, then as a Professor at Peking University from 2008 to 2012. Since 2012, she has been a Professor at Sichuan University. She is also the Director of the Key Laboratory of Organic Waste Valorization for Environmental Protection in Sichuan Province, a Standing Director of the Microbiology Society of Sichuan Province, and a member of the Archaea Committee of the Chinese Society for Microbiology. Her research focuses on the valorization of waste biomass for the production of biofuels, biochemicals, and biofertilizers, as well as microbial breeding and environmental microbial ecology. Dr. Tang has developed extensive expertise, particularly in technologies for producing fuel ethanol and biochemicals from lignocellulosic biomass waste, the construction of superior fermentation strains, anaerobic fermentation for methane production, and the underlying microbiological mechanisms. She has published over 250 research papers and holds more than 30 authorized patents.

K-10 - Anaerobic Digestion Performance and Microbial Response Mechanisms under High Salinity Stress

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Abstract: The valorization of seafood processing waste via anaerobic digestion (AD)faces significant challenges due to high salinity, which typically inhibits microbial activity and reduces methane production efficiency. In this study, with simulated seafood processing waste as the substrate and conventional anaerobic sludge as the inoculum, three continuous AD systems with different configurations: suspended sludge, biofilm carriers (packing media), and electrochemical coupling, were constructed. By gradually increasing the NaCl concentration in the feed (from 1% to 5%), we investigated the AD efficiency of each system under varying salt stress conditions. Furthermore, multi-omics approaches were employed to elucidate the responses of microbial communities to salinity stress.

Results indicated that all three process configurations could tolerate salinity levels up to 4%. The addition of biofilm carriers and electrochemical measures enhanced AD performance slightly, primarily attributed to differences in microbial community structures on the carriers and electrodes. Microbial communities responded to salt stress by regulating extracellular polymeric substances (EPS), cell membrane lipids, intracellular Na^+/K^+ ion balance, and the composition of intracellular small molecules. While different functional microorganisms exhibited both similarities and differences in

their preferred salt-tolerance mechanisms, the expression of molecular chaperone proteins and the synthesis of intracellular metabolites appeared to be the priority strategies adopted by the majority of microbes in three AD systems.

Keywords: Anaerobic digestion; Meta-omics; Microbial community; Salt stress; Seafood processing waste

Prof. Shao-Yuan (Ben) Leu is a Full Professor of Civil & Environmental Engineering at The Hong Kong Polytechnic University. His research interest is in developing urban biorefinery techniques to convert lignocellulosic biomass into value-added chemicals and biofuels, such as Sustainable Aviation Fuel (SAF). Prof. Leu received BSc/MPhil Degrees in Wood Processing from National Taiwan University and PhD degree in Wastewater Engineering from UCLA. He was a registered Professional Engineer in California and a postdoctoral researcher at the USDA Forest Products Laboratory, USA. At PolyU, Prof. Leu establishes the Bioenergy Lab and constructs the solid-state NMR platform to characterize the decomposition mechanisms of woody cell walls under natural and engineered conditions. He has developed innovative pretreatment technologies for organic waste valorization, which is particularly relevant to the waste management and sustainable development goal of highly populated cities like Hong Kong. Since 2013, he has secured over HK$42 Million in R&D grants, published 110 peer-reviewed papers, filed 4 patents, edited 1 book, and received multiple awards.

K-11 - Process-Control-Guided Sequencing Fractionation Improves Monolignol Recovery from Food-Processing Lignocellulosic Biomass

○Jianyu Guan[1], Ho-Yin Tse[1], Raffel Dharma Patria[1], Shao-Yuan Leu[*, 1, 2, 3, 4]

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[2]*Research Institute of Smart Energy (RISE), PolyU, Hong Kong SAR, China*
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Abstract: Lignin-first biorefineries often increase delignification at the expense of lignin integrity and hemicellulose preservation, even though reactive lignin recovery is essential for efficient monolignol production. This study investigated whether process-control-guided 1,4-butanediol organosolv fractionation could improve whole-biomass

valorization of *Camellia oleifera* shell. Sixty-six pretreatment and catalytic hydrogenolysis experiments, together with solution- and solid-state NMR, were used to develop a Pretreatment Depolymerization Factor (PDF) model that tracks hemicellulose hydrolysis, delignification, and lignin structural integrity. The model predicted delignification dynamics, lignin integrity, and monolignol yield with 90.9% accuracy. PDF-guided sequencing-batch fractionation selectively dissociated lignin-associated xylan, revealed a previously unexplored C_β–C_γ bond-cleavage pathway initiated by C_γ–OH activation, and increased monolignol production by over 30% without additional solvent, energy, or chemicals. The optimized strategy achieved 40.1 mg monolignols per g biomass with 95% lignin removal and raised overall green biomass utilization from 57.7% to 72.0%. These results show that smart fractionation control can preserve carbohydrates while enhancing aromatic product recovery, providing a practical route toward more sustainable and economically attractive lignin-first biorefineries.

Keywords: Biorefinery; Lignin; Monolignols; Organosolv; Sustainability; Xylan

Dr. Yongmei Li is a full professor of the College of Environmental Science and Engineering at Tongji University. She obtained a PhD in Environmental Engineering Department at Tongji University, China, in 1999, and joined Tongji University in the same year. During 2006-2007, she was a postdoc researcher in Stanford University, USA. Her research focuses on removal and recovery of nutrients (phosphorus and nitrogen) from wastewater, anaerobic digestion of biosolids and resource recovery, and modelling of biological treatment processes. She is a member of IWA (International Water Association) Fellows and a member of the management committee of the IWA nutrient removal and recovery specialist group. She has published over 200 scientific papers and has more than 40 patents. She has been awarded as a New Century Excellent Talent by the Ministry of Education of China and has also received the Science and Technology Progress Awards of the Ministry of Chinses Education.

Research Keywords: Removal and recovery of phosphorus; biological nitrogen removal; anaerobic fermentation of biosolids; fate and attenuation of emerging organic contaminants

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K-12 - Enhanced Methane Production from Waste Activated Sludge: Calibrated ADM1-guided Optimization and Mechanistic Insights

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Abstract: Nowadays, the anaerobic digestion (AD) process still encounters significant challenges of low bioconversion efficiency for biogas production from waste activated sludge (WAS). Mathematical models serve as a useful and cost-effective tool to optimize the operation of the AD. In this study, Anaerobic Digestion Model No 1 (ADM1) was calibrated and used to obtain optimal operational conditions for methane production from the AD of WAS. Using global sensitivity analysis (GSA), pH, solids retention time (SRT), and organic loading rate (OLR) were recognized as critical operational conditions for methane production in the mesophilic AD. The ADM1 was calibrated for major model component fractions and parameters, improving methane production simulation with the Theil's inequality coefficient (TIC) of 0.069 – 0.102. Using this calibrated ADM1, optimal conditions for methane production were obtained as SRT=30 d, pH=7.2±0.1, and OLR=1.56 g $TS \cdot L^{-1} \cdot d^{-1}$. Both lab-scale and pilot-scale semi-continuous AD experiments confirmed the optimization results, with 68.7 – 93.4% improvement of methane production under the optimal conditions over other conditions. Based on partial least-squares path modeling (PLS-PM) analysis and Gibbs free energy (ΔG) calculations, the calibrated ADM1 contributed to a deeper comprehension of the AD process mechanisms. Especially, the calculations of ΔG confirmed the better stability of the AD under the above optimal conditions, a desirable feature. This study provides a robust method to rapidly optimize methane production during the AD of biomass, and contributes to an in-depth model-based understanding of the AD mechanisms. These developments encourage the application of AD technology in biosolid treatment to reap financial and environmental rewards.

Keywords: ADM1 calibration; Gibbs free energy; Global sensitivity analysis; Methane production; Process optimization; Waste activated sludge

Dr. Caixia "Ellen" Wan is an Associate Professor in the Department of Chemical and Biomedical Engineering at the University of Missouri. She is also a core faculty member of the Missouri Water Center and an affiliated faculty member of the MU Materials Science and Engineering Institute. Dr. Wan earned her Ph.D. in Biological Engineering from The Ohio State University. Her research focuses on biorefining and biomanufacturing, with particular emphasis on biomass conversion, biodegradable polymers, fermentation engineering, and biocatalysis. With over 20 years of experience in bioprocessing and bioresource valorization, she has led a number of research projects supported by federal agencies, commodity councils, and industries. She has published more than 100 peer-reviewed articles and received 8500+ citations. She is ranked among the top 2% of scientists worldwide. Her work advances sustainable bioprocesses and biobased products, bridging fundamental research and industrial applications to promote circular bioeconomy.

K-13 - Advances in Sustainable Bioprocess Systems for Waste Carbon Conversion

○Caixia "Ellen" Wan[1]

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Abstract: The transition toward next-generation manufacturing will increasingly depend on bioprocess systems that can efficiently utilize diverse waste carbon feedstocks to produce value-added products with improved process performance and reduced environmental burden. This talk will highlight recent advances in sustainable bioprocess systems that integrate feedstock selection, conversion pathways, product recovery, and process evaluation into a more unified framework for waste carbon utilization. Rather than viewing individual processing steps in isolation, this approach emphasizes system-level design to improve resource efficiency, broaden feedstock flexibility, and strengthen scalability and industrial relevance.

Drawing on research in industrial fermentation, biomass residue valorization, waste-derived bioprocessing, and bio-based product development, the presentation will illustrate how sustainable bioprocess systems can expand the use of underutilized carbon resources for manufacturing applications. Representative examples will include the conversion of agricultural and food processing residues, waste-derived carbon intermediates, and other low-value carbon streams into biodegradable polymers, functional biomaterials, and related value-added products. Particular attention will be given to integrated processing strategies, hybrid conversion approaches, and the role of techno-economic and life-cycle considerations in guiding scale-up and process design. Together, these advances demonstrate how sustainable bioprocess systems can move waste carbon utilization beyond proof-of-concept studies toward more practical and impactful manufacturing solutions. The talk will provide a forward-looking perspective on the opportunities and challenges in developing resource-efficient bioprocess platforms for the conversion of waste carbon feedstocks into value-added products.

Dr. Yi Zhang obtained her Bachelor degree in the Department of Environment Science and Engineering, Fudan University, in 2002, before pursuing her graduate study with Nanyang Technological University, Singapore. In School of Civil and Environmental Engineering, she focused her research on the treatment of toxic industrial wastewaters via novel biological processes, i.e. aerobic granular sludge systems. She started working as a project officer in 2006, in the Institute of Environmental Science and Engineering, where she expanded her expertise into areas such as ballast water treatment, bunker fuel and clean energy. After being awarded her Doctoral degree, she joined her alma mater as a lecturer, and later became Associate Professor. Her research interests, though centering on, are not limited to environmental engineering and wastewater treatment. Dr. Zhang believes the solution to mankind's environmental problems requires interdisciplinary collaboration and holistic mindset. Therefore, her present research involves the interconnection of resource reclamation from waste streams, new materials and renewable energy, as well as social aspects and human values.

K-14 - Solvent-free Recovery of Polyhydroxyalkanoates (PHA) from Mixed Microbial Cultures (MMCs), and Cost and Scalability Analysis

○Yi Zhang[*, 1], Yuqi Zou[1], Qiuyue Tao[1], Ioanna Ntaikou[2], Marie K. Harder[1, 3]

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Abstract: PHA is a class of biopolymers cappable of replacing conventional plastics. After its intracellular synthesis, PHA has to be recovered from cells through various means. However, present recovery processes suffer from poor environmental-friendliness, low scalability and lack of application with MMCs. In this study, an MMC accumulating >50% PHA was used to test two solvent-free treatments, i.e. ultrasonic (US) + NaOH and acidification-NaClO (forming HClO). US, NaOH or NaClO digestion alone achieved poor efficiency, sometimes accompanied by high energy consumption and PHA degradation. Combining US and NaOH significantly improved PHA recovery, that under semi-optimized conditions, >70% Recovery and 80% Purity were achieved from a 3 g L^{-1}slurry. NaClO alone obtained 55~74 % Purity and 57~73 % Recovery, which was increased to 62~83 % and 75~97 %, respectively, upon acidification. The cost was estimated based on lab scale tests, and showed \$24±2 kg pure PHA^{-1} for US + NaOH, and 225 ± 4 kg^{-1} for acidified NaClO. The latter can be significantly reduced by applying a denser culture, and is easier to scale up. However, HClO digestion resulted in more severe PHA depolymerization, while US + NaOH treatments obtained comparable or higher molecular weight to previously reported results, and good thermal stability compared to the commercial standard.

Keywords: Acidification-NaClO; Mixed microbial culture (MMC); Polyhydroxyalkanoate (PHA); Recovery; Sodium hydroxide; Ultrasonic

Prof. Dr. Juan Carlos Colmenares Q. graduated from Warsaw University of Technology (Chem. Eng. 1995) and obtained his M.Sc. (1997) in catalysis for organic technology and Ph.D. (2004) in chemical and material sciences from the same university, the scientific degree of habilitation (D.Sc. 2015) from the Institute of Physical Chemistry of the Polish Academy of Sciences in Poland, and in 2023 Full Professor in Chemical Sciences given by the Council of Excellence in Poland/Office of the President of Poland. His interests range from materials science, nanotechnology, and heterogeneous catalysis to biomass/CO_2 valorization, solar chemicals, sonication, photocatalysis, and water/air purification. After obtaining his Ph.D., he worked at the University of Córdoba, Spain (2005–2006) in Prof. Marinas' group as a postdoctoral fellow, and at the University of Southern California, Los Angeles (USA) (2006–2009) in *Prof. G. A. Olah's* (Nobel Prize in Chemistry) group as a postdoctoral research associate. He is a Marie Skłodowska-Curie fellow. He serves as an expert evaluator for many important scientific journals/institutions and chemical companies (Colombia, USA, Poland, Spain, China), and as a member of the editorial advisory board for *Scientific Reports* and *Molecules (Photochemistry Section)* journals. He has coauthored more than 160 works published in international scientific journals and books (>10,000 citations, H-index ≈ 50) and filed seven patent applications (six accepted). Presently, he is working as full professor at the Institute of Physical Chemistry of the Polish Academy of Sciences in Poland.

K-15 - Mechano-Photocatalytic Biorefinery: Advanced Porous Carbon Catalysts from Biomass

○Juan Carlos Colmenares[*, 1], M. Paszkiewicz-Gawron[1], D. Łomot[1], B. Hashemi Hosseini[1], A. M. Djaballah[1]

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Abstract: Under ultrasonic cavitation coupled with light irradiation, we devised renewable sonophotocatalytic routes to valorize lignin-derived compounds. The catalysts were a lignin-based hybrid incorporating Cu-functionalized ZnO and a metal-free chitosan–lignin composite. They were tested under high-frequency ultrasound and UV-A light, while acoustic pressure mapping, time-resolved mass spectrometry and luminol imaging probed radical generation and cavitation stability. Under optimized conditions the lignin–ZnO–Cu system achieved complete conversion of coniferyl alcohol to racemic dehydrodiconiferyl alcohol. Adjusting sonication power altered energy distribution and enabled selectivity control. The metal-free Syn-340 catalyst reached over 99 % selectivity and 32.8 % yield for diapocynin from acetovanillone. Mechanistic studies revealed that

500 kHz ultrasound enhances radical formation, whereas 22 kHz favors reproducibility. Both processes operated at ambient temperature and pressure, eliminating harsh reagents and aligning with circular economy principles. These findings show that combining sound and light with biopolymer catalysts facilitates efficient biomass upgrading and provides design guidelines for next-generation sonophotocatalytic systems.

Keywords: Acoustic cavitation; Biopolymer catalysts; Biomass valorization; Frequency-controlled sonophotocatalysis; Metal-free C–C coupling; Porous photocatalysts.

Dr. Hua Zhang is a full professor of College of Environmental Science and Engineering at Tongji University. Her research mainly focuses on intelligent identification, thermal treatment and beneficial utilization of solid waste. As a PI, she has been responsible for several R&D projects supported by central government. She is an associate editor of "Journal of the Air & Waste Management Association", managing editor of "Waste Management", and member of Youth editorial board for "Carbon Research" and "Biochar".

K-16 - Nondestructive Spectroscopic and Optical Techniques Combined with Machine Learning for Solid Waste Identification: A Review

○Yi-Lin Shen[1], Dong-Ying Lan[1], Pin-Jing He[1, 2], Wei Peng[1], Fan Lü[1, 2], Hua Zhang[*, 1, 2]

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Abstract: Characterizing solid waste is crucial for effective waste management strategies. Traditional waste analysis methods are laborious, time-consuming, and destructive, prompting the emergence of nondestructive techniques. The adoption of efficient machine learning and deep learning methods can enhance data processing and recognition accuracy. However, previous reviews have focused on individual analytical techniques, lacking comprehensive comparisons and systematic summaries. This review aims to compare and discuss rapid and nondestructive optical and spectroscopic techniques, including computer vision, vibrational spectroscopy, hyperspectral imaging, and thermal imaging, combined with the latest developed algorithms to improve solid waste identification and characterization. These techniques have been applied in waste classification and sorting, detecting macro and microplastics, recognizing harmful contamination, and predicting chemical properties. While demonstrating high performance, limitations and challenges remain. Future research is necessary on dual sensor platforms and deeper exploration of solid waste properties. This review will guide the advancement of nondestructive

techniques for rapid solid waste recognition.

Keywords: Computer vision; Hyperspectral imaging; Machine learning; Solid waste characteristics; Thermal imaging; Vibrational spectroscopy

Dr. Fan Lyu is a full professor of College of Environmental Science and Engineering at Tongji University. Her research focuses on: biotechnology and relating microbiology for the treatment and valorization of solid waste, characterization and treatment of traditional and emerging pollutants generated during solid waste treatment, as well as the life-cycle assessment on different waste treatment technologies. She has over 350 publications in top-rated peer-reviewed journals and over 50 granted patents. She is listed in the Highly Cited Chinese Researchers (2024~) and Top 2% Scientists Worldwide for career long (2024~).

K-17 - Rethink the GHG Emission of Anaerobic Digestion

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Abstract: Anaerobic digestion is conventionally regarded as a carbon-negative technology, which is indispensable in the context of circular economy and decarbonation. In this study, we investigated the N_2O and CH_4 emissions in food waste anaerobic digestion plants, in order to identify their emission sources and their contributions to greenhouse gases. We found that the potent greenhouse gas N_2O's emission factor in anaerobic digestion systems has long been underestimated. Offline sampling identified emission hotspots including anaerobic-anoxic-aerobic treatment units, pulpers, coarse screens, and food waste leachate tanks in the pretreatment system. Online monitoring of the odor collection system showed that the N_2O emission rate at the food waste anaerobic digestion plant was 39.2±3.3 kg N_2O /h, corresponding to a GWP100 of 409±35 kg CO_2-eq/t food waste, approximately four times the contribution of CH_4 emissions. These findings challenge the assumption of negligible N_2O emissions for anaerobic digestion technology.

Keywords: Anaerobic digestion; Greenhouse Gas; Food waste; Biowaste; Organic waste

Dr. Chaoxiang Liu, Professor and PI, he received his doctorate (PH.D.) in environmental science and engineering at Tsinghua University in 2003. He had studied and worked in Fukuoka University and National Institute for Environmental Studies (NIES) in Japan for 5 years, and thereafter joined the Institute of Urban Environment, Chines Academia of Science in 2008. Now he is working as a full professor of in the department of Environment Science and Engineering of Fuzhou University since 2022, China. His research is mainly focused in the fields of waste treatment and resource utilization, and sewage ecological treatment. He has done many applications in the pollution control and resource utilization technology for livestock and mariculture Wastewater. His research was funded by the National Science and Technology Major Projects, National Natural Science Foundation projects, major projects of the CAS, and Zhejiang Province, Fujian Province Key Projects. He is the author of more than 100 peer-reviewed scientific publications, and more than ten invention patents have been authorized. He is Vice President of the Fujian Provincial Environmental Education Society, also an overseas member of Japan Society on Water environment, wined the JSWE-IDEA Water Environment International Exchange Award at the annual conference in 2012.

K-18 - Mechanistic Insight into Enhanced Florfenicol Degradation by Micronano Bubbles Ozonation in Mariculture Wastewater

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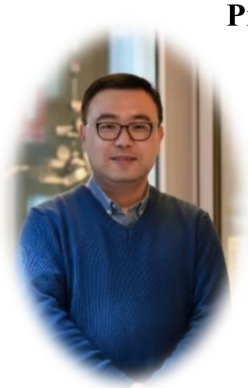
Abstract: Intensive mariculture relies heavily on antibiotics, such as florfenicol (FF), which pose ecological risks due to their persistence, bioaccumulation, and promotion of antibiotic resistance. Conventional macro-bubbles ozonation (MaB-O3) faces challenges in effectively degrading FF due to poor ozone mass transfer and limited reactivity with FF (kO3 < 10 M-1 s-1), especially in high salinity and complex organic wastewater. This study introduces micro-nano bubbles ozonation (MNB-O3) as an efficient alternative, achieving 99.13 ± 0.08% removal of FF in actual mariculture wastewater, significantly surpassing MaB-O3. The enhanced performance is attributed to improved ozone dissolution and elevated generation of reactive oxygen species (ROS). The pseudo first-order rate constant for MNB-O3 was determined to be 3.9 times that of MaB-O3 in ultrapure water and remained 2.4 times greater in artificial seawater. Alkaline conditions further promoted ROS formation and FF degradation. Radical probe experiments and

electron paramagnetic resonance (EPR) analyses verified the predominant role of ROS. Degradation pathways, primarily involving defluorination, dechlorination, and hydroxylation, were elucidated using liquid chromatography-quadrupole time-of-flight tandem mass spectrometry (LC-QTOF-MS) and density functional theory (DFT) calculations. Luminescent bacteria assays confirmed an overall reduction in acute toxicity after treatment. These findings position MNB-O3 as a promising technology for antibiotic abatement in mariculture effluents.

Keywords: Mariculture wastewater; Ozonation; Micro-nano bubbles; Florfenicol; Degradation mechanism



Prof. Qiang Fu received his B.E. in Chemical Engineering from Shanghai Jiao Tong University and completed his Ph.D. in Polymer Chemistry at Fudan University in 2009. He then undertook postdoctoral research at the University of Melbourne. He has been awarded several prestigious fellowships, including an Australian Research Council (ARC) Super Science Fellowship, an ARC Future Fellowship, and an Emerging Future Leader Fellowship from the Australian Academy of Technological Sciences and Engineering (ATSE). A/Prof Fu has secured more than $4 million in competitive research funding and published over 150 peer-reviewed papers in leading journals, including *Nature Communications*, *Energy & Environmental Science*, and *Advanced Materials*. His publications have received more than 9,600 citations, with an h-index of 55. He has also been ranked among Elsevier's World's Top 2% Scientists since 2020. He currently leads a research group at the Centre for Technology in Water and Wastewater (CTWW), University of Technology Sydney. His research focuses on interfacial solar evaporation, controlled radical polymerisations, membrane nanotechnology, two-dimensional metal-organic frameworks, and functional materials for energy and environmental applications.

K-19 - Energy-efficient Approaches to Water Treatment

○Qiang Fu[*, 1], Shudi Mao[1], Casey Onggowarsito[1], Stella Xin Zhang[1], Yihan Shi[1], Ying Long[1], Yuqing Yang[1]

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Abstract: Water is the basis for the existence and continuation of all life on Earth. The water resources on Earth are extremely huge (ca. 1.46 × 10^{16} cubic meters). However,

99.97% of the water exists in the form of seawater or deep groundwater that is difficult to collect, and only less than 0.03% can be easily used by humans. Due to geographical and climate constraints, the shortage of freshwater is of concern to 2.8 billion people in 48 countries all over the world especially in Africa, the Middle East, and Oceania, and the affected population may rise to 4.0 billion based on reasonable predictions. Consequently, the discovery of the next-generation freshwater production technologies with low-cost, high-water production rate and ease of installation and use is considered a promising solution to this global challenge and has attracted increasing attention all over the world. The hydrogel-based Interfacial Solar Evaporation (ISE) system is a floating device mounted on the surface of the sea in which a hydrogel with customized features is integrated. By incorporating a photothermal additive into the hydrogel matrix, ISE can greatly increase the evaporation rate of seawater. Our team has developed a series of new hydrogel materials that enable higher freshwater production efficiency by tuning the hydrogel structure on the nanometer, micron, and millimeter scale. These systems offer excellent water production performance and high solar-to-steam conversion efficiency compared to state-of-the-art materials.

Keywords: Desalination; Hydrovaltaic; Interfacial solar evaporation; Resource recovery; Zero-liquid discharge

Dr. Suyun Xu is the Professor in the Department of Environmental Science and Technology in the School of Environment and Architecture at the University of Shanghai for Science and Technology, China. She received her Master degree from Tongji University in 2009, and obtained the Ph. D degree from Hong Kong Baptist University in 2012. Her research interests mainly focus on the fields of biowaste treatment, bioenergy conversion, biological treatment of wastewater and bio-electrochemical system development. She is dedicated to turning energy and resource recovery from biowaste and wastewater, including the biogas upgrading, nutrients recovery from the source-separated sewage, and the high-value products from various biowaste. She has published over 100 peer-reviewed papers and serves as the Executive Editor of Bioresource Technology.

K-20 - Early Prediction of Volatile Fatty Acids Concentration Using Microbial Electrochemical Sensor and Machine Learning

○Ruixiang Zou[1], Hongbo Liu[1], Suyun Xu[*, 1]

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Abstract: Volatile fatty acids (VFAs) are critical indicators of anaerobic digestion stability, yet continuous online monitoring remains challenging. We developed an enhanced microbial fuel cell (MFC) sensor platform through a synergistic strategy combining carbon felt (CF) electrode with chemical modification and functional strain inoculations. Four anode configurations were compared: unmodified carbon felt (CF), neutral red-modified (CF-NR), *Shewanella*-inoculated (CF-S), and the composite (CF-NR-S). The composite CF-NR-S sensor (CF combined with neutral red modification and *Shewanella*-inoculated) exhibited the fastest voltage response and highest sensitivity, detecting VFAs as low as 0.5 mM in a mixed VFA system (acetic: propionic: butyric = 8:2:1) within 300 minutes with excellent linearity ($R^2 = 0.98$). Among four tested strains, CF-S (S. *oneidensis*) showed the lowest detection limit (0.1 mM acetate), followed by CF-P (*Pseudomonas aeruginosa*), while CF-E (*Escherichia coli*) and CF-B (*Bacillus subtilis*) exhibited higher detection limits. To enable faster early screening, we integrated machine learning to predict VFAs concentration from partial sensor responses. Fusion models provided the greatest advantage for short sequences, while sequence-only models became competitive as temporal information accumulated. The MMAttFusion-GRU model achieved optimal performance at 120 min, enabling reliable predictions using only half the full monitoring duration. This work demonstrates that combining synergistic sensor design with machine learning enables rapid, robust VFA monitoring suitable for practical anaerobic process control.

Keywords: Early prediction; Machine learning; Microbial electrochemical sensor; Volatile fatty acids

Prof. Tong Yen Wah joined the Department of Chemical and Biomolecular Engineering at the National University of Singapore (NUS) in 2001 after graduating from the University of Toronto with a PhD in Chemical Engineering. His expertise is in biomaterials research for tissue engineering and in bioenergy from food wastes and biomass wastes, with over 300 publications and 22000 citations with a h-index of 85. His recent works in food wastes management has been commercialized with distributed anaerobic digesters that can be effectively used in cities through a spin-off company from NUS. He is currently focusing on novel photobioreactor designs to grow cyanobacteria for biofuel production in a collaboration with Shanghai Jiaotong University.

K-21 - Digestate to Dinner: Microalgae-Driven Single-Cell Protein for the Urban Bioeconomy

○Yen Wah Tong[1]

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Abstract: Urban food waste presents a persistent challenge and a missed opportunity for resource recovery. While anaerobic digestion (AD) can convert food waste into biogas and a nutrient-rich digestate, the land constraints of dense cities limit digestate use as a biofertilizer, creating a bottleneck to wider AD deployment. This plenary will present a circular, biotechnological pathway to address that gap: the upcycling of food-waste digestate into single-cell protein (SCP) via microalgal biotransformation.

We evaluated the feasibility of using digestate as a cultivation medium for microalgae, benchmarking growth performance under batch and semi-continuous operations to identify operational regimes that balance productivity and stability. To probe practical scalability, we advanced the process to a 100 L pilot and operated it over 10 weeks to assess long-term robustness. The talk will synthesise lessons from these trials, including media preparation and variability management, nutrient balancing, and process control considerations essential for reliable SCP production from heterogeneous waste streams. Beyond the technical results, we will discuss integration pathways with urban AD infrastructure, potential nutritional and safety considerations for SCP applications, and the environmental and economic implications of coupling waste valorisation with low-carbon protein production. By reframing digestate as a feedstock for high-value biomass, this work outlines a resource recovery platform that can unlock broader adoption of AD in cities, advancing both decarbonisation and the circular bioeconomy.

Keywords: Anaerobic digestion; Digestate valorisation; Microalgae cultivation; Single-cell protein; Urban resource recovery; Pilot-scale bioprocessing

Dr. Hongtao Wang is a Professor in Tongji University and UNEP-Tongji Institute of Environment for Sustainable Development. His research fields include sustainable urban water systems, physicochemical treatment of water, as well as sludge conditioning. He is an Editorial Board Member of *Water Environment Research* as well as Editorial Advisory Board Member of *ACS ES&T Water.*

K-22 - Influence of Discharge Standards on Water-Energy-Carbon Nexus of Wastewater Treatment Plants

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Abstract: Wastewater treatment plants (WWTPs), as one of the important point sources of water pollution, need to comply discharge standards to ensure water environment quality. However, while reducing effluent discharge pollutants, it also leads to increased energy consumption and carbon emissions. Therefore, it is necessary to consider the water-energy-carbon nexus. In this study, we collected the data of 927 WWTPs (from 2,827 WWTPs in China based on data availability) and their receiving water bodies across 28 provinces through multiple sources, and constructed a "water-energy-carbon" coupling index (coupling coordination degree, CCD) including indicators such as grey water footprint, energy intensity, and carbon emission intensity to assess their comprehensive environmental impacts under 3 different discharge standards: most strict (quasi-Class IV), moderate strict (quasi-Class V), and less strict (Grade I A). The results how that compared with WWTPs implementing Grade I A standard, facilities complied with stricter surface water standards (quasi-Class V and quasi-Class IV) exhibit approximately 0.074 kWh/m^3higher energy intensity (about 22.5%) and 0.107 kg CO_2-eq/m^3higher carbon emission intensity (about 24.1%) while improving effluent water quality. According to the CCD analysis, WWTPs that comply with quasi-Class V standards outperform those follow quasi-Class IV and Grade I A standards. This indicates that it is inadvisable to adopt overly stringent discharge standards for WWTPs without considering the broader environmental impacts. This study provides scientific support for decision-makers to choose appropriate discharge standards for WWTPs in different areas.

Keywords: Coupling coordination degree; Discharge standard; Water Energy-Carbon nexus; Wastewater treatment plants

Dr. Qiyong Xu is an Associate Professor and the Vice Dean of the School of Environment and Energy at Peking University Shenzhen Graduate School. He earned his Ph.D. in Environmental Engineering from the University of Florida in 2005, followed by four years of industry experience as a professional engineer at a U.S. environmental consulting firm. Currently, Dr. Xu serves as the Director of the Shenzhen Engineering Laboratory for Eco-efficient Recycled Materials. His research primarily focuses on sustainable waste valorization, encompassing municipal solid waste and food waste management, anaerobic digestion, biomass conversion, bioreactor landfills, leachate treatment, and odor control. Dr. Xu also serves as an Associate Editor for Waste Management (Elsevier), holds 13 patents, and has authored over 200 papers in peer-reviewed journals.

K-23 - Integrated Valorization of Food Waste Digestate: From Carbon Materials Engineering to Selective Nutrient Recovery

○Qiyong Xu[*, 1], Yuxin Qu[1], Ning Wang[2]

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Abstract: Food waste anaerobic digestion is an important bioprocess for renewable energy generation, yet managing the resulting digestate remains a critical bottleneck. To address this challenge, a closed-loop valorization framework is proposed, redefining digestate from a residual burden into a resource platform for carbon materials engineering and selective nutrient recovery. Our studies show that digestate can function simultaneously as a reactive carbonization medium, a precursor for mineral-rich biochars, and a nutrient reservoir that enables recovery-oriented process design. First, digestate-mediated carbonization utilizes liquid digestate as a reactive medium to engineer functional hydrochars and biochars, a process that drives spontaneous nitrogen doping, facilitates substantial ammoniacal nitrogen recovery, and promotes surface functionalization alongside pore evolution. Second, digestate-derived carbons are engineered into high-efficiency sorbents for phosphorus capture, where calcium modification and endogenous minerals work synergistically to improve structural stability and chemisorption. Finally, the resource recovery paradigm advances from passive adsorption to active electrochemical extraction in complex, real digestate matrices. By integrating waste-derived layered double hydroxide (LDH)/biochar composite electrodes into membrane capacitive deionization (MCDI), highly selective phosphate separation is achieved. Furthermore, a redox-enhanced dual-mode CDI system enables the simultaneous, low-energy capture of NH_4^+ and PO_4^{3-}. Together, these results outline an integrated pathway linking digestate-mediated carbonization, functional material design, and selective nutrient recovery for circular and low-carbon management of food waste anaerobic digestion residues.

Keywords: Closed-loop valorization; Food waste digestate; Functional carbon materials; Selective nutrient recovery; Membrane capacitive deionization

Yasuhisa Adachi

Professor Emeritus University of Tsukuba (2024~)

Education:

Ph-D (Agri.Eng.) The University of Tokyo, March 1988

Thesis title: A Fundamental Study on the Structure of a Floc

Jobs:

Young research fellow (JSPS)

Research Fellowship for Young Scientist (1987)

Research Associate, University of Tsukuba (1988)

Professor, University of Tsukuba (2008-2024)

JSPS System research center Fellow (2012-2014)

Visiting researcher, Wageningen Agricultural University, the Netherlands (1991,1993)

Academic Award:

2017 The Japanese society of irrigation, Drainage and Rural Planning

2023 Japan Association of International Commission of Agricultural and Bio-system Engineering

ETC

Research Interest:

Colloidal Flocculation: Dynamics, Structure, Sedimentation and Rheology

Fundamental to application in relation to aquatic and soil environment.

K-24 - Sedimentation and Flowing Behavior of Flocculated Slurry in Dilute and Semi-dilute Regime

○Yasuhisa Adachi[*, 1], Hu Tianchen[2], Santanu Saha[1]

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Abstract: Sedimentation and flowing behavior of flocculated slurry in dilute and semi-dilute regime are important for the engineering design of effective solid-liquid separation and transportation of sludge. The process involves two phase separations. One is the stability of colloidal dispersion whose threshold of chemical condition is notified by DLVO theory. The other, hydrodynamic stability from laminar to turbulent flow. Because these processes occur simultaneously, formation of fractal structured flocs, their break-up, and rearrangement into dense granules occur from time to time. However, the detail of this process is not cleared yet. For this process, we have conducted studies using model colloids, i.e., coagulated montmorillonite, kaolin as well as flocculation of standard latex nanoparticles. In this presentation, I will summarize our long-term effort together with recent progress placing an emphasis on the hydrodynamic transition done mainly using the suspension of coagulated flocs. The remarkable findings are:

1) Rate of sedimentation is much enhanced by the formation of big flocs followed by the feed forward process termed sedimentation turbulence. This process is strongly influenced by the size of container.
2) In the flowing suspension of flocs, laminar to turbulent transition is significantly delayed by the presence of flocs; as the critical Reynolds number increases and the laminar flow region expands, the flow resistance in that area becomes extremely low, sometimes falling below the value for water.
3) Net-work formation of flocculated material together with the hydrodynamic slip along the boundary of the container are considered to be very important to explain these apparently abnormal behaviors.
4) Solid concentration and bond strength of flocs are coupled with size of container.

Keywords: Solid-liquid flow containing big flocs; Montmorillonite floc; Transition from laminar to turbulence; Net-work structure; Hydrodynamic slip; Container effect

Dr. Zhiwei Wang is a Professor and the Dean of School of Environmental Science and Engineering, Tongji University, China. Dr. Wang's interests are in the field of membrane-based processes for water/wastewater treatment and energy/resource recovery. He has authored 3 books, and published over 300 peer-reviewed papers in journals such as *Nature Water, Science Advances, Nature Communications, Environmental Science & Technology, Water Research*, etc., and listed as Most Cited Chinese Scholars in Environmental Sciences Field Scopus-Elsevier. He has authorized over 70 invention patents, and was awarded Science &Technology Development Award of Ministry of Education of China First-class in 2017, Science &Technology Development Award of Shanghai in 2024 and National Distinguished Young scholar Funding of China in 2019. He is an International Water Association IWA fellow, the secretary of Management Committee of IWA Specialist Group on Membrane Technology and was named a Distinguished Membrane Scientist ISPT in 2024.

K-25 - Advancing Anaerobic Dynamic Membrane Bioreactors for Enhanced Bioenergy and Resource Recovery: From Mechanisms to Applications

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Abstract: Waste activated sludge is an inevitable byproduct of biological wastewater treatment, yet it can serve as a valuable resource for bioenergy recovery via anaerobic digestion. However, conventional anaerobic digestion (CAD) faces inherent limitations, including low solids loading, biomass washout, and prolonged retention times. Herein, we propose anaerobic dynamic membrane bioreactors (AnDMBRs) for simultaneous sludge thickening and digestion enhancement. By decoupling hydraulic and solids retention times via a self-formed dynamic membrane (DM), this system concentrated total solids to 56 g/L, achieving volatile solids reduction of 55.9% and biogas yield of 0.79 L/g VS. Mechanistically, the AnDMBR enriched Chloroflexi, which facilitated the degradation of recalcitrant macromolecular metabolites and thereby enhanced the utilization of dissolved organic matter, including proteins and polysaccharides. Meanwhile, the relative abundances of *Methanobacterium, Methanobrevibacter* and *Candidatus_Methanofastidiosum* increased, shifting methanogenesis from acetoclastic dominance toward enhanced hydrogenotrophic and methylotrophic pathways. Furthermore, we advanced this technology from lab to pilot scale, optimized full-scale configurations via computational fluid dynamics, and coupled it with electrochemical phosphorus recovery from the effluent. Comprehensive evaluations demonstrated that AnDMBRs can effectively enhance overall digestion efficiency and reduce carbon emissions compared to CAD. These results highlight the potential of AnDMBRs for high efficient and sustainable sludge digestion.

Keywords: Anaerobic dynamic membrane bioreactor; Sludge anaerobic digestion; Microbial community; Process scale-up; Carbon emission reduction

Dr. J. Paul Chen has been a professor in NUS since 1998 right after receiving his PhD from Georgia Tech. He is currently Chair Professor of Shenzhen University and previously served as a full professor in Technion and assistant vice chancellor of Technion-Guangdong. He has worked in the field of environmental/chemical engineering for over 25 years, focusing on R&D in material development, processes optimization, and applications in water and manufacturing. He has served as a PI or co-PI for over 30 projects. He has trained 18 post-doc fellows, and 22 PhD students. He has authored over 195 research articles, most of which are published in several prestigious journals, such as PNAS, Advanced Materials, Chemical Society Reviews, EST, Water Research and JMS with H-index of 82 and citation of over 26,000 (citation > 100 per published paper). He has authored one book published by CRC and has nine edited books by the CRC and Springer. He has 15 patents, three of which are commercialized. He has served as an expert for the review of research proposals for over 20 funding agencies (e.g., NSF, RGC, NRF, and NSFC). He is in the editorial boards of 20 journals and publishers, including JCIS, CRC and Springer. He is in management committees of several prestigious professorial societies, such as Vice Chair of IChemE, member of IChemE Congress, and Chair of IWA Nano & Water. He is a Chartered Engineer and Scientist, and an elected FRSC, FIChemE, FIET, FIWA, and FIMarEST. He is an award recipient of the Distinguished Overseas Chinese Young Scholarship of NSFC and the IChemE Water Technology Awards.

K-26 - Advanced Physiochemical + Biological Processes for Mitigation of Unwanted Organic Matters

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Abstract: Mitigation of unwanted organic matters such as industrial effluent with low BOD/COD ratio and algae containing surface water is of great importance, but very challenging. Traditional approaches such as aerobic and anaerobic processes and dosing of biocides are typically less cost-effective. On the other hand, advanced oxidation processes (AOPs) and membrane filtration are intensively studied but are less reported with combination of biological treatment for mitigation. We have done a series of studies, aiming at enhancement of treatment through AOPs and/or membrane filtration. Two case studies are given in this talk. The first one is on application of AOPs for algae control by using CaO_2 engineered material, which is through encapsulation of CaO_2 in environmentally friendly alginate polymer. The results demonstrate that cyanobacteria species are largely inhibited, which lasts for over several months. The cells are only inactivated, but not raptured, which would not cause additional water pollution problems. The pH remains unchanged, ranging from 7 to 9. Several active oxidants contribute to outstanding performance. In the second case study, we combine AOPs (3-d catalyst driven by low voltage DC), ultra-membrane and traditional activated sludge process together, aiming at treatment of an industrial effluent from an industrial park, which has lower BOD/COD ratio of around 0.1 and contains several surfactants. The catalyst degrades the contaminants and increases the BOD/COD ratio, while membrane further separates certain species, by which treatment is enhanced. After the treatment, the COD level becomes far less than 30 mg/L and the treated would be allowed to be discharged.

Prof. Xiaoyan Li is currently a Professor in Environment and Ecology at Shenzhen International Graduate School of Tsinghua University in Shenzhen, he has been a member of Overseas High-Level Talents Program of China. He received Outstanding Young Overseas Researcher Award from the NSFC in 2008, First-Class Scientific Research Outstanding Achievement Award from the Ministry of Education in 2012, Second-Class State Natural Science Award from the State Council in 2014, Second-Class Award in Environmental Science and Technology from Ministry of Ecology and Environment in 2019, and First-Class Award in Environmental Science and Technology of Guangdong in 2024, China. Prof Li has been an ISI top 1% highly cited author in the environmental field since 2009 and received an award of Top Cited Author 2007-2011 from Water Research. He has published more than 300 SCI journal papers with over 22000 citations and an H-index of 72. He is an expert in solid-liquid separation, membrane filtration, biotechnology and nanotechnology for advanced water and wastewater treatment. He has proposed new theories and developed models for particle flocculation in water, nutrient flux from sediment, membrane fouling in membrane filtration and membrane bioreactors, anaerobic and aerobic sludge granulation and anammox process for biological wastewater treatment, and electrochemical processes for pollutant degradation and material separation. In recent years, he has been working on innovative and energy-saving technologies for resource recovery from wastewater and urban organic wastes.

K-27 - Aerobic Sludge Granulation for Efficient Biological Wastewater Treatment - Experimental Study, Process Modeling and Pilot Test

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Abstract: Aerobic sludge granulation is one of innovative biological wastewater treatment technologies. Aerobic granules are considered as a special form of biofilm growth in sludge suspension. In comparison to conventional activated sludge, granules are large in size and faster in settling velocity, which allows rapid sludge-effluent separation and an increase in biomass concentration in bioreactors. However, the mechanism of sludge granulation under aerobic conditions is still unclear, and the scale-up application and stability of aerobic granules under different operating conditions in wastewater treatment remain to be investigated.

In this study, a new mechanism, gelation-facilitated biofilm formation, is proposed for the phenomenon of aerobic sludge granulation. It is supposed that the interactions

between microbial extracellular polymeric substances (EPS) under special conditions would result in gel formation other than bio-flocculation. Laboratory experiments were carried out using sequencing batch reactors (SBRs) to investigate the granulation formation and related microbial structure under different organic loading conditions in biological wastewater treatment. Granules cultivated at different reactor loading rates, 1.5, 3.0 and 4.5 kg COD/m^3·d, were rather different in morphology, structural feature and the bacterial species diversity. A higher loading would facilitate faster formation of larger but loose granules, while a lower loading would allow slower formation of smaller but more tightly packed granules. The biomass underwent a dynamic transformation in terms of bacterial species richness and dominance during the granulation process. The reactor received the highest substrate loading rate had the lowest species diversity, while the reactor with the lowest loading had the highest species richness. It is possible that a few specific bacteria could sustain the selection pressure and played an important role in the formation and growth of aerobic granules in the bioreactors. The research findings provide an important insight into the mechanism of granulation in terms of the evolution of microbial population during granule formation and growth. Accordingly, a mathematical model was developed to simulate the granulation process and to determine favorable operating conditions for rapid granule formation. In addition, pilot experiments were successfully conducted on aerobic sludge granulation using a continuous plug-flow bioreactor treating brewery wastewater.

Dr. Lin Lin is an Associate Professor at Tsinghua University. She received her Bachelor's and Master's degrees from Fudan University and earned her Ph.D. from the University of Hong Kong. Her research focuses on water pollution control and resource recovery, with particular expertise in environmental electrochemistry and biorefinery. Dr. Lin has published over 50 SCI papers as the first or corresponding author in prestigious journals, including Nature Water, PNAS, Water Research, and Environmental Science & Technology, capturing an H-index of 37. Recognized as one of the World’s Top 2% Scientists by Stanford University, she holds over 10 authorized Chinese and American patents, several of which have been commercialized. She is also the recipient of numerous honors, including the Award of Geneva City by Geneva Invention Exhibition, First Prize of China Environmental Protection and Technology Development Award.

K-28 - Phosphorus Recovery from Municipal Wastewater Targeting Battery-Grade Iron Phosphate

○Lin Lin[1]

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Abstract: The skyrocketing demand for lithium iron phosphate ($LiFePO_4$) batteries has intensified the depletion of global phosphorus (P) reserves, driving an urgent need for sustainable P recovery alternatives. This study highlights a paradigm shift in wastewater management by transforming municipal wastewater sludge, specifically iron-enhanced primary sedimentation and chemical phosphorus removal (CPR) sludge, into a highly sustainable, high-value P source for lithium-ion battery cathodes, rather than conventional low-value fertilizers. Two innovative technical pathways demonstrate the viability of this approach. The first method utilizes upfront P capture via Fe-enhanced sedimentation, followed by acidogenic fermentation and selective oxidative precipitation (pH=2 with H_2O_2). This process yields a crystalline $FePO_4$precursor with a purity of 99.3%, surpassing standard industrial sources (93.8%). When integrated into $LiFePO_4$ cathodes, it delivers a robust discharge capacity of 143mAh/g after 50 cycles, matching conventional industrial materials. Alternatively, a second method applies a sintering treatment with acid washing to CPR sludge, converting P and Fe into purified P–Fe oxides ($Fe_{2.1}P_{1.0}O_{5.6}$). These oxides can substitute up to 35% of commercial $FePO_4$ reagents, producing cathodes with a specific capacity of 114.9 m Ah/g and an exceptional 99.2% cycle stability after 100cycles, partially enhanced by beneficial structural stabilization from trace sludge impurities (like Ca^{2+} and Na^{+}). Economic and environmental assessments confirm that this wastewater-to-battery P recovery strategy offers superior economic advantages over traditional fertilizer production. By converting up to 100% of P in CPR sludge into valuable battery-grade materials, this technology could fulfill up to 35% of the P demand in major lithium-ion battery industries (such as China's), offering a cost-effective, circular economy solution to global phosphorus scarcity.

Dr. Xiaoyuan Zhang is an Associate Professor in the College of Environmental Science and Engineering at Nankai University. Her research focuses on innovative low-carbon biotechnologies for wastewater and biosolids management, with particular emphasis on energy and resource recovery as well as the development of functional biomaterials from waste sludge and biosolids. She currently serves as Principal Investigator for several projects funded by the Ministry of Education of China, the National Natural Science Foundation of China, and industrial partners. She has published more than 70 journal articles, which have received over 2,200 citations on Google Scholar, with a h-index of 24.

K-29 - Redox-active Conductive Carrier Enables Direct Electron Transfer for Efficient Methanogenesis in Anaerobic Biofilms

○Xiaoyuan Zhang [1]

Abstract: Anaerobic process has been widely recognized as a sustainable approach for energy recovery in the form of methane from wastewater and sludge digestion. However,

methane production in anaerobic process could be significantly hindered by the limited interspecies electron transfer. The application of conductive materials in anaerobic processes has attracted increasing attention to improve electron transport and facilitate interspecies electron transfer (IET) between bacteria and methanogens. In this study, a novel tannic acid (TA)-modified iron-biochar composite (TA-FeBC) with a high electron transfer capacity of 18.6 μmol e-/g and a specific capacitance of 1.14 F/g was developed. The Fe-TA-C composite promoted redox-active quinone groups and Fe(II)/Fe(III) redox cycle, significantly increasing the cumulative CH_4 yield volume by 107 % through participating in direct interspecific electron transfer (DIET) pathway. Furthermore, integrating the redox-active conductive carrier into a continuous-flow anaerobic fixed-bed biofilm reactor enabled long-term operation and increased methane production by 7.38-fold compared with anaerobic suspended sludge. This study established a reproducible model for conductive carrier-biofilm systems, which laid a foundation for extending this strategy across diverse environmental applications to support more sustainable and efficient anaerobic wastewater treatment.

Dr. Ling Zhao is a Professor at the School of Environmental Science and Engineering, Shanghai Jiao Tong University, and also a doctoral supervisor. She serves as a dual supervisor at the SJTU-UK International Low Carbon College and Xi'an University of Architecture and Technology.She received her Ph.D. from Shanghai Jiao Tong University and completed postdoctoral research at Tongji University. She was a visiting scholar at the University of Edinburgh and the University of Illinois.Her research focuses on solid waste treatment, soil and groundwater remediation, and soil carbon sequestration. She has developed a full research chain from fundamental theory to engineering application.She has hosted 4 NSFC projects, 2 national key R&D programs, and published 140 SCI papers with high citations. She also holds 15 authorized invention patents, and her core technologies have been applied in industrial practice.

K-30 - From Agricultural Waste to Soil Solutions: Sustainable Conversion and Economic Viability

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Abstract: Biochar-based soil amendment is a promising approach for soil remediation, carbon sequestration, and low-carbon agricultural development. However, its large-scale application is constrained by high pyrolysis costs, disorganized supply chains, and poor economic viability. This study proposes an integrated, closed-loop "waste-energy-soil"

system implemented in large-scale agricultural parks, combining on-site organic waste pyrolysis with greenhouse photovoltaic (PV) synergy. By using energy-efficient pyrolysis equipment and modular production, agricultural organic wastes are converted into functional biochar and char-based fertilizers for in-situ soil improvement, heavy metal passivation, and contaminated farmland remediation. Three representative edible mushroom parks across northern, central, and southern China were investigated. Results show that the integrated system achieves net revenues of 8.2-31.3 USD per ton of biomass, with an internal rate of return of 5-44%, while reducing 588-974 kg CO_2 e per ton via soil carbon sequestration and fossil fuel replacement. Nationwide upscaling in the edible fungi sector could abate 25.3 Mt CO_2 e annually. Meanwhile, a targeted technology chain of "classified treatment–intelligent pyrolysis-targeted modification-char-microbe composite" has been developed to produce functional char-based fertilizers for cadmium, arsenic, lead, and chromium contaminated farmlands. The low-carbon pyrolysis equipment and "three-dual" efficient fertilizer-making process greatly reduce energy consumption and improve product value. This technology has been applied in Guizhou, Shanghai, Jiangxi, and other regions, remediating over 20,000 hectares of heavy metal-contaminated farmland with remarkable carbon sequestration and emission reduction benefits. his work provides a scalable, economically sustainable paradigm for circular bioeconomy, supporting green agriculture, soil safety, and climate change mitigation.

Dr. Sang-Hyoun Kim is a professor in the Department of Civil and Environmental Engineering and a Lee Youn Jae Fellow at Yonsei University, Korea. He has been served as a vice president of Korean Society of Waste Management since 2024. He received his Ph.D. in Civil and Environmental Engineering at Korea Advanced Institute of Science and Technology (KAIST), where he also got his master's and bachelor's degrees in civil engineering and chemistry, respectively. Before coming to Yonsei University, he was a faculty member at Daegu University (2010 to 2018), a senior researcher at Korea Institute of Industrial Technology (2009 to 2010), a postdoctoral researcher at Iowa State University (2006 to 2009) and, a visiting scholar at University of Illinois at Urbana-Champaign (2016 to 2017). His research interests lie in waste-energy-resources nexus. Specifically, his research focuses on anaerobic digestion and biohydrogen production. He was named as a highly cited researcher (HCR) in 2024 by Clarivate and the scientist of the month in July 2025 by the Ministry of Science and ICT, Korea.

K-31 - Simultaneous Recovery of Phosphorus and Organic Acids from Organic Waste via Vivianite Formation

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Abstract: Phosphate rock is finite and concentrated in a few countries, whereas phosphorus discharge from waste streams can accelerate eutrophication. This study evaluated the continuous acidogenic fermentation coupled with vivianite formation for the simultaneous recovery of phosphorus and organic acids from protein-rich organic waste. Batch tests were first conducted to determine suitable conditions for vivianite precipitation under different pH values, Fe/P ratios, and mixing intensities. The highest phosphorus recovery was achieved at pH 8, a Fe/P ratio of 1.5, and 400 rpm, where more than 90% of phosphate was recovered as vivianite. Under continuous operation at HRT 10 d, increasing the influent Fe/P ratio from 1.5 to 2.0 increased inorganic phosphorus precipitation from 45.9% to 49.3–70.0% and raised the vivianite concentration from 6.59 to 11.18 mM, while organic acid recovery remained high at 76.0 ± 0.7% to 76.9 ± 0.1%. These results demonstrate that acidogenic fermentation can be effectively integrated with vivianite-based phosphorus recovery, providing a practical route for simultaneous organic acid production and magnetically separable phosphorus capture.

Keywords: Acidogenic fermentation; Magnetic phosphorus separation; Organic acid recovery; Phosphorus recovery; Protein-rich waste; Vivianite formation

Dr. Dongsheng Wang has been actively committed to the research of coagulation technology and water quality in the water treatment process, focusing on the characterization of particulate matter in water bodies, the morphological transformation and regulation mechanism of coagulants such as aluminum/iron and composite silicic acid, and the all-round promotion of industrial application, and has made a number of major achievements and practical applications in the fields of sludge treatment and disposal, two odor traceability analysis, toxic pollutant adsorption catalytic control technology, watershed pollution control, and water quality control and transformation technology in the past 30 years,. He has presided over or undertaken 23 national foundation committees, key projects, 863/973 water projects and Chinese Academy of Sciences, published more than 300 SCI papers, cited more than 10,000 times, and h-index 56. He has applied for more than 30 invention patents and edited (including participation) 4 books. He has won the first prize of the Natural Science Award of the Chinese Academy of Sciences in 2000 (ranked 8), the second prize of the 2009 China Construction Science and Technology Award (ranked 9), the first prize of the Ministry of Education Technological Invention Award in 2013 (ranked 2), the second prize of the National Science and Technology Progress Award in 2005 (ranked 8), the third prize of Guangdong Science and Technology Award in 2016 (ranked 1), the second prize of the National Natural Science

Award in 2017 (ranked 3), and the first prize of the China Construction Science and Technology Award in 2021 (ranked 1).

K-32 - From High-Purity Al_{13} to Adaptive Coagulation: Resolving the Trade-Off Between Purity and Species Selectivity

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Abstract: To date, nano-Al_{13} with a purity exceeding 99% can be synthesized and exhibits excellent charge neutralization capacity under controlled conditions. However, its practical application remains constrained by the thermodynamically metastable nature of Al_{13}, which is prone to aging during synthesis, transportation, and dosing, and can further transform into less active Alc species induced by AlO_4^-, resulting in performance decay. In industrial polyaluminum chloride (PACl), the fraction of highly active Al_{13} is typically below 40%, whereas laboratory-prepared PACl can achieve up to 77% Al_{13} without purification, with less than 10% decay over one year. Nevertheless, coagulation performance is strongly dependent on water quality and the distribution of Al species. In low-turbidity, high-alkalinity water during winter, high-purity Al_{13} (70 μM) exhibits comparable adsorption-charge neutralization efficiency to commercial PACl (Al_b 48%) at SUVA≈1.5. However, in waters dominated by hydrophilic organic matter (SUVA < 1.2), it performs poorly, achieving only 18% turbidity removal and a zeta potential of −8.9 ± 2.4 mV, inferior to industrial products. These findings reveal a fundamental contradiction between static Al_{13} high purity and species selectivity. Therefore, adaptive in-situ synthesis strategies, enabling real-time regulation and "on-demand preparing", are proposed to enhance stability and coagulant efficiency under dynamic water conditions.

Keywords: Al_{13} clusters; *in-situ* synthesis; Polyaluminum chloride; Species-dependent coagulation; Water quality adaptability

Oral Presentation

Theme I: Biological Waste/Wastewater Treatment

O-A-1 - Decoupling Functional Selection Pressures via Return Sludge Fermentation for Energy-Efficient Shortcut Nitrogen and Phosphorus Removal

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Abstract: Resource-oriented wastewater treatment increasingly requires energy-efficient nutrient removal strategies with improved carbon utilization. This study established a process-level functional decoupling strategy by integrating return sludge side-stream anaerobic fermentation into a continuous anaerobic–anoxic–aerobic system to regulate microbial competition. The side-stream unit functioned as an internal carbon redistribution module, enhancing volatile fatty acid availability and strengthening the competitive advantage of polyphosphate-accumulating organisms (PAOs). With coordinated dissolved oxygen and hydraulic retention time control, total nitrogen and phosphate removal efficiencies exceeded 75%, while stable nitrite accumulation ratio remained above 80%. Nitrification activity tests revealed progressive suppression of nitrite-oxidizing bacteria (NOB) activity to near zero, shifting the nitrifying guild toward ammonia-oxidizing bacteria (AOB) dominance, corroborated by increased *amoA*, decreased *nxrB* gene abundances, and fluorescence in situ hybridization evidence of NOB reduction. The progressively enhanced nitrite reduction rate indicated reduced carbon demand for denitrification. Microbial analysis further confirmed coordinated enrichment of AOB and PAOs under differentiated selection pressures. This study achieved stable carbon-self-sufficient shortcut nitrogen and phosphorus removal, offering a scalable and sustainable pathway for advanced municipal wastewater treatment.

Keywords: Biological phosphorus removal; Carbon redistribution; Functional decoupling; Nitrite accumulation; Return sludge fermentation; Shortcut nitrification

O-A-2 - Real-Time Hyperspectral Video Monitoring of Biological Waste and Wastewater Treatment Using Edge Computing

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Abstract: Process Optimization: Real-time monitoring allows operators to track treatment efficiency, detect anomalies, or identify stages where additional treatment is required detection of some harmful algal blumes is well documented for hyperspectral imaging where concentrations are sufficiently high to warrant public health interventions. Use of the living optics camera enables low cost spectral imaging from lower level observation platforms potentially enabling detection in a wider range of weather contions. Microbial Activity Analysis: HSI can help assess the presence and growth patterns of beneficial or harmful bacteria in biological treatment systems without needing extensive lab sampling. using fluorescence techniques it may be possible to detect a range of bacteria with the same imaging system but this is untested. Typically bacteria will still have to be grown from cultivars in laboratory conditions prior to imaging. An interesting area of research for teams using the Living Optics camera could be, working with microfluidics and microscopy imaging to use the real-time video aspecs of the Living Optics Dev Kit to continiously analyse a microfluidic extraction and detect low volumes of the bacteria without the need for laboratory cultivation.

Keywords: Video hyperspectral imaging (V-HSI); Real-time environmental monitoring; Biological wastewater process monitoring; Precision agriculture & crop health assessment; Biomass and feedstock characterization; AI-enabled spectral analysis for bioeconomy

O-A-3 - Vermicomposting: A Green Solution for Food Waste Resource and Sustainable Agriculture

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Abstract: Effective waste management is essential for conserving natural resources and protecting the environment, especially in addressing the challenge of recycling organic solid waste. This study investigates the potential of earthworm composting as an eco-friendly solution for food waste management and its role in sustainable agriculture. By integrating a high-temperature membrane pretreatment phase with traditional earthworm composting, the study aimed to accelerate the composting cycle and mitigate odor emissions. The pretreatment stage achieved a maximum temperature of 62.1°C and maintained temperatures above 50°C for 98 hours, effectively reducing odor and shortening the composting process. Fluorescence spectral analysis revealed enhanced humification, characterized by increased formation of humic acids and a decrease in soluble microbial byproducts. Microbial community analysis using 16S rRNA gene

sequencing indicated a significant increase in diversity throughout the process, with dominant bacterial groups such as Proteobacteria and Bacteroidota contributing to organic matter degradation and the carbon cycle. PICRUSt functional predictions revealed heightened metabolic activity, facilitating the breakdown of organic matter. Pot experiments demonstrated that the composted products stabilized at a near-neutral pH (6.57–7.11) and reduced electrical conductivity, reflecting improved compost quality. The results underscore the potential of earthworm composting, combined with high-temperature membrane pretreatment, as an effective strategy for transforming food waste into nutrient-rich compost. This method supports soil fertility, reduces reliance on synthetic fertilizers, and contributes to sustainable agricultural practices. The study advocates for the broader adoption of this integrated composting approach to enhance resource efficiency and environmental sustainability.

Keywords: Vermicomposting; Food waste management; Microorganisms; Earthworms; Sustainable agriculture

O-A-4 - Effects of Industrial Wastewater Effluents on Irrigation Water Quality around Bompai Industrial Area, Kano State, Nigeria

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Abstract: Smallholder farmers in Nigeria's Kano State struggle with a lack of irrigation water, particularly during dry seasons. An alternative is to irrigate their crops using water sources that have been contaminated by industrial water. Sadly, there is a high probability that the wastewater may contain a significant amount of toxins. This study examines the impact of industrial wastewater effluents on irrigation water quality around Bompai industrial areas of Kano State, Nigeria. Samples of water were taken from September to November at the peak of irrigation activities. Samples were collected randomly across the width of the river, from the upstream, midstream and downstream. The samples were taken to Bayero University Kano for analysis and determine pH, electrical conductivity (EC), total dissolved solids (TDS) and trace elements. Standard methods were used to determine these characteristics. The result indicated that parameters at various sampling locations are within the permissible limits except for pH, EC, TDS, Mg and Pb which are above the irrigation water quality compliance of the World Health Organization (WHO) and Federal Environmental protection agency (FEFA). According to the results of this study, the water at Bompai that has been exposed to industrial wastewater effluents is

contaminated, and continuing use of this water could have a negative impact on the quality of the soil and crops.

Keywords: Crop yield reduction; Industrial wastewater; Irrigation water quality; Soil pollution; Wastewater treatment

O-A-5 - Advanced Nitrogen Removal and PFASs Transformation in the SAD/A System Treating Municipal Secondary Effluent

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Abstract: In response to increasingly stringent wastewater discharge standards, there is an urgent need for advanced nitrogen removal from secondary effluent. The sulfur autotrophic denitrification (SAD) coupled with anaerobic ammonium oxidation (Anammox) process (SAD/A) holds significant promise for this application due to its advantage of requiring no external organic carbon. However, its resilience to emerging contaminants, such as per- and polyfluoroalkyl substances (PFASs), which may persist in secondary effluent, remains unknown. This study investigated the long-term impact of perfluorooctanoic acid (PFOA), perfluoropropionic acid (PFPrA), and perfluorohexanoic acid (PFHxA) on the nitrogen removal performance, microbial community, and contaminant fate of SAD/A systems treating secondary effluent. Results indicated that exposure to PFOA and PFHxA inhibited the autotrophic denitrification process, reducing the total nitrogen removal efficiency to 49.68% and 67.7%, respectively. Exposure to PFPrA, in contrast, led to irreversible inhibition, which could be alleviated by optimizing the electron donor supply. Microbial community analysis revealed a significant decrease in the abundance of key denitrifiers, such as *Thiobacillus*, under PFAS stress, whereas *Candidatus_Kuenenia* exhibited stronger functional resilience. Metagenomic analysis further revealed that exposure to low concentrations of PFAS not only triggered differential expression of functional genes such as *nirS* and *nirK*, but also stimulated the expression of genes involved in the Fe/S cycling metabolic pathway, including *soxB* and *ccoN*. DFT calculations and product identification revealed that PFOA was transformed within the SAD/A system, generating shorter-chain products including PFHxA. Defluorination and carbon chain shortening of PFHxA were also observed, and the Fe/S cycling within the system promoted the transformation of PFPrA into less toxic trifluoroacetic acid (TFA). Toxicity assessment suggests that some transformation products may pose higher ecological risks than the parent compounds, highlighting the need to consider the potential hazards associated with contaminant transformation in such treatment systems. This study demonstrates the resilience and transformation potential of the SAD/A process for wastewater containing PFASs, providing a crucial theoretical basis

for process selection in relevant treatment applications.

Keywords: Anammox; Biotransformation; Emerging contaminants; Nitrogen removal; Per- and polyfluoroalkyl substances (PFAS); Sulfur autotrophic denitrification

O-A-6 – Fe (III) Dosage Regulates Microbial Synergy and Carbon-Nitrogen Co-removal in Anaerobic Digestion-Feammox-Denitrification Systems Treating Aquaculture Wastewater

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Abstract: Fe (III) dosage effects on microbial synergy and nitrogen-carbon co-removal were investigated in anaerobic digestion (AD)-Feammox-denitrification systems treating aquaculture wastewater. Increasing Fe (III) from 100 to 800 mg/L progressively inhibited the removal of ammonium and soluble chemical oxygen demand (sCOD), reducing the efficiencies from 100.0% to 80.1% and 94.3% to 85.8%, respectively, by day 35. Fe (III) shifted the dominant carbon removal pathway from AD to dissimilatory iron reduction (DIR). For nitrogen removal, low-to-moderate Fe (III) boosted Feammox and the resulting heterotrophic denitrification (HD). When the Fe (III) exceeded 600 mg/L, activation of nitrate-dependent ferrous oxidation (NDFO) and dissimilatory nitrate reduction to ammonium (DNRA) created a parallel pathway that halved net ammonia removal via ammonium recycling while accumulating nitrite. Microbially, increased Fe(III) shifted dominance from heterotrophic denitrifiers (*Thauera*) and fermentative bacteria (*norank_f__Anaerolineaceae*) to iron-reducing bacteria, while methanogenic diversity declined with enrichment of stress-tolerant *Methanosarcina* and *Methanobacterium*. Overall, Fe(III) dosage acted as a metabolic dial: $\leq$ 300 mg/L synchronized AD with Feammox-HD for rapid sCOD and ammonium removal, whereas $\geq$ 600 mg/L shifted to iron-driven, low-CH_4 mineralization that sacrificed speed but stockpiled nitrite for downstream microbial processes like Anammox.

Keywords: Dissimilatory iron reduction; Dissimilatory nitrate reduction to ammonium; Feammox; Heterotrophic denitrification; Nitrate-dependent ferrous oxidation

O-A-7 - Unraveling Sulfur Biotransformation in Coal Gangue Co-composting: Insights from $\delta^{34}S$ Isotope Fingerprinting and Metagenomics

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Abstract: High sulfur content hinders coal gangue utilization. Composting offers a potential recycling strategy, yet the underlying biogeochemical sulfur transformation mechanisms remain unclear. Using coal gangue, sludge, and straw under a two-stage aerobic-anaerobic strategy, we investigated sulfur speciation dynamics and driving mechanisms via sulfur fractionation, $\delta^{34}S$ fingerprinting, multi-enzyme profiling, and metagenomics. Composting significantly altered sulfur fate. Total sulfur mass decreased by 47.6%–50.8%, confirming substantial gaseous volatilization. Sulfur speciation was significantly altered: iron sulfide and organic sulfur underwent oxidation and mineralization, with absolute masses decreasing by 16.0%–37.1% and 62.2%–66.6%, respectively. As a key intermediate, sulfate dynamics shifted from an "increase-then-decrease" pattern to "continuous accumulation" with higher gangue dosages, suggesting sulfur supply regulates oxidation/reduction intensities. $\delta^{34}S$ fractionation provided critical fingerprints: during the aerobic phase, gangue-amended treatments exhibited a significant negative shift ($\Delta\delta^{34}S$ = –6.58‰ to –14.29‰), indicating light isotope release from intense pyrite oxidation. The anaerobic phase showed a positive shift ($\Delta\delta^{34}S$ = +4.91‰ to +15.61‰), characteristic of microbial sulfate reduction. Metagenomic and enzymatic analyses revealed that dominant *Thiobacillus* and *Acidithiobacillus* elevated SOX activities, catalyzing aerobic pyrite oxidation, while enriched *Desulfovibrio* increased TSR/SUR activities, driving anaerobic sulfate reduction and volatilization. This study provides a theoretical basis for coal gangue utilization.

Keywords: Coal gangue; Composting; Metagenomics; Stable isotope; Sulfur

O-A-8 - Mechanisms of Direct Electron Transfer Governed by Redox-active Conductive Carrier with Superior Wettability in Anaerobic Biofilms

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Abstract: Anaerobic process has been widely recognized as a sustainable approach for energy recovery in the form of methane from wastewater and sludge digestion. However, the low coordination of syntrophic metabolism and limited electron transfer constrained the efficiency and stability of anaerobic process. Conventional conductive materials mainly function as passive electron transfer conduits and lack the ability to regulate

electron allocation among different electron acceptors. Herein, a redox-active tannic acid (TA)-modified iron-biochar conductive carrier (TA-FeBC) with an exceptional electrondonating capacity of 16.6 μmol e^{-}/g and superior wettability of 15.0 ± 0.4° was engineered. The redox-active conductive carrier possessed redox-active quinone groups and Fe (II)/Fe (III) redox cycle, which governs direct electron transfer (DET) at the anaerobic biofilm-carrier interface, enabling *Methanobacterium* to directly harvest electrons from carrier, as evidenced by a stable 110 $\mu A/cm^2$ cathodic current. Furthermore, the development of novel carrier module for long-term operation in continuous-flow anaerobic fixed-bed biofilm reactors resulted in a 1.3-fold increase in methane production. Meanwhile, the carrier module-supported anaerobic biofilm gradually evolved into a steady-state microbial community structure, with *Methanobacterium* predominantly enriched in the inner layer and *Methanothrix* in the outer layer, thereby providing the potential to spatially reorganize electron flow within anaerobic biofilm. Consequently, this work fills a critical knowledge gap in the mechanistic understanding of DET and provides a robust theoretical framework and engineering basis for the rational design of conductive carriers to enable directional electron transport and the efficient anaerobic process.

Keywords: Anaerobic process; Redox-active conductive carrier; Direct electron transfer; Methane production

O-A-9 - Green and Efficient Disinfection of Antibiotic-Resistant Bacteria via PI/H_2O_2 Homogeneous System

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Abstract: The proliferation and spread of antibiotic-resistant bacteria (ARB) significantly threaten human health and ecosystem. Periodate (PI) based advanced oxidation process has potentials for water purification but limited by complex activators or activation process. Herein, we demonstrated that H_2O_2 could be used to activate PI, achieving efficient ARB disinfection performance. Particularly, we found that the PI/H_2O_2 system (0.1 mM for both oxidants) could inactivate ARB (*Escherichia coli*) within 35 min. The intracellular defense system attacked by HO· radicals generated in the disinfection system, resulting in the inactivation of ARB. Antibiotic resistance genes (ARGs) released with the lysis of cell membrane could be further degraded by HO· radicals. Moreover, we found that the PI/H_2O_2 system was effective to inactivate ARB in a broad range of ionic strengths, with coexisting common ions and humic acid, as well as in four typical actual water bodies. The PI/H_2O_2 system could also efficiently disinfect other types of bacteria and degrade typical organic contaminants. In addition, under sunlight irradiation, the ARB inactivation performance of the PI/H_2O_2 system could be greatly improved. This study provided a practical and efficient way for decontaminating ARB/ARGs-polluted water.

Keywords: Periodate/H_2O_2 system; Advanced oxidation processes; Antibiotic-resistant bacteria; Water disinfection; Real waters

O-A-10 - A Comparative Experimental Study of Different Water Treatment Bio-carriers in Recirculating Aquaculture Systems for Enhanced Nitrogen Removal

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Abstract: Driven by rising demand for high-quality protein and sustainable development goals, recirculating aquaculture system (RAS) is emerging as a key solution for aquaculture. Ammonia nitrogen and nitrite nitrogen in aquaculture wastewater pose a severe threat to animal health in RAS, emphasizing the urgent need for effective wastewater treatment technologies especially under low ammonia loading. In this study, different bio-carriers were evaluated in simulated wastewater and a practical RAS. The innovative bio-carrier used in this study showed the highest ammonium nitrogen removal efficiency (72.7%) and the highest ammonium nitrogen removal rate at 4.91 mg-N/h per 1L bio carrier than the commercial bio-carrier, followed by continuous aeration for 6 hours. Subsequently, the innovative bio-carrier was applied in the recirculating aquaculture system for *Litopenaeus vannamei* farming at 20 kg/m^3. Throughout the two-year cultivation period, water quality remained ammonia nitrogn at 0 mg/L, nitrite nitrogen below 0.5 mg/L. These results demonstrate that the selected bio-carrier effectively maintains water quality under low ammonia loading, providing a reliable and scalable aquaculture wastewater treatment solution for sustainable aquaculture. Combining with artificial intelligence and automatic control, RAS has a high potential for an intensive cultivation of *Litopenaeus vannamei*.

Keywords: Bio-carrier; Recirculating aquaculture system (RAS); Artificial intelligence

(AI); Aquaculture wastewater treatment; Water-efficient aquaculture.

O-A-11 - Synergistic Mechanism underlying N_2O Mitigation in ABGS Systems Driven by *Chlamydomonas reinhardtii*

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Abstract: Biological nitrogen removal in wastewater treatment is an anthropogenic source of nitrous oxide (N_2O), a potent greenhouse gas. By combining algal nitrogen assimilation with superior settleability, algal-bacterial granular sludge (ABGS) offers an effective strategy for mitigating N_2O emissions. In this study, a stable ABGS system was established utlizing the high-efficiency nitrogen-assimilating microalgae *Chlamydomonas reinhardtii*. Notably, the N_2O emission factor decreased from 4.2 to 0.4 g N_2O-N/kg N upon maturation. Multi-factor analysis revealed that a moderate light intensity (120 μmol/m^2/s) maximized total nitrogen (TN) removal while minimizing N_2O emissions by optimizing the abundance of nitrification and denitrification genes. Compared to low and high intensities, moderate aeration (0.6 cm/s) optimized the ABGS system by achieving superior nitrogen removal (>90%) and minimal N_2O emissions through a coordinated balance of key denitrification genes. While ammonium-only sources maximize TN removal, mixed nitrogen sources (NH_4^+-N:Urea-N = 3.5:1) superiorly enhance granular stability and N_2O reduction potential through increased *nosZ* abundance and extracellular polymeric substances. These findings demonstrate the balance between high-efficiency nutrient recovery and low-carbon emissions in ABGS systems under various operating conditions, providing theoretical guidance for N_2O mitigation in wastewater treatment.

Keywords: Algal-bacterial granular sludge; Chlamydomonas reinhardtii; Metagenomics; Nitrogen metabolism; Nitrous oxide mitigation

O-A-12 - Effects of Trace Amounts of Antibiotics on a Biofilm-based Nitrification Reactor

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Abstract: Trace amounts of antibiotics discharged from medical and livestock sources have been detected in wastewater, raising concerns about their effects on biological nitrification processes. This study investigated the impact of low concentrations of kanamycin on nitrifying microbial communities and nitrification performance in a biofilm reactor. A continuous-flow reactor (1.1 L, filled with 10% vol/vol biocarriers) was operated with synthetic wastewater containing 100 mg/L NH_4^+-N. After stable nitrification efficiency (> 95%) was achieved, kanamycin (0.1–1.0 μg/L) was added. Inorganic nitrogen concentrations were monitored, and microbial communities were analyzed using qPCR and 16S rRNA gene amplicon sequencing. As results, ammonia removal efficiency significantly decreased by 11.7% ($p < 0.01$) after exposure to 0.1 μg/L kanamycin. In contrast, the abundance of ammonia-oxidizing bacteria (AOB), primary drivers in ammonia oxidation, significantly increased during the kanamycin exposure period. Amplicon analysis showed a selective increase in family *Nitrosomonadaceae*, consistent with qPCR results, while α-diversity decreased. β-diversity analysis revealed significant shifts in microbial community structure between control and kanamycin treated-periods. These results suggest that trace antibiotics alter microbial community structure and indirectly impair nitrification performance in biological wastewater treatment systems. Further studies are planned to investigate the effects of higher antibiotic concentrations on nitrifying microbial communities.

Keywords: Nitrification; AOB; Microbial diversity; Antibiotics; Kanamycin

O-A-13 - Elucidation of the Effects of Trace Copper on Nitrifying Microbial Communities

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Abstract: Nitrification is a key process in wastewater treatment and is carried out by ammonia-oxidizing bacteria (AOB), ammonia-oxidizing archaea (AOA), nitrite-oxidizing bacteria (NOB), and complete ammonia oxidizers (comammox). However, the factors determining the dominance of these nitrifiers in wastewater treatment systems remain largely unclear. Recent studies in groundwater treatment systems have suggested that trace copper may influence the composition of nitrifying microbial communities and

thereby enhance nitrification efficiency. However, the effects of copper under wastewater-relevant ammonia concentrations have not yet been investigated. Therefore, this study investigated the effects of trace copper addition on nitrifying microorganisms in a bioreactor operated at typical wastewater ammonia concentrations. A moving bed biofilm reactor (MBBR) was continuously operated using synthetic wastewater containing 40 mg/L NH_4^+-N, with copper concentrations set at 0, 0.3, and 1.5 μg/L. Treatment performance and microbial community responses were evaluated through water quality analysis and qPCR. The results showed that effluent copper concentrations decreased compared with influent levels, suggesting microbial adsorption or uptake. qPCR results showed that AOB remained dominant throughout the experiment and significantly increased at 0.3 μg/L copper, whereas comammox abundance kept stable. Amplicon sequencing on 16S rRNA V3-V4 region was further conducted to assess shifts in the microbial community structure.

Keywords: Nitrification; Ammonia oxidation; AOB; Comammox; Copper; MBBR

O-A-14 - The Urban-Regional Synergistic Model for Food Waste Treatment via Black Soldier Fly Larvae: A Quantitative Assessment of Carbon Reduction Benefits Based on Life Cycle Assessment

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Abstract: Addressing food waste in megacities requires innovative solutions that reconcile waste reduction, resource recovery, and carbon neutrality. This study presented a comprehensive life cycle assessment (LCA) of a large-scale, urban-regional synergistic system for food waste treatment using black soldier fly larvae (BSFL). The system featured centralized preprocessing in Shenzhen and bioconversion in a suburban Huizhou facility. Results demonstrated a net negative carbon emission of –28.5 kg CO_2-eq per tonne of waste, primarily driven by substantial carbon offsets from BSFL-derived protein meal and organic fertilizer substituting conventional feed and fertilizer. The urban-rural synergy proved to be a critical mechanism, optimizing land use and operational efficiency. Compared to mainstream treatments like incineration and composting, this model exhibited superior carbon reduction potential and created higher-value bio-based products. This work provides robust empirical evidence and a methodological framework for evaluating decentralized, circular waste management strategies, offering a scalable and technologically feasible pathway for low-carbon urban metabolism.

Keywords: Black soldier fly; Carbon footprint; Demonstration project; Food waste; valorization

O-A-15 - Impact of Temperature on Nitrogen Transformation and Community Structure in a Hybrid Membrane-aerated Biofilm Reactor for Treating Coking Wastewater

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Abstract: Thermal stress frequently compromise the biological nitrogen removal efficiency in coking wastewater (CWW) treatment, primarily due to nitrification instability. This study proposed a hybrid membrane-aerated biofilm reactor (H-MABR) by integrating MABR membrane modules into the oxic tank for treating CWW at high temperatures (35–44 °C), and compares its performance with a hybrid fixed bed biofilm reactor (H-FBBR). The results showed that the H-MABR system maintained highly efficient NH_4^+-N removal, with an average removal efficiency of 97.51 ± 1.23% (the removal rate was 34.73 ± 4.66 g/m^3/d), which was higher than the NH_4^+-N removal performance of the H-FBBR system (removal efficiency was 95.29 ± 0.97% and removal rate was 33.93 ± 3.36 g/m^3/d) under 40 °C. High-throughput sequencing indicated that ammonia-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB) exhibited the highest relative abundances at 40 °C, potentially explaining the optimal NH_4^+-N removal performance. Furthermore, functional genes responsible for NO_3^--N reduction (e.g., *napAB* and *nasA*) maintained high abundance under high temperatures, potentially explaining the reduced NO_3^--N accumulation concentration with increasing temperature. Our study highlights the application potential of H-MABR for stable and efficient carbon-nitrogen synergistic removal in treating high temperature CWW.

Keywords: Coking wastewater; Hybrid membrane-aerated biofilm reactor (H-MABR); Intermediary effect; Microbial community; Nitrogen cycle pathways; Temperature effects

O-A-16 - Steering Microbial Succession via a Transient Influent Carbon Pulse towards Rapid Assembly of Halotolerant Algal-bacterial Granular Sludge for Robust Nitrogen Removal from Saline Carbon-limited Mariculture Wastewater

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Abstract: Algal-bacterial granular sludge (ABGS) holds great promise for nitrogen (N) removal from saline mariculture wastewater, yet its large application is hindered by its protracted start-up and instability under dual stresses of high salinity and low carbon (C) source. Herein, we developed a novel domestication strategy employing a transient influent C/N elevation (i.e., carbon pulse) to treat wastewater with 1%~3% salinity and a C/N mass ratio of 1. Although granulation was initially inhibited at salinity >2%, the phased carbon pulse rapidly enhanced biomass accumulation and granule integrity. This enabled robust nitrogen removal >84%, which was maintained even after reverting to C/N of 1 at 3% salinity, contributed by reinforced denitrification pathways. Metagenomic analysis revealed that the carbon pulse decisively reshaped the microbial community, driving succession towards a halotolerant denitrifying core (e.g., *Thauera*, *Denitromonas*) and diatom-dominated phototrophs (e.g., *Fistulifera*). Importantly, the upregulated indole-3-acetic acid (IAA) biosynthesis likely supplied a cross-kingdom signal that stimulated denitrifier activity and microalgal assimilation, forming a self-reinforcing feedback loop that conferred long-term resilience after external carbon supply ceased. This work provides an effective operational strategy for treating challenging mariculture effluent and advances the fundamental understanding of steering microbial community assembly through targeted resource manipulation to engineer robust ecosystems.

Keywords: Algal-bacterial granular sludge; Mariculture wastewater; Nitrogen removal; Transient C/N elevation; Microbial succession

O-A-17 - Genomic Insights into Cellulose Anaerobic Digestion of CEPT Sludge for Net Energy Recovery

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Abstract: Chemically enhanced primary treatment (CEPT) is applied in Hong Kong to efficiently capture pollutant from municipal sewage. The resulting cellulose-rich primary sludge provides a promising feedstock for anaerobic digestion (AD), yet cellulose hydrolysis remains a key limitation for stable methane production. This presentation aims to clarify the biological mechanisms governing cellulose-to-methane conversion in CEPT sludge and assess its implications for low-carbon wastewater treatment. A mesophilic semi-continuous AD system was operated under different organic loading conditions, combined with substrate characterization, COD mass balance, metagenomic analysis and energy assessment. The digester achieved stable methane production, with a maximum yield of approximately 0.42 m^3/kg VSS_{in}. Bioinformatic results revealed that cellulolytic bacteria, including DMER64, *Fibrobacter* and *Proteiniphilum*, carried abundant glycoside hydrolases, carbohydrate-binding modules and cellulosome-related genes, enabling cellulose conversion to acetate and hydrogen. Their interaction with *Methanosarcina* supported an efficient substrate-acetate-methane pathway, reducing volatile fatty acid accumulation and improving process stability. Coupling CEPT with AD can recover bioenergy, reduce downstream aeration demand and lower electricity-related carbon emissions, supporting Hong Kong's transition toward resource-efficient and low-carbon wastewater treatment.

Keywords: Anaerobic digestion; Cellulose hydrolysis; Cellulosome; Chemically enhanced primary treatment; Microbial syntrophic metabolism

O-A-18 - Uncovering Batch-to-Batch Heterogeneity in Dewatered Food Waste Digestate: Seasonal Physicochemical Variation and Heavy-Metal Profiles with Implications for Resource Recovery

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Abstract: Food waste management is an increasing urban challenge driven by population growth and resource consumption. Anaerobic digestion (AD) converts food waste into bioenergy is an attractive option, but the process by-products, *i.e.*, the dewatered food waste digestate (FWD), are with high variation in physiochemical properties, which constrain the downstream resource recovery. To clarify this problem, four batches of dewatered FWD were collected and characterized at various seasons, showing a wide range of total solids (TS) 21.0–32.3%, VS/TS 60.9–65.3%, and 1,259–4,438 mg-N/kg

raw digestate as total ammonia nitrogen. The very fine particles (those <1 mm in diameter) have dominated the biosolid samples (48.36–92.27%), followed by those of 1–2.5 mm (3.9–18.7%), 2.5–5.1 mm (2.4–13.9%), 5.1–8.6 mm (0.9–9.3%), 8.6–12.7 mm (0.38–8.10%), and >12.7 mm (0.16–14.76%), respectively. ICP analysis revealed batch-dependent heavy-metal profiles: As, Cr, Cu, Ni, Se, Zn, and Pb ranged 1–2, 20–239, 70–95, 33–107, 3–4, 257–373, and 4–7 mg/kg-dried samples, respectively, indicating different metal distribution patterns among batches. Overall, the combined characterization demonstrates strong batch-to-batch heterogeneity in FWD and highlights metal distribution as a key factor for downstream process for resource recovery. More details of the experiments will be provided in the presentation.

Keywords: Anaerobic digestate; Batch heterogeneity; Food waste; Heavy metal; Resource recovery

Theme II: Bioenergy and Resource Recovery

O-B-1 - Syngas Production from Pyrolysis Catalytic Steam Reforming of Plastic Wastes over Char Catalysts

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Abstract: The thermochemical conversion of plastics represented a promising technology for producing high-value-added products. Catalytic steam reforming of plastic wastes to produce hydrogen/syngas has been investigated at 800 °C in a two-stage pyrolysis catalytic reforming reaction system. Pyrolysis char obtained from the pyrolysis of tires, biomass and refuse-derived fuels at 800 °C was used as catalysts. The catalysts were characterized by X-ray diffraction, atomic absorption spectroscopy, scanning electron microscope coupled with energy dispersive X-ray spectroscopy and specific surface and porosity analysis. The pyrolysis char contained substantial inorganic substances, contributing to excellent catalytic activity in steam reforming. To further explore the influence of inorganic components, Zn/Carbon, Fe/Carbon and Cu/Carbon were prepared using the impregnation method based on the metal components present in the pyrolysis char. Using waste plastics as an example, the effects of different metals on the steam catalytic process were investigated and the effects of sacrificial char catalysts and conventional catalysts (Ni/Al_2O_3) were compared. Also, the study presented a comprehensive analysis including mass balance, hydrogen yield and gas composition.

Keywords: Catalysis; Hydrogen; Plastic wastes; Pyrolysis; Syngas

O-B-2 - Cascade Valorization of *Furcellaria lumbricalis* Processing Residues Using Green Extraction Strategies

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Abstract: The industrial extraction of furcellaran from the red seaweed *Furcellaria lumbricalis* generates substantial quantities of residual biomass that remain underutilized despite containing valuable biochemical components. Developing strategies to recover additional compounds from these residues could improve the resource efficiency of seaweed processing and support the implementation of marine biorefinery concepts. This study investigates green extraction approaches for the valorization of *F. lumbricalis* processing residues, with particular focus on designing sequential recovery pathways for multiple product fractions. Building upon previous work on protein-rich extract recovery from these residues, additional extraction strategies targeting phenolic compounds were explored. Enzyme-assisted treatments and deep eutectic solvent systems were evaluated as environmentally compatible extraction methods under mild processing conditions. The potential influence of process sequencing was also examined by considering alternative cascade strategies, including protein-first and polyphenol-first extraction routes. Preliminary results indicate that furcellaran extraction residues retain recoverable phenolic compounds and other bioactive constituents that can be extracted using green solvent systems. These findings support the feasibility of sequential extraction approaches and provide insights for the development of integrated valorization pathways for seaweed processing residues within sustainable marine biorefinery frameworks.

Keywords: Cascade valorization; Deep eutectic solvents; Enzyme-assisted extraction; Marine biorefinery

O-B-3 - Enhanced 2,3-Butanediol Bioproduction via isFBB and Catalytic Upgradation to 1,3-Dioxolane: A Route to SAF Building Blocks

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Abstract: Sustainable aviation fuel (SAF) stands as a pivotal decarbonization strategy for global aviation, capable of slashing CO_2 emissions by up to 80%. In 2021, the International Air Transport Association renewed its pledge to cut emissions to half of 2005 levels by 2050. Regulatory progress is accelerating: the EU mandates SAF to make up at least 2% of aviation fuel by 2025, escalating to 70% by 2050, with similar targets in the US and China. Diverse SAF production routes exist, including hydro-processed esters and fatty acids (HEFA) from oils and fats, Fischer-Tropsch synthesis (FT) from gasified biomass, and alcohol-to-jet (ATJ). The ATJ pathway, upgrading biosynthesized 2,3-butanediol (2,3-BDO) to iso-alkanes, excels in atom economy, feedstock versatility, and integration with biorefineries, making it ideal for valorizing lignocellulosic sugars. The process started with efficient fermentation of C5/C6 sugars to 2,3-BDO using an in-situ Fibrous Bed Bioreactor (isFBB). *Klebsiella pneumoniae* PM2, which was screened from waste oil for superior C5/C6 sugar utilization (Rehman et al., 2021), achieved ~90% sugar consumption from lignocellulosic hydrolysates. Applying these bacteria, the isFBB immobilized cells on low-cost agricultural residues, which boosted stability, yield, and durability (Li et al., 2018), and achieved a 111.04 g/L 2,3-BDO titer in fed-batch mode, which is 14.5% higher than free-cell fermentation. Subsequent thermochemical upgrading involved transform 2,3-BDO to 1,3-dioxolane, catalytic conversion to C3+ olefins, oligomerization to C8-C14 compounds, hydrogenation, to obtain SAF products.

Keywords: Carbon neutralization; In-situ fibrous bed bioreactor; Sustainable aviation fuel; Yard waste valorisation; 2,3-butanediol

O-B-4 - Iron Nanoparticles-Confined Graphene Oxide Membranes Coupled with Sulfite-Based Advanced Reduction Processes for Ultrafast and Stable Removal of Bromate

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Abstract: Toxic oxygen anions such as bromate (BrO_3^-) exhibit carcinogenic and mutagenic effects on humans, necessitating their removal. Advanced reduction processes (ARPs) are widely adopted due to their high efficiency. However, ARPs still face the challenge of separating the activator from water via energy-intensive centrifugation. Therefore, constructing a membrane-catalyzed system overcomes this issue, enabling efficient removal of anions such as bromate. Iron nanoparticles were incorporated into graphene oxide to prepare iron nanoparticles-intercalated graphene oxide (GO@FeNPs) membranes. In the presence of 1.0 mM sulfite (S(IV)), the GO@FeNPs membrane/S(IV) system achieved nearly complete removal of 80 μg/L bromate in 3 min. The first-order reaction rate constant for bromate removal in this system was 420 ± 42 min^{-1}, up to 5 orders of magnitude faster than previously reported ARPs. The GO@FeNPs membrane showed excellent stability, maintaining >97.0% bromate removal over 20 cycles of repeated runs. The membrane can also be applied for fast catalytic reduction of other oxyanions, showing >98.0% removal of nitrate and chlorate. In summary, the GO membrane-based nanocatalytic systems offer advantages including rapid reduction, high efficiency, high stability, and low energy consumption, demonstrating significant potential in water treatment processes.

Keywords: Graphene oxide catalytic membranes; Advanced reduction; Water treatment; Oxyanions; Confinement effects

O-B-5 - Synergistic Catalysis for Sustainable Biodiesel Production from Biomass Platform Compounds: Combining Solid Acid Catalysts with Commercial Hydrogenation Metals

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Abstract: In response to the pressing need for sustainable energy solutions, this study presents a novel co-catalytic approach for the efficient production of long-chain fatty acid methyl esters (FAME) from lignocellulose-derived biomass platform compounds. By integrating solid acid catalysts with commercial hydrogenation metals, we developed a one-pot hydrodeoxygenation and esterification (HDOE) process that significantly enhances the yield of biodiesel. Our findings demonstrate that the co-catalytic system, comprising a sulfonated carbon catalyst and a Pd/C hydrogenation catalyst, achieves over 90% yield for FAME from 4 long-chain oxygenated substrates. The dual role of methanol was identified as pivotal, facilitating both esterification and the ring-opening of furan derivatives, which influences product selectivity. This work not only elucidates the intricate dynamics of catalytic interactions but also proposes a universal method for converting biomass-derived compounds into valuable methyl ester chemicals, thereby

contributing significantly to the advancement of biodiesel production and the broader realm of sustainable chemical processes.

Keywords: Biodiesel; Co-catalytic system; Hydrodeoxygenation; Esterification; Lignocellulose-derived compounds

O-B-6 - Highly Selective Hydrodeoxygenation of Furfural to 2-Methylfuran over Cu-Nb/Al-MCM-41 under Mild Conditions

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Abstract: The selective hydrodeoxygenation (HDO) of furfural (FAL) into 2-methylfuran (2-MF) is a crucial transformation for upgrading lignocellulosic biomass into liquid fuels. Herein, a series of Cu-Nb catalysts supported on mesoporous MCM-41 were developed. Over the optimized Cu-Nb/Al-MCM-41 catalyst, FAL was completely converted and the selectivity of 2-MF was 99.6% at only 160 °C under ambient hydrogen pressure. Structural analyses revealed that Al incorporation reinforced metal-support interactions, enhanced Cu dispersion, and producing moderate Brønsted-Lewis acid sites, which synergistically facilitated hydrogen transfer and selective C-O bond cleavage. In situ DRIFTS and XPS measurements confirmed a tandem hydrogenation-dehydration pathway proceeding via furfuryl-alcohol (FOL) intermediates, where Nb promoted H_2 activation and Al-derived acid centers accelerated dehydration at interfacial Cu^+-Nb-Al sites. The catalyst exhibited shows stable operation in a fixed-bed reactor for 500 h time-on-stream. These findings establish a clear structure-function correlation between electronic modulation and acid-metal synergy, offering a sustainable strategy for efficiently producing furan-based biofuels under mild conditions.

Keywords: Furfural; 2-Methylfuran; Selective hydrodeoxygenation; Cu-Nb/Al-MCM-41; Acid-metal synergy; Biomass-derived biofuel

O-B-7 - Redirecting Dissolved Organic Matter Transformation during Anaerobic Digestion via External Electric Field-Driven Microbial Network Succession

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Abstract: Integrating a mild external electric field with anaerobic digestion is a promising and chemical-free strategy to enhance bioenergy recovery. However, how this

approach regulates the biotransformation of dissolved organic matter (DOM) remains unclear. Here, ultrahigh-resolution mass spectrometry and transformation-based networks were combined to resolve how an external electric field alters DOM molecular trajectories. The applied voltage imposed stronger deterministic selection on DOM succession, reshaping its temporal evolution. It accelerated both molecular synthesis and degradation while increasing OH-related transformations, suggesting a shift in microbial metabolic strategies. These altered transformation patterns lowered the Gibbs free energy change associated with key transformations, making the turnover of relatively recalcitrant fractions more thermodynamically favorable. Meanwhile, physicochemical properties and sludge conductivity drove microbial topological succession, and the resulting network reorganization was closely associated with shifts in predicted functional profiles linked to these thermodynamic changes. This work links external electric-field regulation, microbial interaction structure, and DOM turnover during anaerobic digestion, offering new insight for more efficient and sustainable resource recovery.

Keywords: Anaerobic digestion; External electric field; Dissolved organic matter; Molecular transformation; Microbial co-occurrence network; Thermodynamic favorability

O-B-8 - Predict Flocculation and Sedimentation in High-Turbidity Water Based on Multimodal Physical-informed Constraints

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Abstract: In a southern Chinese river, the raw water turbidity varies sharply during flood seasons, with suspended solids varying from 154 to 11,000 mg/L (exceeding 64,000 NTU under extreme conditions). To address the measurement lag, poor model generalization, and insufficient physical constraints in high-turbidity flocculation-sedimentation, a machine vision-based real-time monitoring platform was built in this study. Python-OpenCV was used to preprocess the images and extract multi-source features including texture, grayscale, and degree of flocculation (DF) derived from suspended solid removal efficiency. The model employs a multi-view conditional architecture that integrates side and top view images, time-step information, and dosing conditions, while incorporating sedimentation-interface auxiliary supervision and time-conditioning modules to enhance physical consistency. A total of fifteen experimental groups were conducted, yielding nearly 9,000 samples on the test set, the model achieves MAE = 46.53 NTU, RMSE = 130.71 NTU, and R^2 = 0.9249. Ablation studies show MAE rises to 60.23 NTU without interface supervision and to 72.67 NTU without time conditioning. Single-view

comparisons favor side view (MAE = 53.28 NTU) over top view (65.93 NTU), with the main model's average side-view attention weight at 0.699. Vertical stratification and downward migration of the sedimentation interface are key visual signatures. This method resolves measurement lag and cross-turbidity generalization challenges. The multimodal physical constraints is applicable for predicting the flocculation and sedimentation in high-turbidity water.

Keywords: High-turbidity water; Flocculation-sedimentation; Multi-view conditional model; Machine vision; Physical constraints; Generalization performance

Theme III: Biomass Reclamation and Recycling

O-C-1 - Dynamic Steering of H* Spatiotemporal Matching Strategy Boosts Selective Electrocatalytic Hydrogenation of Phenol to Cyclohexanone

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Abstract: Upgrading phenols from petroleum refining and biomass conversion to high-value chemicals is crucial for the sustainable development of the chemical industry. Compared with traditional thermal catalytic hydrogenation, electrochemical hydrogenation (ECH) of phenol under ambient conditions, as a green and efficient alternative, has attracted wide attention, with cyclohexanone being a highly valuable target due to its applications in synthesizing nylon and caprolactam. Pt-based catalysts are widely used in phenol ECH for their excellent aromatic ring adsorption and hydrogen activation, but selective synthesis of cyclohexanone remains a key challenge. Following the Langmuir-Hinshelwood mechanism, the reaction depends on the interaction between adsorbed phenol and H*. The precise regulation of H* coverage is critical, because excessive H* causes over-hydrogenation and HER, while insufficient H* slows kinetics. Although the H spillover strategy alleviates over-hydrogenation, it has kinetic limitations and poor adaptability to dynamic reaction conditions. Herein, we propose a dynamic spatiotemporal matching strategy via pulsed electrochemical modulation to control H* and phenol coverage. Differential electrochemical mass spectrometry tracked interfacial species evolution, and applications on various Pt-based catalysts and phenol analogs confirm this strategy provides in-situ evidence for the L-H mechanism's coverage dependence and establishes a universal regulation method, offering new insights for high-selectivity ECH system design and industrial application of green phenol conversion.

Keywords: Phenol; Pulse; Coverage modulating; DEMS

O-C-2 - Catalytic Wet Air Oxidation of Municipal Sludge for Simultaneous Carbon Recovery and Nitrogen Removal

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Abstract: The residual liquid phase from wet air oxidation (WAO) of sludge is a potential carbon source due to its richness in volatile fatty acids. However, ammonia accumulation during WAO undermines its use for enhancing nitrogen removal in bioreactors. To address this, we first characterized the dissolved organic matter in the WAO liquid phase, identifying lipids and lignins as major components along with several key intermediates. Various catalysts (noble metals on metal oxide supports) were then compared for nitrogen removal and carbon source production. Under optimized conditions, 110.1 g of carbon source (as chemical oxygen demand) was produced per kg of dry sludge. A pilot-scale reactor was used to produce the sludge-derived carbon source. The efficacy of certain carbon source was evaluated in sequencing batch reactors via conventional parameters (e.g., nitrogen removal rate) and microbial community analysis. Comparative performance showed that liquid from simple thermal hydrolysis or common WAO was unsuitable due to abundant non-biodegradable organics and ammonia, whereas the carbon source from catalytic WAO was comparable to sodium acetate. This study offers a viable approach for municipal sludge resource utilization.

Keywords: Biomass disposal; Carbon source; Catalytic wet air oxidation; Nitrogen removal; Resource recovery; Wastewater treatment

Theme IV: Biosystem and Bioassay

O-D-1 - Immobilization of Pb and Cd in Contaminated Soil with Composite of Phosphate, Bentonite and Calcium Hydroxide

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Abstract: Heavy metal pollution in soil is the phenomenon that heavy metals content in soil is higher than the natural background values, leading to ecological destruction. The lower the bioavailable state of heavy metals, the lower their harm to the ecological environment. Pot experiments of wheatgrass were conducted to evaluate the effectiveness of a composite of phosphate, bentonite and calcium hydroxide on immobilization of lead

(Pb) and cadmium (Cd) in contaminated soil. The physical and chemical properties of the soil, diethylenetriaminepenta (DTPA) extractable Pb and Cd concentration in the soil, uptake of Pb and Cd from the soil by wheatgrass, and sequential extraction were investigated in this study. The results indicate that the composite can effectively decrease DTPA extractable Pb and Cd concentration in the contaminated soil by 6.8%-25.9% and 16%-23.8%, respectively. Uptake of Pb and Cd by wheatgrass reduced the Pb and Cd content in the soil by 18.8%-25.5% and 13.6%-68.0%, respectively. The results of sequential extraction experiment have shown that bio-availability of Pb was mainly transformed from exchangeable and oxides fractions to residual fraction. Meanwhile, bio-availability of Cd was mainly transformed from exchangeable and carbonates fractions to oxides fraction.

Keywords: Phosphate; Bentonite; Calcium hydroxide; Immobilization; Pb; Cd

Theme V: Sustainable Management and Analysis

O-E-1 - Deciphering the Formation Mechanism of Non-Biodegradable Microplastics during Bioplastic Degradation in Aerobic Environment

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Abstract: Biodegradable plastics are often regarded as completely degradable materials. Although the application of bio-based substitutes for traditional plastics has become widespread, numerous studies have reported that these materials also contribute to microplastics contamination and plastic pollution. However, the formation and degradation dynamics of recalcitrant microplastics remain insufficiently understood. This study investigated the degradation behavior of two commercially available plastics over a 100-day period under aerobic conditions. Results showed that microplastics in compost were mainly distributed around 10 μm, and a significant proportion of aromatic ring structures persisted in the degradable products. Besides, nitrogen plays a significant role in biodegradable plastic degradation. Nitrogen supplement promotes microbial growth facilitating plastic degradation. However, N-containing hydrogen bonding, forming from the carboxylic acid plastic products and organic nitrogen, will hinder the degradability. These recalcitrant microplastic with organic compost as a vehicle may lead to the microplastics accumulation in the environment. This finding offers novel insights for the

degradation of biodegradable polyester plastic and the fate of their derived non-biodegradable microplastics.

Keywords: Bioplastic; Biodegradation; PLA/PBAT; Microplastics; Hydrogen bond

Theme XI: Biogeochemistry and Flocculation in Water Environment

O-K-1 - From High-Purity Al_{13} to Adaptive Coagulation: Resolving the Trade-off between Purity and Species Selectivity

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Abstract: To date, nano-Al_{13} with a purity exceeding 99% can be synthesized and exhibits excellent charge neutralization capacity under controlled conditions. However, its practical application remains constrained by the thermodynamically metastable nature of Al_{13}, which is prone to aging during synthesis, transportation, and dosing, and can further transform into less active Alc species induced by AlO_4^-, resulting in performance decay. In industrial polyaluminum chloride (PACl), the fraction of highly active Al_{13} is typically below 40%, whereas laboratory-prepared PACl can achieve up to 77% Al_{13} without purification, with less than 10% decay over one year. Nevertheless, coagulation performance is strongly dependent on water quality and the distribution of Al species. In low-turbidity, high-alkalinity water during winter, high-purity Al_{13} (70 μM) exhibits comparable adsorption-charge neutralization efficiency to commercial PACl (Alb 48%) at SUVA ≈ 1.5. However, in waters dominated by hydrophilic organic matter (SUVA < 1.2), it performs poorly, achieving only 18% turbidity removal and a zeta potential of −8.9 ± 2.4 mV, inferior to industrial products. These findings reveal a fundamental contradiction between static Al_{13} high purity and species selectivity. Therefore, adaptive in-situ synthesis strategies, enabling real-time regulation and “on-demand preparing”, are proposed to enhance stability and coagulant efficiency under dynamic water conditions.

Keywords: Al_{13} clusters; In-situ synthesis; Polyaluminum chloride; Species-dependent coagulation; Water quality adaptability

Theme XII: Greenhouse Gases Emission/Mitigation and Carbon/Nitrogen Neutrality

O-L-1 - Quantifying the Spatiotemporal Characteristics and Regionally Heterogeneous Drivers of Synergistic Pollutant-Carbon Control in China's Municipal Wastewater Treatment Plants

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Abstract: Collaborative carbon-pollutant control in wastewater treatment sector is vital for China's "Dual Carbon" goals, yet quantitative assessments of synergistic performance in municipal wastewater treatment plants (MWWTPs) at macro-scale and investigations into its influencing factors, remain insufficient. Based on "water-energy-chemical-carbon" nexus, this study constructed provincial greenhouse gas (GHG) emission inventories of China's MWWTPs from 2009 to 2019. Using super-efficiency slacks-based measure data envelopment analysis (Super-SBM DEA), Spearman correlation, principal component analysis (PCA), and multiple linear regression model (MLR), we quantified the synergistic efficiency of pollutant-carbon reduction in MWWTPs across China's 29 provinces and identified key influencing factors and their regional heterogeneous patterns. During the study period, total GHG emissions increased nearly 3.5-fold, with significant spatial disparities. The 11-year national average synergistic efficiency was at a moderate level (0.63). Temporal decline and elevated levels in the northwest in synergistic efficiency were both strongly associated with influent COD concentration (r=0.77). From the perspective of geographic regions, common drivers of collaborative efficiency were divided into internal operational factors (pollutant removal, influent quality, energy-carbon costs) and external socioeconomic development. Regional heterogeneity in their impacts suggests three distinct strategic pathways for MWWTPs: prioritizing GHG reduction in northern/eastern regions, emphasizing pollutant removal in central/southern regions, and advancing both simultaneously in the northeast and northwest.

Keywords: Collaborative carbon-pollutant control; Municipal wastewater treatment plants; Influencing factors; Regional heterogeneity

O-L-2 - Biochar Preparation and Carbon Sequestration and Emission Reduction Technologies in Paddy Fields

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Abstract: Carbon removal technologies, including chemical methods and biological carbon sequestration, are essential for achieving global carbon neutrality. Biological carbon sequestration technologies have drawn considerable attention due to their ecological benefits and cost-effectiveness. Biochar has demonstrated substantial potential in soil carbon sequestration and greenhouse gas mitigation, yet systematic assessments of its production and application are still limited. This study systematically optimized biochar production technologies and evaluated their effectiveness in rice paddy systems. Major achievements include: (1) Developing and optimizing biochar production processes and equipment, identifying an optimal pyrolysis temperature of 500℃ for rice straw, achieving a biochar carbon content of 53%, and enhancing biochar adsorption capacity through Fe_3O_4 magnetization, increasing specific surface area by 310.6% and pore volume by 512.5%; (2) Laboratory and field experiments revealed that applying biochar produced at 500℃ significantly reduced methane (CH_4) and nitrous oxide (N_2O) emissions by up to 91.77% and 38.21%, respectively, and increased rice yield by 28%; (3) Lifecycle assessment (LCA) of practical applications indicated that transportation contributed most (92%) of carbon emissions, recommending extending application intervals for mutual economic benefit between farmers and producers. These findings provide essential theoretical and technical support for biochar's large-scale agricultural application.

Keywords: Biochar; Paddy field carbon sequestration and emission reduction; Carbon peaking and carbon neutrality

O-L-3 - Assessment of Greenhouse Gas Emission Reduction Benefits of Rice Biochar Returning to the Field Based on Life Cycle Assessment

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Abstract: Rice cultivation emits CH_4 and N_2O. Returning rice straw biochar to the field can effectively sequester carbon and reduce emissions. However, the popularization rate of this technology in actual production is relatively low. The study evaluated the environmental and economic benefits and popularization obstacles of applying biochar to paddy fields through the LCA and CBA methods combined with a survey of farmers' willingness. The results showed that applying biochar can significantly reduce GHG emissions but increase energy input. The net GHG emission reductions under the

application rates of 10 t/ha and 20 t/ha were 2315.74 kg CO_2 and 8386.89 kg CO_2 e, respectively. The energy consumption mainly came from the transportation process of rice straw and biochar. The survey of farmers' willingness found that farmers' overall acceptance of biochar was low, mainly due to distrust of biochar, the labor-intensive application process, and high prices. The years of rice cultivation, family strength, and cognitive level all affect farmers' acceptance. Therefore, it is necessary to make efforts both externally and internally: externally, reduce costs, shorten transportation distances, and extend the cycle; internally, strengthen publicity, improve granulation to adapt to machine sowing, and enhance farmers' willingness to adopt.

Keywords: Biochar; Life cycle assessment; Carbon sequestration and emission reduction

Theme XIII: Microalgal-Bacterial Consortium and its Advancements

O-M-1 - Deciphering Microalgal Response Mechanisms to High Ammonium-Nitrogen Stress

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Abstract: High concentrations of ammonium nitrogen (NH_4^+-N) act as a significant environmental stressor, severely inhibiting microalgal growth and metabolism, yet the underlying inhibitory and adaptive mechanisms remain unclear. In this study, the physiological responses and transcriptomics of three microalgal strains under different NH_4^+-N gradients were comparatively analyzed. The results showed that elevated free ammonia (FA) levels and low pH were the main factors inhibiting microalgal growth under high NH_4^+-N stress. Furthermore, the differential tolerance observed among these strains derived from their distinct response strategies involving in photosynthesis, central carbon metabolism, oxidative stress defense, and genetic information maintenance. *Tetradesmus obliquus* SCU-4 exhibited optimal growth at 1 g/L NH_4^+-N. However, concentrations exceeding 2 g/L caused severe FA toxicity, disrupting its Calvin and Citrate cycles and inducing significant DNA damage. Under these conditions, limited cellular energy was preferentially allocated to stress defense and DNA repair, which consequently suppressed microalgal growth. In contrast, *Chlorella sorokiniana* SCU-6 showed strong tolerance at 2 g/L NH_4^+-N by maintaining photosynthetic efficiency through enhanced photodamage repair and antioxidant capacity, while strategically redirecting carbon flux towards extracellular polysaccharide synthesis and membrane lipid remodeling. These results provide a theoretical basis for optimizing microalgal performance under high-nitrogen loads and developing tolerant strains.

Keywords: Ammonium nitrogen; Microalgae; Tolerance mechanism; Transcriptomic; Wastewater treatment

O-M-2 - Research on the Microbial Synergistic Mechanism in the ABGS System under Ciprofloxacin Antibiotic Stress

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Abstract: As a novel and sustainable biological treatment technology with broad application prospects, the degradation mechanism of algal-bacterial granular sludge (ABGS) under ciprofloxacin (CIP) stress remains rarely explored. In this study, the degradation performance and stress resistance mechanisms of ABGS were systematically investigated under varying CIP concentrations (1, 3, and 5 mg/L). The average CIP removal efficiencies were 90.38%, 74.78%, and 51.85%, respectively. Notably, CIP stress at 1 mg/L and 3 mg/L did not compromise system stability; instead, it enhanced granule integrity, compactness, and settleability. Under 3 mg/L CIP, the ABGS system achieved a maximum mixed liquor suspended solids (MLSS) concentration of 5564 mg/L, with a sludge volume index (SVI30) of 48 mL/g, while algal growth remained unaffected. Microbial community and metabolic function analyses revealed that *Pseudoxanthomonas* and *Leptolyngbya* exhibited strong resistance to CIP. As a result, the ABGS system sustained its stability and high degradation efficiency primarily through the establishment of a synergistic and stable algal-bacterial symbiotic relationship.

Keywords: Algal-bacterial granular sludge; Antibiotic stress; Ciprofloxacin; Degradation mechanism; Symbiotic relationship

O-M-3 - Quorum Sensing Signal Molecules Regulate the Microbial-Algae Membrane Aeration Biofilm for Nutrients and Sulfadiazine Removal: Community Response and ARGs Transfer

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Abstract: Membrane aerated biofilm reactor (MABR) system can achieve efficient removal of high ammonia nitrogen wastewater and antibiotics. It has been proven that the exogenous addition of the quorum sensing (QS) signaling molecules N-acyl homoserine lactones (AHLs) can regulate the activity of nitrifying bacteria and affect QS. This study focuses on the impact of exogenous addition of AHLs on the removal of sulfadiazine (SDZ) in the bacterial-algae MABR (ab-MABR) system. The results demonstrate that AHLs enhance nitrogen metabolism and SDZ removal, achieving 76.5 ± 3.0% ammonia and 95.4 ± 5.8% SDZ removal efficiency under 50 μg/L SDZ stress. Mechanistically, AHLs promoted tightly bound extracellular polymeric substances (TB-EPS) secretion to bolster biofilm stability, while reducing oxidative stress. AHLs also restructured the microbial community, enriching functional genera involved in nitrogen and pollutant removal. AHLs upregulate the expression of QS synthesis genes fadD and rpfF, with the abundance of rpfF increasing by 250%. AHLs regulation of quorum sensing can reduce the risks of antibiotic resistance genes (ARGs) enrichment and transfer such as *sul1* and *sul2*. Compared to a nitrifying-only MABR, the AHL-mediated ab-MABR achieved superior pollutant removal while posing a lower risk for ARGs transfer, offering a promising strategy for sustainable wastewater treatment.

Keywords: Antibiotic resistance genes; Membrane aerated biofilm; Microalgae-bacteria consortium; Quorum sensing; Sulfadiazine

Theme XIV: Biomass-Based Agriculture and Bioeconomy Creation

O-N-1 - Potential Impacts on Aquatic Environments of Organic Fertilizer Produced from Granular Sludge via Hydrothermal Treatment

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Abstract: Novel granular sludge has attracted significant research interest due to its resource recovery potential and considerable availability. Our previous study primarily focused on recovering nutrients from granular sludge through hydrothermal (HT) carbonization and utilizing the resulting HT process water as an organic liquid fertilizer. Results show that HT treatment can dissolve most of the nutrients present in the granular sludge into the reaction medium. However, when such liquid organic fertilizers are applied to agricultural land, they may enter nearby surface water bodies through runoff, potentially affecting aquatic ecosystems and organisms. Despite these concerns, limited studies have examined the environmental impacts of granular sludge-derived liquid organic fertilizers on aquatic systems. Therefore, the objective of this study is to evaluate the potential effects of the produced organic fertilizer on aquatic environments. To achieve this, an acute fish toxicity test was conducted using Japanese rice fish across five dilution ratios (1:10, 1:25, 1:50, 1:75, and 1:100) of the liquid produced from HT at 180°C

for 60 minutes. In addition to dissolved oxygen (DO) and pH, the visible appearance and general behavior of the fish were recorded three times per day during the test period. The fish were detected to have an average weight of 0.2 g and an average length of 4 cm. The average DO concentration decreased from 6.0 mg/L to 3.0 mg/L, while the diluted HT liquid pH (1:50 and 1:100) gradually increased within the acidic range (5.0-6.8). Furthermore, the concentrations of heavy metals in the produced organic fertilizers support the development of a safe, low-toxicity fertilizer derived from granular sludge for future agricultural applications.

Keywords: Algal bacterial granular sludge; Hydrothermal treatment; Nutrient recovery; Organic liquid fertilizer; Sustainability; Toxicity

Theme XV: Other Related Topics

O-O-1 - Integrating Receptor-Molecule Interaction Refines Odor Prediction

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Abstract: Predicting odor detection thresholds (ODTs) and odor qualities remains a challenge for identifying odorants. Current machine-learning prediction approaches predominantly rely on molecular physicochemical properties, while overlooking the biological interaction with human olfactory system. A computational framework is developed that integrates molecule-human olfactory receptor (OR) binding affinities with molecular descriptors and structural fingerprints to estimate ODTs and odor qualities in this study. Its performance outperforms conventional methods based solely on molecular features, presenting particularly strong discriminative ability for garlic, alliaceous, and sulfurous odors. The molecular polarity, structural complexity, and binding affinity are further identified as prior factors for odor perception, shedding mechanistic insights into the olfactory perception. The key ORs for predicting ODTs and odor qualities are separately pinpointed. By bridging odorant-OR interaction and molecular information, this work can facilitate the identification of unknown odorants, support food flavor design, and advance the understanding of olfactory mechanism.

Keywords: Computational framework; Food flavor design; Multi-feature integration; Odor perception prediction; Odorant-receptor binding affinity

Poster Presentation

Theme I: Biological Waste/Wastewater Treatment

P-A-1 - Selective Phosphate Recovery from Real Digestate by Waste-Derived LDH/Biochar MCDI: Linking Separation Performance with Fouling Dynamics

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Abstract: Recovering phosphate from anaerobic digestion digestate is hindered by high ionic strength, competing anions, and fouling-prone matrices. We report a waste-derived Mg_3FeAl layered double hydroxide/biochar (LDH/BC) composite anode integrated into membrane capacitive deionization (MCDI) to selectively separate and enrich phosphate from real AD-MBR permeate. Under ±1.2 V cycling, the LDH/BC electrode sustained phosphate adsorption capacities of 55.85-60.82 mg g^{-1} with regeneration efficiencies of 89.3-98.8% over 50 cycles, while retaining >98.5% of Mg, Fe, and Al. The eluate achieved ~15-fold phosphate enrichment (~950 mg L^{-1}), whereas co-ions showed substantially lower enrichment (2.57-3.30), yielding removal selectivity coefficients >7 in a multi-anion matrix, at a total specific energy consumption of 4.85 ± 0.21 kWh kg^{-1}-P. To interpret matrix-dependent operability, in situ optical coherence tomography (OCT) from our digestate filtration studies reveals that particle removal and salt chemistry reshape early interfacial behaviors: excessive particle removal can shift fouling from reversible surface deposition to compact internal blockage, while NaCl-induced hydration repulsion delays deposition but can promote denser cakes at high ionic strength. These insights support a process pathway that couples targeted pretreatment with selective MCDI to enable robust, low-chemical phosphate recovery from digestate.

Keywords: Digestate; Electrosorption; Membrane capacitive deionization; Optical coherence tomography; Phosphate recovery; Selective separation

P-A-2 - Optimization of Hydrogen Fermentation Conditions Using Cow Manure and Waste Milk

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Abstract: Hydrogen has attracted significant attention as a next-generation clean energy

source because it does not emit CO_2 during combustion. However, conventional hydrogen production methods involve high economic costs and CO_2 emissions during the production process. Hydrogen production from organic waste has therefore gained increasing interest. Nevertheless, a major challenge of hydrogen fermentation from organic waste is process instability, highlighting the need to develop a sustainable culture system with high hydrogen productivity. The objective of this study was to determine the optimal conditions for hydrogen fermentation using a mixture of cow manure and waste milk. Batch hydrogen fermentation experiments were conducted using substrates prepared from cow manure and waste milk. The produced gas was collected by the water displacement method, and hydrogen concentration was analyzed. The results showed that the maximum hydrogen concentration reached 72%, indicating the feasibility of producing high-purity hydrogen gas under appropriate conditions. The optimal culture conditions identified in this study were as follows: culture temperature of 50 °C, pH 6-7, and a mixing ratio of cow manure to waste milk of 2:1.

Keywords: Cow manure; Waste milk; Hydrogen; Hydrogen fermentation

P-A-3 - Bimetallic Oxides with Package Structure for Enhanced Degradation of Bisphenol A through Peroxymonosulfate Activation

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Abstract: Cobalt oxide (CoO) could activate peroxymonosulfate (PMS) to remove pollutants but the catalytic performance was restricted by limited active sites with risk of harmful Co^{2+} leaching. In order to solve these problems, bimetallic oxides with package structure were researched by dispersing CoO nanoparticles on the support (magnesium oxide, MgO) via simple one-step coprecipitation method. Co-Mg bimetallic oxides could efficiently activate PMS for degradation of bisphenol A (BPA). The catalytic properties of catalysts with different molar ratios of Co and Mg were evaluated. The optimal molar ratio (0.075:15) of Co and Mg could maximize its catalytic performance for PMS in a wide pH range. Influences of different systems, catalyst dosages, PMS concentrations, temperatures, initial pH values and mineralization rates were researched for BPA degradation. The addition of anions and nature organic matter (NOM) showed that there existed positive (Cl^- and $H_2PO_4^-$) and negative (NO_3^-, HCO_3^-, HPO_4^{2-} and NOM) effects for BPA degradation. Main reactive radicals were certified by quenching experiments. Successive experiments and evaluation of concentration of Co^{2+} leaching illustrated good stability of catalyst, which was related with its package structure. Finally, activation mechanism of PMS, proposed degradation pathways of BPA and acute toxicity of degradation intermediates of BPA were analyzed.

Keywords: Bisphenol A; Co-Mg bimetallic oxides; Degradation pathways; Peroxymonosulfate; Package structure

P-A-4 - N_2O Emission from Algal-Bacterial Granular Sludge Systems Fed with Different Volatile Fatty Acid Species

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Abstract: Mitigation of nitrous oxide (N_2O) emission is crucial for maintaining the sustainable management of wastewater treatment plants (WWTPs). This study monitored and compared N_2O production from algal-bacterial granular sludge (ABGS) systems during 5-day operation when fed with different volatile fatty acid (VFA) species as carbon source respectively. Under an identical influent carbon concentration (150 mg-C/L) with the same operational cycle consisting of 2-h non-aeration and 4-h aeration, > 90% dissolved organic carbon was removed in all test ABGS systems. About 80% total inorganic nitrogen (TIN) removal was achieved in the propionic acid (HPr)-, butyric acid (HBu), and valeric acid (HVa)-fed ABGS systems, whereas a significantly lower TIN removal (59%) was detected in the acetic acid (HAc)-fed ABGS system in addition to an evident nitrate (NO_3^-) accumulation. On the other hand, the dissolved N_2O concentration in the bulk reached 600 μg/L in the HAc-fed ABGS system, while this concentration remained below 200 μg/L when HPr, HBu, or HVa was applied. During the 5-day operation, total nitrogen was slightly accumulated in the HAc-fed ABGS system, suggesting inefficient denitrification. As a result, the N_2O emission factor in the HAc-fed system reached 9.7%, which was significantly higher than those in the HPr- (1.9%), HBu- (0.3%), and HVa- (0.3%) fed systems. Results from this study highlight the importance of carbon source on N_2O emission control from ABGS systems, suggesting that an efficient carbon source composition management may greatly enhance the environmental sustainability of WWTPs.

Keywords: Algal-bacterial granular sludge; Carbon source; Nitrous oxide; Volatile fatty acid species

P-A-5 - Size-Dependent Nitrous Oxide Emissions from Algal-Bacterial Granular Sludge under Anaerobic and Aerobic Conditions

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Abstract: Nitrogen oxides, particularly nitrous oxide (N_2O), are potent greenhouse gases, and wastewater treatment plants are important emission sources. In algal-bacterial granular sludge (ABGS) systems, granule size influences mass transfer and internal microenvironments, potentially leading to differences in N_2O emission behavior. In this study, size-fractionated ABGS were used to evaluate N_2O emissions under conditions representing different nitrogen metabolisms and transformation phases. The anaerobic phase was created by sealing the reactor to assess net N_2O accumulation, while aerobic emissions were quantified by integrating the temporal variation of N_2O concentration in the off-gas to estimate cumulative release. During the anaerobic phase, N_2O dynamics were closely associated with nitrite concentration. For instance, in the reactor with 1.0-1.4 mm granules, nitrate was nearly depleted in about 60 min when nitrite concentration peaked (~ 9 mg/L), coinciding with the most rapid increase in the N_2O signal, which was followed by a gradual leveling-off as nitrite was further consumed. In contrast, in the reactor with larger granules (1.4-2.0 mm) more gradual nitrite accumulation with a smoother N_2O response was tracked, indicating a slower overall reaction progression, likely due to intragranular mass transfer limitation. These findings suggest that granule size may play an important role in shaping N_2O emission dynamics in ABGS systems, which also highlight the potential of granule size regulation as a strategy for mitigating N_2O emissions in ABGS systems.

Keywords: Algal-bacterial granular sludge; Granule size; Nitrous oxide; Wastewater treatment

P-A-6 - Advanced Stratified Biofilm Carriers for Anammox Processes: Design, Functionalization, and Microbial Synergies

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Abstract: The anaerobic ammonium oxidation (Anammox) process offers energy-efficient nitrogen removal for low C/N wastewater, yet large-scale application is hindered by slow bacterial growth, biomass detachment, and oxygen sensitivity. Recent advances suggest that functionalized biofilm carriers can mitigate these issues by creating favorable microenvironments. Specifically, polyurethane (PU) sponges provide ideal three-dimensional architecture, and surface modifications such as iron for enhanced adhesion and zeolite for ammonium enrichment can further improve system performance. Additionally, encapsulation in hydrogel-based polymeric materials, such as PVA-SA, can

protect microorganisms from dissolved oxygen (DO) and accelerate start-up. Despite these individual breakthroughs, the integrated application of these technologies to construct a structured micro-ecosystem remains insufficiently explored. Recent research findings indicate that integrating Fe-zeolite-modified PU carriers with PVA-SA microencapsulation can facilitate the construction of a stratified algal-bacterial symbiotic system. Recent studies further suggest that a two-stage transition from mixotrophic to autotrophic conditions, facilitated by transient organic carbon supply, can rapidly establish a protective microalgal layer, thereby suppressing heterotrophic overgrowth while regulating dissolved oxygen (DO). Consequently, future research should focus on coupling interfacial material modifications with dynamic operational control strategies. The integration of functionalized carriers and stratified ecological structures represents a promising approach to overcoming current bottlenecks, enabling stable nitrogen removal in low C/N wastewater while facilitating value-added biomass recovery.

Keywords: Anammox; Algae-bacterial symbiosis; Composite biocarrier; Stratified micro-ecology; Low-carbon wastewater treatment

P-A-7 - Rapid Functionalization of Granular Sludge via Granulation of Broken Aerobic Granular Sludge with Microalgae Suspension

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Abstract: The synergistic interactions of microalgae and bacteria in algal-bacterial granular sludge (ABGS) can maximize the functions of both microorganisms in wastewater treatment when taking climate resilience, resource recovery and sustainable development into consideration. Still, the long startup and performance stability of ABGS are challenging its practical application. This study employed intact bacterial aerobic granular sludge (BAGS), mixture of crushed BAGS, and the separate solid and liquid fractions from crushed BAGS as seeds to produce granules from Chlorella sorokiniana suspension. The effects of above different seeds on ABGS formation were investigated, aiming to achieve rapid granulation and better functionality of the formed ABGS. Results show that granulation can be achieved within 24 h when the mixture of crushed BAGS and the solid and liquid fractions of crushed BAGS were applied as the seeds. Granules with diameters of 0.5-2 mm were observed, exhibiting excellent settleability, whereas aggregates with diameters of only 0.05-0.5 mm appeared in the control group (no seed). After 24-h operation, the harvesting efficiencies in 30 min increased between 50% ~ 80%, in which the system with liquid fraction of crushed BAGS achieved the highest. In addition, the systems seeded with crushed BAGS and the solid fraction of crushed BAGS removed >80% chemical oxygen demand (COD) and >70% total nitrogen (TN) in 24

hours when treating wastewater containing 500 mg/L COD and 80 mg/L NH_4^+-N. In contrast, only 20% TN removal was detected in the control group. These results suggest that soluble extracellular polymeric substances (S-EPS) from BAGS may play an important role in the early granulation of microalgae; however, the resultant granules exhibited poor structural stability and required continuous hydraulic shear conditions to maintain their integrity. The increase in total EPS may be associated with the more stable algal-bacterial granules during the later operation period. The findings from this study may provide a novel approach for rapid startup of ABGS system by using crushed BAGS, which can rapidly functionalize the granular sludge and promote the large-scale engineering application of ABGS in wastewater treatment.

Keywords: Algal-bacterial granular sludge; Functionality; Rapid granulation; Wastewater treatment

P-A-8 - Impact of Intermittent Aeration on Nitrogen and Phosphorus Removal in Algal-Bacterial Granular Sludge

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Abstract: This study investigated and compared nutrients removal of three different sourced algal-bacterial granular sludge (ABGS) under continuous and intermittent aeration strategies. Batch tests were conducted using ABGS from sequencing batch reactor (SBR) systems with different operational histories. R1 used ABGS cultivated at an air uplift velocity (AUV) of 0.5 cm/s and was tested under continuous aeration. R2 and R3 used ABGS cultivated at 0.15 cm/s, with R2 operated under continuous aeration while R3 under intermittent aeration (30-min on/off). Results showed that ABGS cultivated at 0.15 cm/s exhibited significantly lower extracellular polymeric substances (EPS) and pigment contents but a higher proteins/polysaccharides ratio when compared to ABGS cultivated at 0.5 cm/s, indicating structural adaptation to lower shear stress. R1 achieved complete nitrification, whereas R2 exhibited incomplete nitrification, likely due to lower nitrite-oxidizing bacteria (NOB) activity under a low AUV. Notably, R3 demonstrated partial nitrification with the highest total inorganic nitrogen (TIN) removal efficiency (68.2%), significantly outperforming R1 (19.7%) and R2 (36.2%). R3 also showed a substantially higher phosphate release (9.2 mg/L) during the initial phase compared to R1 and R2, suggesting the alternating anaerobic and aerobic condition may stimulate phosphorus-accumulating organisms (PAOs). Overall, intermittent aeration enhanced nutrient removal, highlighting its potential as an energy-efficient strategy for ABGS-based wastewater treatment.

Keywords: Aeration strategy; Algal-bacterial granular sludge; Air uplift velocity; Intermittent aeration; Nitrification

P-A-9 - Effects of Salinity on Freshwater Algal-Bacterial Granular Sludge: Ion-Specific Stress

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Abstract: The treatment of saline municipal wastewater is increasingly critical due to seawater intrusion, saline flushing, and industrial discharges. Algal-bacterial granular sludge (ABGS) offers a sustainable and energy-efficient strategy for nutrient removal; however, the ion-specific mechanisms governing its performance remain insufficiently understood. In this study, the effects of short-term salinity shock and long-term ion-specific stress (sea salt, NaCl, KCl and Na_2SO_4) on ABGS were systematically investigated. Short-term exposure significantly inhibited ammonia and nitrite oxidation, with IC_{50} values of 1.55-1.69% for specific ammonia uptake rate and 1.11-1.22% for specific nitrite uptake rate. The inhibition kinetics were well described by a modified Hill model, indicating non-competitive suppression. Under prolonged salinity stress (0.5%), nitrogen and phosphorus removal exhibited divergence among different salts, confirming strong ion-specific effects. In contrast, removal of organics indicated by chemical oxygen demand remained consistently high (> 90%) across all conditions. In addition, the distinct granule morphologies developed under different ionic pressures were associated with the shifts in microbial aggregation and extracellular polymeric substance dynamics. Collectively, these findings elucidate ion-specific salinity effects on ABGS and support its resilient application in saline wastewater treatment.

Keywords: Algal-bacterial granular sludge; Ionic stress; Nutrient removal; Salinity; Sludge characteristics

P-A-10 - Evaluation of a 10 L-Scale High-Solid Fermentation System for High-Efficiency Biogas Production from Cattle Manure and Lignocellulosic Waste

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Abstract: This study evaluates the performance of a 10 L pilot-scale biogas production system at the Oriental Shiraishi Corporation R & D Center. The biogas production system consists of a two-phase high-solid fermentation system equipped with biogas and liquid recirculation and operates under high solid conditions. The biogas production rates and methane concentrations were monitored and compared with a conventional wet fermentation system using cattle manure and pruning waste as the substrate. The total solid contents were adjusted to 17% for the high-solid system and 5% for the wet system. Results indicated that while biogas production per volatile solids (VS) was comparable, 251 L/kg-VS in the high-solid system and 242 L/kg-VS in the wet system, the high-solid system demonstrated a significant advantage in methane yield. Specifically, 179.3 L/kg-VS of methane yield was achieved, surpassing the wet system by approximately 30%. Furthermore, in terms of volumetric efficiency, the high-solid system produced 27.48 L/L of biogas and 20.29 L/L of methane, representing increases of 140% and 216%, respectively, over the wet system. These findings confirm that the proposed high-solid fermentation system offers superior waste processing capacity and more efficient methane recovery within the same fermentation volume.

Keywords: Anaerobic digestion; Biogas and liquid recirculation; Livestock waste; Volumetric efficiency

P-A-11 - Feasibility and Challenges of Microalgae-Based Technologies for Microplastic Removal from Wastewater

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Abstract: Microplastics have become an emergent and major pollutant in the global aquatic environment. Small plastic particles less than 5 millimeters are widespread in rivers, lakes, oceans, and wastewater systems due to increased plastic production and improper waste management. The problem is especially critical in developing countries because of limitations in measurement capabilities and detection technologies, resulting in restricted assessment and management of microplastic pollution. Wastewater systems are a major pathway for microplastic discharge into aquatic environments, as traditional wastewater treatment processes cannot completely remove small plastic particles. In recent years, microalgae-based technologies have gained increasing attention as an environmentally friendly and sustainable method for removing microplastics from wastewater. Microalgae can interact with microplastics through various mechanisms such as adsorption to cell surfaces, hetero aggregation between microalgae and plastic particles, in which the production of extracellular polymers may promote particle aggregation and sedimentation. However, the application of such technologies faces several challenges, including the impact of microplastics on microalgal growth, difficulties in biomass harvesting, and limitations to practical implementation. This review summarizes current knowledge on microplastic occurrences in wastewater and evaluates the feasibility and challenges of applying microalgae-based technologies for microplastic removal.

Keywords: Microplastics; Microalgae; Wastewater treatment; Emerging pollutants; Developing countries

P-A-12 - Magnetic Co-N-C Catalyst for Ultrafast Non-Radical Activation of Peroxymonosulfate toward Efficient Antibiotic Wastewater Treatment

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Abstract: Antibiotic contamination in water bodies poses a serious threat to ecological safety and public health. In this work, we developed a magnetic Co-N-C catalyst via one-pot pyrolysis of ZIF-67, which enables ultrafast degradation of the antibiotic metronidazole (MNZ) through peroxymonosulfate (PMS) activation. The Co-N-C/PMS system achieves 94% removal of 20 mg/L MNZ within only 3 minutes under ambient conditions. Notably, the catalyst exhibits high selectivity toward PMS over peroxydisulfate (PDS), strongly indicating a non-radical dominant pathway (singlet oxygen or direct electron transfer), rather than conventional free-radical mechanisms. Furthermore, the catalyst possesses strong magnetic responsiveness, allowing convenient separation and recovery using an external magnet, which minimizes secondary pollution and enhances reusability. This work provides a simple, efficient, and recoverable catalyst system for the rapid treatment of antibiotic-contaminated wastewater, offering new insights into the design of magnetic non-radical catalysts for selective PMS activation.

Keywords: Co-N-C, Peroxymonosulfate, Metronidazole, Non-radical pathway, Magnetic recovery

P-A-13 - Differential EPS Production of Filamentous Prokaryotic and Eukaryotic Algae under Temperature and Ammonium Stress

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Abstract: Extracellular polymeric substances (EPS) play a central role in the formation and stability of algal biofilms and algal-bacterial systems in wastewater treatment. In this study, a filamentous cyanobacterium, *Leptolyngbya* sp., and a filamentous green alga, *Stigeoclonium* sp., were compared under different temperatures (25, 30, and 35 °C) and ammonium concentrations (0, 50, and 100 mg NH_4^+-N/L) to investigate EPS production and fractionation. Soluble EPS (SEPS), loosely bound EPS (LBEPS), and tightly bound EPS (TBEPS) were analyzed together with carbohydrates and protein contents. Structural and compositional characteristics were further examined by 3D-EEM, FTIR, and confocal laser scanning microscopy. Preliminary results suggest that both algal species showed distinct EPS fractionation patterns in response to temperature and ammonium conditions, reflecting species-specific strategies for extracellular matrix formation. Under nitrogen-deficient conditions, both species still maintained considerable EPS production, accompanied by faster organic carbon consumption, suggesting stress-induced carbon reallocation and possible heterotrophic contribution. These findings provide new insight into how filamentous prokaryotic and eukaryotic algae regulate EPS formation under wastewater-relevant conditions.

Keywords: Extracellular polymeric substances (EPS); *Leptolyngbya* sp.; *Stigeoclonium* sp.; Temperature; Ammonium nitrogen

P-A-14 - Role of the Extracellular Polymeric Matrix in the Size-Dependent Mechanical Strength of Aerobic Granular Sludge under Aeration Stress

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Abstract: Maintaining the structural integrity of aerobic granular sludge (AGS) under varying hydrodynamic shear forces remains a critical challenge. This study systematically investigated the size-dependent mechanical strength of AGS and the role of the extracellular polymeric matrix. Three parallel sequencing batch reactors (SBRs) were operated under superficial gas velocities of 1.2, 1.6, and 2.0 cm/s. With increasing aeration intensity, the total protein (PN) content in bulk sludge decreased from approximately 230 to 160 mg/g VSS, whereas polysaccharide-related components increased markedly. In the dominant 1-2 mm size fraction, the concentrations of alginate-like exopolysaccharides (ALE) and polysaccharides (PS) increased to approximately 100 and 110 mg/g VSS, respectively. Correspondingly, the specific compressive strength of

this fraction increased from 0.79 MPa at 1.2 cm/s to 4.06 MPa at 2.0 cm/s. These results indicate that elevated aeration stress induced a size-dependent restructuring of the extracellular polymeric matrix, in which ALE- and PS-enriched matrices contributed substantially to the enhanced mechanical strength of granules under high-shear conditions.

Keywords: Aerobic granular sludge; Aeration stress; Mechanical strength; Extracellular polymeric matrix

P-A-15 - Seasonal Stability of Bacterial and Algal-Bacterial Granular Sludge under Summer-Winter-Summer Disturbances

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Abstract: Seasonal variations in temperature and wastewater characteristics significantly affect the stability of biological treatment systems. This study evaluated the performance and resilience of bacterial aerobic granular sludge (BAGS) and algal-bacterial granular sludge (ABGS) under a controlled summer-winter-summer disturbance cycle. Results showed that winter conditions significantly deteriorated nutrient removal in both systems. Phosphorus removal in BAGS remained below 30% throughout the winter phase, whereas ABGS gradually recovered and reached a level comparable to summer conditions by day 20. For ammonia removal, ABGS was only slightly affected, showing an approximate 10% decrease followed by rapid recovery, while BAGS experienced a more pronounced decline of 30-40%. In addition, nitrite accumulation was observed during winter, indicating a temporary imbalance in nitrification. Despite these variations, both systems consistently achieved high chemical oxygen demand (COD) removal efficiency (> 95%). Overall, ABGS demonstrated superior resistance to seasonal disturbances and better operational stability than BAGS. These findings highlight the potential of ABGS systems for enhancing wastewater treatment robustness under fluctuating environmental conditions.

Keywords: Algal-bacterial granular sludge; Bacterial aerobic granular sludge; Seasonal disturbance; System stability

P-A-16 - Unveiling the Enhanced Performance and Fouling Mitigation in an Algal-Bacterial Granular Sludge-Membrane Bioreactor for Liquor Wastewater Treatment

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Abstract: Liquor wastewater contains high concentrations of organic matter, ammonium, and refractory aromatic compounds, while its imbalanced carbon-to-nitrogen (C/N) ratio further complicates biological treatment. In this study, an algal-bacterial granular sludge membrane bioreactor (ABGS-MBR) was applied for liquor wastewater treatment and compared with a conventional activated sludge membrane bioreactor (AS-MBR) under C/N ratios of 10, 8, and 4. Reactor performance, sludge characteristics, membrane fouling, and microbial responses were systematically investigated. ABGS-MBR consistently outperformed AS-MBR, with the best performance observed at C/N = 8. Under this condition, ABGS-MBR achieved higher removal efficiencies of COD (93.1%), p-cresol (82.1%), NH_4^+-N (78.6%), TN (65.7%), and PO_4^{3-}-P (70.0%). It also exhibited better sludge settleability, higher biomass and chlorophyll-a contents, and stronger microbial activity. In addition, ABGS-MBR showed superior fouling control, with lower transmembrane pressure, reduced filtration resistance, and a looser, more porous membrane-associated EPS structure. Microbial and metagenomic analyses further revealed enhanced enrichment of aromatic compound-degrading taxa and higher abundances of genes related to carbon, nitrogen, and phosphorus metabolism. Overall, C/N = 8 was identified as the optimal condition for ABGS-MBR, highlighting its strong potential for efficient treatment of refractory liquor wastewater.

Keywords: Algal-bacterial granular sludge; C/N ratio; Extracellular polymeric substances; Liquor wastewater; Membrane fouling

Theme II: Bioenergy and Resource Recovery

P-B-1 - High Resolution Analysis of Phosphorus Speciation and Functionality of Algal-Bacterial Granular Sludge

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Abstract: This study employed confocal microscope, microsensors, and nuclear magnetic resonance (NMR) to investigate three different algal-bacterial granular sludge (ABGS) systems dominated by organic nitrogen hydrolysis (ON), nitrification (NI), and denitrification (DN), respectively, with the aim of elucidating its composition, phosphorus (P) speciation and spatial distribution, and coupled N-P removal performance. Approximately 44% and 66% P were stored within extracellular polymeric substances (EPS) in $ABGS_{ON}$ and $ABGS_{NI}$, respectively, whereas 95% of P in $ABGS_{DN}$ was retained in the residual fraction. Both NMR and confocal imaging confirmed pronounced hydroxyapatite precipitation in the core of $ABGS_{DN}$, and its orthophosphate fraction reached 88%, indicating that P removal in the DN-dominated ABGS system did not follow the enhanced biological phosphorus removal pathway. The highest P removal rate (1.51 mg P for per gram of suspended solids (SS) per hour) was detected in the NI-dominated ABGS system, while the DN-dominated ABGS system exhibited the strongest denitrification activity (11.80 mg N for per gram of volatile suspended solids (VSS) per hour). In summary, this study demonstrates that nitrogen transformation pathways strongly influence P structure and removal behavior in ABGS systems, which can provide insights for process optimization and engineering applications in the future.

Keywords: Algal-bacterial granular sludge; Hydroxyapatite; Nitrogen conversion pathways; Orthophosphate; Phosphorus fractionation

Theme III: Biomass Reclamation and Recycling

P-C-1 - Scalable and Green Synthesis of MOF/Carbon Composites from Agricultural Waste for CO_2/CH_4 and CO_2/N_2 Separation

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Abstract: The separation of CO_2 from industrial flue gas and biogas is critical for mitigating greenhouse gas emissions and enabling sustainable energy utilization. In this context, cost-effective and environmentally friendly adsorbents are urgently needed. Activated carbon (AC), derived from renewable precursors such as agricultural waste, offering a sustainable alternative. Herein, straw-derived AC is employed as a bio-based support for the in-situ synthesis of Al-CDC, a low-cost MOF prepared under mild conditions using inexpensive reagents in a recyclable system, demonstrating high potential for scalable and green production. The resulting Al-CDC/AC composite integrates the advantageous porosity of both components, enhancing CO_2 adsorption selectivity. Comprehensive characterization (PXRD, BET, FT-IR, SEM, TEM, TGA) confirms structural integrity, while gas adsorption isotherms for CO_2, CH_4, and N_2 reveal improved performance. Ideal Adsorbed Solution Theory (IAST) analysis shows significantly enhanced CO_2/CH_4 and CO_2/N_2 selectivities compared to the individual components. This work highlights a sustainable route to high-performance MOF-composite adsorbents, with promising applications in CO_2 separation technologies and

potential extension to mixed matrix membranes for global environmental challenges.

Keywords: Bio-based activated carbon; MOF/carbon composite; CO_2 capture; Sustainable synthesis; Gas separation

Theme V: Sustainable Management and Analysis

P-E-1 - Toward Agentic Intelligence: Foundations, Architectures, and Challenges of Autonomous AI Systems

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Abstract: Artificial intelligence agents are emerging as a new paradigm in which foundation models evolve from passive generators of content into goal-directed systems capable of perception, reasoning, planning, memory, tool use and social interaction. By coupling large-scale models with external environments, APIs, symbolic modules and human feedback, agents can iteratively decompose objectives, adapt to uncertainty and execute extended sequences of actions in pursuit of complex goals. This transition from static inference to dynamic agency marks a conceptual shift in artificial intelligence, with implications that extend from digital assistants and scientific discovery to robotics, healthcare and collective decision-making. Yet the growing autonomy of agents also exposes fundamental challenges, including unreliable long-horizon reasoning, error accumulation, weak interpretability, poor robustness under environmental shift and unresolved questions of alignment, accountability and governance. Here, we synthesize the emerging foundations of agentic intelligence, highlighting the architectural principles, learning mechanisms and coordination strategies that underlie autonomous behaviour. We further argue that the next stage of progress will depend not only on more capable models, but on unified frameworks that integrate cognition, action and safety into verifiable, adaptive and human-compatible systems. AI agents may therefore represent not merely an application layer of large models, but a foundational step towards scalable, interactive and societally embedded intelligence.

Keywords: Accountability; Agentic intelligence; Autonomy; Foundation models; Safety

Theme XII: Greenhouse Gases Emission/Mitigation and Carbon/Nitrogen Neutrality

P-L-1 - Carbon Footprint Accounting and Analysis in the Operation Stage of Multi-Campus Universities: A Case Study of University A in Beijing

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Abstract: Against the backdrop of the "dual carbon" strategy, the low-carbon transformation of universities holds exemplary significance. This study takes the "one university with six campuses" system of University A in Beijing as the research object. Based on the measured energy data from 2011 to 2024, through carbon footprint accounting, LMDI driving force analysis, and STIRPAT scenario simulation, it reveals the carbon emission patterns and governance paths of multi-campus universities. The study finds that the total carbon emissions of University A show a trend of "growth-fluctuation-decline". The proportion of emissions from purchased electricity and heat exceeds 90%, and there are significant spatial heterogeneities among different campuses. Energy intensity suppresses carbon emissions, while population growth and building expansion are the key driving factors. The scenario simulation shows that carbon emissions will continue to grow under the baseline scenario. Under the LC scenario, carbon emissions are expected to peak in 2028. Under the ELC scenario, in-depth decarbonization can be achieved through smart energy and management structural optimization. The study suggests that multi-campus universities adopt differentiated emission reduction measures: old campuses should focus on improving energy-side efficiency, while new campuses should prioritize energy structure optimization.

Keywords: Multi-campus carbon footprint; LMDI decomposition; Carbon peak; STIRPAT model

P-L-2 - Crop-Soil-Environment Benefits of Equivalent Carbon Input from Organic Amendments in Rice Production Ecosystems

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Abstract: Achieving carbon neutrality in rice cultivation depends on selecting organic amendments that improve productivity and soil health while reducing greenhouse gas (GHG) emissions. To compare their effects under the same conditions, rice straw, fermented pig manure, and biochar were each applied at 1,200 kg C ha^{-1} in a paddy field. We measured GHG fluxes, soil physicochemical properties, microbial diversity, a comprehensive soil health index (SHI), and rice agronomic traits. Biochar performed best overall. It significantly reduced cumulative CH_4 and N_2O emissions, lowering global warming potential (GWP) by 29.9% relative to the control. It also produced the largest SHI increase (+10.14), mainly through improvements in soil organic carbon, dissolved organic carbon, and nutrient availability. In contrast, manure increased CH_4 emissions by 53.9% and GWP by 41.0%, although it markedly enhanced rice yield (+155.7%). Straw caused no significant net change in GWP. While biochar and straw had limited short-term effects on yield, both improved key agronomic traits. Overall, biochar offers the most balanced strategy for sustainable rice production by simultaneously mitigating GHG emissions and improving soil health, making it a promising amendment for advancing carbon-neutral rice cultivation.

Keywords: Rice agroecosystem; Carbon footprint; Manure; Biochar; Straw

Theme XIII: Microalgal-Bacterial Consortium and its Advancements

P-M-1 - Algal-Mediated miR-7 Suppression via STTM Technology for Sustainable Aedes aegypti Population Control

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Abstract: The strong reproductive plasticity of Aedes aegypti, a primary vector for dengue, Zika, and chikungunya viruses, exacerbates the transmission of mosquito-borne pathogens, imposing a severe global public health burden. Our published research has confirmed that microRNA-7 (miR-7) knockdown suppresses reproduction in female A. aegypti. Chlamydomonas reinhardtii, a critical food source for A. aegypti larvae, also serves as a stable expression vector for short tandem target mimic (STTM) technology, a tool for miRNA inhibition. To develop potential vector control strategies, we aimed to generate a stable C. reinhardtii strain capable of inhibiting A. aegypti miR-7 by transforming it with an STTM vector containing a miR-7 inhibitory sequence. Existing results indicate that this exogenous miR-7 inhibition promotes excessive gamma-aminobutyric acid (GABA) secretion from the midgut, thereby disrupting energy transfer homeostasis in A. aegypti and consequently impairing reproductive capacity (fewer eggs laid). Ecological risk assessment demonstrated that this miR-7 inhibitory sequence exhibits high specificity, with no significant targets identified in several common algae-feeding aquatic organisms, including rotifers and cladocerans. In conclusion, our study provides an environmentally friendly strategy for the population control of A. aegypti,

offering a targeted approach to mitigate its reproductive plasticity and associated disease transmission risks.

Keywords: Aedes aegypti; Chlamydomonas reinhardtii; Environmentally friendly; MiR-7; Vector control

P-M-2 - Phosphorus Accumulation and System Performance Recoverability of Algal-Bacterial Granular Sludge after Experiencing Low-Light Stress

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Abstract: As a novel biogranulation technology, algal-bacterial granular sludge (ABGS) enables energy savings and emission reduction of greenhouse gases in wastewater treatment. Light condition plays a key role in ABGS performance and microbial community, and insufficient illumination poses significant challenges to its practical application. The objective of this study was to evaluate the stability and recoverability of ABGS systems under low-light conditions, focusing on phosphorus (P) accumulation. To achieve this, a defined period of low-light exposure was applied to simulate natural overcast and rainy conditions, followed by a 30-day recovery phase under four different scenarios: Scenario I (control, natural sunlight), Scenario II (increased light intensity), Scenario III (extended photoperiod), and Scenario IV (increased aeration intensity). During the low-light period, P removal efficiency declined markedly from 89% to 33%, and the mixed liquor suspended solids (MLSS) concentration and chlorophyll a content decreased by approximately 28% and 59%, respectively. However, at the end of the recovery phase, Scenarios II and III demonstrated improved chlorophyll content and P removal/accumulation performance exceeding their levels during the low-light periods. These findings suggest that strategies such as increasing light intensity and/or prolonging illumination duration can effectively restore and enhance ABGS performance after experiencing the low-light stress. Results from this study will provide in-depth insight into instable ABGS properties in addition to a better design and operation of ABGS systems serving for practical application.

Keywords: Algal-bacterial granular sludge; Low light illumination; Nutrient removal; Phosphorus accumulation; System recovery

P-M-3 - Low-Intensity Intermittent Artificial Aeration Sustains Granular Stability with Efficient Nitrogen Removal in Continuous-Flow Algal-Bacterial Granular Sludge-Based Recirculating Aquaculture System

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Abstract: Algal-bacterial granular sludge (ABGS) has been proposed as a promising alternative to conventional biofilters in recirculating aquaculture systems (RAS). However, practical application of continuous-flow ABGS in RAS remains hindered due to the inherent granule instability under weak hydraulic shear and insufficient nitrification capacity with only microalgal photooxygenation and natural oxygenation from ambient air. In this study, two continuous-flow ABGS-based RAS were operated under different aeration regimes, i.e., RC (control) with no additional artificial aeration and RA with 2-h non-artificial aeration (AA) followed by 4-h low-intensity AA at 0.006 cm/s, to evaluate the effects of low-intensity intermittent AA on system performance. After 28 days' operation, RA exhibited markedly higher granule stability (with integrity coefficient of 3.0% versus 10.3% in RC), which maintained daily NH_4^+-N removal rates of 27-42 mg-N/d for per gram of volatile suspended solids (VSS), whereas RC showed pronounced performance fluctuations (14-36 mg-N/g-VSS/d) with NH_4^+-N concentration accumulated up to 9.87 mg/L, exceeding the safe threshold for aquatic organisms. This functional improvement was further supported by a substantially higher specific ammonium oxidation rate in RA (averagely 1.1 versus 0.2 mg-N/g-VSS/h in RC). Overall, results from this study show that low-intensity intermittent AA can effectively sustain granule stability with efficient nitrogen removal in continuous-flow ABGS-based RAS, providing a viable solution for sustainable aquaculture industry.

Keywords: Algal-bacterial granular sludge; Aquaculture wastewater; Continuous-flow reactor; Recirculating aquaculture system; Sustainable development

Theme XV: Other Related Topics

P-O-1 - Application of Dark Septate Endophytes for Improving Heat Stress Tolerance in Plant Cultivation

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Abstract: High-temperature stress during summer cultivation substantially reduces lettuce productivity, often causing yield losses exceeding 40%. Dark septate endophytes (DSE), beneficial root-associated fungi, have emerged as promising microbial agents for enhancing plant stress tolerance. This study evaluated the effectiveness of two DSE strains, *Veronaeopsis* sp. (Vs) and *Cadophora* sp. (Cc), inoculated at sowing for improving lettuce heat tolerance. Lettuce seedlings were inoculated during germination and cultivated under either normal (25 °C/18 °C day/night) or heat-stress (35 °C/22-24 °C day/night) conditions. Plant growth was assessed based on shoot fresh weight after transplantation into substrate. Heat stress reduced shoot fresh weight by 42% in untreated controls. DSE inoculation alleviated heat-induced growth inhibition in a strain-dependent manner. The Vs strain showed the strongest protective effect, limiting growth reduction to 15.0%, corresponding to 63.0% mitigation of heat-induced damage. The Cc strain provided a moderate effect, with 10.0% mitigation compared to the untreated control. DSE-treated plants also exhibited improved recovery after re-irrigation following stress exposure. These results demonstrate that DSE inoculation at sowing, particularly with *Veronaeopsis* sp., is a practical strategy for enhancing lettuce heat tolerance and stabilizing production under elevated temperature conditions.

Keywords: Dark septate endophytes; Heat tolerance; Lettuce production; Summer cultivation

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