The 18th IWA Leading Edge Conference on Water and Wastewater Technologies

the international water association

Achieving Sustainability Through Water Technology

Conference Programme

29 MAY — 2 JUNE 2023
DAEGU | SOUTH KOREA
www.iwa-let.org | # iwaLET

Organisers

the international water association

KOREA WATER PARTNERSHIP

Host City

DAEGU 대구광역시 DAEGU METROPOLITAN CITY

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The Korea Environment Corporation (K-eco) is a quasi-governmental organisation, under the Ministry of Environment of the Republic of Korea, which is responsible for running the Korea Water Cluster. Our dedicated team of 3,326 employees leads the way in promoting environmental pollution prevention, resource circulation, and greenhouse gas reduction projects.

Based in Incheon Metropolitan City, our headquarters, along with eight branches, two regional offices, and the Korea Water Cluster in Daegu Metropolitan City, enable us to execute national environmental policies across various fields.

We prioritise creating clean and safe water environments through the establishment of water management plans, support for wastewater treatment facilities, operation of river and pollutant monitoring networks, restoration of aquatic ecosystems, and environmental impact assessments. Additionally, we take charge of chemical substance safety management, hazardous substance inspection and analysis, and greenhouse gas emission reduction projects. K-eco's efforts contribute to the well-being of our communities and foster eco-friendly national development. Join us in building a sustainable future for all, as we work towards a cleaner, greener planet.

www.keco.or.kr

Silver Sponsor

KWWA
KOREA WATER AND WASTEWATER WORKS ASSOCIATION

Korea Water and Wastewater Works Association (KWWA) has been leading the development of water and wastewater systems by working together with the government, local governments, industry, and academia. We have been supporting both the national and local governments so that people can drink safe tap water, leading the advancement of water and wastewater. Moreover, we have exerted continuous efforts to build public trust in tap water, conducted researches, and prepare alternatives to pending issues affecting the government and water companies. KWWA will fulfill its social responsibilities by actively implementing Korea's "Green New Deal" and "Carbon Neutral" in the future.

www.kwwa.or.kr

Welcome Reception Sponsor

RAMBØLL

Ramboll is a global architecture, engineering and consultancy company founded in Denmark in 1945. Our 16,500 experts create sustainable solutions across Buildings, Transport, Energy, Environment & Health, Management Consulting, Architecture & Landscape and Water, where we have three global divisions within climate adaptation, water resources management and water & wastewater treatment. Across the world, Ramboll combines local experience with a global knowledge base to create sustainable cities and societies. We combine insights with the power to drive positive change for our clients, in the form of ideas that can be realised and implemented. We call it: Bright ideas. Sustainable change.

www.ramboll.com

Organisers

IWA the international water association

KOREA WATER PARTNERSHIP

Partners

Korea Environment Corporation

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KOREAN SOCIETY ON WATER ENVIRONMENT

KSWW Korean Society of Water & Wastewater

K water

KWWA KOREA WATER AND WASTEWATER WORKS ASSOCIATION

Host City

DAEGU | 대구광역시 DAEGU METROPOLITAN CITY

Daegu is a city which is strongly committed to improving its approach to water management. Since a pollution incident in the early 1990s, the city of Daegu has taken bold steps to improve how it deals with its water resources. Thanks to technological advancements and citizen engagement, the city has been able to greatly improve water quality, and the Sincheon stream flowing through eastern Daegu has achieved excellent water quality results.

In 2019, the city government successfully completed construction of the Korea Water Cluster (KWC), Korea's first landmark project dedicated to the water industry. This also included the establishment of the Korea Institute for Water Technology Certification (KIWATEC), a one-stop facility providing support for water companies on R&D, certification & verification, international trade, and more.

www.daegu.go.kr/english/index.do

Supporting Organisation

KOREA TOURISM ORGANIZATION

Official Magazine

the Source

The Source is the quarterly official magazine of the International Water Association, received by all members of this influential water sector organisation around the world. Offering practical intelligence for the water professional, The Source contains feature stories, in-depth articles, industry case studies, and profiles of industry leaders, with a focus on the strategic issues facing the sector.

www.thesourcemagazine.org

Media Partner

GWI GLOBAL WATER INTELLIGENCE

Contents

Welcome to Daegu

& The IWA Leading Edge Conference on Water and Wastewater Technologies 2023, from the IWA President

Dear colleagues and friends,

It is my great pleasure to extend a warm welcome to IWA's 18th Leading Edge Conference on Water and Wastewater Technologies, where we will be focusing on the latest developments in water and wastewater treatment. This event provides a unique global platform for water sector professionals like you to explore the latest innovative ideas, share your expertise, and connect with fellow industry leaders.

The needs and challenges around water are great. Solutions have numerous dimensions, spanning aspects such as regulation, finance, and human capacity. Technology has a vital part to play, and this conference aims to provide access to insights at the forefront of technological development. The goal is to inspire and ignite transformative solutions that can create a sustainable and resilient future for our world.

This edition of the conference features trending themes that highlight the magnitude of the opportunities for improvement and innovation in the water sector. These span process innovation and sustainability for clean water production, including desalination and industrial use, through to climate-smart and circular economy approaches for treatment of used water.

On behalf of IWA, I would like to express sincere gratitude to our organising partner, the Korea Water Partnership, and all the partner organisations in Korea that it represents, to the LET 2023 organising and programme committees, and to our supporting partners and sponsors. Thank you for your work and support in making this event possible.

As water sector professionals, we understand the importance of exploring and sharing innovative ideas. This conference provides the perfect platform to do so. On behalf of IWA, we look forward to your participation and hope you find opportunities to collaborate and create a better water future. I wish you all a fruitful time during your stay in Daegu.

Tom Mollenkopf, *IWA President*

from the Chair of the Organising Committee

I am delighted to welcome you all to the 18th IWA Leading Edge Conference on Water and Wastewater Technologies (IWA LET 2023). Our country is a technological and innovation hotspot, making it a great setting for this important event, and we are particularly pleased to be able to hold the event here in Daegu.

We are honoured to have been selected as the host location for this conference, which provides a unique opportunity for water professionals from around the world to meet, exchange ideas, and learn about the most recent technological advancements and innovations in water and wastewater management.

We are aware that water is one of the most valuable resources on the planet, and that managing it effectively and efficiently is more important than ever. At IWA LET 2023, we hope to provide a forum for water professionals to discuss the challenges facing the water sector and share latest thinking on new solutions to these challenges.

The conference promises to provide insights into the most recent research and technology breakthroughs in water management, and we are thrilled to host some of the world's most renowned water specialists. We invite you to take advantage of this opportunity to network, share your experiences, and engage with peers from across the world.

Once again, on behalf of the Organising Committee, I extend a warm welcome to all of you, and we hope that you will have a fantastic time in Korea. Welcome to Daegu!

Seungkwan (SK) Hong *(Korea University, South Korea)*

Welcome

from the Programme Committee

Welcome to the 18th Leading Edge Conference on Water and Wastewater Technologies (LET 2023), on behalf of the Programme Committee. The conference's theme for this year is 'Achieving Sustainability Through Water Technology'. This is crucial in the modern world, not least because of the need to respond to climate change and deliver on Net-Zero goals.

This edition of the conference in Daegu, South Korea, promises to be a memorable occasion, especially as we are proud to celebrate 20 years of the LET series.

The conference, as always, aims to bring together innovative, cutting-edge solutions and novel technological developments from across the water industry. We have carefully curated sessions to foster cohesive and interesting discussions, featuring some of the industry's most influential water technology leaders. We hope to attract the same exciting and novel contributions that have helped to make the LET conferences such a high-level event over the last two decades.

Our goal is to provide a forum for the exchange of knowledge, ideas, and solutions that will advance the field of water technology and lead us to a more sustainable future. We are confident that the LET 2023 conference will be a stimulating and invigorating exchange of ideas, and we hope that you will take full advantage of the opportunity to network, collaborate, and learn from your peers in the industry.

As Chairs of the 18th Leading Edge Conference on Water and Wastewater Technologies, we look forward to hearing more about your innovative ideas and to a very memorable conference, here, in Daegu!

Thank you.

Jonathan Clement *(Ramboll, The Netherlands)*
Ana Soares *(Cranfield Water Science Institute, Cranfield University, United Kingdom)*

Programme Committee

CO-CHAIRS

Jonathan Clement *(Ramboll , The Netherlands)*
Ana Soares *(Cranfield Water Science Institute, Cranfield University, United Kingdom)*

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Organisers

The International Water Association (IWA) is a global network of water professionals, spanning the continuum between research and practice and covering all facets of the water cycle. Through IWA, members collaborate to promote the development and implementation of innovative and effective approaches to water management.

The strength of IWA lies in the professional and geographic diversity of its membership – a global mosaic of member communities, including academic researchers and research centres, utilities, consultants, regulators, industrial water users, and water equipment manufacturers. IWA members from each of these communities represent the leading edge in their fields of expertise; together they are building new frontiers in the research and implementation of water and wastewater treatment technologies within the framework of the total water cycle.

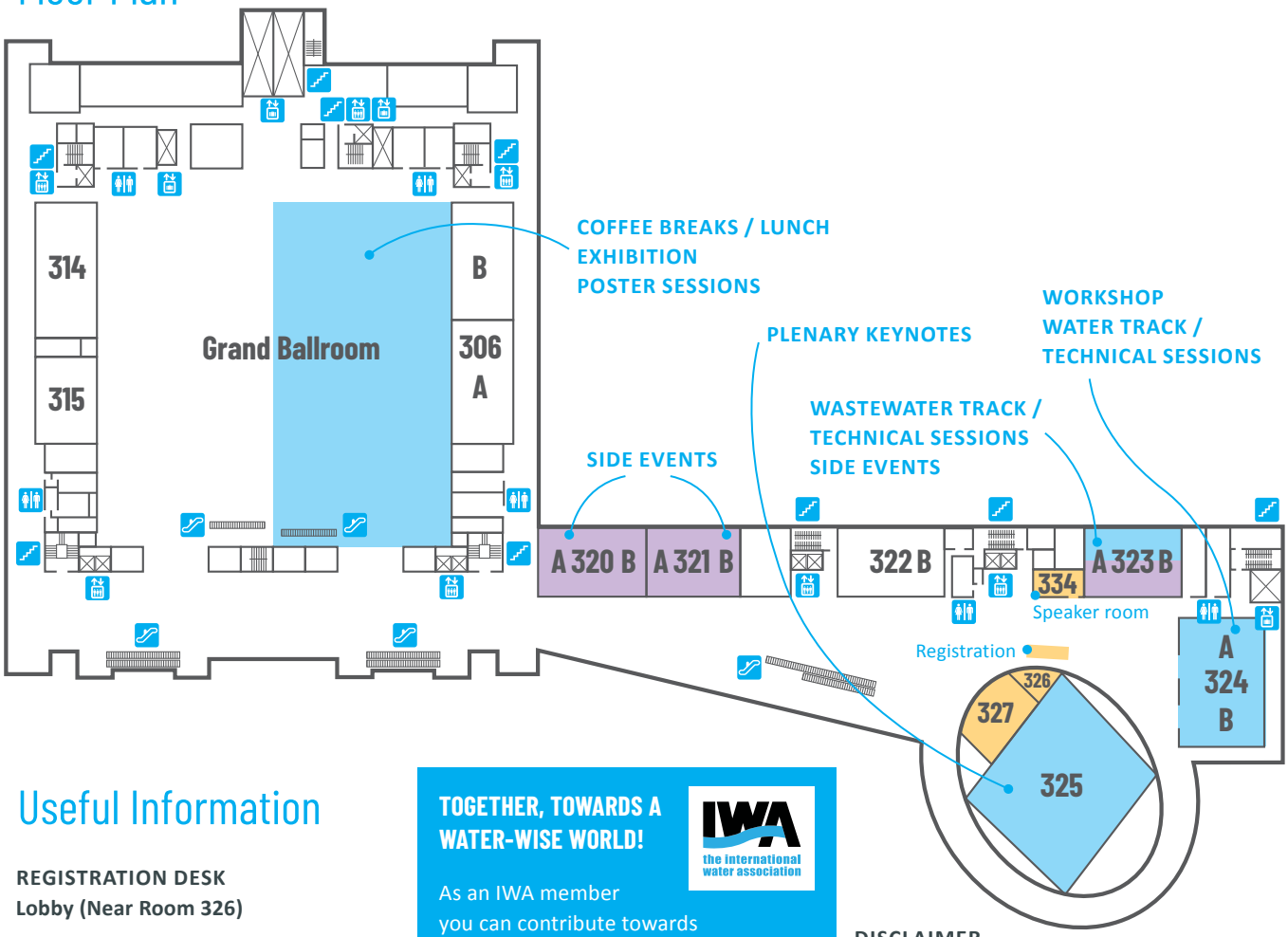
www.iwa-network.org

Korea Water Partnership (KWP) is a non-profit legal organisation that serves as a platform to connect experts and institutions in the water sector. KWP is making efforts to solve problems in the global water sector and share new technical information. The 'World Water Cluster Leaders Forum' is held every year to link the opinions of cluster leaders from each country. We create a Korean Pavilion at exhibitions to introduce advanced water technology and discuss business cooperation with overseas organisations. Through our activities, we have maintained a network with over 100 water companies and cooperation with domestic and foreign public institutions.

www.kwp.or.kr/en/

Practical Information

Floor Plan



Useful Information

REGISTRATION DESK
Lobby (Near Room 326)

The registration desk will be open from:

Monday 29.5 — 13:00 until 17:30
Tuesday 30.5 — 7:30 until 17:00
Wednesday 31.5 — 7:30 until 18:00
Thursday 1.6 — 8:00 until 18:00

DIGITAL PROCEEDINGS

You should have received the access information to the digital proceeding with an email. In case you haven't, please contact us at let@iwahq.org.

WI-FI

Wifi will be free at the venue (EXCO) without password but attendee needs to reconnect every 50 minutes.

To stay up to date with the latest updates please visit the programme page: www.iwa-let.org/programme-2023/

SOCIAL MEDIA

Planning to use social media while at the conference?
Join the conversation:

#iwaLET @IWAhq
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Programme Overview

	Monday 29 May	
13:00 — 17:30	**REGISTRATION OPEN**	
15:00 —17:30	**WORKSHOP** The Changing Landscape of Technology Development	
17:30 — 19:30	**WELCOME RECEPTION** *(Sponsored by Ramboll)*	
	Tuesday 30 May	
7:30 — 17:00	**REGISTRATION OPEN**	
09:30 — 12:15	**PLENARY KEYNOTES** Jonathan Clement, Jaehong Kim, Nikolay Voutchkov.	
12:15 — 13:15	**LUNCH BREAK**	
13:15 — 17:00	**PLENARY KEYNOTES** Miriam Otoo, Samuel Chui, Xiaodi Hao, Zhiyong Jason Ren.	
	Wednesday 31 May	
7:30 — 18:00	**REGISTRATION OPEN**	
9:00 — 12:45		**TECHNICAL SESSION 1** Monitoring and Reduction of Greenhouse Gas Emissions
12:45 — 14:00	**LUNCH BREAK**	
14:00 — 17:45	**TECHNICAL SESSION 2** Sustainability	**TECHNICAL SESSION 3** Energy Positive Wastewater Technologies
	Thursday 1 June	
8:00 — 18:00	**REGISTRATION OPEN**	
9:00 — 12:45	**TECHNICAL SESSION 4** Innovations in Desalination	**TECHNICAL SESSION 5** Emerging Innovative Wastewater Technologies
12:45 — 14:00	**LUNCH BREAK**	
14:00 — 17:45	**TECHNICAL SESSION 6** Emerging Innovative Water Technologies	**TECHNICAL SESSION 7** Sustainable Green Technologies
17:45 — 18:00	**CLOSING CEREMONY** *(Room 324)*	
19:00	**GALA DINNER** *(Grand Ballroom, BF, Hotel Inter-burgo EXCO)*	
	Friday 2 June	
9:30 — 13:00	**TECHNICAL TOUR** Korea Water Cluster Tour	
13:00 — 16:20	**CULTURAL TOUR** Donghwasa Temple / Palgongsan Cable Car	


WBC

Monday 29 May

LET 2023 | Afternoon | Workshop

Room 324

THE CHANGING LANDSCAPE OF TECHNOLOGY DEVELOPMENT

Organiser: **Jonathan Clement** *(Ramboll, The Netherlands)*

This workshop addresses how technology development and implementation is changing with new emphasis on sustainability, energy, and resource recovery.

15:00 - 15:10	Welcome & Introduction **Jonathan Clement** *(Ramboll, The Netherlands)*
15:10 - 17:30	**Panel Perspectives** — panellists will discuss perspectives on what in their opinion are the biggest problems and potential solutions. Ana Soares *(Cranfield University, United Kingdom)* Mark van Loosdrecht *(TU Delft, The Netherlands)* Morton Rebsdorf *(Aarhus Vand A|S, Denmark)* Shane Snyder *(NEWRI, Singapore)* Jiwon Park *(CAMBI, Korea)*

Hotel Inter-Burgo EXCO | Room: 2F

17:30 - 19:30	**WELCOME RECEPTION** *(Sponsored by Ramboll)* *The welcome reception will take place at 2F of the Hotel Inter-Burgo EXCO, (a 5 minutes' walking distance from the venue).*

Tuesday 30 May

LET 2023 | Plenary Keynotes

Room: 325	
7:30	**REGISTRATION OPENS** *(Lobby)*
9:00 - 9:30	**WELCOME ADDRESSES** *(Room 325)* **Seungkwan Hong,** *Organising Committee Chair* | **Ana Soares & Jonathan Clement,** *Programme Committee Co-chairs* **Tom Mollenkopf,** *IWA President* **Joon-pyo Hong,** *Mayor of Daegu* | **Seon Jai Baik,** *Executive Director of K-eco*
9:30 - 10:00	**LOOKING BACK AND CREATING A VISION FOR A BETTER FUTURE** **Jonathan Clement**, *Ramboll, The Netherlands*  Jonathan Clement currently is the Director of Global Advanced Water Treatment at Ramboll. Since 1997 he has focused on advanced water treatment technologies including ceramic membranes advanced oxidation, and ion exchange. Previously, Jonathan Clement was Chief Executive Officer of PWN Technologies a subsidiary of PWN, the innovative water supply company of North Holland. At PWNT he led the application of two of the largest ceramic membrane plants in the world. One includes a 180 mld integrated ozone ceramic plant in Singapore. His career has focused highly on examining alternative treatment schemes for water reuse and drinking water to improve energy efficiency and reliability. These include combined steps of ozone and ceramic membranes. Current R&D focus in on desalination pre-treatment and low energy desalination. He was the founder of the Leading Edge Technology (LET) Conference and chaired the conference for the first 6 years. He is past member of the IWA water reuse committee and is now chairing the technical program committee of the LET. In 2013 he received a special award for outstanding leadership from the IWA. He is a committee member of water treatment program of the Singapore Water International Water Work (SIWW). He has been listed as one of the top 25 global water leaders in the world. **ABSTRACT:** In the past 30 the water industry from a treatment technology has undergone some remarkable changes. From moving from conventional treatment that has been employed since the early 1900s to the domination of membranes in the mid 2000s. Water reuse was often considered a risky undertaking, now in most parts in the world it is approached with confidence. Desalination was considered a last resort, but now with growing population and water scarcity it is a critical necessity. Overlying all this are the new drivers mainly energy reduction and sustainability. All these treatment challenges have been met with barriers, slow development and adoption of new technologies, and large application failures. We, utility leaders, academicians, consultants, and technology providers must find a way to move things forward with higher speed and success. This presentation will take a critical look over the past 30 years and suggest a pathway forward.
10:00 - 10:15	**DISCUSSION**
10:15 - 10:45	**Morning Coffee Break** *(Grand ballroom A)*

Tuesday 30 May

LET 2023 | Plenary Keynotes

Room: 325

10:45 - 11:15

MEMBRANE-CONFINED HETEROGENEOUS ADVANCED OXIDATION

Jaehong Kim, *Yale, United States*

Jaehong Kim is Henry P. Becton Sr. Professor of Chemical and Environmental Engineering at Yale University where he served as a department chair from 2006 to 2012. Prior to joining Yale in 2013, he was Georgia Power Distinguished Professor at Georgia Institute of Technology. Kim received B.S. and M.S. degrees in Chemical Engineering from Seoul National University and a Ph.D. degree in Environmental Engineering from University of Illinois at Urbana-Champaign. His research focuses on environmental application of nanomaterials and single atom catalysts and catalytic / electrocatalytic advanced oxidation processes.

ABSTRACT: Heterogeneous advanced oxidation processes (AOPs) allow for the destruction of aqueous organic pollutants via oxidation by reactive oxygen species such as hydroxyl and sulfate radicals. However, practical treatment scenarios suffer from the low availability of short-lived radicals in aqueous bulk, due to both mass transfer limitations and quenching by water constituents such as natural organic matter (NOM) and carbonate. We have been exploring ways to overcome these challenges by loading various catalysts within the pores of a ceramic ultrafiltration membrane, resulting in an internal heterogeneous Fenton reaction that can efficiently degrade organics in complex water matrices. With radicals confined inside the nanopores below 20 nm, a critical length scale that exerts a nanoconfinement effect, these membrane reactors completely removed various organic pollutants through single-pass treatment, with water fluxes equivalent to a retention time of a few seconds. These membranes, with a pore size that excludes NOM, selectively exposed smaller organics to radicals within the pores under confinement and showed excellent resiliency to representative water matrices. Moreover, these membranes exhibited a sustained AOPs over long term operation and could be regenerated for multiple cycles due to oxidative removal of foulants on the membrane surface and pore walls. This talk summarises a few different ultrafiltration membrane based AOPs platforms that we have been developing for organic pollutant degradation in complex water scenarios.

11:15 - 11:30

DISCUSSION

11:30 - 12:00

BRINE MINING – A NEW FRONTIER IN SUSTAINABLE DESALINATION AND WATER REUSE

Nikolay Voutchkov, *ENOWA, Saudi Arabia*

Nikolay Voutchkov is the Executive Director of the ENOWA Water Innovation Center. ENOWA is a world-class Energy, Water, and Hydrogen company founded in NEOM, Saudi Arabia. NEOM Water sector is focused on improving water performance sustainably, building off the implementation of a world class, smart and connected, water infrastructure in NEOM, utilising the latest, and future innovation and technology with the best minds in the industry.

From 2009 to 2023, Mr. Voutchkov was the Founder and the Director General of Water Globe Consultants, a US company providing worldwide engineering consulting and training services in the field of desalination and water reuse worldwide. For 11 years prior to 2009, Mr. Voutchkov was a Chief Technology Officer and Corporate Director of Poseidon Resources, a US company specialising in developing desalination and water reuse projects. In this capacity, Mr. Voutchkov has served as an expert technical advisor to project developers of over a dozen desalination projects in the US, Mexico, Australia, the Middle East, South Africa, Indonesia, and Singapore.

ABSTRACT: Ocean brine mining has the potential to surpass earth mining as a source of rare-earth metals such as magnesium, lithium, strontium, cesium, rubidium and barium. As such, NEOM considers desalination plant brine to be a valuable resource of highly prized commodities that can also support environmentally and fiscally sustainable desalination and water reuse. This presentation discusses the latest trends for extraction of minerals and rare metals from wastewater and desalination brine and shares highlights from advanced research by the ENOWA Water Innovation Center. Circularity based on the valorisation of brine can subsidise the cost of water production and support the ultimate vision of "zero-cost" water and "zero liquid discharge" (ZLD). As NEOM strives to develop technologies that rely on renewable power, our approach represents a new perspective of exploration of the vast water resources of the planet.

12:00 - 12:15

DISCUSSION

12:15 - 13:15

Lunch *(Grand Ballroom A)*

Tuesday 30 May

LET 2023 | Plenary Keynotes

Room: 325

13:15 - 13:45	**SCALING CIRCULAR ECONOMY INNOVATIONS FOR SUSTAINABLE WATER AND SANITATION MANAGEMENT: A GLOBAL PERSPECTIVE** **Miriam Otoo,** *Tetra Tech, United States*  Dr. Miriam Otoo is a senior economist with 15+ years of experience in research, policy and project implementation in WASH and natural resources management. She holds a PhD degree in Applied Economics from Purdue University, USA. She is the Deputy Chief of Party of an urban water and sanitation resilience research project at Tetra Tech, ARD. She specialises in urban sanitation, business innovations in wastewater and fecal sludge management, economics of water, energy and nutrient recovery, and solid waste management. She has worked extensively in sub-Saharan Africa and South Asia, and previously led the International Water Management Institute's research program on Circular Economy and Pollution (previously named Resource Recovery and Reuse). **ABSTRACT:** Circular economy innovations offer considerable economic value through the provision of health and environmental benefits, water and energy cost-savings and opportunities. What the green development has lacked so far, however, thus limiting its success, are workable business models and an enabling environment that incentivise economic agents to act on the basis of social and environmental concerns, and consider these as concrete bottom lines in their business decisions. Successful implementation and scaling of circular economy innovations require increased political will, formulation and effective implementation of policies and regulations, appropriate financing, strengthened capacity of key actors, and importantly viable business models. This session will examine successful examples from around the world that demonstrate how: i) better governance and an enabling environment for private sector participation; ii) the development and enforcement of regulations to improve performance monitoring; iii) professionalisation of public and private actors; and iv) innovative financing and business models can all help scale sustainable circular economy solutions.
13:45 - 14:00	**DISCUSSION**
14:00 - 14:30	**HONG KONG'S EXPERIENCE IN USING SEWAGE VIRUS SURVEILLANCE FOR REAL-TIME CASE ESTIMATION AND INTERACTIVE COVID-19 PANDEMIC CONTROL** **Samuel Chui**, *Environmental Protection Department, Hong Kong SAR Government, Hong Kong SAR*  Dr. Samuel Chui is the Director of Environmental Protection Department of the Hong Kong SAR Government. He is also an Adjunct Professor of the Hong Kong University of Science and Technology. He has been working in the field of wastewater treatment for 30 years. During the COVID-19 pandemic, he has launched a territory-wide sewage surveillance program for Hong Kong, helping to fight the virus. **ABSTRACT:** Covid-19 pandemic has seriously affected the whole world in the past three years. Being an international city, Hong Kong has also been suffering from the pandemic. Since December 2020, the Hong Kong SAR Government has developed a sewage SARS-CoV-2 virus surveillance programme to facilitate informed planning of the intervention measures for combating the pandemic, including social distancing, compulsory testing and distribution of Rapid Antigen Test kits. Over the past three years, the surveillance programme has helped to identify over 26,000 hidden cases, and provided accurate real-time estimation of the number of cases in Hong Kong with R2 of 0.97. In the conference, Dr. Chui will present the development of the sewage surveillance programme, the sampling arrangement, and how the surveillance programme was used to help combating the COVID-19 pandemic in Hong Kong.
14:30 - 14:45	**DISCUSSION**
14:45 - 15:15	**Afternoon Coffee Break** *(Grand ballroom A)*

Tuesday 30 May

LET 2023 | Plenary Keynotes

Room: 325

15:15 - 15:45	**CHINA'S ACTIONS IN REDUCING CARBON EMISSIONS IN THE URBAN WATER SECTOR** **Xiaodi Hao**, *Beijing University of Civil Engineering and Architecture, China*  A full professor in Beijing University of Civil Engineering and Architecture/China and an editor of Water Research. He acquired a BSc degree in Taiyuan University of Technology/ China, an MSc degree in Harbin Institute of Technology/China, and a PhD degree in Delft University of Technology/the Netherlands. He worked in the Netherlands (TU Delft and TNO), France (CEMAGREF), Hong Kong (Poly-U and UST), United States (Auburn University), Japan (Gifu University) for 8 years. His research interests focus on nutrient removal & recovery (also modeling) and energy recovery from wastewater. **ABSTRACT:** China's urban water sector is facing the challenges of being labeled as a high energy consumer and greenhouse gases (GHG) contributor. Coping with the problem, the China Urban Water Association (CUWA) showed foresight in proposing to compile local and unified guidelines to orient carbon accounting in the water sector, which was finished and titled Guidelines for Carbon Accounting and Emission Reduction in the Urban Water Sector, covering general principles, urban water systems and carbon emissions, carbon accounting principles and methodologies, planning and construction, operation and maintenance, asset replacement and demolition, carbon emission reduction pathways of urban water systems, data acquisition and management, interpretation of results and reporting, and appendices. One of the highlights of Guidelines is the provision of life cycle accounting methods covering the whole of the water sector. Besides the operational stage. Guidelines also provides accounting methods for calculating emissions in the construction and demolition stages.
15:45 - 16:00	**DISCUSSION**
16:00 - 16:30	**WHAT IT TAKES TO DECARBONISE AND VALORISE THE WASTEWATER SECTOR** **Zhiyong Jason Ren**, *Andlinger Center for Energy and the Environment/Princeton University, United States*  Dr. Zhiyong Jason Ren (@zjasonren) is a professor in the department of Civil and Environmental Engineering and the Andlinger Center for Energy and the Environment at Princeton University. He leads the Princeton WET (Water & Energy Technologies) Lab with research focusing on energy and resource recovery during environmental processes such as wastewater treatment and reuse, water desalination, and remediation (https://ren.princeton.edu). He currently leads several initiatives for water sector decarbonisation and digitalisation, including books and programs on water data infrastructure and literature mining. He has received various recognitions with most recent being a recipient of the 2020 ASCE Walter L. Huber Civil Engineering Research Prize. **ABSTRACT:** The wastewater sector faces unique challenges when it comes to decarbonisation, as it must balance multiple objectives and constantly adapt to shifting stakeholder interests. In this talk, I will share some of our recent work on understanding the sector's greenhouse gas emissions using mobile sensing and machine learning tools. I will also discuss the technologies we have developed for wastewater resource recovery. Furthermore, I aim to identify the synergies and conflicts between waste decarbonisation and valorisation, and explore ways to achieve a circular water economy more broadly. The goal is to stimulate discussion and encourage further development in this critical field.
16:30 - 16:45	**DISCUSSION**
16:45 - 17:00	**OPEN DISCUSSION**

Wednesday 31 May

LET 2023 | Morning | Technical Sessions

	Room: 323
	WASTEWATER TRACK / SESSION 1: MONITORING AND REDUCTION OF GREENHOUSE GAS EMISSIONS Co-chairs: **Eveline Volcke** *(Belgium)* **& Akihiko Terada** *(Japan)*
9:00 - 9:30	**Keynote** Nitrous oxide formation and emission from activated sludge plants in Europe and Australia **Morten Rebsdorf,** *Aarhus Vand A|S (Denmark)*
9:30 - 9:45	Long-term off-gas monitoring supported by microbial community studies to understand nitrous oxide emissions **Milla Sieranen,** *Aalto University (Finland)*
9:45 - 10:00	The impact of carbon sources on the nitrous oxide emissions of wastewater utilities **Alessio Fenu,** *Aquafin (Belgium)*
10:00 - 10:30	**Discussion**
10:30 - 11:00	**Coffee Break** *(Grand Ballroom A)*
11:00 - 11:30	**Keynote** Long-term direct ghg monitoring from a full-scale Australian WWTP demonstrated that upstream carbon capture can stimulate GHG emissions **Kaili Li,** *The University of Queensland (Australia)*
11:30 - 11:45	Organic carbon species selects predominant N_2O-reducing bacteria: The insights from biokinetics and genomics of canonical denitrifying bacteria **Akihiko Terada,** *Tokyo University of Agriculture and Technology (Japan)*
11:45 - 12:00	Monitoring of organic compounds and greenhouse gases during cold plasma (CP) treatment on leachate **Gerardo Ortiz Vanegas,** *Jeonbuk National University (Korea)*
12:00 - 12:30	**Discussion**
	POSTER PITCH SESSION 1
12:30 - 12:35	Alkalinity demand and successful pH control by CO_2 removal for stable treatment of municipal wastewater using anaerobic membrane bio-reactor **Runda Du,** *Tohoku University (Japan)*
12:35 - 12:40	
12:40 - 12:45	
12:45 - 14:00	**Lunch** *(Grand Ballroom A)*

Wednesday 31 May

LET 2023 | Afternoon | Technical Sessions

	Room: 324	Room: 323
	WATER TRACK / SESSION 2: SUSTAINABILITY Co-chairs: **Junhong Shan** *(Singapore)* **& Jonathan Clement** *(The Netherlands)*	**WASTEWATER TRACK / SESSION 3: ENERGY POSITIVE WASTEWATER TECHNOLOGIES** Co-chairs: **Ana Soares** *(United Kingdom)* **& Guanghao Chen** *(Hong Kong SAR)*
14:00 - 14:30	**Keynote** Developing of predictive fuzzy logic model in a drinking water treatment plant for controlling ozone dosing rate **Laura Ferrandez-Galceran,** *University of Girona (Spain)*	**Keynote** Design and operational lessons learned from low DO and suboxic nutrient removal process operation in North America **Michelle Young,** *Carollo Engineers, Inc. (United States)*
14:30 - 14:45	Reducing chemical demand for drinking water treatment: Coupling electrochemical as (III) oxidation to E-softening **Erik Kraaijeveld,** *Delft University of Technology (The Netherlands)*	Recovery of pure oxygen to promote the cost-effective production of green hydrogen in WRRFs **Samuel Reifsnyder,** *Carollo Engineers, Inc. (United States)*
14:45 - 15:00	Towards a more sustainable water treatment and reuse through brines valorisation **Eric Santos-Clotas,** *CETAQUA (Spain)*	Electro-anammox: A novel anaerobic process for the oxidation of ammonium with recovery of energy from wastewater as hydrogen in microbial electrolysis cell **Dario R. Shaw,** *King Abdullah University of Science & Technology (KAUST) (Saudi Arabia)*
15:00 - 15:30	**Discussion**	
15:30 - 16:00	**Coffee Break** *(Grand Ballroom A)*	
16:00 - 16:30	**Keynote** Breathing a new life into a legacy treatment process **Christoph Schwaller,** *Ramboll (Netherlands)*	**Keynote** Advanced sludge processing: Emerging technologies and energy implications **Julian Sandino,** *Jacobs (United States)*
16:30 - 16:45	Micropollutants removal from filtered raw river water in artificial infiltration | Quaternary sediments-based waterworks **Marek Svab,** *Dekonta, a.s. (Czechia)*	Long-term effects of sulfite pre-treatment on the continuous anaerobic sludge digester for improving methane production and volatile solid reduction: Towards sustainable sludge treatment **Feixiang Zan,** *Huazhong University of Science and Technology (China)*
16:45 - 17:00	Benchmarking study for water reuse: Activities for process design and social acceptability **Naason Velasco,** *Maynilad Water Services, Inc. (Philippines)*	Considering the external and intrinsic application of sulfide dosing for the establishment of partial nitrification **Magray Owaes Hassan,** *Institute for Water & Wastewater Technology (South Africa)*
17:00 - 17:15	Addressing Metro Manila's future water supply shortage through potable water reuse: The NEW WATER **Edmundo Jr Llagas,** *Maynilad Water Services, Inc. (Philippines)*	**Discussion**
17:15 - 17:30	**Discussion**	
	POSTER PITCH SESSION 2	**POSTER PITCH SESSION 3**
17:30 - 17:35	Current groundwater arsenic pollution problems and potential treatment options in Bangladesh **Md Tashdedul Haque,** *Kongju National University (Korea)*	NEOM: Through innovation, developing a global leading biosolids strategy to deliver the greatest benefits to the environment **Nick Burnett,** *NEOM (Saudi Arabia)*
17:35 - 17:40	Awareness of rural communities on faecal contamination of water sources using sanitary risk and hydrogen sulphide test **Arinao Murei,** *Tshwane University of Technology (South Africa)*	An effective electro-dialysis for recovering and concentrating ammonia from wastewater treatment facilities **Gwangmin Kim,** *INHA University (Korea)*
17:40 - 17:45	Nitrogen removal efficacies of landfill leachates treatment by using partial nitritation and anammox processes both laboratory and full scales **Pongsak Noophan,** *Kasetsart University (Thailand)*	LCFAs accumulation and degradation in the methanogenic treatment of lipid-rich diary wastes using high-solid AnMBR **Liuying Song,** *Tohoku University (Japan)*

Thursday 1 June

LET 2023 | Morning | Technical Sessions

	Room: 324	Room: 323
	WATER TRACK / SESSION 4: INNOVATIONS IN DESALINATION Co-chairs: **Nikolay Voutchkov** *(Saudi Arabia)* **& Ho Kyong Shon** *(Australia)*	**WASTEWATER TRACK / SESSION 5: EMERGING INNOVATIVE WASTEWATER TECHNOLOGIES** Co-chairs: **Mark van Loosdrecht** *(The Netherlands)* **& Yan Zhou** *(Singapore)*
9:00 - 9:30	**Keynote** Desalination and resource recovery using membrane capacitive deionisation **Shon Hokyong,** *University of Technology Sydney (Australia)*	**Keynote** Intensive microalgal cultivation for nutrient removal and recovery from municipal wastewater: Characterisation of the ecorecover process **Hannah Molitor,** *University of Illinois Urbana-Champaign (United States)*
9:30 - 9:45	Cost-effectiveness of using electro-coagulation for seawater desalination pre-treatment **Enyu Liu,** *NUS Environmental Research Institute (Singapore)*	Start-up and operation of the largest anaerobic photobioreactors in the world using purple phototrophic bacteria for low-cost wastewater treatment **Victor Perez,** *University of Valladolid (Spain)*
9:45 - 10:00	Application of advanced seawater reverse osmosis desalination technologies for carbon neutralisation in water production **Jungbin Kim,** *Korea University (Korea)*	Hybrid ozonation with photocatalytic ceramic membranes for degradation of micro-pollutants **Stefan Herrmann,** *RWTH Aachen University (Germany)*
10:00 - 10:30	**Discussion**	
10:30 - 11:00	**Coffee Break** *(Grand Ballroom A)*	
11:00 - 11:30	**Keynote** RO-TRACK: Predictive analytics for monitoring and diagnostic of large-scale desalination plants **Ratul Das,** *ACWA Power (United Arab Emirates)*	**Keynote** Vivianite as a novel strategy for phosphorus recovery: Latest developments, bottlenecks, and future perspectives **Thomas Prot,** *Wetsus (The Netherlands)*
11:30 - 11:45	Seawater reverse osmosis desalination using advanced oxidation as a pre-treatment method **Abayomi Alayande,** *Korea University (Korea)*	Integrated urban water management by coupling iron salt production and application with biogas upgrading **Zhetai Hu,** *The University of Queensland (Australia)*
11:45 - 12:00	Performance model for reverse osmosis **Ratul Das,** *ACWA Power (United Arab Emirates)*	Recovery of nutrients from biosolids using intensified anaerobic treatment under alkaline condition **Eunkyung Jang,** *USP Technologies (Canada)*
12:00 - 12:30	**Discussion**	
	POSTER PITCH SESSION 4	**POSTER PITCH SESSION 5**
12:30 - 12:35	Assessing the impact of ICT In operation optimisation in water service utility companies **Jane Mithamo,** *Nairobi City Water & Sewerge Company LTD (Kenya)*	A quantitative review of PFAS elimination rates in domestic wastewater sludge using supercritical water oxidation **Sudhakar Viswanathan,** *374Water Inc. (United States)*
12:35 - 12:40	Enhanced asymmetric capacitive deionisation using Fe-MOF|rGO and GQDs@PANI|rGO nanocomposites as electrode material **Ruey-An Doong,** *National Tsing Hua University (Chinese Taipei)*	Demonstration of a multiple resource recovery wastewater treatment plant **Ana Soares,** *Cranfield University (United Kingdom)*
12:40 - 12:45	Automation of membrane capacitive deionisation process using real-time control system **Jaegyu Shim,** *Ulsan National Institute of Science and Technology (UNIST) (Korea)*	Further insights into aerobic granular sludge microbiome and performance **Cheikh Fall,** *Universidad Autónoma del Estado de México (UAEM) (Mexico)*
12:45 - 14:00	**Lunch** *(Grand Ballroom A)*	

Thursday 1 June

LET 2023 | Afternoon | Technical Sessions

	Room: 324		Room: 323
	WATER TRACK / SESSION 6: EMERGING INNOVATIVE WATER TECHNOLOGIES Co-chairs: **Shane Snyder** *(Singapore)* **& Jörg Drewes** *(Germany)*		**WASTEWATER TRACK / SESSION 7: SUSTAINABLE GREEN TECHNOLOGIES** Co-chairs: **Xiaodi Hao** *(China)* **& Pablo Ledezma** *(Australia)*
14:00 - 14:30	**Keynote** The cutting-edge of electrochemical membrane technology for wastewater treatment **Kwang-Ho Choo,** *Kyungpook National University (Korea)*		**Keynote** Waste to resource: Circular economy approach towards the effective re-use of iron rich drinking water sludge in the urban water system **Mario Jr Rebosura,** *The University of Queensland (Australia)*
14:30 - 14:45	Ceramic ultrafiltration membrane operation in water reuse applications using secondary effluent **Javad Ahmadi,** *Technical University of Munich (Germany)*		Quantitative sustainable design and decision-making for sanitation and resource recovery technologies-open-source tools and applications **Xinyi Zhang,** *University of Illinois Urbana-Champaign (United States)*
14:45 - 15:00	Trihalomethanes in drinking water: causes, occurrences, prediction and control using H_2O_2|UV + BAC processes **Ropru Rangsivek,** *BAUM (New Zealand)*		Destruction of spent media from PFAS treatment applications using supercritical water oxidation **Tali Harif,** *374Water (United Kingdom)*
15:00 - 15:30	**Discussion**		
15:30 - 16:00	**Coffee Break** *(Grand Ballroom A)*		
16:00 - 16:30	**Keynote** Characterisation of nitrogenous disinfection by-product precursors in wastewater by chemical derivatisation **Euna Kim,** *University of Southern California (United States)*		**Keynote** Simultaneously biogas upgrading and value-added chemical production in a membrane biofilm reactor **Linjie Zhou,** *The University of Queensland (Australia)*
16:30 - 16:45	Retrofitting of an electrochlorination system for the sustainable provision of safe drinking water in regional and remote communities in Australia **Pablo Ledezma,** *The University of Queensland (Australia)*		Quenching Big-Data's thirst: A novel water recycling strategy for datacenter cooling & community reuse **Victory Fiifi Dsane,** *Tomorrow Water (United States)*
16:45 - 17:00	Effective removal of water contaminants of emerging concern by biologically active filters **Mengyan Li,** *New Jersey Institute of Technology (United States)*		Innovative thermal hydrolysis process as a game changer for compact and efficient sludge treatment at Anyang Bakdal WWTP **Jiwon Park,** *Cambi Korea (South Korea)*
17:00 - 17:30	**Discussion**		
	POSTER PITCH SESSION 6		**POSTER PITCH SESSION 7**
17:30 - 17:35	The fate of low molecular weight organic matter in the ultrapure water system: Mechanism identification and performance evaluation of RO-VUV **Jiuk Kwon,** *Korea University (Korea)*		Enhancing the ecological value of constructed wetlands through a comprehensive efficiency evaluation method **Hyeseon Choi,** *Kongju National University (South Korea)*
17:35 - 17:40	Establishment of wastewater-based SARS-CoV-2 monitoring system in South Korea over the past two years **Lan Hee Kim,** *Korea University (Korea)*		Utilisation of long-term monitoring data in the development of a Deep Learning model for a rain garden **Minsu Jeon,** *Kongju National University (Korea)*
17:40 - 17:45			Characteristics and water quality benefits of riparian buffer zones in Yongdam watershed, South Korea **Nash Jett Reyes,** *Kongju National University (Korea)*
17:45 - 18:00	**Closing Ceremony** *(Room 324)*	19:00	**Gala Dinner** *(Grand Ballroom, BF, Hotel Inter-burgo EXCO)*

Friday 2 June

LET 2023 | Technical Tours

KOREA WATER CLUSTER TOUR

Date: *Friday 2 June 2023*
Time: *9:30-13:00*
Cost: *20 EUR*

The Korea Water Cluster is a research and development centre located in Daegu, South Korea, that is dedicated to advancing water-related technologies and solutions. The centre is part of the South Korean government's efforts to address water-related issues, such as water scarcity, pollution, and climate change, through research and innovation.

The Korea Water Cluster was established in 2009 and is housed in a state-of-the-art facility that includes research labs, testing facilities, and a technology commercialisation center. The centre brings together researchers, engineers, and entrepreneurs from various disciplines to collaborate on developing new technologies and solutions related to water.

The centre's research areas include water purification, wastewater treatment, desalination, water reuse, and smart water management. Some of the technologies developed at the Korea Water Cluster include a membrane bioreactor for wastewater treatment, a low-cost water treatment system for rural communities, and a water quality monitoring system using drones.

The Korea Water Cluster also offers various programmes and services to support start-ups and entrepreneurs in the water industry, such as a start-up incubation programme, a technology transfer programme, and a commercialisation support programme.

Overall, the Korea Water Cluster is an important hub for research and innovation in the field of water in South Korea, and it plays a vital role in advancing the country's water-related technologies and solutions.

CULTURAL TOUR (OPTIONAL)

DONGHWASA TEMPLE

Date: *Friday 2 June 2023*
Time: *13:00-14:30*

Palgongsan Mountain is home to Donghwasa Temple, which boasts stunning rocky peaks, picturesque valleys, and a wealth of historical landmarks. The highlight of the temple is a majestic Buddha statue standing at a towering 17 meters high, with a building that symbolises the Korean peoples' desire for unity.

PALGONGSAN CABLE CAR

Date: *Friday 2 June 2023*
Time: *15:00-16:20*

The Palgongsan Mountain Cable Car is a 1.2km ride from Donghwa Facility District to the 820-meter high mountain peaks. Once at the top, visitors can grab some refreshments and take in the breath-taking panoramic views of Daegu. For those who might wish to stretch their legs, there's a hiking trail that leads to Donghwasa Temple in the same direction.

Technical Tours schedule summary:

09:30: Departure to Korea Water Cluster
10:30: Arrival at Korea Water Cluster for a guided tour
12:00: Lunch break
13:00: Departure from Korea Water Cluster to Donghwasa Temple
14:00: Arrival at Donghwasa Temple for a guided tour
15:00: Take the Palgongsan Cable Car for scenic views
16:20: Return to EXCO

Presentations

LET 2023 | Abstracts

Session 1: Monitoring and Reduction of Greenhouse Gas Emissions

Keynotes

NITROUS OXIDE FORMATION AND EMISSION FROM ACTIVATED SLUDGE PLANTS IN EUROPE AND AUSTRALIA

Rebsdorf, Morten; Vale, Peter; Wardrop, Peter; Srinamasivayam, Bharanitharan; Wardley, Tom

Three water utilities; Aarhus Vand (Denmark), Melbourne Water (Australia) and Severn Trent (UK) have formed a Net Zero Partnership to jointly develop and share across the sector approaches for measuring and mitigating greenhouse gas emissions from wastewater treatment. A significant proportion of our direct (Scope 1) emissions come from the activated sludge process (ASP). Long term (>1 year) gas phase and liquid phase nitrous oxide monitoring has been undertaken on three full-scale ASPs operating in different geographical and climate areas. Results show significant temporal and spatial variation of emissions between the sites, demonstrating emissions are dependent on the treatment technology, operational and climatic conditions. Results also indicate actual emissions vary significantly from those reported using the Intergovernmental Panel on Climate Change (IPCC) scheme emissions factors.

Morten Rebsdorf, Denmark
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LONG-TERM DIRECT GHG MONITORING FROM A FULL-SCALE AUSTRALIAN WWTP DEMONSTRATED THE UPSTREAM CARBON CAPTURE CAN STIMULATE GHG EMISSIONS

Li, Kaili; Duan, Haoran; Wang, Shuting; Wu, Ziping; Wardrop, Peter; Lloyd, James; Ye, Liu

The direct monitoring and quantification of fugitive greenhouse gas (GHG) emissions are essential towards the successful development of mitigation strategies. In this work, an ongoing long-term methane (CH_4) and nitrous oxide (N_2O) monitoring campaign has been conducted in an Australian wastewater treatment plant (WWTP) where the secondary treatment receives a mixture from anaerobic lagoon effluent and raw sewage. The results showed clear GHG spatial variations due to the step-feed configuration of the plant. N_2O is the dominant GHG while CH_4 only contribute to 3.43% of the plant fugitive emissions. The assessment of N_2O emissions revealed that even in the same reactor with continuous operation, the production pathways and seasonal emission variations can be significantly different in different locations, i.e., AOB and HB respectively dominated N_2O productions in different locations. It was revealed that the COD removal in the anaerobic primary treatment leads to insufficient organic carbon for denitrification. The mitigation strategy has been correspondingly developed.

Kaili Li, Australia
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Presentations

LONG-TERM OFF-GAS MONITORING SUPPORTED BY MICROBIAL COMMUNITY STUDIES TO UNDERSTAND NITROUS OXIDE EMISSIONS

Mikola, Anna; Sieranen, Milla; Hilander, Helena; Haimi, Henri; Kinnunen, Oona; Nissinen, Petri; Larsson, Timo; Kuokkanen, Anna

The direct nitrous oxide emissions may cause majority of the overall greenhouse gas emissions of a wastewater treatment plant. High variation and uncertainty still make it difficult to reliably predict the emission level and find the right mitigation strategies. A long-term off-gas monitoring of nitrous oxide was carried out in six activated sludge plants in Finland. The factors increasing the emissions were estimated. The analysis of the relevant nitrous oxide production pathways was supported by the microbial community information. The results confirmed a high spatial and temporal variability as well as big differences between the plants. They confirmed some of the suggested triggers for emissions which can be also identified by process modelling. In some cases, the microbial community data seems to be the missing piece of the puzzle making it possible to understand the nitrous oxide emissions.

Milla Sieranen, Finland
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THE IMPACT OF CARBON SOURCES ON THE NITROUS OXIDE EMISSIONS OF WASTEWATER UTILITIES

Fenu, Alessio; Dockx, Lennert; Van Damme, Sandra; Delgado, Rosalia

Aquafin, wastewater treatment plant (WWTP) utility of Flanders (Belgium) is since a decade engaged in mapping its own greenhouse gases (ghg) emissions along its asset. The complexity of the task relies on the variety of processes owned by the utility, not mentioning the variability of local conditions that can firmly influence the emissions pattern. A significant number of installations have been screened in search of aerobic nitrous oxide (N_2O) emissions but with poor results. Nonetheless, the analytical sampling campaign indicated that large-scale and unexpected N_2O emission was caused by the use of waste glycerine as carbon source.

Alessio Fenu, Belgium
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ORGANIC CARBON SPECIES SELECTS PREDOMINANT N_2O-REDUCING BACTERIA: THE INSIGHTS FROM BIOKINETICS AND GENOMICS OF CANONICAL DENITRIFYING BACTERIA

Qi, C; Zhou, Y, Oba, K; Suenaga, T; Yoon, S; Terada, A

For mitigation of a highly potent greenhouse gas, nitrous oxide (N_2O), emitted from engineered systems, leveraging bacteria capable of respiring N_2O is of significance. Canonical heterotrophic denitrifying bacteria, possessing a complete set of denitrifying genes encoding enzymes consecutively converting nitrate into nitrogen gas, have been often detected in denitrifying bioreactors. However, the predominant microbial species and activities are significantly different, resulting in a broad range of N_2O emissions during denitrification. The resultant divergent N_2O emissions may be ascribed to overlooking the effect of organic carbon source as an electron donor on N_2O production and consumption during denitrification. To tackle the unresolved issue, this study aimed to systematically compare the effect of five different organic carbon sources on the activity of canonical full-fledged denitrifying bacteria, hereafter termed N_2O-reducing bacteria, and their relevance to genomic potentials. Acetate, succinate, glycerol, ethanol, and methanol were fed as an external carbon source with N_2O to four pure cultures of N_2O-reducing bacteria. For systematic biokinetic analysis, we applied a microrespirometric assay using O_2 and N_2O microsensors. Irrespective of the tested N_2O-reducing bacteria, higher N_2O consumption rates were attained with succinate and acetate than with the other organic carbons. Among the pure cultures, Azospira sp. strain I13 (clade II nosZ) exhibited higher N_2O consumption activities. In contrast, this strain showed a limited availability of organic carbon sources for N_2O consumption. The noticeable differences in N_2O consumption activities across the examined organic carbon sources were rationally explained by the genomes of the pure cultures. Combining the microrespirometric and genomic analyses unveiled the varieties of N_2O-reducing bacteria with different conversion rates of electron donors and acceptors, indicating that compositions and loadings of organic carbon in wastewater likely shape bacterial communities. Collectively, our results underpinned the significance of selecting suitable electron donors for intensifying N_2O sink potentials in a nitrogen-removing system.

Akihiko Terada, Japan
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MONITORING OF ORGANIC COMPOUNDS AND GREENHOUSE GASES DURING COLD PLASMA (CP) TREATMENT ON LEACHATE

Ortiz Vanegas, Gerardo; Kim, Hyun-Woo

Leachate is created from organic and inorganic waste which is accumulated in landfills producing high pollution hazards and affects human health. Wastewater treatment plants usually process these wastes, usually using high hydraulic retention times (HRT) with lower organics removal efficiencies. Thus, advanced oxidation processes had demonstrated to remove organic compounds due to improved OH radicals production and enhanced oxidation mechanisms. Leachate usually generating high amounts of ammonia and carbon dioxide gases when is treated still has no monitoring system. In addition, landfill gases production from leachate accumulation and depletion when leachate is treated is still uncaptured and the amounts of these hazardous gases released to atmosphere is not completely known or accurate. Therefore, this study proposes a 24/7 monitoring system using internet of things (IoT) technologies and CP adapted for leachate collectors and treatment plants.

Gerardo Ortiz Vanegas, Korea
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Poster Pitches

ALKALINITY DEMAND AND SUCCESSFUL PH CONTROL BY CO_2 REMOVAL FOR STABLE TREATMENT OF MUNICIPAL WASTEWATER USING ANAEROBIC MEMBRANE BIO-REACTOR

Li, Yu-You; Du, Runda

Recently, the anaerobic membrane bioreactor (AnMBR) has gained huge attention as a municipal wastewater (MWW) treatment process that combines high organics removal, low sludge yield, low greenhouse gas (GHG) emissions and bioenergy recovery. However, when AnMBR encounters some low-alkalinity MWWs, the lack of neutralisation capacity can lead the liquid pH close to or even below 6.5, which inactivates methanogenic bacteria. In this study, a 20 L AnMBR was set up and operated steadily for 270 days at 25 degrees treating for real MWW with effluent alkalinity between 150~190 mg-$CaCO_3$/L. The liquid pH was controlled in a safe range by removing CO_2, achieving biogas upgradation and low carbon emission simultaneously. Then, a control strategy with the pH and the CO_2 composition as feedback was proposed.

Runda Du, Japan
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Session 2: Sustainability

Keynotes

DEVELOPING OF PREDICTIVE FUZZY LOGIC MODEL IN A DRINKING WATER TREATMENT PLANT FOR CONTROLLING OZONE DOSING RATE

Ferrandez-Galceran, Laura; Cabrera-Codony, Alba; Agustí, Pere; Carrasco, Marina; Monclús, Hèctor; Poch, Manel

Drinking water treatment plants (DWTPs) must ensure that customers receive high-quality water, thus removing numerous compounds from surface waters that are under governmental regulations. The presence of natural organic

matter (NOM) is the main cause for disinfection byproducts (DBP) formation, such as toxic trihalomethanes (THM), upon final chlorination. Ozonation is a technology that ensures high NOM removal in the initial stage of the DWTP. In the Figueres DWTP this operation consumes the 30% of the total electricity expenses. The objective of this work was to develop a digital tool for predict the optimum dose of ozone in the water pre-treatment to both enhancing the effluent quality, minimising THM formation and reducing the energy expends.

Laura Ferrandez-Galceran, Spain
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BREATHING NEW LIFE IN AN OLD TREATMENT TECHNOLOGY: SUSTAINABILITY STUDY ON 2 ALTERNATIVE SURFACE WATER TREATMENT SCENARIO'S

Rockey, Chris; Lee, Cassidy; Galjaard, Gilbert; Farago, Maria

South West Water (SWW) / Bournemouth Water (BW) operates two large sites in the Bournemouth area which are due for replacement or significant maintenance. The sites, Knapp Mill and Alderney Water Treatment Works (WTWs), both rely on raw water screening followed by slow sand filtration (SSF) to pretreat water from the River Avon (Knapp Mill WTWs) and River Stour or Avon via Longham Lakes (Alderney WTWs), prior to disinfection, stabilization and distribution. The assets require significant upgrade or complete replacement and therefore SWW wants to assess the best available options in terms of treatment processes. Highest current treatment risks and challenges are:

- High post treatment DOC (leading to high DBP's after super chlorination)
- Risk of turbidity and cryptosporidium breakthrough
- Blinding of filters and reduction in production volumes but river upsets

Besides these risks the demand in the area is increasing leading to a higher capacity need. In this study two alternative scenario's are investigated and compared with the existing treatment (E) on pilot scale but also on an initial rough Life Cycle Assessment (LCA) including CO_2-footprint, energy demand, chemical demand and resource need.

The first alternative (A1) introduces in-line coagulation followed by ceramic microfiltration to form an absolute barrier against suspended solids including crypto and Giardia as the first initial step of the surface water treatment. In that scenario the SSF are removed and replaced by granular activated carbon filter (GAC). In the 2nd alternative scenario (A2) the ceramic microfiltration step is placed after the current SSF and a very small amount of ozone (residual of 0,5 mg O3/L) is dosed up front of the ceramic membrane. Also, here GAC is placed after the ceramic MF but the SSF stay in place. The outcome of this study will show that A2 leads to the highest water quality but also to a very robust treatment with less than half of the membrane surface needed compared to A1. A2 also has the lowest environmental impact and overall costs. Identified hotspots that need further investigation for sustainability were chlorine gas for post disinfection and the decision to use liquid oxygen or ambient air for ozone production.

Christoph Schwaller, The Netherlands
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Presentations

REDUCING CHEMICAL DEMAND FOR DRINKING WATER TREATMENT: COUPLING ELECTROCHEMICAL AS(III) OXIDATION TO E-SOFTENING

Kraaijeveld, Erik; Rijsdijk, Silvy; van der Poel, Suzanne; Rabaey, Korneel; van Halem, Doris

The objective of this study was to couple As (III) oxidation by an anodic electrochemical advanced oxidation process (eAOP) to the cathodic production of a base (electrochemical softening, i.e. e-softening). The produced base can reduce chemical demand for pellet softening (NaOH) at drinking water treatment plants. Charge dosages (CDs) of 20 and 40 C/L were required for oxidation of 80 µg/L of As(III) in a synthetic and Managed Aquifer Recharge and Recovery (MARR) (i.e. natural) water matrix, respectively. Considering implementation, operational costs (OPEX) were estimated at 0.039 Euro/m^3 and chemical base consumption could be reduced by over 50%. As such, the cleverly coupling of anodic As(III) oxidation with electrochemical softening can reduce, or even replace, conventional chemical oxidant and base dosing (such as $KMnO_4$, Cl_2, NaOH).

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TOWARDS A MORE SUSTAINABLE WATER TREATMENT AND REUSE THROUGH BRINES VALORISATION

Romero, Adriana; Santos-Clotas, Eric; Casals, Ignacio; Mena, Eva; Lefèvre, Benoit; Echevarria, Carlos; Tobella, Joana

Environmental impact and costs related to the management of membrane concentrates are the main challenges from Drinking Water Treatment Plants and Reclaimed Water Treatment Plants. These types of facilities are at the same time large consumers of chlorine-based disinfectants. Two processes for brine valorisation will be demonstrated in two real case studies in Spain. Two semi-industrial prototypes have been designed using the results of laboratory scale tests and simulations for ionic and mass balances, chemicals, and energy consumption calculations based on Nanofiltration (NF), Selective Electrodialysis (SED) and Electrochlorination (EC) technologies. The prototypes will be operated until January 2024 to assess the feasibility of the solutions to produce N-rich reclaimed water and sodium hypochlorite.

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MICROPOLLUTANTS REMOVAL FROM FILTERED RAW RIVER WATER IN ARTIFICIAL INFILTRATION|QUATERNARY SEDIMENTS-BASED WATERWORKS

Svab, Marek; Stepanova, Barbora; Janda, Vaclav; Pohorely, Michael; Skalicky, Marek

Karany waterworks, the water supplier for the city of Prague, uses an artificial infiltration of raw Jizera river water into quaternary sediments, where the water naturally achieves drinking water quality. Unfortunately, similarly as in other developed countries, trace concentrations of various micropollutants have been observed in the raw river water. Since the waterworks operates only sand filtration of the water before the infiltration, there is no simple method for removing the traces of micropollutants for the elimination of them from the water and protection of the valuable quaternary sediments. Thus, the only way is to convert a suitable number of sand filters onto activated carbon filters in the existing technology. In order to examine this solution, test columns with identical hydraulic parameters were installed beside the existing sand filters. The columns were filled with 3 types of granular activated carbons (GAC) and have been operating in the same mode as the main sand filters, including shut-down periods depending on raw water quality. Although it was expected that the GAC will be saturated in a short time, it serves for 1,5 years and still removes about 70 — 80% of micropollutants from the water before infiltration.

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BENCHMARKING STUDY FOR WATER REUSE: ACTIVITIES FOR PROCESS DESIGN AND SOCIAL ACCEPTABILITY

Velasco, Naason; Llagas, Edmundo Jr; Tajon, Ma. Cristina; Gabayno, Beverly

Metro Manila's water supply has become vulnerable due to climate change and detrimental human activities. During summer season, the level of Angat Dam decreases and algal bloom happens in Laguna Lake while during rainy season, turbidity increases. Since both these sources face challenges, it is imperative to look for alternative that will augment our current supply. Water reuse is a climate-change proof source and a very viable additional source of water for Metro Manila. This study examines the best practices in terms of water reuse. It looks into the process train of the pioneer plant in water reuse as well as the closest installation from our country. Moreover, the study examines the activities made by other countries in making the water reuse acceptable to the consumers.

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ADDRESSING METRO MANILA'S FUTURE WATER SUPPLY SHORTAGE THROUGH POTABLE WATER REUSE: THE NEW WATER

Llagas, Edmundo Jr; Tajon, Ma. Cristina

About 15 million customers in Metro Manila, parts of Cavite and Rizal are highly reliant to Angat Dam and Laguna Lake. However, due to climate change that affects the current water sources and growing population that leads to increasing demand, Maynilad explored the untapped potential water source — the treated used water. Processing the treated used water for further purifications to make it potable and passed the Philippine Standards for Drinking Water (PNSDW) 2017 will close the loop between water supply and wastewater disposal and the product water be called NEW WATER — 1st direct potable water reuse scheme in the Philippines. The initial plant capacity of 10 million liters of NEW WATER per day is blended with La Mesa treated water that ensure the water reliability of 38,700 customers in Paranaque. Furthermore, Maynilad plans to utilise more treated used water from the existing and other planned WRFs to have a greater volume of sustainable water supply from NEW WATER treatment plants.

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Poster Pitches

CURRENT GROUNDWATER ARSENIC POLLUTION PROBLEMS AND POTENTIAL TREATMENT OPTIONS IN BANGLADESH

Bangladesh is a developing country that mostly relies on groundwater for potable uses. One of the major issues in Bangladesh is the poisoning of groundwater with arsenic (As). In order to provide a thorough assessment of the current status of groundwater As contamination in Bangladesh and several low-cost remediation options, 92 papers in total were evaluated for this study. With concentrations over 0.05 mg/L, Brahamanbariya, Tangail, Barisal, Pabna, Patuakhali, Kurigram, Magura, and Faridpur are the districts with the greatest levels of groundwater As contamination. There were just six districts including Kushtia, Khagrachari, Jessore, Dinajpur, Meherpur, and Munshiganj with groundwater arsenic values that were less than 0.1 mg/L. There are now a number of technologies available to treat As in groundwater, however, when efficiency and cost of treatment were taken into account, aerated electrocoagulation, Mg-Fe-based hydrotalcite-like compound, and ECAR reactor were determined to be the most effective methods.

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AWARENESS OF RURAL COMMUNITIES ON FAECAL CONTAMINATION OF WATER SOURCES USING SANITARY RISK AND HYDROGEN SULPHIDE TEST

This study assessed the relationship between observed sanitary risks and Hydrogen Sulphide test in the identification of faecal contamination in various water sources used in households located in rural communities. A Sanitary inspection and survey-using questionnaire were conducted to identify activity that introduce faecal matters in water resources. Hydrogen sulphide test was used to determine the presence of faecal contamination in various water sources used in rural communities. The overall results showed a significant and positive correlation ((r18) = .623, P = .003 in wet season and (r20) =.504, p = .017 in dry season) between sanitary risk and H_2S test results. The findings of the study showed that there was a relationship between the sanitary risks and Hydrogen Sulphide production by faecal contamination, indicating bacteria in water sources. Hence this study is raising an awareness among community members to monitor the quality of water from their water sources.

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NITROGEN REMOVAL EFFICACIES OF LANDFILL LEACHATES TREATMENT BY USING PARTIAL NITRITATION AND ANAMMOX PROCESSES BOTH LABORATORY AND FULL SCALES

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Attached-growth or biofilms systems are recommended to use in order to promote heterogeneous microbial communities for partial nitritation and anammox in two stages or two tanks, to better retain microorganisms with low growth yield, and to increase resilience to changing conditions (e.g. loading rate, oxygen concentration). It was strongly recommended as partial nitritation and anammox processes in a hybrid system combining both suspended- and attached-growth (biofilms) because bacterial balance can be more easily controlled; the hybrid system provided high nitrogen removal efficiency, handled variable influent, and required less oxygen supply than biofilm-only systems. The results of nitrogen removal efficacies and microbial communities were shown and discussed in this research work by using both fresh and stabilised landfill leachates). For fresh landfill leachate as laboratory scale, the hydraulic retention time (HRT) was used as 12 hr. The nitrogen removal efficiency was 72% TN. However, fresh landfill leachate consists of biodegradable only 50% and another 50% of COD might not be able to remove by biological treatment. Chemical treatment process by using strong oxidising chemical reagents is strongly recommended to use. For stabilised landfill leachate consists of high biodegradable content but there were low COD but high nitrogen. In this research work, IFAS (integrated fixed-film activated sludge) was possible use and nitrogen removal efficiency was 75%. Media in IFAS is very main factor to operate.

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Session 3: Energy Positive Wastewater Technologies

Keynotes

DESIGN AND OPERATIONAL LESSONS LEARNED FROM LOW DO AND SUBOXIC NUTRIENT REMOVAL PROCESS OPERATION IN NORTH AMERICA

Young, Michelle; Rauch-Williams, Tanja; Beach, Natalie

More facilities are seeking to meet more stringent discharge standards while reducing operating costs. Low dissolved oxygen (DO)/suboxic nutrient removal (SNR) operations demonstrate the potential to remove BOD and nutrients while operating with lower aeration demands, decreasing overall water resource recovery facilities (WRRFs) energy consumption. While low DO/SNR processes are operating in the US, there has been no concerted effort to understand what is required for successful design and operations of these widely varying systems. In this work, we summarise the results of a design workshop that identified key performance design and performance criteria for low DO/SNR operations.

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ADVANCED SLUDGE PROCESSING: EMERGING TECHNOLOGIES AND ENERGY IMPLICATIONS

Carbon embedded in residual sludge plays a key role in the energy balance of water resource recovery solutions, by affecting both demand for its processing and enabling renewable generation from it. To this end, several advanced processing technologies are increasingly being considered to optimise this balance and facilitate offsite management of biosolids by reducing quantities and/or improving characteristics.

This presentation will discuss recent developments in sludge processing covering three specific technologies: microbial hydrolysis process, biodrying, and gasification/pyrolysis. These innovative approaches are aimed at maximising the optimisation potential of embedded carbon in treatment residuals.

These developments should be of great interest to utilities, consultants, and academics involved in the development of sustainable water resource recovery solutions by properly considering the need to optimise

the carbon and energy balance of facilities through the leveraging of recent technology advancements.

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Presentations

RECOVERY OF PURE OXYGEN TO PROMOTE THE COST-EFFECTIVE PRODUCTION OF GREEN HYDROGEN IN WRRFS

Reifsnyder, Samuel; Gabel, Dale; Rauch-Williams, Tanja; Hodel, Tracy

By installing electrolyzers powered by renewable energy onsite of water resource recovery facilities (WRRFs) it is possible to generate green hydrogen while also supplying a stream of pure oxygen that can be used to decarbonises the aeration of the biological nutrient removal process. This paper presents findings from a desk-top evaluation and demonstration-scale case study at the WRRF in St. Cloud, MN, that assesses the practical utilisation of green oxygen for aeration and thereby improve the cost/benefit analysis of implementing electrolyzer systems at WRRFs.

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ELECTRO-ANAMMOX: A NOVEL ANAEROBIC PROCESS FOR THE OXIDATION OF AMMONIUM WITH RECOVERY OF ENERGY FROM WASTEWATER AS HYDROGEN IN MICROBIAL ELECTROLYSIS CELL

R. Shaw, Dario; Bibiano Guadarrama, Carlos; Tobon, Julian; Katuri, Krishna; Saikaly, Pascal;

In this study, we demonstrated the potential of marine and freshwater species of anaerobic ammonium oxidation (Anammox) bacteria to couple the oxidation of ammonium with the transfer of electrons to electrodes poised at a certain potential in microbial electrolysis cells (MECs). Unlike conventional anammox process, extracellular electron transfer-dependent anammox process (Electro-anammox) achieved complete removal of ammonium (at low and high concentrations) to nitrogen gas with no accumulation of nitrite, nitrate or the production of the greenhouse gas (GHG) N_2O. Also, the energy released from ammonium oxidation can be captured in the form of energy-rich hydrogen gas (H_2) at the cathode. In this study, highly enriched cultures of three physiologically distant anammox bacteria were inoculated in microbial electrolysis cells (MECs). Different potentials were tested using multiple working electrodes (anode) as the sole electron acceptor. The reactors were operated for more than two months without the presence of any electron acceptor other than the anode. Biofilm formation, anaerobic ammonium oxidation and current generation with a coulombic efficiency higher than 80% were observed in the MECs with the anode as the sole electron sink. Biotic and abiotic controls, experiments with addition of allylthiourea to inhibit nitrifiers, open circuit voltage, fluorescent in-situ hybridisation, metagenomics and cyclic voltammetry analysis confirmed that ammonium removal coupled to current generation was mainly due to anammox biofilm, which was in direct contact with the anode. Isotope labelling experiments revealed the molecular mechanism behind this novel process. Also, we explored the feasibility of electro-anammox process for anaerobic treatment of ammonium and hydrogen production from real domestic wastewater conditions using granular biomass as inoculum. These results suggest a novel and sustainable process that enables removal of ammonium with high effluent quality and recovery of energy in the form of hydrogen gas.

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LONG-TERM EFFECTS OF SULFITE PRETREATMENT ON THE CONTINUOUS ANAEROBIC SLUDGE DIGESTER FOR IMPROVING METHANE PRODUCTION AND VOLATILE SOLID REDUCTION: TOWARDS SUSTAINABLE SLUDGE TREATMENT

Zan, Feixiang; Wu, Xiaohui; Chen, Guanghao

Using sulfite pretreatment to improve anaerobic sludge digestion has been proved to be effective. However, the effect of sulfite pretreatment on sludge digestion was verified by the batch tests in previous work, and its effects on continuous operation remain unclear, which is crucial to determine the long-term viability of using sulfite pretreatment in the real application. In this study, the impacts of sulfite pretreatment on the continuously operated anaerobic sludge digester were experimentally investigated to reveal its long-term role. The methane production and volatile solid reduction of sulfite-pretreated sludge were significantly improved by 25% with pretreatment at sulfite of 100 mg S/L, pH of 6 for 24 h. Moreover, sulfite pretreatment stimulated more organics extracted from sludge for methane conversion. Adopting sulfite pretreatment for sludge management could overall enhance energy recovery by 37.40%, save operational cost by 31.43%, and reduce carbon emission by 37.80%, implying the potential of sulfite-based technology for sludge treatment towards environmental sustainability.

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CONSIDERING THE EXTERNAL AND INTRINSIC APPLICATION OF SULFIDE DOSING FOR THE ESTABLISHMENT OF PARTIAL NITRIFICATION

Sulphide is assumed a useful as an electron donor in autotrophic denitrification. However, the investigations on NOB (nitrite-oxidising bacteria) suppression are investigated in a distinct mode from actual practice. Being intrinsically present in anaerobic effluents and externally dosed in aerobic reactors. In external dosing, it can initiate partial nitrification (PN) more effectively as there can be abiotic and biotic suppression of NOBs. While using intrinsic sulfide, enrich

the PN reactors with AOB (ammonia-oxidising bacteria) and SOB(Sulphur oxidising bacteria) to achieve PN by autotrophic denitrification of nitrate. When the reactor was fed with sulfide addition (up to 25 mg/L) without pH control, the average nitrite accumulation rate increased from 63% to 85%. The obtained results indicate that nitrite oxidation is a process more sensitive to sulfide than ammonium oxidation, which may be due to the change in pH caused by sulphide addition. As a result of this study, the presence of a sulfide content of (25 mg/L) in wastewater can be useful in suppressing nitrite oxidation and imposing partial nitrification.

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Poster Pitches

NEOM: THROUGH INNOVATION, DEVELOPING A GLOBAL LEADING BIOSOLIDS STRATEGY TO DELIVER THE GREATEST BENEFITS TO THE ENVIRONMENT

Burnett, Nick; Lancaster, Rick

Wastewater is now becoming widely recognised as a goldmine of energy and resources. The paradigm shift from linear to sustainable circular water economies is driven by rising concerns for water scarcity, more stringent effluent quality requirements and climate change concerns. The need to manage wastewater and biosolids in a sustainable and beneficial way is a key pillar of NEOM's circular economy. Starting with a blank slate, NEOM is pushing the boundaries and is embracing the 'art of the possible'.

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AN EFFECTIVE ELECTRO-DIALYSIS FOR RECOVERING AND CONCENTRATING AMMONIA FROM WASTEWATER TREATMENT FACILITIES

Kim, Gwangmin; Kim, Sanghyeon; Ha, Kyungeun; Lee, Haesung; Han, Changseok

In this study, we investigated an electro-dialysis (ED) system for effective ammonia recovery and concentration from public environmental infrastructures. The effects of different operating parameters, such as current, flow rate, volume ratio of concentrate and dilute, and ED composition on ammonia recovery and concentration were evaluated. The experiment was performed using two different solutions of raw wastewater and pre-treated wastewater with struvite synthesis treatment. Also, to control fouling and scaling problems of the ED system, we performed ED reversal (EDR), which periodically changes the direction of applied voltage to the system. These experiments were conducted under a constant current that was the measured limiting current density (LCD). As a result, a maximum concentration of ammonium of 5228 ± 135 mg/L NH_4+-N could be concentrated for pre-struvite wastewater. When the struvite synthesis process was applied, the surface of ion exchange membranes was significantly improved from fouling and scaling.

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LCFAS ACCUMULATION AND DEGRADATION IN THE METHANOGENIC TREATMENT OF LIPID-RICH DIARY WASTES USING HIGH-SOLID ANMBR

Song, Liuying; Li, Yu-You

Efficient methanogenic treatment of lipid-rich dairy waste has attracted more and more attention in recent years. In the present study, ice cream waste was chosen as the typical lipid-rich dairy waste added gradually (0%-5%-10%-20%) in the AnMBR operated under HRT of 6 days treating with diary processing wastewater (DPW). The bio-methanation has been inhibited with higher OLR of 32.64 g COD/L/d and LLR of 11.24 g lipid/L/d. Inefficient degradation with C18:0 and C14:0 mainly caused LCFAs accumulation in this AnMBR system. Once stopping the continues feeding, the functional anaerobic microorganisms of syntrophomonas and methanogen enriched, leading to the rapid degradation of LCFAs and VFAs.

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Session 4: Innovations In Desalination

Keynotes

DESALINATION AND RESOURCE RECOVERY USING MEMBRANE CAPACITIVE DEIONISATION

Electrochemical desalination is an emerging desalination technology, which becomes more energy efficient for the desalination of less saline water sources. In particular, capacitive deionisation (CDI) is of interest in low-carbon and low-energy electrochemical process. However, the application potential of CDI has certainly widened beyond brackish water desalination. Now, the CDI application includes water softening, heavy metal and nutrient removal. Over the years, different types of CDI architectures have been proposed such as membrane capacitive deionisation (MCDI), flow electrode capacitive deionisation and development of intercalated electrode materials for MCDI application. This presentation covers the current state of MCDI development and focus more on the application potential of MCDI for various water and wastewater treatment options based on some lab-scale and pilot-scale studies conducted. The key findings and perspectives on the future direction of MCDI with resource recovery will be shared for potential application.

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RO-TRACK: PREDICTIVE ANALYTICS FOR MONITORING AND DIAGNOSTIC OF LARGE-SCALE DESALINATION PLANTS

Muhammad Ghifari; Altmann, Thomas; Yousry, Ahmed; Das, Ratul

Lower cost and energy-efficient seawater desalination process is becoming a critical agenda among desalination investors, developers, and off-takers in water-stress regions. One of the major sources of operational cost is the membrane replacement cost. While membrane replacement is certainly unavoidable due to for instance irreversible fouling, however, its frequency can be further minimised. One common action to avoid irreversible fouling is clean in place (CIP) procedure — circulating chemicals on the membrane to dissolve the fouling matter. However, CIP efficacy is highly dependent on the timing and type of the foulant. In addition, the current procedure to investigate the type of foulant can take months as the membrane autopsy procedure requires many sophisticated instruments. To address this problem, we present a monitoring and diagnostic system that can provide the user with the potential type of foulant along with the CIP timing based on the membrane performance parameters.

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Presentations

COST-EFFECTIVENESS OF USING ELECTRO-COAGULATION FOR SEAWATER DESALINATION PRE-TREATMENT

Liu, Enyu; Pee, Chun Wee; Chandra Mohan, Kishan; Lee, Lai Yoke; Ng, How Yong; Lefebvre, Olivier

Electro-coagulation (EC) has been demonstrated as an effective alternative to chemical coagulation (CC) in various water and wastewater applications. However, limited information is available on the cost-effectiveness of adopting EC for seawater desalination pre-treatment. This study examined the technical feasibility of EC pre-treating seawater for desalination and demonstrated the significant cost-effectiveness of EC over CC. Results showed that EC using iron (Fe) electrodes coupled with ultrafiltration (UF) process was able to pre-treat seawater to desirable qualities for downstream Seawater Reverse Osmosis (SWRO) process under fluctuating seawater qualities. UF membrane fouling was significantly mitigated for the EC-treated seawater compared with that pre-treated with CC. Results from the continuous lab-scale EC system showed that the operating cost of EC was > 50% lower than CC. These findings demonstrated the technical feasibility and economic advantage of replacing CC with EC in the desalination pre-treatment process. Important insights for future scale up were provided as well.

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APPLICATION OF ADVANCED SEAWATER REVERSE OSMOSIS DESALINATION TECHNOLOGIES FOR CARBON NEUTRALISATION IN WATER PRODUCTION

Kim, Jungbin; Hong, Seungkwan

Seawater reverse osmosis (SWRO) desalination is the key to securing freshwater sources but high energy use of the technology hinders further applications. Strategies to lower SWRO plant energy use are examined by pilot plant operation and further validated by theoretical analysis.

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SEAWATER REVERSE OSMOSIS DESALINATION USING ADVANCED OXIDATION AS A PRETREATMENT METHOD

Seungkwan; Hong; Abayomi, Alayande

The occurrence of harmful algal blooms (HAB) affects the performance of the membrane-based processes for freshwater production. Here, we systematically report on the mineralisation of HAB-related contaminants such as transparent exopolymer particles (TEPs), natural organic matter (NOM), and algal toxins using UV-activated peroxymonosulfate (UV/PMS) system. The effects of PMS concentration, feed salinity in the form of chloride ions, pH and ionic composition on removal rate were investigated, and the reaction mechanisms for each contaminant were postulated. In addition, the scavenging effect of the co-presence of cations and anions with chloride ions was examined. The results indicated that 100% organic mineralisation could be achieved in freshwater. However, the presence of anionic species retarded the removal efficiency. Nevertheless, a significant removal efficiency was obtained using the UV/PMS system, implying its feasibility as a pretreatment unit in membrane-based desalination.

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PERFORMANCE MODEL FOR REVERSE OSMOSIS

Yousry, Ahmed; Ridwan, Muhammad Ghifari; Altmann, Thomas; Rousseva, Ana; Azab, Khaled; Das, Ratul

Reverse Osmosis is a widely used technology for seawater desalination to meet freshwater global demands. SWRO is an energy intensive process that comprises of multiple systems consuming typically 3-4 kWh per m^3 of water produced. It of utmost importance to minimise Specific Energy and Chemical Consumption in a SWRO plant, thus, continuous monitoring of operating parameters as well as seawater quality are required to predict and optimise plant performance in real time operations. Performance model of Reverse Osmosis is the first of a kind simulation tool that covers the entire seawater desalination plant from seawater supply till potable water production with desired

specifications. Developed model predicts the performance of an operating SWRO plant with an accuracy of 93% from actual performance in terms of Specific Energy Consumption (SEC).

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Poster Pitches

ASSESSING THE IMPACT OF ICT IN OPERATION OPTIMISATION IN WATER SERVICE UTILITY COMPANIES

Mithamo, Jane; Supeyo, Charity

Innovation in the water sector is a progressive process that could be defined as a continuous cycle of finding, evaluating, and adopting innovation to improve customer service, provide cost-effective solutions, and operate more efficiently. Accurate data and information management systems are a precursor for sound management and decision support systems. ICT plays a crucial role in managing the accounting function, billing & revenue collection functions. The purpose of this paper is to contribute and demonstrate how application of IT innovative systems affects the ability to solve accounting tasks in an organisation. We will measure the impact of IT on accounting information use and accounting and billing tasks. The findings suggest that user satisfaction in IT usage and the use of accounting techniques and accounting information increases with new IT innovations. There is also a tendency for change in the decentralisation of management accounting tasks.

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ENHANCED ASYMMETRIC CAPACITIVE DEIONISATION USING FE-MOF/RGO AND GQDS@PANI/RGO NANOCOMPOSITES AS ELECTRODE MATERIALS

Doong, Ruey-An; Nguyen, Thi Kim Anh

In this study, iron metal-organic frameworks (Fe-MOF) decorated with reduced graphene oxide (rGO) (FeMr) and a hybrid of graphene quantum dots@PANI (GQDs@PANI) and rGO (GPro) nanocomposites were successfully prepared by hydrothermal syntheses and utilised as an electrode pair for asymmetric CDI. Decoration of octahedral Fe-MOF onto 2-D rGO significantly decreased the hydrophobicity and electrical resistance, resulting in enhanced ion storage with a high specific capacitance of 310.8 F/g at 5 mV/s. In the case of GPro, the combination of highly conductive GQDs@PANI and rGO enhanced charge transfer and increased the capacitance, which significantly boosted the ion storage capability with a specific capacitance of 267.2 F/g at 5 mV/s. Additionally, the use of GPro||FeMr in asymmetric CDI exhibited the highest electrosorption capacity of 127.4 mg/g at an operating voltage of 1.2 V and 1000 mg/L NaCl. Moreover, the influence of co-ion of Ca_2+ on the desalination performance was further discussed. Results of this study provide the promising and novel materials for next generation of innovative desalination performance.

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AUTOMATION OF MEMBRANE CAPACITIVE DEIONISATION PROCESS USING REAL-TIME CONTROL SYSTEM

Shim, Jaegyu; Lee, Su-In; Yoon, Nakyung; Hwa Cho, Kyung

Membrane capacitive deionisation (MCDI) is an emerging desalination technology. However, the economic feasibility of an MCDI process depends on various parameters including the physical structures of an MCDI system and the water quality of feed solutions. Recently, reinforcement learning (RL) is a potential decision-maker to optimise operation cost in an MCDI process, but still, no application has been conducted on a real MCDI process. As a basis for the application of RL, in this study, we prepared an automatic MCDI control system to control a lab-scale MCDI process using a Python-based algorithm. The MCDI control system experimentally controlled the MCDI process. The result demonstrates that the MCDI control system can control the MCDI process in real-time (<0.1 sec). This study will be followed by the application of the RL on the actual MCDI process to optimise the feasibility such as energy consumption.

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Session 5: Emerging Innovative Wastewater Technologies

Keynotes

INTENSIVE MICROALGAL CULTIVATION FOR NUTRIENT REMOVAL AND RECOVERY FROM MUNICIPAL WASTEWATER: CHARACTERISATION OF THE ECORECOVER PROCESS

Molitor, Hannah R; Kim, Ga-Yeong; Li, Yalin; Avila, Nickolas M; Alam, Md Mahbub; Hodaei, Mahdi; Gincley, Benjamin; Hartnett, Elaine; Fisher, Autumn; Kelly, Patrick; McGraw, Kevin; Bradley, Ian M; Pinto, Ameet J; Guest, Jeremy S

Mixed community microalgal wastewater treatment technologies have the potential to recover wastewater nutrients and achieve effluent nutrient concentrations below the current limit of technology while producing biomass for biofuels and bioproducts. Greater understanding of the microbial communities and treatment processes is required to optimise system design and control to realise financially and environmentally sustainable commercialised technologies. In Fall 2020, a 0.15 MGD CLEARAS EcoRecover microalgal treatment system was integrated into the

wastewater treatment train at Roberts, Wisconsin (USA), to address their pending 0.04 mg•L-1 TP effluent permit. Long-term monitoring helped identify indicators of stable performance and periods of performance with effluent phosphorus concentrations below the discharge limit. Bench-scale experiments elucidated carbon dynamics and nutrient recovery trends across the EcoRecover system.

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VIVIANITE AS A NOVEL STRATEGY FOR PHOSPHORUS RECOVERY: LATEST DEVELOPMENTS, BOTTLENECKS, AND FUTURE PERSPECTIVES

Prot, Thomas; Korving, Leon; Wijdeveld, Wokke; Nguyen, Ha; van Loosdrecht, Mark

In 2016, the importance of the mineral vivianite ($Fe_3(PO_4)2*8H_2O$) for phosphorus recovery from wastewater was first highlighted. Since then, several crucial steps have been undertaken to understand and promote vivianite formation and magnetically extract this mineral from sewage sludge. This paper aims to give an overview of the latest developments of this novel phosphorus recovery strategy, both in the scientific understanding and technological aspects. The bottlenecks for the upscaling of the technology and potential wider applications will also be discussed.

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Presentations

START-UP AND OPERATION OF THE LARGEST ANAEROBIC PHOTOBIOREACTORS IN THE WORLD USING PURPLE PHOTOTROPHIC BACTERIA FOR LOW-COST WASTEWATER TREATMENT

Zamora, Patricia; Marin, Eugenio; Monsalvo, Victor; Rogalla, Frank; Perez, Victor

Efficient resources recovery from domestic wastewater by low-cost and reduced-carbon footprint technologies and the development of suitable technologies for affordable wastewater treatment of small populations remain as the key challenges to ensure sustainability and cost-effectiveness in wastewater management. In this study, a novel and disruptive technology for low-cost domestic wastewater treatment in anaerobic photobioreactors using purple phototrophic bacteria is proposed. This technology is aimed at small population areas, due to the reduction of energy consumption and process simplicity. The technology has been scaled to two demonstrative photobioreactors of 150 m^3 each at the wastewater treatment plant Linares in Jaén, Spain, being the largest in the world up to date, with a maximum treatment capacity of 350 m^3/d. Treated water complies with discharge limits for COD, BDO5 and SST, reaching average discharge concentrations of 55 mg/L, 12 mg/L and 10 mg/L respectively.

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HYBRID OZONATION WITH PHOTOCATALYTIC CERAMIC MEMBRANES FOR DEGRADATION OF MICRO-POLLUTANTS

Herrmann, Stefan; Padligur, Maria C; Dietz, Konstantin; Bieneck, Conrad J; Tepper, Maik; Wessling, Matthias

Two drawbacks of classical ozonation processes are the formation of carcinogenic bromate and the low degradation rate of certain micro-pollutants. This work uses bubble-less ozonation with ceramic membranes to prevent bromate formation during ozonation. Furthermore, the tubular reactor is equipped with static mixers to avoid hotspots of dissolved ozone. Additionally, a photocatalyst (TiO_2) on the membrane's surface increases the concentration of OH-radicals in water, resulting in increased micro-pollutant degradation. A tubular UV reactor is used for the irradiation of the photocatalyst. Simulations of this process reveal a decrease in bromate formation of up to 36% at the same ozone exposure using static mixers. Experiments with the hybrid process and static mixers show a 30% faster complete degradation of sulfamethoxazole and an increase of diclofenac degradation from 27% to 78% after two hours compared to sole ozonation.

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INTEGRATED URBAN WATER MANAGEMENT BY COUPLING IRON SALT PRODUCTION AND APPLICATION WITH BIOGAS UPGRADING

Hu, Zhetai; Li, Lanqing; Zheng, Min; Hu, Shihu; Wang, Xiuheng; Song, Yarong; Xu, Kangning; Yuan, Zhiguo

Integrated urban water management is a well-accepted concept for managing urban water. It requires innovative and integrated technological solutions that enable system-wide gains via a whole-of-system approach. Here, we create a novel link between the manufacturing of an iron salt, its application in an urban water system, and high-quality bioenergy recovery from wastewater. An iron-oxidising electrochemical cell is used to remove CO_2 (also H_2S and NH_3) from biogas, thus achieving biogas upgrading, and simultaneously produce $FeCO_3$. The subsequent dose of $FeCO_3$ to wastewater and sludge removes sulfide and phosphate, and enhances sludge settleability and dewaterability, with comparable or superior performance compared to the imported and hazardous iron salts it substitutes (e.g. $FeCl_3$). The process enables water utilities to establish a novel, self-reliant, and more secure supply chain to meet its demand for iron salts and simultaneously achieve recovery of high-quality bioenergy.

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RECOVERY OF NUTRIENTS FROM BIOSOLIDS USING INTENSIFIED ANAEROBIC TREATMENT UNDER ALKALINE CONDITION

Jang, Eunkyun; Bai, Xuanye; Al-Omari, Ahmed; Kirim, Gamze; Amoye, Frances; Khadir, Ali; Santoro, Domenico; Nakhla, George; Walton, John; Muller, Christopher; Bell, Kati

Biosolids contain valuable nutrients such as rbCOD (VFAs) and ammonia which can be utilised. To improve the recovery of those valuable nutrients, IntensiCarb process can be used which is combined process with anaerobic fermentation/digestion and vacuum evaporation. The previous studies related to IntensiCarb process show that it can separate free ammonia from the sludge as condensate and improve VFAs production by applying intermittent vacuum evaporation without pH adjustment. There is the potential for improvement in the recovery and the production of those nutrients under alkaline condition. Thus, this study was conducted to figure out the improvement of ammonia recovery and VFAs production with application of IntensiCarb process under alkaline condition. The results shows that the ammonia recovery rate improved by more than double compared to vacuum at neutral pH. In addition, VFA yield was improved by 84% compared to the control.

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Poster Pitches

A QUANTITATIVE REVIEW OF PFAS ELIMINATION RATES IN DOMESTIC WASTEWATER SLUDGE USING SUPERCRITICAL WATER OXIDATION

Viswanathan, Sudhakar; Deshusses, Marc A; Harif, Tali; Hatler, Doug; Nagar, Kobe

Supercritical Water Oxidation (SCWO) is rapidly emerging as the technology of choice for PFAS destruction. The reasons are the many advantages of the technology, namely the ability of SCWO to (1) rapidly and effectively mineralise all organofluorine and PFAS compounds (including low molecular weight ones) without the formation of secondary PFAS (e.g., volatile PFAS); (2) to treat other organic co-contaminants; and (3) to destroy PFAS laden sludge from wastewater treatment plant. In this paper, we will unveil the AirSCWO™ system, and we will present and discuss recent results on the mineralisation of PFAS.

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DEMONSTRATION OF A MULTIPLE RESOURCE RECOVERY WASTEWATER TREATMENT PLANT

The 360 m^3/day demonstration plant incorporating a upflow anaerobic sludge blanket-membrane bioreactor (AnMBR) complete with a membrane degassing unit to recover dissolved methane followed by ion exchange (IEX) for ammonia and phosphorus removal was explored with aim of boosting resource recovery. The AnMBR enabled municipal settled wastewater treatment with no aeration energy for removal of COD/BOD, biogas production (production of electricity/heat), pathogen and solids free effluent to be re-used (e.g.: farming and industrial use). The IEX process enabled targeted ammonia (N) and phosphorus (P) removal and recovery of high purity calcium phosphate salts and ammonia sulphate solutions. At 15Â°C, the AnMBR showed high COD (60-70%) and solids (>97%) removal, even without prior inoculum acclimation, although the influent COD/SO4 ratio affected methane production and recovery. The high-quality effluent obtained (COD: 70 mg/L; BOD: 5.3 mg/L; TSS <10 mg/L; TN: 1.6 mg/L; TP: 0.93 mg/L) offered several options for local water re-use. The flowsheet here investigated is one of its kind, demonstrating multi-stream technologies focused on resource recovery that can be linked as single flowsheet or incorporated with traditional processes in existing treatment plants.

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FURTHER INSIGHTS INTO AEROBIC GRANULAR SLUDGE MICROBIOME AND PERFORMANCE

Two aerobic granular sludge reactors of 4.2 L fed with synthetic influent and operated under anaerobic-aerobic cycle and sludge retention time of 30d provided long-term stable granules (> 500 days) and removals of around 97% COD, 98% NH_4, 85% P and 77% total N. The abundance of P accumulating organisms (PAO, 6%) was significant, but ordinary heterotrophs (OHO) were dominant in the systems, not resulting in unstable granules. Moreover, it seemed contradictory that OHOs (PHA-aerobic storage bacteria) could still persist in the AGS, despite the fact that almost all the COD was removed during the anaerobic phase. The 16S rRNA analyses revealed the presence of fermentative anaerobes, micro-predators and other bacteria known for their strong proteolytic character, which predispose these OHOs to good survival in the systems. In contrast, the PHA aerobic-storing OHOs detected were characterised by some multivalence or extremophile character, but their long-lasting persistence in the sludge was inexplicable, suggesting some unknown synergy or metabolism.

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Session 6: Emerging Innovative Technologies

Keynotes

THE CUTTING-EDGE OF ELECTROCHEMICAL MEMBRANE TECHNOLOGY FOR WASTEWATER TREATMENT

The research underscores the potential of electrochemical membrane technology as a viable solution for wastewater treatment. Contaminants were efficiently removed by employing membrane electro-oxidisers (MEOs)

in conjunction with microfiltration or bifunctional electrocatalytic filter anodes, controlling membrane fouling effectively. The study yields promising results in removing color, turbidity, bacteria, and specific organic molecules, including 1,4-dioxane and perfluorooctanoic acid. The electrochemical filtration technology produces high-quality effluent with low transmembrane pressure and excellent permeability. Furthermore, the study suggests developing electrochemical membrane systems that simultaneously remove organic contaminants and produce hydrogen gas. These findings demonstrate that electrochemical membrane technology is an advanced wastewater treatment option with tremendous potential.

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CHARACTERISATION OF NITROGENOUS DISINFECTION BYPRODUCT PRECURSORS IN WASTEWATER BY CHEMICAL DERIVATISATION

Kim, Euna; Van Buren, Jean; McCurry, Daniel

In this study, we aimed to characterise the precursors of nitrogenous disinfection byproducts (N-DBPs) in real wastewater on a functional group basis, using chemical derivatisation techniques we adapted from the organic synthesis literature to selectively block primary, secondary, and tertiary amines. We hypothesised that the precursors of halonitroalkanes, N-nitrosoamines, and haloacetonitriles are amines, and selective derivatisation of these amines to protect the reactive functional group would diminish N-DBP formation potential during disinfection, indicating that these amines are the principal N-DBP precursors in wastewater. Secondary amines were responsible for most nitromethane formation. Tertiary amines were responsible for most NDMA formation, and dichloroacetonitrile formation was primarily attributable to primary amines. These results (1) allow us to attribute the precursor pool of priority N-DBPs to specific functional groups, and (2) show the potential of chemical derivatisation as a technique to characterise the precursors of DBPs in real waters.

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Presentations

CERAMIC ULTRAFILTRATION MEMBRANE OPERATION IN WATER REUSE APPLICATIONS USING SECONDARY EFFLUENT

Ahmadi, Javad; Schwaller, Christoph; Drewes, Jörg. E

Water reuse is a promising approach tackling the climate change issue by providing an alternative sustainable water resource, especially for agricultural and urban irrigation purposes. Ultrafiltration (UF) membrane system is one of the most appropriate advanced water treatment technologies for dealing with contaminations and risk mitigation in water reuse applications. Ceramic UF membranes have shown more robustness against intensive cleaning procedures compared to polymeric membranes. These systems have not been employed for water reuse purposes in large scales fed by secondary effluent. In this study, ceramic UF membranes are used in a water reuse system in WWTP of the city Schweinfurt. Several pre-treatment approaches for ceramic UF membranes, including pre-ozonation, powder activated carbon, and conventional coagulation processes were applied to achieve the highest operational stability, pathogen removal, as well as proper water quality for the downstream multibarrier treatment systems' efficiency.

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TRIHALOMETHANES IN DRINKING WATER: CAUSES, OCCURRENCES, PREDICTION AND CONTROL USING H_2O_2|UV + BAC PROCESSES

Trihalomethanes (THMs) are a group of regulated compounds formed during drinking water disinfection and are carcinogenic. The aim of this work was to analyze the causes and occurrences, establish model prediction as well as assess the technological and economic aspects of H_2O_2/UV + biological activated carbon (BAC) for THMs control. Operational parameters including temperature, contact time, chlorine doses, and water quality parameters such as organic content (DOC, UV254) were used for the analysis of factors of formation. It was found that the concentration of THMs at the WTPs is generally well below the maximum available value (MAV). High THMs of above 50%MAV occasionally occurred during warmer periods with long water ages. The large molecular weight UV254 adsorbing compounds correlate strongly with THMs formation. While chlorinated THM dominated the majority of detected THMs from Dams and River waters, the brominated THMs are the majority found in plants treating Groundwater, presumably due to the presence of Br-. The established multivariable prediction model incorporating operational parameters predicts the occurrences of THMs satisfactorily. Finally, the results of 4 months of operation of a pilot-scale H_2O_2/UV + BAC system aiming to control THMs < 50%MAV are presented. Technological and economical analysis shows that H_2O_2/UV + BAC is a competitive approach to other methods, deriving stable low THMFP water. The results of the work support the designing and retrofitting of plants to secure an even higher quality of water for the development of a sustainable and livable city of Auckland.

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RETROFITTING OF AN ELECTROCHLORINATION SYSTEM FOR THE SUSTAINABLE PROVISION OF SAFE DRINKING WATER IN REGIONAL AND REMOTE COMMUNITIES IN AUSTRALIA

Suliartini, Ni; Keller, Jurg; Ledezma, Pablo

Working hand-in-hand with water utilities and technology providers, we are developing and upscaling a novel membrane-less electrochemical solution for the removal of nitrate and heavy metals from groundwater. The novel EC+RR reactors (ElectroChlorination with expanded Reductive capacity by Retrofitting) do not require chemical consumables/additions and do not produce brines/wastes that require frequent disposal, while meeting quality targets ≤50% below current guidelines at a competitive energy consumption of 14 kWh/m^3.

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EFFECTIVE REMOVAL OF WATER CONTAMINANTS OF EMERGING CONCERN BY BIOLOGICALLY ACTIVE FILTERS

In biologically active filters (BAFs), microorganisms acclimated on the media surface are the key players responsible for removing organic water contaminants. In this study, next generation sequencing by Illumina MiSeq was used to characterise the microbial community structures in the influent, effluent, and media of a set of bench-scale BAFs that have been demonstrated with high removal efficiency (>75%) of 16 contaminants of emerging concern (CECs), which include a variety of pharmaceuticals (e.g., sulfamethoxazole and ibuprofen), x-ray contrast agent (i.e., iopromide), and pesticides (e.g., atrazine) that are prevalently found in municipal waste streams. Proteobacteria and Planctomycetes were the most abundant phyla in filter media, while the influent and effluent samples were dominated by Proteobacteria, Actinobacteria, and Chlamydiae. Factorial and principal component analysis revealed microbial structures in the media were significantly affected by the operation conditions, including media type (GAC versus dual media anthracite sand), EBCT (10 versus 18 minutes), and pre-ozonation. Detrended correspondence analysis demonstrated media materials predominantly governed the structures of the acclimated biofilm in BAFs as they provide direct attachment surface. This is in line with the higher microbial activity and better treatment performance exhibited by GAC BAFs compared to the dual media BAF, corroborating the importance of filter media selection to promote the acclimation of active and robust biofilm for efficient CEC removal. Principal component analysis revealed the significant influence from ozonation, which does not only break down CECs, but also stimulates microbes that grow on the ozonation products. Partial canonical correlation analysis further proved the shaping of biofilm communities on the BAF media is more associated with media type and ozonation compared to EBCT. Putative CEC degraders are predicted based on their dominance in the media and degradation capabilities reported in previous literature. This is the first study to examine the relationship between the microbial community structure and the BAF operating parameters, which are both aligned with the treatment performance exhibited by the BAFs.

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Poster Pitches

THE FATE OF LOW MOLECULAR WEIGHT ORGANIC MATTER IN THE ULTRAPURE WATER SYSTEM: MECHANISM IDENTIFICATION AND PERFORMANCE EVALUATION OF RO-VUV

Kwon, Jiuk; Kang, Yonghwan; Hong, Seungkwan

Controlling the organic contamination in the ultrapure water production system is now rising issue regarding water reuse due to water scarcity. In order to derive a way to improve removal of organic matter, performance evaluation of reverse osmosis process and vacuum UV oxidation process which are the core processes for decrease TOC concentration in the ultrapure water system were conducted and the removal mechanism at each process was studied. In RO process, the key factor is mean pore size of the membrane and vdV of the organic molecule. On the other hand, efficient collision between OH radical and organic matter is the key to improve degradation rate of TOC concentration. Finally, as a follow-up study, it is necessary to study an effective urea treatment technology suitable for application to ultrapure water production system.

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Session 7: Sustainable Green Technologies

Keynotes

WASTE TO RESOURCE: CIRCULAR ECONOMY APPROACH TOWARDS THE EFFECTIVE RE-USE OF IRON RICH DRINKING WATER SLUDGE IN THE URBAN WATER SYSTEM

Rebosura, Mario Jr; Salehim, Sirajus; Pikaar, Ilje; Keller, Jurg; Sharma, Keshab; Yuan, Zhiguo

In this study, the effects of iron-rich drinking water sludge-dosing in the sewer system on wastewater treatment and anaerobic digestion were investigated using a laboratory-scale urban wastewater system comprising sewer reactors, a sequencing batch reactor (SBR) for wastewater treatment, sludge thickeners, and anaerobic digestion reactors. Two systems were operated in parallel and fed with real domestic wastewater. The experimental system received in-sewer DWS-dosing at 10 mgFe L-1 while the control had none. The sulfide concentration in the sewer effluent decreased; the phosphate concentration in the SBR effluent decreased; The sulfide concentration of the

anaerobic digester decreased. The settleability of the mixed liquor suspended sludge (MLSS) improved, along with the dewaterability of the anaerobically digested sludge. The introduction of DWS into the experimental system significantly increased the COD and TSS concentrations in the wastewater, this did not affect normal operations.

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SIMULTANEOUSLY BIOGAS UPGRADING AND VALUE-ADDED CHEMICAL PRODUCTION IN A MEMBRANE BIOFILM REACTOR

Zhou, Linjie; Wu, Mengxiong; Guo, Jianhua

Biogas produced from anaerobic digestion usually contains impurities, particularly high content of CO_2 (15%-60%), thus decreasing its caloric value and limiting its application as an energy source. H_2-driven biogas upgrading via homoacetogens is a promising approach in converting biogas to biomethane and CO_2 to acetate simultaneously. Herein, we developed a novel membrane biofilm reactor (MBfR) with H_2 and biogas separately supplied via hollow fibre membranes. Biomethane content of 94% and acetate production rate of 450 mg/L/d were achieved with >97% H_2 and CO_2 utilisation efficiency. 16S rRNA gene amplicon sequencing suggested the enriched microbial communities were dominated by genus of Acetobacterium (38~48% relative abundance). In addition, reverse transcription quantitative PCR of the functional marker gene formyltetrahydrofolate synthetase (FTHFS) showed its expression level increased with increasing H_2 and CO_2 utilisation efficiency. These results indicate Acetobacterium might play a major role in CO_2 to acetate conversion. Further economic analysis suggests the application of H_2-driven biogas upgrading in WWTPs can potentially generate an extra profit of ~$3.6Ãff-105-3.8Ãff-105 per year from biomethane and offset approximately 75-102% COD demand from acetate. These findings are expected to facilitate energy-positive wastewater treatment and contribute to the development of a circular economy in WWTPs. Keywords: biogas upgrading; carbon and energy capture; membrane biofilm reactor.

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Presentations

QUANTITATIVE SUSTAINABLE DESIGN AND DECISION-MAKING FOR SANITATION AND RESOURCE RECOVERY TECHNOLOGIES-OPEN-SOURCE TOOLS AND APPLICATIONS

Li, Yalin; Lohman, Hannah; Zhang, Xinyi; Kim, Ga-Yeong; Morgan, Victoria; Rowles, Lewis; Watabe, Shion; Cusick, Ro; Guest, Jeremy

Research prioritisation is critical to expedite the development and deployment of sanitation and resource recovery technologies across the expansive landscape of potential pathways. This presentation introduces QSDsan-an open-source platform for process modeling, system design, techno-economic analysis (TEA), and life cycle assessment (LCA), and decision-making, all under uncertainty. After introducing the tool, we illustrate its application through two sets of examples: (i) advancing the research and development of emerging technologies including an algal wastewater treatment process (EcoRecover) and an anaerobic hydrogen and methane-producing system (modular encapsulated two-stage anaerobic biological system, METAB), and (ii) context-based deployment of three non-sewered sanitation (NSS) systems including Biogenic Refinery, NEWgenerator, and Reclaimer.

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DESTRUCTION OF SPENT MEDIA FROM PFAS TREATMENT APPLICATIONS USING SUPERCRITICAL WATER OXIDATION

Harif, Tali; Viswanathan, Sudhakar; Deshusses, Marc; Hatler, Douglas

Granular activated carbon (GAC) and anion exchange resin (AIX) are widely used for removal of per- and polyfluoroalkyl substances (PFAS) from water. Once the media is spent, it becomes a residual waste, requiring disposal. Various types of thermal technologies appear in the USEPA PFAS thermal treatment database, however, they cannot necessarily address efficiently destruction of PFAS saturated spent media, including complete PFAS destruction. Supercritical water oxidation (SCWO) is emerging as an efficient and sustainable PFAS destruction process. This paper is a first study using a commercially scaled SCWO system with AirSCWOTM technology to effectively destroy AIX and GAC spent media and the PFAS adsorbed or immobilised onto it.

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QUENCHING BIG-DATA'S THIRST: A NOVEL WATER RECYCLING STRATEGY FOR DATACENTER COOLING & COMMUNITY REUSE

Liberzon, Jon; Erdal, Ufuk

New process intensification and cooling technologies can be used to integrate and co-locate datacenters and wastewater treatment infrastructure. This provides mutual benefits to communities and datacenter operators through increased production of recycled water, net-positive cooling, land leases, renewable energy generation and other benefits. A modelling feasibility study comparing biofiltration and MBR-based intensification trains for datacenter-WRRF integration found that biofiltration achieved similar effluent quality at lower cost and with lower footprint requirements. Technical and economic feasibility of the concept was demonstrated using a novel closed-loop cooling approach which reduces energy requirements and improves sustainability of datacenter operation, especially in arid regions.

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INNOVATIVE THERMAL HYDROLYSIS PROCESS AS A GAME CHANGER FOR COMPACT AND EFFICIENT SLUDGE TREATMENT AT ANYANG BAKDAL WWTP

Anyang Bakdal underground WWTP treats 250,000 m^3/d of wastewater. Sludge from wastewater treatment, food waste leachate, and septic sludge are treated by advanced anaerobic digestion (AAD) with thermal hydrolysis process (THP) as pre-treatment, demonstrating innovative compact and efficient sludge treatment. Design parameters and operational experience since 2016 are outlined in the first THP plant in South Korea for sustainable biosolids management for low carbon circular economy.

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Poster Pitches

ENHANCING THE ECOLOGICAL VALUE OF CONSTRUCTED WETLANDS THROUGH A COMPREHENSIVE EFFICIENCY EVALUATION METHOD

Choi, Hyeseon; Jeon, Minsu; Jett, Reyes Nash; Kim, Leehyung

Constructed wetlands are considered nature-based solutions that provide various ecosystem services to humans and nature. Despite the known benefits of constructed wetlands, the value of these systems are only measured in terms of pollutant removal performance. Other functions of constructed wetlands, including cultural, provisioning, and supporting services, among others, are seldom considered in studies concerning the ecological value of nature-based systems. This study was conducted to develop a comprehensive evaluation index for constructed wetlands using field observations and the analytical hierarchy process (AHP). A total of 54 constructed wetlands installed across South Korea were utilised to establish an evaluation tool that can be used to assess the holistic performance of constructed wetlands. Results indicated that a comprehensive efficiency evaluation should be performed every five years to ensure that the constructed wetlands perform all intended ecosystem services. Moreover, facilities that do not meet satisfactory scores in the comprehensive evaluation must undergo design, operational, and maintenance improvements to ensure optimum benefits.

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UTILISATION OF LONG-TERM MONITORING DATA IN THE DEVELOPMENT OF A DEEP LEARNING MODEL FOR A RAIN GARDEN

Jeon, Minsu; Choi, Hyeseon; Jett, Reyes Nash; Kim, Leehyung

Low impact development (LID) technologies are applied in urban areas to solve environmental problems related to water quality degradation. An extensive collection of data from past monitoring activities and atmospheric sensors were used to assess the ability of deep learning models to predict the pollutant removal performance of LID technologies installed in urban areas. Three predictive models, including deep neural network (DNN), recurrent neural network (RNN), long short-term memory (LSTM) networks, were developed to determine the applicability of automatic sensors in monitoring a rain garden. Despite the relatively low accuracy of the three models, LSTM model was had the highest predictive accuracy. Moreover, the observed pollutant concentrations obtained from actual monitoring had similar trends with the modelled results. Since deep learning models require a large amount of data in order to achieve accurate results, it is still recommended to perform further monitoring activities to reduce the errors caused by lack of data. LID facilities also involve various biological mechanisms to treat polluted stormwater and thus, the installation of additional sensors intended for monitoring chemical transformation and biological activities in the system are recommended.

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CHARACTERISTICS AND WATER QUALITY BENEFITS OF RIPARIAN BUFFER ZONES IN YONGDAM WATERSHED, SOUTH KOREA

Reyes, Nash Jett; Geronimo, Franz Kevin; Guerra, Heidi; Choi, Hyeseon; Jeon, Minsu; Kim, Lee-Hyung

The Yongdam catchment in South Korea is one of the areas that are critically affected by agricultural NPS pollution. The creation of the riparian buffer zones, also known as eco-belts, as a nature-based environmental management approach is already implemented in the Yongdam catchment; however, this scheme is expected to have long-term effects and thus, it is necessary to assess the characteristics and effectiveness of these systems. This study was conducted to evaluate the water quality benefits of the riparian eco-belts in the Yongdam catchment. Soil and water quality monitoring was conducted to determine the effectiveness of eco-belts in mitigating the negative impacts of agricultural activities in the receiving water bodies. Overall, the eco-belts in the Yongdam catchment exhibited the capability to improve the water quality up to a certain extent, but further amendments in the design or components of the riparian buffers are essential to optimise the benefits of these nature-based systems.

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Posters

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INDUSTRIAL SOLUTIONS	
P1	Automating algae classification using deep learning by StyleGAN2-ADA-augmented images of rare freshwater algae Chan, Wang Hin; Fung, Benjamin Siu Bong; Tsang, Danny Hin Kwok; Lo, Irene Man Chi; *(Hong Kong SARy)*
SESSION 1: MONITORING AND REDUCTION OF GREENHOUSE GAS EMISSION	
P2	Alkalinity demand and successful ph control by CO_2 removal for stable treatment of municipal wastewater using anaerobic membrane bio-reactor Li, Yu-You; Du, Runda *(Japan)*
SESSION 2: SUSTAINABILITY	
P3	Awareness of rural communities on faecal contamination of water sources using sanitary risk and hydrogen sulphide test Murei, Arinao *(South Africa)*
P4	Biopolymer recovered from excess aerobic granular sludge used as flame retardant filler for plastics in the building material Lin, Yuemei *(The Netherlands)*
P5	Current groundwater arsenic pollution problems and potential treatment options in Bangladesh Haque, Md Tashdedul *(Korea)*
P6	Nitrogen removal efficacies of landfill leachates treatment by using partial nitritation and anammox processes both laboratory and full scales Noophan, Pongsak; Jaturongkach, Tanapon; Wantawin, Chalermraj *(Thailand)*
SESSION 3: ENERGY POSITIVE WASTEWATER TECHNOLOGIES	
P7	Considering the external and intrinsic application of sulfide dosing for the establishment of partial nitrification Magray, Hassan Owaes *(South Africa)*
P8	Energy trade-offs in design decisions of a novel anaerobic system for onsite treatment of industrial wastewaters Zhang, Xinyi; Rai, Saumitra; Song, Ian; Gutenberger, Gretchen; Ajayi, Olutooni; Wright, Natasha; Arnold, William; Novak, Paige; Guest, Jeremy *(United States)*
P9	High-rate activated sludge at very short SRT: Key factors for process stability and performance of cod fractions removal Cabrera Codony, Alba; Monclus, Hector; Poch, Manel *(Spain)*
P10	Integrated dark fermentation-microbial electrosynthesis system for enhanced wastewater treatment and energy recovery Tabish, Md; Minji, Park; Min, Booki *(Korea)*
P11	LCFAs accumulation and degradation in the methanogenic treatment of lipid-rich diary wastes using high-solid AnMBR Song, Liuying; Li, Yu-You *(Japan)*
P12	Managing key players to effectively use in-plant biodegradable carbon through a robust fermentation platform Sathyamoorthy, Sandeep; Cecconi, Francesca *(United States)*

P13	Mechanical scouring of media to control membrane fouling in a submerged hollow-fiber membrane reactor for synthetic greywater filtration Alam, Md Kawser; Kim, Jeonghwan *(Korea)*
P14	NEOM: through innovation, developing a global leading biosolids strategy to deliver the greatest benefits to the environment Burnett, Nick; Lancaster, Rick *(Saudi Arabia)*
P15	Preparation of graphitised porous carbides by low-temperature catalysis and its application in fermentation detection Chen, Yu-Hsin; Lin, Chin-Jung; Lin, Zhi- Yi; Huang, Yi-Shan *(Chinese Taipei)*
P16	Reinforced amine-rich pressure retarded osmosis membrane for efficient ammonia recovery and robust energy production Viet Nguyen, Duc; Wu, Di *(Korea)*
P17	Sustainable biohydrogen production in microbial electrosynthesis system using iron-sulfide complex nanomaterials Qing, Bu; Noori, MD Tabish; Booki, Min *(Korea)*
P18	Towards energy neutrality: Novel wastewater treatment incorporating acidophilic ammonia oxidation Zheng, Min *(Australia)*
P19	Use of fluidised agent with a conductive surface in anaerobic membrane bioreactor treating greywater Kim, Minseok; Choi, Changwoo; Cho, Eunho; Kim, Jeonghwan *(Korea)*
SESSION 4: INNOVATIONS IN DESALINATION	
P20	Automation of membrane capacitive deionisation process using real-time control system Shim, Jaegyu; Lee, Su-In; Yoon, Nakyung; Hwa Cho, Kyung *(Korea)*
P21	Application of alternating current for electrically conductive membrane (ECM) for inorganic scaling mitigation of membrane distillation (MD) Kim, Junghyun; Shon, Hokyong; Hong, Seungkwan *(Korea)*
P22	Effect of the natural organic matter fouling on the membrane of seawater battery desalination system Kim, Su Kyoung; Hwa Cho, Kyung *(Korea)*
P23	Enhanced asymmetric capacitive deionisation using Fe-MOF/rGO and GQDs@PANI/rGO nanocomposites as electrode materials Doong, Ruey-An; Nguyen, Thi Kim Anh *(Chinese Taipei)*
P24	Graphene oxides obtained from waste batteries for solar desalination Chen, Jing-Ting; Lin, Sin-Yi; Lin, Zhi-Yi; Lin, Chin-Jung *(Chinese Taipei)*
SESSION 5: EMERGING INNOVATIVE WASTEWATER TECHNOLOGIES	
P25	A quantitative review of PFAS elimination rates in domestic wastewater sludge using supercritical water oxidation Viswanathan, Sudhakar; Deshusses, Marc A; Harif, Tali; Hatler, Doug; Nagar, Kobe *(United States)*
P26	Activated carbons for acetaminophen removal and regeneration by photo-Fenton oxidation Lin, Sin-Yi; Chen, Jing-Ting; Chen, Yu-Hsin; Lin, Chin-Jung *(Chinese Taipei)*
P27	Activation of persulphate by a waste derived MIL-53(Fe)@Fe_3O_4 photocatalysts for effective degradation of salicylic acid Priyadarshini, Monali; Ahmad, Azhan; Ghangrekar, Makarand *(India)*

P28	Adsorption of green fluorescent protein-marked *E. Coli* on activated sludge flocks Ishizaki, Shota; Ishizuka, Yusuke; Higuchi, Kosuke; Oshiki, Mamoru; Nakaya, Yuki; Satoh, Hisashi *(Japan)*
P29	Aerosol synthesis of graphene-Fe_3O_4 composites and electrodes for applications in the electro-Fenton process Lin, Zhi-Yi; Lin, Chin-Jung; Ko, Pin-Jung; Chen, Yu-Hsin *(Chinese Taipei)*
P30	Applications of supersaturated oxygenation technology to biological wastewater treatment Kim, Sang Yeob; Brdjanovic, Damir; Garcia, Hector *(Korea)*
P31	Analysis of unamplified 16S RRNA of ammonia-oxidising bacteria in activated sludge by spectrophotometry using gold nanoprobes Satoh, Hisashi; Nakajima, Meri; Nakaya, Yuki *(Japan)*
P31A	Assessing the impact of ICT in operation optimisation in water service utility companies Mithamo, Jane; Supeyo, Charity *(Kenya)*
P32	Battery waste derived magnetic Fe-Mn-Zn/C composite as an electro-Fenton like catalyst for the degradation of sodium dodecyl surfactant Ahmad, Azhan; Priyadarshini, Monali; Ghangrekar, Makarand; Surampalli, Rao *(India)*
P33	Biosorption of aqueous Pb(II) by a metabolically inactive battery recycling plant consortium: The role of paraclostridium bifermentans Kpai, Patrick; Chirwa, Evans; Brink, Hendrik *(South Africa)*
P34	Bioactive anti-biofouling membranes with the immobilisation of live quorum-quenching bacteria Shah, Syed Salman Ali; Park, Hyeona; Lee, Kibaek; Choo, Kwang-Ho *(Korea)*
P35	Biochar enhanced the resilience of anammox to NO_2-/NH_4+ fluctuation by triggering nitrate reduction Li, Qian; Fu, Jingwei; Li, Yu-You *(China)*
P36	Challenges and solutions: Pioneer implementation of nutrient removal processes for domestic wastewater treatment facilities in Metro Manila Manrique, Angelica Euara *(Philippines)*
P37	Comparative study on degradation of carbamazepine by ultraviolet activated hydrogen peroxide and persulfate Rongkui, Su *(China)*
P38	Degradation of an insecticide carbaryl by UV|Cl process and identification of its degradation pathway Choi, Ayoung; Kim, Jungyeon; Kim, Gwangmin; Lee, Haesung; Han, Changseok *(Korea)*
P39	Degradation of phenol and selected contaminants of emerging concern (CECs) by catalytic wet peroxide oxidation (CWPO) and photo-assisted Fenton (PHF) under circumneutral PH Aad visible-light irradiation Galeano, Luis Alejandro; Vallejo, Carlos-Andre; García, Ana-Maria; Hidalgo-Troya, Arsenio; Hidalgo, Andres-Fernando; Paredes, Manuela-Alejandra; Burbano, Evelyn-Alejandra *(Colombia)*
P40	Demonstration of a multiple resource recovery wastewater treatment plant Soares, Ana *(United Kingdom)*
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P44	Digital transformation for water trunk mains location Sirithum, Panyawat *(Thailand)*
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P46	Effect of operational conditions on the performance of photocatalytic membrane process by response surface methodology analysis Jang, Hoseok; Lee, Chang Soo; Kim, Jong Hak; Kim, Jeonghwan *(Korea)*
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P51	Elucidating prioritised factor for mainstream partial nitritation between C|N ratio and dissolved oxygen Choi, Daehee; Yun, Wonsang; Jung, Jinyoung *(Korea)*
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P78	Fabrication of ceramic membranes from natural materials Alsubei, Mohammed; Campos, Luiza; Reid, Barry; Coppens, Marc-Olivier; Aljlil, Saad *(United Kingdom)*
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P80	Optimising membrane synthesis approach to enhance pharmaceutical rejection by uf nanoengineered GO-ZnO/ PES membranes Mahlangu, Oranso; Mamba, Bhekie *(South Africa)*
P81	Oxidation of trace aqueous aldehydes with dissolved oxygen and a platinum catalyst McCurry, Daniel; Kim, Euna *(United States)*
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P85	Removal of soluble Iron (II) and manganese (II) from natural water by peroxymonosulfate assisted oxidation process Hua, Lap-Cuong; Huang, Chihpin *(Chinese Taipei)*
P86	The development of transparent polypropylene jerrycans for solar disinfection (SODIS) of drinking water O'Dowd, Kris; Pillai, Suresh; Oller, Isabel; Polo-López, María Inmaculada, García-Gil, Ángela, Marugán, Javier; Gómez-Couso, Hipólito; Marasini, Ramesh; McGuigan, Kevin G *(Ireland)*
P87	The fate of low molecular weight organic matter in the ultrapure water system: mechanism identification and performance evaluation of RO-VUV Kwon, Jiuk; Kang, Yonghwan; Hong, Seungkwan *(Korea)*

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P89	Characteristics and water quality benefits of riparian buffer zones in Yongdam watershed, South Korea Reyes, Nash Jett; Geronimo, Franz Kevin; Guerra, Heidi; Choi, Hyeseon; Jeon, Minsu; Kim, Lee-Hyung *(Korea)*
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P92	Enhancing the ecological value of constructed wetlands through a comprehensive efficiency evaluation method Choi, Hyeseon; Jeon, Minsu; Jett, Reyes Nash; Kim, Leehyung *(Korea)*
P93	Improved secondary sludge anaerobic digestion by alkaline-thermal pretreatment Kim, Sang-Hyoun; Park, Jungsu *(Korea)*
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P96	Organic matter management for stringent industrial wastewater regulations in South Korea Kim, Sang Yeob; Maeng, Sung Kyu *(Korea)*
P97	Sewage sludge for sustainable composting technology toward green AlMuzaini, Saleh *(Kuwait)*
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P99	Wastewater reclamation using green technology Owako, Caroline *(Kenya)*
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LET 2023 posters from side event presentations

SP1	Application of pd/co/carbon composite as low-noble-metal content catalyst for persulfate activation: Exploring a role of co in enhancing persulfate activation efficacy and switching a primary oxidant Min, Dahye; Choi, Jaemin; Lee, Jaesang *(Korea)*
SP2	Effects of groundwater background anions on the treatment performance of heat activated persulfate Choi, Wooseok *(Korea)*
SP3	Effects of Ru heteroatom doping on electronic structure and electrocatalytic activity of CoFeP nanoframe structure Jang, Kunik; Kim, Dong-Wan *(Korea)*
SP4	Electronically modulated bimetallic ruthenium phosphide electrocatalysts for hydrogen evolution reaction Jung, Kyounghoon; Kin, Dong-Wan *(Korea)*
SP5	Enhancing the applicability of forward osmosis membrane process utilising food additives as draw solutes Yang, Seung-Heon; Hong, Seungkwan; Lee, Seockheon *(Korea)*
SP6	Experimental and theoretical analysis of membrane contactor for improving carbon dioxide stripping performance Lee, Seonkyu; Hong, Seungkwan *(Korea)*
SP7	Highly efficient Perovskite solar cells with CuSCN hole transport layer via 2D Perovskite protective layer interface treatment Kim, Geonhyeong; Noh, Jun Hong *(Korea)*
SP8	Highly selective performance ofsurface platinization TiO_2 (Pt-TiO_2) for photocatalytic oxidation of tetramethylammonium hydroxide (TMAH) and phenolic compounds Park, Taegeun; Lee, Jaewon; Shin, Yeojin; Hong, Seungkwan *(Korea)*
SP9	Improving efficiency & thermal stability of flexible Perovskite solar cell with interfacial defect engineering Kim, Su Hyun *(Korea)*
SP10	Intelligent monitoring of algal blooms using hyperspectral imaging system Kwon, Da Yun; Hong, Seungkwan *(Korea)*
SP11	Modified separators Using CeO_2@CNT nanocomposites as dual-mode li-polysulfide adsorption for high-performance lithium-sulfur batteries Kim, Dokyung; Kim, Dong-wan *(Korea)*
SP12	Ni-based electrocatalytic hydrogen production and electrodialysis with bipolar membranes Kim, Byeong-ju; Byun, Kyunghyun; Park, Hyunwoong *(Korea)*
SP13	Non-radical oxidation by nickel oxide/hydroxide in the presence of oxyanions: Role of Ni(III)/Ni(IV) as reactive intermediates Oh, Hoon; Kim, Ji-Young; Moon, Gun-hee; Lee, Jaesang *(Korea)*
SP14	Novel zero liquid discharge system of vacuum UV - flow electrode capacitive deionisation for sustainable tetramethylammonium hydroxide (TMAH) wasterwater treatment Shin, Yeojin; Lee, Jaewon; Lim, Jihun; Lee, Hyuncheal; Hong, Seungkwan *(Korea)*
SP15	Persulfate activation by Mn/N-doped carbon composites: Structure-sensitivity of catalytic performance and degradative pathway Song, Soyeon *(Korea)*

SP16	Process optimisation and analysis of FCDI through a comparative evaluation of multi-operational parameters Lee, Hyuncheal; Lim, Jihun; Sitepu, Amrina Rosyada; Hong, Seungkwan *(Korea)*
SP17	Stability improvement of inorganic Perovskite solar cells through solid-state-in-plane growth (SIG) Kang, Sohyun; Noh, Jun Hong *(Korea)*
SP18	Study of photoluminescence measurements for characteristics analysis of halide Perovskite films Cho, Hyeonah; Jun Hong *(Korea)*
SP19	Synthesis and development of the 2D siloxene for lithium ion batteries anode Kim, Se In; Kang, Jin Gu; Kim, Dong-Wan *(Korea)*
SP20	Usage of alternative water resources for various industry in Korea Lee, Kyung-Hyuk *(Korea)*

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- *Tofwerk* mass spectrometers (CI-TOF-MS_VOCUS S)

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- Establishment of the Korea Institute for Water Technology Certification (KIWATEC), which specializes in water technology certification/ verification and the development of relevant standards
- Donation of a water treatment facility (280,000 USD) to Vinh Long Province, Vietnam (2017)
- Implementation of an ODA project for Water Treatment Techno-Park in Columbia (2019~2023)

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- Water quality improvement in rivers: BOD 191mg/L (1983) > 2.4mg/L (2022)
- Investment of 3.8 billion USD in wastewater treatment system upgrades
- Winner of the silver prize from the UNEP's Asia Pacific Forum for Environment and Development (APFED) (2006)
- Selected as a pilot city for UNESCO's new project for "Seal of Excellence for Urban Water Management" (2021)

Global Water Partnership & Network

- Host city of the 7th World Water Forum (2015)
- Annually hosting the Korean Int'l Water Week (KIWW) since 2016
- Annually hosting the World Water Cities Forum (WWCF), where participants discuss urban water issues and solutions, since 2015
- Host city of the IWRA's XVII World Water Congress for the first time in East Asia (2021)

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