

# The 14th IWA Leading Edge Conference on Water and Wastewater Technologies



## Innovative technology solutions to address challenges at the water-energy-food interface



### Conference Programme

29 MAY – 2 JUNE 2017  
FLORIANÓPOLIS, BRAZIL

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**JULY 23-27, 2017**

**11<sup>TH</sup> IWA INTERNATIONAL CONFERENCE  
ON WATER RECLAMATION AND REUSE**

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**IWA's Prime Event on Water Reclamation and  
Reuse Comes to North America for the First Time**

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## Leading Edge Conference on Water and Waste Water Technologies



LET 2018 · Nanjing, China · #iwaLET

## INVITATION FROM THE IWA PRESIDENT



The 14th IWA Leading Edge Conference on Water and Wastewater Technologies is designed to be the place where new ideas are introduced and the opportunity is provided to interact with the “best of the best”. This is the IWA conference where a new insight into how pioneering science, technological innovation and leading practices shape the major transformation in water management that is underway.

Year after year, leading researchers can meet and discuss breakthroughs, but also new challenges for the water and wastewater communities. LET is an IWA “think tank” to develop solutions to these challenges, and combines the ideas and results of leading scientists with water industry practitioners, connecting the global with the local.

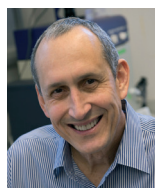
The 2016 LET took place in Jerez, Spain – after 2015 in Hong Kong and 2014 in Abu Dhabi – complementing the technological approaches of urban water management between megacities, smaller towns and rural environments, driven by the diversity of climatic conditions and the natural and human Environments.

Florianópolis is the city selected to provide the bridge towards the Americas, and to attract experts from the region, which is facing great water challenges. It showcases the integration of water between agriculture and cities.

It is a good place to measure the progress of knowledge and advanced technologies on topics such as resource recovery, control of micropollutants and pathogens of emerging concern, anaerobic technologies, materials and membrane granular processes. But it is also the place to move and try new routes. Decentralized technologies could be the right solutions for green fields and developing countries, and green-blue infrastructure another way to combine and optimize hard technologies and soft ones. Come and have a taste of 14th LET 2017. Florianópolis is waiting for you and your leapfrog ideas.

**Diane D'Arras**  
IWA President

## INVITATION FROM THE CHAIRMAN OF THE PROGRAMME COMMITTEE



Ensuring access to safe, inexpensive and reliable sources of water in a food- and energy-constrained world is one of the greatest global challenges of this century. Accordingly, the beneficial impact that technological innovation can have in controlling water pollution, recovering resources from used water, and making clean water more accessible to more people cannot be overstated.

On behalf of the Programme Committee, I invite researchers and practitioners worldwide to register for the 14th LET conference in the “Magic Island” of Florianópolis, Brazil. Your participation – as presenters and delegates – will ensure that LET maintains its hallmarks: the highest quality for a technical content that reflects scientific rigor and societal relevance (r2), and the greatest opportunity for networking.

The programme will be organized by themes, which are described in this brochure. The Programme Committee is inviting recognized world leaders to anchor each theme, and it seeks additional platform speakers, workshop leaders, and poster presenters to complement the invited speakers. All abstracts are peer reviewed to ensure high quality and thematic consistency. Indeed, the programme will feature only the “best of the best”. I encourage your participation and look forward to welcoming you to beautiful Florianópolis.

**Pedro Álvarez**  
Chair of the Programme Committee  
Rice University, United States

## INVITATION FROM THE CHAIRMAN OF THE ORGANISING COMMITTEE



Brazil is a country of continental dimensions having many natural resources, known for its great biodiversity and possessor of the largest springs in the world of surface and underground freshwater. Much of its economy comes from the extractive industry, having an important base industrial park and a transformation industry in development. Its environmental protection laws are restrictive, however, and it suffers from lack of supervision and resources for implementing advanced technologies to promote adequate control. With technological advancement, more efficient and lower-cost alternatives are being made available on the market, enabling Brazil to develop the management of its wastewater systems and treatment.

Being a developing country and possessing natural attributes that must be preserved, there are numerous business opportunities in the environmental area. Brazil has a large number of professionals who work directly with topics related to water and wastewater treatment issues, involving scientists, professionals from public and private companies, as well as consulting and national and multinational engineering companies, creating a very opportune time to host LET in 2017 in Florianópolis, in order to stimulate and create an environment for discussion of new technologies most suitable for application.

Participants will find in Florianópolis not only an environment with high-level technical discussions, but also a city with many natural and cultural resources, bringing a unique experience both professionally and personally.

**Hugo Moreira Soares**  
Chair of the Organising Committee  
Federal University of Santa Catarina, Brazil



## CONFERENCE TOPICS

### Advanced anaerobic technologies

Co-Chairs: Carlos Chernicharo and Juan M. Lema

Anaerobic digestion (AD) is a very powerful technology not only for an efficient waste and wastewater treatment but also for resource recovery. The session will address several topics: Integration of Anaerobic Digestion units with novel technologies such as anammox-based reactors, Bioelectrochemical systems or Pre-concentration strategies using physico-chemical or biological units; Processes considering the use of combined C/N/S cycles; Efficient AD reactors with enhanced biomass retention; Technologies for recovery or abatement of methane from effluents to reduce environmental impacts, namely in municipal wastewater plants; and Upgrading of biogas to biomethane to facilitate energy recovery.

### Advanced treatment materials and multifunctional membranes

Co-Chairs: Pedro Alvarez and Wei Chen

Novel materials are making significant improvements in the way we treat water, wastewater and solid waste. Nanotechnology utilizes materials at the nanometer scale, whose unique properties enable novel functions. It has been actively pursued for various applications in water and wastewater treatment including adsorption, catalysis, membrane separation and sensing. In addition, advances in membrane materials continue to bring innovation in membrane processes, whose application is becoming increasingly common in water and wastewater treatment systems of different scales. This session will address the development and application of such advanced materials to enable a paradigm shift of treatment from the current chemical- and energy-intensive processes to high efficiency, physical and catalytic processes that minimize chemical and energy use as well as waste production.

### Applying advanced microbiology/genetics tools

Co-Chairs: Tom Curtis and Trina McMahon

Microorganisms are key features of water and wastewater systems. Great advances have been made in the application of molecular tools to detect specific organisms and to disentangle how microbial communities assemble and interact. This session will feature outstanding examples of modern tools and approaches while emphasizing how they can be used to understand, predict and control engineered microbial ecosystems. Examples of such tools and approaches include the application of next-generation sequencing for metagenomic or metatranscriptomic analyses, powerful microscopy methods combined with stable isotope labeling, and metabolic flux modeling. Systems of interest include drinking water treatment systems, drinking water distribution systems, wastewater treatment systems, resource recovery systems and aquaculture systems.

### Green-blue infrastructure to enhance urban water management

Co-Chairs: Nilo de Oliveira Nascimento and Wolfgang Rauch

Blue-green infrastructure refers to approaches to integrate planning and management of urban space with water infrastructure. Such blue-green networks are multi-objective territorial structures aiming to promote biodiversity, reduce natural risks, and their impacts and create opportunities for leisure and sport activities, social cohesion and income generation, among other functions. This session will address challenges and opportunities arising from such an integrated approach and share experiences of first implementations – especially in (but not limited to) the context of South American metropolitan areas.

### Innovative biofilm and granular processes

Co-Chairs: Rejane Costa and Mark van Loosdrecht

Novel biofilm processes (e.g. MBBR, MABR) and aerobic, anammox and anaerobic granular sludge processes are under development or implementation, all leading to significant reduction of footprint and energy usage. This session aims to create an overview of the process engineering developments of such processes and illustrate this array of innovative technologies.

### Innovative decentralized technologies for developing countries

Co-Chairs: Jurg Keller and Doulaye Kone

Given the major challenges of implementing large-scale centralised technology solutions in many developing areas worldwide, particularly in the fast growing mega-cities, the need for novel, small-scale and/or decentralised technologies is clearly growing. This session will specifically look for such innovative ideas and solutions that can be applied from single-household to neighbourhood or precinct scales, for both safe water supply and sanitation systems. Also, examples of innovative non-sewered sanitation systems and solutions that may combine decentralised technology innovations within (partly) centralised systems will be explored.

### Resource recovery

Co-Chairs: Bruce Rittmann and Marcelo Zaiat

Wastewater can become a source of value and economic gain if its treatment is re-oriented to emphasize the recovery of water, energy, nutrients and, in some cases, other materials. This session focuses on emerging processes and systems of processes whose primary goal is recovering the resources present in "used water". Examples include direct anaerobic treatment to give a net energy output, nitrogen and phosphorus separation and concentration to provide high-value fertilizer feedstock, water reclamation for beneficial use, and recovery of other materials, such as metals and fiber.

### Technologies for control of micropollutants and pathogens of emerging concern

Co-Chairs: Marcia Dezotti and Amy Pruden

Water quality is threatened by chemical micro-pollutants of emerging concern, such as pharmaceuticals, personal care products, or endocrine disruptors, and by emerging pathogenic microorganisms, including chlorine- and UV-resistant viruses and protozoa, and antibiotic-resistant bacteria. Although there is still a lack of quantitative data on their effects on ecological and physiological processes, especially on human health, the detection of those contaminants in natural waters and wastewater treatment plant effluents raises concerns about the efficiency of current treatment processes. This session focusses on innovative technologies for the control of emerging contaminants in water and wastewater.

## LET2017 CONFERENCE PROGRAMME

Monday, 29 May 2017

### Workshops

11:30	Registration opens
13:00- 17:00	<b>Workshop 1:</b> Bringing Leading Edge Technology to the Market - A path of Innovation <b>Workshop 2:</b> Wastewater Treatment of Biorefinery
18:00	End of Day

### Workshops details:

**Workshop 1: Bringing Leading Edge Technology to the Market - A path of Innovation**

**Organiser:** BlueTech Research

**Objective:** One of the biggest challenges facing the water industry is to bring new technologies fully into the market place where they can be applied full-scale. Many effective appearing ideas spring out of bench-scale research but often never make it to market because the innovation process lacks many of the full-scale engineering and operational aspects. The process involves integrating many diverse resources and disciplines. This workshop will bring together successful innovators and technology companies for an exciting and insightful discussion on challenges and ways to improve bringing new technology to the market place.

**Topics:** The workshop will contain modules prepared by BlueTech Research covering the following areas:

1. Key success factors and failure nodes that are linked bringing leading edge technology to market.
2. Analysis of timelines required to commercialise a technology and move through the market adoption curve.
3. Case studies of different types of innovation in water.
4. Workshop discussion with participants looking at some of the next waves of innovation.

Guest speakers will also include Sembcorp, who will describe their work in setting up the Nanjing technology incubator in China to support technology transfer into the Chinese marketplace.

**Workshop 2: Wastewater Treatment of Biorefinery**

**Organiser:** Marcelo Zaiat and Hugo Moreira Soares

**Objective:** This workshop intends to present an overview of the byproducts generated in an ethanol biorefinery, mainly focusing the vinasse from sugarcane, and the potential to recover energy and value-added products by the application of anaerobic biotechnology. It is expected that participants will get a broad view of the productive process of bioethanol from sugarcane and other lignocelluloses sources with the characterization of the main byproducts generated, and of the role of anaerobic biotechnology for the energetic integration of the process.

**Topics:**

1. **The industry of bioethanol from sugarcane in Brazil**  
Overview of the current production of sugar and ethanol in Brazil, description of the production process and energy potential of a sugarcane biorefinery.
2. **Byproducts generated in bioethanol production**  
General description of the byproducts with the alternatives applied for bagasse, straw and vinasse. The focus will be on the characterization of vinasse as a more abundant and problematic waste.
3. **Potential application of anaerobic biotechnology for product and energy recovery from vinasse**  
Alternatives for anaerobic processing of vinasse, generation of biogas (hydrogen and methane), generation of biofertilizer and other value-added products.
4. **The Sugarcane Virtual Biorefinery (SVB) and its potential use to evaluate scenarios for energy utilization from vinasse**  
Presentation of the SVB tool and scenario simulations for anaerobic biodigestion of vinasse, environmental and economic balances, with energy integration of the process, including 1G2G ethanol.



Programme	Workshop 1
13:00 - 13:30	<b>Fundamentals of technology commercialisation in the water sector</b> Conor Dennehy, Bluetech Research
13:30 - 14:00	<b>The development of ceramic membranes</b> Johnathan Clement, PWN- Case study
14:00 - 14:30	<b>Identifying markets and common success factors</b> Conor Dennehy, Bluetech Research
14:30 - 15:00	<b>Developing new markets with innovative technology</b> Daniel Wong, Sembcorp
15:00 - 15:30	Coffee and breakout session
15:30 - 15:40	<b>Velocity to market</b> Conor Dennehy, Bluetech Research
15:40 - 16:40	<b>Case study examples and discussion</b> Bruce Rittmann, Arizona State University, Pedro Alvarez, Rice University

Programme	Workshop 2
13:00 - 13:30	<b>Lecture 1: The industry of bioethanol from sugarcane in Brazil and byproducts generated in the industrial process</b> Marcelo Loureiro Garcia, UNESP
13:30 - 14:00	<b>Lecture 2: Case study of BIOPAQ ICX reactor producing biogas from vinasse</b> Sérgio Cruz, PAQUES
14:00 - 14:30	<b>Lecture 3: VMethae – The edge technology for vinasse treatment</b> Luis Felipe Dornfeld Colturato, Methanum Residuo e Energia
14:30 - 15:00	<b>Lecture 4: Anaerobic digestion of sugarcane vinasse and biogas generation in high-rate hybrid anaerobic reactor (HANR)</b> Moacir Messias de Araujo Jr, Bioproj Tecnologia Ambiental
15:00 - 15:30	Coffee-break
15:30 - 16:00	<b>Lecture 5: Scenarios of energy production from vinasse, using the Virtual Sugarcane Biorefinery (VSB)</b> Antonio Bonomi, CTBE/CNPEM
16:00 - 16:40	<b>Discussion</b>



**Tuesday, 30 May 2017**  
Plenary Session

8:00	<p><b>Registration opens</b></p>
9:00	<p><b>Opening Ceremony</b>  <b>Pedro Alvarez</b>, Programme Committee Chairman of LET2017, USA  <b>Hugo Moreira Soares</b>, Organizing Committee Chairman of LET2017, Brazil  <b>Sebastião Roberto Soares</b>, Prorector UFSC, Brazil  <b>Helmut Kroiss</b>, IWA Immediate Past President, Austria  <b>Kennedy Nunes</b>, Santa Catarina State Deputy, Brazil</p>
9:30 - 10:15	<p><b>Advancing NGS Technologies for Investigating Engineered Water Systems</b>  <b>Joan Rose</b>, Michigan State University, United States</p>  <p>Prof. Dr. Joan Rose is currently a Professor at Michigan State University, and holds the Homer Nowlin Chair in Water Research. She serves as the Co-Director of the Center for Advancing Microbial Risk Assessment which addresses evidence-based risk assessments for management of waterborne pathogens. Dr. Rose is an international expert in water microbiology, water quality and public health safety, and has published more than 300 manuscripts. For more than 20 years she has been involved in drinking water investigations of waterborne outbreaks and is well known for her work on the waterborne outbreak of <i>Cryptosporidium</i> in Milwaukee. Her work addresses the monitoring of bacteria, protozoa and viruses in polluted recreational and drinking water using conventional and advanced techniques. Dr. Rose recently won the Stockholm Water Prize and is a member of the US National Academy of Engineers. She is a member of the Great Lakes Science Advisory Board for the EPA. She is currently a member of the National Academy of Sciences Board on Environmental Sciences and Toxicology. She is a Fellow of the IWA and Vice Chair of the US National Committee for IWA. Dr. Rose earned her Ph.D. in microbiology from the University of Arizona, Tucson.</p>
10:15 - 10:45	<p><b>Morning Tea/Coffee</b></p>
10:45 - 11:30	<p><b>Urban Wastewater Treatment In Brazil: Status, Perspectives, Challenges</b>  <b>Marcos von Sperling</b>, Federal University of Minas Gerais, Brazil</p>  <p>Prof. Marcos von Sperling works in the Department of Sanitary and Environmental Engineering of the Federal University of Minas Gerais, Brazil. Marcos is a civil engineer, having worked in the field of wastewater treatment for more than 35 years. He obtained his PhD in Environmental Engineering at Imperial College London. Professor von Sperling is an IWA Fellow and was Chair of the IWA Specialist Group on Wastewater Pond Technology. Marcos also serves as Editor of the IWA <i>Journal of Water, Sanitation and Hygiene for Development</i> and author of many journal papers and five books published by IWA.</p>
11:30 - 12:15	<p><b>Irruption of digital technologies in water management operations : value creation and perspectives</b>  <b>Carlos Campos</b>, Cefas - Weymouth Laboratory, United Kingdom</p>  <p>Dr. Carlos Campos has been with SUEZ since 1999. He is currently the Chief Operating Officer of Suez Advanced Solutions, a business line with the remit of proposing new services with innovative technologies and business models to clients in the municipal, industrial, and irrigation markets. He manages a worldwide network of service delivery platforms and "Technologies factories" in charge of the management of the portfolio Offering, and its evolution through both in-company developments and M&amp;A. Service Lines include Smart Water (including Smart metering), Revenue Management, Smart Building, Environmental Quality Monitoring, and Asset Performance (including Wells, Water Networks, and Sewers). Carlos former responsibilities within SUEZ included Senior VP Research and Innovation, General Manager for the SUEZ Technical and Research Network, and Senior VP of Environmental Technologies businesses within SUEZ water Spain (formerly Aqualogy).</p>
12:15 - 13:15	<p><b>Lunch</b></p>
13:15 - 14:00	<p><b>Utility Leadership: The Missing Link for Water Technology Innovation</b>  <b>Jonathan Clement</b>, PWN Technologies, The Netherlands</p>  <p>Jonathan Clement worked at Black &amp; Veatch for 18 years, most recently as a Global Technology Leader, prior to joining PWNT. His experience covers 10 years in the United States where he worked on advanced water technology projects with large water utilities. He was the principal investigator and co-investigator of 10 water research foundation (WRF) projects. He has won awards for innovation from the International Water Association (IWA) and published many articles in the area of distribution and water quality. Jonathan Clement has also worked for nearly a decade in Southeast Asia and Australia on advanced water technology projects including membranes and reuse. He has been a IWA fellow since 2012. He is the founder of the IWA's Leading Edge Water Technology Conference and was the Chairman for the first 6 years. In 2013 he received a special award for outstanding leadership for this. Since 2004 he has focused on expanding and improving the application of ceramic membranes for drinking water treatment.</p>



14:00 - 14:45

**Advanced Solution for Wastewater Reuse: Directional Transformation and Deep Removal of Low Dose Hazardous Organic Compounds**

**Aijie Wang**, Harbin Institute of Technology, China



Prof. Aijie Wang of Harbin Institute of Technology (HIT), and Professor of Eco-environmental Sciences, Chinese Academy of Sciences, P.R. China. Her research interests cover bio-based technology for heavily polluted industrial wastewater treatment and resources recovery from waste (water)/biosolids. A well-recognized feature of her research is the effective integration of fundamental (interdisciplinary) and practically applicable research. Her work on anaerobic acidogenesis of recalcitrant organic compounds based on the concept of biological phase separation have been proved to bring substantial benefits to the Chinese industries (e.g. Pharmaceutical Industry, Chemical Engineering Industry), which suffer from heavy pollution long. Her latest research on the electrochemically assisted anaerobic wastewater treatment significantly accelerates the reductive detoxification, decolorization and dehalogenation of refractory pollutants, as well as facilitates their deep removal from wastewater, which has been indicated by various application cases and got wide interests from industry in this technology. She was awarded as Distinguished Professor of Yangtze River Scholar by Ministry of Education in 2011. She received the National Outstanding Youth Science Fund Award in 2012, the Youth Science and Technology Innovation Talent Award in 2013 and the Ten-thousand People Program: Leading Talent Award in 2016. In 2015, she was awarded as a member of the IWA Fellows.

14:45 - 15:15

**Afternoon Tea/Coffee**

15:15 - 16:00

**Challenges in Anaerobic Treatment: Addressing Constraints**

**Jules van Lier**, Delft University of Technology, The Netherlands



Prof. Dr. Ir. Jules van Lier is full professor in "Wastewater Treatment / Environmental Engineering" at the Section of Sanitary Engineering of Delft University of Technology, with a 0.2 fte seconded position at Unesco-IHE, Delft. He received both his MSc and PhD from Wageningen University, The Netherlands, and specializes in anaerobic treatment technology. He has (co-)published over 200 papers in peer-reviewed journals and over 350 publications in conference proceedings and scientific books. Research projects are focused on closing water cycles in industries and sewage water recovery for irrigated agriculture. Jules van Lier chaired the IWA Anaerobic Digestion Specialist Group between 2001 and 2009 and is an associated editor of *Water Science & Technology*. In 2011 he became a nominated member of the IWA Fellows programme.

16:00 - 16:45

**Environmental causes for the emergence of diseases: precipitation and temperature**

**Paolo Zanotto**, University of Sao Paulo, Brazil



Prof. Paolo Zanotto, graduated in biology from the University of Sao Paulo (1981), gained a Masters degree in Molecular Virology from the University of Florida (1990), and a doctorate from the NERC Institute of Virology & Biochemistry, University of Oxford (1995). Has experience in microbiology, focusing on virology, and he acts in the following subjects: molecular biology, evolution, emergence and epidemiology of viruses.

16:45

**Industry Innovation Forum**

18:00

**Reception cocktail – poster hall**

**Wed, 31 May 2017**  
Technical Sessions

**Room 1**

**SESSION 1: INNOVATIVE BIOFILM AND GRANULAR PROCESSES**

**Co-Chairs:** Rejane Costa, Mark van Loosdrecht

08:30

**Keynote (1): From failures to successful granular sludge process: Hints for real wastewater treatment under coastal warm climate**

Lorena Guimarães and David Weissbrodt, Federal University of Santa Catarina (Brazil)

09:00

**Formation Of Aerobic Granular Sludge During The Treatment Of Industrial Chemical Wastewater**

Michel Caluwé, University of Antwerp (Belgium)

**Room 2**

**SESSION 2: GREEN-BLUE INFRASTRUCTURE TO ENHANCE URBAN WATER MANAGEMENT**

**Co-Chairs:** Nilo de Oliveira Nascimento, Wolfgang Rauch

**Keynote (1): From a blue and green vision to hard infrastructure - An interdisciplinary approach to planning and design of multi-functional spaces**

Christian Urich, Monash University, Melbourne (Australia)

**Transforming Sao Paulo Through Green Blue Infrastructure, The Pilot Project Of The Jaguare Creek**

Taícia Helena, Negrin Marques, University of Sao Paulo (Brazil)

09:15	<b>Unique Mechanisms Of Pore Formation In MABR Biofilms, And Its Effects On Process Performance</b> Marcelo Aybar, University of Concepcion (Chile)	<b>Assessing Of An Urban Watershed Hydrological Response To Rainfall-runoff Events In Different Land Use Scenarios</b> Deyvid Rosa, Federal University of Minas Gerais (Brazil)
09:30	<b>Discussions</b>	<b>Discussions</b>
10:00 - 10:30	<b>Morning Tea/Coffee</b>	
10:30	<b>Keynote (2): Two-stage granular sludge nitrification/ anammox process for mainstream wastewater treatment</b> Julio Perez, Autonomous University of Barcelona (Spain)	<b>Keynote (2): Towards Sustainable Urban Drainage Systems Planning - Experiences from Bogotá (Colombia)</b> Juan Pablo Rodriguez, University of The Andes (Colombia)
11:00	<b>Examination Of Biofiltration Operation Strategies For Organics Removal</b> Michael McKie, University of Toronto (Canada)	<b>Using Green Stormwater Infrastructure To Reduce Combined Sewer Overflow And Mitigate Runoff Up To 30-year Storm Event In</b> Nian She, Guangzhou University (Switzerland)
11:15	<b>Mainstream Partial Nitrification-anammox Process: Granular And Integrated Fixed Film Activated Sludge Systems</b> Alba Pedrouso, University of Santiago de Compostela (Spain)	<b>Vulnerability Assessment And Contamination Potential Of Unconfined Aquifer From Compensatory Infiltration Techniques</b> Jakcemara Caprario, Federal University of Santa Catarina (Brazil)
11:30	<b>Discussions</b>	<b>Discussions</b>
12:00	<b>Poster Pitch</b>	<b>Poster Pitch</b>
	<b>Towards Anammox Full-flow Implementation: Impact Of Environmental Conditions On The Microbial Competition</b> Marc Caligaris, SUEZ (France)	<b>Biological, Hydrologic And Economic Importance Of Forest Patches Maintenance In Urban Watersheds</b> Juliana Caroline da Silva, EP- University of São Paulo (Brazil)
	<b>Formation Of Aerobic Nitrite Granules Treating Two Different Industrial Wastewaters Originating From The Food Industry</b> Thomas Dobbeleers, University of Antwerp (Belgium)	<b>Empowering Remote Water Sensors Through Predictive Data-driven Modelling For Water Treatment Optimisation</b> Rodney Stewart, Griffith University (Australia)
	<b>Investigation Of The Impact Of Wood Ashes In Nitrifying Granule Formation</b> Jamile Wagner, CEBEDEAU (Belgium)	<b>Evaluation Matrix Of An Infiltration Trench As Compensatory Technique For Urban Stormwater Management.</b> Elisa Pacheco, Federal University of Santa Catarina (Brazil)
12:15 - 13:15	<b>Lunch</b>	
	<b>SESSION 3: TECHNOLOGIES FOR CONTROL OF MICROPOLLUTANTS AND PATHOGENS OF EMERGING CONCERN</b> Co-Chairs: Marcia Dezotti, Amy Pruden	<b>SESSION 4: ADVANCE ANAEROBIC TECHNOLOGIES</b> Co-Chairs: Carlos Chernicharo, Juan M. Lema
13:15	<b>Keynote (1): Antibiotic-independent Resistance Induction-Role of Environmental Pollutants in Antibiotic Resistance Phenomena</b> April Gu, Northeastern University (United States)	<b>Keynote (1): Recovery of Critical Metal and Metalloid Resources by Anaerobic Processes</b> Jim A. Field, University of Arizona (United States)
13:45	<b>The Cost-Benefit Of Technologies For The Control Of Emerging Contaminants In Water And Wastewater</b> Tanja Rauch-Williams, Carollo Engineers (United States)	<b>From Wastewater To Resource Source: AnMBR Technology For Urban Wastewater Treatment</b> Jose Vazquez Padin, FCC Aqualia S.A. (Spain)
14:00	<b>Micropollutants Control And Disinfection In A Fully Integrated Indirect Reuse Management Scheme: Lausanne WWTP</b> Christophe Mechouk, Suez & the City of Lausanne (France)	<b>Designing Biodigestion Plants For The Treatment Of Sugarcane Vinasse: Impacts Of Phase Separation And Alkalinization</b> Marcelo Loureira Garcia, University of São Paulo (Brazil)
14:15	<b>Discussions</b>	<b>Discussions</b>
14:45 - 15:15	<b>Afternoon Tea/Coffee</b>	
15:15	<b>Keynote (2): Mitigation Of Micropollutant Issue Along The Water Cycle</b> Sylvie Baig, SUEZ (France)	<b>Keynote (2): Recovering dissolved methane downstream of anaerobic processes: feasibility, economics and technology selection</b> Ewan McAdam, Cranfield University (United Kingdom)



15:45	<b>Photocatalytic Ozonation For The Removal Of Organic Micropollutants And Pathogens In Municipal Wastewater</b> Maggy Momba, Tshwane University of Technology (South Africa)	<b>Biological Treatment Of Ammonia-Rich Wastewater By Partial Nitrification/ANAMMOX In BioCAST Reactor</b> Nayareh Saborimanes, Concordia University (Canada)
16:00	<b>The Chemical Structure Of Organic Micropollutants Drives Their Enzymatic Biotransformation In Sewage Treatment Plants</b> Juan M. Lema, University of Santiago de Compostela (Spain)	<b>Utilization Of Duckweed (Spirodela Polyrhiza) For Sewage Treatment And Biogas Production: An Integrated Approach</b> Rubia Gaur, Doon University (India)
16:15	<b>Discussions</b>	<b>Discussions</b>
16:45	<b>Poster Pitch</b>	<b>Poster Pitch</b>
	<b>Enhancement Of E2 And EE2 Degradation In Activated Sludge Processes Through Hydrodynamics Optimization</b> Tamara Coello Garcia, Newcastle University (United Kingdom)	<b>Alterations In Carbon Flux Impair Glycerol Fermentation By Enterobacter Cloacae 9R At High Substrate Concentration</b> José Zorel, Federal University of Ouro Preto (Brazil)
	<b>Removal Of Micropollutants And Nutrients From Municipal Wastewater With Ozone And Granular Activated Carbon Filtration</b> Manon Bechger, Waternet (The Netherlands)	<b>Extended Design Algorithm Of Municipal UASB-reactors As A Tool For The Estimation Of Energy Recovery Potential</b> Klaus Nelting, NeTra Consult UG (h.b.) (Germany)
	<b>Cork Granules As Concentrators/Recuperators Of Oil: Studies On Oil Recovery By Mechanical Compression</b> Vitor Vilar, Federal University of Santa Catarina (Brazil)	<b>Brackish Water Treatment And Simultaneous Electricity Generation Driven By Microbial Desalination Cells</b> Simone Perazzoli, Federal University of Santa Catarina (Brazil)
17:00	<b>End of Day</b>	

## Thursday, 1 June 2017

### Technical Sessions

	Room 1	Room 2
	<b>SESSION 5: APPLYING ADVANCED MICROBIOLOGY/ GENETIC TOOLS</b> Co-Chairs: Tom Curtis, Trina McMahon	<b>SESSION 6: INNOVATIVE DECENTRALIZED TECHNOLOGIES FOR DEVELOPING COUNTRIES</b> Co-Chairs: Jurg Keller, Doulaye Kone
08:30	<b>Keynote (1): Paradoxes and Genius In Engineered Wastewater Treatment Systems</b> Tom Curtis, Newcastle University (United Kingdom)	<b>Keynote (1): Birthing the Decentralized (Non-Sewered) Sanitation Industry : Status update and Development of Non-sewer Sanitation system (ISO) Standard</b> Andreas Hauser, TÜV SÜD Asia Pacific Pte. Ltd. (Singapore)
09:00	<b>Bioenergetics Suggests A Novel Mechanism Of Energy Harvesting In Ammonia Oxidising Bacteria</b> Rebeca González-Cabaleiro, Newcastle University (United Kingdom)	<b>Can Microalgae-based Wastewater Treatment Plants Be Energy Self-sufficient?</b> Fabiana Passos, Federal University of Ouro Preto (Brazil)
09:15	<b>Phage Diversity In Activated Sludge Reflects The Environmental Differences That Select For Host Bacterial Communities</b> Leonardo Erijman, INGEBI-CONICET (Argentina)	<b>Sub-critical Wet Oxidation Of Excreta: Performance Review And Treatment Product Quality Evaluation</b> Niken Wijaya, SCION (New Zealand)
09:30	<b>Discussions</b>	<b>Discussions</b>
10:00 - 10:30	<b>Morning Tea/Coffee</b>	
10:30	<b>Biological Phosphorus Removal Through The Lens Of Microbial Ecosystems Biology</b> Trina McMahon, University of Wisconsin-Madison College of Engineering (United States)	<b>Keynote (2): Decentralised nutrient recovery from human excreta: empowering sanitation coverage by creating value on site</b> Pablo Ledezma, The University of Queensland (Australia)

11:00	<b>Evaluating Neutral Assembly In The Formation Of Water Filters Microbial Communities</b> Marta Vignola, Newcastle University (United Kingdom)	<b>Design And Implementation Of Integrated Electrochemical Wastewater Treatment And Recycling Systems For Onsite Sanitation</b> Clément Cid, Caltech (United States)
11:15	<b>Diversity And Dynamics Of Bacterial Communities In A Water Supply System</b> Ana Maria Batista, Federal University of Minas Gerais (Brazil)	<b>Integration Of Solar Septic Tank And Constructed Wetland For Treatment Of Black Water</b> Thammarat Koottatep, Asian Institute of Technology (Thailand)
11:30	<b>Discussions</b>	<b>Discussions</b>
12:00	<b>Poster Pitch</b>	<b>Poster Pitch</b>
	<b>Adaptation Of Ammonia Oxidizing Bacteria Under Low Dissolved Oxygen Conditions In Laboratory Scale Wastewater Treatment</b> Morais Cristiana, Newcastle University (United Kingdom)	<b>Reliability Analysis And Applicability Of The First Stage Of The French System Of Vertical Flow Constructed Wetlands</b> Camila Trein, Federal University of Minas Gerais (Brazil)
	<b>Evaluation Of The Bacterial Community Present In Biofilter With Peat Media</b> Maria Allievi, Federal University of Santa Catarina (Brazil)	<b>Denitrification In Constructed Wetlands Enhance By Anammox</b> Adriano Tonetti, State University of Campinas - UNICAMP (Brazil)
	<b>Microalgae Growth And Nutrient Removal In Photobioreactor With Black Water Previously Treated In UASB Reactor</b> Nathalie Slompo, University of São Paulo (Brazil)	<b>Vertical Flow Constructed Wetland With Recirculation In Southern Brazil: Removal Of Organic Matter And Solids</b> Delmira Wolff, Federal University of Santa Maria (Brazil)
12:15 - 13:15	<b>Lunch</b>	
	<b>SESSION 7: RESOURCE RECOVERY</b> Co-Chairs: Bruce Rittmann, Marcelo Zaiat	<b>SESSION 8: ADVANCE TREATMENT MATERIALS AND MULTIFUNCTIONAL MEMBRANES</b> Co-Chairs: Pedro Alvarez, Wei Chen
13:15	<b>Keynote (1): How To Manage Microbial Communities To Recover Energy From Wastewater Systems?</b> Claudia Etchebehere, Clement Estable Biological Research Institute (Uruguay)	<b>Keynote (1): Overcoming Implementation Barriers for Nanotechnology in Drinking Water Treatment &amp; A Case Study</b> Paul Westerhoff, Arizona State University (United States)
13:45	<b>Impact Of pH On The Product Spectrum Of A Granular Sludge Bioreactor Producing Mainly Odd-numbered Volatile Fatty Acids</b> Alexander Hendriks, Delft University of Technology (The Netherlands)	<b>SBR Anaerobic / Aerobic Coupled To Photocatalysis For The treatment Of Azo Dye Direct Red 23</b> Rubí Casimiro-Chávez, Autonomous University of the State of Morelos (Mexico)
14:00	<b>Potential To Produce Lactic Acid From Cassava Flour Wastewater Using Indigenous Mixed Culture</b> Jéssica Cavalcante, EESC- University of São Paulo (Brazil)	<b>Increasing COD Removal And Energy Efficiency Of An AnMBR By Using The Membrane As Microbial Anode</b> Joana Madjarov, University of Freiburg (Germany)
14:15	<b>Discussions</b>	<b>Discussions</b>
14:45 - 15:15	<b>Afternoon Tea/Coffee</b>	
15:15	<b>Keynote (2): Maximizing the Value of Resources Recovered from Wastewater</b> Bruce Rittmann, Arizona State University (United States)	<b>Keynote (2): Nanophotonics Enhanced Membrane Distillation: Potentials And Limitations. Multifunctional Membranes for Solarthermal and Electric Resistance Heating in Membrane Distillation</b> Qilin Li, Rice University (United States)
15:45	<b>Removal And Recovery Of Nutrient Without Biology: Understanding The Challenge Of Implementing A New Paradigm</b> Bruce Jefferson, Cranfield University (United Kingdom)	<b>Solar Semiconductor Photocatalysis For Advanced Water Treatment: Performance Of Novel Catalysts Activated By Sunlight</b> Rafaela Marcelino, Federal University of Minas Gerais (Brazil)
16:00	<b>Resource Recovery From Acid Mine Drainage Without Chemical Dosing Using Microbial Electrochemical Technologies</b> Pablo Ledezma, Advanced Water Management Centre, The University of Queensland (Australia)	<b>Life Cycle Evaluation Of Anaerobic Membrane Bioreactor Co-Management Of Domestic Wastewater And Food Waste</b> Adilson Becker Jr., University of Southern California (United States)

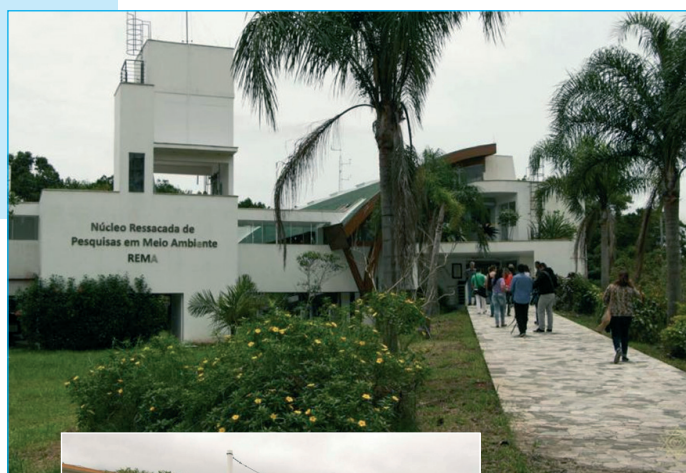
16:15	<b>Discussions</b>	<b>Discussions</b>
16:45	<b>Poster Pitch</b>	<b>Poster Pitch</b>
	<b>Recovering Energy From Two Stage Anaerobic Digestion Of Effluent Generated In Second Generation Bioethanol Production</b> Sergio F. De Aquino, Federal University of Ouro Preto (Brazil)	<b>Expanding The Sustainability Of Reverse Osmosis Membranes</b> Miriam Amaral, Federal University of Itajubá (Brazil)
	<b>Extreme Thermophilic Biohydrogen Production From Sugarcane Stillage In Structured Anaerobic Packed-bed Reactor</b> Mirian Krauspenhar Niz, EESC- University of São Paulo (Brazil)	<b>Tailoring Silica-cage Frameworks Of Natural Macroporous Materials</b> Marcia Silva, University of Wisconsin-Milwaukee (United States)
	<b>Biogas Recovery From Blackwater And Sewage Sludge As A Transition Component Towards Resource-Oriented Sanitation</b> Carlo Morandi, University of Stuttgart (Germany)	<b>Commercial Membranes Modification With TiO<sub>2</sub> Nanoparticles By Layer- Deposition Method For Textile Wastewater</b> Maria Teresa Pessoa Amorim, University of Minho (Portugal)
17:00	<b>End of Day</b>	
	<b>Closing ceremony</b>	
	<b>Gala Dinner (Hotel Slaviero Essential)</b>	

Friday , 2 June 2017

## Technical Visits (8:00-12:00)

### 1 Universidade Federal de Santa Catarina Experimental Sites

Visit to two laboratories with experimental sites that have pilot studies, one being at Algae Cultivation Laboratory (LCM) and the other at Contaminated Soil Bioremediation (REMA).



### 2 Sewage Treatment Decentralised Systems

Two different systems will be visited, one using up-flow anaerobic sludge blanket (UASB) reactor and one using sequencing batch reactor (SBR).





## PROGRAMME AND ORGANISING COMMITTEE

### Programme Committee Core Group

<b>Bruce Rittmann</b>	Arizona State University (United States)
<b>Hugo Moreira Soares</b>	Federal University of Santa Catarina (Brazil)
<b>Jurg Keller</b>	The University of Queensland (Australia)
<b>Mark van Loosdrecht</b>	Delft University of Technology (The Netherlands)
<b>Pedro Alvarez</b>	Rice University (United States)

### Programme Committee Members

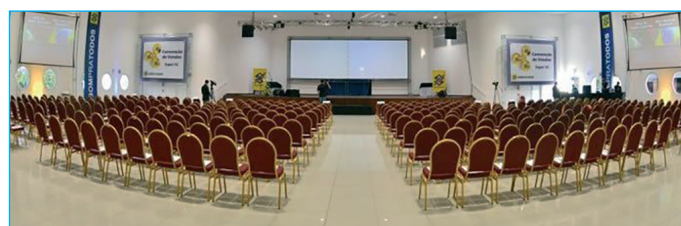
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<b>Wei Chen</b>	Nankai University (China)
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<b>João Grilo</b>	IWA (The Netherlands)
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<b>Marco Di Luccio</b>	Federal University of Santa Catarina (Brazil)
<b>Maria Eliza Hassemer</b>	Federal University of Santa Catarina (Brazil)



## CONFERENCE VENUE

The 14th Leading Edge Conference on Water and Wastewater Technologies will be hosted at:

### Oceania Convention Centre

Rua do Marisco, 550 - Ingleses Centro, Florianópolis, Santa Catarina, Brazil

### GALA DINNER VENUE

Hotel Slaviero Essencial  
Rua das Gaivotas, 1114 - Ingleses Norte, Florianópolis - SC, 88058-500, Brazil

### ENQUIRIES

#### Conference Programme Secretariat

Please contact: [let2017@iwahq.org](mailto:let2017@iwahq.org)

#### Registration Secretariat

Please contact: [Registrationlet2017@iwahq.org](mailto:Registrationlet2017@iwahq.org)

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Do you want to read all the details of the content being presented during the Conference? Visit the Digital Proceedings:  
<https://www.eventscribe.com/2017/LET>

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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.



**UNIVERSIDADE FEDERAL DE SANTA CATARINA**

The **Universidade Federal de Santa Catarina (UFSC)** is committed to excellence and solidarity towards the construction of a more just and democratic society. The university counts a community of fifty thousand people, including teachers, administrative staff, and students.

# SESSION 1: INNOVATIVE BIOFILM AND GRANULAR PROCESSES

## PRESENTATIONS

### **IS KN1 From Failures To Successful Granular Sludge Process: Hints For Real Wastewater Treatment Under Coastal Warm Climate**

L. Guimarães, J. Wagner, T. Akaboci, G. Daudt, P. Nielsen, M. van Loosdrecht, D. Weissbrodt, R. Costa (Brazil)

Granular sludge technology for municipal wastewater treatment expands worldwide. Sewage composition and climate differ geographically, impacting granulation and biological nutrient removal (BNR). Process implementation requires investigating under local settings. Impact of low-strength domestic wastewater and warm climate on granular sludge physical properties and nutrient removal was studied at pilot scale. Two SBR were tested, involving (i) pulse feeding followed by an idle period and (ii) slower up-flow feeding, both prior to aeration. Slower static feeding was beneficial for hydrolysis of particulate organic matter, biomass accumulation, and P-removal. Along with microbial ecology principles, keys for successful engineering will consist in the management of well-functioning (i) anaerobic selector for COD uptake and (ii) aeration control to limit endogenous respiration while enhancing nitrogen removal. Parametrization of cycle configuration is conducted for higher water quality.

Lorena Guimarães and David Weissbrodt, Federal University of Santa Catarina, UFSC, Brazil. (lobguimaraes@gmail.com)

### **OP1 Formation Of Aerobic Granular Sludge During The Treatment Of Industrial Chemical Wastewater**

M. Caluwé, T. Dobbeleers, J. D'aes, S. Miele, V. Akkermans, D. Daens, L. Geuens, F. Kiekens, R. Blust, J. Dries (Belgium)

Aerobic granular sludge (AGS) has been proven to be a significant step forward in biological wastewater treatment. The system is getting increasingly used for the treatment of domestic wastewater, although formation of granules in industrial applications needs more research. In this study, a chemical industrial wastewater from the harbour of Antwerp (Belgium) was used to turn poor settling sludge over into granular sludge. Two reactor setups were used, a completely aerated sequencing batch reactor (SBR) with a feast famine regime and a SBR operated with an alternating anaerobic feast/aerobic famine strategy. In both reactors granulation was reached after 30 days. After a stable period, reactor operation was changed and organic loading of the sludge was changed. As a conclusion of this research it is shown in that the influent composition plays a key role in the stability of the granules.

Michel Caluwé, University of Antwerp, Belgium. (michel.caluwe@uantwerpen.be)

### **OP2 Unique Mechanisms Of Pore Formation In MABR Biofilms, And Its Effects On Process Performance**

M. Aybar, P. Perez-Calleja, R. Nerenberg (Chile)

The membrane-aerated biofilm reactor (MABR) is a novel wastewater treatment technology based on air-supplying, hollow-fiber membranes. Biofilms naturally form on the membrane surface, providing nitrification and denitrification, and allowing up to 100% oxygen transfer efficiencies. In this work, we showed that certain operating conditions promote the formation of pores or voids within MABR biofilms. This was determined via advanced imaging techniques, microelectrodes and modelling. Our results suggest a link between metabolic activity and pore development. Large pores form in the interior of the biofilms when the bulk-supplied substrate become rate limiting within the biofilm. Pores may result from unique growth patterns within the biofilm, or from special modes of decay and predation. Understanding the dynamics of a pore development can help to identify critical operational conditions, which could explain some bench, pilot and full scale observations.

Marcelo Aybar, University of Concepción (UDEEC), Chile (maybar@udec.cl)

**IS KN2 Two-Stage Granular Sludge Nitritation/Anammox Process For Mainstream Wastewater Treatment**

J. Perez (Spain)

Autotrophic nitrogen removal through partial nitritation – anammox (PN/AMX) in the mainline of wastewater treatment plants would result in considerable energy savings because of (i) a decrease in oxygen requirements compared to conventional nitrification-denitrification processes and (ii) more incoming COD available to produce energy. Among the different alternatives for process configuration, a two-stage PN/AMX has proven to attain promising results in recent lab scale trials. In the first reactor, granular sludge is used to oxidize roughly half of the ammonium into nitrite under stable conditions. Stability has been demonstrated at temperatures as low as 10°C for several months, treating synthetic wastewater (nitrogen loading rate at 10°C 0.6 kgN·m<sup>3</sup>·d<sup>-1</sup>). The stratification of the ammonium-oxidizing bacteria (AOB) in the biofilm, occupying the external shell has been found of importance for the competition for oxygen between AOB and nitrite-oxidizing bacteria (NOB). A pH gradient in the granule was measured and it is thought to play an important role in the process stability. In a second stage, ammonium and nitrite are substrates for anammox bacteria, completing nitrogen removal by producing N<sub>2</sub>. The anammox reactor configuration is an upflow anaerobic sludge blanket (the so called upflow anammox sludge bed, UAnSB). This reactor demonstrated unique behavior against decreases in temperature due to the overcapacity built up during the operation and the plug-flow hydrodynamics. The reactor operated under stable conditions at 11°C during several months treating synthetic wastewater (nitrogen loading rate at 11°C 0.9 kgN·m<sup>3</sup>·d<sup>-1</sup>) as well as real wastewater (nitrogen loading rate at 11°C 0.6 kgN·m<sup>3</sup>·d<sup>-1</sup>). An overall picture of the advances in the development of this approach will be presented at the conference.

Julio Perez, Autonomous University of Barcelona, Spain (julio.perez@uab.es)

**OP3 Examination Of Biofiltration Operation Strategies For Organics Removal**

M. McKie, L. Taylor-Edmonds, S. Andrews, R. Andrews (Canada)

A pilot-scale biofiltration study was conducted to compare the performance of continuous and cyclical operation for drinking water treatment. This study examined changes in water quality and biomass characteristics to determine their impact on organics and disinfection by-product (DBP) precursor reduction. Continuous operation led to increased concentrations of active biomass; shorter empty bed contact times (EBCT) resulted in increased biological enzyme activity. Filters operated with a shorter EBCT improved removals of organics (as measured by dissolved organic carbon), whereas continuous operation improved reductions of DBP precursors. It is recommended that filters be operated continuously where possible. If cyclical operation is required due to plant capacity, higher flow rates will maximize organics reduction.

Michael McKie, University of Toronto, Canada (m.mckie@mail.utoronto.ca)

**OP4 Mainstream Partial Nitritation-anammox Process: Granular And Integrated Fixed Film Activated Sludge Systems**

A. Pedrouso, J. Trela, Á. Val del Río, N. Morales, J. Campos, A. Mosquera-Corral, E. Plaza (Spain)

The stable partial nitritation-anammox (PN/A) process implementation in the main line of a wastewater treatment plants would lead them closer to the energy autarky. In this study, granular sludge and integrated fixed film activated sludge (IFAS) reactors are presented as two promising configurations to develop the one-stage mainstream PN/A process. This work is focussed on the analysis of the different biofilm forms (granules or attached biomass on carriers) and the segregation of different microbial populations. In case of the IFAS system, ammonium oxidizing bacteria (AOB) were more abundant in the activated sludge while anammox bacteria were primarily located in the biofilm. In the granular sludge both anammox and anammox are in the granule. Regarding the undesirable nitrite oxidizing bacteria, they are more predominant or active in flocs.

Alba Pedrouso, University of Santiago de Compostela, Spain (alba.pedrouso@usc.es)

**POSTER PITCHES**

**P114 Towards Anammox Full-flow Implementation: Impact Of Environmental Conditions On The Microbial Competition**

I. Mozo, T. Saur, G. Gaval, M. Caligaris, B. Barillon (France)

Deammonification process has brought opportunities for efficient nitrogen removal under more economically and environmentally friendly conditions for wastewater treatment. However, one of the main challenges to overcome is the competition of anammox bacteria with other species. Anammox reaction was investigated in an SBR pilot plant during a whole year. A change from centrate to a mainstream wastewater biologically treated, lead to a switch on microbial populations. The ratio AOB/NOB changed from 4 to 0.5 and the anammox bacteria relative amount decreased. Although anammox reaction was kept as the main process, the influence of the matrix nature should not be neglected. In addition, several short-term tests were performed under aerobic and anoxic conditions. In the latter, the NH<sub>4</sub><sup>+</sup>, NO<sub>2</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup> and COD concentration was varied showing that anammox reaction remains the main mechanisms under concentrations of COD lower than 180 mgCOD/L, when the COD/NH<sub>4</sub><sup>+</sup>-N ratio ranges between 1.5 and 4.

Marc Caligaris, SUEZ, France (marc.caligaris@suez.com)



**P101 Formation Of Aerobic Nitrite Granules Treating Two Different Industrial Wastewaters Originating From The Food Industry**

T. Dobbeleers, D. Daens, S. Miele, J. D'aes, M. Caluwé, L. Geuens, J. Dries (Belgium)

In this study formation of aerobic nitrite granules (ANG) was examined, treating two different industrial wastewaters. It has been shown that granules can be formed for these types of wastewater, although the time to develop might be different. Through the use of aeration control strategies it was possible to maintain the nitrite-pathway, which was proved by activity measurements and qPCR analysis for AOB and NOB. Furthermore, an excellent COD and N-removal could be realised, while the P-removal showed more variation throughout the experiments.

Thomas Dobbeleers, University of Antwerp, Belgium (thomas.dobbeleers@uantwerpen.be)

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**P112 Investigation Of The Impact Of Wood Ashes In Nitrifying Granule Formation**

J. Wagner, B. Schoonbroodt, C. Meunier (Belgium)

Several studies attempted to evaluate different strategies to enhance the formation of slow growth nitrifying bacteria. One possible option is the addition of carriers to stimulate microbial growth and granule formation. Wood ashes have an intrinsic use value due to chemical composition, low cost, and good adsorbent properties. The present study aims at evaluating the impact of the use of ashes as biomass carriers on nitrifying granule formation and substrate removal efficiency. Two reactors fed with synthetic wastewaters are under operation in absence (R1) or presence (R2) of wood ashes. The preliminary results showed that higher biomass retention in the reactor and better settleability of the sludge were obtained in R2 (with ashes). Ashes can be regarded as a promising cost-effective product to enhance nitrifying granulation.

Jamile Wagner, CEBEDEAU, Belgium (jwagner@cebedeau.be)

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## SESSION 2: GREEN-BLUE INFRASTRUCTURE TO ENHANCE URBAN WATER MANAGEMENT

### PRESENTATIONS

#### **IS KN3 From A Blue And Green Vision To Hard Infrastructure - An Interdisciplinary Approach To Planning And Design Of Multi-Functional Spaces**

C. Urich (Australia)

In the context of climate change and increasing urban density, innovative adaptation measures are needed to enhance the flood resilience of cities. There is an emerging paradigm for land use planning and urban design that includes integrated urban water systems specifically for addressing increased flood vulnerability associated with rising sea levels and anticipated higher climate variability including more intense storms. This necessarily involves multiple disciplines to support the identification and delivery of a suite of technical, design and policy strategies that fit well with an area's local cultural, geographical and ecological context. This presentation discusses the application of such an integrated approach to planning to the case study of the Elster Creek Catchment, Melbourne, Australia that draws from social science, architecture, urban planning and environmental engineering to develop solutions for increasing a local area's resilience to flooding and urban liveability.

This presentation will show that adaptation to ensure a city's flood resilience and long-term liveability involves a range of technical, urban design, policy and social measures to retreat from, adapt to and defend against flooding. Developing and implementing a full and complementary suite of such strategies therefore requires an integrated and interdisciplinary approach to: (1) engage effectively with communities to understand their concerns, aspirations and priorities, (2) utilise modelling techniques to test the performance, robustness and economic viability of proposed adaptation solutions, and (3) design specific measures to densify and activate urban forms in ways that implement the proposed solutions while responding to the local contextual conditions.

The outcomes showed that, with appropriate guidance, community stakeholders were capable of problem-solving at multiple scales simultaneously. The community's adaptation ideas for improving flood resilience were developed through analytical insights gained from modelling and urban design processes, which helped identify how the envisioned water future for Elwood could be achieved. This interdisciplinary experience highlighted the need for an integrated approach to strategy development, in which ideas are iteratively refined with different disciplinary insights.

Christian Urich, Monash University, Australia (christian.urich@monash.edu)

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#### **OP5 Transforming Sao Paulo Through Green Blue Infrastructure, The Pilot Project Of The Jaguare Creek**

T. Negrin Marques, D. Rizzi, E. De Souza Tominaga, P. Mesquita Pellegrino, J. Scarati Martins, N. Becker de Moura, A. Zubiaurre Brites, A. Daniel Morihama (Brazil)

The partial results of the proposal of a green-blue infrastructure network for the Jaguare Water Basin, located in the city of Sao Paulo, are being presented. Making use of geoprocessing tools, the multi scale project analyses the application of low impact development (LID) facilities in open spaces throughout the basin, to further analyse their design in a local scale. The methodology shall be replicable to other urban water basins of Sao Paulo's Metropolitan Area.

Taícia Helena Negrin Marques, University of São Paulo, Brazil (marques.taicia@gmail.com)

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#### **OP6 Assessing Of An Urban Watershed Hydrological Response To Rainfall-runoff Events In Different Land Use Scenarios**

D. Rosa, N. Nascimento, P. Macedo, G. Macedo (Brazil)

This paper presents preliminary results of a research which intends to assess the response of an urban watershed to rainfall-runoff events in different scenarios. In this sense, hydrological and hydraulic models were constructed to assist in the analysis and to study possible ways to lessen the occurrence of flash floods. Results of preliminary GIS analysis of the watershed and hydrological modelling are presented and briefly discussed. The research is still on-going, but it can be noted in the shown preliminary results, the remarkable influence of green and pervious areas on reduction of peak flow and runoff volume, as well as confirm the hydrological benefits of possible implementation of Green and Blue Infrastructure in the watershed.

Dayvid Wavel Barreto Rosa, Federal University of Minas Gerais (UFMG), Brazil (dwbarreto@gmail.com)

### **IS KN4 Towards Sustainable Urban Drainage Systems Planning - Experiences from Bogotá (Colombia)**

J. P. Rodriguez (Colombia)

Augmentation of urbanized areas and densification of cities have raised flooding events frequency and have caused degradation of receiving water bodies as a result of changes in the natural hydrological cycle. Besides, conventional urban water management has focused in evacuating the runoff as quickly as possible, which increases the negative effects of the urbanization process. Therefore, an alternative approach for the management of urban waters is the use of sustainable urban drainage systems (SUDS) to prevent and mitigate these effects. The success of SUDS depends on the correct interpretation of the needs and opportunities of a particular area. In this presentation, different research efforts that have been recently carried out in the context of Bogotá (Colombia) will be presented. The main aspects to be discussed are:

- (a) A methodology that guides the planning of SUDS in public areas based on a multi-scale approach and cost-benefit quantification.
- (b) A methodology for identifying the feasibility of implementing non-structural and structural storm water management in private land uses.
- (c) A methodology for optimal SUDS siting and pre-dimensioning.

Juan Pablo Rodriguez, University of the Andes (UNIANDES), Colombia (pabl-rod@uniandes.edu.co)

### **OP7 Using Green Stormwater Infrastructure To Reduce Combined Sewer Overflow And Mitigate Runoff Up To 30-year Storm Event In**

N. She (China)

Abstract. In 2015 China launched "Sponge City" pilot program that has established aggressive treatment targets for flood reduction, water conservation, and improved water quality. Zhenjiang City is one of 16 pilot cities located in the South East of China downstream of Yangtze River. The pilot project area is 22 km<sup>2</sup> that is all in old highly developed business and residential zones. The treatment targets for the pilot project area set by Zhenjiang City is to treat 75 percent of annual runoff through control at sources, in the processes of conveyance and at the of the pipe. 60% of pollutants measured by suspended solids (SS) must all be removed from the runoff. In addition, significant flooding up to the 30-year event must be prevented in the pilot area. Through the site investigation and system modeling exercises we concluded that the combined sewer overflow (CSO) and flooding are two biggest problems in the pilot area. If CSO can be reduced to less than 10 times annually, then 60%

Nian She, Guangzhou University, China (nianshe@gzhu.edu.cn)

### **OP8 Vulnerability Assessment And Contamination Potential Of Unconfined Aquifer From Compensatory Infiltration Techniques**

J. Caprario, A. Schuck, A. Finotti (Brazil)

The contamination of superficial aquifers, due to the infiltration of runoff in urban areas, constitutes an increasingly worrying factor, which led to many studies in recent decades. In this sense, the objective of this study is to assess the vulnerability of the Campeche aquifer, identifying potential areas of possible contamination by direct infiltration of compensatory techniques drainage. For this analysis, we used the DRASTIC model, mapping vulnerability to contamination based on seven hydro-geological parameters. The results show that approximately 29% of aquifer vulnerability areas are classified as high to very high. This vulnerable area covers approximately 500 compensatory structures drainage, showing in this way, the high potential for groundwater contamination by direct infiltration of runoff.

Jakcemara Caprario, Federal University of Santa Catarina, Brazil (jakcemara@hotmail.com)

## **POSTER PITCHES**

### **P205 Biological, Hydrologic And Economic Importance Of Forest Patches Maintenance In Urban Watersheds.**

J. Da Silva, M. Porto (Brazil)

Healthy watersheds, ie those with significant green areas well managed, are natural capital of high value because they provide many ecosystem services to society. However, despite this obvious importance, these areas are constantly threatened by the advance of real estate speculation and illegal occupation. This study evaluated the impact of the loss of urban forest patches in Jaguaré stream watershed, located in São Paulo, which confirmed the relevance of these areas to control peak flow, as in the simulated critical scenario (complete loss of the urban forest patches) peak flow jumped from current 86,39m<sup>3</sup>/s to 133,66m<sup>3</sup>/s. In addition to the loss of important species of the Atlantic forest, this flow increase resulted in financial losses due to the need to implement measures to control the floods.

Juliana Caroline da Silva, EP- University of São Paulo, Brazil (juliana.ambiental@gmail.com)



**P201 Empowering Remote Water Sensors Through Predictive Data-driven Modelling For Water Treatment Optimisation**

E. Bertone, R. Stewart, K. O'Halloran, G. de Oliveira, S. Bird (Australia)

In recent years, a growing number of monitoring tools able to remotely collect weather and water parameters have been introduced in several drinking water reservoirs around the world. In particular, vertical profiling systems can continuously monitor several lake parameters for the full water column, thus providing support to the water treatment. Nevertheless, most of the collected data are stored away with negative cost-benefit, and manual lake samplings are still required to measure a range of parameters that remote instrumentation cannot measure. However, with advancements in artificial intelligence research, there is potential for exploiting such big dataset to extract useful information for the water suppliers. In this paper, we describe a number of data-driven predictive models, developed based on remote sensing tools data, which led to energy use and treatment costs reduction, and more proactive water treatment management, for a number of locations in Australia.

Rodney Stewart, Griffith University, Australia (r.stewart@griffith.edu.au)

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**P204 Evaluation Matrix Of An Infiltration Trench As Compensatory Technique For Urban Stormwater Management.**

E. Pacheco, A. Finotti (Brazil)

The aim of this paper was to evaluate a ditch infiltration, used since the 70's by the city of Florianópolis-SC / Brazil, as a compensatory technique of infiltration. To this was carried out instrumentalization and monitoring this structure for a period of 2 years. For analysis of the raw data of runoff and hydraulic behavior of infiltration trench, events were defined by the time of runoff in the catchment contribution area. For the analysis of the data an structure evaluation matrix was developed as compensatory infiltration technique, considering the hydraulic behavior of the trench. Around 360 interactions were performed, and in only 49% of the 60 events analyzed the structure behaved as an infiltration technique, and in 8% there was overflow of the structure. the city was recommended some adjustments to the structure it increases its efficiency in the flow control, as compensate the urban water cycle affected by urbanization.

Elisa Pacheco, Federal University of Santa Catarina (UFSC), Brazil (elisafpacheco@hotmail.com)

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## SESSION 3: TECHNOLOGIES FOR CONTROL OF MICROPOLLUTANTS AND PATHOGENS OF EMERGING CONCERN

### PRESENTATIONS

#### **IS KN5 Antibiotic-independent Resistance Induction-Role of Environmental Pollutants in Antibiotic Resistance Phenomena**

A. Gu (United States)

The spread of antibiotic resistance represents a global threat to public health, and researches have mostly focused on clinically relevant high-level resistance enriched by antibiotics above the minimal inhibitory concentrations (MICs). Here, we report that common water disinfection byproducts had antibiotic-like effects that led to evolution of resistant *E. coli* strains under both high (near MICs) and low (sub-MIC) environmentally relevant exposure concentrations. The sub-inhibitory concentrations of DBPs selected strains with resistance higher than those evolved under above-MIC exposure concentrations. In addition, whole-genome analysis revealed distinct mutations in small sets of genes known to be involved in multiple drug and drug-specific resistance, as well as in genes not yet identified to play role in antibiotic resistance. We also showed that widely-used disinfectants promoted ARGs transfer within *Escherichia coli* strains and across genera from *Escherichia coli* to *Salmonella*.

A. Gu, Northeastern University, United States (april@coe.neu.edu)

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#### **OP9 The Cost-Benefit Of Technologies For The Control Of Emerging Contaminants In Water And Wastewater**

T. Rauch-Williams, E. Dickenson, J. Drewes, S. Bieber, S. Deslaurier, S. Snyder (United States)

This research developed a systematic method for comparing conventional and advanced technologies for wastewater or drinking water treatment to control of emerging contaminants in water and wastewater. The cost-benefit evaluation was conducted for the following technologies: conventional drinking water and wastewater treatment, biological nutrient removal, ozonation followed by biological active filtration, membrane treatment, and point-of-use devices. This work addresses the needs of communities who are not only interested in the technological treatment efficiencies for CEC removal but also inquire about the holistic evaluation including aquatic and human health benefits as well as unintended or undesired environmental and economic costs of treatment upgrades.

Tanja Rauch-Williams, Carollo Engineers, United States (trauch-williams@carollo.com)

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#### **OP10 Micropollutants Control And Disinfection In A Fully Integrated Indirect Reuse Management Scheme: Lausanne WWTP**

S. Donnaz, S. Baig, A. Gonzalez Ospina, C. Mechouk (France)

The Federal Government of Switzerland has recently addressed a pioneer regulation's program in mid-2014 with regards to the need of treating micro-pollutants to protect water resource in surface waters. The original Swiss ordinance for water protection (October 28th 1998, OEaux; RS 814 201) has been amended to integrate a stage of micropollutants in wastewater treatment plants. As Lausanne wastewater treatment plant does discharge treated water to the Lake Geneva, in respect to its interaction with the water resource cycle, Lausanne WWTP is directly concerned by the Swiss ordinance amendment of 2014 that came into force on January 2016. The targeted substances of the new Swiss ordinance (the first 5 micro-pollutants indicators and now extended to 12) are favorable to the O3+PAC combined solution, which presents the highest performance by achieving optimized OPEX costs.

Christophe Mechouk, SUEZ Treatment Infrastructure, France (sylvain.donnaz@suez.com)

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### **IS KN6 Mitigation Of Micropollutant Issue Along The Water Cycle**

S. Baig (France)

Pollution of the environment by micropollutants is an emerging problem by posing a potential risk to aquatic organisms and human health. Contamination has indeed been reported throughout the hydrological cycle from source waters for drinking water treatment plants to drinking water distribution and wastewater treatment plants influents and effluents.

The generic term "organic micropollutants" includes a wide range of water contaminants: biogenic hormones, pharmaceuticals and personal care products (PPCP), pesticides, flame retardants, detergents, veterinary drugs, industrial chemicals and their metabolites and by-products. More than 50,000 are in current uses nowadays and hundreds enter the market every year. Some of them are persistent in the environment due to their low biodegradability and low photosensitivity. Their occurrence made arise two main concerns; the negative impact they have in the biota, especially the hormonally active compounds, and the contamination of the water bodies used in the food chain as well as for water potabilization and industry usage. Many national surveys pointed out that urban wastewater treatment plants (WWTP) are major collection points and then emission sources of such microcontaminants.

Wastewater treatment plants can eliminate part of the micropollutants detected in the inlet water. However, some micropollutants remain in effluents at the outlet of the plants depending on their physico-chemical properties and on the treatment technologies operated. The fate of micropollutants in the conventional wastewater treatment can indeed be predicted from their physicochemical properties that affect the occurrence and extent of removal pathways: volatilization during mixing and aeration, adsorption onto suspended solids and sludge, biodegradation, photodegradation on the surface of water. The market trend to use less bioaccumulative substances means that more compounds with low adsorption potential will be used resulting in an even lower removal in conventional treatment plants. To reach discharge values compatible with a good status of the water bodies, existing processes can be upgraded and additional advanced treatments can be implemented.

It is now well known that many advanced technologies enhance the elimination of persistent organic matter in the effluent from sewage treatment plants: biological secondary processes specific to age of high sludge as membrane bioreactors or tertiary treatments such as membrane separation, adsorption and chemical oxidation using ozone and advanced oxidation processes (AOPs). Tertiary treatments physical type have drawbacks related to the disposal mechanism - transfer of pollutants in streams concentrates for membrane technologies, adsorbent for adsorption technologies - because they then require additional treatment for concentrates and waste adsorbents. For those that involve a biological or chemical reaction, it is in addition necessary to assess the fate of both parent compounds, products released because potentially bioactive. Extensive R&D studies are carried out in this field. Early full scale installations under operation demonstrate performances.

Advanced wastewater treatment guarantees that the contamination of the environment with micropollutants is lowered and that the costly end-of-pipe approach consisting in drinking water treatment can be reduced. Simultaneously, the ability of drinking water treatments to eliminate these substances needs to be controlled in order to comply with the precautionary principle. In the drinking water field, some plants are equipped for decades with technological processes used to eliminate usual micropollutants like pesticides. Advanced treatments like ozone oxidation and/or adsorption onto activated carbon, biofiltration, membrane separation are shown applicable for most compounds.

To protect the water sources from contamination by bioactive micropollutants is a priority in future development in water supply services. The ongoing intensification of the hydrologic cycle and potable water reuse in addition emphasizes the need for developing a global strategy for micropollutant mitigation at water users' basin level by considering particularly the optimization of drinking water and wastewater treatments in relation to the environmental risk assessment and the sustainability of the solutions proposed.

S. Sylvie, SUEZ, France (sylvie.baig@degremont.com)

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### **OP11 Photocatalytic Ozonation For The Removal Of Organic Micropollutants And Pathogens In Municipal Wastewater**

M. Momba, A. C. Mecha, M. Onyango, A. A. Ochieng (South Africa)

There is a great need for the development of appropriate treatment technologies for wastewater remediation for reuse. The present study evaluated the treatment of municipal wastewater containing organic and microbiological contaminants using the photocatalytic ozonation process. The concentrations of phenol, dissolved organic carbon (DOC), and waterborne pathogens (*E.coli*, *S. enterica* and *S. flexneri*) were determined before and after treatment. The treated water satisfied the South African drinking water quality standards in terms of phenol and DOC levels and bacteriological quality. No bacterial regrowth was observed after 24 h in the dark thus implying that photocatalytic ozonation disinfection was effective. This means that this technology can be implemented to enable water-scarce countries like South Africa to explore the reuse of treated wastewater for potable purposes.

Maggy Momba, Tshwane University of Technology, South Africa (mombamnb@tut.ac.za)

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**OP12 The Chemical Structure Of Organic Micropollutants Drives Their Enzymatic Biotransformation In Sewage Treatment Plants**

L. Gonzalez-Gil, T. Alvarino, E. Fernandez-Fontaina, S. Suárez, F. Omil, M. Carballa, J. Lema (Spain)

To date most studies have focused on the fate of OMPs during sewage treatment plants (STPs), but not on understanding the mechanisms behind their removal. Trying to fill this information gap, we have investigated the cometabolic processes responsible for OMPs biotransformations in the main biological systems (activated sludge and anaerobic digestion) of a STP. Particularly, we have look for the relationship between the biotransformation and the chemical structure of compounds, the type of biomass and the enzymatic cycles involved. Results allow us to have an overview of the biological mechanisms behind OMPs removal to better understand the contradictory results reported in the literature, to predict possible transformation products and to minimize their emissions via STP effluents.

Juan M. Lema, University of Santiago de Compostela, Spain (lorena.gonzalez@usc.es)

**POSTER PITCHES**

**P344 Enhancement Of E2 And EE2 Degradation In Activated Sludge Processes Through Hydrodynamics Optimization**

T. Coello Garcia, T. Curtis, W. Mroziak, R. Davenport (United Kingdom)

Currently, advanced treatments are perceived as the only feasible way for wastewater industry to comply with prospective European legislation in beta-Estradiol (E2) and alpha-Ethynylestradiol (EE2). We wanted to know what scope, if any, there is for the optimization of existing plants via the engineering of their hydrodynamics. We carried out degradation experiments and tracer studies in six UK WWTP and we found that modest structural changes in aeration tanks would translate into tangible improvements in their hydrodynamic behaviour, thus enhancing biological degradation. In the case of E2, this could be sufficient to ensure compliance whilst for EE2 removal can only be assured if we are able to change the first order removal rate.

Tamara Coello Garcia, Newcastle University, United Kingdom (t.coello-garcia@newcastle.ac.uk)

**P323 Removal Of Micropollutants And Nutrients From Municipal Wastewater With Ozone And Granular Activated Carbon Filtration**

M. Bechger, P. Piekema, R. Van der Aa, A. Van Nieuwenhuijzen, A. Dekker (The Netherlands)

Ozonation combined with granular activated carbon filtration can be used to remove micropollutants and nutrients, phosphorus and nitrate, from municipal wastewater. Based on literature and a software tool for cost calculation four different scenarios were developed and judged. Adding ozone and granular activated carbon, with off-site thermal reactivation, seems cost effective and will be studied on laboratory scale.

Manon Bechger, Waternet, The Netherlands (manon.bechger@waternet.nl)

**P331 Cork Granules As Concentrators/Recuperators Of Oil: Studies On Oil Recovery By Mechanical Compression**

D. Todescato, F. Hackbarth, A. Ulson de Souza, S. Guelli U. Souza, R. Boaventura, V. Vilar (Brazil)

The objective of this study was to investigate the recovery of mineral oil by mechanical compression of regranulated cork (RGC) particles loaded with different mineral oils using a pneumatic press, as well as to evaluate their possible reuse in consecutive cycles of loading / compression. The oil impregnated RGC was inserted into a cylindrical compression cylinder and then compressed using a conical piston. The percentage of oil recovered (% RO) was evaluated as a function of the mechanical compression pressure applied ( $P = 2.0$  to  $7.0$  bar), compression time ( $t_C = 1$  to  $4$  min), cork mass in the compression cylinder ( $MC = 8$  to  $12$  g) and number of compressions ( $NC = 1$  to  $4$ ). The time interval between each compression was set at  $1$  min. The reusability of RGC particles was tested by exposing them, in some cases, up to  $30$  cycles of saturation / compression using the following optimized compression variables ( $P = 5.0$  bar,  $MC = 9.0$  g,  $t_C = 2$  min,  $NC = 2$  min).

Vitor Vilar, Federal University of Santa Catarina, Brazil (vilar@fe.up.pt)

## SESSION 4: ADVANCE ANAEROBIC TECHNOLOGIES

### PRESENTATIONS

#### **IS KN7 Recovery of Critical Metal and Metalloid Resources by Anaerobic Processes**

J. A. Field (United States)

Certain metals and metalloids are needed for critical advanced technology but are becoming limiting resources. Examples of such compounds include platinum group metals (PGM), selected heavy metals (e.g. zinc) and important semiconducting metalloids such as tellurium. Thus there is a great need to recover these metal(loid)s from waste streams. The very same metal(loid)s often pose elevated environmental and public health risk when discharged with waste streams. A potential opportunity exists to convert a severe environmental liability into valuable material assets by remediating and recovering the toxic metal(loid)s in waste as resources. There are two main strategies that can be employed with anaerobic biotechnology to recover critical metal(loid)s from aqueous streams or from leachates of solid waste. Firstly heavy metals can be recovered as metal sulfides by the action of sulfate reducing bacteria generating sulfide ligands to precipitate these metals. Secondly, many metal(loid)s can be reductively precipitated as insoluble biogenic nanoparticles. Fractionating and enrichment of recovered materials can be achieved by utilizing pH gradients to selectively coagulate/sediment nanoparticles, to selectively precipitate metal sulfides or by utilizing biosurfactants for floatation.

This study focused on the recovery tellurium (Te) which is metalloid utilized in photovoltaic solar panels. Anaerobic sludge granules, widely available from high rate anaerobic wastewater treatment systems, were selected to biologically reduce the two Te oxyanions, tellurite (Te(IV)) and tellurate (Te(VI)), to zero valent Te-nanoparticles (Te(0)-NP). These granules contain a microbial partnership of methanogens and bacteria with powerful reducing enzymes that are postulated to cometabolically reduce Te oxyanions. In our research, we demonstrated that the sludge granules readily reduced both Te(IV) and Te(VI) to Te(0)-NPs confirming their intrinsic capacity for Te bioconversion. Reduction rates of Te(IV) were much greater than Te(VI) suggesting that the reduction of Te(VI) as the rate limiting step. Redox mediating compounds (RM) that shuttle electrons from microorganisms, greatly improved the rate of Te oxyanion reduction by up to 11-fold. However the truly novel finding is the role of RM have in shifting the location Te(0)-NP formation from inside cells to the extracellular media. The implication for technology innovation is obvious, without RM, microbial cells would have to be lysed and destroyed to gain access to recover Te(0)-NP. In contrast by utilizing RM, the Te(0)-NP are localized as a colloidal suspension in the extracellular aqueous medium that can be harvested without damaging the microorganisms responsible for catalyzing the reaction. In conclusion, with the example of Te used in this study, we have demonstrated that anaerobic granular sludge can be deployed in biorefinery strategies to recover critical metal(loid)s. Our research group along with others have also demonstrated that anaerobic microorganism can convert soluble metal ions PGM to zero valent nanoparticles utilizing similar principles.

Jim A. Field, University of Arizona, United States (jimfield@email.arizona.edu)

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#### **OP13 From Wastewater To Resource Source: AnMBR Technology For Urban Wastewater Treatment**

F. Durán Pinzón, C. Dorado Barragán, E. Jiménez Douglas, J. Vazquez Padín, Á. Robles Martínez, J. Giménez García, J. Ribes, Bertomeu, A. Seco Torrecillas, J. Serralta Sevilla, J. Ferrer Polo, (Spain)

In order to demonstrate the feasibility of Anaerobic Membrane Bioreactor (AnMBR) technology for urban wastewater (UWW) treatment, an industrial prototype has been designed and started-up. This AnMBR plant is fitted with industrial-scale hollow-fibre membranes modules and is fed with the effluent from the pre-treatment of the Alcázar de San Juan full-scale WWTP (Alcázar de San Juan, Ciudad Real, Spain). This research work aims to demonstrate the potential of AnMBR technology as alternative to traditional aerobic UWW treatment. Preliminary results indicated adequate performance of both biological and filtration processes.

Jose Vazquez Padin, FCC Aqualia S.A., Spain (jvazquezp@fcc.es)

**OP14 Designing Biodigestion Plants For The Treatment Of Sugarcane Vinasse: Impacts Of Phase Separation And Alkalinization**

L. Fuess, M. De Araújo Júnior, M. Garcia, M. Zaiat (Brazil)

Anaerobic digestion (AD) is the most suitable approach for the management of vinasse in sugarcane distilleries, as both environmental adequacy and bioenergy recovery may be achieved. Because the literature lacks data on the implementation of full-scale AD plants for enhanced energy recovery from vinasse, this study presents different designs for AD plants applied to vinasse in large-scale distilleries, considering both single- and two-phase schemes and different alkalinizing strategies. The results indicate that phase separation is economically feasible when scaling up AD plants in biorefineries. Despite the higher capital and operating costs in such cases, the estimated biogas and electricity production costs could be equivalent or lower compared with single-phase AD. With respect to the alkalinizing strategy, the best results were associated with sodium hydroxide dosing and/or effluent recirculation, with electricity costs reaching values 1.8- to 2.3-fold lower than grid electricity.

Methane produced within engineered anaerobic processes subsequently dissolves into the treated wastewater to create a fugitive gaseous emission which has financial impact as well as health and safety and environmental implications. The discharge of dissolved methane has now been reasonably well quantified. For example, around half of the methane produced from anaerobic reactors applied to municipal wastewater treatment, is released as a dissolved emission. The technological means for separation and recovery have not been well explored. However, in drinking water, air stripping technology is comparatively common for dissolved gas separation. This includes the air stripping of methane from shallow groundwater. Whilst studies arising from these natural anaerobic systems and drinking water applications are insightful, the applicability of the arising knowledge in the design of air stripping systems for wastewater is somewhat constrained as wastewater composition is inherently more complex and the objective of recovering and concentrating the dissolved gas for subsequent re-use, imposes a very different problem set that will require unique operational and design considerations. The presentation will review existing and proposed technological approaches to gas desorption in engineered anaerobic wastewater processes, with specific focus on technology compatibility and downstream gas phase management.

Marcelo Loureira Garcia, University of São Paulo, Brazil (mfgarcia@rc.unesp.br)

**OP15 Biological Treatment Of Ammonia-Rich Wastewater By Partial Nitrification/ANAMMOX In BioCAST Reactor**

N. Saborimanesh, E. Castillo Arriagad, D. Walsh, L. Yerushalmi, C. N. Mulligan (Canada)

Nitrogenous pollution has deleteriously impacted human health and aquatic environments. The objective of this study was to investigate the potential application of a biological reactor (BioCAST) for the treatment of an ammonia-rich synthetic wastewater by providing a balance in the environmental conditions for aerobic nitrifying bacteria and anaerobic ammonium oxidizers ("Anammox") in a single reactor. The bioreactor was inoculated with Anammox sludge and fed with an ammonia-rich wastewater (NH<sub>3</sub>-N: 350 mg/L) at a hydraulic retention time of 2 days and temperature of 35C. The DO levels in the aerobic and anoxic zones were maintained at 1.5 mg/L and 0.1 mg/L, respectively. Despite nitrite limited feeding conditions (NO<sub>2</sub>: 0 mg-N/L), microbial communities contributed to 80% and 91% of TN and NH<sub>3</sub>-N removal, respectively. This suggests that the favorable conditions for the activity of nitrifying and Anammox communities were provided in this system under the tested conditions.

Nayareh Saborimanesh, Concordia University, Canada (mulligan@civil.concordia.ca)

**OP16 Utilization Of Duckweed (Spirodela Polyrhiza) For Sewage Treatment And Biogas Production: An Integrated Approach**

R. Gaur, S. Suthar, B. Lew (Israel)

This study explores the feasibility of duckweed (*Spirodela polyrrhiza*) for sewage treatment and anaerobic co-digestion of harvested *Spirodela polyrrhiza* and waste activated sludge (WAS) for biogas generation. The experiments were performed in the laboratory scale batch reactors inoculated with cow dung as seed. The batch reactors were gradually acclimated to a higher duckweed concentration (2.5 to 20 gm). Varied ratio of duckweed and WAS by keeping constant volume of inoculum were studied to optimize maximum biogas generation. Results suggested that the maximum cumulative methane production of 1190 mL CH<sub>4</sub> g<sup>-1</sup> VS achieved in batch reactor T2. It was demonstrated that sewage treated with *Spirodela polyrrhiza* show high degree of removal of BOD (77.7 %), NO<sub>3</sub>-N (84.4 %), PO<sub>4</sub><sup>3-</sup> (83.4 %), SO<sub>4</sub><sup>2-</sup> (98.1 %), Natot (83.9 %), Ktot (66.7 %) and Catot (75.8 %). The Gompertz equation on experimental data fits well and indicated the strong correlation. It was conclude that the harvested *Spirodela poly*.

Rubia Gaur, Doon University, India (benilew@ariel.ac.il)

## POSTER PITCHES

### **P422 Alterations In Carbon Flux Impair Glycerol Fermentation By Enterobacter Cloacae 9R At High Substrate Concentration**

J. Zorel (Brazil)

The sustainability of biodiesel industry is dependent of the treatment of huge amounts of glycerol co-produced in the transesterification process. Despite the advances achieved in biological glycerol treatment, up to now it is feasible only at low substrate concentrations. Thus, in this work we aimed to identify metabolic alterations that can possibly impair glycerol bioconversion at elevated concentrations, focusing primarily at hydrogen production. For this purpose, glycerol consumption, bacterial growth, hydrogen and metabolite production were monitored during glycerol fermentation by *Enterobacter cloacae* 9R at three initial substrate concentrations (5, 14 and 40 gL<sup>-1</sup>). From the obtained results, we can suppose that diminished bacterial performance at higher glycerol concentration was caused by intracellular redox imbalances, which diverges carbon flux from acetyl-CoA, an essential intermediary in H<sub>2</sub> production.

José Zorel, Federal University of Ouro Preto, Brazil (joseazorel@gmail.com)

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### **P418 Extended Design Algorithm Of Municipal UASB-reactors As A Tool For The Estimation Of Energy Recovery Potential**

K. Nelting, K. Rosenwinkel (Germany)

Existing design algorithms for UASB-reactors treating municipal waste water do not allow a differentiated prediction of the degradation of dissolved COD and as well as the retention and hydrolysis of particulate COD. Thus, disabling the prediction of the potential methane yield based on the prevailing COD load of each application, much less allowing a differentiation between dissolved methane in the effluent and captured methane in the 3-phase-separator. To this end, empirical dependencies for the main processes that influence the aforementioned processes have been developed based on extensive measurements in UASB-reactors in laboratory, pilot and full scale. Finally, these results have been integrated in an extended design algorithm (Nelting 2016, DWA - Nelting & Rosenwinkel 2016), which enables a differentiated estimation of energy recovery potential and GHG emissions.

Klaus Nelting, NeTra Consult UG (h.b.), Germany (nelting@netra-consult.de)

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### **P408 Brackish Water Treatment And Simultaneous Electricity Generation Driven By Microbial Desalination Cells**

S. Perazzoli, R. Bastos, F. Santana, H. Soares (Brazil)

Microbial desalination cells (MDC) are a promising alternative for traditional desalination technologies, once they can convert the energy stored in wastewater directly into electricity by microorganisms and utilize it in situ to drive desalination process, producing a high-quality reuse water. However, there are several challenges to be overcome in order to translate it from laboratory research in successful application. Herein, this study assessed the influence of the number of desalination chambers and time of desalination cycle during the treatment of brackish water treatment in MDC. Results shown that efficiency of salt removal was improved from 12.4, 27.1 and 25.2 to 42.5, 64.8 and 58.0 for 3-MDC, 5-MDC and 7-MDC, respectively. The same tendency was observed for electrochemical data. These results encourage further development of the MDC for sustainable brackish water treatment and reuse.

Simone Perazzoli, Federal University of Santa Catarina, Brazil (perazzoli.simone@gmail.com)

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## SESSION 5: APPLYING ADVANCED MICROBIOLOGY/GENETIC TOOLS

### PRESENTATIONS

#### IS KN8 Paradoxes and Genius In Engineered Wastewater Treatment Systems

T. Curtis (United Kingdom)

The paradox and genius of wastewater engineering has been to develop a global applied system of microbial treatment technologies with little or even, no, knowledge of microbial ecology. Microbial ecologists sometimes seem to do the reverse: to develop great knowledge of biology of wastewater treatment systems without actually improving anything. The truth is subtler than this caricature. Though most of our technologies were developed by accident and trial and error there have been some important scientific insights that have been absorbed into the canon of wastewater engineering. These insights and discoveries are sometimes profound and at the absolute frontier of science. Nevertheless there is often a gap between what microbial ecology could do for wastewater engineers and what gets done. The price for this gap is avoidable failure; futile research and an excruciatingly slow rate of development of technology. The solutions are three fold: Measurement, Theory and Simulation. Simply being able to measure the specific populations being engineered is the very first step. It relates observation to performance and forces microbial ecologists to submit to the discipline of quantification. Our measurement technologies are good, but not yet good enough, and not accessible. Numbers open the way to theories. Theories to describe the most basic phenomena in reactors: how the species get there and how they change are here now. They are an antidote to the "muck and magic" thinking and can tell researchers and practitioners what to do, and very importantly, what not to do. But the long-term goal is the ab initio (from the beginning) simulation of wastewater treatment; it is a challenge and a change in mind-set. Simulation will force us to acquire unfamiliar skills so that we may combine the biological and the physical. But the effort is worthwhile as simulation has the potential to change the rate of change in wastewater treatment and not only make a better planet, but put our community at the absolute leading edge of science and engineering.

Tom Curtis, Newcastle University, United Kingdom (Tom.curtis@ncl.ac.uk)

#### OP17 Bioenergetics Suggests A Novel Mechanism Of Energy Harvesting In Ammonia Oxidising Bacteria

R. González-Cabaleiro, T. Curtis, D. Ofiteru (United Kingdom)

The bioenergetics of the metabolism of ammonia-oxidising bacteria (AOB) shows an inefficient process. 47% of the energy released when a mole of NH<sub>3</sub> is consumed is dissipated. Paradoxically, AOB seem to thrive in challenging conditions: growing readily in most aerobic environments, except the laboratory pure culture. In this study, a model of the metabolism of AOB is presented and with it, a feasible maximum yield of 0.16 gBio/gN is predicted. But, in reality, the measurements of this parameter vary between 0.04 and 0.45 gBio/gN. Thermodynamics and observations can only be reconciled if AOB have an extra source of energy. Chemoheterotrophic growth of AOB only offers a partial explanation since it occurs in specific conditions. Alternative source of energy could be realised if the ammonia monooxygenase reaction was coupled to an energy harvesting mechanism. Then, co metabolism could confer a benefit on the cell. If this was true, it would explain the robust growth of AOB in communities.

Rebeca Gonzalez-Cabaleiro, Newcastle University, United Kingdom (rebeca.gonzalez-cabaleiro@ncl.ac.uk)

#### OP18 Phage Diversity In Activated Sludge Reflects The Environmental Differences That Select For Host Bacterial Communities

M. Perez, L. Guerrero, E. Figuerola, L. Erijman (Argentina)

This report describes the study of phage and bacterial metagenomes of activated sludge samples from a full-scale municipal wastewater treatment plant performing along a gradient of solid retention times, over a period of three years. Co-occurrence of bacterial species was highly dependent on the operational regime. Low SRT were associated with bacteria characterized by high maximum growth rates, whereas higher SRT were distinguished by phyla with slower growth rates and higher substrate affinities. Most of the contigs assembled from the reads of supernatant data with size larger than 5 kb, which could be assigned taxonomically, were classified as phages belonging to the order Caudovirales. Interestingly, shifts in phage composition mirrored those changes in bacteria, suggesting that phage ecology reflect the environmental differences that select the host bacterial communities

Leonardo Erijman, INGEBI-CONICET, Argentina (erijman@gmail.com)

**IS KN9 Biological Phosphorus Removal Through The Lens Of Microbial Ecosystems Biology**

T. McMahon (United States)

Biological wastewater treatment systems are ideal models with which to study “eco-systems biology” of microbial communities. Polyphosphate accumulating bacteria are used world-wide to remove phosphorus from wastewater but the most abundant phylogenetically defined group (*Candidatus Accumulibacter phosphatis*) cannot be cultured in isolation. I will describe recent advances in our understanding of *Accumulibacter* ecophysiology based on comparative genomics and genome-enabled analyses of expressed genes by transcriptomics. The *Accumulibacter* lineage is comprised of at least two major lines of descent, which we call Types I and II. In our lab-scale reactors, clades IA and IIA can together comprise up to 85% of the total bacteria visualized by fluorescent in situ hybridization. The original metagenome sequence completed in 2005 was derived from a clade IIA-enriched sludge and the clade IIA genome has since been finished. A draft genome from Clade IA was recovered from a second sample and it shared ~80% identity with the finished Clade-IIA at the DNA level. We recently completed analysis of a time series metatranscriptome generated from enrichment cultures of *Accumulibacter* under steady state bioreactor operation to gain insight into anaerobic/aerobic metabolism and regulatory mechanisms within a single EBPR cycle. Co-expression analysis identified ecologically relevant trend categories including genes with increased transcript abundance upon anaerobic acetate contact or oxygen contact, and genes with differential transcript abundance under low and high phosphorus concentrations, consistent with batch cycle phases. We experimentally demonstrated hydrogen production after anaerobic acetate contact, suggesting a previously unknown strategy for *Accumulibacter* to maintain redox balance. A comparative genomics analysis of sequences upstream of co-expressed genes resulted in the identification of two statistically significant putative regulatory motifs. This analysis provides a basis for further investigations into *Accumulibacter* metabolism and a framework for additional metatranscriptomic analysis under perturbed conditions and the reconstruction of regulatory networks.

Trina McMahon, University of Wisconsin-Madison, United States (kdmcmahon@wisc.edu)

**OP19 Evaluating Neutral Assembly In The Formation Of Water Filters Microbial Communities**

M. Vignola, D. Werner, R. Davenport (United Kingdom)

Drinking water treatment plants (DWTPs) have abundant and highly diverse microbial communities at all the different treatment stages. The role played by these communities is of great interest to water treatment engineering researchers. The high diversity of bacteria present in the filters can improve final drinking water quality by enhancing the removal of contaminants, but might also play a detrimental role, by harbouring potential pathogens or releasing DOC. The rules responsible for shaping the assembly of these naturally occurring microbial populations are still poorly understood; identifying them represents a significant opportunity to optimise DWTPs performance. Two contrasting ecological theories might explain how natural microbial communities assemble; niche theory and neutral theory where environmental deterministic factors or stochastic factors predominate respectively. In this work, we evaluated how stochastic factors shape microbial communities in water filters.

Marta Vignola, Newcastle University, United Kingdom (marta.vignola@ncl.ac.uk)

**OP20 Diversity And Dynamics Of Bacterial Communities In A Water Supply System**

A. Batista, P. Meynet, G. P. P. Garcia, D. Wernder, R. J. Davenport, J. C. Araujo, C. Mota Filho (Brazil)

This study assessed the composition and relative abundance of the general bacterial community of a Water Supply System (WSS) serving a mid-sized city (population 120000 inhabitants) in the state of Minas Gerais, Brazil. DNA was extracted using a FastDNA Spin Kit Soil (Qbiogene) from the filters collected in seven points throughout the WSS, including raw and treated water, during six months, through dry and wet seasons. DNA was sequenced using advanced sequencing techniques (Ion Torrent). Free chlorine was measured in situ, as well as temperature and turbidity. Results showed that the highest relative abundance was of the Proteobacteria phylum, followed by Euryarchaeota, Bacteroidetes and Actinobacteria.

Ana Maria Moreira Batista, Federal University of Minas Gerais, Brazil (ana\_mb7@yahoo.com.br)

## POSTER PITCHES

### **P501 Adaptation Of Ammonia Oxidizing Bacteria Under Low Dissolved Oxygen Conditions In Laboratory Scale Wastewater Treatment**

C. Morais, T. Curtis (United Kingdom)

The adaptation of a wastewater treatment plant to new operating conditions is a difficult and uncertain process. It is never clear how long the adaptation will take or how it happens. A successful adaptation could be caused by a change in the physiology of the most abundant taxa, the selection of a minority taxon from within the system or the immigration of a new species. In this study, we investigate the adaptation of ammonia oxidizing bacteria to a very low dissolved oxygen concentration. We are able to show that the adaptation takes place through the selection of very rare taxa present in the original seed. The time to adaptation can be modelled by a simple exponential growth and thus can, in principle, be predicted a priori. We observed that the time to adapt to such conditions appeared to be dependent on the initial concentration of the selected bacteria in the seed.

Cristiana Morais, Newcastle University, United Kingdom (cristiana.morais@ncl.ac.uk)

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### **P503 Evaluation Of The Bacterial Community Present In Biofilter With Peat Media**

M. Allievi, D. Silveira, E. Santos, D. Camanõ, P. Filho (Brazil)

This study evaluated the bacterial community present in a biofilter that processes the odors from a sewage pumping station, where the mainly formed gas is the hydrogen sulfide gas. To evaluate the structure of the bacterial community, the techniques polymerase chain reaction (PCR), followed by denaturant gradient gel electrophoresis (DGGE), and Sanger genetic sequencing were used. We can observe bacterial diversity in the system, indicating that the different physical-chemical and environmental conditions interfere in the bacterial community structure.

Maria Allievi, Federal University of Santa Catarina, Brazil (mjallievi@gmail.com)

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### **P502 Microalgae Growth And Nutrient Removal In Photobioreactor With Black Water Previously Treated In UASB Reactor**

N. Slompo, R. Ferrer, M. Reali, L. Daniel (Brazil)

Microalgae for nutrient removal are a promising alternative to reach sustainable wastewater treatment systems. It is an opportunity to change the treatment concept to advance for resource recovering and energy efficiency. This study evaluated the growth and nutrient removal with *Chorella sorokiniana* in flat panel photobioreactor fed with black water effluent previously treated by UASB reactor. The system was operated in batch and nutrient concentration, biomass production and physicochemical variables was monitored during seven days. The photobioreactor reached 84% and 50% orthophosphate and total nitrogen removal, respectively, even without temperature and pH control. Moreover, the microalgae biomass achieved 0,58g/L. According to these preliminary findings, *C. sorokiniana* showed a great potential for wastewater treatment and nutrients recovery.

Nathalie Slompo, University of São Paulo, Brazil (nathaliedmiranda@usp.br)

## SESSION 6: INNOVATIVE DECENTRALIZED TECHNOLOGIES FOR DEVELOPING COUNTRIES

### PRESENTATIONS

#### **IS KN10 Birthing the Decentralized (Non-Sewered) Sanitation Industry: Status update and Development of Non-sewer Sanitation system (ISO) Standard**

A. Hauser, D. Kone (Singapore)

In the developing world, 2.5 billion people practice open defecation or lack adequate sanitation facilities; an additional 2.1 billion urban residents use facilities that do not safely dispose of human waste. Poor sanitation contributes to about 700,000 child deaths from diarrhea each year. Improved sanitation—including waste treatment and resource recovery—is essential to a healthy and sustainable future for the developing world. [gatesfoundation.org]. The construction of centralized sewer systems, as the predominant sanitation concept in the developed world, is not feasible not only due to the high investment costs, but also because of the fast and dynamic urbanization outpacing centralized infrastructure development. On the other hand, existing on-site sanitation solutions, such as pit latrines or septic tanks, are less expensive but are often unappealing because they don't kill disease-causing pathogens, have impractical designs, or retain odors and attract insects. Although numerous innovative solutions serving local needs have been developed, no scalable product that is suitable for mass adoption, and hence for solving this problem has reached the market. Against this background, the Bill & Melinda Gates Foundation has started a new initiative to develop non-sewered sanitation technologies that are safe, affordable and appealing. Starting with the development of technologies, a strong focus has been put on its scalability by developing - in parallel - an international standard that defines the minimum requirement in terms of safety (human and environment) and "fit for use". By defining the boundaries for the corresponding innovations, this best practice approach does not only create trust and acceptance by the users, guides entrepreneurs and innovators, and drives down costs, it also allows governments to select the right criteria for their procurement and compare different solutions. By using standards in such a pioneering way, the chances of mass adoption are considerably increased, and therefore paves the way for the successful adoption of non-sewered sanitation technologies.

This contribution motivates the need for new non-sewered sanitation technologies and for deploying standardization in a new way. Latest updates of different technologies will be given and the development and status of the international standard presented.

Andreas Hauser, TÜV SÜD Asia Pacific Pte. Ltd., Singapore (Andreas.hauser@tuv-sud.sg)

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#### **OP21 Can Microalgae-based Wastewater Treatment Plants Be Energy Self-sufficient?**

F. Passos, R. Gutierrez, J. Garcia, E. Uggetti, M. Garfi, I. Ferrer (Brazil)

Wastewater treatment in high rate algal ponds (HRAPs) and anaerobic digestion of microalgal biomass have been widely studied. In this manner, the following step towards the dissemination of these systems is the evaluation of the energy aspects. For the first time, a year-round energy assessment of a microalgae-based WWTP was undertaken based on experimental data gathered in a pilot-scale plant over one year. The data was used to evaluate different scenarios of anaerobic co-digestion of primary sludge and non-pretreated and thermally pretreated microalgal biomass, and biogas conversion into heat using boiler and heat and electricity in cogeneration plants. According to the results, electricity balance was always positive, due to the low electrical consumption of anaerobic digestion. However, heat balances were only favourable when thermal pretreatment was applied, obtaining neutral or positive energy balance.

Fabiana Passos, Federal University of Ouro Preto, Brazil (fabianapassos@ufop.br)

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#### **OP22 Sub-critical Wet Oxidation Of Excreta: Performance Review And Treatment Product Quality Evaluation**

N. Wijaya, J. Andrews, D. Gapes (New Zealand)

The performance and product quality of a sub-critical wet oxidation based toilet were addressed in this paper. The proposed toilet was built to bring a decentralise toilet to those current without access to sanitation. The current wet oxidation design was proven to destroy the TSS, VSS and tCOD of the excreta by 80%, 96% and 65%, respectively, in just 20 minutes. The remaining solids were sterile, easily separated, and concentrated in N, P, and K. Although the COD concentration of the effluent exceeds the discharge demands, its TSS is very close to meeting the standard. The coliforms concentration of the treatment effluent was below limit of detection. Further treatment of the effluent is required to reduce COD prior to discharging. Up to 40% of the tCOD in the effluent are VFAs that can be recovered and used in other applications offering beneficial reuse.

Niken Wijaya, SCION, New Zealand (niken.wijaya@scionresearch.com)



**IS KN11 Decentralised Nutrient Recovery From Human Excreta: Empowering Sanitation Coverage By Creating Value On Site**

P. Ledezma, J. Monetti, X. Plakhotnik, V. Koskue, J. Jermakka, T. Hülsen, J. Keller, S. Freguia (Australia)

This outline paper proposes to combine nutrients removal and recovery from human excreta to produce horticultural products and protein feed as a mechanism to finance and increase decentralised sanitation coverage in low-income peri-urban scenarios. To achieve this, we propose to combine the recently developed Bio-Electroconcentration systems (BECS) -- a hybrid microbial electrolysis/electrodialysis technology that recovers nutrients in a pathogen-free concentrate using very little power -- with local horticultural practices as well as the production of high-value single-cell protein by phototrophic organisms. These two new products from 'mined' nutrients could help finance sanitation installations where other options are unavailable.

Pablo Ledezma, The University of Queensland, Australia (p.ledezma@awmc.uq.edu.au)

**OP23 Design And Implementation Of Integrated Electrochemical Wastewater Treatment And Recycling Systems For Onsite Sanitation**

C. Cid, M. Hoffmann (United States)

Self-contained wastewater treatment and recycling (WWTR) system prototypes based on electrochemical oxidation of feces and urine have been designed, constructed, and implemented in regions where access to sanitation is limited. Integrated designs in shipping containers for an average 40-person daily load have been chosen in order to minimize the footprint and maximize the flexibility of installation and the security of the users. First tested in the United States, the system has been installed in India and China in semi-controlled public testing environments.

Clément Cid, Caltech, United States (clement.cid@caltech.edu)

**OP24 Integration Of Solar Septic Tank And Constructed Wetland For Treatment Of Black Water**

T. Pussayanavin, T. Koottatep, C. Polprasert (Thailand)

Integration of solar septic tank and constructed wetland systems as a highly efficient, low investment and simple technique is the goal of this study. The testing area of the integrated system, located at the academic building at the Asian Institute of Technology, Thailand, has received black water from a communal public toilet serving more than 40 users/ day. The 1000 L-solar septic tank equipped with a 12 m<sup>2</sup> solar water heating device was constructed followed by 6 m<sup>2</sup>-constructed wetlands. The hydraulic residence times of the solar septic tank and constructed wetland were about 0.5-2 days. The experimental results revealed that there were more than 90% reduction in organics, solids and nitrogen in the effluent while the fecal coliform and E. coli count were reduced about 3-5 log units. The quality of the treated wastewater could meet the discharge standard of Thailand with no problems of odor or insects.

Thammarat Koottatep, Asian Institute of Technology (AIT), Thailand (thammaratkoottatep@gmail.com)

**POSTER PITCHES**

**P605 Reliability Analysis And Applicability Of The First Stage Of The French System Of Vertical Flow Constructed Wetlands**

J. García Zumalacarregui, C. Trein, E. Manjate, M. von Sperling (Brazil)

This article presents an assessment of the performance of the first stage of Vertical Flow Constructed Wetlands - French System (VFCW-FS) for raw sewage treatment operating under tropical conditions (Brazil). A system designed for 100 p.e. was investigated during seven years under the following operational conditions: i) 2 units in parallel, operated with two strategies (12 and 24 feed pulses.day<sup>-1</sup>); and ii) 3 units in parallel (12 feed pulses.day<sup>-1</sup>). A reliability analysis was employed for the determination of the coefficients of reliability (COR) in terms of the compliance of effluent BOD, COD, TSS and TKN to discharge standards. The results showed the strong potential applicability of VFCW-FS under the observed operational conditions, with reliable performances and small variability of the effluent quality. Although simple, this system can play a leading role in the improvement of wastewater treatment status in tropical countries.

Camila Trein, Federal University of Minas Gerais, Brazil (jalegarciaz@ufmg.br)

**P616. Denitrification In Constructed Wetlands Enhance By Anammox**

R. Lima Coasaca, D. Bueno, A. Camargo, A. Tonetti (Brazil)

Nitrogen impact in the environment increases with the population growth. In that sense, the nitrogen removal has become a necessary process in the Wastewater Treatment Plants (WWTP). However, this does not happen in the most of decentralized treatment systems. The search of new alternatives in the nitrogen removal brought several discoveries in the past decades, the most relevant was the Anammox process. The application of this technology is complicated due to nitrite demanding. In this study, we use the benefits of constructed wetlands as a decentralized treatment system along with Anammox technology. Two experimental units (planted and unplanted wetlands) were evaluate for denitrification. The results showed two different pathways in the nitrogen cycle, nitrification for the panted unit and denitrification for the unplanted one. Curiously, both units have an enhance in the nitrogen removal when Anammox biomass were applied.

Adriano Tonetti, State University of Campinas, Brazil (adriano@fec.unicamp.br)

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**P608. Vertical Flow Constructed Wetland With Recirculation In Southern Brazil: Removal Of Organic Matter And Solids**

R. De Araújo, S. Decezaró, D. Wolff, H. Faccenda, J. Goeck (Brazil)

In Brazil, the constructed wetlands are systems still poorly applied in cities due to the lack of managers and engineers in environmental sanitation sectors. This paper shows the results of the treatment efficiency of a vertical flow constructed wetland (VFCW) with primary treatment for septic tank, which is installed at the Federal University of Santa Maria, Brazil. The system operates daily for the treatment of 1500 L of domestic effluent from Student's House. The VFCW was fed with 8 pulses distributed every 1h and 15min, from 8:30 am to 5:15 pm. The hydraulic application rate, determined by testing with tracer Rhodamine WT, was 88.21 L m<sup>-2</sup> d and the design rate was 85.71 L m<sup>-2</sup> d. The average BOD removal was 45% on ST, 38% on VFCW and 66% on ST + VFCW. The average removal of SS was 40% on ST, 10% on VFCW, and 44% on ST + VFCW.

Delmira Wolff, Federal University of Santa Maria, Brazil (delmirawolff@hotmail.com)

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## SESSION 7: RESOURCE RECOVERY

### PRESENTATIONS

#### IS KN12 How To Manage Microbial Communities To Recover Energy From Wastewater Systems?

C. Etchebehere, Clement Estable Biological Research Institute (Uruguay)

The increase of energy demand in the world require the development of energy producing systems based on sustainable and environmental friendly processes. On the other hand, the production of increasing amount of wastes demand solutions to reduce their impact on the environment. Coupling these two needs is possible by developing processes that recover energy from wastes. In our lab we study three different processes to produce energy using local wastes: methane production, hydrogen production by dark fermentation and the production of electricity using microbial fuel cells. The production of methane is a consolidated technology which is applied to treat wastewaters and solid wastes generated in different industries and cities. Specially in South America it has been intensively applied in the last decades. The production of hydrogen by dark fermentation and the electricity production using microbial fuel cells are incipient technologies with important advances in the last years. The three technologies are driven by microbiological processes which involve complex communities. The production of methane is a robust process performed by a complex community of bacteria and archaea. In this process the community has to work together to complete all the reactions of the anaerobic chain to produce methane from organic compounds. The communities have to be diverse, dynamic and with a specific organization to ensure that all the important microorganisms are present. On the other hand, the production of hydrogen involve few microbial populations composed by fermentative bacteria with the capacity to produce hydrogen during fermentation. The microbial communities from these reactors present low diversity and high dominance of a particular organism conferring the process a high instability. The production of electricity in microbial fuel cells requires the dominance of microorganisms with anode-respiration capacity but, depending on the substrate, a cooperation of several organisms might be needed to degrade complex organic compounds. In order to optimize these three processes and prevent failures, it is necessary to understand how these communities have to be managed to recover a high energy production yield and a stable performance. Examples of the three processes applied to different wastewaters from Uruguay will be presented.

Claudia Etchebehere, Clement Estable Biological Research Institute, Uruguay (cetchebe@gmail.com)

#### OP25 Impact Of pH On The Product Spectrum Of A Granular Sludge Bioreactor Producing Mainly Odd-numbered Volatile Fatty Acids

A. Hendriks, M. De Kreuk, J. Van Lier ((The Netherlands)

This research focused on the changes in product spectrum, the substrate consumption rate, and the base requirements at different pH values for a mainly odd-numbered VFA producing granular sludge bioreactor. Lower pH values decreased the base consumption and substrate conversion rates and lowered the biomass yield. The system is stable as long as the pH is 6.0 or higher.

Alexander Hendriks, Delft University of Technology, The Netherlands (a.t.w.m.hendriks@tudelft.nl)

#### OP26 Potential To Produce Lactic Acid From Cassava Flour Wastewater Using Indigenous Mixed Culture

J. Cavalcante, M. Zaiat (Brazil)

Lactic acid is widely applied in several industries, such as chemical and pharmaceutical, and it has drawn more attention due to its applications in the production of biodegradable polymer and green solvents. Recently, many studies have focused on evaluating alternative substrates for lactic acid production, intending to decrease production costs. Therefore, this research evaluated the potential of lactic acid production through the fermentation of an agro-industrial residue, cassava wastewater, by its own indigenous culture. Three temperature conditions were tested (25, 30 e 36°C) with uncontrolled pH. Lactic acid was the main fermentation product of the three fermentation temperatures, reaching maximum concentration and yield of 9.9 g/L and 0.69 g/g, respectively, at 25°C on the 7th day of fermentation.

Jéssica Cavalcante, EESC- University of São Paulo, Brazil (jessicasoarescavalcante@gmail.com)

**IS KN13 Maximizing the Value of Resources Recovered from Wastewater**

B. Rittmann (United States)

While wastewater treatment has focused on removing water pollutants, many of the pollutants are valuable resources if recovered in a useful form. This presentation begins by addressing means to capture the energy value of the BOD in domestic sewage and high-strength organic waste streams, such as from animal operations and food processing. New developments in anaerobic membrane biofilm reactors make it feasible to generate methane from domestic sewage. Microbial electrochemical cells offer the potential to generate a range of outputs with higher economic value than methane. Thus, methanogenesis and microbial electrochemical cells allow us to transform expensive, energy-consuming treatment of BOD into energy-positive and income-generating recovery conversion of BOD to energy. After recovery of the energy from the BOD, most of the N and P are released as inorganic forms that can be recovered for recycle to agriculture. This presentation focuses on P recovery, but the principles also apply for N. An important take-home lesson is that traditional techniques for "P removal" do not generate an output readily useful in agriculture. Instead, P-recovery techniques that produce a product useful in agriculture include precipitation as struvite or selective sorption of ortho-phosphate to iron-based sorbents. This talk introduces the new technologies, offer insights into their pros and cons, and highlights the economic benefits from resource recovery.

Bruce E. Rittmann, Arizona State University, United States (Rittmann@asu.edu)

**OP27 Removal And Recovery Of Nutrient Without Biology: Understanding The Challenge Of Implementing A New Paradigm**

B. Jefferson (United Kingdom)

To maximise the recovery of nutrients from sewage a new paradigm is required that is not based on biological processing. The current work explores the key challenges associated with such an alternative based on sorbents processes and presents both a technically effective and economically beneficial approach that is viable as a removal process alone.

Bruce Jefferson, Cranfield University, United Kingdom (B.Jefferson@cranfield.ac.uk)

**OP28 Resource Recovery From Acid Mine Drainage Without Chemical Dosing Using Microbial Electrochemical Technologies**

G. Pozo, P. Ledezma, J. Keller, S. Freguia (Australia)

In this work, we report on a novel 3-reactor microbial-electrochemical process (R1-R3; see Fig. 1) for the selective recovery of elemental sulfur (S<sub>0</sub>), metal hydroxides and water from acid mine drainage (AMD) without the need for chemical additions. A maximum autotrophic sulfate reduction rate of  $211 \pm 95$  gSO<sub>4</sub>-S m<sup>-3</sup> d<sup>-1</sup> in the bioelectrochemical reactor (R1) formed sulfide that was subsequently oxidised to S<sub>0</sub> in an electrochemical reactor (R2) at a rate of  $348 \pm 52$  g HS-S m<sup>-3</sup> d<sup>-1</sup>, resulting in an energy consumption of 2.8 kWh kgS<sub>0</sub> <sup>-1</sup> recovered. Concomitantly, OH<sup>-</sup> production at the cathode of the electrochemical reactor (R2) raised the pH of the AMD from 2.7 to 8.1 in a precipitation vessel (R3), resulting in 100% removal of Fe, Al, As, Cd, Cu, Cr, Ni, Pb and Zn.

Pablo Ledezma, The University of Queensland, Australia (p.ledezma@awmc.uq.edu.au)

**POSTER PITCHES**

**P724 Recovering Energy From Two Stage Anaerobic Digestion Of Effluent Generated In Second Generation Bioethanol Production**

B. Baeta, D. R. S. Lima, J. G. B. Filho, O. F. H. Adarme, L. V. A. Gurgel, S. F. de Aquino (Brazil)

This study aimed to evaluate the net energy recovery from hydrogen and methane production through two stage anaerobic digestion (AD-2S) of an effluent generated during the pretreatment by autohydrolysis (AH) of sugarcane bagasse (SB) for the production of second generation bioethanol denominated hemicellulose hydrolyzate (HH). Anaerobic digestion was carried out in a two-stage (acidogenic-methanogenic) batch system where the acidogenic phase worked as a stage of improvement of methanogenic biodegradability. This allowed the utilization of more severe AH pretreatment conditions, i.e. T = 180°C and t = 55 min (DC3) and T = 185°C and t = 41 min (DC4). Such severe conditions resulted in higher extraction of hemicelluloses from SB (1 = 68.07%, 2 = 48.99%, 3 = 77.40% and 4 = 73.90%), which consequently improved the net energy balance of the proposed process. The estimated energy from the combustion of both biogases (H<sub>2</sub> and CH<sub>4</sub>) accumulated during the AD-2S digestion of HH was of 3.15 MJ.kg.

Sergio F. De Aquino, Federal University of Ouro Preto, Brazil (sergio@iceb.ufop.br)



**P704 Extreme Thermophilic Biohydrogen Production From Sugarcane Stillage In Structured Anaerobic Packed-bed Reactor**

M. Krauspenhar Niz, M. Zaiat (Brazil)

This study evaluated the application of dark fermentation of sugarcane stillage in a Structured Anaerobic Packed-bed Reactor (sAPBR) at extreme thermophilic condition (70°C) for biohydrogen production. Stable and continuous hydrogen production was observed throughout the experimental period (100 days). Maximum volumetric hydrogen production rate (VHP) of 1303.4 mLH<sub>2</sub>.d<sup>-1</sup>.L<sup>-1</sup> was observed when an organic loading rate (OLR) of 47.9 gCOD.L<sup>-1</sup>.d<sup>-1</sup> was applied. Compared to other studies about thermophilic biohydrogen production with sugarcane stillage, higher yields were observed at extreme thermophilic condition. The application of operational strategies was not necessary to maintain hydrogen production.

Mirian Krauspenhar Niz, EESC- University of São Paulo, Brazil (mirian.niz@gmail.com)

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**P707 Biogas Recovery From Blackwater And Sewage Sludge As A Transition Component Towards Resource-Oriented Sanitation**

C. Morandi, S. Wasielewski, K. Mouarkech, R. Minke, H. Steinmetz (Germany)

The set-up of vacuum toilets at household level allows separate collection and specific treatment of blackwater for biogas recovery. As an approach to investigate its co-digestion with municipal sewage sludge in municipal digesters, a 630 l continuously stirred tank reactor was operated over 320 days; the transition to resource-oriented systems was achieved by incrementally replacing sewage sludge with blackwater up to 34% blackwater (referred to the COD load at the reactor inlet). A constant methane concentration of 60% in the biogas and removal efficiencies mostly above 70 % were reported, which corroborated the stable mesophilic operation of the anaerobic process. The increase in the blackwater fraction from 1.8 to 34% enhanced the biogas yield by 30% up to 332 l CH<sub>4</sub>/kg CODremoved in the last phase. The results indicate that blackwater co-digestion in municipal digesters may be a possibly energy-efficient approach for transition strategies.

Carlo Gottardo Morandi, University of Stuttgart, Germany (carlo.morandi@iswa.uni-stuttgart.de)

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## SESSION 8: ADVANCE TREATMENT MATERIALS AND MULTIFUNCTIONAL MEMBRANES

### PRESENTATIONS

#### **IS KN14 Overcoming Implementation Barriers for Nanotechnology in Drinking Water Treatment & A Case Study**

P. Westerhoff (United States)

Nanotechnology enabled water treatment is a promising approach to enhance the effectiveness and efficiency of purifying water in many areas of the world. Nanotechnology offers significant opportunities to revolutionize approaches towards drinking water treatment by enhancing the multifunctionality and versatility of treatment systems while reducing reliance on stoichiometric chemical addition (thus minimizing associated waste streams), shrinking large facilities with relatively long hydraulic contact times and minimizing energy intensive processes. The unique material properties that emerge at the nano-scale enable solutions to treat pollutants in water for which existing technologies are inefficient or ineffective. This presentation describes the rationale, opportunities and barriers for translating this nascent technology from promising bench-scale discoveries to full-scale commercialization and production of safe drinking water.

Paul Westerhoff, Arizona State University, United States (p.westerhoff@asu.edu)

#### **OP29 SBR Anaerobic / Aerobic Coupled To Photocatalysis For The treatment Of Azo Dye Direct Red 23**

R. Casimiro-Chávez, R. Melgoza-Alemán, F. Morales-Guzmán, M. Cruz-Carrillo, C. Cuevas-Arteaga (Brazil)

An efficient biological-Photo coupled system that combines a packed SBR anaerobic / aerobic and a photoreactor with TiO<sub>2</sub> nanotube was developed and evaluated for treating the azo dye direct red 23. The removal efficiency azo dye RD23 at concentration 50 mg L<sup>-1</sup> by the SBR was 82.5%, and total organic carbon was removed by 57%. The photocatalytic reactor reached efficiencies of 93% of residual coloring. Overall removal efficiency of coupling the bioreactor and photocatalytic reactor was 98.7% and a 66.7% TOC removal.

Rubí Casimiro-Chávez, Autonomous University of State of Morelos Mexico (rubi\_xv@hotmail.com)

#### **OP30 Increasing COD Removal And Energy Efficiency Of An AnMBR By Using The Membrane As Microbial Anode**

J. Madjarov, S. Kerzenmacher (Germany)

This work reports on a novel concept for the integration of bioelectrochemical systems into AnMBRs. By operating a conductive filter membrane simultaneously as microbial anode, significant COD degradation across the filtration membrane can be converted directly into electricity. In experiments conducted with a 0.1 μm stainless steel membrane using *Geobacter sulfurreducens* in an acetate containing medium, current densities of 6 A/m<sup>2</sup> and a permeate flow of 9 l·m<sup>-2</sup>·h<sup>-1</sup> after 18 days have been reached. During this period, COD degradation up to 200 mg/l across the membrane was achieved. In an ongoing experiment, the system is tested with synthetic brewery wastewater and sewage sludge, yielding similar current densities in the range of 5 A/m<sup>2</sup> but achieving higher COD degradation rates of up to 450 mg/l across the membrane. This demonstrates the promising potential of our system to convert excess COD into electricity while increasing removal efficiencies of AnMBRs.

Joana Madjarov, University of Freiburg, Germany (joana.madjarov@imtek.uni-freiburg.de)

#### **IS KN15 Multifunctional Membranes for Solarthermal and Electric Resistance Heating in Membrane Distillation**

S. Pedersen, B. Kellogg, J. Lou, Q. Li (United States)

Membrane distillation (MD) is an emerging technology that can be used to desalinate and purify water of a very wide range of total dissolved solids concentrations. Existing membrane distillation technologies, however, are highly energy intensive. Utilization of renewable energy such as solar energy is a promising approach to reduce the electric energy use of the membrane distillation process. In the meantime, it is desirable to be able to operate with electric power so that production is possible. In the study reported here, we develop a low cost, multifunctional, nanocomposite coating that are both photothermally active and electrically conducting on a conventional PVDF microporous membrane. The coating was formed by an electrospinning process using a polymer solution containing nanoparticles with photothermal activity, high electric conductivity, and antimicrobial properties. These nanoparticles allow the membrane distillation process to be driven directly by sunlight (i.e., photothermal heating) when it is available, and by electric energy (i.e., resistance heating) at other times. The coating also provides biofouling resistance, a very important feature for intermittent operation of the system. The membranes are evaluated in a bench scale direct contact membrane distillation unit using simulated sunlight and electricity as the energy sources. The biofouling potential is evaluated using a model biofilm forming bacterium, *Pseudomonas Aeruginosa*. The localized heating provided by the photothermal effect and resistance heating of the coating is shown to significantly improve the thermal efficiency of the MD process.

Qilin. Li, Rice University, United States (Qilin.li@rice.edu)

**OP31 Solar Semiconductor Photocatalysis For Advanced Water Treatment: Performance Of Novel Catalysts Activated By Sunlight**

R. B. P. Marcelino, M. Ratova, M. C. V. M. Starling, L. A. S. Castro, M. C. M. Ribeiro, F. M. Simões, Y. N. Yukawa, M. A. Tenenwurcel, P. Kelly, M. M. D. Leão, C. C. Amorim (Brazil)

Solar photocatalysis has been used for the removal of contaminants of emerging concern from water. Titanium dioxide is the most widely used photocatalyst worldwide. However, TiO<sub>2</sub>-based photocatalysts present major drawbacks. At first, titania-based materials are only activated by UV light, which corresponds to less than 5% of solar spectrum. In addition, it is difficult to achieve high reaction rates using TiO<sub>2</sub>. Moreover, the use of the catalyst in its powdered form results in high surface area, but poses some difficulties to recover the powder after treatment. Meanwhile, TiO<sub>2</sub> coatings deposited onto flat substrates are usually characterised with low surface areas, thus being unsuitable for high throughput processes. In this context, this work presents a solution in the attempt to fill the need for the development of novel, efficient, low band gap semiconductors activated by solar radiation with high surface area and which are easily manageable in water detoxification facilities.

Rafaela Marcelino, Federal University of Minas Gerais, Brazil (rafaelabrito@ufmg.br)

**OP32 Life Cycle Evaluation Of Anaerobic Membrane Bioreactor Co-Management Of Domestic Wastewater And Food Waste**

A. Becker, Jr., K. Yu, L. Stadler, A. Smith (United States)

Food waste is an energy-rich resource that should be diverted from landfills. We used life cycle assessment to compare co-management of food waste and domestic wastewater using anaerobic membrane bioreactor (AnMBR) against conventional activated sludge (CAS) and high rate activated sludge (HRAS) with three disposal options for food waste: landfilling (LF), anaerobic digestion (AD), and composting (CP). Based on the net energy balance (NEB), AnMBR and HRAS/AD were the most attractive scenarios. However, cogeneration negatively impacted carcinogenics, non-carcinogenics, and ozone depletion, illustrating unavoidable tradeoffs between energy recovery from biogas and environmental impacts. Fugitive emissions of methane severely increased global warming impacts of all scenarios except HRAS/AD with AnMBR being particularly affected by effluent dissolved methane. AnMBR was highly sensitive to food waste diversion participation and required at least 40% participation to achieve a positive NEB.

Adilson Becker Jr., University of Southern California, United States (smithhada@usc.edu)

**P803 Expanding The Sustainability Of Reverse Osmosis Membranes**

E. Coutinho de Paula, J. Gomes, M. Amaral (Brazil)

Reverse osmosis (RO) is the most employed technology for water desalination and demineralization. However, the RO membrane modules have a limited life cycle. Thus, the impacts caused by the disposal of thousands of tonnes per annum of RO membranes modules have grown dramatically around the world. The objective of this study was to evaluate the technical feasibility of recycling by chemical oxidation of end-of-life RO membranes for applications in other separation processes with less demanding specifications, such as ultrafiltration. The recycling technique consisted in to cause a membrane exposition with oxidant solutions in order to remove its dense aromatic polyamide layer and subsequent conversion to a porous membrane. The performance and SEM, EDS, AFM and contact angle characterizations of recycled membranes has been evaluated systematically. In short, very interesting results on water permeability were obtained with the purpose of expanding the sustainability of RO membranes.

Miriam Cristina Amaral, Federal University of Itajubá, Brazil (mcsamaral@yahoo.com.br)

**P833 Tailoring Silica-cage Frameworks Of Natural Macroporous Materials**

M. Silva, J. Corrao, D. Boehm, D. Garman (United States)

Multiple methods have been developed to tailor silica-cage of synthetic zeolite and tune their porosity. However, synthetic zeolites are more expensive, may not have the hardness needed for some applications and may not be viable for large scale applications. In this work, we show that we can control the silica --cage framework of natural zeolites and regulate their porosity by exposing the particles to a variety of cleaning and selectively leaching techniques and regulating final properties by number of cycles of exposure.

Marcia Silva, University of Wisconsin-Milwaukee, United States (msilva@uwm.edu)

**P831 Commercial Membranes Modification With TiO<sub>2</sub> Nanoparticles By Layer- By --layer Deposition Method For Textile Wastewater**

M. Pessoa Amorim, M. Tavares, T. Linhares (Portugal)

A composed film of TiO<sub>2</sub> nanoparticles was applied on modified microfiltration polyethersulfone membrane by layer-by-layer self assembly technique. The treated membranes were characterized by FTIR, contact angle, scanning electron microscopy and permeability experiments. Photocatalytic activity of the treated membrane was evaluated through the degradation of a basic dye the methylene blue under UV radiation. The stability of the catalytic effect was evaluated for five treatment cycles, with and without activation. The results show a slight decrease on the photocatalytic activity after five cycles. However, this technology is promising and can be applied as pre or post treatment to wastewaters from the dyeing process of the textile industry.

Maria Teresa, Pessoa Amorim University of Minho, Portugal (mtamorim@det.uminho.pt)

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