26th Annual Environmental Engineering and Science Symposium

April 23, 2021

Gather Town Virtual Experience

9:00 AM – 4:30 PM

Contents

Introduction

2021 marks the 26th annual Environmental Engineering and Science (EES) Symposium at the University of Illinois at Urbana-Champaign (UIUC) as well as 2020 Association of Environmental Engineering and Science Professor (AEESP) Distinguished Lecturer. This year's theme is "*Envisioning the Future of Environmental Engineering*". This theme was chosen by the symposium organizers to arouse concerns about the increasing need for an ecologically sustainable future. The future is likely to see more technological development, population growth, and new potential contaminants. These are likely to see more areas needing management to avoid pollution or ecological damage; we will see a need to change conditions in some areas to cope with the changing climate. We hope that this symposium will bring together researchers from a wide variety of backgrounds and specialties to present their research, ideas, and visions for the future. Join us as we explore the engineering solutions to these pressing environmental challenges.

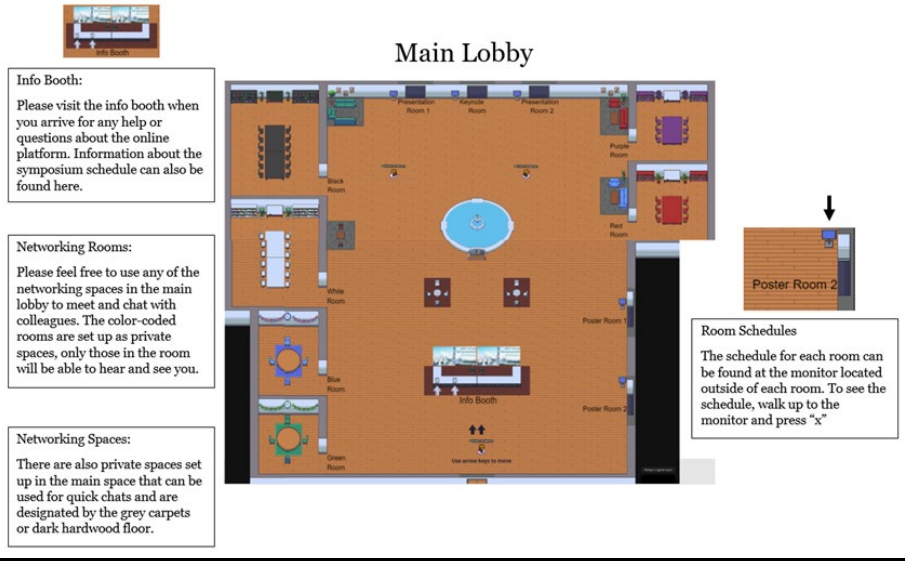
Organizers

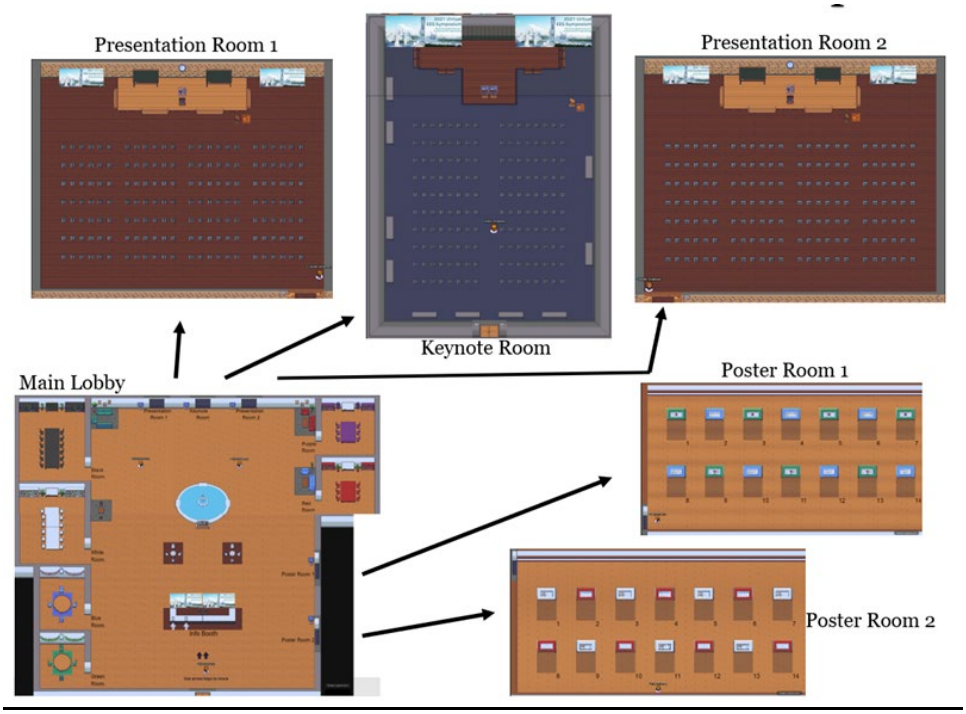
Students from CEE 595 G are major organizers of this event. CEE 595 G is a course taken by UIUC Civil and Environmental Engineering master's students. Students in the EES program are responsible for hosting the annual EES Symposium. This is an opportunity for us to gather together and invite the environmental engineering community to learn about our work. Each student presents either a poster or oral presentation which displays their research or a project they are working on.

Schedule

Time	Event	Location
8:30 am	**Gather Space Opens**	
8:50 – 9:00 am	**Opening Remarks: Professor Roland Cusick**	**Keynote Room**
9:00 – 9:55 am	**Keynote: Professor Pratim Biswas**	**Keynote Room**
9:55 – 10:00 am	**Transition Break**	
10:00 – 11:00 am	**Poster Presentation Session 1**	**Poster Room 1**
11:00 – 12:00 pm 11:00- 11:20 am 11:20 –11:40 am 11:40 –12:00 pm	**Podium Session 1** Samuel Aguiar- Plantwide implications of low yield struvite precipitation and fines washout Xinyi (Joy) Zhang- QSDsan: An Integrated Platform for Quantitative Sustainable Design of Sanitation and Resource Recovery Systems under Uncertainty – Process Modeling and Beyond Haoran Yu- Spatiotemporal variability of oxidative potential of PM2.5 in the Midwest United States	**Presentation Room 1**
11:00 – 12:00 pm 11:00- 11:20 am 11:20 –11:40 am 11:40 –12:00 pm	**Podium Session 1** Yanina Nahum- Using shear rheometry and image analysis to study effectiveness of biofilm disruptors Bumkyu Kim- Effects of extracellular-polymeric substances (EPS) on the performance of membrane bioreactors Emily Clements- Effect of Temperature on Nitrifying Membrane Aerated Biofilm Reactors	**Presentation Room 2**
12:00 – 1:00 pm	**Networking/Lunch**	
1:00 – 2:00 pm	**Poster Presentation Session 2**	**Poster Room 2**
2:00 – 3:00 pm 2:00 – 2:20 pm 2:20 – 2:40 pm 2:40 – 3:00 pm	**Podium Session 2** Sarang S. Bhagwat- Sustainable Production of Acrylic Acid via 3-Hydroxypropionic Acid from Lignocellulosic Biomass Charles Graham- Removal of Per- and Polyfluoroalkyl Substances (PFAS) in Point-of-Use (POU) Activated Carbon and Membrane Filtration Systems Hsin-Yin Yu- Removal of assimilable organic carbon in activated carbon and reverse osmosis water filtration systems	**Presentation Room 1**
2:00 – 3:00 pm 2:00 – 2:20 pm 2:20 – 2:40 pm 2:40 – 3:00 pm	**Podium Session 2** Katherine Crank- From Theory to Practice: Expanding the Quantitative Microbial Risk Assessment Framework Brooke Stemple- Biogeochemistry of the Antrim Shale Natural Gas Reservoir Sudheer Salana- Development of a semi-automated instrument to measure the cellular Reactive Oxygen Species (ROS) activity of ambient particulate matter	**Presentation Room 2**
3:00 – 3:05	**Transition Break**	
3:05 – 4:00 pm	**Keynote Speaker: Dawn Taffler-** Integrated Water Management Planning	**Keynote Room**
4:00 – 4:15 pm	**Announcement of Results and Prizes**	**Keynote Room**
4:15 – 4:30 pm	**Closing Remarks: Professor Roland Cusick**	**Keynote Room**

Gather Space Conference Map





Keynote Speaker

Dr. Pratim Biswas

Assistant Vice Chancellor & Department Chair, Washington University in St. Louis

(9:00 AM to 10:00 AM, Keynote Speaker Room)

Dr. Pratim Biswas is the Dean of Engineering at the University of Miami in Coral Gables, Florida. He also serves as an Assistant Vice Chancellor of International Programs. He has more than 400 refereed journal publications, has presented several invited presentations nationally and internationally, holds ten patents and has spun off two start-up companies based on his inventions. He has advised and graduated 54 doctoral students, all of whom are accomplished in their careers in academia, government, and industry. Pratim Biswas received his Ph.D. from the California Institute of Technology; his MS from the University of California, Los Angeles, and his BTech degree from the Indian Institute of Technology, Bombay.

Keynote Speaker

Dawn Taffler, P.E., LEED AP

One Water Practice Leader and Vice President at Kennedy Jenks Consultants

(3:00 PM to 4:00 PM, Keynote Speaker Room)

Dawn Taffler, an alumnus of the CEE department at the University of Illinois at Urbana-Champaign, is a recognized specialist in recycled water and planning and has been successfully leading Kennedy Jenk's Recycled Water Community Practice for the past four years. Based in Pasadena, she is now taking on the additional responsibility of leading the One Water Community Practice. Dawn's work has included a variety of projects that seek to diversify and optimize the way we use and reuse water. She is currently leading seven non-potable and potable reuse studies throughout California to maximize the use of local, sustainable and reliable water supplies.

Poster Presentation Session 1

(Posters #1-13)

10:00 AM to 11:00 AM

Poster Room 1

Poster #1 – Chamteut Oh

A new method of concentrating viruses for wastewater-based epidemiology

Wastewater-based epidemiology (WBE) is a new approach that monitors pathogens in wastewater to understand a local community's public health. A series of studies showing the relationship between the genome copy number of SARS-CoV-2 and the daily confirmed cases proved the feasibility of WBE. Since the virus concentration in the wastewater is usually lower than the detection limit of instruments, viruses have to be concentrated to have the virus concentration within the detection range. Ultracentrifuge and ultrafiltration have been widely used for concentrating viruses. However, these are resource-demanding methods that limit WBE from being widely applied. We suggest the porcine gastric mucin conjugated magnetic beads (PGM-MBs) for better virus concentration from the wastewater. The PGM-MBs method turned out to be simpler and faster to concentrate the viruses from the wastewater. Besides, this assay showed a lower detection limit than that of the conventional virus concentrating methods.

Poster #2 – Gemma G Clark

Efficacy of point-of-use filters used beyond the recommended lifetime

Even after treatment at the drinking water treatment plant, contaminants can be introduced to the drinking water distribution system. To address this problem, some people have chosen to install point-of-use (POU) filters at the tap. Filter user manuals specify recommended filter age and gallons of water filtered, after which, filters should be replaced. Not every user follows those recommendations. In a previous study, we found that some POU filters release lead (Pb) and bacteria following a stagnation period. Our study examines year-old POU filters to understand the efficacy of these filters after the recommended period of use. We measure chlorine removal, cell counts, and disinfection byproduct (DBP) removal.

Poster #3 – Sydney Gard

Disinfection Kinetics of Echovirus 12 with Free Chlorine at High pH

Regulatory agencies must assess a wide variety of emerging chemical and microbial substances detected in water sources used for drinking water supply that could potentially have negative impact on public health. The USEPA is currently evaluating the possibility of setting regulations for enteroviruses, a common genus of waterborne viruses. Several serotypes of enterovirus species B have shown high resistance to inactivation by free and combined chlorine, the two most common disinfectants used in the United States. Previous studies have found that echovirus serotypes 1 and 12 have the highest resistance among enteroviruses to free chlorine at high pH levels. My MS research project focuses on characterizing the kinetics of echovirus 12 inactivation with free chlorine at pH 9-10 and temperatures in the range of 1-30oC. The data will be compared to that reported for coxsackievirus B5, another serotype of enterovirus species B with high resistance to free chlorine.

Poster #4 – Tessa Clarizio

Predicting regional air quality and climate impacts of future agricultural and land use change scenarios in the Midwest United States

Agricultural land use and land cover change (LULCC) impacts climate through greenhouse gas emissions and perturbing land-atmosphere energy, water and chemical fluxes. Additionally, agriculture impacts air quality through emissions of fine particulate matter (PM2.5), PM2.5 precursors, and ozone precursors. Regional-scale climate impacts of agricultural intensification have been shown in the Midwest, and this impacts the heat stress and air quality experienced in local urban areas. However, the impacts on and feedbacks of climate and air quality resulting from future LULCC scenarios is uncertain. Therefore, the main objectives of this research are to 1) estimate potential heat stress and air quality impacts to the Midwest region and local urban areas under projected agricultural scenarios and 2) assess the physical and chemical drivers of these heat stress and air quality effects. The GEOS-Chem chemical transport model integrated within the Community Earth System Model (CESM) will be used to carry out research tasks.

Poster #5 – Hannah Lohman

Overcoming the barriers of resource recovery sanitation: analyzing the interdisciplinarity of the sanitation field

In resource limited settings, barriers related to disciplines outside of engineering (e.g., economics, social sciences) contribute to the failure of sanitation systems within a community. Bibliometric analyses have been conducted to evaluate the scholarly production of engineering topics, however, there is a lack of research related to the level of interdisciplinarity collaboration of sanitation and other relevant fields. The objective of this work is to characterize the existing convergence of interdisciplinary research related to resource recovery sanitation and alignment between disciplinary engagement and barriers to resource recovery. Interdisciplinarity will be calculated based on the fraction of cited references in the engineering/technology, agriculture, health, economic, and social science disciplines. Preliminary Scopus searches indicate 75% of sanitation papers use keywords related to at least one barrier discipline, but only 0.1% of papers have terms related to all five. Overall sanitation research should be more interdisciplinary to overcome the barriers of system success.

Poster #6 – Weiqi Ni

NOVEL COVALENT ORGANIC FRAMEWORK (COF) THIN-FILM COMPOSITE NANOFILTRATION MEMBRANE FOR EFFECTIVE REMOVAL OF ORGANIC COMPOUNDS FROM PETROLEUM PRODUCED WATER

Petroleum produced water is considered the largest waste stream associated with oil and gas extraction. The treatment and further reuse of produced water are essential to address environmental protection and global water scarcity challenges. The removal of small organic matters remains a challenge for produced water treatment. A novel thin-film composite nanofiltration membrane with a covalent organic framework (COF) active layer developed in early phases of this study was used to investigate its rejection capability for organic model compounds. Permeation experiments with the COF membrane resulted in 60-70% rejection for three model compounds, Propyl-, Butyl- and Pentyl-benzoic acids, along with 85-90% rejection of the higher-molecular weight organic surrogate, Rhodamine-WT (R-WT), and less than 10% rejection of model inorganic salt, NaCl. The solution-diffusion model revealed that a significant portion of the overall permeation was due to advection through imperfections. Further refinement of the COF membranes focusing on eliminating the imperfections would result in the model compound rejection increasing to 90-95%.

Poster #7 – Shion Watabe

Implications of financing mechanisms on the relative economic sustainability of sanitation technologies in underserved communities

Economics and financing are central to the sustained supply of safely managed sanitation services to low-income settings. Globally, access to basic sanitation is grossly insufficient and significant investment is required to achieve universal sanitation coverage (UN SDG 6.2) by 2030. There are multiple mechanisms for financing sanitation development, and efficient allocation of resources is critical to build momentum. The objective of this study is to characterize the impacts of at least five financing mechanisms on the relative economic sustainability of sanitation technologies. Traditional and innovative financing mechanisms such as subsidies, output-based aid, grants, microfinance, and market-based models from the public and private sectors will be evaluated via techno-economic analysis of a model system. The financial implications of each financing mechanism will be characterized based on daily user cost under uncertainty. This analysis will demonstrate how public and private sectors can most effectively deploy funding to deliver technologies for sustained sanitation.

Poster #8 – Yichen Lyu

A Review: Intelligent IoT systems for traffic management: A practical application

The increasing of carbon dioxide emission along with the expand of urbanization is a crucial problem people are facing. According to the EPA dataset, there are at least 25 percent carbon dioxide is released from vehicles. In this study, the researchers developed a new model for intelligent IoT system for traffic signal light management. The iREDVD model is improved from random early detection for vehicles dynamic models by using evolutionary algorithm to get the better parameter configuration. By stimulating the iREDVD model in the microscopic traffic simulator SUMO v1.0.1 with TraCI (Traffic Control Interface), researchers found that using iREDVD model to control the traffic signal light would effectively reduce the waiting time for vehicles at every intersection, which could reduce the total carbon dioxide emission by vehicles.

Poster #9 – Yifei Bi

Removal of manganese and uranium in tap water with point-of-use filtration systems

Point-of-use (POU) water filtration systems, such as activated carbon systems and reverse osmosis membrane filtration system, provide many benefits to remove trace level contaminants that remain in tap water, but their potentials to remove trace level heavy metals have not been fully explored. Manganese may pose health risks on neurobehavioral impairment, idiopathic Parkinson's disease, or kidney stones, but limited studies have been done on its removal in POU systems. Uranium may cause cancer and kidney damage. In this study, removal efficiency of manganese and uranium quantified with inductively coupled plasma-optical emission spectrometry (ICP-OES) and inductively coupled plasma-mass spectrometry (ICP-MS). Overall manganese and uranium were not effectively (<20%) removed in activated carbon but were effectively (>90%) removed in reverse osmosis systems. Information collected in this study will be valuable in developing cost-effective treatment devices to improve water quality and mitigate risks of metals in tap water.

Poster #10 – Gus Greenwood

Why do liquids slip on graphene? Effects of layering and supporting substrate underneath graphene

Understanding modulation of liquid molecule slippage along graphene surfaces is crucial for many promising applications of two-dimensional materials, such as in sensors, nanofluidic devices, and membrane filtration. We use atomic force microscopy (AFM) to directly measure hydrodynamic, solvation, and frictional forces along the graphene plane in seven liquids. Greater measured slip lengths correlate with the interfacial ordering of the liquid molecules, suggesting that the ordering of the liquid forming multiple layers promotes slip. Furthermore, the slip boundary condition of the liquids along the graphene plane is sensitive to the substrate underneath graphene, indicating that the underlying substrate affects graphene's interaction with the liquid molecules. Because interfacial slip can have prominent consequences on the pressure drop, electrical and diffusive transport through nanochannels, and on lubrication, this work can inspire innovation in many applications through the modulation of the substrate underneath graphene and of the interfacial ordering of the liquid.

Poster #11 – Trevor Gresham

Literature Review: Microalgae-based Biorefineries for Wastewater Resource Recovery

Long-term sustainability issues exist with the current socio-economic production system, whereby raw materials are extracted and transformed by industrial processes into products. Sustainability issues and limits in resource availability are main drivers for some global economies to seek a more self-sufficient, bio-based economy. Many wastewaters are rich in resources that can be recovered through biotechnical processes and provide an economical pathway for sustainable production practices. This presentation will highlight the use of microalgae-based biorefineries for wastewater resource recovery. Microalgae biorefineries offer high efficiency in nutrient and resource recovery, pollutant removal, and energy production. Currently, high operational costs and some knowledge gaps limit their development and use in commercial-scale systems. The sustainability of biorefineries depend on multiple factors including upstream and downstream processes, land uses, and environmental impacts. Life cycle assessments and techno-economic assessments can be used to determine the stability of a microalgal refinery with integrated processes.

Poster #12 – Wen Cong

Mechanistic Study of Coxsackievirus and Adenovirus Inactivation by Chlorine and Aptamer-Nanopore Sensor Development

Assessing drinking water disinfection performance on viral pathogen removal has been challenging. Culture-based method is expensive and time-consuming and there are viruses not culturable. qPCR-based method does not differentiate viral infectivity. A promising solution is sensor for fast detection of infectious viruses. Aptamer (short single-stranded nucleotides) selected with Sequential Evolution of Ligands by Exponential Enrichment (SELEX) is potential for biosensor. Adenovirus and Coxsackievirus can be used as model virus to be monitored for their high resistance to free, combined chlorine or UV disinfection. We previously obtained an aptamer that selectively binds to a molecular motif on the capsid of infectious Adenovirus 2 that is transformed by chlorine disinfection and it can be used to monitor Adenovirus number concentration in water without interference of non-infectious virions. On this basis, our team aim to select a comparable aptamer for Coxsackievirus and identify the limiting transformation of Adenovirus or Coxsackievirus by chlorine resulting in loss of infectivity to support the sensor development.

Poster #13 – Yuehao Shi

Inactivation Of Adenovirus Serotype 41 With Monochloramine

Monochloramine is widely used in drinking water facilities all over the world as a common disinfectant. However, the disinfection kinetics between monochloramine and different pathogens are not fully studied. Human Adenovirus (HAdV) serotype 41, as a common kind of enteric virus to cause gastroenteric diseases, can cause the risk for infants, children, elder people as well as those with immune deficiency if present in drinking water. However, HAdV41 is highly resistant to monochloramine. Thus, the current study is focused on the kinetics and mechanism between HAdV41 and monochloramine and try to provide the solution for better monochloramine disinfection efficiency in drinking water treatment process. Current results shows that HAdV41 has a different disinfection kinetics than well-studied HAdV2, and the kinetic rate could be impacted by other organic matters present in water.

Podium Session 1

(Presenters #1-6)

11:00 AM to 12:00 PM

Podium Presenter #1

(Room #1)

Samuel Aguiar – 11:00 AM to 11:20 AM

Plantwide implications of low yield struvite precipitation and fines washout

WRRF's are increasingly implementing sidestream struvite ($MgNH_4PO_4 \cdot 6H_2O$) crystallization to reduce concentrated P streams generated from anaerobic digestion of biological nutrient removal sludge. This method reduces P recycling to mainline treatment while producing a P-rich fertilizer with the potential to reduce agricultural runoff. One challenge faced by the widespread introduction of struvite recovery technologies is the dissolution of P rich fines in mainline treatment after washout from crystallizer reactors. In WRRFs where struvite crystallization has been implemented, an unknown impact on downstream plant operation is present due to the lack of data characterizing the dissolution of these fines.

In this work, the dissolution of field grown struvite was characterized in batch mode at the lab scale using the shrinking object model. Then, a kinetics-based plantwide modelling study was conducted using discretized particle size distributions to understand the impact of fines washout from struvite crystallizers on plant efficiency in terms of total cost and efficacy of the overall treatment chain.

Podium Presenter #2

(Room #2)

Yanina Nahum – 11:00 AM to 11:20 AM

Using shear rheometry and image analysis to study effectiveness of biofilm disruptors

Biofouling is a major concern in water filtration processes, piped conveyance systems, and many others. It is caused by the development of biofilms, which are aggregates of bacteria embedded in a self-produced matrix of extracellular polymeric substances. The EPS matrix provides the biofilm with mechanical strength and stability. The composition of the matrix is affected by flow, shear stresses, growth conditions or biofilm age, and it defines the shape and intrinsic characteristics of the biofilm. To better understand the effects of biofilm disruptors on the structural cohesiveness of a biofilm, and to develop more effective removal strategies, this research is developing a methodology to link changes in biofilm mechanical properties with biofilm disruption. The effect of disruptors on the biofilm mechanical properties is determined using shear rheometry. Optical coherence tomography (OCT) is used to track in situ biofilm disruption and removal. This research brings novel approach to study biofilm control strategies by measuring the effectiveness of chemical or biological disruptors under different biofilm conditions.

Podium Presenter #3

(Room #1)

Xinyi (Joy) Zhang – 11:20 AM to 11:40 AM

QSDsan: An Integrated Platform for Quantitative Sustainable Design of Sanitation and Resource Recovery Systems under Uncertainty – Process Modeling and Beyond

QSDsan is an open-source quantitative sustainable design platform in Python for design, simulation, and sustainability assessment of sanitation and resource recovery systems under uncertainty. QSDsan aims to provide an integrated framework for evaluation of the landscape of designs and scenarios for early-stage technologies to guide their research, development, and deployment (RD&D). In particular, through abstraction of kinetic processes and equilibrium reactions in physical, biochemical, and thermal treatments, a module is developed to provide flexibility in process modeling for diverse applications in RD&D. It is shown to simulate the dynamics of stream composition in a biological treatment unit (continuous stirred tank reactor with DO controller) in close match with the same design modeled in proprietary software (GPS-X). By incorporating features for equilibrium chemistry and leveraging existing package (Thermosteam) for thermodynamic calculations, we will further improve QSDsan to enable robust modeling and unit design for applications such as resource- and energy-recovery technologies.

Podium Presenter #4

(Room #2)

Bumkyu Kim – 11:20 AM to 11:40 AM

Effects of extracellular-polymeric substances (EPS) on the performance of membrane bioreactors

This research studied the effects of extracellular polymeric substance (EPS) characteristics on the performance, biofilm structure, and biofouling of membrane bioreactors, e.g., membrane aerated biofilm reactors (MABRs) and filtration membrane reactors. We studied this using Pseudomonas aeruginosa PAO1. P. aeruginosa produces three main types of EPS: alginate, Pel and Psl. We compared the P. aeruginosa wild type with a mutant impaired in Pel production (Pel-). For the MABR reactor, the biofilm thickness, effluent sCOD, and effluent suspended solids were lower for Pel- system than for the wild type. For filtration membrane reactors, the biofouling occurred much more quickly for the wild type. This work suggests that less EPS and higher bacterial density (i.e., Pel-) not only resulted in higher biodegradation rates, but also in reduced biofouling. Our lab currently is addressing practical ways to achieve low-EPS, high-density biofilms.

Podium Presenter #5

(Room #1)

Haoran Yu – 11:40 AM to 12:00 PM

Spatiotemporal variability of oxidative potential of PM2.5 in the Midwest United States

We investigated the comprehensive oxidative potential of ambient particles in Midwest US using five commonly used OP endpoints [ascorbic acid (AA) and glutathione (GSH) consumption in surrogate lung fluid (SLF), dithiothreitol (DTT) consumption and •OH generation in SLF and DTT]. Ambient PM2.5 samples were collected from three urban sites, one roadside site and a rural site during May 2018 – May 2019, and a semi-automated multi-endpoint ROS activity analyzer (SAMERA) developed in our lab was used to analyze all the samples in both water and methanol extracts. A stronger spatiotemporal heterogeneity was observed for most OP endpoints compared to PM2.5 mass, while water-soluble OP showed higher variations than methanol-soluble OP. Higher levels of OP were generally found in methanol extracts for OPAA, OPOH-SLF and OPOH-DTT. Furthermore, we found poor-to-moderate correlations between OP and PM2.5 mass, indicating a decisive effect of chemical compositions in the health outcomes of PM2.5.

Podium Presenter #6

(Room #2)

Emily Clements – 11:40 AM to 12:00 PM

Effect of Temperature on Nitrifying Membrane Aerated Biofilm Reactors

The membrane aerated biofilm reactor (MABR) is a novel wastewater treatment technology that greatly reduces energy requirements. However, little is known about effect of temperature on nitrifying MABRs. In MABRs, ammonium is supplied from the bulk, while oxygen from the base of the biofilm. The impact of temperature on the substrate diffusivity and oxygen solubility is expected to affect the MABRs more than conventional biofilms, which are less affected by temperature than suspended growth. Also, ammonia oxidizing bacteria (AOB) have higher growth rates than nitrite oxidizing bacteria (NOB) at higher temperatures, but microbial competition in MABRs is different from conventional biofilms due to substrate counter diffusion. Experiments and modeling were carried out to explore the effects of temperature. Preliminary experiments show that, at higher temperatures, the ammonium removal flux is higher and nitrite accumulation more significant. This agrees with the model predictions. Ongoing tests are exploring different temperatures.

Poster Presentation Session 2

(Posters #14-27)

1:00 PM to 2:00 PM

Poster Room 2

Poster #14 – Runsen Ning

A molecular approach to remove lead from drinking water.

Lead can enter drinking water when plumbing materials that contain lead corrode, it usually happens in high acidity or low mineral water that corrodes pipes and fixtures. The most common sources of lead in drinking water are lead pipes, faucets, and fixtures. In home with lead pipes that connect the home to the water main, also known as lead services lines, these pipes are typically the most significant source of lead in the water. Lead pipes are more likely to be found in older cities and homes built before 1986. Among homes without lead service lines, the most common problem is with brass or chrome-plated brass faucets and plumbing with lead solder. A new concept has been explored that relies on solid phase extraction by covalent attachment of a lead-selective macrocylic sequestering agent onto the surface of silica gel. An N-carbamoylmethyl substituted 1,4,8,11-tetraazacyclotetradecane(cyclam) derivative was shown to exhibit favorable protonation properties. Extensive simulations have shown that the selected tetraacetamide cyclam ligand was able to successfully compete in a large pH and alkalinity range with complexing anions usually present in tap water to uptake the target metal.

Poster #15 – Shadiyar Smagulova

Smart grid for energy saving

An overview of the level of development of smart grids and its impact on improving energy efficiency and, consequently, greenhouse gas emissions is presented. Conducting an analysis of the mechanisms that affect the effectiveness of smart grids from the environmental point of view. Analysis of the level of their impact on the final reduction of greenhouse gas emissions. Identify the key factors affecting energy consumption and propose a strategy for optimal implementation of smart grids. Assessment of the feasibility of the potential implementation of a smart grid system based on the action of mechanisms to reduce energy consumption and greenhouse gas emissions.

Poster #16 – Kathleen Martinez

A review of the contamination and remedial processes for the Former Champaign Manufactured Gas Plant

A literature review of Ameren's Former Manufactured Gas Plant (MGP) in Champaign, IL was performed with the intent to educate the community about the MGP and associated groundwater, soil, and soil gas contamination; health hazards; and remedial processes. Reports, summaries, letters, and other communication from Ameren's website, the IEPA website, community groups, etc. were reviewed. Special emphasis will be placed on soil and soil-gas contamination located in the neighborhood around the site.

Poster #17 – Devin North

Evaluation of Viral Concentration Methods for Enteric and Pathogenic Viruses in Wastewater

Viruses are dilute in comparison to pathogenic and fecal indicator bacteria in environmental waters, and a concentration step is necessary for viral metagenome and quantification protocols. In this study, four methods were compared to evaluate concentration efficiency in wastewater, including polyethylene glycol (PEG) precipitation, skimmed milk flocculation, filtration through a .45 µm filter, and centrifugation using an Amicon filter. Recovery was calculated using native virus populations in a direct extraction, as well as a spike-in control. DNA and RNA were extracted using a QIAGEN PowerViral Kit and droplet digital PCR was performed on each sample for various target viruses, both indicators and pathogens, including SARS-CoV-2. A bacterial marker was included to compare retention of bacteria and isolation of viral populations. The results of this study will suggest an optimized method for concentrating and isolating target viruses in wastewater for molecular assays, including PCR and metagenomic studies.

Poster #18 – Kristin Anderson

A Review: The Use of Plasma-Based Water Treatment on the Removal of Pharmaceutical Compounds

This will be a review of the effectiveness and scientific progress of using non-thermal plasma treatment to eliminate pharmaceutical compounds in water. Traditional water treatment technologies have not been able to successfully remove certain non-biodegradable pharmaceuticals. Plasma-based treatment is an emerging technology that could potentially aid in this effort. A majority of experiments and research have resulted in these compounds being removed quickly, partly degraded and partly mineralized. Various studies and their findings will be presented and explored to determine the efficacy of utilizing this technological approach.

Poster #19 – Yixiang Wang

Contribution of Fe and Organic Compounds to Cellular Oxidative Potential (OP) of PM2.5 Collected in Midwestern United States.

This research's core objective is to investigate the contribution of Fe and organic compounds to the PM2.5 overall cellular oxidative potential (OP). All experiments were conducted from Sep 2020 to Dec 2020. Here, a C-18 column coupled with a chelex column was used to separate the water-soluble PM2.5 into three parts: hydrophobic, organic hydrophilic, and metallic hydrophilic fractions. The importance of these three fractions on PM2.5 OP and the effect of Fe on metallic hydrophilic fraction's OP was assessed by a cellular assay. Among the three fractions, the metallic hydrophilic fraction, which is typified by abundant Fe, dominates the PM2.5 overall cellular OP. Further experiments indicate that although organic compounds did not substantially contribute PM2.5 cellular OP, their presence enhanced the solubility of Fe. Our study highlights different roles of Fe and organic compounds on altering the overall PM2.5 cellular OP.

Poster #20 – Joseph V. Puthussery

Influence of Episodic Events on the Oxidative Potential of Ambient Particulate Matter in Delhi, India

The oxidative potential (OP) of fine particulate matter (PM2.5) is a health metric used to estimate the PM2.5 toxicity. In this study, we investigated the effect of biomass burning emissions, fireworks emissions, and haze events on the OP of ambient PM2.5 in Delhi (India). We sampled ambient PM2.5 at Delhi intermittently from October 11, 2019, to January 8, 2020 (~50 days). We used an automated OP measuring instrument, which was recently developed in our lab, to measure the hourly averaged real-time OP of ambient PM2.5. The chemical composition of PM2.5 was also measured using various collocated online instruments such as high-resolution time-of-flight aerosol mass spectrometer, aethalometer, and Xact® (total metals). Preliminary results showed extremely elevated ambient PM2.5 OP (>13 nmol/min/m3) on the night of Diwali and during haze events. Dust and secondary sulfate/coal combustion aerosols were identified as the main drivers of PM2.5 OP at Delhi.

Poster #21 –Taylor Stephen

Integrating a chemical precipitation model into QSDsan – An open-source platform for the design and evaluation of resource recovery technologies

The growing demand for sustainable wastewater infrastructure requires a tool which can provide insight into the performance and sustainability of emerging technologies. Current wastewater models are not equipped to support research and development for novel technologies or decentralized treatment. In the development of a flexible, open-source modeling framework (QSDsan), there is an opportunity to evaluate nutrient recovery via precipitation of soluble phosphorus salts. This study aims to develop a chemical precipitation model to be integrated into QSDsan – a platform for process design, simulation, techno-economic analysis, and life cycle assessment. The model will be based on equilibrium chemistry with an emphasis on the supersaturation threshold and precipitation potential of phosphorus minerals. It will identify where phosphorus will precipitate, what complexes will drive the thermodynamics for precipitation, and where there is potential for recovery. The developed model will be utilized in prioritizing opportunities for nutrient recovery for various novel wastewater treatment systems.

Poster #22 – Dalton Stewart

Incorporation of Policy Incentives and Other Location-Specific Parameters into BioSTEAM for the Techno-Economic Analysis of Biorefineries

Biofuels will be an important part of a successful bioeconomy and the transition to renewable sources of energy. For this reason, various programs and incentives have been implemented at the federal and state levels to stimulate the production of biofuels from various sources. However, despite this incentivization, production of biofuels from cellulosic biomass has historically fallen short of targets set by the national Renewable Fuels Standard. Thus, it is apparent that further financial support from the government or elsewhere is necessary to promote the development of the biofuels industry. This project explores the effect of various existing incentives on biorefinery economics while simultaneously considering a range of biorefinery operating conditions and other contextual parameters with uncertainty using BioSTEAM. Results will be used to inform policymakers of the efficacy of the incentives they have implemented and to recommend new incentives that will be more beneficial to the biofuels industry.

Poster #23 – Kenneth Ruffatto

Mapping the National Phosphorus Recovery Potential from Wastewater Treatment Plants and Corn Biorefineries

Anthropogenic discharge of excess phosphorus (P) to water bodies and depleting phosphate rock resources have fostered interest in P recovery and reuse. Previous P recovery research centered on populations data for estimates despite accuracy concerns given the centralization of wastewater treatment. To improve mapping opportunities for P recovery, we used wastewater treatment plant (WWTP) flow data and plant-wide process models to determine maximum P recovery as a crystalline fertilizer product (struvite) across the US. We also use geospatial information and process models for corn wet milling and dry grind ethanol plants to compare recovery potential of biorefineries to WWTPs. We performed a spatial analysis that aggregated county P recovered and determined localization with P demand. P recovery supply from biorefineries and WWTPs in the upper Midwest appears well localized with P demand. We plan to consider economic limitations and environmental impacts of recovery which can aid recovery strategies and policy.

Poster #24 – Dinaz Kureishy

Uncovering the Link Between Land Use and Water

In the United States, urban and agricultural land contribute to worsening water quality. As urban areas develop, streams and their ecosystems have been altered and contaminants have entered waterways. Agriculture results in contaminants, mainly nutrients and pesticides, polluting groundwater and surface water. These types of land uses have resulted in various problems relating to environmental and human health. This paper aims to review studies conducted by the United States Geological Survey (USGS) that analyze the effects of urban and agricultural land use on water quality. The results of this paper highlight the link found between urban and agricultural land use on stream ecosystems, streamflow alterations, groundwater quality, and contaminants in water found by the USGS.

Poster #25 – Emmanuel Kayiwa

Understanding the impact of organometallic redox polymer electrode fabrication and cycling conditions on stability and selective separation of oxyanion pollutants

Organometallic polymers that can undergo faradaic (redox) reactions have shown the ability to selectively and efficiently remove micropollutants with varying physico-chemical properties. However, these redox -electrodes degrade during long term cycling due to structural degradation, and subsequent ion channel collapse. To identify strategies that promote pollutant selectivity and redox polymer electrode longevity, various redox polymer electrodes were fabricated with chemical compositions, and operated across different operating potential windows while evaluating the selective removal of regulated pollutant oxyanions (HAsO42-) commonly found in contaminated groundwater. Carbon paper substrates were modified by electrodepositing and dip coating poly(vinylferrocene) (PVF), and 3-ferroceneylpropyl acrylamide (PFPMAm)). The electrodeposited electrodes exhibited higher uptake capacities for arsenic oxyanion of 219 mg/g and 136 mg/g for PFPMAm and PVF respectively relative to their dip coated counterparts of 99.7 mg/g and 89.7 mg/g respectively. Electrodeposition was found to be a more stable fabrication method after 15,000 galvanostatic cycles with nearly identical arsenic oxyanion uptake capacities before and after cycling.

Poster #26 – Aijia Zhou

Virus detection in sewage water by one-step qPCR

What i am doing now is around SARS-CoV-2 detection in sewage water and virus properties research in sewage sludge. To detect tiny amount of virus in sewage, a necessary step is to concentrate virus till exceeding minimum detection limits. After concentrating virus by centrifugation, how to extract genes and purify them to avoid inhibition come to the first priority. A commercial kit called QIAamp viral RNA mini kit is applied. Then one step qPCR is followed to detect virus' genes. To calculate overall SARS-CoV-2 in wastewater, Bovine coronavirus is selected as control virus for recovery calculation. Bovine coronavirus is added to wastewater before processing, and the recovery of it can show SARS-CoV-2 loss in treatments. Besides, viral persistence in different temperature as well as viral resuspension within various time periods are experimented using Bovine coronavirus.

Poster #27- Marcel Briguglio

Review and Recent Developments of the Community Multiscale Air Quality (CMAQ) Model

The World Health Organization (WHO) attributes 4.2 million deaths per year due to exposure to ambient air pollution, causing regional air quality to become a focus for both researchers and policy makers. This necessitates the use of numerical modeling of air quality to predict the concentration of airborne gases and particles. Chemical Transport Models (CTMs) are used to model and predict air quality over regional and smaller scales, relying on meteorological inputs and emissions inventories to predict chemical concentrations. The Community Multiscale Air Quality (CMAQ) model is the most used CTM for the assessment and management of air quality in the United States. The capabilities, major use cases, and recent developments of the CMAQ model are highlighted in this presentation.

Podium Session 2

(Presenters #7-12)

2:00 PM to 3:00 PM

Podium Presenter #7

(Room #1)

Sarang S. Bhagwat – 2:00 PM to 2:20 PM

Sustainable Production of Acrylic Acid via 3-Hydroxypropionic Acid from Lignocellulosic Biomass

3-hydroxypropionic acid (3-HP) is a potential platform chemical that may be converted to useful commodities; notable among these is acrylic acid (global demand of 5.5 million-ton·yr-1). We leveraged BioSTEAM to design, simulate, and evaluate biorefineries fermenting sugars obtained from 1st&2nd generation feedstocks to 3-HP, which is dehydrated to and sold as acrylic acid.

For baseline fermentation parameters (49% of theoretical yield on sugars; titer of 54.8 g·L-1), the minimum product selling price (MPSP) was estimated to be $1.53-1.84 kg-1 (5th – 95th percentiles), potentially competitive with market prices ($1.35- 1.68 kg-1). Baseline environmental impacts were global-warming-potential/GWP100 of 1.85-2.83 kg-1 and fossil-energy-consumption/FEC of 18.7-32.4 MJ·kg-1). With advancements, biorefinery performance could be greatly enhanced (MPSP $ 1.14 kg-1, GWP100 1.26 kgCO2-eq·kg-1; FEC 17.0 MJ·kg-1).

This research showcases the ability of first-order, agile TEA/LCA to compare alternative biorefinery designs, benchmark the state-of-the-art, prioritize research needs, and work toward sustainable replacement of fossil-based production routes.

Podium Presenter #8

(Room #2)

Katherine Crank – 2:00 PM to 2:20 PM

From Theory to Practice: Expanding the Quantitative Microbial Risk Assessment Framework

Water quality management often relies on Fecal Indicator Bacteria to estimate risk associated with interaction with wastewater impacted water. FIB poorly represent viruses, which account for the majority of risk. We developed a Quantitative Microbial Risk Assessment (QMRA) model which relates viral water quality indicators to swimmer illness, allowing decision makers to easily estimate the probability of illness to a swimmer at a beach after a wastewater pollution event. The model, entitled QMRAswim, is available via a Web app and is generalizable to any indicator or pathogen. Currently, QMRA is not widely used as estimates are often based on worst-case scenarios and require a risk management approach that may not align with community resources. A contributing factor to the overly-conservative estimates is the assumption of instant contact with raw wastewater. Our ongoing research is improving QMRAswim by adding dynamic pathogen decay models and exposure scenarios to provide more realistic risk estimates.

Podium Presenter #9

(Room #1)

Charles Graham – 2:20 PM to 2:40 PM

Removal of Per- and Polyfluoroalkyl Substances (PFAS) in Point-of-Use (POU) Activated Carbon and Membrane Filtration Systems

Point-of-use (POU) water treatment systems are often used to remove contaminants in drinking water, but limited studies have been done to evaluate whether they are effective to remove per- and polyfluoroalkyl substances (PFAS) at trace levels. The objective of this study is to evaluate the removal efficiency of three PFAS compounds- perfluorooctanesulfonic acid (PFOS), perfluorohexanesulfonic acid (PFHxS), and perfluorobutanesulfonic acid (PFBS) – in both activated carbon systems and membrane filtration POU systems. Drinking water spiked with PFAS at varying concentrations was used as influent for both the membrane and activated carbon POU system. The removal efficiency was determined by comparing the concentration of PFAS in both influent and effluent samples, measured using solid phase extraction followed by tandem liquid chromatography mass spectrometry- (LC/MS). Results showed that POU systems were generally effective to remove PFAS. The effects of various impact factors on removal efficiency are being evaluated.

Podium Presenter #10

(Room #2)

Brooke Stemple – 2:20 PM to 2:40 PM

Biogeochemistry of the Antrim Shale Natural Gas Reservoir

The shallow, vertically drilled Antrim Shale is a major source of unconventional natural gas located in the Michigan Basin. For this study we analyzed produced water from ten Antrim Shale gas wells to elucidate the important biogeochemistry and microbial community dynamics of this unique subsurface ecosystem. qPCR and 16S rRNA sequencing analysis showed relatively low abundance and high variability within the microbial community. The majority of bacterial sequences were identified within Proteobacteria, Firmicutes, and Actinobacteria phyla and metagenomic sequencing revealed a low presence of Methanobacteriaceae in all samples. We detected high TDS in most wells, composed primarily of chloride and sodium, with the exception of 3 wells located along the basin's northern margin that had significantly low TDS. Varying geochemical conditions between wells demonstrates different subsurface environmental niches, potentially driving the heterogenous microbial communities we observed. This suggests an important relationship between well location, geochemistry, and the reservoir microbial community.

Podium Presenter #11

(Room #1)

Hsin-Yin Yu – 2:40 PM to 3:00 PM

Removal of assimilable organic carbon in activated carbon and reverse osmosis water filtration systems

Point-of-use (POU) water treatment systems in consumers' houses or buildings provide many benefits to remove trace-level contaminants that remain in treated drinking water. However, undesired microbial growth on membrane surface—which is also known as biofouling—significantly reduces performance of POU water filtration systems and increase maintenance costs. Limited studies have been done to understand microbial growth in POU systems. The objective of this study was to evaluate removal of assimilable organic carbon (AOC)-an indicator of microbial growth potential-in POU systems. The results showed that more than 93% AOC was effectively removed in activated carbon systems and between 65% and 90% AOC was removed in reverse osmosis systems. The effects of various impact factors on removal efficiency, such as hardness, are being evaluated. The results from this study can provide useful information to control microbial growth in POU systems to improve its removal efficiency and reduce maintenance costs.

Podium Presenter #12

(Room #2)

Sudheer Salana – 2:40 PM to 3:00 PM

Development of a semi-automated instrument to measure the cellular Reactive Oxygen Species (ROS) activity of ambient particulate matter

Several automated instruments exist today to measure the acellular oxidative potential of ambient particulate matter (PM). Moreover, a few online instruments have also been developed for the real time measurements of the acellular reactive oxygen species (ROS) activity of the ambient particles. However, no such automated system exists for measuring the cellular ROS activity, which severely limits the comparison between two types of assays. Cellular assays provide a much better means of ROS assessment as they incorporate the biological processes involved in the PM-induced ROS generation. Considering this need, here we aim to develop a semi-automated instrument to conduct the macrophage ROS assay using rat alveolar cells (NR8383), which is a well-established and widely used cell line for the cellular oxidative potential measurements. The instrument uses dichlorofluorescein (DCFH) as a probe to detect the ROS activity of particulate matter. The instrument is capable of analyzing at least two ambient PM samples extracted in water, within a span of four hours, including both negative and positive controls. Preliminary experiments conducted on various standard metal solutions show a very good agreement between manual and automated results for the relative ROS response as compared to the negative control (slope = 0.74 and r2=0.9). The instrument also has a very low limit of detection (<2.6 µg equivalents of Zymosan). The analysis of the time dependent ROS response, and measurement of the ROS activity of the PM-laden filter samples collected during field trials is currently underway, which will help to further evaluate the precision and accuracy of the system. Coupled with other acellular assays, this instrument would provide a comprehensive analysis of the cellular oxidative potential of particular matter samples