

**25 June 2021 (Friday)**

**6.00pm-6.30pm (SGT) (GMT +8)**

**Poster Session 3**

### **A Case Study On The Performance Of A Transmission Pipe Leak Monitoring System**

W. Khan, P. Murray, J. Koh. PUB, Singapore's National Water Agency (Singapore)

In 2018, a transmission pipe leak monitoring system was installed on approximately 100 kilometers of mains owned by the Public Utilities Board (PUB) of Singapore. Tracking leak indications in both time and space allows water asset owners to rapidly and effectively deploy their transmission main repair crews. This paper provides a narrative description of the design and deployment for this novel leak monitoring system with advanced detection and notification capabilities. General and site specific deployment considerations are presented. With investment in new technologies there is a need to define, measure, and evaluate the program success. Technology implementation effectiveness is a qualitative measure of project success. Quantitative performance metrics around leak monitoring performance, and value for money are evaluated and presented as well.

### **A Pilot Aquaponics Project On The An Intermediate Floor Of A High Rise Building In Malaysia**

Y. Wong. EcoClean Technology Sdn Bhd (Malaysia)

This is the first of its kind of Aquaponics system in the world, utilizing town water for only once to raise 6000 Tilapia and Jade Perch fishes, 1000 vegetables and 300 panels of vertical sun shading green walls at the intermediate floor of high rise building. The system is fully integrated as the wastewater from the fishes are treated with a specially designed treatment plant and by the very vegetables and green walls themselves before returning to the same channel. Both volcanic aggregates and floating boards in trays are used instead of soil for growing vegetables and green wall plant. The fish channel is created from the building's balcony itself. All the fish and vegetable harvests will travel down by a cargo lift to a " farm-to-plate" restaurant on the lower floor.

### **Application Of Deep Learning Models In Radar Rainfall Nowcasting And Flood Forecasting: A Case Study Of Singapore**

KW. Teo, D. Solomatine. Ministry of Sustainability and the Environment (Singapore)

In light of the recent advancement in deep learning many studies have cited promising results of deep learning models (ConvLSTM) on radar rainfall nowcasting. This research was dedicated to pilot study the application of deep learning models (ConvLSTM and its variants) in radar rainfall nowcasting and flood forecasting, for the case of Singapore. The deep learning model adopts a hybrid combination of convolutional neural network (CNN) and recurrent neural network (RNN). Past observed radar images from Meteorological Services Singapore (MSS, NEA) between 2011 and 2015 were processed and used. The deep learning models were used to forecast future water levels at 5 locations in Bedok Catchment of Singapore using observed radar images of last 30 minutes. It was found that the deep learning models can obtain an average Root-Mean-Square-Error of 0.19m across all 5 sensors, indicating its potential as a possible alternative to flood forecasting. The results of this research would also be useful for tropical countries with dynamic weather patterns like Singapore.

## **Assetmanagement And Safe Drinking Water For Amsterdam**

S. Holthuijsen. Waternet (Netherlands)

Traditionally, Amsterdam won its drinking water partly from the dunes. From 1853, the first drinking water companies pumped the water for Amsterdam directly from the deeper layers of the dunes. Due to the increasing demand, the sand bottom was found to dry out and salt water was coming up. From 1940 river water was infiltrated into the dunes. In the seventies it was discovered that this technique polluted the dune bottom. So the water companies proceeded to infiltrate pre-purified river water to great depths into the dunes. Nowadays, Amsterdam's drinking water is mainly coming from the river Rhine. From the assetmanagement point of view we use a so-called 3x5 format as a way of thinking about our assets. We answer 5 questions on 3 levels, object-network-system. It leads to transparent choices for investments and maintenance of our assets. The delivery of drinking water and the associated assets are used to illustrate the method.

## **Case Study - Demonstration Plant Of Water Recycling Of Treated Industrial Wastewater Using Microfiltration/Reverse Osmosis And Activated Carbon Filter For Process Use In A Petrochemical Plant**

KS. Sim, F. Tan, BS. Ee. Petrochemical Corporation of Singapore (Private) Limited (Singapore)

The aim of this case study is to demonstrate a phased approach of carrying out technological and economic assessment in adopting membrane technology for water recycling of treated industrial wastewater for process use. It was co-funded with a grant from National Research Foundation (NRF) Singapore. Due to the large variability of industrial effluents, this demonstration plant was developed in-house following a rigorous Phase 1 - Pilot Plant testing with different configurations of pre-treatment membrane (MF/UF) and material selection for RO membrane. Actual treated wastewater effluent was used for the testing process, particularly on the susceptibility of membranes fouling and formulation of membrane cleaning solutions for membrane flux recovery. Phase 2 demonstration plant was then constructed, followed by trial runs with enhanced cleaning regimes for fouling control, carried out to validate critical parameters such as allowable flux for a pressurised pre-treatment membrane units and RO permeate quality. The implemented treatment system consists of MF/RO and Activated Carbon Filtration (ACF).

## **Colorectal Cancer And Nitrates: Implications For Health And The Economy**

A. Humphrey, M. Savill, J. Mike. Affordable Water (New Zealand)

Nitrate concentrations have been increasing steadily in New Zealand groundwater over the last two decades. This has coincided with an unprecedented increase in intensified dairy farming. Monitoring has demonstrated that increases in nitrate levels in the South Island province of Canterbury were initially mainly confined to shallower bores, but deeper, community supplies are increasingly threatened as nitrate permeates deeper aquifers. Modelling from the Canterbury Regional Council indicates that the Christchurch (population 400,000) urban supply is likely to experience a significant increase in nitrate contamination within 100 years. This is particularly concerning considering a recent population based Danish study which indicated that the risk of colorectal cancer from nitrate in drinking water begins well below the current maximum allowable value (MAV) of 50mg/L nitrate ion (nitrate measured as nitrate ion. This is equivalent to 11.3 mg/L nitrate as nitrogen). Although nitrate leaching is limited using the land-use consenting process, compliance, monitoring and enforcement of land-use rules is difficult. Moreover, such rules may be too little, too late, as nitrate in groundwater can take many years to build and conversely, many years to diminish – the nitrate levels in New Zealand groundwater today are a consequence of farming practices twenty or thirty years ago. If drinking water suppliers are to avoid the expense of nitrate removal, radical measures may be required more urgently, such as destocking intensified farming areas.

## **Deterioration Diagnosis For Underwater Equipment By Vibration Analysis**

J. Nakazawa, Y. Masuya, D. Kawataka, A. Nagao, N. Kanemaru. NJS Co., Ltd. (Japan)

The development of equipment diagnosis technology using Vibration Analysis aims to improve the quality and efficiency of asset management for preventive maintenance of sewage treatment plant equipment. The main function of this development is to comprehend the deterioration signs of sewage facilities and to estimate and identify the cause of deterioration using IoT such as wireless sensors on equipment and a cloud centre, and automatic analysis of photographs taken by an onsite robot. Comprehending deterioration signs is necessary to screen which STP machines are deteriorating. The deterioration causes of the screened STP machines are estimated and identified to be checked by IoT, using information picked up in the previous process. When actually using this system, repair work can be carried out considering the cost and timing. In this paper, we targeted the sludge scraper because it is normally underwater and difficult to comprehend the deterioration signs and report the technology development for identifying deterioration signs and estimating the cause.

### **Driving Economic Prosperity, Through BIM Adoption**

D. Murray, S. Kearney. Mott MacDonald (Singapore)

BIM adoption can improve lives, by reducing poverty in the world's fastest growing communities. That's the view of the UK Foreign & Commonwealth Office (FCO) who have allocated part of the Cross-Government Prosperity Fund (Fund) to the BIM delivery methodology, via the Global Infrastructure Programme (GIP). The Fund aims to remove barriers to economic growth and promote sustainable development in partner countries. The Fund's focus is on middle-income countries (MICs), where 59% of the world's poor live and 60% of global growth will occur by 2030. BIM supports the efficient design, delivery and maintenance of infrastructure and buildings. There is a strong link between infrastructure development and increased prosperity, including supporting gender equality and inclusion. Additionally, the Fund seeks to improve trade links between partner countries and the rest of the world, including the UK.

### **Energy Efficiency And Generation Opportunities For Wastewater Services - Perspective From A Developing Country**

J. Zvimba, E. Musvoto. Water Research Commission (South Africa)

About 55% of energy used in the South African water cycle is for wastewater treatment, with bulk of energy used for aeration. However, up to 15% of wastewater energy demand can be offset by energy generation from sludge, while best practices adoption can deliver energy efficiency gains of 5 to 25% in the water cycle. Advanced process modelling and simulation was applied to evaluate optimal process and aeration control strategies, including investigation and prediction of potential energy consumption and consumption cost pattern by the sector resulting from implementation of optimal process and aeration energy use reduction strategies. Aeration energy consumption and cost savings of 9 -- 45% are achievable through implementation of energy conservation measures without compromising effluent regulatory compliance. Energy savings of 50% and 78% from implementation of simple and complex measures respectively are achievable, while coupling energy efficiency with generation ensures maximum consumption and cost saving benefits are achieved.

### **Full Scale Reality Of Micropollutant Removal With Ozone**

T. Puehmeier, A. Wieland, H. Stapel, S. Bressmer, C. Abegglen. Xylem Services Germany GmbH (Germany)

The term "micropollutant" stands for thousands of man-made substances such as residues of pharmaceuticals, cosmetic products, pesticides and biocides. The conventional sewage treatment does not provide a sufficient barrier to protect drinking water sources from micropollutants discharged with the treated effluent. The realization approach of micropollutant removal processes of two countries (namely Germany and Switzerland) is being addressed. In particular, the micropollutant removal process of one reference -- Werdhoelzli, the largest sewage treatment plant in Switzerland -- is being further explored.

### **Maximum Likelihood Estimation Of Inactivation Kinetic Parameters For *Escherichia coli* In Concentrated Urine**

W. Oishi, D. Sano, I. Kato, O. Nishimura. Tohoku University (Japan)

The present study investigated the inactivation kinetics of *Escherichia coli* and relevant biocidal factors in concentrated urine. The inactivation rate constant was calculated using the maximum likelihood method, which well simulated the measured concentration of *E. coli*. Higher osmotic pressure caused faster inactivation of *E. coli* in hydrolyzed urine, while inactivation rate of *E. coli* was much smaller in non-hydrolyzed urine.

### **Metal-Free Graphitic Carbon Nitride Photocatalyst For Environment Remedy**

D. Lu, FYS. Li. National University of Singapore (Singapore)

Graphitic carbon nitride (GCN) has emerged as a promising metal-free photocatalyst because of its suitable bandgap, low cost of starting material, facile in preparation, highly chemical stable and pollution-free features. However, the photocatalytic activity of GCN is limited by the unsatisfactory photocatalytic efficiency, mainly because of fast recombination of charge carriers and insufficient visible light range absorption. With solvothermal method, red in color graphitic carbon nitride (RGCN) had demonstrated significant improvement in its absorption edge in the visible range. Further carbon doping reduced the charge carrier recombination and improved the activity 5.68 times as compared to GCN.

### **Performance Of Reverse Osmosis Membrane For Water Reuse And Reclamation -- Rejection And Fouling Investigation**

J. Ogier, U. Doelchow, J. Lipnizki, D. Lau. IAB Ionenaustauscher GmbH (Germany)

Chemical pollution of water poses a threat to the environment and human health and the water scarcity is a clear on going challenge for the mankind. Water reclamation is implemented to reduce this water shortage and treat its contamination. Reverse osmosis membrane can provide an efficient step in that water reclamation treatment process. Therefore the performances of ultra-low pressure reverse osmosis membrane were investigated in laboratory and in a pilot-study on the reclamation of municipal waste water for the production of high quality process water. The efficiency of the RO-membranes were evaluated thoroughly in term of contaminants and micro pollutant removal and fouling impact on performances. The results showed a high rejection capacity even under fouling conditions.

### **Prussian Blue @ Reduced Graphene Oxide Aerogel As An Intercalation Anode To Remove Sodium Ions In Hybrid Capacitive Deionization System**

S. Vafakhah, HY. Yang. Singapore University of Technology and Design (Singapore)

With rapid population growth, and spreading environmental pollution, freshwater shortage has become one of the most significant global challenges nowadays. As a result, many research efforts have been devoted to exploring new methods to overcome the water scarcity. Hybrid Capacitive Deionization (HCDI) has been attracting the attention as a high performance, energy-efficient, cost-effectiveness, and environmentally friendly method. In HCDI, desalination is running based on a faradaic reaction with salt ions to boost the removal capacity of the systems. In this study, we introduced an efficient Hybrid Capacitive Deionization (HCDI) system for removal of NaCl from brackish water. In this study, Prussian blue (PB) Nano cubes embedded in a highly conductive reduced graphene oxide aerogel (rGA) has been used as a binder-free intercalation anode to remove Na<sup>+</sup> ions. Furthermore, the real-time intercalation process was verified by In-situ XRD measurements, which confirmed the intercalation and deintercalation processes during charging and discharging, respectively.

### **Reduction Of Energy Consumption In MBR With New High Performance (NHP) Module**

KK. Latt. Toray International Singapore Pte.Ltd. (Singapore)

Membrane bioreactor (MBR) process with low energy consumption was studied using our newly developed MBR module, New High Performance (NHP) module which has a higher membrane packing density compared to the previous MBR module fabricated with rigid plate type membrane element. Energy consumption was reduced by increasing product capacity with higher membrane packing density. In this study, NHP module was operated under higher flux (42 LMH) and investigated a stable operation for about 6 weeks. Maintenance cleaning (MC) with sodium hypochlorite resulted to keep transmembrane pressure (TMP) increasing rate less than 0.05 kPa/day. Aeration energy consumption per product water was reduced 60% in high flux operation. The feature of NHP membrane element is thin and semi-flexible which helps to dislodge the sludge foulant and improve cleaning efficiency with scrubbing air.

### **Seawater RO Facility Optimizes Membrane Performance With Novel Hydro-Optic UV Technology**

Y. Rozenberg, A. Felder. Alantium Technologies (Israel)

A seawater reverse osmosis (SWRO) facility in Asia with a 100,000 m<sup>3</sup>/day drinking water capacity undertook a comparative study to evaluate the disinfection efficacy of a novel hydro-optic (HOD) ultraviolet (UV) technology to provide enhanced protection of the RO elements and positively effect overall RO system and facility performance. Membrane system operation and maintenance from a six-month period prior to and following the installation of the HOD UV technology were evaluated; data was also compared to performance from unprotected RO trains. Following the installation of the HOD UV technology, the facility experienced significant operational improvements, including a 50% decrease in SWRO clean-in-place (CIP) frequency and a 65% decrease in the number of micron filter replacement events. Membrane performance also improved, evident from a 11% decrease in post CIP differential pressure (DP). The HOD UV technology offers the facility a proven and economical non-chemical disinfection treatment approach to protect RO membranes.

## **Siloxane Based Ions Imprinted Sensor For Lead Ions Detection Using Quartz Crystal Microbalance**

S. Li, XH. Lin, Q. Li. National University of Singapore (Singapore)

Traditionally lead ions are tested in laboratory by sophisticated instruments AAS, ICP/AES, and ICP/MS. However, they are lack of mobility for onsite and online monitoring and need well-trained personnel and high maintenance cost. Here we report a selective, sensitive, simple and cost-effective siloxane based ions imprinted sensor for the detection of Pb<sup>2+</sup> ions in water using QCM 1,2. Siloxane monomers, cross-linker, and lead ions template were mixed in water. When siloxane hydrolyzed and condensed to form polysilane, lead ions coordinated by the functional groups were removed to form complementary cavities, which are able to recognize target lead ions. The IIP based lead sensor exhibited high selectivity toward Pb<sup>2+</sup> ions against other interfering ions with a LOD as low as 1ppb. The sensor was well characterized by SEM, FTIR, ICP-AES. The developed siloxane based IIP sensor has great potential for the high through-put monitoring of Pb<sup>2+</sup> ions in water quality control.

## **Sustainability Reporting By Companies Listed In SGX**

C. Tortajada, W. Lim, I. Bindal. National University of Singapore (Singapore)

From 2018, companies listed on Singapore Stock Exchange needed to report their environmental, social, and governance (ESG) practices. Following a "comply or explain" approach, company reports must include board statements that describe their sustainability actions, identify ESG factors that affect business strategy, as well as explain their practices and performances, and set sustainability targets. Using the annual and sustainability reports these companies submitted to SGX in 2018, our study aims to understand the sustainability efforts companies had espoused to perform or commit to after the new SGX ruling. Specifically, our ongoing study plans to investigate how sustainability reporting relates to firm industry, business strategy, and financial performance, especially their utility disclosures on water, energy, emissions, and solid waste disclosures, particularly water. Our research has the potential to inform research and policymaking on how businesses can become better members of water-wise communities, particularly in fostering innovative business models and public-private-people partnerships.

## **Towards A Rapid On-Site Test That Can Detect All Serogroups Of *Legionella Pneumophila***

M. Connolly, G. Rankin. Hydrosense Ltd (United Kingdom)

*Legionella pneumophila* serogroup 1 (Ip sg1), is the cause of most fatal outbreaks of legionnaires' disease recorded globally. However, outbreaks from other serogroups are known to occur and, in some geographies, non-Ip sg1 bacteria are more prevalent. The development of a test that can rapidly detect all serogroups of *legionella pneumophila* on-site would therefore be of value for reducing global legionella risk. The immediacy and easy to use nature of a rapid legionella pneumophila lateral flow test has the potential to provide accessible, fast actionable results at the site of testing - thus supporting effective water system management and protecting public health. This paper reports the advancements made by the hydrosense ltd technical team in developing a rapid on-site testing method for legionella pneumophila serogroups 1-15 (Ip sg1-15) in water. The test is based on the detection of Ip sg1-15 antigens using specific antibodies, which have been shown to detect Ip serogroups in under 25 minutes.

## **Towards Drinking Water Quality Monitoring Directly At The End-point Of Use: Evaluating An In-pipe Monitoring System For Drinking Water Networks**

C. Wagner, B. Buysschaert, B. De Gusseme, A. Weingartner. s::can Messtechnik GmbH (Austria)

One case study is presented where s::can's technology was used to monitor the drinking water quality directly in the pipeline of a water distribution network. The used monitoring system was installed directly in a high-pressure pipeline and measured turbidity, UV254, color, TOC, DOC, free chlorine, temperature, pressure and conductivity. The in-pipe system proved itself as a valuable tool in Belgium during the burst of the main pipe connecting Sint-Pieters-Leeuw with Brakel. Using the data from the in-pipe system the change in water quality due to the burst and the necessary rerouting of water could be monitored in real time.

## **Understanding The Needs Of The Individual User Leads To Organisational Adoption Of Digital Twins**

P. Bonk. Innovyze (Australia)

Prospective technologies, even when accepted by an organisation in theory for the problems they may solve, do not necessarily lead to adoption in day to day practice by prospective users and practitioners. Universal reasons exist within the global water industry why adoption of emerging technologies remains a challenge.

Technology adoption occurs at the organizational level when the trust of the individual users is established by solving a problem and improving their daily workflows, has a simple interface that allows for timely interpretation of results and allows the user to solve problems more effectively than their current tools and software applications. Digital Twins adoption use cases to be discussed include: Day to day decisions on construction crew deployment, crew safety when in live sewers mitigating the risks associated with failing depth monitors and predictive incident management for deploying tanker trucks to strategic spill locations prior to an incoming storm event.

The intent of this paper is to methodically demonstrate how Digital Twin technology has been successfully adopted by meeting the needs and workflows for individual users.

## **Wetting Characteristics And Progression Of Polyvinylidene Fluoride Hollow Fibre Membrane Contactors**

W. Ge. Memstar (Singapore)

This paper involves the studying of wetting in two Thermally Induced Phase Separation (TIPS) hydrophobic membranes as hollow fibre membrane contactors used for the removal of ammonia from wastewater. By comparing key characteristics and observing the wetting progression, we can avoid the wetting of membranes and optimize ammonia removal. Two dry TIPS membranes with different hydrophobicity and gas flux are characterized for physical and chemical characteristics. Both membranes are deliberately wetted to define wet characteristics to understand the definition of wet membranes. Membranes were then soaked in water for 60 days to observe wetting progression and phenomena. Dry membranes progress to partially wet membranes almost immediately after the first day. Partially wet membranes remain stable for quite some time (30- 60 days) depending on the type of conditions. However, the partially wet status does not affect the transfer of the gas.