Monday, 11/13/2023; 8:00 - 11:00 AM

M1: Pilot-Scale Studies for PFAS Treatment: Comparing the Effectiveness of Emerging Technologies

IWC Rep: Brandon Delis, Electric Power Research Institute, Charlotte, NC

Session Chair: Joseph M. Woodley, UCC Environmental, Waukegan, IL

Discussion Leader: Thomas Gurley, ChemTreat, Glen Allen, VA

Join us for an engaging technical discussion on PFAS treatment, where we'll explore advancements in technology, pilot results, and industry challenges in managing these contaminants. Attendees are encouraged to actively participate, share experiences, and ask questions to foster a dynamic and informative dialogue on this environmental issue. Don't miss this opportunity to deepen your technical understanding and contribute to the conversation!

IWC 23-01: A Carbon-Based Adsorption/Separation Process Removes Long- and Short-Chain PFAS with Minimal Waste Production

Time: 8:10 AM

Dave Holland, Aqua-Aerobic Systems, Loves Park, IL USA; Terrence Reid, P.E., Aqua-Aerobic Systems, Loves Park, IL

Under the Environmental Security Technology Certification Program (ESTCP), testing of a novel adsorption/separation process was conducted to remove per- and poly-fluoroalkyl substances (PFAS) from highly-contaminated surface water and groundwater at two military sites. Both bench top and field pilot trials were conducted using production level sorbent media and separation technologies. Thirteen tests were conducted over a 9-month period at the Horsham Air Guard Station (HAGS) using a dual-train pilot system on surface water. Follow-up testing evaluated five test conditions at the Willow Grove Naval Air Station (WGNAS) on groundwater. The process evaluations were conducted to confirm the technology's higher specific adsorption rates (SARs) exhibited in a prior study on groundwater containing aqueous film forming foam (AFFF).

The 2-year program validated the technology's ability to meet the US EPA Regional Screening Limits (RSLs) for tap water from influent PFAS levels of 5,000 to 40,000 ng/L. At HAGS, the PFAS removal system (AquaPRS) was able to remove 99.7% of the six priority compounds identified in the USEPA's Third Unregulated Contaminant Monitoring Rule (UCMR3) at levels 275 times greater than observed for granular activated carbon (GAC) on the same waste; the GAC achieved only 90% removal of the UCMR3 compounds, not attaining the 40 ng/L target. At WGNAS, the system removed 99.94% of the compounds at an SAR of 3,530 µg PFAS per g sorbent; these results were similar to the three single-use IX resins tested and much higher than the two regenerable IX resins tested.

Lifecycle cost comparisons performed with GAC and ion-exchange (IX) resins were favorable for the new sorbent, revealing payback periods of 8 to 24 months depending on the water characteristics. High unit adsorption rates resulted in reduced waste product volumes with sorbent characteristics that are amenable to treatment with destructive technologies in lieu of incineration or landfilling.

This paper details the methodology used and the results obtained at both sites, comparing the findings to those of GAC and IX technologies on the same source water. Also presented are challenges encountered while treating each water type as well as the remedies employed.

Discusser: Ryan Schipper, Barr Engineering, Ft. Wayne, IN

IWC 23-02: Evaluation of PFAS Removal via Adsorption from Groundwater Infiltrating into a Chrome Plating Facility Basement

Time: 9:00 AM

Francisco Barajas-Rodriguez, AECOM, Omaha, NE USA; Matt Vander Eide, AECOM; Barry Harding, AECOM

Poly- and perfluoroalkyl substances (PFAS) are persistent compounds in the environment and have associated health risks, making their treatment in water a prominent topic. Groundwater infiltrating into the basement of an abandoned former chromium plating facility has been impacted with 1,4-Dioxane, chlorinated volatile organic compounds (VOCs), various metals, and PFAS. Maximum concentration of PFAS at the site is as high as 19,000 ng/L. PFAS can be treated via adsorptive media, which concentrates PFAS in a small volume waste stream while attaining cleanup. In this study, traditional and novel PFAS adsorbents were evaluated via bench-scale treatability testing to meet treatment objectives for the impacted water.

The study was designed to evaluate effectiveness of adsorption-based PFAS treatment technologies, and included batch and flow-through experiments. Batch isotherms evaluated eight adsorbents at six doses to screen for the highest performing products in terms of adsorption capacity; these products included four ion exchange (IX) resins (two regenerable), one granular activated carbon (GAC), one nanoscale iron oxide, and one cyclodextrin polymer. Three adsorbents were selected, based on their adsorption capacities and removal efficiencies, for rapid small-scale column tests (RSSCTs) to assess adsorption of PFAS under flowthrough conditions with an empty bed contact time of 5 minutes. Analytical constituents included PFAS, total organic carbon, and volatile organic compounds.

Isotherm results indicated a superior adsorption capacity from the cyclodextrin polymer (up to 99.9% removal of individual PFAS) among all adsorbents, whereas IX resins were superior to GAC and iron oxide. The cyclodextrin, one regenerable IX resin, and one single-use IX resin, were selected for RSSCT evaluation, as they showed PFAS removals above 99%. RSSCT results showed removal of PFAS in effluents from all sorbents tested, with the single-use IX resin producing the longest retention of PFAS, followed by the regenerable IX resin in second place, and the cyclodextrin in third place. Breakthrough above 5% of the influent concentration of total PFAS did not occur during the entire RSSCT operation (>50,000 bed volumes) for the IX resins, whereas the cyclodextrin's total PFAS effluent concentration broke through at 26,000 bed volumes. The cyclodextrin's lower performance in the RSSCT is attributed to adsorption kinetics limitation. The RSSCT metrics obtained in this study may be used to inform a pilot-scale design to evaluate the removal of PFAS on-site. Future bench-scale activities will evaluate spent sorbent regeneration and the use PFAS destructive technologies that may be coupled with adsorption-based technologies.

Discusser: Tom Gurley, ChemTreat, Glen Allen, VA

IWC 23-03: The Cost of PFAS Destruction in Landfill Leachate: A feasibility study from Minnesota

Time: 10:10 AM

Andy McCabe, Barr Engineering Co., Minneapolis, MN USA; Ali Ling, Barr Engineering Co., Minneapolis, MN; Katie Wolohan, Barr Engineering Co., Minneapolis, MN; Becca Vermace, Barr Engineering Co., Minneapolis, MN; Scott Kyser, Minnesota Pollution Control Agency, St, Paul

The Minnesota Pollution Control Agency (MPCA) commissioned a feasibility study to understand costs associated with treatment and destruction of per- and polyfluoroalkyl substances (PFAS) in four major waste streams: effluent from water resource recovery facilities (WRRF), biosolids from WRRF, contact water from commercial composting facilities, and leachate from mixed industrial and municipal solid waste (mixed MSW) landfills. This paper focuses on the treatment options, costs, and challenges identified for landfill leachate. PFAS treatment in landfill leachate is challenging due to the complexity of the matrix, which requires extensive pre-treatment ahead of most commercially available PFAS treatment options.

This feasibility study had two overarching goals:
1.Break the PFAS cycle: Identify treatment options that have demonstrated an ability to mineralize PFAS associated with landfill leachate (as opposed to maintaining the PFAS within the landfill facility, discharging to a WRRF, or land applying).
2.Apply today's best available treatment technologies: Identify options that are currently commercially available at applicable scales (focusing on technologies that are rated at technology readiness levels of 8 or 9).

This paper will present conceptual capital cost estimates (+50%/-30% uncertainty) and flow-based cost curves developed for four conceptual treatment alternatives, listed below. Estimated unit costs per mass of PFAS removed and the 20-year present value estimates for the four treatment alternatives will also be discussed.

1.Granular activated carbon (GAC) with incineration of the spent media,
2.Modified clay adsorption with incineration of the spent media,
3.Reverse osmosis (RO) membrane filtration with GAC adsorption for the concentrate and incineration of the spent media, and
4.Foam-fractionation with incineration of the foamate.

End-of-pipe treatment for PFAS in landfill leachate is costly to implement, and if implemented, could potentially impact tipping fees and residential solid waste service fees. Implementing PFAS treatment technologies that require limited or no pretreatment, such as foam fractionation, may be one strategy to reduce capital expenses. There are other alternative technologies that are promising (e.g., specialty RO, supercritical water oxidation, electrochemical oxidation, and regenerable anion exchange resin), but have challenges when implemented for landfill leachate that will be discussed. PFAS treatment is most cost-effective in concentrated waste streams, thus treatment of landfill leachate at the landfill facility is likely more cost-effective than treating PFAS in WRRF effluent. Source reduction of PFAS mass in wastes routed to mixed MSW landfills will likely be more cost-effective (on a cost per mass of PFAS removed) than end-of-pipe treatment.

Discusser: Nicole Bolea, ECT2, Minneapolis, MN

Monday, 11/13/2023; 8:00 - 11:00 AM

M2: Applying Advanced Oxidation Processes for Destruction of APIs and Other Problem Constituents

IWC Rep: Dennis McBride, Burns & McDonnell, Kansas City, MO

Session Chair: Karen Budgell, WSP, Athens, TX

Discussion Leader: Ben Zhang, Ph.D., P.E., Burns & McDonnell, Chicago, IL

Advanced water treatment technologies, such as advanced oxidation processes (AOP), may be required to meet tightening effluent limits for active pharmaceutical ingredients (APIs) and other problem constituents. Optimizing AOP for the removal of these contaminants is the focus of this session. These three papers dive into the details on different types of AOP and how AOP can be implemented to remove APIs, 1,4-dioxane, nitrosamines, and chlorine. Operating parameters such as operating UV wavelength, various oxidant chemicals, reaction time, and balancing radical generation and energy consumption are discussed. Operational data and projected capital and annual operations costs are presented.

IWC 23-04: Advancements in AOP HOD™ UV – More Radicals with Less Energy & Equipment in AOP

Time: 8:10 AM

Ytzhak Rozenberg, Atlantium Technologies, Beit Shemesh, Israel; Dennis Bitter, Atlantium Technologies, Sarasota, FL; Joshua Scott, Atlantium Technologies, Dallas, TX; Amichai Felder, Atlantium Technologies, Beit Shemesh, Israel

The Hydro-Optic™ UV technology can efficiently produce more hydroxyl radicals with less energy using less capital and operating expenses than traditional UV in Advanced Oxidation Processes (AOP). The HOD UV uses medium pressure (MP) technology within an internal reflection technology (IRT) chamber. The MP lamp will produce more energy in the vacuum UV range (less than 200nm) than low Pressure (LP) technology. While high energy could be considered a detriment within traditional AOP UV process, the HOD UV has an Internal Reflective Technology (IRT) that mimic fiber optic science. The IRT recycles and concentrates the valuable energy to increase radical formation over typical MP, LP or LPHP (low pressure high output) UV. This presentation will detail past performances with the continuous use of the HOD UV technology to create more hydroxyl radicals with less energy.
Since the installation of the HOD UV technology for chemical free dechlorination / membrane protection at Georgia Power's Plant Bowen in 2014, the HOD AOP UV achieved 4 log reduction of chlorine and significantly reduced biofouling, colloidal fouling and CIP's. After 9 years of operation, the RO membranes operate at the same level as new elements (when previous exceeding 60 psi after three (3) years). This presentation will discuss several projects using dechlorination (AOP UV for Chlorine removal), NDMA and a 1,4 dioxane remediation project. Through the past years of operation, we're learning that the HOD UV can create more hydroxyl radicals with less energy. Thus, in applications of 1,4 dioxane, NDMA and water reuse applications, the HOD AOP UV will bring big value with higher efficacy using lower energy.

Discusser: Srikanth Muddasani, Civil & Environmental Consultants, Inc., Pittsburgh, PA

IWC 23-05: Active Pharmaceutical Ingredients Reduction via Advanced Oxidation Processes and Reverse Osmosis

Time: 9:00 AM

Mohsen Ghafari, Evoqua Water Technologies, Tewksbury, MA USA; Joshua W. Griffis, Evoqua Water Technologies, Tewksbury, MA; Simon P Dukes, Evoqua Water Technologies, Tewksbury, MA; Thomas K Mallmann, Evoqua Water Technologies, Rockford, IL

Active pharmaceutical ingredients (APIs) have shown negative impacts on the environment despite being designed to treat a variety of ailments in humans and animals. One of these negative impacts can be bacterial antibiotic resistance. The non-biodegradable nature and persistence of many APIs render conventional biological and chemical treatments ineffective. Advanced oxidation processes (AOPs) have shown great potential for treating recalcitrant contaminants. AOPs involve in-situ generation of highly reactive oxygen species to oxidize and eventually mineralize the organic compounds.
This study evaluated API destruction using different AOPs including UV-NaOCl, UV-H2O2, ozonation, peroxone, and electrooxidation (EOX). Additionally, API separation and concentration was tested via reverse osmosis (RO) to examine viability of RO process for removal of the compounds. RO is not a destructive technology but is an effective method to concentrate the APIs in a smaller volume for either thermal destruction or more efficient degradation using AOPs. A synthetic wastewater contained ppm levels of six different APIs (four antibiotics and two hypertension treatment drugs) was prepared. Ozonation and peroxone were found as the most promising AOPs for destruction of 5 out of 6 APIs by > 99.9% destruction in less than 30 min. There was only one compound that ozonation and peroxone were not effective to destruct. However, UV-NaOCl and UV-H2O2 were able to destruct the compound to below its detection level in less than 90 min. Therefore, for the full treatment of the wastewater, combination of ozonation and UV-based reaction is recommended as the best solution. RO membrane was also effective in separating and concentrating APIs. Greater than 99% removal was achieved even with 90% recovery rate that means the wastewater volume can reduce 10-fold via RO treatment. The advantage of RO over the AOPs could be significant COD and TOC reduction in case that water re-use/reclamation is considered for the treated water.

Discusser: William Celenza, P.E., Burns & McDonnell

IWC 23-06: Recalcitrant Pharmaceutical Wastewater Advanced Oxidation Pilot Study and Full-Scale Design

Time: 10:10 AM

Jason Lewandowski, Ramboll, Raleigh, NC USA

A global leader in pharmaceutical manufacturing generates wastewater containing active pharmaceutical ingredients (APIs) designed to pass through the human digestive system unchanged. The APIs are non-biodegradable and consist of halogenated aromatic hydrocarbons and azines with molecular weights in the range of 200 to 700 g/mol. The Manufacturer's current procedure for preventing APIs from being discharged to the municipal sewer and ultimately reaching surface water is to collect 150 gal/day of API waste residue for offsite disposal via incineration. The current procedure for collecting API waste consists of blocking the floor drains and manually vacuuming the waste. The Manufacturer was interested in pretreatment that would allow the APIs to be washed down the floor drains because the current vacuum collection procedure is cumbersome and interferes with production time. The pilot study confirmed that advanced oxidation with ozone and hydrogen peroxide can reduce the waste API concentrations below analytical detection limits. The study was designed to assess the oxidant demand for the worst-case scenario with high API, TOC, and COD concentrations of 27 mg/L, 78 mg/L, and 319 mg/L, respectively. Graphs of pilot study data show that up to 1,018 mg/L of ozone and 509 mg/L of hydrogen peroxide were required to reduce the API concentration below its detection limit of 0.006 mg/L, resulting in treated effluent TOC and COD concentrations of 25 mg/L and 75 mg/L respectively. A feasibility level design and cost estimate of the full-scale system was developed assuming the API waste is washed down the floor drains to combine with other non-API containing process wastewater, resulting in a total treatment flow of 125,000 gal/day. The full-scale system included equalization, a 22,000-gallon oxidation reactor, liquid oxygen and nitrogen storage, ozone generators, a new treatment building, and an activated carbon filter to polish the final effluent. Ultimately, the Manufacturer decided to continue incinerating API waste because the installed and annual operating costs for the full-scale system were estimated at $12.8M and $0.5M, respectively.

Discusser: Joe Tamburini, P.E., P.Eng., AWC Water Solutions, Englewood, CO

Monday, 11/13/2023; 8:00 - 11:00 AM

M3: Lithium & Rare Earth Unleashing the Power of Lithium in Water: Applications, Challenges, and Future Prospects

IWC Rep: Jeff Easton, Ph.D., P.E., ClearStream Environmental, Sandy, UT

Session Chair: John Yen, Marmon Industrial Water, Warren, NJ

Discussion Leader: Juan Pinto, Energy Recovery, Inc., San Leandro, CA

Join us for an exciting glimpse into the future, discussing emerging trends and cutting-edge developments in lithium-water systems. Here, we will focus on the challenge of extracting lithium from brine using membrane, ion exchange and other cutting edge technologies. Whether you are a researcher, engineer, industry professional, or simply curious about the potential of lithium in water, this session offers valuable insights and networking opportunities.

IWC 23-08: Direct Lithium Extraction and Post Processing Optimization for Brine to Battery Chemicals

Time: 9:00 AM

Sheida Arfania, M.A.Sc., Saltworks Technologies Inc., Richmond, BC Canada; Megan Low, Saltworks Technologies Inc., Richmond, BC, Canada; Benjamin Sparrow, P.Eng., M.B.A., Saltworks Technologies Inc., Richmond, British Columbia, Canada

Direct lithium extraction (DLE) technology using various types of sorbents or ion exchange media is being widely explored for the harvest of lithium from saline brines. After DLE, the dilute lithium chloride mixed salt solution is concentrated, refined, and converted (CRC) into an upgraded lithium product, often lithium carbonate or lithium hydroxide. Data and tools are presented for economic optimization and lithium yield maximization when combining DLE and CRC.

An important, and often neglected, relationship exists between the chemistries of the DLE and CRC process steps, which should be considered in conjunction, as opposed to as wholly separate unit operations. Attendees are provided with methods to maximize total system lithium recovery while minimizing costs and energy. Attendees will learn how to prevent lithium yield loss in CRC processes and avoid the need for, or reduce the size of, costly and energy-intensive evaporative processes by optimizing the DLE system and employing recently commercialized ultra-high pressure reverse osmosis technology.

Not all DLE processes are equal, and the common singular metric of eluent lithium concentration is misleading. For example, the lithium to TDS and lithium to hardness ratios can be far more important than DLE lithium eluent concentration alone. Over-processing in DLE to increase lithium concentration can result in higher costs and lithium yield loss in downstream CRC. An optimum balance exists.

The authors will present an overview of CRC processing technology for a typical DLE eluent. They will explore the chemical levers that help or hamper CRC lithium recovery and economics. These tools will help readers understand how to best tune the process balance between DLE and CRC processing for optimal lithium recovery and economics.

Discusser: Jake Moen, DuPont Water Solutions, Duluth, MN

IWC 23-09: Ion Exchange Resins for the Purification, Refining and Recovery of Critical Battery Metals

Time: 10:10 AM

Zhendong Liu, Lanxess Corporation, Birmingham, NJ USA; Dirk Steinhilber, LANXESS Deutschland GmbH, Cologne, Germany

The growing demand for high purity battery materials such as lithium, nickel, cobalt and copper, requires efficient methods for the purification of those metals, to meet the high purity specifications of battery producers. Ion exchange resins are crucial for many different metals processing applications. For instance, selective removal of small amount of hardness ions in lithium brine by chelating resins is the most viable technology during the purification steps in manufacturing battery grade lithium carbonate and lithium hydroxide. Initial studies also show promises in using a special resin for selective capture and elution of lithium over sodium ions. Mining and extraction of high purity cobalt relies on special resins to selectively remove metal impurities such as copper, zinc and nickel. Refining and recovery of nickel in the presence of high concentrations of ferric and cobalt can be achieved with selective chelating resins with smaller bead size which provides shorter diffusion path and fast kinetics during ion exchange and resin regeneration. This results in higher capacity utilization and longer service lives with lower chemical requirements for regeneration as compared to conventional resins.

The recycle of end of life lithium ion batteries becomes more and more important in enabling sustainable operation, circular economy, reduction of carbon footprint and cost savings. Key elements such as lithium, nickel, cobalt and manganese are leached into a solution often containing such impurities as aluminum, zinc, iron and copper. Selective ion exchange resins can remove these impurities and produce high purity battery metal concentrates.

The paper presents lab testing data and studies on using ion exchange resins in producing key lithium ion battery materials. It covers broad applications such as impurity removal, metal separation, selective extraction and recycling. Special functional groups and high selectivity are the key for the resins to work effectively.

Discusser: Rusi Kapadia, Newterra, Toronto, ON

Monday, 11/13/2023; 8:00 - 11:00 AM

M4: Energy Transition and Carbon Capture—Many Colors and Stripes

IWC Rep: Tisha Scroggin-Wicker, Burns & McDonnell, Kansas City, MO

Session Chair: HG Sanjay, Ph.D., P.E., Bechtel Corporation, Reston, VA

Discussion Leader: Don Downey, Purolite, an Ecolab Company, Paris, ON, Canada

We have all colors and stripes, green hydrogen, blue hydrogen, carbon capture. Come join us for the first energy transition session at International Water Conference (IWC) to hear about water challenges, needs and opportunities related to carbon capture and the energy transition. We have three great papers discussing carbon capture, hydrogen, and the energy transition to interest people of all stripes.

IWC 23-10: Carbon Capture Water Requirements and Wastewater Treatment

Time: 8:10 AM

Steve Russell, P.E., Kiewit Corporation, Lenexa, KS USA; Eric Eisenbarth, Kiewit Corporation, Lenexa, KS

Carbon capture systems tend to be water intensive due to the need for cooling water, demineralized water, and steam along with the generation of a flue gas condensate wastewater stream. The flue gas quality and quantity will vary between projects making each carbon capture system and associated water and wastewater treatment configuration unique. Understanding the drivers that impact the flue gas condensate quality, including the use of neutralizing agents such as sodium hydroxide, is essential in developing an optimal flue gas condensate treatment and recycling/disposal plan. Furthermore, the carbon capture systems are frequently retrofitted into existing facilities which can provide for the utilization of existing water sources and treatment systems along with site specific wastewater recycle and disposal options. This report provides discusses and provides guidance on water and wastewater issues commonly seen on carbon capture systems. Handling and treatment of the carbon dioxide absorption and amine regeneration system purge stream is also discussed.

Discusser: Brad Buecker, Buecker & Associates, Lawrence, KS

IWC 23-11: Blue and Green Hydrogen: Water and Wastewater Treatment Needs and Challenges

Time: 9:00 AM

Kishor Nayar, Ph.D., P.E., Evoqua Water Technologies, Houston, TX USA; Alexander McDonald, Evoqua Water Technologies, Houston, TX; Juvencio Casanova

Greenhouse gas emission targets are driving the decarbonization of hydrogen usage. While there is significant ‘hype’ around the hydrogen economy, there are very real economic cases for the application of blue and green hydrogen. Around 71% of global hydrogen production in 2019 (70 million tonnes) was driven by refineries, ammonia, and methanol production, with the hydrogen being sourced primarily from natural gas. Emissions targets and government tax credits are driving existing users to decarbonize hydrogen production by shifting to blue and green hydrogen. While significant attention has gone towards the ‘hydrogen economy’, the water issues related to hydrogen have not gotten much attention. In this paper, we discuss water usage and focus on water treatment for green hydrogen and wastewater treatment for blue hydrogen projects with key challenges highlighted.
Water usage: Every kilogram of hydrogen produced can have a water demand of 18-44 liters for blue hydrogen and 60-95 liters for green hydrogen, when evaporative cooling and treatment efficiencies are considered.

Green hydrogen water treatment: Water treatment for green hydrogen requires producing ‘ultra pure water’. However, currently every electrolyzer company has a different requirement for feed water quality for their electrolyzers with required water quality varying from ASTM D1193 Type I water (semiconductor quality; >18 MΩ-cm resistivity) to ASTM D1193 Type III water (reagent quality; >4 MΩ-cm resistivity). A case-study is presented where multimedia filtration, reverse osmosis, ion-exchange and ultraviolet light systems were used to treat city water to produce electrolyzer grade water.

Blue hydrogen wastewater treatment: Blue hydrogen projects couple steam methane reforming (SMR) with carbon capture and sequestration, to convert natural gas to hydrogen. A less known fact is that the SMR process also creates byproducts such as ammonia, formic acid and hydrogen cyanide which ends up in the wastewate4r. Depending on how the SMR process and the overall chemical plant is engineered, the composition of ammonia, formic acid and cyanide in wastewater can vary significantly. This can present a significant challenge for wastewater treatment with some constituents at toxic levels for conventional biological treatment. The variation in constituents also leads to vastly different optimal wastewater treatment solutions for projects. Approaches for cyanide wastewater treatment within the context of blue hydrogen projects are discussed.

Discusser: Matt Roth, DuPont Water Solutions, Philadelphia, PA

IWC 23-12: Key Water Issues for the Major Energy Production Technologies of the Energy Transition

Time: 10:10 AM

Andrew Hodgkinson, MScEng, FIChemE, CeEng, Worley, Melbourne, VIC Australia; Thomas Higgins, Worley, St. Augustine, FL; Hubert Fleming, Ph.D., Sc.,D., P.E., Worley, Fernwick Island, DE

Water is essential for energy production, and for the global energy transition.

Across the world a wide range of renewable energy production technologies are undergoing rapid development to facilitate a large scale transition from the current fossil carbon intense system, to one that is fossil carbon free. Almost all of these technologies require water, as a feedstock, for cooling processing or even as the energy storage reservoir itself. These water demands, in some cases are of similar character to existing demands, and in others are markedly different, either in scale, quality or both. They all pose significant new challenges for water engineers.

This paper will review the major energy production technologies of the transition, with particular focus on their water needs, including:
•Hydrogen and ammonia
•Nuclear power, particularly small modular reactors
•Renewable natural gas
•Renewable diesel fuel, and other low carbon fuels
•Pumped Storage hydropower
•Battery materials and battery manufacturing

We will present basic facts and figures, rules of thumb, trends and summarize principal technologies used or emerging in each field. We will demonstrate that the energy transition, while requiring a very large transformation of the global energy system, does not pose insurmountable obstacles – at least in regard to water supply and treatment.

Discusser: Jillian Flanagan, P. Eng., Stantec, Houston, TX, USA

Monday, 11/13/2023; 1:15 - 5:00 PM

M5: Mining Water Treatment

IWC Rep: Ivan Morales, Nalco Water, an Ecolab Company, Calgary, AB, Canada

Session Chair: Ashwin Thakkar, Aquatech International, Canonsburg, PA

Discussion Leader: Bryan D. Hansen. P.E., Burns & McDonnell, Kansas City, MO

Mining Wastewater Treatment using different methods, i.e. Advanced Membrane Treatment using UF/High-Pressure RO, Biological Treatment for metals removal, Bio-based polymers for heavy metals precipitation, and Evaporation for treatment of highly concentrated waste. Interesting facts highlighting Lessons Learned from wastewater storage pond treatment. Session also highlights the hybrid approach of membranes and evaporators for CapEX and OpEX optimization.

IWC 23-13: Mine Water Treatment using Ultrahigh-pressure RO Membrane (UHPRO) system optimizing the size of the downstream Thermal Evaporation System

Time: 1:25 PM

Mahesh Bhadane, Aquatech International, Canonsburg, PA USA; M. N. Rao, Aquatech International, Canonsburg, PA; Vinod Mojar, Aquatech International, Canonsburg, PA; Charles Desportes, Aquatech ICD, Hartland, WI

Mine Water Treatment using Ultrahigh-pressure RO Membrane (UHPRO) system optimizing the size of the downstream Thermal Evaporation System

The Mine Water Desalination Project was awarded by a reputed mining company in Canada to supply a modularized water treatment system capable of desalinating underground mine water according to the performance specification. This being an underground mining operation, it produces saline water with very high in TDS (about 20-40 g/L), total hardness, sulfate, sodium, and chloride along with heavy metals. Temperature of the mine water ranges from -2 to 23 °C. Mine water treatment system (MWTS) is provided to treat the highly contaminated mine water to comply with discharge requirement of chloride and TDS.
The mine water treatment solution provided with the lowest life cycle cost (CAPEX and OPEX) includes two (2) advanced technologies, an ultra-high pressure reverse osmosis units (UHP-RO) followed by a forced circulation thermal evaporators. RO systems use both seawater (SWRO) and ultrahigh-pressure (UHP-RO) membranes specifically designed to minimize the brine flow to the downstream thermal evaporation system (TES). UHP-RO unit is designed to operate at pressures range from 110 bar to 118 bar. Concentrate TDS concentrations in the UHP-RO reject stream feeding the thermal system ranges from 90 g/l to 105 g/l. This is the first full-scale industrial application in North America where an ultrahigh-pressure RO membrane system is being used. The TES system designed to concentrate the UHP-RO Reject produced by the MWTS into a concentrated brine which is further used in paste making.
This paper demonstrates, how advanced membrane technology, combined with thermal evaporators can successfully process challenging highly contaminated mine waters while respecting effluent disposal limits and customer goals and objectives.

Discusser: Ken Martins, Stantec, Carson Valley, NV, USA

IWC 23-14: Modeling the Direct Lithium Extraction (DLE) from Brines using Rigorous Electrolyte Thermodynamics

Time: 2:15 PM

Leslie Miller, OLI Systems, Inc., Reston, VA USA; Anthony J. Gerbino, Ph.D., OLI Systems, Inc, Parsippany, NJ

As the lithium industry continues to expand, more complex lithium extraction techniques from geologic fluids and other brines are being developed. With that, a rigorous chemistry model that can be used in a process simulator for pilot and full-scale plant design is required. In this study, electrolyte thermodynamics, a DLE media database with reaction kinetics, and a steady state process simulator are used to predict the mass, energy, and chemistry balance in a direct lithium extraction plant.

The electrolyte thermodynamic model contains the thermochemical data of key elements like Li, Na, K, Ca, Sr, Fe, Cl, CO3, SO4, H, OH, and B. It is used to calculate pH, density, buffer capacity, vapor pressure, activity coefficients, solids saturation and precipitation formation, and chemical demand and predicts the equilibrium state of the brine as it flows in and out of each process unit in the extraction and regeneration process.

The DLE media database was developed using experimental data from media providers to quantify lithium and other ions uptake as a function of contact time, pH, temperature, and brine chemistry. The experimental data was used to back-calculate the media's formula using the moles of exchangeable sites available per gram of media, a rate expression and a set of rate coefficients to calculate ion uptake as a function of temperature, pH and time.

The electrolyte model with the DLE media database was used in a steady-state process simulator to predict lithium extraction efficiency, contaminant ion uptake, solids deposition, chemical requirements, and LiCl extractant composition. A full-plant simulation was developed for several hypothetical extraction plant design scenarios. The model has some limitations that are primarily mass-transport-based, such as solids settling rates, media fouling, incomplete mixing, and membrane and ion exchange performance.

In summary, three capabilities were developed to enable the simulation, with relative accuracy, the geological fluid extraction processes. This includes simulating critical unit operations like ion exchange and media regeneration, membrane separation processes, predicting the formation of unwanted solids, and predicting the chemical and water demand under different process conditions.

Discusser: Bridget Moyles, GHD, Pittsburgh, PA

IWC 23-16: Mining Wastewater Storage Pond Treatment - 10 Years of Lessons Learned at a Remote Site with Extreme Algae Issues

Time: 3:20 PM

Linea Miller, E.I.T., WSP E&I Canada, Cambridge, ON Canada; Jack Hinds, P.Eng., WSP E&I Canada, Cambridge, ON, Canada

Since 2008, WSP has provided ongoing support to a remote open pit mining operation in the northern arctic for treatment of its on-site wastewater, including design, set-up, commissioning, operation, and decommissioning of several mobile water treatment systems deployed on-site.

As part of its operation, the mine utilizes lined waste berms to store potentially hazardous materials, such as totes and drums of used oil. Hydrocarbon impacted stormwater accumulates in these ponds during spring ice melt, which must be treated and discharged seasonally when the impounded water is not frozen, between June and September. Due to the remote nature of the site and environmentally sensitive receiving environment, the final discharge of the treated effluent is held to strict criteria. The water quality in these ponds varies by location and discharge season depending on upstream management of onsite hazardous waste, and therefore the systems are designed to be modular such that treatment unit operations can be switched out as required. In addition, the environmental conditions in which the treatment systems are operated in is extremely variable, where rain, wind and sun will impact water quality throughout the treatment period. Historically, the wastewater has been contaminated with suspended solids, ammonia, phosphorus, oil and grease, BTEX compounds, volatiles, nickel, and lead.

Effective treatment of the impacted water has proved to be challenging. Specifically, the increased levels of organics from mining operations, algae, and COD/BOD during the summer months reduces the effectiveness of water treatment, resulting in non-compliant effluent and inability to discharge. These effects are exacerbated by long periods of daylight and twilight during the mid-summer months, where the arctic algae can enjoy sunlight for up to 23 hours per day.

This paper presents the lessons learned from over 10 years of remote wastewater treatment support, and how the treatment approach and system performance has changed over time due to the presence of algae.

Discusser: Jason Monnell, Ph.D., PMP, Electric Power Research Institute, Charlotte, NC

Monday, 11/13/2023; 1:15 - 5:00 PM

M6: Membranes are Everywhere

IWC Rep: Lyndsey Wiles, ZwitterCo, Los Osos, CA

Session Chair: Wayne Bates, Nitto, Rockton, IL

Discussion Leader: Anthony Zamarro, P.E., CDM Smith, Boston, MA

This membrane session covers a wide variety of topics and shows that membranes are truly everywhere. Papers cover a unique low energy ultrafiltration method for produced water treatment, an academic study on electrical energy savings and reduction of carbon emissions at desalination plants, a review of polymer-based and inorganic-based membrane systems in the Middle East, and the reduction or elimination of hazardous sulfuric acid in high iron feed NF plants.

IWC 23-17: Replaceable Skin Layer Membrane Technology for Produced Water Treatment: Five Case Studies

Time: 1:25 PM

David Bromley, M.ENG., P.E., DBE Hytec Ltd, Vancouver, BC Canada; Sobhan Iranmanesh, M.Sc., DBE Hytec Ltd.,

Edmonton, Canada

Produced water is a dichotomy of the oil and gas industry. Is it a waste or is it a resource? The produced water volume is 2 -8 times the oil produced. Produced water typically contains high TDS, TSS, oil, Fe and high levels of bacteria. Treated produced water is used for hydrofracking operations and enhanced oil recovery (EOR) operations. For fracking operations, the key parameters are colloidal solids and iron. For EOR the key parameters are colloidal solids and oil. The unconventional geological zones, where EOR is applied, has the pore sizes similar to nanofiltration and RO membranes. The favored method of disposal of produced water is deep well injection. Due to the poor quality of the injected water, seismic events as high as 5-Richter scale are occurring due to the high pressure of injection. Therefore, the produced water needs to be treated whether it is being used as a resource or disposed.

At the 2013 IWC, David Bromley M. Eng, P.E., co-authored a paper on RSL Membranes™ with Dr. Kavithaa Loganathan. Ph.D - Canadian Natural Resources Ltd.. The 2013 paper was the introduction of RSL Membranes™ and reviewed a one-year evaluation of this new membrane technology versus conventional ceramic membranes (Veolia Ceramem). The RSL Membranes™ are now an accepted treatment technology for produced waters to be reused in fracking operations and EOR. The paper reviews the high-quality water produced by the technology to satisfy the new standards.
The technology is compared to dissolved air flotation technology on a cost basis. The comparison with DAF technology is important as DAF was the best available technology (BAT) to treat produced water. The industry tried to use conventional ultrafiltration membrane technology, but it was a failure resulting in DAF technology becoming BAT. On a cost basis, the paper outlines how RSL Membranes are at least 40% less operating cost than DAF technology.
In addition, the RSL Membrane™ technology is compared on a quality basis to conventional UF membranes. Pretreatment requirements are compared as well as treated water quality. Quality parameters discussed are TSS, colloid size, turbidity, Fe, and oil and grease. The paper outlines how RSL Membranes™ provide similar quality water as UF with lower pretreatment requirements, energy consumption, footprint and retentate/waste water. All these comparisons are made via five case studies which are reviewed in the paper.

Discusser: Tony Fuhrman, NX Filtration, Pittsburgh, PA

IWC 23-18: Reducing Sulfuric Acid Consumption in High Iron Environment: Case studies on Nanofiltration Plants

Time: 2:15 PM

Melissa Fernandes, American Water Chemicals, Plant City, FL USA

Over decades, pH adjustment has been implemented as part of the raw water pre-treatment in Reverse Osmosis and Nanofiltration systems. Sulfuric acid is the most common acid used to reduce the feed pH, and plants all over the world have been using H_2SO_4 as standard pre-treatment, with or without addition of antiscalant.
With the underlying safety concern and acid market volatility, membrane treatment professionals are working to shift away using acid as pre-treatment. Improvements on membrane technology, system design, and chemical pre-treatment have provided ideal conditions to run systems without feed pH adjustment.
With this change of thought, many factors need to be considered when increasing the feed pH, not only for the nanofiltration membranes, but for the entire treatment system and distribution. An extensive study of the water quality, system design, post-treatment and distribution system need to be conducted to safely eliminate or reduce pre-treatment acid injection.
In South Florida, the surficial Biscayne Aquifer presents low sodium and chloride, making it a perfect candidate for Nanofiltration treatment. However, significant amounts of iron have led to common iron fouling issues with multiple nanofiltration systems. Some oxidation on wellfields is suspected causing iron to precipitate to Fe^{3+}.
Acid as a pre-treatment is well known as a powerful tool to control calcium carbonate scale. However, change in pH influences on speciation and oxidation for various components in the water, including iron. Furthermore, it is understood reducing the feed pH helps to control the iron oxidation. With the iron fouling upsets, there is also the concern how this iron oxidation and precipitation will be influenced with the higher feed pH and if the antiscalant alone will be able to compensate and control the iron.
This presentation goes over case studies on Nanofiltration systems where the main goal was to reduce sulfuric acid consumption while maintaining safe margins for scaling control and acceptable levels of iron fouling.
The studies and data shared are divided into 3 phases: 1) Water quality and operation conditions analysis, lab simulations, projections, and benchtop testing; 2) Pilot plants running in parallel with the existing systems; 3) Full implementation of acid elimination on the feedwater and performance data over the years.

Discusser: Frank Brinson, McCafferty Brinson Consulting, LLC, Fort Lauderdale, FL

IWC 23-19: Optimizing Seawater Desalination: Trade-offs in Costs and Emissions Through Flexibility

Time: 3:20 PM

Akshay K. Rao, Stanford University, Stanford, CA USA; Adam A. Atia, Ph.D., National Energy Technology Laboratory, Pittsburgh, PA; Timothy Bartholomew, Ph.D., National Energy Technology Laboratory, Pittsburgh, PA; Meagan S. Mauter, Ph.D., Stanford University, Stanford, CA

The carbon intensity of reverse osmosis desalination processes for treating non-traditional water supplies is dominated by embedded carbon in the electric power grid. Aligning electricity intensive water production with time windows that have a low carbon grid mix could decarbonize desalination through the renewable energy transition and stabilize the electricity grid. One approach to varying desalination energy intensity is to vary intake or water recovery throughout the day, subject to a constraint on total water produced. Past work has explored the potential financial benefits of dynamic plant operation but has not explicitly valued the carbon benefits or investigated the cost-carbon tradeoffs of this operational strategy. This work develops a computational workflow for computing the marginal emissions and electricity cost savings of dynamically operated desalination facilities. We develop detailed process models to simulate plant energy consumption and integrate these with high temporal resolution electricity grid emissions data. Next, we parametrically evaluate characteristic applications of brackish water and seawater reverse osmosis treatment trains under wholesale electricity markets around the US (CAISO, ERCOT, FPL). In most cases, fixed operations are pareto-suboptimal with respect to both the electricity cost and grid emissions intensity, though the magnitude of savings are strongly dependent on the composition of the local grid and the design of the system. In select instances, dynamic operation reduces cost by 10% reduction without increasing the marginal emissions. For example, dynamic operation of the Charles E. Meyer Desalination Plant in Santa Barbara, CA would simultaneously achieve positive electricity cost savings and a marginal emissions reduction at a price of < $9/tonne of CO2, far below the EPA's current range of $51 to $190/tonne for the social cost of carbon. Ultimately, this workflow can aid in the valuation of energy flexibility for plant designs or retrofits, as well as informing innovation needs to support intermittent operation.

Discusser: Shiladitya Basu, P.E., Stantec, Houston, TX

IWC 23-20: State of art critical review on advancement, design, and improvement strategies for modern-era membranes for treatment of wastewater

Time: 4:10 PM

Nadeem Ahmad Khan, KFUPM, , Dhahran Saudi Arabia; Allan Amorim Santos, Biophysics Institute, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil., Rio de Janeiro, Brazil; Afzal Husain KHan, Department of Civil Engineering, College of Engineering, Jazan University, Jazan, Saudi Arabia

Advances in membrane technologies are concentrated on optimization for specific processes, focusing on different uses from classical separation to purification in different applications such as protein purification, water purification, wastewater treatment and water desalination. These membranes are widely used in industries such as food and beverage, pharmaceuticals, and wastewater treatment plants, among others, to purify and recycle water, separate dissolved substances from the environment, such as organic and inorganic contaminants, and recover valuable materials. Additionally, they may be supported by different materials such as a fibrous network that should be impermeable to substances in a solution. Along with the type of materials, the polymeric membranes may be classified into different groups according to the process and respective usage. They can be divided according to the type of material into organic and inorganic ones, besides the organizational structure of their matrices as isotropic and anisotropic. Organic membranes are made from synthetic organic polymers and the most used in industrial applications are polyethylene (PE), polytetrafluorethylene (PTFE), polyamide (PA), polyvinylidene fluoride (PVDF), polypropylene (PP), polysulfone (PS), regenerated cellulose (RC) and cellulose acetate (CeA). Meanwhile, the main inorganic membranes used in industry technologies are made from materials such as ceramics, silica, zirconia, glass, metals, and zeolites. Regarding the structure of polymeric membranes and their respective matrix, they can be classified as isotropic and anisotropic. This review article will cover various aspects of membrane and its treatment towards wastewater.

Discusser: Xiaofei Huang, Hydranautics - A Nitto Group Company, Oceanside, CA, USA

Monday, 11/13/2023; 1:15 - 5:00 PM

M7: Wastewater 1 -No Wasting of Wastewater: Reuse, Recovery, Reversals and Cost - it's all here

IWC Rep: Mike Soller, Bowen Engineering, Indianapolis, IN

Session Chair: Russell Huffmyer, V-Systems, Pittsburgh, PA

Discussion Leader: Mark Owens, P.E., UCC Environmental, Waukegan, IL

Wastewater comes from many sources, yet cleaning and recovery is a smart business decision. These papers address Beverage Recovery and Reuse, Recirculating expandable granular bioclarifiers, Electrodialysis reversal, and Sour Water recovery from Oil operations. The variety of papers highlight critical industries using solutions that address hard to treat waters with positive outcomes.

IWC 23-21: Advance Recovery and Reuse of Beverage Facility Wastewater

Time: 1:25 PM

Brian Arntsen, Veolia WTS, Oakville, Ontario Canada; Michele Migliavacca, Veolia WTS, Tomball, TX; Craig Duvall, Veolia WTS, Oakville, Ontario, Canada

Freshwater scarcity has become a serious global issue. The U.S. is experiencing water shortages in several states, and water costs are increasing due to prolonged depletion of groundwater (Thomas & Famiglietti, 2019). Rising water/wastewater treatment costs and enforcement of new direct discharge limits are accelerating the need for evaluation and implementation of water recovery and reuse projects. Water reuse prevents the reduction of groundwater tables and protects freshwater resources for future generations.

This Food & Beverage Manufacturer has a goal to achieve net zero greenhouse gas (GHG) emissions by 2050. As part of the global effort, the company announced new commitments to projects in the U.S to accelerate its path towards a sustainable future and net zero emissions. Water is fundamental to its operations and is a vital resource for everyone. Water preservation is at the heart of their efforts to build a more efficient business. They have implemented programs to continuously improve water efficiency at their factories, and have consistently reduced water withdrawals, even as production volumes increase.

The project commenced in 2007 during the construction of a greenfield Beverage Manufacturing Facility in Indiana. Several treatment technologies were evaluated on their ability to treat the highly organic wastewater while providing a high enough quality for direct reuse in on-site cooling towers. Given the reuse criteria, Membrane Bioreactor (MBR) technology was chosen as the best solution because of its extremely high quality permeate that could meet the specification for re-use in the onsite cooling towers. The full-scale wastewater treatment plant (WWTP) was designed for an average flow of 1.5 MGD. In 2021, the cooling tower makeup water specification changed, so a reclaim Reverse Osmosis (RO) plant was added to further enhance the quality of the reuse water. With this system, the plant can offset their cooling water demand through reuse by as much as 50% a year. The WWTP consists of the following processes:

- Flow collection, pumping, equalization & screening
- Dissolved air floatation (DAF), sludge dewatering & bio-solids disposal
- Membrane Bioreactor (Activated sludge with ZeeWeed* ultrafiltration (UF) membranes)

This paper will present key design criteria, operational data for the last 4 years of operation, and figures on the water

savings through reuse with Veolia ZeeWeed MBR + Reclaim RO.

Discusser: David Donkin, UCC Environmental, Waukegan, IL

IWC 23-22: Recirculating Expandable Granular Bioclarifiers, Single Step Wastewater Treatment

Time: 2:15 PM

Ronald Malone, Ph.D., P.E., Aquaculture System Technologies, Baton Rouge, LA USA; Rhine Perrin, P.E., Aquaculture Systems Technology, Baton Rouge, LA

Single pass granular floating bead beds are effective at solids capture and both aerobic nitrification and anaerobic denitrification. Their aerobic biofiltration capabilities are historically limited by oxygen transport. Integration of this expandable granular media with recirculating airlifts dramatically enhances their ability to operate as high-rate fixed film bioreactors by removing oxygen limitations. With specific surface areas of 1150 m2/m3 and no water loss pneumatic backwashing, the units are capable of BOD5 and ammonia removal rates in excess of 1-2 Kg/m3 of media while concurrently capturing solids. Ideal for small scale applications (<1 mgd) the technology can be configured and deployed in remote locations.
The robust nature of the technology is demonstrated by use of these bioclarifiers to avoid surcharges often placed industrial facilities. Roughing filter applications reduce suspended solids, BOD5, and/or ammonia from levels in the range of 1000/1000/100 to acceptable pretreatment levels of 200/200/20. The high solids and BOD5 levels do not interfere with nitrification; heterotrophic interference on the bead surfaces is mitigated with high frequency (3-24 times daily) pneumatic backwashing. Backwash waters are internally reconditioned and recycled. Sludge is discharged pneumatically with no moving parts or electronic controls.
The effectiveness of the bioclarifiers meet stringent effluent standards is demonstrated by several lagoon upgrade applications which have been documented. Here effluents in the range of 30/30/20 are upgraded to standards of perhaps 10/5/2. In these applications organic oxidation and nitrification are predictable, but suspended solids removal can be challenging reflecting rapid changes in algae populations.
The units are finding a niche behind dissolved air flotation units where they target residual solids and soluble BOD. In these applications, care must be taken to fully degasify waters prior to injection into the bead bed as bubble formation within the bed can disrupt fine solids capture. No problems have been observed with oils and greases adhering to the media although this can be expected in some industrial applications. A float switch (the only electronic control point) has proven beneficial in remote applications to accelerate backwashing in response to sudden load increases, or, discontinue backwashing when source pumps are automatically shut off.

Discusser: David Krasiewich, Parkson Corporation, Ft. Lauderdale, FL

IWC 23-23: Incorporating Electrodialysis Reversal in the Treatment of Industrial Wastewater

Time: 3:20 PM

Mavis Wong, Ph.D., P.E., Magna Imperio (MI) Systems Corp., Houston, TX USA; Sunil Mehta, Magna Imperio (MI) Systems Corp., Houston, TX; Chad Unrau, Ph.D., Magna Imperio (MI) Systems Corp., Houston, TX

As water scarcity intensifies, the need to treat non-traditional water sources becomes increasingly more important. Electrodialysis reversal (EDR) is a process in which ions are removed from a feed stream as a result of an applied voltage. Recent advancements in EDR stack and system design have made the technology competitive in the treatment of brackish water. These innovations, which include spacer improvements and increased membrane efficiency, along with operational changes such as tunable applied voltage and timed polarity reversals have reduced scaling issues and increased the versatility of the system compared to traditional separation technologies.

A wine packaging facility in California uses treated wastewater in their bottling processes. The industrial wastewater first goes through a membrane bioreactor (MBR) to remove organics, followed by ultrafiltration to remove fine particulates and then ozonation to disinfect the water. Finally, electrodialysis reversal (EDR) is used to lower the TDS of the water. EDR was chosen as the treatment technology for this application due to the high silica content in the in the resulting MBR effluent. EDR does not concentrate silica due to its neutral charge compared to other separation technologies such as RO. This allows for the product water to be recycled back to the inlet of the EDR system to be further treated until the product quality is reached for the facility's bottling processes. The EDR system reduced the MBR effluent from ~1200 ppm TDS to < 500 ppm at 95% recovery and < 0.25 kWh/m3 meeting all target parameters for the water to be used in the plant's downstream bottling processes. This installation shows that EDR is able to treat non-traditional water sources, especially where silica scaling would have limited other separation technologies from reaching such high water recoveries.

Discusser: Evan Claytor, Veolia WTS, Midlothian, VA

IWC 23-24: Oil Refinery Sour Water - Temporary Treatment System Implementation

Time: 4:10 PM

Carl Finlay, P.Eng., WSP, Vancouver, BC Canada

A local oil refinery reached out to WSP for assistance in assessing options to treat stored refinery sour water using a temporary treatment system based on rental equipment. The refinery had experienced problems with their regular sour water treatment unit resulting in a stockpile of stored sour water in crude oil and product tanks. Sour water contains high concentrations of ammonia and hydrogen sulphide. The objective was to rapidly implement a treatment system which would be capable of treating the stockpiled water to a suitable quality to go as feed to the refinery wastewater treatment plant or to offsite third party disposal, thus returning the crude and product tanks to their regular service as quickly as possible.

WSP developed a number of potential options for temporary treatment systems based on rental equipment from vendors, and the client selected an option for implementation: hydrogen peroxide treatment to remove hydrogen sulphide, closed loop air stripping to remove ammonia and convert to ammonium sulphate solution for offsite disposal, and augmentation of the refinery biological wastewater treatment system to enable it to process the pre-treated sour water.

WSP performed the detailed process design, operator training, SOP's and commissioning advisory services for the temporary treatment system in a phased manner so that treated sour water could begin processing as soon as possible.

In this presentation the approach towards design of a temporary treatment system for rapid deployment is discussed, along with site photos and model shots of the temporary plant constructed, and operating results from the Phase 1 treatment system which enabled truck-out of treated water to commence. Difficulties with vendor delivery of the Phase 2 system (closed loop air stripping of ammonia), and site seasonal impacts on the Phase 3 system (augmentation of the site biological treatment system) are also discussed.

Discusser: John Van Gehuchten, P.E., McKim & Creed Inc., Sewickley, PA

Monday, 11/13/2023; 1:15 - 5:00 PM

M8: Sustainability Performance – 2023

IWC Rep: Michelle Funk, P.E., Bechtel Corp., Reston, VA

Session Chair: Juvencio Casanova, , The Woodlands, TX

Discussion Leader: Rosana Ramirez, Veolia, Portland, TX

Over the years, sustainability has increasingly gained importance in organizations and communities. Whether self-imposed or mandated by regulation, industrial users and municipalities are setting specific and stricter water targets to ensure the long-term availability and responsible use of water. After the development of the UN Sustainable Goals in 2015 and more recently with the Inflation Reduction Act, Infrastructure Law, and America's Water Infrastructure Act, sustainable performance is at the center of how the industry is responding.

On one end, many projects aim to improve water efficiency, but on the other hand, decarbonization is particularly driving higher water demand usage and is challenging the water balance of industrial organizations. This session explores various cases illustrating how sustainability is shaping environmental, social, and governance programs - from addressing fundamental industrial needs to water reuse, and from balancing water and energy to water-positive initiatives.

IWC 23-25: Roadmap for Developing a Facility Water Management Plan

Time: 1:25 PM

Daniel Sampson, HDR, Walnut Creek, CA USA

Water management means many things to many people. There are a lot of different definitions, drivers, and impacts. At its heart, though, water management must meet the needs of specific facilities or stakeholders. It's often difficult to decided where to begin and how to determine what must be done and when.
There are many potential constraints. Raw water availability, raw water chemistry, discharge permits, industry-specific effluent guidelines, NPDES permits, local POTW discharge limits – all of these and more may create constraints with which a water management plan must comply. It's also important to evaluate water management and its role in facility and corporate sustainability goals. Meeting these goals may require recovery and management systems above and beyond than those required for regulatory compliance.

Historically, most facilities have focused on meeting BOD, TSS, and volume limits. These may still apply, but there's an increasing emphasis on problem contaminants and water efficiency.
This paper provides a general approach to developing a water management plan for a specific facility or a corporate entity. Every situation is different, but the paper will provide a general framework that can be used for any industrial or municipal facility. The discussion will examine important general concepts and considerations including the setting of policy and goals, the assessment of water uses and costs, development of facility water balances, identifying and closing data gaps, assessing funding opportunities and economics, developing implementation plans, monitoring and measuring progress, and planning for contingencies. The narrative will provide a template that others may find useful when implementing sustainability goals.

Discusser: Jorvic Vital, Nalco Water, An Ecolab Company, Katy, TX

IWC 23-26: What can industry learn from the municipal sector about implementing advanced reuse projects?

Time: 2:15 PM

Greta Zornes, CDM Smith, New Orleans, LA USA

To secure access to reliable, sustainable water supplies, particularly in water-scarce areas, the implementation and practice of advanced water reuse will continue to grow. Although the technology exists to safely implement advanced reuse, there are still many challenges, including permitting of facilities, operations, staffing and monitoring of sophisticated treatment systems, the cost of advanced treatment, understanding and acceptance of advanced reuse, and the engineering and vendor support required to implement advanced reuse projects. These challenges are amplified in small settings and particularly in remote locations. This paper will use the case study of The Village of Cloudcroft (Cloudcroft), NM to clearly define and discuss the steps required to successfully implement advanced reuse.

Cloudcroft identified potable reuse as a solution to stressed water resources in the early 2000's. The PURe Water direct potable reuse (DPR) project was conceptualized and designed shortly thereafter. The design consisted of a membrane bioreactor (MBR) upgrade to the existing wastewater treatment plant (WWTP), plus a new water treatment plant (WTP) housing both advanced water treatment (AWT) and drinking water treatment (DWT). The AWT treatment train design consists of reverse osmosis (RO), an advanced oxidation process (AOP) utilizing ultraviolet disinfection (UV) and hydrogen peroxide, followed by chlorination.

Construction on the MBR and WTP began in 2007 but was delayed due to legal and other issues. MBR construction resumed in 2015 and was completed in 2018. The MBR is currently online and operational. WTP construction has not yet been completed and RO brine management remains a significant challenge.

In this presentation, lessons learned will be presented to share the challenges and obstacles facing the implementation of advanced reuse for smaller systems (<100,000 gpd) as well as the challenges facing advanced reuse projects in remote locations such as Cloudcroft. These lessons learned are applicable to many industrial advanced reuse projects, where securing future water supplies is critical, but resources, funding and technical support are challenging to secure. A few of the lessons learned to date include:

•Advanced reuse projects can be complicated, requiring a multifaceted team of experts
•It is critical to have a strong project leader!
• An understanding of water demands and usage projections should be well understood
•Ongoing stakeholder outreach/communication is required
•Financing can be difficult - both CAPEX and OPEX
•Operator training is critical
•More remote operations/support may be required
•Vendor support can be challenging to secure

Discusser: Drew Desembrana, P.Eng., Veolia WTS, Oakville, ON, Canada

IWC 23-27: The Value of Inside the Fenceline Projects as Part of a Water Sustainability Program

Time: 3:20 PM

Rebecca Maco, Brown and Caldwell, Seattle, WA USA; Andy Wright, PepsiCo, San Fernando, CA; Carla De Las Casas, Ph.D., Brown and Caldwell, Walnut Creek, CA

Many private sector industries are now incorporating water commitments as part of an Environmental, Social, and Governance (ESG) program. PepsiCo is one such company and has set a goal to be net water positive by 2030. PepsiCo approached this as many companies do by first implementing onsite efficiency projects to reduce their water use and then using that optimized annual use volume as the standard by which to achieve net positive. After that point, all ESG reporting is related to the watershed replenishment projects and achievement towards the goal. At no point are the relative contributions and costs of the onsite water efficiency projects compared with those of the outside the fenceline projects; they are considered together as one portfolio for prioritization of investment. Our paper will provide visibility and share examples of how private industry can programmatically evaluate net positive water use including 1) which types of projects achieve the greatest benefit (i.e., water use reduction or replenishment volume) for the lowest lifecycle cost, and 2) how projects should be prioritized for implementation to achieve the most rapid progress towards net water positive goals. This paper provides an analysis of PepsiCo's net water positive program, including both replenishment projects and water efficiency projects, to compare the relative value of each and provide insights to other industries also endeavoring to meet net water positive goals.

Comparison of the costs of the inside and outside the fenceline projects shows that the majority of inside the fenceline projects are cash positive before they reach the end of their project life and outside the fenceline projects do not similarly result in a financial return on investment (ROI). However, there are practical limits on the degree of water efficiency that can be achieved in any production facility. Over time, PepsiCo has seen the simple payback period for water efficiency projects trend upward each year.

Both efficiency and replenishment projects are essential to a comprehensive water strategy. Although efficiency projects are more expensive in terms of capital spend per gallon saved, it is necessary to get one's own house in order and "walk the talk" of water stewardship. Then one can work with others to be as transformative outside the fenceline as possible to address the usage that remains essential to the business.

Discusser: Mark Knight, LuminUltra, Toronto, ON, Canada

IWC 23-28: How to Focus Industrial Facility Managers on Water Minimalization: Case Study in Decreasing Water Waste While Increasing Energy Efficiency

Time: 4:10 PM

Lisha Wu, HDR, Rosemont, IL USA; Brian Mulinix, HDR, Omaha, NE

Industrial facility managers typically focus on measuring performance as a cost center by analyzing production cost and amount of profit. This paper will discuss how to turn their attention to the benefits of minimizing water waste and increasing energy efficiency to help them meet performance goals. Through the lens of a case study at a food and beverage facility that manufactures gelatin and collagen products, we'll see how a thorough evaluation of processes and systems can uncover opportunities for reducing water and energy use, minimizing waste, and saving money. The methodologies for water and energy minimization used in this case study are both insight-based and mathematical techniques. The former consists of a two-step approach in synthesizing a batch water network balance through different unit operations that features freshwater and steam usage and wastewater flow for a given production schedule. The mathematical technique, on the other hand, will describe the water and contaminant balances across the water-using processes, process operation, and capacity with or without a predefined schedule. Project work highlights will illustrate the process of reviewing individual unit operation throughout the facility's production processes, including utilizing existing Sequence of Operation (SOP) and extracting data from Human-Machine-Interface (HMI) systems, verifying the data accuracy with the client/operator's feedback, and handling data gap or discrepancy to eventually develop the water and energy balance and inventory model. We'll discuss specific water management and preservation recommendations on the foundation of an accurate water and energy balance model. With proper monitoring and automation technologies, we will show the facility owner how to collect the relevant data, analyze the production process, control the water and energy usage, and sustain the win for both short-term and long-term gains from the practice. Implementing a water minimization management system means a dual reduction of freshwater and wastewater flows, which leads to increased sustainability, reduced operation costs, and benefits for the bottom line, environment, and community. We'll also discuss how to handle challenges with implementing changes and how a project like this can be accomplished in approximately one month.

Discusser: Diane Martini, Burns & McDonnell, Chicago, IL

Tuesday, 11/14/2023; 8:00 AM - 12:00 PM

T1: Further Adventures in Brine Management

IWC Rep: John A. Korpiel, P.E., Veolia Water Technologies, Pittsburgh, PA

Session Chair: Adam Sutherland, Stantec, Nashville, TN

Discussion Leader: Richard Stover, Ph.D., GP Water, Woburn, MA

Whether you are planning for minimum/zero liquid discharge, water reuse, resource recovery, or tackling PFAS removal, brine management is one of the biggest challenges facing the water industry today. This session will touch on several novel applications of membrane technology as the water industry continues to drive towards increased water recovery and sustainability.

IWC 23-29: Brine Concentration Membranes: New Applications and Design Concepts for Super Concentrating Brines

Time: 8:10 AM

Craig Bartels, Hydranautics - A Nitto Group Company, Oceanside, CA USA; Rich Franks, Hydranautics - A Nitto Group Company, Oceanside, CA; Xiaofei Huang, Hydranautics - A Nitto Group Company, Oceanside, CA; Alan Franks, Hydranautics - A Nitto Group Company, Oceanside, CA

Brine concentration membranes (BCMs) are a new type of membrane which can achieve very high brine salinities that cannot be reached by seawater reverse osmosis (SWRO) or ultra-high-pressure RO (UHP RO) membranes. Softened brines can reasonably be concentrated to the range of 100,000 – 250,000 mg/l of dissolved salts (TDS) by BCM's. Thus, design engineers are just now exploring options to use these membranes in minimum/zero liquid waste (MLD/ZLD) processes. A variety of examples will be discussed to show some of the unique features of these membranes and the special design considerations that must be utilized when applying these membranes to a high recovery RO process. One example is the treatment of SWRO brine at a pilot site in Saudi Arabia. In this case, a two-stage hybrid process was used, where a higher rejection BCM was used in the first stage and a lower rejection BCM was used in the second stage. Final salinity as high as 120,000 mg/l TDS was achieved with a feed pressure less than 725 psi (50 bar). A second example is the treatment of a high salinity industrial wastewater using a first stage SWRO membrane and a second stage BCM membrane. The goal of this treatment (MLD) was to maximize the concentration of salts and organics in one of their waste streams, such that the permeate can be blended with other waste streams at the plant and still meet their discharge limits. The concentrated waste is hauled away from site, which based on our evaluation, should be > 60% reduced compared to their current practice. Other applications are considered as well. In all these cases, the permeate from the BCM will likely need to be returned to the SWRO membrane for further water recovery and salt concentration. Projection of such systems is complicated due to these recycle streams. We will share the methods of carrying out such difficult analysis and the importance of generating lab and pilot data to verify the expected performance.

Discusser: Omkar Lokare, Gradiant Corporation, Woburn, MA

IWC 23-30: Case Study: More than 93% Recovery of Power Plant's Cooling Tower Blowdown with an Advanced Reverse Osmosis Demonstration Plant

Time: 9:00 AM

Roi Zaken Porat
Zaken, IDE Technologies, Kadima, Israel Israel; Alex Drak, IDE Water Technologies, Kadima, Israel, Israel; Vijay Ahire, IDE Technologies, Carlsbad, CA

The power industry is one of the most intensive water consuming industries. However, due to water shortages, increasing numbers of regulations, and related effluent discharge and makeup water costs, power plants must manage their net water consumption in the most efficient way.

The major water consumers in a power plant are the cooling towers, which also produce the major amount of wastewater as cooling tower blowdown (CTBD).

The straightforward way for power plants to save water, is to efficiently treat the CTBD and reuse the treated water back in the cooling towers as makeup water. However, due to the challenging composition of the CTBD water, conventional membrane technologies are limited in their ability to achieve high water recovery.

IDE developed a membrane-based technology, The MAXH2O DESALTER, that maximizes high recovery of CTBD and reuses most of the treated water as makeup.

The technology contains a single stage reverse osmosis system, with an integrated salt precipitation unit. This technology operates by recirculating the CTBD through the RO system, followed by a fluidized bed reactor in which controlled precipitation of supersaturated sparingly soluble salts is performed.

This cyclic process, which occurs in small and controlled intervals, allows for a continuous concentration and precipitation of the salts that would otherwise limit the recovery, and does so without increasing the scaling and biofouling inside the membranes, thus enabling extremely high recovery (rates beyond 95%).

The produced by-products contain over 90% solids, which lead to easy and cost-effective disposal without additional sludge minimization processes.

This paper presents the results of a 48 m3/day MaxH2O Desalter demonstration unit set up in a power plant in Chile which operated for 60 days (24/7) to achieve a 93.5% recovery. The sparingly soluble salts' (Calcite, Gypsum Silica, and Phosphate) saturation indices stayed below the antiscalant limitation and were removed during the process by a dedicated sub-unit (crystalactor). The demonstration unit proved the process' robustness and reliability for CTBD treatment.

With conventional technologies, scaling of the membranes would have a limited recovery of (only) up to ~50%. At 93.5% recovery, the theoretical saturation indices reach for: Log SI ~3.4, $CaSO_4$ SI ~ 1270%, and SiO_2 SI ~ 700% (equivalent to 900 mg/l of Silica). Achieving such a high recovery under these conditions presents a viable and revolutionary solution that can significantly reduce the costs and enhance the operation associated with CTBD in power plants and across the industry.

Discusser: David Shin, Hydranautics - A Nitto Group Company, Oceanside, CA

IWC 23-31: Recovering 90% of RO Reject Water for Further Use

Time: 10:20 AM

Kevin Slough, Ionic Solutions, Calgary, AB Canada; Jordan Grose, Ionic Solutions, Calgary, AB, Canada; Azaroghly Yazdanbod, Ionic Solutions, Calgary, AB, Canada; Bill Sellerberg, Con Edison, New York City, NY; Gary Thorn, Con Edison, New York City, NY

There is huge opportunity in the water desalination and softening industry to improve water recovery of existing RO systems with low risk, bolt-on solutions. One exciting way to do this is to install a super energy efficient capacitive electrodialysis reversal (C-EDR) system in series with RO reject lines to recover more water. This new C-EDR technology can be installed on the reject lines of existing RO units to recover up to 90% of remaining water for many applications using very low power to do it. This paper presents operational data obtained from a small commercial scale C-EDR system processing RO Reject quality over a range of salinities and builds on the results of paper IWC-22-42 presented in 2022. The data presented will illustrate how further water recovery can be extracted from RO Reject streams to minimize waste and increase recovered volumes of this increasingly scarce resource.

The paper will focus on the new C-EDR technology and the drastic operational improvements possible in terms of clean water yield, reduced concentrate, dramatically lower power consumption, reduced anti-scalant chemical usage and more. It will discuss the increased operating flexibility of the resulting systems and their applicability to a much wider range of desalination applications than previously contemplated for electrodialysis. The analysis will demonstrate how C-EDR systems can outperform comparable reverse osmosis systems in virtually every performance category and ranges of brine salinities, while ultimately demonstrating a step change improvement in desalination performance for the desalination marketplace.

Discusser: Robert Haresdin, P.E., GHD, Allison Park, PA

IWC 23-32: Removing AFFF Residue in America's Refineries & Chemical Process Facilities

Time: 11:10 AM

Elaine Towe, P.Eng., Veolia WTS, Oakville, ON Canada; Christopher Scott, Veolia WTS, Trevose, PA

Aqueous Film Forming Foam (AFFF) has started to enter the lexicon of PFAS (Perfluoroalkyl Substance challenges, and the public's consciousness, in a big way in the refining & chemical process industries. AFFF has long been strongly associated with US Military bases and associated support sites, due to its near ubiquitous use over a period of decades in training and actual firefighting events at these facilities.

In the last few years, the Military has taken very public steps to replace AFFF materials, and to contain the legacy PFAS contamination. Perhaps partly as a result, less attention has been paid to past use of AFFF at non-Military sites such as fuel depots, pipelines, Refineries, and Chemical Process plants across the nation, and world. These other facilities are now starting to ramp up their efforts to control AFFF runoff and contamination in local aquifers, process water, wastewater, groundwaters, storm waters, and surface water supplies.

These efforts coincide with and are accelerated by rising regulatory scrutiny. In this paper, we will share our company's experiences designing, building, starting, and running large scale (800gpm), refinery wastewater treatment plants installed specifically to remove PFAS. The discharge water goes to either a receiving stream or a local POTW. Specifications for either must be met. The technologies utilized include chemical pretreatment, membrane ultrafiltration, carbon adsorption, specialty ion exchange, chemistry management, and ultra-low PFAS level design components, among other technologies. Since the concentration of AFFF in the water is very high, special considerations are required to be able to meet the exacting specifications.

Discusser: Hari Parthasarathy, Geosyntec Consultants, Chicago, IL

Tuesday, 11/14/2023; 8:00 AM - 12:00 PM

T2: INTRODUCTION TO INDUSTRIAL BOILER AND STEAM SYSTEM PASSIVATION, CARRYOVER, CARRYUNDER, AND CHEMICAL TREATMENT

IWC Rep: Colleen M. Scholl, P.E., HDR, Whitewater, WI

Session Chair: Robert D. Bartholomew, P.E., Sheppard T. Powell, Baltimore, MD

Discussion Leader: Daniel Sampson, HDR, Walnut Creek, CA

Sponsored by the ASME Research & Technology Committee on Water and Steam in Thermal Systems

This is a good session for both seasoned veterans and those that are new to the field of industrial boiler water treatment. Steam/water cycles are mostly fabricated of steel, which is inherently unstable in steam or water. Thus, surfaces are passivated to provide a barrier between the steel and the fluid. There is much attention to carryover of boiler water into steam to protect turbines and steam system components, but it is less commonly understood that carryunder of steam in water also can cause significant problems. There are multiple types of conventional internal treatment approaches to control corrosion and deposition in boilers and the rest of the steam/water cycle. Recent research is also indicating that film forming products may affect heat transfer performance of steam/water cycle components. This session provides the essential science needed to understand these concepts and the practical advice to apply them to your industrial steam system.

IWC 23-33: Passivation in Steam Generating Systems

Time: 8:10 AM

Loraine Huchler, P.E., CMC, MarTech Systems, Inc., Exmore, VA USA

The term "passivation" has been applied to a wide variety of conditions, ranging from the strict electrochemist's definition of electrochemical potentials to the operator's measurement of soluble and insoluble iron in the boiler system. Other definitions include the existence of a tight, adherent iron oxide film or environmental conditions of minimum iron solubility (i.e., minimum corrosion). If the definition of passivation is the conversion of an oxide to magnetite, then a reduction reaction must have occurred. If the definition of passivation is the creation of a tight adherent oxide film from the substrate metal, then an oxidation reaction occurred – that's corrosion! How can passivation be both an oxidation reaction and a reduction reaction?
Despite the various descriptions, the objectives are the same: to create conditions that minimize the corrosion of iron. This paper will describe the basic chemistry of iron oxides in boiler systems, the postulated corrosion mechanisms, the thermodynamic and kinetic conditions that control iron oxide formation in boiler systems, the effects of dissolved oxygen and chemical oxygen scavengers on these system conditions, and some passivation/corrosion measurement techniques.

Discusser: Edward Beardwood, Beardwood Consulting & Technologies Inc, London, United Kingdom

IWC 23-34: Identifying and Understanding Boiler Carry-Over and Carry-Under

Time: 9:00 AM

Kevin Boudreaux, ChemTreat, Sioux Falls, SD USA

Boiler carry-over and carry-under are two phenomena that occur frequently in industrial boilers. Because of its effects on overall boiler and process operations, more are familiar with boiler carry-over; but knowing why it is occurring and what corrections to make is not so familiar. Boiler carry-under is far less frequent in its occurrence, and there is a modest amount of literature available on the subject. Also, carry-under typically has more of a design root cause, as opposed to operational or water chemistry. As such, very few have experience with this phenomenon, and corrective actions are usually ad hoc.

This paper attempts to highlight how carry-under and carry-over occur, the tell-tale signs of each, and some ideas for correction where applicable. Also, because it is so critical and yet so rarely implemented, a detailed discussion about the proper online instrumentation necessary for monitoring carry-over is provided. This includes key parameters, as well as an explanation as to why the selected parameters are so important.

Discusser: Ivan Morales, Nalco Water, an Ecolab Company, Calgary, AB, Canada

IWC 23-35: Film Forming Products: Application, Corrosion Reduction, Layup Benefits, and Heat Transfer Improvement

Time: 10:20 AM

George Patrick, Veolia WTS, Trevose, PA USA

Film forming chemistries have seen a significant growth over the last decade. Filmers have been used for many years, but new innovations make them more applicable to current industry challenges. VEOLIA WTS has been an active member of the science community in helping move forward this unique treatment approach, partnering on multiple research projects with other organizations. The volatility of new film forming technologies has spread protection throughout water/steam systems. Research and case studies have shown improved corrosion rates throughout these studies. In addition to improved corrosion protection, improvement in heat transfer is another benefit of film forming technologies. Heat transfer improvement while using a film forming product was identified in studies by VEOLIA WTS and research partners. These studies were supported by key field applications. An overview of the development of the film forming products and the research will be provided in this paper. Results of the industrial applications will also be summarized in the paper.

Discusser: Kevin Boudreaux, ChemTreat, Sioux Falls, SD

IWC 23-36: Chemistry Control of Industrial Steam Generators & Waste Heat Boilers (including TLEs)

Time: 11:10 AM

Robert Bryant, Nalco Water, an Ecolab Company, Sugar Land, TX USA

Steam production is central to the petroleum refining and chemical manufacturing industry. Steam generators and waste heat boilers are used to cool plant processes, and steam is used for various purposes, from heating the process to spinning the turbines that drive pumps and compressors. Maintaining the reliability and energy efficiency of the steam generators and waste heat boilers can significantly impact the production rates and energy costs at these facilities. Conversely, steam generator failures can lead to reduced production rates and unscheduled unit outages.

This paper will discuss boiler internal treatment in refineries and chemical processing facilities. It will include chemical programs ranging from controlling scale in 25 psig waste heat boilers to preventing corrosion in 1800 psig TLEs (transfer line exchangers). The paper will consist of choosing the correct program based on the boiler type and boiler feed water (BFW) pretreatment scheme and how to monitor and control the different types of internal treatment programs. We will also examine the BFW quality requirements for the various chemical programs and the advantages and limitations of each of internal treatment program.

Discusser: David Daniels, Acuren Inspection
Acuren Inspection, Leander, TX

Tuesday, 11/14/2023; 8:00 AM - 12:00 PM

T3: PFAS 2/ Best Practices in PFAS Management and Treatment

IWC Rep: Bradley D. Wolf, P.E., BRG, Pittsburgh, PA

Session Chair: Bill Malyk, WSP E&I, Cambridge, ON, Canada

Discussion Leader: Pierre Kwan, P.E., P.Eng., HDR, Seattle, WA

Join us for an enlightening technical session at the Industrial Water Conference as we dive into the world of PFAS treatment. In this session, industry experts will explore the latest advancements, challenges, and strategies for effectively managing and treating per- and polyfluoroalkyl substances (PFAS) in industrial water systems. Discover innovative technologies, operational best practices, and case studies that shed light on sustainable and efficient approaches to PFAS removal and destruction. Don't miss this opportunity to expand your knowledge and contribute to the collective effort in safeguarding our water resources.

IWC 23-37: From Bench to Field: Foam Fractionation and Electrochemical Oxidation Performance on Source Zone and Plume PFAS Treatment

Time: 8:10 AM

Jessica Beattie, P.G., CDM Smith, Edison, NJ USA; Mark Salvetti, CDM Smith, Boston, MA; Tamzen Macbeth, CDM Smith, Helena; Dung Nguyen, CDM Smith, Bellevue, WA

The treatment of Per- and Polyfluorinated Substances (PFAS) is challenging due to the carbon to fluorine (C-F) bond, the strongest known chemical bond in nature. Currently, water treatment systems rely on processes that separate PFAS from the water stream, such as carbon, ion exchange, or reverse osmosis. These separation technologies leave PFAS concentrates or spent media requiring costly waste handling and maintenance. Our project team recently completed a pilot study aimed at implementing a cost-effective, sustainable system to treat two types of PFAS impacted groundwater: air stripper effluent (~500 ppt total PFAS) and source zone groundwater (~11,000 ppt total PFAS). To achieve this, the team performed a bench-scale and field pilot demontration assessing foam fractionation (FF) followed by electrochemical oxidation (ECO) to partition PFAS from the water stream and degrade PFAS to innocuous end products (carbon dioxide, water and fluoride).

The source of PFAS at the project site is Class B aqueous film forming form (AFFF). The FF/ECO bench scale study was completed to meet four primary objectives: 1) confirm PFAS removal and concentration; 2) assess the need for, and impacts of, surfactant addition; 3) assess PFAS destruction; and 4) evaluate adverse impacts of treatment (if any). The bench study also informed the design of a field pilot study to test onsite PFAS treatment using EPOC's SAFF® temporary container system and offsite ECO treatment of the concentrated foam waste stream by CDM Smith. An 11-week field demonstration was performed for both groundwater types.

The bench scale study determined both the air stripper effluent and source zone groundwater did not foam readily. Multi-log PFAS reduction could not be achieved at the bench scale without surfactant addition. The bench-scale study did demonstrate good PFAS mass balance across both treatment stages. Surfactant can be readily removed from solution. Multi-log destruction of PFAS present in the final foam fractionates can be achieved using ECO. However, longer ECO treatment time was required for PFNA. Nitrate likely a degradation byproduct of surfactant degradation during ECO treatment. Perchlorate generated during ECO treatment required treatment. The field demonstration was comprised of initial short-term tests for performance optimization followed by longer-term tests with optimized metrics. The field study determined SAFF/ECO treatment duration, surfactant addition parameters, and SAFF concentration factor and provided lessons-learned for future demonstrations.

Discusser: Kevin Dufresne, Geosyntec Consultants, Guelph, ON, Canada

IWC 23-38: Operational Learning and Best Practice Development at a Multi-Year PFAS Treatment Facility

Time: 9:00 AM

Christopher Scott, Veolia WTS, Trevose, PA USA; Elaine Towe, P.Eng., Veolia WTS, Oakville, ON, Canada

PFAS regulations are becoming increasingly comprehensive and restrictive. As a consequence of ultra-low final PFAS effluent requirements, several factors have taken on more significance. Factors such as overall system flow sheet, pretreatment, vessel design, and operating procedures (particularly around system cleanliness) have become very important–even central–to the successful operation of PFAS water and wastewater treatment systems.

To summarize, the PFAS treatment challenge is getting so demanding that re-designed equipment and upgrades in the handling of media are needed, not only for spill and groundwater sites, but also for process water discharge, and drinking water facilities.

In this paper, we will share our multi-year optional experience of a full-scale municipal water system using ion exchange for PFAS removal. After a year of successful operation, number of operational challenges were encountered related to the factors mentioned above. The plant was shut down for maintenance, upgrades & operational changes. We will share the steps taken restarting the facility, and the critical adjustments made in the pre-treatment. We will also identify what we believe to be operational best practices for PFAS removal.

Discusser: Cathy Swanson, Purolite, an Ecolab Company, Fullerton, CA

IWC 23-39: PFAS Mass Balance in a City

Time: 10:20 AM

Ivan Cooper, Civil & Environmental Consultants, Inc., Charlotte, NC USA

The City of Lebanon, New Hampshire, sought to understand how PFAS moves through their waste and wastewater infrastructure. Starting with disposal by consumers and/or industry, the City was interested in understanding all of the pathways by which PFAS moves into and out of its landfill, into and out of its sewer systems, interrelationships between the two and points of discharge to the environment. Once this data was gathered, it was analyzed in the context of the current regulatory framework, as well as, the context of reasonable/plausible future regulations. Finally, the City evaluated how it might best reduce and control the release of PFAS to the environment from the waste/wastewater infrastructure. The flux of PFAS through the infrastructure was conceptualized through construction of semi-quantitative conceptual models.
Based on the evaluation of PFAS concentrations in the landfill leachate and in the wastewater treatment plant effluent, a range of treatment options and costs were developed for both landfill leachate and wastewater effluent.
Technologies included PFAS separation and concentration technologies including activated carbon, ion exchange, modified clay adsorbents, reverse osmosis, foam fractionation, and evaporation, as well as a range of innovative PFAS destruction approaches. Residuals management approaches, costs and operation considerations were compared on a life cycle basis and on a cost per gallon for treatment and disposal.
Key findings of the study identified the PFAS sources and discharges from the landfill and considerations of future regulatory limitations for discharge. The treatment technologies detailed an initial capital cost range of $3 million to $17 million for landfill leachate, and treatment of municipal wastewater for PFAS treatment ranged from $10 million to $47 million.

Discusser: John Van Gehuchten, P.E., McKim & Creed Inc., Sewickley, PA, USA

IWC 23-40: PFAS Rejection with RO and NF

Time: 11:10 AM

Wayne Bates, Hydranautics - A Nitto Group Company, Rockton, IL USA; Yue Wang, Hydranautics - A Nitto Group Company, Oceanside, CA, United States; Megan Lee, Hydranautics - A Nitto Group Company, Oceanside, CA

PFAS is a classification of 5,000 to 12,000 poly-or-perfluoroalkyl chemicals which have strong carbon-fluorine bonds dubbed “forever chemicals”. Extensively used in industries of all types around the world and replacing them are not easily done. The have long half-lives and are not readily degraded in nature and have a concerning tendency to bioaccumulate in animals and humans. Exposure to PFAS from water, soils, food, and air is unavoidable and can lead to adverse health effects resulting in local, state and federal governments around the world promulgating regulations in the PPT (parts per trillion PPT or ng/L) levels.
In literature, PFAS rejection ranges have been reported from 71-99% for NF, 82-99% for low pressure brackish water RO, and 82-99% for high pressure brackish water RO. This paper will report on PFAS rejection studies by progressively tighter NF and RO membranes. The rejection of specific PFAS compounds can vary by carbon chain length, molecular weight, functional groups attached at the hydrophilic end, whether it is the acid or salt form, pH, etc. What could be an important discovery was the PFAS rejection may vary from site-to-site dependent on NOM and TOC variations in the feed. 4 different studies will be reviewed.
The 1st study was a cell test with lab generated synthetic feed with no TOC, no TDS and spiked with 1 ppm of PFAS compounds. The 2nd study was a Pennsylvania land-fill leachate cell test whose feed was with 534 ppm TOC, 12,100 ppm TDS and 8,881 ppt PFAS. The 3rd study was a pilot ran on the concentrate stream of an existing well-sourced California potable drinking water low-pressure RO plant which ran at 85% recovery, resulting in a pilot feed to a 1x1-1M array of 7 different membranes ran at 10-day intervals with a feed of 10 ppm TOC, 9,000 ppm TDS and 100 ppt total PFAS as the sum of 11 different PFAS compounds. The 4th study is a follow-up at the same California plant in the 3rd study where cell testing for PFAS rejection was performed with the feed to the 85% recovery 1st stage LPRO, the 2nd stage feed and 2nd stage concentrate. The objective is to show what effects to % rejection may exist with progressively increasing levels of NOM and TOC.

Discusser: Kishor Nayar, Ph.D., P.E., Evoqua, Houston, TX

Tuesday, 11/14/2023; 8:00 AM - 12:00 PM

T4: Good to the Last Drop: Water Reuse in Action

IWC Rep: Jay Harwood, Newterra, Oakville, ON, Canada

Session Chair: Mike Preston, Kiewit, Lenexa, KS

Discussion Leader: Shira Colsky, Geosyntec Consultants, Atlanta, GA

Water reuse continues to be a topic that garners a high level of interest across most all industries and all levels of government. As the US experiences a resurgence in industrial activity and development, water reuse will be critical to the feasibility and success of these new facilities. While we all embrace the concept, the implementation can be challenging. In this Session we will hear from several industrial applications considering the opportunities and challenges of implementing an effective reuse program in their particular setting. We’ll also have an opportunity to learn more about an emerging membrane solution designed to address some of the challenges encountered in the reuse applications.

IWC 23-41: Identify Water Reuse Opportunities in the Beverage Industry – EPA Water Reuse Action Plan Report-Out

Time: 8:10 AM

Holly Churman, P.E., GHD, Allison Park, PA USA; Peter J. Capponi, GHD, Atlanta, GA; Tyler Abercrombie, GHD, Irvine, CA; Nort Fogel, P.E., GHD, Farmington Hills, MI; Paul T. Bowen, Ph.D., GHD, Clemson, SC

The United States Environmental Protection Agency (USEPA) is spearheading the National Water Reuse Action Plan (WRAP), an initiative intended to address barriers and drive opportunities for water reuse in the public and private sectors. The initiative is collaborative, with over 100 action leaders and partners focused on Actions, or targeted projects, that focus on technical, institutional, and financial issues related to water reuse. Under the WRAP, Action 5.7 has been developed to identify and communicate opportunities for water reuse within the beverage industry, a sector that is characterized by intensive water and energy use and significant liquid and solid waste generation. For example, on average, breweries use four to 12 gallons of water per gallon of beer. Water supply and disposal options are often constrained due to regulations governing discharge quality, environmental factors such as droughts, and other issues. Water reuse and associated treatment can maximize energy efficiency and water recovery, helping breweries and other beverage companies meet their sustainability goals.

As part of WRAP Action 5.7, a team of public sector, beverage companies (including the Beverage Industry Environmental Roundtable), and non-profit representatives has convened to assess the level of water use implementation in the industry, as well as available treatment capabilities. Regulatory requirements and study stakeholder perceptions associated with recycling water to potable levels and use of recycled water within the product itself comprise other key topics. The team is writing a white paper that references case studies and drivers that have been implemented within other programs and within the industry to create an effective water recycling strategy for the beverage industry. The white paper will also review the wastewater characteristics that drive the selection of certain treatment technologies and highlight strengths and weaknesses of these technologies, and next steps toward implementation.

This paper will summarize the activities undertaken to fulfill the mission of WRAP Action 5.7, including a report-out of the key findings that will be incorporated into the white paper. We will discuss our next steps and seek feedback from the attendees for consideration in a subsequent phase of the project.

Discusser: James Scholl, P.E., BCEE, DWRE, ASCE Fellow, Kiewit, Okemos, MI

IWC 23-42: Challenges Associated with the Adoption of Industrial Water Reuse

Time: 9:00 AM

Anthony Zamarro, P.E., CDM Smith, Boston, MA USA

Many companies are adopting new water reuse strategies, driven by water scarcity concerns or corporate environmental goals and sometimes both. The starting point for these projects tends to be existing wastewater plants that have been designed for publicly-owned treatment works (POTW) discharge, where variability in plant effluent is diluted by municipal waste contributions before final treatment.

Most reuse schemes will include reverse osmosis to remove dissolved contaminants not removed by biological treatment. These systems have a low tolerance for dissolved organics. This paper will discuss two industrial treatment sites where instability in effluent organics has delayed the adoption of reuse. The root causes of these issues will be discussed, including both the operation of the treatment plant and the manner in which waste is generated by the production facility.

The adoption of reuse by existing plants will involve challenges in design and operation of treatment plants, but also challenges for industrial plant operation. Additionally, changes in the way the value of water is calculated by corporate leadership needs to be re-evaluated as serious investments in plant operations and wastewater treatment are considered to deal with future reuse challenges.

Discusser: Edward Greenwood, P.Eng., BCEE, WSP, Barrie, ON, Canada

IWC 23-43: Reclaimed Water for Data Center Direct Evaporative Cooling Systems

Time: 10:20 AM

Carla De Las Casas, Ph.D., Brown and Caldwell, Walnut Creek, CA ; Shannon Cavanaugh, Brown and Caldwell, Seattle, WA; Rebecca Maco, Brown and Caldwell, Seatlle, WA; Austa Parker, Brown and Caldwell, Lakewood, CO

In the United States (US), water scarcity continues to be an imminent concern as severe droughts become commonplace. The rise of cloud computing and the influx of data centers with large cooling water demands are exerting additional pressure on freshwater supplies. These corporations are looking to reduce freshwater consumption and/or to replenish water consumed back to the watershed where their facilities are located. Reclaimed water, if available, is a potential source to meet cooling system needs and offset freshwater consumption.

Reclaimed water has been used for industrial cooling in the US since the 1960s; however, this use has generally been in indirect evaporative cooling (IDEC) systems. Unlike IDEC systems, in direct evaporative cooling (DEC) systems, cooled air is in direct contact with personnel, resulting in health risk concerns associated with pathogens in reclaimed water. Additionally, equipment and cooling system media are at greater risk of degradation due to scaling, corrosion, and biofouling when using reclaimed water. Because of these concerns, DEC systems typically operate using potable water and are common in industrial applications throughout the world. Although there are data centers that use reclaimed water as make-up water for their DEC systems in the US, very little is known about these data centers and treatment systems. Data center operators are interested in utilizing reclaimed water to offset their freshwater demands if they can successfully mitigate risks. This paper explores strategies to utilize reclaimed water in data center DEC systems; relieving water stress from ecosystems and communities while (1) mitigating potential risks, (2) assessing relevant regulatory pathways, and (3) utilizing innovative and efficient pre-treatment systems for effective implementation. A case study example of a utility that is providing reclaimed water to a data center for use in DEC will be shared.

This evaluation indicates that while there are both risks and challenges associated with implementing DEC at data centers, these risks can be mitigated by engineering the right water treatment systems to address different constituents of concern. These systems have been implemented in the US and are a win-win for utilities looking to expand their reclaimed water programs and for data center operators looking to reduce their dependence on potable water and achieve sustainability and Environmental, Social, and Governance (ESG) goals.

Discusser: Michael Hicks, Ramboll Water, Brentwood, TN

IWC 23-44: Full-Scale Implementation of Novel, Zwitterionic Membranes for Water Reuse in High-Strength Wastewaters

Time: 11:10 AM

Chris Roy, ZwitterCo, Woburn, MA

Achieving exceedingly high water recoveries in membrane processes has become increasingly important in establishing environmentally sustainable plant operations and meeting corporate sustainability goals across industries. This paper focuses on a breakthrough, patented zwitterionic membrane chemistry immune to irreversible fouling that has demonstrated its ability to reach ultra-high recoveries in the most difficult-to-treat wastewater and process fluids.

This paper is a follow-up to “Driving High Recoveries in Water Reuse Applications with Novel, Zwitterionic Membranes” (IWC-22-13) presented at IWC 2022, which reviewed the in-field pilot data in dairy wastewater, landfill leachate, and produced water applications. In this paper, the commercial progress of these novel zwitterionic membranes in all three applications is reviewed, including full-scale performance data of the resulting commercial installations and comparison to the previous pilot trials. Additional applications of zwitterionic membranes are also reviewed as the technology continues to expand its impact and what is possible in the membrane treatment space.

Discusser: Victoria Oveson, DuPont Water Solutions, Edina, MN

Tuesday, 11/14/2023; 1:15 - 5:00 PM

T5: Making it Work - ZLD Objectives, Operations, and Optimization

IWC Rep: Ed Greenwood, WSP, Barrie, ON, Canada

Session Chair: Krystal Perez, Brown & Caldwell, Seattle, WA

Discussion Leader: Kirk Ellison, Electric Power Research Institute, Charlote, NC

This session will share knowledge from four zero liquid discharge (ZLD) facilities and the management and treatment strategies used to successfully achieve ZLD objectives. The presentations will share water quality data and process design approaches used at several operating ZLD facilities. We’ll learn how each of these ZLD systems function as the authors share operations and performance data. We’ll also learn about water/wastewater management challenges faced by ZLD facilities and potential ways to optimize through system improvements and resource recovery.

IWC 23-45: Wastewater Reuse and By-Product Recovery at the First ZLD in an India Viscose Plant

Time: 1:25 PM

David Ciszewski, Veolia WTS, Bellevue, WA ; Suresh Kodali, Grasim Industries Limited, Nagda, India; Thentral N, Veolia Water Technologies & Solutions, Bangalore, India; Wing Cho, Veolia Water Technologies & Solutions, Bellevue, WA

Grasim Nagda is the world’s largest producer of spun-dyed specialty fibre located in the Madhya Pradesh region of India. Grasim Nagda was required to install the first ZLD facility in a viscose plant in 2020. The company embarked on the design and implementation of a large multi-step wastewater treatment system to maximize reuse of water and by-product recovery to produce a purified sodium sulfate salt for sale to a nearby industrial facility.

The novel complex process scheme selected includes the following main technologies:
•Lime/soda softening and clarification
•Submerged ultrafiltration (UF)
•Weak acid cation (WAC) ion exchange (IX) softener
•Four stage reverse osmosis (RO) preconcentration
•Mechanical vapor recompression (MVR) falling film evaporation
•Absorption crystallizer
•Multiple effect crystallizers
•Sodium Sulfate Dryer and bagging equipment
•Purge mixed salt ZLD crystallizer

The reuse and recovery plant was commissioned and became operational in 2022. This paper will describe the design of the plant and examine the operation and performance since its start-up. The paper will present recovered water quality data, sodium sulfate product purity data, and process unit interface data.

Discusser: Raquel D. Onsurez, El Paso Electric Company, El Paso, TX

IWC 23-46: Techno -Economic Evaluation to Optimize a ZLD Wastewater Treatment System at A Western US Utility

Time: 2:15 PM

Ren Farmer, AECOM, Portland, OR USA; John Krinks, P.E., AECOM, Columbus, OH

AECOM performed a feasibility study and technoeconomic assessment for optimization upgrades to a zero liquid discharge (ZLD) wastewater treatment system at a combined cycle power utility in the western US. Due to the changes in total dissolved solids (TDS) content of the freshwater makeup, the ZLD system that culminates in a brine concentrator and crystallizer has historically underperformed relative to design. As a result, the utility sends concentrated brine to an emergency evaporation pond. The emergency pond was not intended for regular use and is undersized to handle sustained flow. AECOM is designing and installing a new 38-acre evaporation pond to receive the continuous flow of concentrated brine. The objective of the assessment study was to reduce the volume of concentrated brine requiring disposal as cost effectively and efficiently as possible to extend the life of the new ponds. The cooling water blowdown treatment system consists of the following treatment steps:
•Water softening and clarification
•Multimedia filtration – 3 filters in parallel

•Reverse Osmosis (RO) – 3 RO skids in parallel
•Sea Water Reverse Osmosis – SWRO skid downstream of RO to further concentrate RO reject
•Evaporation – RO reject is concentrated in a thermal evaporator unit
•Crystallization – concentrated brine is crystallized into a solid waste product.
•Dewatering – a centrifuge is used to reduce moisture content of the waste crystals prior to disposal
The evaporator and crystallizer units have historically been unable to process all the RO reject which caused the utility to add a single seawater RO (SWRO) skid to reduce the volume of wastewater discharged to the emergency ponds. Work is currently underway by AECOM to design a 38-acre evaporation pond system for better management of the concentrated wastewater. Included in this effort, AECOM is also identifying the location of future evaporation ponds and providing guidance as to when construction for those additional ponds should be planned. Figure 2 provides the site plan identifying the existing facility, current work and the proposed location of future evaporation ponds.
RESULTS
At the time of this submission, the work is currently in progress. The results will be finalized prior to the presentation and will be discussed at that time. Co-authorship is being sought with the client; if not secured, the presentation will remain anonymous.

Discusser: Brad Berles, Arizona Public Service, Tonopah, AZ

IWC 23-47: Zero Liquid Discharge Evaluation of Pharmaceutical Wastewaters in India

Time: 3:20 PM

George Hollerbach, P.E., BCEE, Geosyntec Consultants, Lyndhurst, NJ USA; Joseph Cleary, P.E., BCEE, Geosyntec Consultants, Lyndhurst, NJ

In 2018 and 2022, Geosyntec Consultants, Inc. (Geosyntec) was retained by a confidential pharmaceutical client to perform an independent review of zero liquid discharge (ZLD) systems at four pharmaceutical manufacturing facilities in in India. Geosyntec worked with a local firm who provided on-site observation and evaluated process data from each facility to document the wastewater flow balance and confirm controls were in place. Geosyntec provided project management, technical support and peer review of the final report.
The overall goal was to document that each facility maintained in-plant source control and wastewater treatment systems in place to minimize or eliminate the release of treated wastewater and any antibiotics to the environment. Objectives consisted of confirmation that the two plants are: designed and operated as ZLD with no treated wastewater discharge to the environment; well maintained and operated with trained and qualified personnel; and adequate redundancy is provided for standby equipment and storage volumes.
The four plants are similar in design. Hydraulic balances are presented. The treatment technologies evaluated for the high total dissolved solids (TDS) wastewater included solids removal, steam stripping, multiple effect evaporator (MEE), agitated thin film dryer (ATFD) and salt collection and disposal. Condensate from the MEE and ATFD are combined with the low TDS streams generated from equipment washing, utility blowdown, etc. Subsequential process units consist of primary and biological treatment, membrane bioreactor polishing and reverse osmosis in series for utility reuse. The paper and presentation will also include other design and operational issues, water chemistry objectives for reuse in utilities and cooling tower makeup, membrane fouling challenges, RO recovery, brine management and disposal alternatives and energy consumption and operational cost. For example, the design of both facilities is based on segregating high strength waste streams / high TDS streams from low strength / low TDS streams to optimize economics. The ZLD facility at all are designed and operated as ZLD with no treated wastewater discharge to the environment. Both plants are well maintained and operated with trained and qualified staff and adequate redundancy is provided for standby equipment and storage volumes. In addition, periodic reviews are completed and ensure proper operation and consistent performance.

Discusser: Malynda Cappelle, Bureau of Reclamation, Alamogordo, NM

IWC 23-48: Using Economic Modeling to Evaluate Recovery of Product Water and Mineral Salts from Brine Streams

Time: 4:10 PM

Tamim Popalzai, Fluor, Sugar Land, TX USA; Craig Bartels, Hydranautics - A Nitto Group Company, Oceanside, Ca; Marta Vanturova, Fluor, Calgary, Alberta, Canada

Sustainable water management is now an essential necessity as water resources are highly stressed across many parts of the world and global water demand is projected to increase by more than 40% by 2030. This water crisis is a risk that can significantly impact a project's financial success based on factors such as availability of water, the quality of water, transport distance of project's water source and reject disposal location, as well as overall water capacity required.

A wholistic water management approach needs to be considered to mitigate the risk of water scarcity. This requires utilizing the most efficient technologies that reduce water consumption, increase recovery, lower energy usage, and minimize costly waste streams. Design strategies incorporating minimum liquid discharge (MLD) or Zero Liquid Discharge (ZLD) are such approaches. Newly developed water technologies such as Brine Concentration Membranes (BCMs) can be used for MLD/ZLD applications which can provide higher water recovery at lower costs and energy consumption.

BCMs are a new type of membrane that can achieve remarkably high brine salinities. BCMs can concentrate softened brines to a range of 100,000 – 250,000 mg/l of dissolved salts (TDS). This in turn translates into a higher water recovery, more product water produced, as well as potential recovery of salts such as sodium chloride which can be sold as product.

A case study will be evaluated on treating SWRO (seawater reverse osmosis) brine and incorporating BCM technology as a part of the treatment strategy to produce extra desalinated water and generate a salt product such as sodium chloride. Both the newly produced desalinated water and mineral salt can be sold as revenue generating product. An economic analysis will be conducted for a 30-year project lifecycle cost (CAPEX/OPEX) to determine the profitability of this brine treatment scheme compared against the base case of not having such a system and just disposing the brine.

By evaluating this case study with brine concentration membrane technology, companies can increase their overall water recovery, reduce their concentrated waste volumes, advance their water sustainability objectives, and develop revenue generating products with potentially positive economic outcomes.

Discusser: Thomas Popple, American Electric Power, Columbus, OH

Tuesday, 11/14/2023; 1:15 - 5:00 PM

T6: What's new with the Cooling Water Trilemma

IWC Rep: Max Brefeld, Toyota Motor North America, Georgetown, KY

Session Chair: Swamy Margan, Halliburton, Conroe, TX

Discussion Leader: Rena Bae, Stantec, Charlotte, NC

Corrosion, Scale and Microbiology pose the fundamental challenges for industrial water consumers. Treatment approaches have evolved over the decades. This session presents 4 papers with current approaches to address today's water treatment challenges – effective corrosion control with the Non-P chemistries, the versatility of Chlorine dioxide to manage microbiology and the modeling on the evolution of scale inhibition.

IWC 23-49: Factors that Influence the Successful Treatment of Cooling Towers with ClO2

Time: 1:25 PM

Greg Simpson, Pureline Treatment Systems, Houston, TX USA

The use of ClO2 to treat cooling towers is well known, having been done since the early 1980s. Generally, the early papers involved systems for which chlorine did not work effectively. Since then, methods of treatment have evolved. Sometimes, the success or failure of treatment depended on the conditions under which treatment was done.
The methodology of treatment, i.e., low level continuous treatment or intermittent treatment at higher dosages depends a great deal on the conditions under which the ClO2 is being applied. The frequency and duration of treatment are other factors which depend on conditions.
In general, there are several major factors that influence the success or failure of a ClO2 program. These include but are not limited to:
1. The potential for leaks of one kind or another and the nature of those leaks
2. The quality of the air being drawn into the tower
3. The quality and consistency of the makeup water
4. Design features of the cooling tower
In this paper each of these factors is discussed and one or more case histories for each are included.

Discusser: Juan Meneses, Nalco Water, an Ecolab Company, Minneapolis, MN

IWC 23-50: The Evolution of Scale Inhibitor Models – An Update

Time: 2:15 PM

Robert Ferguson, French Creek Software, Valley Forge, PA

Papers published in the 1908's and early 1990's delineated correlations for modeling the mimum effective scale inhibitor dosage as a function of water chemistry and critical system parameters. Subsequent correlation models have been expanded to cover additional factors such as inhibitor speciation state and active form, induction time, the presence of an existing scale, and synergy.
The original models included factors to account for:
•Water chemistry in the form of scale indices or more sophisticated saturation ratios
•Temperature as it affects rate, independent of any impact upon scale indices and saturation ratios
•Time in the form of delay in seed crystal formation or growth sufficient to allow a water to pass the through the system of interest.
Many of the earliest models were based upon simple indices such as the Langelier Saturation index, and used polynomials force fits rather than natural models. The evolution of the models to the use of natural models and sophisticated indices based upon free ion concentrations calculated by speciation engines are discussed.
Subsequent models separated dosage the required to interfere with seed crystal formation until a water had passed through system from inhibiting growth on an existing scale or active site. Other parameters included to improve correlations discussed include:
•Inhibitor speciation form and active versus total inhibitor concentration.
•The impact of synergy and antagonism on minimum dosage required to achieve a desired induction time extension.
•Solubility of the inhibitors to prevent overdosing and the inhibitor itself becoming a scale forming specie.
This paper discusses the evolution of the models to the current state of the art, and provides examples of dosage models developed using different levels of correlations as they evolved.

Discusser: Jasbir S. Gill, Ph.D., Water Energy Solutions Inc., Naperville, IL

IWC 23-51: NPDES Compliance and Dechlorination of Cooling Tower Blowdown

Time: 3:20 PM

Andrew Gomes, National Institutes of Health, Bethesda, MD USA; Chris Lyon, National Institutes of Health, Bethesda, MD; Curtis Deng, National Institutes of Health, Bethesda, MD; Abdul Bhuiyan, National Institutes of Health, Bethesda, MD; Victor Torres, National Institutes of Health, Bethesda, MD

The National Pollutant Discharge Elimination System (NPDES) is a regulatory program implemented by the United States Environmental Protection Agency to control water pollution by regulating point source discharges. Cooling towers are commonly used in industrial and commercial facilities to remove heat from processes and equipment. The blowdown from cooling towers contains high levels of total residual chlorine (TRC) originating from oxidizing biocides and their byproducts. TRC can be harmful to aquatic life if discharged into receiving waters. Dechlorination of cooling tower blowdown is therefore necessary to ensure compliance with NPDES regulations.
This paper will review the current regulations governing NPDES compliance for cooling tower blowdown, including discharge limits for chlorine and other pollutants. It will also discuss effectiveness and limitations of various dechlorination techniques used to treat cooling tower blowdown. A comprehensive account of a chemical dechlorination system will be presented based on real time data and improvised dosing mechanism applied to a central utility plant.

Discusser: Rangesh Srinivasan, Ph.D., P.E., Tetra Tech, Houston, TX

IWC 23-52: The use of Definitive Screening Design (DSD) to Understand the Impact of Water Composition, Operating Conditions and Non-Phosphorus Corrosion Inhibitor Dosages on Carbon Steel Corrosion in Circulating Cooling Water Systems

Time: 4:10 PM

Stan Barskov, Halliburton Multi-Chem, ,

The use of Definitive Screening Design (DSD) to understand the impact of water composition, operating conditions and non-phosphorus corrosion inhibitor dosages on carbon steel corrosion in circulating cooling water systems
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Since the 1980s, phosphate-based corrosion inhibitors have been the primary solution to protect carbon steel equipment in circulating cooling water systems. Their low cost and lower toxicity compared to chromate offers excellent effectiveness for a wide range of operating conditions, making them the inhibitor of choice for most industrial water treatment companies. A key drawback of a phosphate-based inhibitor is the requirement to add polymeric dispersants for calcium phosphate scale control, which significantly increases the overall treatment cost. Phosphate discharges also impact the downstream ecosystem by promoting unwanted algae and biological growth. Algae blooms can be harmful to other organisms and disruptive to the surrounding environment and ecosystem. A global phosphate shortage and the increasing cost of phosphate-based corrosion inhibitors continue to stress supply chains, making phosphate-free corrosion inhibitors more attractive to the end user. The global corrosion inhibitor market is anticipated to reach US$ 12.4 billion in 2032, a rise from US$ 8.3 billion in 2022. As a result, industrial manufacturers are seeking more effective, environmentally friendly, and economically sustainable inhibitors that reduce downtime for equipment repair. This paper discusses the development and use of a non-phosphorus corrosion inhibitor and uses Definitive Screening Design (DSD) to better understand the significance of temperature, pH, calcium hardness, magnesium hardness, chlorides and sulfates on the corrosion rate of carbon steel. A model is developed and used to validate inhibitor effectiveness across a wide range of operating conditions and several cooling water makeup compositions.

Discusser: Almadoria Rettinger, Michael Baker International, Pittsburgh, PA

Tuesday, 11/14/2023; 1:15 - 5:00 PM

T7: Heavy Metal; It's not just Hard Rock

IWC Rep: Jonathan Shimko, Michael Baker International, Pittsburgh, PA

Session Chair: Donna Murphy, DuPont, Bend, OR

Discussion Leader: Joe Tamburini, P.E., P.Eng., AWC Solutions, Englewood, CO

While it isn't a Rocky Mountain High, it is still more than A Mile High In the city of Alamosa Colorado where they are preparing for more stringent Arsenic removal. And while we won't be talking about the late great Freddy Mercury, we will be discussing a paper on meeting new compliance limits for Total Mercury in surface runoff. And no, Trace Adkins won't be here singing about Chrome and pink and purple paisleys, but you can groove to some Hex Chrom reductions using Pickle Liquor. And Bob Dylan may be lying by the Juniper in the pale moonlight with his Copper Kettle, but we will be talking about copper (and lead) reduction in potable water and nothing about corn mash.

IWC 23-53: Corrosion Inhibitor Testing in Potable Water Systems

Time: 1:25 PM

John Van Gehuchten, P.E., McKim & Creed, Sewickley, PA USA; Nicole Bartolleta, McKim & Creed Inc., Sewickley, PA

New regulations under the EPA's updated Lead and Copper Rule it is necessary to have a compliance plan in the event that elevated levels of lead or copper are detected in the distribution system. A major part of these compliance plans includes the use corrosion inhibitors in the water to reduce the propensity for the supplied water to dissolve these metals in the distribution system. For this project two chemical additives, zinc orthophosphate and a proprietary chemical, were evaluated on a drinking water system west of Pittsburgh Pennsylvania. The testing included varying pH and additive dose and compared to a control group. The test included immersion testing of pipe samples and included testing from a loop test rig, using harvested lead pipe samples, in order to perform a test reflecting real world conditions. Test rigs were custom designed to allow for a flushing period and a holding period using automated valves and chemical a chemical feed system. Low level metal sampling and analysis was used to determine content after a stagnation period. This paper will review data from both test methods and provide discussion on the sometimes surprising results.

Discusser: Chris Baron, ChemTreat, Newark, DE

IWC 23-54: Removal of Hexavalent Chromium from Existing Steel Mill Heavy Metal Wastewater using Spent Pickle Liquor (SPL)

Time: 2:15 PM

Srikanthreddy Muddasani, Civil & Environmental Consultants, Inc. (CEC), Moon Township, PA USA; David Larson, Civil & Environmental Consultants, Inc. (CEC), Moon Township, PA

A Steel Mill located in Midwest, US generates heavy metal wastewater from Tin Mill Chrome plating and Tin plating process. The heavy metal wastewater is treated onsite in the existing heavy metal treatment plant. The existing heavy metal treatment plant consists of equalization tank followed by inline sulfuric acid addition for pH adjustment, hexavalent chromium reduction tank with sodium bisulfite (SBS) addition, to reduce hexavalent chromium (Cr+6) to tri chromium (Cr+3) and followed by precipitation of tri chromium as chromium hydroxide (Cr(OH)3) via addition of magnesium hydroxide in the neutralization tanks, clarification and sludge dewatering process. The treated effluent is discharged to the river.
One of the major concerns for the Steel Mill is the high operating cost due to sodium bisulfite addition. In order to reduce the operating cost, CEC in collaboration with Steel Mill came up with innovative idea of using the Spent Pickle Liquor (SPL) as an alternative to sodium bisulfite addition in treatment of hexavalent chromium. SPL is the waste byproduct that is generated during pickling process in the Steel mill. SPL contains high concentrations of ferrous chloride (>15%). Currently the SPL is disposed offsite. This is additional disposal cost for the Steel Mill. Using SPL as alternative to SBS will reduce the disposal cost and chemical cost.
Successful bench scale studies were performed to demonstrate SPL is alternative to SBS. Our paper describes the bench scale study, data and operating cost analysis.

Discusser: Jaron Stanley, WesTech Engineering, Salt Lake City, UT

IWC 23-55: Treatment of Surface Runoff Using TMT15® to achieve Parts Per Trillion Levels of Mercury

Time: 3:20 PM

Ramtin Jahani, WSP, Cambridge, ON Canada; Bill Malyk, WSP E&I, Cambridge, Ontario, Canada; Edward Greenwood, WSP, Barrie, Ontario, Canada

In this study, the removal of dissolved mercury from yard drainage was evaluated at a decommissioned chemical plant. The plant already has a drainage containment and treatment system in place. The system involves a collection sump, as well as a pump-and-treat system that is comprised of cartridge filtration, granular activated carbon vessels, and TiO2 based adsorbent media vessels. A newly established effluent compliance limit of 0.026µg/L for total mercury has resulted in the existing system being unable to produce compliant effluent. With this challenge, the objective of this study was to evaluate the treatability of raw water samples with a 15% (by weight) solution of Trimercapto-s-triazine, trisodium salt (TMT 15®) to precipitate the dissolved fraction of mercury, followed by filtration to remove the precipitate formed. A raw water sample was analyzed and found to contain a total mercury concentration of 0.182µg/L. A bench-scale study was completed by conducting jar tests and gravity filtration. Factors such as operating pH and different doses of TMT15® were pre-screened in a series of jar tests. Two doses of TMT15® (0.25 and 1 mL/L) were selected and further studied in additional jar testing. The concentrations of total mercury in the treated samples were compared to that of the raw water sample. For this comparison, several analytical methods were utilized and the results from each analysis were evaluated to successfully establish and validate mass balances. Each of the treated water samples were then filtered through 5-, 1- and 0.45-µm filters, and each filtrate sample was analyzed for total and dissolved mercury. Ultimately, it was determined that treatment with a 1 mL/L dose of TMT15® followed by gravity filtration (0.45µm) resulted in effluent samples containing total mercury concentrations that were well below the required compliance limit. This paper will discuss the results of the testing as well as specific analytical challenges that were faced with the analysis of the mercury and closing the analytical mass balance of the system.

Discusser: Ben Zhang, Ph.D., P.E., Burns & McDonnell, Chicago, IL

IWC 23-56: City of Alamosa Evaluates In-Situ Electrogenerated Ferrous Reagent to Support Arsenic Removal and Replace Bulk Ferric

Time: 4:10 PM

Vladimir Dozortsev, Ph.D., Aqua Metrology Systems, Sunnyvale, CA USA; Roy Sanchez, CWP, City of Alamosa, Alamosa, CO

In drinking water supplies, arsenic (As) poses a threat to human health because it is a known carcinogen. In 2001, the U.S. Environmental Protection Agency (EPA) lowered the federal maximum contaminant level (MCL) for arsenic in drinking water from 50 parts per billion (ppb) to 10 ppb, where it remains today. Currently, the EPA is reviewing its MCL recommendations for arsenic. This has led utilities across the U.S. to prepare for the possibility of a more stringent federal regulation and evaluate the efficacy of their existing As removal treatment systems to remove this trace contaminant.
Since 2008, The City of Alamosa in Colorado has been using an ultrafiltration (UF) membrane filtration treatment system scheme and a ferric dose of 16-19 mg/L to successfully reduce arsenic from an influent value of 35-45 ppb to an effluent below 10 ppb. The City’s drinking water treatment plant has a maximum flow rate capacity of 5.25 million-gallons-per-day (MGD) and obtains source water from 5 wells across the region that is then blended at the facility. Source water contains naturally occurring arsenate and other inorganic contaminants.
While the City’s existing treatment scheme can achieve greater As removal efficiency, it would require additional chemicals and an increased ferric dose of 25-40 mg/L to reduce As to 5 ppb or less. Concerned with having to increase reliance on bulk chemicals to meet a lower As MCL and the associated inherent concerns, the City of Alamosa evaluated a novel technology that generates a ferrous regent in-situ to replace the use of bulk ferric chloride. The technology uses a food grade iron precursor and an in-situ electrolytic generator to create a ferrous reagent onsite and on-demand. The process is simple, effective and sustainable; offering benefits compared to bulk chemicals.
The technology evaluation was completed via bench-scale testing and a subsequent pilot demonstration. The bench-scale test was used to characterize the efficacy of the technology and the coagulation filtration requirements. The demonstration was initiated to show the ability of the technology to provide effective and reliable As removal below the MCL, to quantify the material costs savings provided by this new technology, evaluate the purity of the in-situ generated ferrous reagent compared to bulk ferric chloride and study the impact of both reagents on membrane health.
This paper will present results from the evaluation of the in-situ ferrous reagent generation technology for As removal at the City of Alamosa.

Discusser: Diane Martini, Burns & McDonnell, Chicago, IL, USA

Tuesday, 11/14/2023; 1:15 - 5:00 PM

T8: Texans Take their Boilers Seriously

IWC Rep: Derek Henderson, Duke Energy, Raleigh, NC

Session Chair: Thomas Gurley, ChemTreat, Glen Allen, VA

Discussion Leader: Rebecca D. Osteen, Southern Company, Birmingham, AL

Everything is bigger in Texas and this session is no different! Boilers are at the heart of any process, but come with a wide assortment of problems, side systems, and even unique opportunities. In this session, we will chili up some methods in iron deposition, herd us up some produced water, rassle with deaerators and even woo some steam and condensate systems. So bring your favorite coffee pot and blanket for this fun (and informative) rodeo boiler session.

IWC 23-57: Pressure Deaeration - Alpha to Omega

Time: 1:25 PM

Robert Holloway, Holloway Associates, Toronto, Ontario Canada

The author has been involved with deaerators since 1950 and has been involved in many with problems from a variety of causes. Some were complex issues but many were simple and due to lack of knowledge and understanding of how the unit and process should work. Influencing ancillary equipment and the importance of efficient operation was frequently neglected. The problems were repeated time after time and the lack of knowledge about the units and process repeatedly became troublesome. This document is written to include as much information as possible to help users and operators in the daily operation of scrubber (spray), atomizing and tray units including the major differentials in tray unit designs. It covers detailed descriptions of each type of unit along with illustrations and service limitations of each. The present performance warranty statements, by some manufacturers, cover 90% of design outlet capacity for two types of deaerators. Such statements may be misleading to users. While that performance may be theoretically possible, it relies on problem free operating conditions. So, it is very important that deaerator operators be cognizant of operating problems, big or small, that may cause higher oxygen values. Sources of troubleshooting information are listed. It is hoped that this document will be of assistance, not only in training new operating personnel but also in refreshing and improving the operating knowledge and skills of steam plant operators in steam plants small and large.

Discusser: Emma N. Wolff, P.E., GAI Consultants, Pittsburgh, PA

IWC 23-58: Modeling Software for Predicting Steam System Chemistry in Today's Applications

Time: 2:15 PM

Jacob Tilley, Veolia WTS, Prairieville, TX USA; Robin Wright, Veolia WTS, Tomball, TX, United States; Wah Siong, Veolia WTS, Oakville, Ontario, Canada

Maintaining the reliability of power and other industrial utility steam systems has long been a primary objective for plant operators. Recently, there has been a renewed focus, not just on the reliability of the steam-condensate system, but also on reducing total cost of ownership while ensuring a more sustainable operation. Improving the efficiency of the steam system can reduce water usage, decrease energy consumption, reduce greenhouse gas emissions, provide asset protection, reduce operating costs, and increase overall reliability of the steam producers and consumers.

The desire to accurately model and predict the impact of common feedwater contaminants and of the applied treatment chemistry on the steam plant is nothing new. A proprietary Condensate Modeling System (CMS) software application has been available for many years and has been used in various industries to evaluate, troubleshoot and optimize steam and condensate system operation. The CMS program has evolved and been upgraded with improved input controls, new product databases and added functionalities. These improvements allow the software to be used not only for steam and condensate applications, but also for modeling, designing and optimizing boiler water and feedwater chemical treatment programs. This new version of the CMS program can also assist in troubleshooting during upset conditions, as it allows the user to assess the impact of non-volatile contaminants on boiler water chemistry.

This paper provides several case studies that illustrate how the upgraded CMS software can be used to design, troubleshoot and optimize chemical treatment programs. Overall, the examples show that the software can be an effective tool to help plant operators maintain reliability, reduce costs and environmental footprint, and protect valuable capital assets even when applied outside of conventional condensate applications.

Discusser: Evan Grimm, EPRI, Charlotte, NC

IWC 23-59: A Holistic Approach to Iron Transport Using FFA and its Comparison to Polymeric Iron Transport

Time: 3:20 PM

Dale Stuart, Chemtreat, Glen Allen, VA USA

A well planned boiler system will use high purity feedwater, economizers, and return a high percentage of condensate to minimize energy, water, and wastewater expenses. In these systems, feedwater hardness concentration is significantly decreased while iron concentration increases. The increase in iron comes from two sources: the returning condensate and the economizer. A well-managed condensate system would ensure no air in leakage or process leaks and maintain pH > 8.3. For these systems, the iron in the returning condensate is frequently <10ppb. However in many systems, the condensate systems are large and become difficult to maintain these conditions. Condensate polishers can be installed to help reduce the contamination entering the feedwater; however, condensate polishers are frequently left out of the design or not used when present. Economizers in the feedwater systems are also subject to more corrosive environments due to the increased boiler feedwater purity leading to FAC. The iron entering the boiler from the condensate system and economizer will frequently deposit on evaporator tubes in a watertube boiler on the tubes in a firetube boiler because of the high rate of heat transfer but also have been observed depositing in several other areas causing operation difficulties. The U.S. Department of Energy reports that loss in heat transfer efficiency from 1/32 inch iron scale will cause 3.1% fuel loss or 7.0% fuel loss if silica is mixed into the iron scale. In addition to the loss in energy, the heat can cause tube overheating leading to tube failure and/or under deposit corrosion resulting in unplanned outages and loss production capacity. To avoid this, the application of dispersion polymers to prevent iron deposition is frequently recommended. Recent experience has shown the addition of a filming amine to the polymer program significantly lowers feedwater iron and leads to lower deposition.

Discusser: Aaron Drake, Nalco Water, an Ecolab Company, Naperville, IL

IWC 23-60: Successful use of Produced Water Distillate as Feedwater for High Pressure Drum Boilers

Time: 4:10 PM

Martin Godfrey, ChampionX, Eagan, MN USA; Corbin Ralph, ChampionX, Calgary, AB, Canada; Darrell Gillespie, Strathcona Resources Ltd., Calgary, AB; Kevin Wakulchyk, Strathcona Resources Ltd., Calgary, AB, Canada; Chad Orbeck, Strathcona Resources Ltd., Calgary, AB, Canada

The steam assisted gravity drainage enhanced oil recovery process (SAGD) requires large amounts of high-pressure steam. Virtually all the steam is injected downhole to stimulate oil production so the boilers operate on 100% makeup water with no condensate return. Water separated from the recovered oil, so called produced water, is the source of the boiler feedwater. Produced water contains high concentrations of salt, hardness, alkalinity and silica. Without extensive pretreatment it would be unsuitable for operating high-pressure drum boilers. This paper gives two examples of successful operation of high-pressure drum boilers on produced water that is pretreated by evaporation. Both systems use mechanical vapor recompression evaporators to produce a distillate of sufficient purity for direct application as boiler feedwater. One system uses an all-polymer internal treatment program that has produced clean boilers that operate at a very low corrosion rate. Indeed, we discuss subtle changes in the iron release caused by the use of different burners in otherwise identical boilers that would have been undetectable if the boilers were not operating under such remarkably stable conditions. The second example is a system that operates sophisticated high efficiency boilers and combined cycle electric generation units with 100% produced water distillate feedwater. These boilers use a buffer phosphate internal treatment program that is particularly easy to apply and control because of the consistency of the produced water distillate.

Discusser: Ivan Morales, Nalco Water, an Ecolab Company, Calgary, AB, Canada

Wednesday, 11/15/2023; 8:00 AM - 12:00 PM

W1: High Recovery Reverse Osmosis: Pushing the Boundaries

IWC Rep: Elke Peirtsegaele, ZwitterCo, Carpinteria, CA

Session Chair: Matthew Flannigan, Nalco Water, an Ecolab Company, Chicago, IL

Discussion Leader: Jason Monnell, Ph.D., PMP, Electric Power Research Institute, Charlotte, NC

High Recovery RO represents a promising approach that allows for maximizing efficiency, a reduced water footprint, and addresses the challenges posed by limited water supplies. This session will highlight experts, researchers, and industry leaders who have made significant contributions in the field of High Recovery RO, delving into the latest breakthroughs, cutting-edge techniques, and real-world applications that showcase the immense potential of this evolution in reverse osmosis technology.

IWC 23-61: Cherokee High Recovery Reverse Osmosis TDS Reduction Project

Time: 8:10 AM

Tal Fabian, IDE Technologies, Kadima, Israel Israel; Roi Zaken, IDE Water Technologies, Kadima, Israel, Israel

The Cherokee Metropolitan District (CMD) is located in midland Colorado. The effluent from the local wastewater treatment plant is discharged to a groundwater basin. The effluent needs to meet a TDS of below 400 mg/l. This is achieved by treating part of the water by Reverse Osmosis and combining the permeate with the rest of the stream. Until recently, the CMD's wastewater treatment plant used a traditional secondary process. However, to meet the new discharge limits for TDS, a membrane bioreactor, followed by a Reverse Osmosis (RO), have been added. Since brine management is a critical factor in the RO design, and is currently addressed using evaporation ponds, which have a substantial footprint. It has become evident that high recovery of 90-95% is needed to minimize the volume of produced RO brine.
CMD chose IDE's Pulse Flow Reverse Osmosis (PFRO) technology as the RO process. PFRO is a semi-batch process that implements alternating hydraulic and osmotic conditions that significantly reduce the tendency for scaling and biofouling. The unique design of the PFRO eliminates the need for the 3-4 stages that are typically required to reach such high recoveries. Instead, the technology uses a single stage RO that continuously changes the operation mode from dead-end filtration to brine discharge mode by means of opening and closing a brine valve under certain operating conditions.
PFRO uses a preventive maintenance approach, performing periodic online chemical cleaning. The preventive cleaning mechanism eliminates the need to dose with Chloramine, which is typically required to control biofouling. This makes the process safer since there is no risk of formation of any disinfection by-products – such as N-Nitroso dimethylamine (NDMA) and Tri-halo methane (THM) – that could be discharged into the groundwater basin.
The Cherokee project includes 3 trains (2 operating, 1 standby) with a production capacity of 0.7 MGD each.
Each pressure vessel is equipped with a hybrid Reverse Osmosis – Nanofiltration Configuration – 3 Reverse Osmosis membranes in the lead elements and 4 Nanofiltration membranes in the tail elements. Silica scaling potential is alleviated by passing a portion of the Silica in the last elements into the permeate, thus limiting the Silica concentration in the brine to below 230 ppm. In addition, this membrane configuration optimizes the flux distribution between lead and tail elements, thus saving energy and reducing the risk for fouling.
Results from the first few months of operation will be presented.

Discusser: Tom Imbornone, Avista Technologies, Inc., San Marcos, CA

IWC 23-62: Don't Throw that Brine Away! Desalinate it with OARO

Time: 9:00 AM

Richard Stover, Ph.D., GP Water, Woburn, MA USA; Michael Boyd, Gradiant Corporation, Woburn, MA

Reverse osmosis (RO) is the most widely applied desalination technology around the globe because of its lower cost, lower energy consumption, modularity, ease of operation and, most importantly, its high reliability compared to other desalination methods. However, the application of RO to streams with salinities higher than about 75,000 milligrams per liter (mg/l) total dissolved solids (TDS) has been limited because the high hydraulic pressures required for RO operation at these salinities exceeds the limits of available equipment and membranes.

Osmotically-assisted RO (OARO) processes use pressure to drive purified water across a semi-permeable membrane against the osmotic pressure difference between the feed and permeate streams, similar to conventional RO. However, by elevating salinity on the permeate side of the membranes, OARO processes reduce the osmotic pressure barrier, which lowers the feed pressure required to drive permeate flow from high salinity streams. As a result, ultra-saline feeds can be treated at low enough hydraulic pressures to enable the use of standard RO equipment.

The authors previously presented bench-scale test results, theoretical calculations and full-scale projections for application of OARO to seawater brine, municipal effluent and a number of water sources containing atypical salts. This paper presents process and performance details from a full-scale deployment of OARO for seawater RO (SWRO) brine desalination. Specifically, OARO is being used to produce 352 (gpm) (80 m3/h) of drinking water from SWRO brine with a TDS of over 72,000 mg/l. The OARO system is comprised of one train with a recovery rate of 50%. It produces a permeate stream of less than 300 mg/l TDS and a concentrated brine stream with a TDS of 145,000 mg/L. The project was implemented as a retrofit of an existing but unused SWRO train, utilizing available equipment to minimize cost and accelerate project implementation.

Discusser: Guillermo Delgado, Garver, Greenwood Village, CO

IWC 23-63: Challenges and Opportunities in Ultra-High Pressure Reverse Osmosis Operation

Time: 10:20 AM

Jishan Wu, UCLA, Los Angeles, CA USA; Eric Hoek, UCLA, Los Angeles, CA

Herein, we evaluate the performance (i.e., flux and rejection) of commercially-available, thin film composite brackish water RO (BWRO), seawater RO (SWRO) and high-pressure RO (HPRO) membranes operating at pressures from 14 to 207 bar (200 to 3,000 psi). For each membrane material, we elucidate the impacts of permeate carrier morphology on performance using a porous metal frit and woven tricot mesh materials extracted from commercial HPRO, SWRO, BWRO and tap water RO (TWRO) membrane modules. The water permeability of all tested membranes declines with increasing pressure, whereas rejection behaves differently for different combinations of membrane type and permeate carrier. Cross-sectional SEM and FIB-SEM images confirm permanent reduction of the polysulfone support membrane thickness (38% to 60%) as well as collapse of support membrane skin layer pores – both of which contribute to the observed performance decline. Also, at ultra-high pressures, permeate carrier materials with higher porosity caused greater embossing, and ultimately, coating film damage (defect formation) that leads to increased salt passage (loss of salt rejection). In contrast, the permeate carriers with lower porosity still lost water permeability, but maintained higher rejection. Finally, all of the observed compaction and embossing-related performance decline occur within about 60 minutes after a membrane coupon was exposed to ultra-high pressure. Furthermore, we will present a new RO membrane construction with superb compaction-resistance operating up to 207 bar feed pressure. Cross-sectional SEM confirms less than 10% thickness reduction (compaction) of the membrane. In addition to superior compaction-resistance, the novel RO membrane produces good water permeability and rejections over 99% to NaCl solutions (concentrations up to 200,000 mg/L).

Discusser: Seong Hoon Yoon, Nalco Water, an Ecolab Company, Naperville, IL

IWC 23-64: Process Innovations in Ultra-High-Pressure Reverse Osmosis for ZLD, MLD, and Brine Mining Applications

Time: 11:10 AM

Eli Oklejas, FEDCO, Monroe, MI USA; Lester Burton, FEDCO, Monroe, MI

A new generation of components allowing for ultra-high pressure (>83 bar/1,200 psi) reverse osmosis (RO) has opened up horizons for more affordable and efficient approaches to brine concentration. This paper offers a survey of relevant case studies using this approach, and offers recommendations for process designers looking to improve their brine concentration operations.

The paper first presents a summary of options for ultra-high pressure RO systems. At the core of these systems are specialised RO membranes, pressure vessels, couplings, and hydraulic equipment. We highlight the choice between single-stage and brine-staged RO, and show the relative advantages of relying on centrifugal ERDs in a brine-staged RO system when designing for ultra-high pressure.

We then briefly summarize use cases in which brine-staged RO and/or centrifugal ERDs have been deployed successfully in the field. These applications are as follows:

* Brine mining pilot (Saline Water Conversion Corporation/Desalination Technology & Research Institute, Saudi Arabia)
* Industrial wastewater treatment (Eastern USA)
* Conceptual brine concentration application for mining wastewater (end user & location confidential)
* ZLD for flue gas desulfurization wastewater (Poland)

The wide range of operating conditions encompassed by the above cases highlight the flexibility of brine-staged RO in delivering highly efficient and compact membrane brine concentration.

The paper concludes by highlighting lessons learned from the design and deployment of the above ultra-high pressure RO installations. Crucially, using brine-staged RO allows for a lower pressure first-stage RO array, followed by a higher pressure second stage array. This reduces energy consumption and capital costs, and results in improved plant reliability and safety.

Discusser: Nik Mehta, NX Filtration, Los Angeles, CA

Wednesday, 11/15/2023; 8:00 AM - 12:00 PM

W2: The Coolest Ways to Understand and Treat Your Cooling System

IWC Rep: William Kennedy, P.E., Stantec, Charlotte, NC

Session Chair: Jim Woods, Clearstream Environmental, Inc., Sandy, UT

Discussion Leader: Juan Meneses, Nalco Water, an Ecolab company, Minneapolis, MN

Cooling water systems are critical industrial unit operations. This session is for all designers, engineers and operators who are seeking understanding of corrosion, scale and bio fouling mechanisms and prevention. The papers in this session provide insights and real world experience dealing with these issues to provide enhanced cooling system performance.

IWC 23-65: Novel Yellow Metal Corrosion Inhibitor for Multifunctional (Single Drum) Applications in Cooling Water Treatment

Time: 8:10 AM

Anupam Prakash, Nalco Water, An Ecolab Company, Naperville, IL USA; Jeffery Atkins, Nalco Water, An Ecolab Company, Naperville, IL; Malgorzata Krawczyk, Nalco Water, An Ecolab Company, Naperville, IL; Bingzhi Chen, Nalco Water, An Ecolab Company, Naperville, IL; Craig Myers, Nalco Water, An Ecolab Company, Naperville, IL

Yellow metal corrosion during elevated levels of halogenation (such as to control Legionella Risk) is one of the cost drivers for heat exchangers made from copper or brass metallurgy in water cooled chillers, pharmaceutical and microelectronics industries among many other industries. The current technology of Benzotriazole (BZT) and Tolytriazole (TT) degrade in presence of high halogenation in cooling water, increases the yellow metal corrosion rates and degrade performance of water treatment. In addition, BZT and TT are not environmentally friendly and have higher toxicity at the point of discharge.

Novel Benzimidazole (BMDZ) based chemistry, is a greener, less toxic, a significant better performance on yellow metal corrosion inhibition (even in high halogenated waters) alternative when compared to existing Azole chemistries in identical test environments. This paper summarizes 1) the high-level summary and comparison between commercially available yellow metal inhibitors and BMDZ from featured aspects, such as free chlorine stability, toxicity, and blending, 2) and the Pilot Cooling Tower (PCT) data of the formulated multifunctional products with BMDZ in representative application scenarios. In conclusion, the superior performance of BMDZ chemistry is evident in the PCT experimental studies and is a significant upgrade over existing yellow metal inhibitor technology.

Discusser: Erin Diven, Stantec, West Chester, PA

IWC 23-66: Terminology and Mechanisims of Mineral Scale Formation and Inhibition

Time: 9:00 AM

Jasbir Gill, Ph.D., Water Energy Solutions, Inc., Naperville, IL USA

At the 2022 IWC, in couple of sessions, particularly T6 and W2, the audience was confused about the basic mechanism of crystal growth and mineral precipitation as well its management. Terminology, like cluster formation, seeding, nucleation (homogeneous and heterogenous), crystal formation, transportation of crystals to the heat exchangers and deposit formation is not very clear. Scale inhibitor’s interaction from nucleation to deposit formation, threshold inhibition, crystal morphology and surface charge modifications lacks clarity. Different inhibitor molecules interact differently during the aforesaid steps to manage fouling. Water-borne fouling requires different class of inhibitor molecules than the water-born fouling. Why treatment of silica/ silicates, even though a mineral precipitation is associated with distinctive terminology, unique inhibitors, and special rules. Based on the thermodynamic parameters of the minerals, inhibitor classification is very helpful in managing fouling of the surfaces. The importance of balancing scaling and corrosivity of water based on some modifications to the operating conditions is critical in developing most cost-effective and environmentally safe water treatment program. The paper discussion evolves around providing clarity based on scientific principles and provide insight to selecting right water treatment program.

Discusser: Brad Buecker, Buecker & Associates, Lawrence, KS

IWC 23-67: Field Experiences of Engineered Copper Film (ECP) technologies for Cooling Water Systems

Time: 10:20 AM

Jacob Tilley, Veolia WTS, Tomball, TX USA; Eric Zubovic, Veolia WTS, Trevose, PA; Paul Frail, Veolia WTS, Trevose, PA; Carl Peterson, Veolia WTS, Tomball, TX

Inhibiting corrosion of copper and copper alloys in heat exchangers and minimizing galvanic attack to carbon steel surfaces has long been a focus and a challenge of the water treatment industry. Traditionally, azoles have been the most widely used and accepted form of treatment and have provided acceptable performance for decades on both free copper sequestering and copper corrosion inhibition. However, many of these azoles are not stable in the presence of strong oxidizers, such as sodium hypochlorite, and have always had a challenging environmental profile. The increased pressure of creating more environmentally favorable treatment solutions, in conjunction with recent supply chain constraints on azoles, have led to a unique opportunity for the water treatment industry to identify, qualify and implement improved azole technologies.

This paper presents the field experience of a new copper corrosion inhibition technology that exhibits a lower toxicity profile, is halogen stable and offers equal or better protection levels than traditional azole treatments. The methodology of application and the mechanism by which this new technology prevents corrosion will be discussed and compared to traditional azole filmers. The applications presented will discuss the field results in various cooling environments and the comparison to previous azole technologies in the same environments. It will also discuss the benefits to the end user of favorable environmental impact, performance in the system and economic advantages under inflationary cost constraints.

Discusser: Ryan Ross, Nalco Water, an Ecolab Company, Saint John, New Brunswick, Canada

IWC 23-68: Dual Active Biocide Provides Broad Spectrum Performance in Industrial Water Systems

Time: 11:10 AM

Naresh Kanderi, Italmatch USA, Smyrna, GA ; Matthew Bernhart, Italmatch USA, Smyrna, GA

Objective: Provide the audience with new and improved non-oxidizing biocide options.
Outline:
1.Describe advantages of dual active biocide concept.
2.Present comparative efficacy data versus traditional non-oxidizing biocides.
3.Confirm performance with results under field conditions in actual operating industrial water systems.
Summary:
The uncontrolled growth of microorganisms in industrial water systems can lead to several negative issues including loss of efficiency, enhanced corrosion, and potential health risks. Non-oxidizing biocides play a critical role in controlling microbial growth in industrial water systems. A wide variety of non-oxidizing biocides are available to the water treatment professional however, they are not always effective due to narrow spectrum of biocidal activity, slow speed of kill, or compatibility issues. Obviously, there is a need in the industrial water treatment industry for a non-oxidizing biocide which overcomes the limitations of currently available non-oxidizing biocides. We report here on the combination of two biocidal actives, the potent bactericide 2-bromo-2-nitropropane-1,3-diol (BNPD) and the algicide didecyl dimethyl ammonium chloride, into one product. This combination results in a fast acting, broad spectrum non-oxidizing biocide with excellent compatibility with scale and corrosion inhibitors, and fluorescent tracers. Comparative efficacy studies and field trial data have demonstrated the excellent performance of this biocide combination. The results of these evaluations are discussed, and treatment recommendations are presented.

Discusser: Chris Baron, ChemTreat, Newark, DE

Wednesday, 11/15/2023; 8:00 AM - 12:00 PM

W3: Coal, Residuals, and the Facilities that Love Them

IWC Rep: Scott Quinlan, TetraTech, Pittsburgh, PA

Session Chair: John Van Gehuchten, P.E., McKim & Creed, Sewickley, PA

Discussion Leader: Phil Benson, Geosyntec Consultants, Washington, DC

Coal Combustion Residuals, and the associated waters of, are on ongoing target of regulation and increasing scrutiny in the water community. This session goes through many of the management, treatment, and fate of CCR waters.

IWC 23-69: ELG Revisions – 2015 2020 2023 Edition (NOTE: Author would like to strikethru 2015 and 2020)

Time: 8:10 AM

Bryan D. Hansen, P.E., Burns & McDonnell, Kansas City, MO USA; Doug Randall, Burns & McDonnell, Kansas City, MO; Jason Eichenberger, Burns & McDonnell, Kansas City, MO

The United States Environmental Protection Agency (EPA) issued proposed revisions to the Steam Electric Power Generating Effluent Limitation Guidelines (ELGs) in March 2023. The proposed ELG revisions are applicable to flue gas desulfurization (FGD) wastewater, bottom ash transport water, combustion residual leachate, and legacy wastewaters. In this iteration of the ELG rule, the EPA has created an 'early adopter' subcategory for plants that have achieved compliance with the 2015 or 2020 ELG revisions. The ELG revisions now define the Best Available Technology Economically Achievable (BAT) for both FGD wastewater and bottom ash transport water as Zero Liquid Discharge (ZLD) with a compliance date of 2029. For combustion residual leachate the ELG revisions now define BAT as chemical precipitation with limits for mercury and arsenic, and imposes reporting requirements and new ELG website requirements. EPA urges utilities to secure permits for indirect discharges of leachate through groundwater to nearby surface waters, and report constituent data for such CCR leachate releases.

This paper will discuss these proposed ELG rule changes with comparison to the current 2020 ELG rule requirements. We will dive into the implications of these ELG revisions and provide some insight into navigating these new technical challenges facing power plants for compliance with these ELG revisions.

Discusser: Lindy Johnson, Stantec, Everett, WA

IWC 23-70: Troubleshooting Treatment Failures – Lessons Learned

Time: 9:00 AM

Thomas E. Higgins, Ph.D., P.E., Worley, St. Augustine, FL USA

During my 50 plus year career, I have had the opportunity to investigate numerous instances where treatment systems failed to achieve their treatment objectives. This paper will document the causes of failure and changes to the design that resulted in improved performance and reduced maintenance requirements.

The paper will be based on types of failure, understanding of its underlying cause, immediate fixes, as well as lessons learned for future designs.

Specific failures include poor clarifier performance, failures of filters to achieve solids removal goals, plugging of sludge and chemical feed lines, piping and tank leakage, inability of treatment systems to handle design flows, pump and mixer failures, and failure to meet effluent metals limits.

Causes for these failures include failure to account for chemistry of wastewater and treatment chemicals, lack of adequate pH control, scaling of pipes and filters, materials of construction and materials substitution by contractor, lack of high point venting, mix tank geometry and piping, inappropriate mixing intensity,

Solutions included proper choice of pH control; chemicals and operating pH, selection of sludge and chemical slurry pumps, continuous recirculation and automated flushing of lines, use of dip tubes, selection of type and speed of mixers, revised sequence of chemical addition, Careful materials selection and inspection of contractor, optimizing chemical dosage and pH for metals removal, and optimizing particle growth to enhance clarification and filtration.

Discusser: Daniel Sampson, HDR, Walnut Creek, CA

IWC 23-71: Water Treatment and Performance Implications of US EPA's Affirmation of High Recycle Rate Bottom Ash Transport Systems for Coal-Fired Utilities

Time: 10:20 AM

David Donkin, UCC Environmental, Waukegan, IL USA; Bernie Evans, UCC Environmental, Waukegan, IL

In March of 2023, the United States Environmental Protection Agency (EPA) affirmed that the Best Available Technology for Bottom Ash (BA) Transport Systems in the coal-fired utilities that are wet systems will be High Recycle Rate systems, with no provisions for untreated water purge to discharge. Ostensibly the EPA has signaled a goal of Zero Liquid Discharge for BA transport systems, which will require the industry to operate these systems as closed loop systems.

The operational implications for coal-fired utilities on the revised rule are significant. In any closed loop system, the evolution of the water chemistry, especially with respect to scaling and corrosion tendencies, is now of heightened concern. While a large variety of options exist for the treatment and control of these risks, they have only recently been studied and applied to BA transport systems. Trending analytical data and chemical treatment solutions, as well as augmented water treatment technologies, are being studied and will be discussed for this paper.

Discusser: Dallas Torgersen, WesTech Engineering, Salt Lake City, UT

IWC 23-72: Selenium Removal via Electro-reduction to Meet Increasingly Stringent Regulations: A Case Study for the Power Sector

Time: 11:10 AM

Kresimir Ljubetic, BQE Water, Burnaby, British Columbia Canada; Maryam Mohammadi, BQE Water, Burnaby, British Columbia, Canada; H.C. Liang, BQE Water, Burnaby, British Columbia, Canada; David Kratochvil, BQE Water, Vancouver, British Columbia, Canada

Selenium has drawn increasing attention as a constituent of concern in wastewater across different industries in recent years. Through efforts to treat and remove selenium from wastewater streams to comply with discharge regulations, the impact of selenium speciation on viable removal strategies has become increasingly well understood. For example, selenite (selenium (IV)) can be readily removed through co-precipitation or adsorption using ferric-based coagulants or adsorbents, which are the commonly used reagents in industrial wastewater treatment processes. On the other hand, selenate (selenium (VI)) cannot be easily removed with coagulants or adsorbents. As a result, full-scale wastewater treatment facilities have until recently relied on biological treatment to remove selenate. Since 2019, a new non-biological alternative called Selen-IX™, which combines ion exchange (IX) and electro-reduction to remove selenium as a stable iron-base solid by-product, has been successfully implemented at several full-scale selenate removal facilities in the U.S. and Canada in mine impacted and coal ash pond water treatments. Furthermore, a full-scale combination of nanofiltration and electro-reduction for brine treatment has been recently commissioned to remove selenate and sulfate from mine seepage water.

At coal-fired power plants, the flue-gas desulfurization (FGD) wastewater stream requires treatment to comply with stringent effluent limitation guidelines for selenium. Given its high dissolved solids (TDS) content and high electrical conductance, FGD is a suitable candidate for selenium removal through direct electro-reduction. This paper will present bench scale testing results to assess the feasibility of the direct electro-reduction technology to treat FGD wastewater and the design considerations for full-scale implementation. The effects of current density, feed flowrate, selenium speciation, and process configuration on the removal performance and capital and operational costs will be analyzed. The identified benefits of direct electro-reduction compared to conventional biological treatment which include a lower end-of-pipe selenium concentration (<30 ppb), irrespective of selenium speciation, zero generation of bioavailable organoselenium species, ease of seasonal or intermittent treatment if required, and simple design and operation will also be discussed.

Discusser: Rangesh Srinivasan, Ph.D., P.E., Tetra Tech, Houston, TX

Wednesday, 11/15/2023; 8:00 AM - 12:00 PM

W4: Water and Nutrient Management – Policy to Process

IWC Rep: Tom Lawry, McKim & Creed, Pittsburgh, PA

Session Chair: Diane Martini, Burns & McDonnell, Chicago, IL

Discussion Leader: Paul Brandt, P.E., Burns & McDonnell, Kansas City, MO

As the strains on water resources increase, water management and nutrient control become ever more important. This session will look at water management considerations from a policy perspective, followed by plant level case studies, then look at recent developments in ammonia and nitrogen removal.

IWC 23-73: Navigating Greenhouse Gas Reporting and Other Policy Drivers to Inform Sustainable Water Management

Time: 8:10 AM

Melissa Harclerode, Ph.D., CDM Smith, Edison, NJ USA

Recent policy drivers, such as the Bipartisan Infrastructure Law and America's Water Infrastructure Act, and customer demand have put new stressors on companies to report on and better manage their energy and water use, greenhouse gas emissions, and socioeconomic impact. Trying to address this growing requirement can overwhelm companies with the number of sustainability strategy options and no clear path that makes sense.

A recently formalized SustainAlytics framework addresses this very issue. The framework provides an approach that companies can use to develop planning roadmaps and identify sustainable solutions informed by a baseline assessment of the economic, environmental, and societal elements they need to address. Navigating through the SustainAlytics framework will enable companies to clearly represent the true value of water and/or decarbonization, and promote sustainable investment.

Specifically, the framework enables companies to realize the following:
•Tailored roadmap that guides sustainability strategy
•Return on investment (ROI) showing the full value of water stewardship and carbon-reduction efforts
•Increased stakeholder and decision-maker buy-in
•Improved likelihood of project funding
•Clear baseline for meaningful implementation, measurement, and reporting
•Benefits to the community and society

Several case studies will be featured, including a major steel manufacturer that leveraged the framework to be the first to achieve ResponsibleSteel certification in the United States, an aerospace and defense conglomerate that is focusing sustainability efforts to enhance its water stewardship and measure its carbon footprint, and carbon-reduction roadmaps being developed for transportation infrastructure organizations.

The paper will also delve more deeply into how applying a SustainAlytics framework leads to integrated water management. It will discuss understanding water use at an industrial facility, how sustainability is incorporated in water projects, treatment technologies that achieve water reuse and stewardship, and consideration of risk management. Anonymous project examples will illustrate these integrated water management efforts.

Discusser: Anthony Amendola, Newterra, Burlington, ON, Canada

IWC 23-74: Ammonia Removal using Zeolites: Bench Scale Assessment and Scalability Considerations

Time: 9:00 AM

Kresimir Ljubetic, BQE Water, Burnaby, British Columbia Canada; Link Ding, BQE Water, Vancouver, British Columbia, Canada; H.C. Liang, BQE Water, Burnaby, British Columbia, Canada; David Kratochvil, BQE Water, Vancouver, British Columbia, Canada

Ammonia is a common contaminant in wastewaters in different industries, and it is regulated for discharge into the environment due to its aquatic toxicity as well as its role as a nutrient that can contribute to the eutrophication of water bodies. Contamination sources vary from fertilizers to blasting components in the mining sector. Traditional methods to remove ammonia include breakpoint chlorination and biological treatments, both of which have drawbacks for treating industrial wastewaters. For example, breakpoint chlorination requires high reagent consumption for higher ammonia concentrations and can be difficult to control with varying influent ammonia concentrations. Biological treatment to remove ammonia requires long retention times and is sensitive to changes in process conditions so that variable ammonia concentration and flowrates, as is often the case with industrial wastewaters, makes biological ammonia treatment not ideal. Ion exchange can be a better alternative for ammonia removal for industrial wastewaters, where zeolites that remove ammonia as ammonium (NH_4^+) via an ion exchange process show the advantage of lower costs and market availability and simpler and more reliable operations.

This paper presents a bench scale assessment to understand the feasibility of implementing zeolites to remove ammonia from mine-impacted water. The variables studied were zeolite type, feed flow rate and initial ammonia concentration, regeneration efficiency and regenerant brine treatment. The bench scale results were used to determine the design criteria and scalability considerations of the technology for its full-scale implementation. The identified benefits of implementing zeolites for ammonia removal were the design simplicity, insensitivity to changes in feed flowrate, feed ammonia loading, and water temperature, and ease of operation.

Discusser: Stephen Wheeler, ResinTech, Camden, NJ

IWC 23-75: Best Practices & Lessons Learned for the Operation of Aboveground Storage Tank Facilities

Time: 10:20 AM

Samantha Sheehan, McKim & Creed, Inc., Sewickley, PA USA; John Van Gehuchten, P.E., McKim & Creed, Inc., Sewickley, PA; Nicole Stafford, McKim & Creed, Inc., Sewickley, PA

Aboveground storage tank (AST) facilities are crucial to the successful operation of large water gathering and recycling systems in the oil and gas industry. As a mixture of water quality can enter each facility from many different locations and methods of transport, it is important to design the facility with ease of operation in mind. There are many different coordination procedures and technologies available to increase the efficiency of operation in AS facilities.
This paper will discuss two case studies involving recently constructed oil & gas AST facilities. For each case study, benefits and challenges will be discussed for the design, construction, and operational flow of the facility. A review will be given of the truck loading/unloading processes, pipeline tie-ins, water quality monitoring procedures, condensate management methods, solids settling, and overall coordination procedures for each facility. The paper will also discuss best practices for the design of oil and gas AST facilities determined based on lessons learned from the case studies.

Discusser: Jerry Steinwinder, Brown and Caldwell, Nashville, TN

IWC 23-76: Upgrading of Lagoon Treatment to Meet New Ammonia Limits using MBBR

Time: 11:10 AM

Chandler Johnson, World Water Works, Inc., Oklahoma City, OK USA; Scott Langner, DemKota Beef, Aberdeen, SD

A beef slaughter house wastewater treatment system was outdated using lagoons for meeting only BOD and TSS limits prior to discharging to the local treatment plant which was imposing new effluent ammonia regulations to meet less than 20 mg/L ammonia. Being located in South Dakota, a new biological treatment system with a small footprint and which could handle the harsh winter temperatures was needed. The recommendation was a single-stage closed top MBBR treatment system followed by dissolved air floatation (DAF) for solids separation. MBBR and DAF technologies are ideal in this application, as they are capable of treating a wide range of loadings, operating at wide variety of temps during winter & summer with a consistent effluent quality in a relatively small footprint. The system was started up and within 8 weeks had full BOD removal and nitrification under the effluent limit. This paper will present the design and operation of the new MBBR + DAF treatment system along with progressive design approach by the client to look at meeting lower effluent ammonia and even total nitrogen limits which would allow them to have direct discharge capacity.

Discusser: Anthony Zamarro, P.E., CDM Smith, Boston, MA