The 75th Annual

INTERNATIONAL WATER CONFERENCE®

CONFERENCE PROGRAM GUIDE

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WELCOME TO THE IWC

Colleen M. Layman

On behalf of the Engineers' Society of Western Pennsylvania (ESWP), the IWC Executive Committee, and the IWC Advisory Council, I am proud to welcome you to the 75th Annual International Water Conference® (IWC) and the city of San Antonio. The IWC is the premier source of technical information and training in the industrial water and wastewater business today spanning numerous industrial sectors and addressing today's most relevant technical topics.

2014 is a very big year for the IWC – it is our 75th birthday! In addition to our regular events and sessions, we will be celebrating with special activities throughout the course of the conference. There will be a special anniversary celebration dinner on Monday evening and a few surprises sprinkled throughout the conference. Our opening keynote session will honor the history of the conference as we hear from a panel of IWC conference attendees, both long-time and newer conference goers, relating their most memorable IWC moments and sharing their visions for the future of the IWC. We hope that you will find their tales motivating as well as entertaining and that they will inspire you to remember and share your own conference memories as you continue to make new ones this year.

Our Exhibit Hall showcases the latest advancements in water and wastewater treatment, so be sure to take advantage of this great opportunity to meet with the experts and learn more about what's new in industrial water and wastewater treatment. We have sold out the 2014 Exhibit Hall which was expanded yet again this year to accommodate the growing list of valued exhibitors. A big thanks to all of our exhibitors for their continued support of the IWC. Lunch and other refreshments will be provided throughout the Hall during exhibit hours courtesy of our sponsors, so be sure to grab a bite to eat while you are networking.

The technical program is really the heart of our conference and I am extremely excited about the quality and variety of this year's offerings. Our unique format that includes peer review and prepared discussions for virtually every paper presented reflects our commitment to ensuring that sharing and discussion of technical information is the primary focus of our conference. We hope that each of you will learn something new that helps you advance your career or solve a challenge that you might be facing at your facility. I'd like to thank this year's Technical Program Chairperson, Steve Gagnon, for all of his hard work in coordinating this year's technical program. This is one of the most time consuming positions on the IWC Executive Committee and Steve has done an excellent job in developing the program and coordinating with all of this year's Session Chairs, Discussion Leaders, Authors, and Discussers. Steve and all of the participants in the technical program put in a lot of time and effort to make the IWC one of the best technical conferences and I'd like to thank them all for their willingness to share their time and knowledge of the industry with all of us.

Another area of our conference that continues to grow each year is our Continuing Education Workshop program. This year we are pleased to offer 20 different opportunities for you to earn continuing education credits by attending extended 4-hour training sessions presented by experts in the field covering a wide-range of topics for beginner to experienced level water and wastewater treatment professionals. It is not too late to sign up for one or more of the workshops as registration will continue to be open at the registration desk throughout the course of the conference. Debbie Bloom is this year's conference Workshop Chairperson and responsible for coordinating the workshops. I'd like to thank Debbie, as well as all of our workshop presenters, for enabling us to offer so many and such a wide variety of continuing education options to attendees this year.

A conference of this size does not get put together without the hard work of a lot of people. I want to thank the ESWP staff, Dave Teorsky, Stephanie Mueller, Michael Gaetano, and Cori Stellfox. The success and growth that the conference continues to experience each year is a direct result of all their hard work. I'd also like to recognize our dedicated IWC Executive Committee members for their commitment to making this year's conference a success. Every Executive Committee member is a volunteer and has spent countless hours coordinating sessions, exhibits, workshops, and marketing to make sure the conference runs smoothly. I would also like to thank the Advisory Council companies that offer their support, expertise, and guidance to us to maintain a relevant and interesting program each year. The members of the Advisory Council are also the key conference sponsors and allow us to provide coffee breaks, tote bags, the internet café and other items that contribute to a wonderful conference experience for all of us.

In closing, I am excited to be celebrating the 75th Anniversary of the IWC and honored to be the General Chairperson for this historic occasion. As I reflect on all of the industry-leading experts that have played a role over the last 75 years in shaping this event into the premier technical conference that it is today, I am humbled to be part of such a long-standing tradition in our industry. Some of these experts I have had the honor of getting to know over the years while many others will only remain as a piece of legend to me as I lament not having the opportunity to learn from them personally. I hope that you enjoy this year's conference and cherish your chance to network with and learn from everyone that you meet here. I look forward to talking with many of you during our time in San Antonio and I, and the rest of the IWC Executive Committee, welcome your feedback as we strive to make the next 75 years as incredible as the last. Have a great conference!

Sincerely,
Colleen
Colleen M. Layman, P.E.
HDR, Inc.
General Chair, 75th Annual International Water Conference

EXECUTIVE COMMITTEE

The International Water Conference® is sponsored by the Engineers' Society of Western Pennsylvania, a membership based, not-for-profit organization in Pittsburgh, PA. Members of ESWP create the IWC executive committee, who are top industry leaders. These ladies and gentlemen volunteer their time to help execute the conference year after year. ESWP extends a sincere thank you to the entire committee for their efforts. A special thanks goes to the General Chair, Colleen Layman.

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ABOUT THE IWC

The IWC is the world's premier Conference for understanding and dealing with the technical and business challenges of industrial water treatment. IWC presents the latest in scientific advances and practical applications in this field, cutting across a wide range of industries and functional areas.

As the preeminent international technical forum in the field, the IWC will bring together more than 900 end users, researchers, practicing engineers, managers, educators, suppliers and contractors. It is dedicated to advancing new developments in the treatment, use and reuse of water for industrial and engineering purposes.

The IWC has always been a strong educational conference. Attendees come to learn about the latest applications available in the industrial water treatment industry, educate themselves in current technology and applications through attendance in IWC workshops, and network with their peers' active in water treatment.

WHAT MAKES THE IWC DIFFERENT?

All papers presented at the IWC are carefully peer reviewed for quality and to ensure no commercial aspect is evident. In addition to the broad educational and networking opportunities being offered, the IWC invites you to participate through our unique Prepared Discussion program. Each paper presentation at the conference is followed by a Prepared Discussion – a thoroughly considered, different perspective on the topic. This is followed by an open floor discussion when all audience members and presenters can fully interact - ask questions, seek clarification, and raise alternative viewpoints, in essence – learn more!

CONFERENCE PROCEEDINGS

All registered attendees (except Exhibit Only) will receive a CD containing the Official Conference Proceedings of the 75th Annual International Water Conference®. The CD will be direct mailed to you approximately 2 months following the conference.

CALL FOR PAPERS

To participate in the 2015 International Water Conference® as a presenter, please watch for the opening of the IWC Call for Papers. The Call for Papers is done exclusively on-line through the IWC home page at www.eswp.com/water. For more information on how to become active in the IWC as an Exhibitor, Advisory Council Company, Executive Committee member, please contact Conference Manager, Stephanie Mueller, at 412-261-0170 ext. 13 or by e-mail at s.mueller@eswp.com.

AMERICANS WITH DISABILITIES ACT

The International Water Conference® and the Engineers' Society of Western Pennsylvania support the Americans with Disabilities Act (ADA), which prohibits discrimination against, and promotes public accessibility for, those with disabilities. We ask those requiring specific equipment or services as an attendee to contact the ESWP Conference Department and advise us of any such requirements in advance.

PROFESSIONAL DEVELOPMENT HOURS

Attendees are eligible to earn up to 20 Professional Development Hours (PDH) to satisfy Continuing Education requirements. Official confirmation of your attendance will be provided after the IWC, upon request. The Engineers' Society of Western Pennsylvania, sponsor of the IWC, is recognized as an Approved Provider by the Florida Board of Professional Engineers Bureau of Licensing and the New York State Board of Professional Licenses*. ESWP may grant Professional Development Hours to other states as well. *Special sign-in procedures are required for NY State PDH's

75TH ANNIVERSARY EVENTS

In honor of the 75th Anniversary of the International Water Conference®, all registered attendees will receive a special gift courtesy of the IWC. The gift, a book commemorating the history of the International Water Conference® is a collection of essays written by members of the IWC Executive Committee. We hope you enjoy!

Join us on Sunday evening in the Exhibit Hall to celebrate the 75th Anniversary with a special birthday cake celebration, open to all attendees.

On Monday evening, we have a special commemorative dinner planned to celebrate the 75th Anniversary. The dinner is held at the Marriott Riverwalk Hotel, just across Commerce Street from the Marriott Rivercenter Hotel. The social hour begins at 6:00 pm, with dinner scheduled for 7:00 pm. Advance tickets are required. Check at the IWC Registration Desk for details.

ATTENDEE RECEPTIONS

To help you enjoy your stay in San Antonio during the 2014 IWC, we have many special events and activities planned for you. Join your fellow conference attendees at the annual Get Acquainted Reception, held on Sunday in the Exhibit Hall to welcome you to the Conference. Also, all registered attendees are welcome to attend the Receptions on Monday and Tuesday afternoons in the Exhibit Hall. Luncheon buffets are also provided Monday and Tuesday afternoons in the Exhibit Hall. Schedule time to visit the exhibits and enjoy lunch on us!

If your spouse is accompanying you to the IWC, please properly register him or her at the Registration Desk to gain admittance into these events.

LITERATURE TABLE

Our media partners are instrumental in helping promote the IWC. There is a table filled with literature from these partners as well as information about the area. Please take a moment to stop by and check it out!

SPOUSES' WELCOME BREAKFAST

For spouses who are traveling with conference registrants, the IWC will host a Welcome Breakfast on Monday, November 17 at the Rivercenter Hotel. You will be able to meet and network with other spouses to plan your own agenda of activities. Please complete registration form at the IWC Registration Desk. Advance registration is required.

IWC FUN RUN

Come join us for the 28th Annual IWC Fun Run! This event, sponsored by ResinTech, is open to all runners and walkers attending the conference and T-shirts will be awarded to all participants (limited quantity). Start time & place: Tuesday Morning, November 18 at 7:00 AM Sharp; meet in the Rivercenter Hotel lobby at 6:45 AM. Distance: 3 miles – flat and easy course.

MERCHANDISE

IWC shirts and hats are available for sale! Pre-prints for (most) technical presentations are available at the Registration Desk. Pre-prints can be purchased for $5.00 per copy, or $35 per 1GB flash drive with all the available papers. Also, you can find copies of previous years' IWC Proceedings for $55 per volume.

NAME BADGE IDENTIFICATION

All registered conference attendees are asked to please wear your official IWC name badge at all times. Your official IWC name badge is your passport to the Technical Session, the Exhibit Hall, and International Water Conference® social functions. In addition, important local phone numbers have been printed on the back of your badge for your use. To avoid any confusion with access to the events, please refrain from per-

sonalizing your official IWC name badge with any stickers, ribbons, etc., not provided by the Registration Desk.

Please note that exhibit hall only registrations are only entitled to attend functions in the exhibit hall. They are not permitted to attend technical session or plenary sessions. This will be strictly enforced on site.

If you wish to upgrade your registration to a full-conference or one-day registration, please do so at the registration desk.

REGISTRATION LISTS

There will be a registration list of all those attending the conference available to view at the Registration Desk. A PDF version will also be available on the computer in the WebSpot to view and jump onto a USB.

An electronic version of the Registration List will be available at the Registration Desk the morning of Wednesday, November 19. It provides the names of all registered attendees in both Excel and comma-delimited text formats. There is a $25 fee, please provide a USB drive.

INFO SHARE SUITES

VEOLIA WATER TECHNOLOGIES

Monday, November 17, 7:00 - 8:00 AM, Room: Conference 3/4
Join Veolia Water Technologies for Breakfast at 7 AM on Monday, November 17th, in Conference 3/4 to learn more about our ROSS™ produced water treatment technology that incorporates CeraMem® ceramic membranes. This compact treatment solution provides effective removal of oil & grease, hardness, scale-formers and particulates, enabling water reuse. Space is limited! Reserve your spot by emailing katherine.ardaugh@veolia.com or stop by the Veolia Water Technologies booth #302 on Sunday evening to make your breakfast reservations!

AQUATECH INTERNATIONAL CORPORATION

Monday, November 17, 9:30 PM - Midnight, Room: Conference 17/18
Aquatech will be hosting a "Customer Appreciation Night" in the Conference 17/18 on Monday, November 17 beginning at 9:30 pm until midnight. Join them for an evening that includes poker, blackjack and roulette Casino games along with prizes. You can also enjoy cocktails, appetizers & desserts throughout the evening.

ASME CO-MEETINGS

Executive Subcommittee - Sunday, Nov. 16, 5:15 - 6:45 PM, Room CR 16

Produced Water Task Group - Tuesday, Nov.18, 6:30 - 9:30 PM, Room CR 16

Main and WTC Committee - Wednesday, Nov.19, 1:00 - 5:00 PM, Room CR 16

WTC Subcommittee - Thursday, Nov. 20, 8:00 AM - 12:00 Noon, Riverwalk Travis Room

SOCIAL MEDIA

Keep up on the latest details of the conference by using #IWC14 and follow @EngSocWestPA on Twitter, or like us on Facebook: International Water Conference

FUTURE CONFERENCE DATES

See you next year on November 15-19, 2015 - Hilton in the Walt Disney World Resort®, Orlando, FL

PURE WATER APPLICATIONS USING ELECTRODEIONZATION

Monday, Nov. 17, 8:00 - 11:00 AM; Room: Salon J

IWC Representative: Steve Gagnon, AvanTech, Inc., Columbia, SC

Session Chair: Alan Knapp, Evoqua Water Technology, LLC. , Vancouver, WA

Discussion Leader: Larry Gottlieb, ResinTech, Inc., West Berlin, NJ

8:00 AM **SESSION INTRODUCTION**

Alan Knapp, Evoqua Water Technology, LLC. , Vancouver, WA

The use of Electrodeionzation (EDI) for water purification continues to grow. Environment safety concerns and improvements to the technology have gained an increased acceptance for Industrial applications. The session will review traditional mixed bed ion exchange challenged by EDI technology and power plant water purification.

8:10 AM **IWC 14-01: CONVERSION FROM ION EXCHANGE BEDS TO EDI: PILOT TESTING AND FULL SCALE RESULTS AND LESSONS**

Jeff Tate, Agape Water Solutions, Inc, Harleysville, PA

Electrodeionization (EDI) is the standard method of generating high purity water by polishing reverse osmosis permeate. The technology utilizes electrical current to remove ionic impurities while continuously regenerating cation and anion exchange resins. EDI is utilized in all industries that require higher purity water than RO alone can produce including power, pharmaceutical, electronics, laboratories, automotive manufacturing, bottled water and many other industrial applications.

There are several commercially available products with identical principles of operation, but differing designs, materials, costs and applications. This paper will review the principles of operation electrodeionization and compare the various commercially available technologies.

8:35 AM Discusser: Greg Osen, AVANTech, Inc., Columbia, SC

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-02: QUALIFICATION OF CONTINUOUS ELECTRODEIONIZATION FOR TREATMENT OF STEAM GENERATOR BLOWDOWN IN A PWR**

Jonathan Wood, Evoqua Water Technologies, Lowell, MA, Jeffrey Levy and Natalie Rodgers, Westinghouse Electric Company, Cranberry Township, PA

The use of continuous electrodeionization (CEDI) for the demineralization of steam generator blowdown in a nuclear power plant has been investigated at Seabrook Station (USA) in the mid-nineties, at Laborelec (Belgium) in the late nineties and more recently by Ringhals (Sweden). Since this work showed the CEDI process to offer safety and operating cost advantages over the conventional cation/mixed-bed ion exchange process, Westinghouse decided to evaluate CEDI for use in the AP1000®* pressurized water reactor (PWR) design. A cooperative study was performed with Evoqua Water Technologies (Ionpure) to determine the viability of operating at feed water temperature higher than normally allowed by commercial CEDI devices. Since previous work had looked primarily at removal of ammonia, a second phase of the study investigated the effects of other additives that could be

present in the steam generator blowdown, including morpholine, ethanolamine and methoxypropylamine. Laboratory studies showed CEDI to be capable of handling both the temperature/pressure conditions and the various amines.

9:25 AM Discusser: Tom Kosir, GE Water, Guelph, ON Canada

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:10 AM **IWC 14-03: ADVANCEMENTS IN CEDI FOR POWER APPLICATIONS**

Nicholas Armstrong, Jonathan Wood and Joseph Gifford Evoqua Water Technologies, Lowell, MA

Power plants and other industrial companies around the world are adopting continuous electro-deionization (CEDI) technologies for their deionized water over conventional ion exchange resin systems. This is due to many reasons including elimination of hazardous regeneration chemicals and neutralization systems, more consistent product water quality, smaller footprint, and reduced overall cost of ownership. However, in many critical applications, such as for high pressure boiler feedwater, the product water quality specifications can be quite stringent, sometimes requiring extensive pretreatment such as two-pass reverse osmosis (RO). Recent innovations in CEDI technology have allowed for simpler system designs by providing higher flow modules and modules tailored to different feed water qualities and different product water specifications. For example, recently high performance CEDI modules have been made commercially available which target removal of trace ions to the very low levels required. Additionally, other CEDI units have been commercialized that can treat more challenging feedwaters with only a single pass RO as pretreatment. We will discuss some of these new CEDI technologies and their impact on system reliability in critical applications.

10:35 AM Discusser: Venkat Jagannathan, QUA Group, LLC, Canonsburg, PA

10:45 AM Floor Discussion & Closure

11:00 AM Conclusion

WATER REUSE

Monday, Nov. 17, 8:00 - 11:00 AM; Room: Salon I

IWC Representative: Robert Applegate, Graver Water Systems, LLC, New Providence, NJ

Session Chair: William Willersdorf, Veolia Water Solutions & Technologies, Moon Twp., PA

Discussion Leader: Andrew Erickson, Burns and McDonnell, Kansas City, MO

8:00 AM **SESSION INTRODUCTION**

William Willersdorf, Veolia Water Solutions & Technologies, Moon Twp., PA

Reclaim water use in industry is critical in securing a viable environmental future. This session includes industry champions who will use actual experiences and case studies in describing solutions to unforeseen challenges. They will be using actual data, water balance modeling and experiences to implement operational strategies when describing lessons learned. Reclaim water from POTW's along with other sources of water will be reviewed as alternate sources to fresh water in

the Power generation industry. Reclaim use and its concentration in the plant also affects wastewater discharge from both a regulatory aspect and discharge location. Come and give us your hands-on experiences, in our discussion following each paper.

8:10 AM **IWC 14-04: RECYCLED WATER: THE GROWING TREND IN POWER PLANT WATER SUPPLY**

Josh Prusakiewicz, HDR, Inc., Ann Arbor, Michigan

In many areas, power producers are replacing fresh water supply sources with impaired or alternative water sources for cooling systems, and even for other uses in the plant such as feed water to the plant demineralization system. Limited availability of fresh water supplies and societal pressures to conserve are promoting the use of treated municipal wastewaters as common practice for power plants in a growing number of areas. The use of recycled water sources presents a unique set of challenges for power plant designers and operators that are normally not experienced when utilizing more traditional makeup water supplies. Recycled waters may contain unique water quality constituents that are not typically parameters of concern in fresh water supplies necessitating a different approach to selecting water treatment equipment and chemical treatment programs. State and local regulations must also be investigated and understood when considering the use of recycled water sources. This paper will explore the design considerations that must be addressed by a power plant designer or operator when considering the use of recycled water as power plant makeup and it will also discuss how the use of a recycled water supply can impact the selection of a plant wastewater discharge location. It will discuss critical water quality parameters that are frequently encountered in planning for usage of recycled waters, how these parameters can impact the ability to discharge or dispose of recycled waters, and the challenges (both economic and technical) in treating to remove or reduce contaminants. The paper will also discuss practical case study experiences of designing for and implementing recycled water supply and determining wastewater disposal options at power generating facilities.

8:35 AM Discusser: Kenneth Chen, Fluor, Aliso Viejo, CA

8:45 AM Floor Discussion & Closure:

9:00 AM **IWC 14-05: EVALUATION OF RECLAIM WATER FROM A POTW FOR PROCESS WATER SUPPLY AT A 49 MW MERCHANT POWER PLANT**

Daniel Wilkinson and S. Ehrhardt, Dewberry Engineers Inc., Raleigh, NC

Dewberry evaluated and designed a project to reclaim effluent from a POTW for utility water supply to a new merchant 49-MW power plant (2013 start-up). A cornerstone of the project is reuse of reclaimed effluent for 100% process water supply in combination with power plant wastewater discharge to the POTW. The POTW-power plant becomes a recycle loop, whereby inert component concentrations cycle-up until steady state is reached. Literature reports one instance using this configuration where the power plant cooling towers were limited to two cycles of concentration (designed for seven). Our analysis showed that the limiting water quality criteria is the cooling tower standards for TDS, chlorides, and sulfate, rather than POTW microbial inhibition, or POTW effluent quality. However, only 60% utility water supply could

be achieved at four cycles of concentration. And only 25% water supply could be achieved at seven cycles of concentration. To compensate for the water supply deficit, alternative water sources were evaluated. A unique alternative was selected to achieve 100% utility water supply, whereby raw river water entering a municipal water plant intake pump station is diverted into the sanitary sewer thereby reducing the TDS, chloride, and sulfate concentrations of the POTW effluent. This approach reduces the power plant water management life cycle costs and helped facilitate construction of this project. This project demonstrates appropriate due diligence essential to protect WWTP operations, water quality, and expectations of the reclaim user.

9:25 AM Discusser: Michael Reyes, Veolia, Charlotte, NC

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:10 AM **IWC 14-06: AN UPDATED WATER BALANCE: THE KEY TO IDENTIFYING COMPLIANCE OPTIONS**

Karen Burchardt, P.E., Samantha Tewell, Olivia Dawson-Olson Burns & McDonnell, Kansas City, MO, and Maggie Skelton, P.E., Minnesota Power, Cohasset, MO

In an effort to comply with future NPDES permit requirements, Effluent Guidelines, and Coal Combustion Residuals (CCR) regulations, many power plants are currently undergoing efforts to understand their current water usage. The ultimate goal is to reduce overall water usage, reuse waste water where possible, and eliminate waste water discharges. The first step in identifying options for complying with future wastewater discharge limitations is updating a plant's water balance.

A plant water system may already have permanent flowmeters installed to measure water flow at various points is the system. However, the flowmeters may have been removed, may be out of calibration, or may not be operating properly, leaving gaps in the flow measurements. In addition, there may be other streams that do not have flow monitoring making it difficult to assess the current state of the overall plant water balance.

This paper discusses the use of portable flow monitors to collect data and update water balances at power plants. Specific examples from the update of the water balance at Minnesota Power's Clay Boswell Energy Center (BEC) will be discussed. The lessons learned from experience at BEC will be shared, including guidelines for installing ports for the flow monitors, how long it takes to measure flow from a single port, and problems that can occur. A comparison of data collected with a portable flowmeter to data from the plant data historian will be presented.

10:35 AM Discusser: Sean Sudol, Richard Brady and Associates, Greenville, SC

10:45 AM Floor Discussion & Conclusion

11:00 AM Conclusion

PRODUCED WATER TREATMENT

Monday, Nov. 17, 8:00 - 11:00 AM; Room: Salon K/L

IWC Representative: Michael Sheedy, P.Eng. Eco-Tec Inc., Pickering, ON Canada

Session Chair: Rafique Janjua, Fluor Enterprises, Inc., Sugerland, TX

Discussion Leader: William Tuck, P. Eng., Anderson Water Systems, Inc., Ancaster, ON Canada

8:00 AM **SESSION INTRODUCTION**

Rafique Janjua, Fluor Enterprises, Inc., Sugerland, TX

Every oil producing/Hydraulic fracturing for Oil & Gas production facility have an undesirable end product, called produced water. Depending upon the formation and production methods used to extract these products i.e., steam flooding or water flooding, we can expect produced water with different composition consisting of oil & grease, dissolved solids, heavy metals and silica. Depending upon the end use and other Regulatory mandated disposal requirements, produced water treatment can be a technical and capital intensive task. In this session, we have three excellent technical papers in which the authors will share their innovative technical skills and methodology on how best to treat and manage the produced water for optimum usage and disposal.

8:10 AM **IWC 14-07 BORON REMOVAL FROM PRODUCED WATER**

H. Robert Goltz, Ph.D., Chris Eicher and Tom McCandless, The Dow Company, Midland, MI

Boron is an ongoing issue in the recycle of produced water and some brine waters because it causes premature gelling of frac fluids used for "gel" frac operations. Boron causes polysaccharides (guar, etc.) to cross link when placing the proppant. If boron is present in source water, the fluid can gel and cause operational problems. While there are several options available for boron removal, boron selective ion exchange resins are preferred because they achieve removal to < 5 ppm B, can be regenerated for reuse and can produce reasonable volumes of water. This paper will present data on field experience with boron removal from produced water.

8:35 AM Discusser: William Moore, Westech, Inc., Humble, TX

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-08: AUTOMATED SELF-CLEANING FILTER FOR ULTA-HIGH AND VARIABLE SUSPENDED SOLIDS LOADING**

David Levitt, Spiral Water Technologies, San Rafael, CA

A significant segment of industrial filtration applications suffer from high and variable suspended solids loading, but existing automatic, self-cleaning filters handle only low solids loading applications. High solids applications are relegated to using disposable bag and cartridge filters which are manually replaced as often as once per hour. Spiral Water Technologies has developed a new automatic filtration technology that handles high solids loading, with low water loss, low power and a small footprint. The technology consists of a metal filter membrane and a spiral-shaped wiper which continuously cleans the membrane without downtime. Influent concentrations can be as high

as 10,000 mg/l of suspended solids. Filtration levels can range from 10 to 100 microns. Filter units can be used individually or combined in parallel to achieve higher flow rates. A test site was established in the North Dakota Bakken Oil Field to demonstrate advanced remediation of produced water with high solids content. The test took place at a saltwater disposal well in August 2013. Approximately 200 barrels of produced water were filtered at 25 microns and pumped into a disposal well. Samples analysis indicated influent Total Suspended Solids (TSS) as high as 1,040 mg/l and filtrate TSS of 321 mg/l. This represented a 69% reduction in TSS, and demonstrated the potential for this new technology.

9:25 AM Discusser: Vina Arjomandnia, Fluor, Houston, TX

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:10 AM **IWC 14-09: HOW TO ASSESS, SELECT AND DEVELOP YOUR OPTIMAL WATER MANAGEMENT SYSTEM**

Howard McCarthy, P.E., Tetra Tech, Denver, CO

Assessing, selecting, and developing the optimal produced water management system requires consideration of many factors regardless of the size of the project. Proper planning and Front End Engineering Design (FEED) is key to ultimately developing a water management system that is fit-for-purpose and best meets your needs. Factors including technical, economical, commercial, operational, political, health, safety, and environment must be considered during the Planning and FEED phases of the project. Due diligence during these stages will result in a project that meets or exceeds yours and the stakeholders expectations.

10:35 AM Discusser: William Tuck, Anderson Water Systems, Inc., Ancaster, ON Canada

10:45 AM Floor Discussion & Closure:

11:00 AM Conclusion

POWER PLANT STEAM CYCLE CHEMISTRY: DETECTION AND MITIGATION OF CONTAMINANTS

Monday, Nov. 17, 8:00 - 11:00 AM; Room: Salon M

IWC Representative: Wayne Bernahl, W. Bernahl Enterprises Ltd., Elmhurst, IL

Session Chair: Lauren Versagli, DOW Chemical, Philadelphia, PA

Discussion Leader: Vickie Olson, Honeywell, Atlanta, GA

8:00 AM **SESSION INTRODUCTION**

Lauren Versagli, DOW Chemical, Philadelphia, PA

Protecting plant equipment in the make-up water and water steam cycle are of critical importance to maintain power plant performance. The session focuses on analytical detection and monitoring of organic and inorganic contaminants to prevent fouling and flow accelerated corrosion (FAC) in these systems and also includes a paper on investigating ways to remove phosphate from these water systems.

8:10 AM **IWC 14-10: FURTHER ADVANCES IN MONITORING LOW LEVEL IRON IN THE STEAM CYCLE**

Kenneth Kuruc, Denton Slovacek and Luke Johnson, Hach, Loveland, CO

In an earlier paper, it was discussed how a laser Nephelometer could be used to detect the transfer of corrosion products in a HRSG power plant at ppb levels with particles in the sub-micron size range. Also, a modified trace level iron test was documented using colorimetric methods on a lab spectrophotometer to measure total iron levels to 1ppb.

In this paper, further advances will be outlined which improve the accuracy and repeatability of the lab method, while providing further insight into the level of protection being provided to steam cycle components against FAC and other corrosion mechanisms. Focus will be in understanding the chemistry of the measurement so as to provide more specific data to plant personnel regarding the level and species of iron being observed.

8:35 AM Discusser: Randy Turner, Swan Analytical USA, Inc., Wheeling, IL

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-11: PHOSPHATE REMOVAL FROM BOILER & HRSG BLOWDOWN**

Michael Rosen, Sargent & Lundy, L.L.C., Chicago, IL

Adding phosphate for boiler water chemistry control is a common practice in the utility industry. Phosphate used for this purpose will typically be present in the blowdown in the low part per million range. To date, there do not appear to be any power plants that are required to treat blowdown for phosphate removal. However, enforcement of existing regulations and promulgation of new regulations throughout the world may require removal of phosphate from blowdown in the future. The purpose of the current paper is to present several preliminary concepts for treatment systems that the author believes would be feasible in this application.

9:25 AM Discusser: Chad McKnight, Southern Company Water Chemistry, Birmingham, AL

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:10 AM **IWC 14-12:RELIABLE ORGANICS DETECTION HELPS PROTECT POWER PLANT COMPONENTS**

David Gray, Peggy Banarhall, Kirk Buecher, and Steven Carelli, Mettler Toledo Thornton, Inc., Billerica, MA

Organic contamination is increasingly recognized as a contributor to ion exchange resin fouling and corrosion in power plants. To guard against these kinds of losses, the first step is to obtain consistent detection of organics. Presented here is guidance for the use of an especially applicable technology for continuous low level total organic carbon measurement in power plant waters. Appropriate sample handling and conditioning enable long term measurements to be made with minimal oversight.

10:35 AM Discusser: Vance Lummer, GE Power and Water, Portland, TX

10:45 AM Floor Discussion & Closure

11:00 AM Conclusion

KEYNOTE SESSION

Monday, Nov. 17, 11:00 AM - 12:00 Noon; Salon K/L/M

SESSION INTRODUCTION

Colleen Layman, HDR, Inc., Hapers Ferry, WV

The Keynote Session will will celebrate the 75th Anniversary of the International Water Conference by telling the story of the 75 year history of the Conference, reminiscing about the panelists experiences at the IWC and sharing views of the future of the IWC. The panel will be led by Executive Committee member John Lucey. Panelists will include Conference veterans Paul Puckorius and Ray Post and rising stars Melanie Myszczyszyn and Tom Lawry.

2014 AWARDS OF DISTINCTION

The Annual Awards are presented to celebrate the following achievements in the water treatment industry.

Annual Merit Award: Each year, the International Water Conference® presents the Annual Merit Award to honor outstanding individuals in the field of industrial water technology. This year's Merit Award Winner is Dennis McBride, Fluor, Greenville, SC.

Paul Cohen Award: As a memorial to Paul Cohen and his contributions to the power generation industry, the IWC is proud to recognize the authors of the most precise and innovative presentation in the field of power systems water technology that was presented at the 74th Annual International Water Conference®. This year, we honor David Moed, Delft University of Technology, Delft, Netherlands for his presentatoin of Paper IWC 13-75 "The Influence of System Parameters on TOC Degradation.

Joseph A. Levendusky Scholarship: This year, Epicor Inc. donated $3,000 to one scholarship recipient, Morgan DiCarlo, Stony Brook University, Thiells, NY who is striving to continue her education in water engineering.

DESIGN AND OPERATION OF ZERO LIQUID DISCHARGE SYSTEMS

Monday, Nov. 17, 1:15 - 5:00 PM; Room: Salon M

IWC Representative: Brad Wolf, P.E., Berkeley Research Group, LLC, Pittsburgh, PA

Session Chair: Raymond Post, P.E., ChemTreat, Inc., Langhorne, PA

Discussion Leader: David Ciszewski, GE Water and Process Technologies, Bellevue, WA

1:15 PM **SESSION INTRODUCTION: RAYMOND POST, P.E., CHEMTREAT, INC., LANGHORNE, PA**

Zero Liquid Discharge (ZLD) represents the ultimate in water utilization efficiency and responsiveness to environmental discharge concerns. In some configurations, this powerful technology is capable of recovering nearly every drop of water entering the site while freeing the owner from variable and increasingly stringent discharge requirements.

ZLD selection and configuration depend on numerous factors including fuel source, water chemistry, climate, environmental requirements, CapEx, and OpEx. The papers in this session will help you navigate through the many ZLD strategies, select the most appropriate ZLD system for your site, and share valuable ZLD operating experience.

1:25 PM **IWC 14-13: EVALUATING ZLD STRATEGIES**

William Shaw, P.E., Veolia Water North America, Plainfield, IL

Although physical, chemical, and biological treatment methods have adequately served industrial users for many years, they may not be enough to reduce wastewater concentrations of certain constituents, such as heavy metals and certain nitrates or ammonia compounds, to levels often now required. For example, FGD purge water can contain levels of mercury in the parts-per-million (ppm) range. A well designed and operated physical/chemical/biological wastewater treatment system can typically bring that down to parts-per-billion (ppb) levels. However, when a facility is required to meet permit levels of mercury in the parts-per-trillion (ppt) range (which is becoming increasingly common), these conventional systems become no longer adequate. As discharge requirements become more stringent, it is advisable to consider reducing or eliminating all discharges using membrane and thermal processes.

While membrane-based technologies are often used to recover water in recycle/re-use and ZLD schemes, membrane-based technologies are generally limited to treatment of dilute wastewater streams with low TSS. Evaporation and crystallization can, in theory, completely separate all dissolved species (benign, hazardous, or toxic) from the water, producing a stable solid that can be disposed of in a landfill. However, high energy consumption and capital cost are associated with conventional thermal processes. Both membrane and thermal processes are subject to scaling and fouling from chemical and biological species present in the wastewater. Hybrid ZLD systems utilizing membranes and thermal components with appropriate physical, chemical, and/or biological pre-treatment processes to mitigate scaling and fouling are becoming the norm. New technologies including membrane distillation, forward osmosis, and cold crystallization hold promise to improve

recovery, reduce energy consumption, and lower costs.

This paper will describe the limitations of conventional reduced- and zero liquid discharge systems, some new applications for ZLD systems and likely improvements on the horizon based on emerging technologies.

1:45 PM Discusser: Chris Haussmann, P.E., Water Systems Specialists, Inc., Seattle, WA

2:00 PM Floor Discussion & Closure:

2:15 PM IWC 14-14: DESIGN ISSUES FOR A ZERO LIQUID EFFLUENT DISCHARGE (ZLED) WASTEWATER TREATMENT SYSTEM FOR A 6X800 MW WFGD RETROFIT PROJECT

Steve Russell, Black & Veatch, Overland Park, KS, Robert M. Craig Jr., Renisha Lutchminarain, and Abigail Melanie, Eskom, Johannesburg, South Africa

Wet Flue Gas Desulfurization (WFGD) wastewater is fairly difficult to treat as part of a Zero Liquid Effluent Discharge (ZLED) configuration. Uncertainties during the initial phases of design have to be overcome to properly scope out the requirements of the system and integrate it properly with the WFGD and other plant systems. This paper focuses on the early design phase approach to integrate the ZLED wastewater treatment into the design for a 6x800 MW WFGD retrofit project.

The project utilized physical/chemical pretreatment of the wastewater followed by brine concentrators and crystallizers to achieve zero liquid effluent discharge. WFGD operational data was not available since the WFGD retrofit project is occurring simultaneously with the ZLED wastewater treatment project. This report discusses how this issue was mitigated to properly integrate the design between pretreatment and ZLED systems, establish the equipment layout, wastewater and solid byproducts characterization, recovered water purity characterization, recycling options, and selection of the treatment configuration. Some of the unique challenges to this application included treatment of multiple plant waste streams with varying quality, limited upstream storage capacity, high system turndown and limited maintenance opportunities.

2:40 PM Discusser: Jack Lyons, OUC, Orlando, FL

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM IWC 14-15:WATER RECOVERY AND REUSE AT THE PUEBLO CHEMICAL AGENT-DESTRUCTION PLANT (PCAPP)

Yakup Nurdogan, Ph.D., P.E., Bechtel National, Inc., Pueblo, CO, Paul J. Usinowicz, Ph.D., P.E., B.C.E.E., Craig A. Myler, Ph.D., Bechtel National, Inc. Frederick, MD,George D. Lecakes, Battelle, Pueblo, CO, August Benz, P.E., Bechtel National, Inc., San Francisco, CA

Bechtel/URS/Battelle/Parsons team was awarded a contract to safely and efficiently destroy the stockpile of chemical weapons currently stored at the Pueblo Chemical Depot in Colorado. The scope of work includes designing, constructing, systemizing, pilot testing, operating, and closing a chemical agent-destruction plant (Plant). The Plant is expected to start operation in 2015. Southern Colorado is semi-arid, and the State encourages conservation through recycling water and minimizing water usage to the extent practicable. The permitted ca-

pacity of the wells supplying water to the Plant is 218,800 gallons per day (gpd). Water usage above the permitted level must come from additional sources, with none nearby. The Plant has constructed a zero-liquid discharge (ZLD) system to recover the water from the biotreated hydrolysate. The ZLD system includes an evaporator, crystallizer, and dewatering system to remove dissolved and suspended solids from biotreated effluent. The Resource Conservation and Recovery Act (RCRA) permit requires that the recovered water (distillate) quality complies with the National Primary Drinking Water Standards. Therefore, the distillate is treated by activated carbon adsorbers. At the design flow rate, the ZLD system will recover approximately 173,000 gpd of biotreated hydrolysate water, eliminating the need for process makeup water. Recovered water is recycled to the biotreatment system, cooling towers,reverse osmosis units, offgas treatment system scrubber, and agent hydrolysers. This paper will describe challenges of water management at the Plant, water usages by different process units, variations in water usage in summer versus winter,and processes used to recover water.

3:45 PM Discusser: Mike Preston, P.E., Black & Veatch Corporation, Overland Park, KS

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-16: THERMAL ZLD SYSTEM USING A SPRAY DRY EVAPORATOR (SDE) IN A WASTE TO ENERGY PLANT, A CASE STUDY**

Ashwin Patni, Lechler Inc., St Charles, IL

A thermal ZLD process can treat wastewater in an evaporator by slowly evaporating water in single or multiple steps in a very complex process. An alternative method uses a Spray Dry Evaporator (SDE), which evaporates this wastewater in a hot flue gas stream.

A Waste to Energy (WTE) plant, located in Germany had difficulty maintaining normal operation of their wastewater treatment plant. The additional hours of maintenance and unplanned expenses prompted them to search for an alternative solution, so their wastewater could be treated. After evaluating several technologies, they decided to consider installing a SDE. Upon completion of the SDE, they decommissioned their entire wastewater treatment plant.

SDE's do not require multiple process steps like a concentrator or crystallizer would. In the SDE process, wastewater salts aredirectly dried into solids after evaporation and are subsequently captured in a particulate control device. There are several advantages when using this process including: reducing capital costs, control simplicity, limited requirements for hardware, minimal real estate, very low operator oversight, and no exotic alloys are required.

This paper discusses in detail the important design parameters that are used to convert a traditional wastewater evaporator into a reliable spray dry evaporator (SDE) system.

4:35 PM Discusser: Dan Sampson, WorleyParsons, Sacarmento, CA

4:45 PM Floor Discussion & Closure

5:00 PM Conclusion

UPDATES AND INNOVATION IN MINE WATER TREATMENT

Monday, Nov. 17, 1:15 - 5:00 PM; Room: Salon J

IWC Representative: George Abrahim, P.E., Veolia Water Solutions & Technologies, Moon Twp., PA

Session Chair: Paul Pigeon, Golder Associates Inc., Lakewood, CO

Discussion Leader: James Woods, WesTech Engineering, Inc., Salt Lake City, UT

1:15 PM **SESSION INTRODUCTION:**

Paul Pigeon, Golder Associates Inc., Lakewood, CO

Mine water treatment in the United States is driven by Federal and State water quality protection programs, requiring high efficiency removals of metals prior to discharge of water that has come into contact with ore and wastes or that has been dewatered from mineral-bearing zones in the mine workings. The 2014 IWC mining session will explore the performance of two biological treatment technologies for selenium removal, including fluidized and packed bed treatment, in achieving low effluent concentrations. Attendees will be able to compare and contrast the merits of each technology for future applications. In addition, two innovations in metals treatment processes will be presented that hold promise as viable alternatives to standard lime treatment for heavy metals removal. This session will provide food for thought when planning new mine water treatment plants or existing plant upgrades.

1:25 PM **IWC 14-17: OPTIMIZATION OF A HIGH DENSITY SLUDGE MINE DRAINAGE TREATMENT FACILITY**

Brent Means, U.S. Office of Surface Mining Reclamation Enforcement, Harrisburg, PA and Rich Beam Pennsylvania Department of Environmental Protection, Harrisburg, PA

Subsequent to the 2001 bankruptcy of Barnes and Tucker Coal Company (B&T), the Pennsylvania Department of Environmental Protection (PA DEP) attained, through litigation, assets to continue treatment of the Lancashire No. 15 Underground Mine Complex in Cambria County, PA. In order to enhance long-term sustainability, a new relocated treatment facility was constructed and placed in operation in November 2011. This new facility treats an average of seven million gallons per day (MGD) of ferruginous net alkaline drainage.

The treatment process at the new facility consisted of a decarbonation step followed by hydrated lime application, including a high-density sludge recirculation process, polymer addition and solids settling through a clarifier. Treatment optimization evaluations documented the consumption of 3.5 tons of hydrated lime per day ($566/day) under average flow conditions.

Decarbonation removed 34% of CO2(aq) but remaining CO2(aq) consumed 35.3% of the daily hydrate dose. Calcite formation during pH adjustment accounted for 29.2% of the daily hydrate and ferrous iron, the sole targeted contaminate, consumed 35.4%. The evaluation recommended switching reagent to hydrogen peroxide, to avoid pH adjustment and subsequent nuisance consumption, to solely target ferrous iron.

A six-month trial using 50% hydrogen peroxide was conducted. Flow rate, sludge recirculation, and polymer dose were varied to optimize

treatment. Peroxide reduced daily chemical costs by $245 compared to hydrate while improving effluent quality.

The total daily savings of $329 was realized over hydrated lime when reductions in sludge disposal, maintenance, and energy costs were considered. A permanent hydrogen peroxide system was installed in 2014.

1:45 PM Discusser: Rick Szilagyi, WesTech Engineering, Inc., Rockton, IL

2:00 PM Floor Discussion & Closure

2:15 PM IWC 14-18: NEW TECHNIQUES TO REDUCE LONG-TERM OPERATING COSTS OF BIOLOGICAL SYSTEMS REMOVING OXYANIONS IN WATER TREATMENT OPERATIONS

David Enegess, Andy Bohner, Todd Webster, Envirogen Technologies, Inc., Kingwood, TX, Ola Opara and Jack Adams, Inotec, LLC Kingwood, TX

Biological treatment systems such as the Fluidized Bed Reactor have become the treatment technology of choice for oxyanion treatment applications such as perchlorate, nitrate and chromate removal from groundwater and selenium removal from mining waters because of their high performance and low long-term operating costs. Three of the major components of operating costs in these biological systems are the electron donors used as nutrient and energy sources for the microorganisms that achieve contaminant destruction, co-contaminants that affect the efficiency of treatment and the solids handling related to excess biomass generated by the biological process. Recent work has been conducted on alternative electron donor programs that have shown the ability to reduce costs in varying treatment environments. Similarly, new design approaches have been developed to manage the presence of significant amounts of secondary contaminants for both treatment efficiency and cost. Finally, new approaches have been developed to decrease solids generation and to manage lower long-term costs of solids handling. This paper will review the process design and operating ramifications of each of these areas, and present data based on a series of pilot trials and up and running systems.

2:40 PM Discusser: Anthony Vaughn, Monsanto, St. Louis, MO

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM IWC 14-19: CASE STUDY FOR COST EFFECTIVE MINE WATER TREATMENT TO MEET STRINGENT SELENIUM REGULATORY LIMITS

Tom Rutkowski, Chris Beck, Bill Agster, Golder Associates, Lakewood, CO, and James Peterson, Frontier Water Systems San Diego, CA

Over the past several decades, selenium has emerged as a significant water quality issue that impacts multiple industries including mining, agriculture, petroleum, and power generation. At mine sites, selenium is typically leached from waste rock piles or pit walls as the selenate ion and can be present in multiple, high-flow, contaminated discharges. In recent years, biological treatment has emerged as an effective method compared to physical and chemical methods; however, even with the emergence of biological technologies, treatment of selenium to meet stringent regulatory limits is a technical and costly challenge for mine owners.

Frontier Water Systems Biofilter technology was selected by the mine owner after successful pilot testing on site. This technology was first introduced in 2013 and offers a cost effective, modular biological selenium treatment system. Pilot testing was conducted by the vendor at hydraulic retention times of less than 1 hour. Influent selenium concentrations ranged from 54 to 65 μg/L and the pilot consistently met the discharge limit of 4.1 μg/L for total selenium. Golder Associates is the design-builder for the project and responsible for design and construction of the treatment system. The treatment system has a design flow of 500 gpm and will be commissioned in fall of 2014 with a total capital cost, including engineering and construction, of about five million dollars.

3:45 PM Discusser: Kashi Banerjee, Veolia Water Solutions & Technologies, Moon Twp., PA

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-20: MEETING NEVADA DEP-BMRR PROFILE II PARAMETERS WITH ELECTROCOAGULATION-BASED TREATMENT SOLUTIONS**

B. Denney Eames, Bryan Neilsen, WaterTectonics, Everett, WA and Charles Landis, Halliburton, Inc. Houston, TX

Although the basic concepts of electrocoagulation (EC) have been known for nearly 100 years, it was not until the past few years that the technology became commercially viable for large scale, high flow rate applications. EC now provides an innovative and cost-effective approach to the treatment of water impacted with colloidal solids, emulsified oils, heavy metals, and other undesirable constituents. EC has been effectively used to treat mine wastewater from various mine sites to meet the NDEP/BMRR Profile II parameters, specifically meeting the arsenic and antimony treatment target levels.

4:35 PM Discusser: Corne Pretorius, Golder Associates, Ltd., Burnaby, BC, Canada

4:45 PM Floor Discussion & Closure

5:00 PM Conclusion

PRODUCED WATER TREATMENT FROM COAL SEAM GAS AND SAGD OPERATIONS

Monday, Nov. 17, 1:15 - 5:00 PM; Room: Salon K/L

IWC Representative: John Lucey, Jr. P.E., McKim and Creed, Raleigh, NC

Session Chair: Chip Westaby, Turner Designs Hydrocarbon Instruments, Fresno, CA

Discussion Leader: Don Downey, Purolite, Paris, ON Canada

1:15 PM **SESSION INTRODUCTION**

Chip Westaby, Turner Designs Hydrocarbon Instruments, Fresno, CA

Produced water is inherently challenging to treat due to the variable fouling potential and water characteristics from site to site. Treatment techniques will vary according to each sites produced water and effluent requirements. This session will cover Coal Seam Gas and SAGD water treatment methods

1:25 PM **IWC 14-21: THE START-UP/PERFORMANCE TESTING OF THE WORLD'S LARGEST COAL SEAM GAS PRODUCED WATER TREATMENT PLANT**

Carolina Gonzalez and Jennine Finlayson, GE Water, Bellevue, WA

GE commissioned Queensland Gas Company's (QGC's) Kenya Central Water Treatment Plant (CWTP) in mid-2013. The system treats coal seam gas (CSG) produced water that is high in total dissolved solids, alkalinity and silica. The produced water is collected in a network of regional ponds within the gas field and can vary widely in quality based on well location and time in production. As a result, the water treatment system is robust enough to meet stringent quality, recovery and reliability requirements and flexible enough to allow for varying feed water quality. Kenya is comprised of ultra-filtration (UF), ion exchange (IX), reverse osmosis (RO) and brine concentration (BC). Performance testing included operating the RO at different recovery rates and operating the BC at varying concentration factors. This paper summarizes the lessons learned during design, project execution and results during commissioning of the BC portion of the water treatment plant.

1:45 PM Discusser: Allen Daza, Aquatech International Corp., Canonsburg, PA

2:00 PM Floor Discussion & Closure

2:15 PM **IWC 14-22: THE LIME SOFTENER MISNOMER**

René Bélanger, Baker Hughes, Inc., Edmonton, AB Canada and Joe B. Bodeux, Baker Hughes Inc., Cold Lake, AB Canada

Steam-Assisted Gravity Drainage and Cyclic Steam Stimulation facilities commonly use warm or hot lime softener units for recycling and processing their various water streams for the preparation of boiler feedwater for steam generation. The process name implies that the hardness content in these streams will be reduced by such treatment course but in certain instances we have observed just the opposite. This paper describes the treatment strategy where lime addition can be reduced or even completely eliminated for operating lime softening units.

2:40 PM Discusser: Claude Gauthier, Purolite, Toronto, ON Canada

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM **IWC 14-23: CONTROLLING FOULING AND SCALE FORMATION IN SAGD EVAPORATOR OPERATIONS**

John Richardson, Ph.D., ChemTreat, Inc., Glen Allen, VA, Jerod Pluth, Rob Bedinger, and Sanyi Wang , Fort Saskatchewan, AB Canada

The use of falling film evaporators to pre-treat boiler feed water is gaining traction in Northern Alberta "SAGD", Steam Assisted Gravity Drainage operations. In the past, severe inorganic and organic fouling has been experienced in these systems, leading to off-line chemical and mechanical cleanings. This fouling resulted in evaporator down-time, lost steam production and increased operating costs. Using deposit analyses and materials transport studies, a proactive program of chemical development was launched with the goal to operate falling film evaporators without organic or inorganic fouling. This paper describes the significant progress made in this area and details the recommended changes to chemical treatment and system control.

3:45 PM Discusser: Steve Portelance, WorleyParsons Canada, Calgary, AB Canada

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-24: OIL VS. CATION EXCHANGE RESINS IN PRODUCED WATER APPLICATIONS**

Guy Mommaerts, Ion Exchange Services (Canada) Inc., Elora, ON Canada and David Dally, LANXESS Sybron, Inc., Birmingham, N.J.

The impact of oil fouling has been widely experienced. This paper reviews the issues related to the oil-fouling of Cation Exchange Resins, methods to cope with such occurrences and methods to clean the resin. It also offers some insight on the level of oil allowed in the feed-water before it interferes with the regeneration process.

4:35 PM Discusser: Darrell Harkwick, Buckman, Vaudreuil, QC Canada

4:45 PM Floor Discussion & Closure

5:00 PM Conclusion

ASME HRSG SYSTEM CHEMISTRY FOR UNIT RELIABILITY

Monday, Nov. 17, 1:15 - 5:00 PM; Room: Salon I

IWC Representative: Colleen Layman, P.E., HDR Inc., Harper's Ferry, WV

Session Chair: Irvin Cotton, Arthur Freedman Associates, Newport, RI

Discussion Leader: K. Anthony Selby, Water Technology Consultants, Inc., Evergreen, CO

1:15 PM **SESSION INTRODUCTION**

Irvin Cotton, Arthur Freedman Associates, Newport, RI

The reliability of HRSG's is critical to plant operations and availability. This ASME sponsored session reviews using the recent ASME HRSG chemistry guidelines to develop optimum chemistry programs.

The 2nd paper covers the importance of proper chemistry control when using phosphate based programs to avoid corrosion of boiler tubes. The third paper compares amine and amine-ammonia combination programs vs. ammonia treatment to help select the best treatment program. The fourth paper reviews steam purity in HRSG's and setting of effective upper allowable impurity control limits

1:25 PM **IWC 14-25: USING GUIDELINES TO DEVELOP OPTIMUM STEAM CHEMISTRY LIMITS FOR AN HRSG**

David Daniels, M&M Engineering Associates, Inc., Leander, TX

There are a number of industries and utility-related chemistry guidance documents for establishing the proper chemistry for a heat recovery steam generator, including the ASME HRSG Guidelines published in 2012. This paper will discuss how to go about selecting the proper chemistry and chemical guidance for an industrial or utility HRSG.

1:45 PM Discusser: Luis Carvalho, ChemTreat, Glen Allen, VA

2:00 PM Floor Discussion & Closure

2:15 PM **IWC 14-26: CORRECT FOR AMMONIA/AMINE EFFECT ON PH TO AVOID CORROSION WITH PHOSPHATE TREATMENT**

Robert Bartholomew, P.E., Sheppard T. Powell Associates, LLC, Baltimore, MD

The current HRSG chemistry guide (ASME 2012) has an equation for the required correction for the effect of ammonia on boiler water or evaporator water pH and calculated sodium (Na) to phosphate (PO4) mole ratios. Controlling this sodium alkalinity associated with phosphate is more complicated than the old method of just staying within the pH/PO4 control box.

Rigorous calculation of the ratio can be necessary to avoid corrosion of evaporator and boiler tubes. This is of greatest concern in units that have high tube metal temperatures and high underdeposit concentration of boiler water due to such factors as high operating pressure, high heat flux and/or thick, porous waterside deposits.

2:40 PM Discusser: Anton Banweg, Nalco, An Ecolab Company, Naperville, IL

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM **IWC 14-27: THE EFFECTS OF AMMONIA AND ORGANIC AMINES ON THE WATER CHEMISTRY OF GAS TURBINE HEAT RECOVERY STEAM GENERATORS AND ASSOCIATED EQUIPMENT**

James Robinson and Gregory J. Robinson, GE Water & Process Technologies, Trevose, PA

Organic amines have proven beneficial for the control of flow accelerated corrosion (FAC) in many gas turbine heat recoveries steam generator (HRSG) plants. However, amine use does present some limitations not encountered with ammonia only treatments. The advantages and limitations of amine and amine-ammonia combination treatments are compared to ammonia only treatments to aid the plant operator in selecting the best treatment for their system.

3:45 PM Discusser: James Bellows, Siemens, Orlando, FL

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-28: STEAM PURITY IN HEAT RECOVERY STEAM GENERATORS**

Edward Beardwood, Solenis International L.P., Wilmington, DE

The paper will discuss the effects of impurities in HRSG boiling waters on steam purity and carryover into the steam turbine. The equation used for predicting vaporous silica carryover and the equation used

for predicting mechanical carryover of other impurities will be applied to determine for a given operating pressure and pH, the allowable impurity in the HRSG evaporator circuits. The determination of the final Total Steam Purity, which includes attemperation water, will be provided in a fashion that allows the user to assess such without interpolations of multiple graphs. This then allows for the setting of upper impurity control limit values allowable within the boiling waters of multiple drum steam generators and ease of assessment of off specification steam purity. Conditions leading to off specification steam purity will also be itemized to provide site operating personnel directions to investigate for steam purity control restoration.

4:35 PM Discusser: Stephen Shulder, Electric Power Research Institute (EPRI), Charlotte, VA

4:45 PM Floor Discussion & Conclusion

5:00 PM Conclusion

SAGD WORKSHOP
Oil Separation and Water Treatment for In-Situ Oilsands Facilities

This three day work shop will cover all aspects of oil separation and produced water treatment processes.
Focus on the basics of oil water separation and water treatment chemistry, design theory and troubleshooting.

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ADVANCES IN ION EXCHANGE OPERATIONS

Tuesday, Nov. 18, 8:00 AM - 12:00 Noon; Room: Salon K/L

IWC Representative: James Sabzali, Aldex Chemical Company Ltd., Granby, QC Canada

Session Chair: James Summerfield, Dow Chemical Company, Edina, MA

Discussion Leader: Peter Meyers, ResinTech, West Berlin, NJ

8:00 AM **SESSION INTRODUCTION:**

James Summerfield, Dow Chemical Company, Edina, MA

Pure water is an essential part of nearly all industrial processes ranging from process steam production to nuclear power generation. The need for effective and efficient pure water production is often overlooked due to the immediate needs of just producing enough water to satisfy the daily demand. Water treatment technology that exists today provides the water treatment plant operators and management an opportunity to improve their efficiency and while not having to sacrifice efficacy.

8:10 AM **IWC 14-29: RECENT ADVANCES IN THE DESIGN AND OPERATION OF CONTINUOUS ION EXCHANGE EQUIPMENT FOR WATER TREATMENT**

Charles Drewry, R. U. Seneviratne, and T. D. Knowlton, Calgon Carbon Corporation, Pittsburgh, PA

This presentation follows various technological discoveries and developments for Continuous Ion Exchange Equipment. For approximately 100 years, ion exchange has been a known and widely applied technology for water treatment.

Much effort has been expended in the quest for an improved IX and continuous ion exchange (CIX) system that produces low waste volumes, consistent water quality and lower resin inventory. Recent developments from a number of companies have pushed equipment boundaries, resulting in a variety of unique commercial equipment designs each with a varying degree of success. The challenge set forth for all new designs has been a truly continuous process with no sacrifice in process configuration, flexibility while at the same time eliminating any resin movement. Recent equipment designs based on system symmetry appears to have achieved these objectives. In addition to obvious process and operating advantages, these designs allow greater layout flexibility, a reduction in spare parts inventory, reduced maintenance, built in design flexibility for future re-purposing and use of traditional columns. The presentation will close with a few examples of CIX used in the water industry.

8:35 AM Discusser: Rob Loken, Envirogen Technologies Inc, Rancho Cucamonga, CA

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-30: AN INNOVATIVE TREATMENT CONCEPT: DYNAMIC BED ION EXCHANGE**

Kevin Slough, M. Asc., P. Eng. and Amr Zaky Ph.D, P.Eng., FilterBoxx Water & Environmental Corp., Calgary, AB Canada

A new treatment concept for water treatment for removal of dissolved solids from water sources has been investigated on a small bench scale pilot test. The treatment concept consists of a novel continuously re-

generated ion exchange process termed 'dynamic bed ion exchange'. The process was designed to provide a truly continuous countercurrent moving bed ion exchange system to achieve capital and operating costs savings compared to traditional ion exchange systems and semi-continuous Higgins-loop type systems. At full scale, the system is expected to be particularly suitable for large scale softening and brackish water desalting due to much smaller foot-print, reduced chemical usage and rinse water waste. This paper covers the small bench-scale pilot demonstrations of softening using strong acid cation resins operating on sodium cycle. For the developed lab-scale test set-up, results showed that the dynamic bed ion exchange process was capable of achieving 75% hardness removal while simultaneously regenerating the resin bed without process optimization. It is expected that hardness removal and waste volume efficiencies to be improved with improved test apparatus that allow for process optimization.

9:25 AM Discusser:Rich Dennis, Severn Trent, Tampa, FL

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM IWC 14-31: CO-CURRENT VS. COUNTER-CURRENT ION EXCHANGE SYSTEMS (IXS)

Gregory Osen and Steven Gagnon, AVANTech, Inc., Columbia, SC

This paper will present an introduction and understanding of ion exchange systems (IXS) and the ion exchange process as it relates to co-current regeneration (COR) versus counter-current regeneration (CCR). Counter-current regeneration (CCR) is a more difficult process and requires additional engineering to perform correctly, but provides superior water quality. Various operations of the CCR processes will be reviewed. Descriptions of each unit operation will be provided along with basic equipment sizing.

Some waters are very low in minerals and require a small amount of ion exchange resin and a simple co-current IXS can be provided to remove these minerals to acceptable water quality. However many other water sources have a very high mineral content and a more complex, more efficient counter-current IXS would be required. The paper will also discuss why an accurate water analysis must be obtained, and what parameters are required. Many times the demineralizer equipment is not the problem; it is that the design was based upon faulty analyses.

10:45 AM Discusser: Doug Kellogg, Evoqua, Rockford, IL

10:55 AM Floor Discussion & Closure

11:10 AM IWC 14-32: SOFTENING CONCEPTS; UTILIZING A UNIQUE COUNTERCURRENT PACKED BED TECHNOLOGY FOR THE PRODUCED WATER MARKETS

David Dally, LANXESS Sybron Chemicals Inc., Birmingham, NJ and Guy Mommaerts Ion Exchange Services, Canada Inc., Elmira, ON, Canada

This presentation will provide a general discussion of Softener Designs and basic softening technology, including equilibrium equations, followed by a design concept, related to the softening, and utilizing a very unique countercurrent Packed Bed Design.

One case study will be included detailing the operation, effluent quality and operational benefits provided by combining Packed Bed

technology and a unique ULB design for high TDS waters.

11:35 AM Discusser: Cliff Gilbert, Dow Water and Process Solutions, Princeton, NJ

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

INNOVATIVE INDUSTRIAL WASTEWATER SOLUTIONS

Tuesday, Nov. 18, 8:00 AM - 12:00 Noon; Room: Salon I

IWC Representative: John Lucey, Jr. P.E., McKim and Creed, Raleigh, NC

Session Chair: Mike Preston, Black & Veatch, Overland Park, KS

Discussion Leader: Frank Johns, P.E., Tetra Tech, Inc., Denver, CO

8:00 AM **SESSION INTRODUCTION:**

Mike Preston, Black & Veatch, Overland Park, KS

Industrial wastewater treatment can take many forms and have many different objectives. This session is an opportunity to hear about some unique and innovative treatment solutions and be inspired to think "outside the box" for treatment solutions. Our first two papers discuss innovative biologically based treatment processes developed out of necessity to address difficult and unique wastewater treatment requirements. We'll then have an opportunity to examine the many claims and considerations surrounding design and ownership of zero liquid discharge (ZLD) systems in an attempt to establish realistic expectations for ZLD facilities. Our final paper will look at a unique water circulation solution implemented when more traditional solutions failed at one utility to treat troublesome algae blooms that plagued their cooling water pond.

8:10 AM **IWC 14-33: IMMOBILIZED CELL BIOREACTOR TECHNOLOGY FOR HYDROCARBON REMOVAL FROM INDUSTRIAL WASTEWATER**

F. Stephen Lupton, UOP - A Honeywell Company, Des Plaines, IL

Hydrocarbons are a common group of contaminants found in wastewater from various industrial processes. Regulations and water quality standards associated with discharging or reusing wastewater are becoming more stringent, creating a need to remove these contaminants prior to discharge or reuse within a processing facility. UOP's XCeed™ bioreactor technology, also known as an immobilized cell bioreactor, is an advanced, biofilm-based biological treatment technology that can remove recalcitrant organic and inorganic contaminants from a variety of industrial wastewaters, including those generated from coal tar distillation, creosote-based wood treatment and the demilitarization of sulfur mustard chemical weapons. Up to 99.9% reductions in hydrocarbons have been demonstrated on >50 full-scale installations of the company's immobilized cell bioreactor technology worldwide, while minimizing sludge production and energy consumption compared to other biological treatment systems. This paper will describe the process technology and summarize performance data.

8:35 AM Discusser: Anna I. Casasús, Ph.D., Kemira, Atlanta, GA

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-34: INNOVATIVE TREATMENT OF COMBINED SANITARY AND INDUSTRIAL WASTEWATER**

Janean Elbicki, Gene Kroeschen, Nelson Merrick, Dennis Fulmer, Ray

McConville and Jaw Fu Ph.D., Alcoa Inc., Alcoa Center, PA and Yatin Thaker, Bauer Resources GmbH Houston, TX

Alcoa has developed an innovative process for treatment of a combined sanitary and industrial wastewater stream, containing emulsified oils, at one of their US production facilities. With more than three years of lab and pilot scale testing, the treatment is biologically based and achieving the same or better effluent quality as tank based chemical treatment. This technology is being engineered for full-scale deployment at an Alcoa facility in 2016 with the help of Alcoa's partner, Bauer Resources.

9:25 AM Discusser: Abigail Antolovich, PE, UOP, A Honeywell Company, Lakewood, CO

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM **IWC 14-35: RASH STATEMENTS AND EQUIVOCATION – LESSONS LEARNED IN ZLD DESIGN, PROCUREMENT, COMMISSIONING, AND OPERATION**

Daniel Sampson, WorleyParsons, Folsom, CA

Rash statements abound in the Zero Liquid Discharge (ZLD) field, though they're seldom recognized as such. Designers, purchasers, suppliers, and operators have all made statements that have been, in retrospect, rash. This paper examines common rash statements and also generates several. Absolutes seldom exist in the real world, so the narrative provides some equivocation and explanation of the various statements made or evaluated to aid readers in understanding what ZLD is, what it can do, and what it cannot do.

10:45 AM Discusser: Frederick Douglas, Cosmos Technologies Inc., Pittsburgh, PA

10:55 AM Floor Discussion& Closure

11:10 AM **IWC 14-36: ELIMINATING ALGAL BLOOMS IN A COOLING WATER RESERVOIR REDUCED COSTS AND IMPROVED ECOSYSTEMS**

Bert Hibl, Medora Corporation, Little Elm, TX, Gale McGaha Miller Platte River Power Authority, Fort Collins, CO, and H Kenneth Hudnell, Medora Corporation & University of North Carolina at Chapel Hill New Bern, NC.

A perennial algal "bloom" of toxigenic cyanobacteria in the Platte River Power Authority's cooling-water pond caused operational, aesthetic, and environmental problems. The "bloom" caused scaling of the plant's condenser tubes by increasing pH to above 9, a foul smell in the air, potential health risks for the animals in the plant's wildlife preserve, and fish kills due to dissolved-oxygen depletion. Attempts to eliminate the "bloom" with filter-feeding fish, aeration and an algaecide were unsuccessful. Solar-powered, long-distance circulation of the upper-water column terminated the "bloom" and prevented its recurrence. The plant's operational expenses declined, air and water quality improved, and the terrestrial and aquatic wildlife flourished.

11:35 AM Discusser: Tom Higgins PhD, P E, CH2M HILL, Reston, VA

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

ADVANCES IN HYDROFRACTURING WATER TREATMENT

Tuesday, Nov. 18, 8:00 AM - 12:00 Noon; Room: Salon J

IWC Representative: Michael Ryder, P.E., Chester Engineers, Moon Twp., PA

Session Chair: John Schubert, P.E., HDR Engineering, Inc., Sarasota, FL

Discussion Leader: Michael Soller, P.E. CPC, Bowen, Indianapolis, IN

8:00 AM **SESSION INTRODUCTION:**

John Schubert, P.E., HDR Engineering, Inc., Sarasota, FL

The outlook for energy use in the U.S. continues to point toward increased reliance on natural gas from gas shale formations. This still-young technology is advancing rapidly, and the treatment of wastewater from hydrofracturing continues to evolve as more and more shale plays are developed. The four papers in this session all focus on innovative aspects of hydrofracturing water treatment, all based on technical advances in the field

8:10 AM **IWC 14-37: MODELING AND EXPERIMENTAL RESULTS OF VAPOR COMPRESSOR-DRIVEN MEMBRANE DISTILLATION**

Ajilli Hardy, Andy Shapiro, GE Global Research, Niskayuna, NY ,Jens Rütten, GE Global Research, Munich Germany, Josh Dewanaga and Grant Williamson, GE Power and Water, Bellevue, WA

Mechanical vapor compression driven membrane distillation (MVC-MD) is being pursued as a lower cost, more efficient means of treating the highly concentrated brines that result from hydrofracturing shale and the subsequent production of natural gas. MVC-MD is an evaporation process that reduces the volume of brine and creates a pure water stream that can be reused in a variety of applications. The clean brine concentrate can be used as a well kill fluid, transported for reduced deep-well disposal or further processed in a crystallizer to produce solid salts. This report presents analytical modeling and experimental results from a seven-day field test at a reinjection site in the Barnett shale region. Key performance results include a flux of more than 5.5 kg/m2hr and isentropic compressor energy consumption of 14 kWh/m3 of distillate while operating with an average salt concentration of 17 wt% and high distillate purity.

8:35 AM Discusser: Russell Huffmyer, HDR Inc, Pittsburgh, PA

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-38: THE IMPACT OF IONIC STRENGTH UPON INHIBITOR SPECIATION AND EFFICACY**

Robert Ferguson, French Creek Software, Inc., Phoenixville, PA

Previous papers reported observations on the impact of pH, and inhibitor protonation state, on inhibitor efficacy (Ferguson, 2013, Griffiths, 1979, Ramsey, 1985, Tomson, 2002, Hunter, 1993). The results of the data generated in these works are applicable in the low to moderate ionic strength covered. The conditions for the studies did not extend to the high total dissolved solids (TDS) and ionic strength regions encountered in critical current applications for scale inhibition. Flowback systems and production brines can extend into the 100,000 to 300,000 TDS range. Water reuse by cooling water systems push the operating ion ionic strength well beyond traditional limits, as do other

water reuse applications involving reverse osmosis. High TDS studies were conducted in the range of interest to provide insight into scale inhibitor speciation at high ionic strength. pKa's were measured in solutions "spiked" with NaCl (0 to 200,000 mg/L) to provide data for evaluating scale inhibitor species in high T.D.S. systems. pKa profiles were developed for commonly applied polymers and phosphonate inhibitors.

9:25 AM Discusser: Michael Bluemle, Solenis, Wilmington, DE

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM **IWC 14-39: APPLICATION OF CHLORINE DIOXIDE FOR WATER TREATMENT IN UPSTREAM OIL & GAS INCLUDING HYDRAULIC FRACTURING**

Warren Robinson, Aegis Chemical Solutions, LLC, Houston, TX and Jennifer Miller, PhD, Evoqua Water Technologies LLC., Sarasota, FL

Chlorine dioxide is a powerful disinfectant and oxidizing agent. It has been used for many years in water treatment systems for applications such as the elimination of chlorophenols, the oxidation of inorganic compounds such as iron and manganese, and in the control of taste, odor and color. Although it has been occasionally used in upstream oil production there is renewed interest in its potential for break oil water emulsions and disinfection of hydraulic fracturing waters.

Chlorine dioxide has been useful in various applications in the oilfield 1, 2. While the chemistry has long been understood, the adaptation to proper oilfield use has been an evolution over the past several decades. With the increased pressure on all companies to properly manage both water in and water out of the oil and gas operations, chlorine dioxide applications are increasing because of its efficacy as well as its environmentally positive profile. New methods of delivering chlorine dioxide in salt water disposal systems (SWD), water floods, frac water, and tank batteries have demonstrated the value of chlorine dioxide in the separation of entrained oil, elimination of bacteria, iron sulfides, and hydrogen sulfide. Important advances in the process and methods of delivery allow for economically feasible use of chlorine dioxide where it was once cost prohibitive.

We will discuss the efficient generation of chlorine dioxide and the application of chlorine dioxide for salt water disposals, water floods and frac water in which we have been able to alleviate issues faced by systems historically, resulting in a more efficient process with dependable and predictable results.

10:45 AM Discusser: Jason Monnell, GAI Consultants, Homestead, PA

10:55 AM Floor Discussion & Conclusion

11:10 AM **IWC 14-40: INNOVATIVE TREATMENT OF SHALE FRACTURING WATER USING MAGNETIC BALLAST CLARIFICATION AND ADVANCED MEMBRANE SYSTEMS**

Brian Mastin, Ph.D., Southern Research Institute, Birmingham, AL, Behrang (Ben) Pakzadeh, Jay Renew, Southern Research Institute, Cartersville, GA, Bill Chatterton, Southern Research Institute, Durham, NC, Joon Min, and Allen Chan, BKT United, Anaheim, CA

Southern Research Institute, with project partners M2 Water Treatment, Inc. and BKT United are under contract to Research Partnership to

Secure Energy for America, to develop an integrated approach for shale fracturing water treatment that produces high quality water for discharge and/or reuse. The approach focuses on magnetic ballast clarification (MBC), vortex-generating nano-filtration (NF) membrane, and conventional reverse osmosis (RO) to treat flowback waters. Membrane concentrates will be managed with hydrogel adsorbent or solidification/stabilization for landfill disposal.

11:35 AM Discusser: Rudy Labban, Degremont Industry Richmond, VA

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

ANTICIPATING NEW DISCHARGE REQUIREMENTS FOR FGD-EQUIPPED POWER PLANTS

Tuesday, Nov. 18, 8:00 AM - 12:00 Noon; Room: Salon M

IWC Representative: Manoj Sharma, Aquatech International Corp., Canonsburg, PA

Session Chair: Richard Stuebi, MAR Systems Inc., Cleveland, OH

Discussion Leader: Jay Wos, Southern Research Institute, Birmingham, AL

8:00 AM **SESSION INTRODUCTION**

Richard Stuebi, MAR Systems Inc., Cleveland, OH

Power plants equipped with flue gas desulfurization (FGD) systems face challenging wastewater issues. Most notably, the U.S. Environmental Protection Agency (EPA) has proposed new Effluent Limitation Guidelines (ELG) that aim to significantly tighten discharge limits on mercury, selenium, arsenic and nitrates across the U.S. Other contaminants of increasing concern, such as boron, will also be subject to mitigation efforts. Since FGD wastewaters involve complex chemistries, meeting more stringent discharge requirements is rarely simple, and usually requires exploring and advancing state-of-the-art approaches. This session provides some recent learning from real-world efforts to reduce wastewater discharges at FGD-equipped power plants.

8:10 AM **IWC 14-41: MINIMIZING WASTEWATER TREATMENT COSTS THROUGH FGD UPGRADES**

Bryan Hansen, Burns & McDonnell, Denver, CO

The Environmental Protection Agency (EPA) has proposed new Effluent Limitation Guidelines (ELG) affecting steam electric power generating facilities. The proposed ELGs provide new discharge limitations on various metal species (i.e., mercury, arsenic, selenium) and nitrate/nitrite. These proposed rules and the uncertainty of additional regulatory changes in the future will increase the pressure to eliminate wastewater discharges and to move toward a zero liquid discharge (ZLD) or near ZLD facility. This paper discusses the water impacts of a wet FGD system and ways to minimize the amount of wastewater generated and consequently the cost of the new wastewater treatment facilities. Major items for consideration include: use of FGD blow down for fly ash wetting, landfilling versus selling gypsum, spraying FGD wastewater upstream of the particulate collection device, upgrading the FGD system materials of construction to reduce blow down, conversion to inhibited oxidation, and installation of a semi-dry FGD system upstream of the particulate collection device. The paper will discuss the tradeoffs between the increased FGD system costs versus building a larger wastewater treatment facility.

8:35 AM Discusser: Robert Strange, Southern Research Institute, Birmingham, AL

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-42: EVALUATION OF THE ORIGIN OF DISSOLVED ORGANIC CARBON (DOC) AND THE TREATABILITY OF MERCURY IN FGD WASTEWATER**

Mandi Richardson, Catherine Sylvestri, Nicolas Bloom, URS Corporation, Austin, TX, Paul Chu, and Charles Dene, EPRI, Palo Alto, CA

This paper presents and discusses the results of an EPRI funded study to investigate the impact of dissolved organic carbon (DOC) present in FGD systems on the treatability of mercury in FGD wastewater. The role of DOC was explored through investigations of the speciation of the organic matter present as well as bench-scale experiments designed to further the understanding of the treatability of dissolved mercury in the presence of DOC. A geographically wide-ranging selection of 26 limestone samples was analyzed for total organic carbon (TOC) content as well as for speciation of the organic carbon, based on operational definitions of organic species types. FGD purge water was collected from five different FGD systems that experience different levels of success with mercury treatability. Multiple analytical tests were conducted to speciate the yellow-colored DOC in the FGD purge water samples. The impacts of DOC on the success of mercury removal treatments in wastewater were examined for three treatment chemistries, each having a different sensitivity to DOC interferences. Current investigations involve the isolation of organic matter according to operationally defined methodology and spiking synthetic FGD wastewater liquors with this matter to quantify impacts on mercury treatability.

9:25 AM Discusser: Angela Zagala, Nalco, an Ecolab Company, Cary, NC

9:35 AM Floor Discussion & Conclusion

9:50 AM Break

10:20 AM **IWC 14-43: START UP OF A FULL SCALE BORON REMOVAL SYSTEM FOR FGD WASTE WATER**

W. Carlin, M. Roth, and L. Versagli, The Dow Chemical Company, Spring House, PA, S. Wojciechowski and D. Reed, NRG, Springhouse, PA

An increase in environmental regulations has many coal fired power plants evaluating solutions for treatment of flue gas desulfurization (FGD) waste water, which contains particulate and other dissolved contaminants such as Boron, Selenium, and Mercury. Without treatment, some plants stand to be in violation of discharge limits and face decisions on whether to invest in treatment options or retire the facility. Conemaugh Generating Station has installed the first full scale boron removal system for treating FGD waste water. This paper discusses the system design, start up challenges, and current operational data of the boron removal ion exchange system.

10:45 AM Discusser: Paul Chu, EPRI, Palo Alto, CA

10:55 AM Floor Discussion & Closure

11:10 AM **IWC 14-44: FLUE GAS DESULFURIZATION: TECHNOLOGICAL AND OPERATIONAL IMPACT TO PURGE WATER TREATMENT SYSTEMS DUE TO ENVIRONMENTAL REGULATIONS**

Kenneth Chen, Fluor Enterprises, Inc., Aliso Viejo, CA and Dennis McBride, Fluor Enterprises, Inc., Greenville, SC

Wet Flue Gas Desulfurization (FGD) systems have been used in coal fired power plants as a means to remove sulfur dioxide from the exhaust flue gas. The Clean Air Act provides jurisdiction to the Environmental Protection Agency (EPA), and state environmental agencies, to regulate air quality emission requirements. The Clean Water Act provides similar authority regarding water quality discharge requirements. The combination of these acts will require many coal fired power plants to either treat the purge water streams to meet new, more stringent requirements from their FGD system or potentially decommission the existing plants. This paper will discuss the major components for the purge water treatment systems for a Wet FGD system and identify the components affected by these regulations. It will then discuss the technological and operational impacts these changes may have on the operations of coal fired power plants with regard to purge water treatment systems for these Wet FGD systems.

11:35 AM Discusser: William Kennedy, Duke Energy, Charlotte, NC

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

PRACTICAL APPLICATION OF MEMBRANE PRETREATMENT AND TECHNOLOGIES

Tuesday, Nov. 18, 1:15 - 5:15 PM; Room: Salon M

IWC Representative: Dennis McBride, Flour, Greenville, SC

Session Chair: Jane Kucera, Nalco, an Ecolab Company, Naperville, IL

Discussion Leader: Brian Powers, P.E., HDR Engineering, Inc., Charlotte, NC

1:15 PM **SESSION INTRODUCTION:**

Jane Kucera, Nalco, an Ecolab Company, Naperville, IL

This year's IWC Membrane Session covers real-world application of the technology. The papers in this session cover a full gamut of subjects ranging from pretreatment alternatives to chlorine for bio control to multi-membrane processes for zero liquid discharge (ZLD). All are important topics as industry becomes more environmentally conscious either to be green or to follow governmental regulations. One paper paper discusses in detail chlorine and alternatives to chlorine for membrane bio control to minimize formation of disinfectant byproducts. Another paper discusses the replacement of an antiquated demineralizer system with a design, build, own, operate, and maintain system. A third paper discusses a unique crystallization technique that lends itself to pretreatment prior to an ultrafiltration/nanofiltration/ reverse osmosis ZLD system. And, a fourth paper discusses a membrane–based system used for water recycle at a methanol production plant.

1:25 PM **IWC 14-45: ALTERNATIVE DISINFECTION FOR REVERSE OSMOSIS SYSTEMS**

Anne Arza and Jane Kucera, Nalco, an Ecolab Company, Naperville, IL

Reverse osmosis (RO) system owners and operators are continuously challenged with minimizing fouling of the RO membranes. The primary foulant affecting virtually all RO systems is bacterial in nature. Traditionally, chlorine gas or bleach has been used for disinfection of the RO feed stream and pretreatment system in an attempt to minimize bio-fouling of the membranes. However, these techniques promote the formation of undesirable species, such as trihalomethanes (THMs) and haloacetic acids (HAAs), which have already faced increasing regulation by the government. Thus, municipalities are turning to alternative means of disinfection of potable water to eliminate the formation of THMs and HAAs. Corporations are also looking for alternative disinfection methods as a result of the restriction on these compounds as well as foreconomical and corporate sustainability reasons. Alternatives to chlorine that are considered frequently include monochloramine, chlorine dioxide, ozone, and nonoxidizing biocides such as 2.2-di-bromo-3-nitrioproprionamide (DBNPA). This paper discusses some of the more common chemical alternatives to chlorine and their impact on disinfection of an RO feed water and pretreatment system; details on application, efficacy, byproducts, and overall advantages and limitations of each alternative are also discussed. (Note that oxidizing biocides, such as hypochlorite and some of the alternatives to hypochlorite discussed in this paper, are not recommended for direct use for cleaning or sanitization of polyamide-type RO membranes due to the destruction of the membrane polymer by the oxidizer).

1:50 PM Discusser: Paul Olson, The Dow Chemical Company, Minneapolis, MI

2:00 PM Floor Discussion & Closure

2:15 PM **IWC 14-46: AMEREN MERAMEC ENERGY CENTER OUTSOURCED DEMINERALIZER SYSTEM**

Edward Kammerer and Christopher Taylor Ameren Missouri, St. Louis, MO USA

Ameren Missouri Meramec Station needed to replace an aging demineralizer installed in the 1950's. Following evaluation of alternatives, a contractor owned, operated and maintained demineralized water system was specified. Installation and startup was completed in 2012. This paper discusses Ameren Missouri's perspective on the system selection, design, installation, and initial operation.

2:40 PM Discusser: Steven R. Gagnon, AVANTech Incorporated, Columbia, SC

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM **IWC 14-47:REFINERY PROCESS WATER DEOXYGENATION – A CASE STUDY ON GAS TRANSFER MEMBRANE (GTM)**

Scott Willis, M. Ulbricht, J. Schneider, and A. Segupta, Membrana, Charlotte, NC

A case study is presented on the use of gas transfer membrane (GTM) technology to remove dissolved oxygen from process water in a refinery. For plants producing steam, the need to control dissolved oxygen is well-known and in many situations GTM technology offers significant advantages over conventional steam deaerator technology. GTM systems that were installed at a refinery are discussed, including the realization of greater energy efficiency and system mobility.

3:45 PM Discusser: Christian Frye, GE Power and Water, Houston, TX

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-48: WASTEWATER REUSE AT A METHANOL PRODUCTION PLANT**

Mike Snodgrass, Ryan Vargas, TriSep Corporation, Goleta, CA and Jeff Li, Eco Environmental Investments Limited Hong Kong, China

Limited domestic supply of petroleum and natural gas has driven the growth of coal based methanol production in China. Methanol, considered a viable petroleum fuel alternative, is synthesized through a coal gasification process that consumes considerable amounts of fresh water. With growing pressure from local regulators, the Eco Environmental Investments Limited (ECO Environmental) methanol production facility in Erdos, Inner Mongolia implemented an advanced water reuse strategy to conserve fresh water resource while reducing plant wastewater discharge. To satisfy new regulatory requirements, the plant chose to implement a strategy that would treat 1,188 gpm (270 m3/hr) of wastewater for reuse as boiler feed make-up.

All wastewater sources from the methanol plant, which consists of cooling tower blowdown, carbon filter backwash, mixed bed regeneration waste, and main plant wastewater effluent, is combined and sent to the water recycling plant. The wastewater recycling plant utilizes biological aerated filters, clarifiers, multi-media filters, ultrafiltration (UF), and reverse osmosis (RO), and was commissioned in January 2014. Reject streams from both the UF and RO units are sent to front end of the water treatment plant to further enhance water recovery rates.

After commissioning of the treatment, the benefits of water recycling

were quickly realized. Fresh water consumption was reduced from 18 to 12 tons water per ton methanol produced, while reducing wastewater discharge rate 56.7%. The reduction in fresh water consumption alone has saved the methanol plant ¥7.8 million ($1.3 million USD) on an annual basis.

4:35 PM Discusser: Tony Fuhrman, Hydranautics - A Nitto Group Company, Pittsburgh, PA

4:45 PM Floor Discussion & Closure

5:00 PM Conclusion

REFINERY WASTEWATER TREATMENT WITH EMPHASIS ON SELENIUM REMOVAL

Tuesday, Nov. 18, 1:15 - 5:00 PM; Room: Salon J

IWC Representative: Michael Ryder, P.E., Chester Engineers, Moon Twp., PA

Session Chair: Ramesh Kalluri, P.E., Kalluri Group, Inc., Houston, TX

Discussion Leader: Randy Harney, Fluor, Aliso Vieja, CA

1:15 PM **SESSION INTRODUCTION**

Ramesh Kalluri, P.E., Kalluri Group, Inc., Houston, TX

The refining industry is faced with ever increasing and demanding environmental regulations to protect the environment. Wastewater from the refining process contains free and dissolved oil & grease, hazardous hydrocarbons, phenol, amines, ammonia nitrogen, BTEX compounds, heavy metals, total dissolved solids, selenium and other hazardous compounds. This session presents cutting edge trends such as innovative control technology to optimize performance of dissolved gas flotation or induced gas flotation for effective removal of oil and grease, speciation of selenium in refinery wastewater and review of selenium treatment technologies with emphasis on environmental obligations and cost-effectiveness, and pilot scale study results of an innovative non-biological treatment of selenium and other metals.

1:25 PM **IWC 14-49: ENHANCED CONTROL OF WASTEWATER TREATMENT: CHEMICAL OPTIMIZATION AND MANAGEMENT OF FLUCTUATING LOADING FROM HEAVY CRUDES AND TIGHT OILS**

David Workman, Nalco, an Ecolab Company, Naperville, IL and Tina Syvret, Nalco Champion, an Ecolab Company, Houston, TX

The challenges of opportunity crudes include significant impact on the Wastewater Treatment Plant (WWTP) due to associated contaminants in the crude. Specifically, heavy crudes and tight oils result in increased and variable TSS and O&G loading to the primary treatment. A proprietary automation package has been developed to reliably control the chemical treatment program in flotation equipment (DAF/DGF/IAF/IGF) by addressing variable influent loading. Features and capability of the equipment will be outlined and its performance discussed.

1:50 PM Discusser: Milton Crossen, Evoqua, Chino Hills, CA

2:00 PM Floor Discussion & Closure

2:15 PM **IWC 14-50: CHARACTERIZATION OF SELENIUM SPECIES IN REFINERY WASTEWATER STREAMS**

Frank Castaldi, Golder Associates Inc., Houston, TX and Bruce Douglas

Golder Associates, Inc., Denver, CO

A selenium species characterization survey was conducted on petroleum refinery wastewater from desalting, sour water stripping, and miscellaneous condensates to the wastewater treatment plant, which consisted of tank-based oil/water separation, aerated biological treatment, followed by wastewater ponds, and a final effluent waste stabilization pond. Selenium was found to accumulate in the sour water system (SWS). Selenocyanate was the dominant selenium species found in the SWS. The majority of the desalter wash water makeup at this refinery originates from the SWS and this operating condition was responsible for the presence of selenium in the desalter effluent. This was confirmed by the desalter sampling results that indicated selenium mainly as selenocyanate in desalter effluent. During aerobic biological treatment, the majority of the selenium was oxidized to selenite and selenate. The survey indicated that various forms of selenium partition to solids that settle in wastewater impoundments. These solids experience changing oxidation-reduction conditions in the impoundments. The ponds impacted selenium by a combination of adsorption on biomass and sedimentation in poorly mixed areas.

The final effluent waste stabilization pond removed selenium by adsorption on sediments and plant matter that is present in this pond. The selenium species entering this pond were identified by analyses as selenite and selenate, with the remaining forms a combination of selenocyanate and other unidentified dissolved species. There also were a number of organic compounds that contain selenium in its reduced state, including selenium analogs to sulfur-containing amino acids and mercaptans.

2:40 PM Discusser: Prakash Khanolkar, Evoqua, Warrendale, PA

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM **IWC 14-51: A PRACTICAL APPROACH FOR REMOVING SELENIUM FROM OIL REFINERY WASTEWATER**

Timothy Eggert, GE Power & Water - Water and Process Technologies, Seal Beach, CA; Charles Boswell GE Power & Water - Water and Process Technologies, Rancho Palos Verdes, CA; Sarady Ka, GE Power & Water - Water and Process Technologies, Norwalk, CA; Robin W. Kluck, GE Power & Water - Water and Process Technologies, Benicia, CA

Selenium discharge from oil refinery wastewater has come under increased scrutiny over the past 30 years. Environmental regulations have resulted in reduced selenium discharge limits, even for plants that discharge into publically-owned treatment works (POTW's). This paper briefly reviews several available treatment technologies for removal of selenium from refinery wastewater. A case history is presented describing a practical solution that was successful in removing selenium to acceptable levels at a large Southern California oil refinery.

3:45 PM Discusser: Josh Lawrence, Fluor, Calgary, AB Canada

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-52: REMOVAL OF SELENIUM AND MERCURY FROM REFINERY WASTEWATER: EXPERIMENTAL AND PILOT RESULTS**

Michael Wismer and Charles McCloskey, Evoqua Water Technologies LLC, Roseville, MN

Wastewater generated during petroleum refining processes is contaminated with metals and metalloids that must be removed before the wastewater is discharged to surface waters or a POTW. Two notable contaminants are selenium and mercury.

Selenium in refinery wastewater exists in different oxidations states and, therefore, in multiple ionic forms that require complex treatment strategies. Mercury is found as fine, insoluble particulate in these wastewaters. Since mercury must often be removed to less than 1-12 ng/L, treatment, sampling and analysis are challenging.

This paper reports results of laboratory and field studies using an innovative physical/chemical treatment process for the removal of selenium and mercury from sour water stripper (SWS) and end-of-pipe (EOP) wastewaters.

4:35 PM Discusser: John Penca, Fluor, Aliso Viejo, CA

4:45 PM Floor Discussion & Closure

5:00 PM Conclusion

MINIMIZING SCALE AND CORROSION IN OTSG AND EVAPORATOR BOILER, AN ASME-SPONSORED PANEL SESSION

Tuesday, Nov. 18, 1:15 - 5:00 PM; Room: Salon I

IWC Representative: Debbie Bloom, Nalco, an Ecolab Company, Naperville, IL

Session Chair: Melonie Myszczyszyn, Canadian Natural Resources Ltd, Calgary, AB Canada

Discussion Leader: Ivan Morales, Devon, Calgary, AB Canada

1:15 PM SESSION INTRODUCTION

Melonie Myszczyszyn, Canadian Natural Resources Ltd, Calgary, AB Canada

This ASME sponsored session will consist of 4 papers followed by an open floor discussion. Papers being presented will relay applicable knowledge on erosion corrosion; modeling electrolytes within your water/ boiler system; Lab testing methods for hardness, oxygen, and sulfide; and evaporator/boiler boundary heat transfer for Once through Steam Generator and Evaporator Boiler systems.

1:25 PM IWC 14-53: EROSION-CORROSION IN OIL FIELD ONCE THROUGH STEAM GENERATORS

Martin Godfrey, Paul Desch and Logan LaRocque, Nalco Champion, an Ecolab Company, Eagan, MN

Once through steam generators contain many sites exposed to high velocity fluid flow that are susceptible to metal loss by erosion-corrosion mechanisms. Locations of fluid impingement, such as bends, thermowells, and sample separators, are especially susceptible to wastage. Metallurgical analyses of several cases of such metal loss are presented. Erosive particles entrained in the fluid can be a major contributing factor. Techniques used to determine the type and source of erosive particles are discussed. Methodology for studies that seek to measure the iron corrosion products released by the metal loss reactions are detailed.

1:50 PM

IWC 14-54: OLI ELECTROLYTES MODELLING OF PRACTICAL APPLICATIONS IN THERMAL IN-SITU OPERATIONS

Subodh Peramanu, Elise Lagace and Simon Davies, Canadian Natural Resources Ltd, Calgary, AB Canada

In this study, two practical examples of in-situ thermal oil production (Steam Assisted Gravity Drainage and Cyclic Steam Stimulation) challenges were evaluated using OLI Electrolyte Modeling. These scenarios were the salt cavern/disposal well scaling for CNRL Kirby operation (Facility 1) and the Once Through Steam Generator (OTSG) scaling for CNRL Primrose & Wolf Lake operation (Facility 2).

Salt Cavern and disposal well streams were modelled with electrolyte simulation to understand solid scaling when mixing salt cavern return streams before the fluid is sent to the disposal wells. For the steam generator scaling study, potential for increased scaling when increasing from 75% to 90% steam quality was a major concern. Electrolyte model was used to predict the scale amount and composition to understand the scaling tendencies of various species.

The electrolyte simulation took into account pH, alkalinity, and electrolyte composition to simulate the real conditions. This provides a higher degree of confidence in the results which are used to implement design modifications and to adjust process and operating conditions for addressing the problems.

2:15 PM

IWC 14-55: ON-SITE LABORATORY METHODS FOR DETERMINATION OF DISSOLVED HARDNESS, DISSOLVED OXYGEN, AND SULFIDE RESIDUAL FOR STEAM GENERATORS FOR IN-SITU BITUMEN RECOVERY

Ramesh Sharma, ConocoPhillips Company, Houston, TX

Steam Assisted Gravity Drainage (SAGD) produced water is unique in many ways due to high temperature, silica, and organics concentration. One of the primary challenges of CSS/SAGD produced water analysis is identification appropriate analytical methods for on-site process monitoring. Most analytical procedures are set-up for drinking water analysis and not for produced water analyses. Procedures followed to preserve/analyze drinking water samples often produce incorrect test results when applied to CSS/SAGD produced water.

The primary focus of this paper is on identification of suitable "on-site" analytical methods for quantification of dissolved hardness, dissolved oxygen, and sulfide residual in boiler feed water for once through steam generators. The paper provides a review of various analytical procedures, identifies various interferences affecting the measurement, and documents best industry practices for these measurements in CSS/SAGD environment.

2:40 PM

IWC 14-56: EVAPORATOR AND BOILER BOUNDARY HEAT TRANSER PHENOMENA AND WATER CHEMISTRY

Rafael Gay-de-Montella, M.Sc. P.Eng., Transprocess Inc., Calgary, AB Canada

The Author reviews the heat transfer phenomena and the water chemistry occurring in the internal surface of evaporators and boiler surfaces when approaching total evaporation or complete phase change from liquid to vapor (75% steam quality and beyond).

The review addresses the situation of generation of steam or evapora-

tion of brackish water and its tendency to produce scales and surface depositions. The review discusses the heat transfer through the vapor generating wall and boundary layers limiting factors and scaling tendencies.

The author reviews the concept of hardness and importance to understand the importance of the various ionic players such as Calcium and other common polyvalent cations, in the presence of Carbonates, Sulfates, Naphthenics and Silica, and addresses the presence of Hydro-Carbons while generating disperse vapor micro-bubble generation at evaporation surfaces.

The review presentation is supported by boundary layers conditions simulation using OLI analyzer studio package for typical Alberta Produced water cases.

3:05 PM Break

3:20 PM Panel Discussion

5:00 PM Conclusion

FGD WASTEWATER CHARACTERISTICS AND TREATMENT

Tuesday, Nov. 18, 1:15 - 5:00 PM; Room: Salon K/L

IWC Representative: Patricia Scroggin, P.E., Burns & McDonnell, Kansas City, MO

Session Chair: Thomas Lawry, HDR Inc., Pittsburgh, PA

Discussion Leader: Jonathan Shimko, Tetra Tech, Inc., Pittsburgh, PA

1:15 PM **SESSION INTRODUCTION**

Thomas Lawry, HDR Inc., Pittsburgh, PA

FGD wastewater continues to be complex stream that require innovative methods of measurement and treatment. Operational changes and inconsistent loading add to the challenge and require flexible yet effective treatment processes to consistently meet stringent water quality limits. The upcoming Effluent Limitation Guidelines will only sharpen the focus on innovative treatment processes. This session touches on all these points, and includes papers on operational challenges, FGD blowdown chemistry, and various treatment options. The papers include bench scale, pilot, and full scale studies and detailed discussions on heavy metals handling in these complicated streams.

1:25 PM **IWC 14-57: THE IMPACT OF VARIABLE AND LOW LOAD OPERATION ON WET FLUE GAS DESULFURIZATION SLURRY CHEMISTRY AND WASTE WATER, INCLUDING TRACE METAL SPECIATION AND EFFLUENT FLOW RATES, WITH SUGGESTED MITIGATION STRATEGIES**

Shannon Brown, Daniel B. Johnson, Purusha Bonnin-Nartker, Richard F. DeVault, Joseph M. Mitchell and Garrett E. Pavlovicz, Babcock & Wilcox Power Generation Group, Inc., Barberton, OH

With the advent of newer alternative energy production, increased deregulation, and impending environmental regulations, maintenance of electric grid stability leads to oscillations in plant megawatt output. Such variable operation modifies flue gas flux, altering system chemistry. Herein is discussed the impacts of swinging and low load operation on wet FGD chemistry, effluent composition, waste water treatment, and materials of construction, as well as suggestions for system tuning

to afford improved treatment of wet FGD effluent.

1:50 PM Discusser: Jason D. Monnell, Ph.D., GAI Consultants, Inc., Pittsburgh, PA

2:00 PM Floor Discussion & Conclusion

2:15 PM IWC 14-58: REACTIVE IRON MEDIA – AN ENHANCED ZERO VALENT IRON PROCESS FOR METALS AND METALLOID REMOVAL FROM WATER AND WASTEWATER.

Simon Dukes, Evoqua Water Technologies LLC, Lowell, MA, David Berger, Frank Sassaman, Evoqua Water Technologies, Warrendale, PA, Yong Huang, Ph.D., Texas A&M Agrilife Research College Station, TX ,Paul Chu, Electric Power Research Institute, Palo Alto, CA, and Xinjun (Jason) Teng, Southern Company Services, Inc., Birmingham, AL

Recent advances in the understanding of iron chemistry has allowed the development of the Reactive Iron Media Process, an approach utilizing developments in Zero Valent Iron processes, featuring the synergistic effects of ZVI with FeOx and other reagents. This technology allows the robust and predictable removal of heavy metals, including selenium and mercury, arsenic, and nutrients, to low levels across a range of wastewaters and under a wide range of conditions and chemistries.

2:40 PM Discusser: Jay Harwood, GE Power & Water, Burlington, ON Canada

2:50 PM Floor Discussion & Closure

3:05 PM Break

3:20 PM IWC 14-59: PILOT STUDIES FOR THE TREATMENT OF A HIGHLY OXIDIZED FLUE GAS DESULPHURIZATION WASTEWATER

Joseph Chwirka, Tetra Tech, Albuquerque, NM, Jean-Claude Younan SCANA, Albuquerque, NM, and Paul Chu, Electric Power Research Institute, Palo, CA

The treatment of flue gas desulphurization (FGD) wastewater is a relatively new area of wastewater treatment. Although physical/chemical treatment with iron and/or sulfide precipitation has been used for FGD treatment, it has focused extensively on solids removal. The Environmental Protection Agency (EPA) has proposed new Effluent Limitation Guidelines (ELG) which would require treatment of the FGD wastewater for selenium, mercury, arsenic, and nitrates. To meet these proposed ELG's, SCANA and Electric Power Research Institute (EPRI) implemented an extensive program of pilot treatment technologies at a coal fired power plant in South Carolina. The treatment technologies piloted included three biological systems, as well as two zero valent iron chemical technologies. The FGD wastewater was highly oxidized as characterized by oxidation reduction potential (ORP) levels exceeding 500 mv, selenium at 2,500 ug/L, mercury up to 150 ug/L, and pH values as low as 2.9. Due to operational changes with the plants wet flue gas desulphurization absorber, there were two distinct water quality phases. The phases were gradually separated around early January 2014. This paper will examine the FGD water quality characteristics and their impacts on the performance of the piloted technologies.

3:45 PM Discusser: James Beninati, PE, HDR Engineering, Inc., Pittsburgh, PA

3:55 PM Floor Discussion & Closure

4:10 PM **IWC 14-60: HIGH RATE SOFTENING WITHOUT SAND**

Sarah Petrovich, Chuck Blumenschein and Kashi Banerjee, Veolia Water Solutions & Technologies NA, Moon Township, PA USA

Veolia Water Technologies has developed a new process for softening and solids separation, called ACTIFLO® SOFTns™. The process is based on ballasted flocculation and settling technology. This new process is unique in that it uses calcium carbonate as the ballast material. High rate softening with mircosand, as a ballast material, is a proven technology to provide the capability to handle high suspended solids loads and achieve high settling velocities. Using precipitated calcium carbonate as ballast for settling instead of the microsand permits the technology to handle higher concentrations of hardness and suspended solids as compared to high rate softening with microsand. Laboratory testing and a four-week pilot study were completed using this process to test and verify results. Four scenarios were tested during the pilot study, one of which was a control. At influent flow rates of 50 gpm with total hardness concentrations as high as 2,275 mg/l CaCO3, the wastewater was softened to a total hardness of $<$100 mg/l CaCO3 with $<$10 mg/l TSS in the final effluent. Observed settling velocities ranged from 25 to 30 gpm/ft2 with an average calcium carbonate particle size of 30 microns. This paper will describe on the pilot study, the results achieved, capital and operating costs, required footprint and will address the potential need for downstream TSS polishing.

4:35 PM Discusser: Jonathan Shimko, Tetra Tech, Inc., Pittsburgh, PA

4:45 PM Floor Discussion & Closure

5:00 PM Conclusion

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COOLING WATER TREATMENT - IMPROVING MONITORING, PERFORMANCE AND SYSTEM EFFICIENCIES

Wednesday, Nov. 19, 8:00 AM - 12:00 Noon; Room: Salon I

IWC Representative: Paul Puckorius, Puckorius & Associates, Inc., Arvada, CO
Session Chair: Ken Dunn, Solenis, Shrewsbury, MA
Discussion Leader: Scott Quinlan, GAI Consultants, Cranberry Township, PA

8:00 AM **SESSION INTRODUCTION**

Ken Dunn, Solenis, Shrewsbury, MA

Corrosion, deposition and microbial growth are closely interrelated and must be properly controlled to maintain overall cooling water system efficiencies. If any of these three aspects are left unchecked, the cooling water treatment program will suffer poor performance. The four papers in this session cover different areas of a cooling water treatment program. The first paper discusses corrosion monitoring under heat transfer conditions while the second paper targets cooling tower film fill fouling / monitoring. The third paper outlines the impact and control for mussels discovered at Lead Mead. The final paper completes the session with the treatment of high silica cooling water.

8:10 AM **IWC 14-61: CORROSION MONITORING STUDY USING TRADITIONAL METHODS COMPARED TO A NEW INNOVATIVE APPROACH TO "ACTUAL" CORROSION RATES**

L J Aspinall and Paul Puckorius, Puckorius & Associates, Inc., Arvada, CO

This paper presents real time cooling water corrosion monitoring under heat transfer conditions and compares the results obtained by traditional coupons and linear polarization methods. The new method incorporates heat flux, velocity, and skin temperatures over a 30+ days of continuous monitoring. Descriptions of the test unit are provided along with the methodology utilized versus the traditional corrosion monitoring methods. The results are dramatic and illustrate the need to utilize heat transfer cooling water corrosion monitoring methodology that is much more meaningful to protect plant heat exchangers versus older methods which can be misleading. Details of the monitoring equipment and the results of the comparison of the corrosion monitoring are provided.

8:35 AM Discusser: Loraine Huchler, P.E., CMC, MAR Systems, Solon, OH

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-62: UTILIZING GAMMA SCANNING TECHNOLOGY TO MONITOR BLOCKAGE OR FOULING IN FILM FILL COUNTER-FLOW COOLING TOWERS AS PREVENTIVE MAINTENANCE**

Maureen Gerty, Nalco Champion Company, An Ecolab Company, Sugar Land, TX and Paul Chila Quantum Technical Services LLC, Houston, TX

A common concern with high efficiency film fill counter-flow cooling towers is fouling and the degree to which it may be occurring. This technical paper describes how gamma scanning technology can be applied to monitor film fill in counterflow cooling towers. Case histories will be presented, illustrating how this application has been utilized to track film fill fouling, monitor the effectiveness of a chemical treatment program, and improve the overall cooling system reliability.

9:25 AM Discusser: Claudia C. Pierce, Ph.D., GE Power & Water, Trevose, PA

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM **IWC 14-63: MACROFOULING CONTROL - TESTED CONTROL STRATEGIES AND RECENT RESEARCH FOR DREISSENID MUSSELS**

Leonard Willet, Bureau of Reclamation - Hoover Dam, Boulder City, NV and Renata Claudi, RNT Consulting Inc., Picton, ON Canada

January 2007, the quagga mussel, a thumbnail-sized invasive bivalve related to the zebra mussel, was unexpectedly discovered in Lake Mead, Nevada generating instant environmental concern, as these mussels can potentially colonize cooling water supply systems at hydroelectric power plants and other industries to the point of disrupting operations.

The Bureau of Reclamation's Lower Colorado Region immediately initiated a response program with two main objectives: to ensure the mussels did not affect power generation or water delivery operations at Hoover, Davis and Parker dams, and to gather information that could be shared with other water facility owners and operators about the mussel, its potential impacts, and methods of preventing or mitigating those impacts. This paper describes the various control strategies for cooling water systems with special focus on ongoing research sponsored by Reclamation.

10:45 AM Discusser: Chris Baron, Solenis, Newark, DE

10:55 AM Floor Discussion & Closure

11:10 AM **IWC 14-64: COOLING WATER CHEMISTRY PROGRAMS FOR HIGH SILICA WATERS**

Kevin Boudreaux, Nalco, an Ecolab Company, Naperville, IL

To reduce their impact on the nation's freshwater resources, industrial plants are searching for and utilizing alternative water sources for their cooling water needs. Many have turned to well water or gray water sources that often contain high concentrations of silica, especially when compared to commonly-used surface waters. For instance, surface waters such as lakes and rivers may contain 10-15 ppm of silica, but it is not uncommon for well waters or gray waters to contain 30-50 ppm.

Once cycled up in the cooling tower, silica concentrations can easily exceed silica saturation limits and lead to precipitation. Depending on which silica species are present, precipitated silica forms a tenacious scale or deposit that inhibits heat transfer across heat exchangers or cooling tower fill.

Experience has shown that a clear understanding of silica chemistry, specifically its various species and behavior in different cooling water environments, as well as silica monitoring methods to identify precipitation potential, are not widespread throughout the water treatment community. This paper discusses general silica chemistry, various methods for minimizing silica scaling, monitoring and testing for silica, and most importantly, why plants should care.

11:35 AM Discusser: Prasad Kalakodimi, Ph.D., ChemTreat Inc., Ashland, VA

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

	SALON I	SALON J	SALON K/L	SALON M
SUNDAY, NOVEMBER 16				
5:00-7:00 PM	75TH ANNIVERSARY RECEPTION IN THE EXHIBIT HALL			
MONDAY, NOVEMBER 17				
8:00-11:00 AM	**WATER REUSE**	**PURE WATER USING EDI**	**PRODUCED WATER**	**POWER PLANT STEAM CYCLE**
11:00 AM-12:00 NOON	KEYNOTE SESSION IN SALON K/L/M			
12:00 NOON-1:15 PM	ATTENDEE LUNCHEON IN THE EXHIBIT HALL			
1:15 PM-5:00 PM	**ASME HRSG SYSTEM CHEMISTRY**	**MINE WATER TREATMENT**	**PRODUCED WATER/ SAGD OPERATIONS**	**DESIGN & OPERATION OF ZLD**
4:00-6:00 PM	ATTENDEE RECEPTION IN THE EXHIBIT HALL			
6:00 PM	IWC 75TH ANNIVERSARY DINNER - MARRIOTT RIVERWALK HOTEL, SALON A-D (2ND FLOOR)			
TUESDAY, NOVEMBER 18				
8:00 AM-12:00 NOON	**INNOVATIVE INDUSTRIAL WASTEWATER**	**HYDROFRACTURING WATER TREATMENT**	**ION EXHANGE OPERATIONS**	**DISCHARGE REQUIREMENTS FOR FGD**

	SALON I	SALON J	SALON K/L	SALON M
12:00 NOON-1:15 PM	ATTENDEE LUNCHEON IN THE EXHIBIT HALL			
1:15 PM-5:00 PM	**ASME PANEL SCALE & CORROSION**	**REFINERY WASTEWATER SELENIUM REMOVAL**	**FGD WASTEWATER**	**MEMBRANE PRETREATMENT**
5:00-7:00 PM	ATTENDEE RECEPTION IN THE EXHIBIT HALL			
WEDNESDAY, NOVEMBER 19				
8:00 AM-12:00 NOON	**COOLING WATER TREATMENT**	**WASTEWATER REUSE**	**POWER GENERATION**	**OPTIMIZING SAGD PRODUCED WATER**
1:00-5:00 PM	CONTINUING EDUCATION WORKSHOPS IN THE MARRIOTT RIVERWALK HOTEL			
THURSDAY, NOVEMBER 20				
8:00 AM-12:00 NOON	CONTINUING EDUCATION WORKSHOPS IN THE MARRIOTT RIVERWALK HOTEL			
1:00-5:00 PM	CONTINUING EDUCATION WORKSHOPS IN THE MARRIOTT RIVERWALK HOTEL			

WASTEWATER REUSE IN INDUSTRIAL APPLICATIONS

Wednesday, Nov. 19, 8:00 AM - 12:00 Noon; Room: Salon J

IWC Representative: Steve Gagnon, AVANTech, Inc., Columbia, SC

Session Chair: William Moore, Westech Engineering, Inc., Humble, TX

Discussion Leader: Greg Osen, AVANTech, Inc., Columbia, S

8:00 AM **SESSION INTRODUCTION**

William Moore, Westech Engineering, Inc., Humble, TX

Reuse/recycle water demands are driven by tighter regulations on plant discharge, restriction on inlet water volume and water availability. This session will present challenges using municipal waste, grey waters and ash leachate as feed water for power plants. New chemical treatments for cooling towers specifically targeting contaminants in waste water will also be reviewed. Presented will be a sophisticated program that will calculate overall plant chemistry and flows. Experiences from several plants will confirm that one design will not fit all applications."

8:10 AM **IWC 14-65: WATER REUSE APPLICATIONS IN POWER INDUSTRY COOLING TOWER CIRCULATING WATER SYSTEM**

John Van Gehuchten, P.E., HDR Engineering Inc., Pittsburgh, PA

The power industry has many reasons to evaluate reuse applications of water and wastewater as much as possible. Some of the biggest drives are strict regulations on wastewater discharge, limits on water intake volumes, and increased rates when buying water from public utilities. The circulating water system in most power facilities require large amounts of water, which does not have to be of the highest quality. Therefore if a range of water quality parameters can be met, there are significant costs saving opportunities in recycling wastewater. This review will be comprised of work done at two facilities evaluating the reuse of wastewater in the cooling water circulating water system. The first will be reusing treated municipal wastewater as makeup and the second will be reusing treated coal combustion residual landfill leachate.

8:35 AM Discusser: Mike Preston, P.E., Black & Veatch Corporation, Overland Park, KS

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-66: CONTROLLING DEPOSITION & CORROSION WHEN USING RECYCLED WATER FOR COOLING TOWERS**

Caroline Sui, Jeff Melzer, GE, Water & Process Technologies, Trevose, PA, Timothy W. Eggert, GE Power and Water, Water & Process Technologies Seal Beach, CA ,Warren Dan Harbs, GE Power and Water, Water & Process Technologies, Fountain Valley, CA

Worldwide water scarcity issues and environmental concerns are leading to increasing conservation efforts and more stringent water discharge regulations. This is forcing the power and refinery industry to supplement fresh water make up for cooling towers with treated municipal effluent, plant wastewater, and operating at higher cycles of concentration.

The characteristics of wastewater such as high phosphate levels, chlorides, total dissolved solids, ammonia, and biological and chemical oxygen demanding species place significant stresses on the chemical

treatment programs used to control corrosion, deposition and microbiological matters. Operating at high cycles of concentration increases the hardness of the cooling water and the retention time (holding time) of the system, both of which increase the propensity for deposition. To treat these lower quality waters under more stressed operating conditions, cooling water treatment programs must be more robust to resist problems associated with such elevated stresses.

This paper discusses the superior performance of novel polymer and monitoring technology in controlling deposition of mineral scales and in inhibiting corrosion under high stressed grey water conditions. Laboratory test results on tertiary treated municipal waste water with high levels of phosphate are presented. The successful application of this advanced technology in field is also discussed.

9:25 AM Discusser: Diane R. Martini, Sargent & Lundy, LLC

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM IWC 14-67: ADVANCED MODELING TECHNIQUES FOR REFINERY WATER CONSERVATION PROJECTS

Ronald Tebbetts, Nalco Champion, an Ecolab company, Sugar Land, TX and Kenneth J. Cygan Nalco, an Ecolab Company, Houston, TX

As refiners search for ways to conserve, reuse and recycle their available water, it has become apparent that these good intensions are often overshadowed by negative unintended consequences from a water treatment perspective.

An innovative approach is described where an entire water system can be modeled using software that combines a hydraulic model with the accuracy and confirmation of an ionic or salt balance and the ability to recycle reusable streams back to the front of the plant.

10:45 AM Discusser: Kristen Jenkins, P.E., CH2M HILL, Atlanta, GA

10:55 AM Floor Discussion & Closure

11:10 AM IWC 14-68: MUNICIPAL RECLAIMED WASTEWATER IN POWER GENERATION

Gary Engstrom, U.S. Water, St. Michael, MI and Brian Clarke, P.E. Kiewit Power Engineers, Lenexa, KS

The utilization of municipal reclaimed wastewater is becoming more common as the industry reduces its dependence on fresh water for steam generation and cooling applications within the power plant. The utilization of this water source can present unique system design, treatment and operational requirements that need to be identified and addressed at initial project design, through start-up and into steady state operation. This paper presents two (2) case studies that highlight different factors that need to be addressed in the development of a successful project.

11:35 AM Discusser: Vincent Como, Black & Veatch, Overland, KS

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

OPTIMIZING SAGD PRODUCED WATER TREATMENT OPERATIONS

Wednesday, Nov. 19, 8:00 AM - 12:00 Noon; Room: Salon M

IWC Representative: Michael Sheedy, P.Eng, Eco-Tec, Inc., Pickering, ON Canada

Session Chair: Lanny Weimer, GE Water and Process Technologies, Ellicott City, MD

Discussion Leader: David Pernitsky, Suncor Energy, Calgary, AB Canada

8:00 AM **SESSION INTRODUCTION**

Lanny Weimer, GE Water and Process Technologies, Ellicott City, MD

SAGD oil production is a relatively new industry that has been growing rapidly for the past twenty years. During this period the industry has experienced several lessons learned. The industry is constantly striving to optimize current operations and to adopt new technologies to meet future operational challenges. This technical session describes current efforts to optimize first generation SAGD produced water operations and discusses pilot test programs to evaluate emerging technologies.

8:10 AM **IWC 14-69: PROCESS OPTIMIZATION STRATEGIES AT THE ORION SAGD FACILITY**

Chandra Adimoolam, P. Eng., OSUM Oil Sands Corporation, Cold Lake, AB Canada and Greg Mandigo AquaChem ICD, Aquatech International Corp., Hartland, WI

The SAGD process of enhanced oil recovery has become a proven method for the deep oil bearing formations within the Alberta Oil Sands. The Orion SAGD Project is a 10,000 bpd facility operated by Shell Canada (through July 2014) and has been in operation since 2007. During this time, many process optimization strategies have been implemented to improve oil production and minimize various bottlenecks. This paper will examine the operational experiences of Orion SAGD Facility, share the results of process optimization efforts and provide design suggestions for future SAGD projects.

8:35 AM Discusser: Jason Grundler, Conoco Phillips Canada, Calgary, AB Canada

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-70: NEW GENERATION CHEMICAL CLEANING PROGRAM FOR SAGD PRODUCED WATER EVAPORATORS**

Sean Warren, Paul Jacobs Suncor Energy, Calgary, AB Canada, Carol Batton, John Hoots, and Ahmad Faizi, Nalco-Champion, an Ecolab Company Naperville, IL

Silicate-based deposits are prevalent in many produced water (SAGD, steam flood, etc.) plant unit operations. The type and structure of silica deposits can range from amorphous silica to highly complex metal silicates with hardness ions (primarily calcium/ magnesium), aluminum, iron/alkali-metal ions (sodium, lithium, etc.). Amorphous silica, iron salts, carbonates, organic-based foulants and other chemistries may be incorporated into deposits. Presence of silica/silicate deposits can significantly reduce system thermal efficiency and productivity, increase operating/maintenance costs, and in some cases lead to equipment failure. Steam generators and evaporators are especially prone to silicate deposits due to operation at elevated temperatures,

pH and increased cycles of concentration (COC).

One option to deal with declining performance of Mechanical Vapor Compression (MVC) evaporators or evaporators in general due to scale deposits is to implement a chemical wash. Chemistries previously used are commodity acid or caustic which usually are not fully effective for dissolving silicate deposits. Those cleaners can be very hazardous to both equipment and personnel. If a chemical wash does not effectively dissolve tenacious deposits, mechanical cleaning is done. Mechanical cleaning is useful for removing flaky deposits but may only polish more tenacious deposits without removing them. These deposits may continue to build up layer by layer over time. Mechanical cleaning is very time consuming, expensive (waste removal/ labor costs), and can result in significant lost production. This paper describes a safe, novel chemistry used for evaporator washes to remove silica/silicate and organic-based deposits. The new program provides more effective cleaning of deposits, quicker turnaround for equipment and a reduction in the need to mechanically clean. Successful field application at a northern Alberta SAGD site is summarized.

9:25 AM Discusser: Mark Nicholson, Veolia, Plainfield, IL

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM **IWC 14-71: PILOTING NEW TECHNOLOGIES FOR SAGD PRODUCED WATER DEOILING**

Michael Salerno, GE Water and Process Technologies, Trevose, PA

This paper presents results of a six-month pilot study conducted at a Suncor site, near Fort McMurray, AB by GE Water & Process Technologies (GEWPT), Suncor, and Alberta Innovates – Energy and Environment Solutions (AI-EES). The purpose of this pilot study was to vet several conventional and novel technologies, for removing entrained oil and other impurities from Steam Assisted Gravity Drain (SAGD) produced water. The produced water tested in the pilot unit was collected after the Free Water Knock Out (FWKO) and before the surge tank.

The produced water typically has a pH of 7.5, a turbidity of 120 NTU, and is at 85 – 90° C. The deoiled produced water will be further treated for total dissolved solids (TDS) removal before being fed to a Once Through Steam Generator (OTSG) as boiler feed makeup water. The primary goal is to design a full-scale system that will be an ultimate barrier to oil, and prevent potential downstream problems. The pilot testing is broken down into two main segments:

- Coarse Deoiling: three coarse deoiling technologies are evaluated: a centrifugal motion based oil-water separator, a modified induced gas flotation unit with proprietary chemistry, and a stacked filter unit with rotating disks to prevent fouling

- Membrane Filtration: three membrane options include a monolith form factor ceramic membrane, a multi-tube form factor ceramic membrane, and a polymeric spiral-wound membrane.

10:45 AM Discusser: Rafique Janjua, Fluor, Houston, TX

10:55 AM Floor Discussion & Closure

11:10 AM **IWC 14-72: ULTRAFILTRATION USING CERAMIC MEMBRANES FOR THE PURIFICATION OF PRODUCED WATER IN THE STEAM-ASSISTED GRAVITY DRAINAGE (SAGD)**

Adel Guirgis, Sunshine Oilsands Ltd., Calgary, AB Canada and Rafael Gay-de-Montella Transprocess Inc., Calgary, AB, Canada

Produced water that is generated by recovering bitumen in-situ in the SAGD process contains a lot of solids and Naphthenic Acids. The presence of contaminants in BFW has limited the use of boilers to Once Through Steam Generators (OTSG's) which produce a 20% blow-down. Drum boilers however produce less blowdown (about 2%) but require a higher quality BFW and the removal of solids and organic compounds (fatty acids, aliphatic and aromatic carboxylic acids and phenolic compounds).

Due to the presence of dissolved organics, organic membranes are prone to fouling and mechanical failure. Novel ceramic membranes, made from nano-material technology show promise in the application in produced water purification due to their stability in harsh environments and numerous choices for backwashing and cleaning. This paper details the results of investigation of produced water purification by microporous, mesoporous and macroporous ceramic membranes made from metal oxides both in tubular, one time through process.

11:35 AM Discusser: Dave Rowley, Conoco Phillips Canada, Calgary, AB Canada

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

POWER GENERATION PAST AND PRESENT – REFINING PRETREATMENT AND DEMINERALIZATION DESIGN TECHNOLOGIES AND INNOVATING WITH RENEWABLES

Wednesday, Nov. 19, 8:00 AM-12:00 Noon; Salon K/L

IWC Representative: Patricia Scroggin, P.E., Burns & McDonnell, Kansas City, MO

Session Chair: Michele Funk, Bechtel Power, Frederick, MD

Discussion Leader: Richard Roy, Public Services of New Hampshire, Bow, NH

8:00 AM **SESSION INTRODUCTION**

Michele Funk, Bechtel Power, Frederick, MD

Renewable technologies such as solar and geothermal may be adapted at power generation facilities to offset the auxiliary load of the plant or even replace traditional fossil generation. These renewable technologies bring with them new water treatment challenges. While these innovative renewable technologies are making their debut, refinements to existing core water treatment technologies that treat water for steam and cooling applications at power generation facilities, are ongoing. These refinements in traditional technologies are essential to keep up with changing environmental wastewater discharge regulations, more stringent steam purity requirements, and reduce water usage. This session covers a broad range of water treatment applications in the power generation industry from renewables to raw water quality data collection and analysis, demineralization, and wastewater treatment.

8:10 AM **IWC 14-73: THERMAL DESALINATION AND SOLAR ENERGY: A CASE STUDY**

Charles Desportes, Aquatech International Corp., Hartland, WI

Thermal desalination requires a heat source. Solar power is an environmentally friendly, renewable source of energy and of heat. With the improvement in efficiency of solar panels, be it Concentrated Solar Power (CSP) collectors or Photovoltaic ones, and their industrial development, this is becoming more cost effective and competitive compared to traditional energy sources. This paper presents the concept of an industrial size project where an MED desalination unit is associated with CSP collectors. The CSP collectors are associated with a steam turbine to produce electricity and then the low pressure steam is used to produce the water needed for the power plant as well as potable water for the neighboring town. We will look into the technical challenges faced and how they can be handled using proven technologies in innovative ways.

8:35 AM Discusser: Joe Potts, Duke Energy, Raleigh, NC

8:45 AM Floor Discussion & Closure

9:00 AM **IWC 14-74: CONTROL OF METAL SULFIDE DEPOSITS IN GEOTHERMAL BINARY PLANTS**

Jasbir Gill, Nalco, an Ecolab Company, Naperville, IL, Logan Muller Nalco, An Ecolab Company, Auckland, New Zealand, David Rodman, Nalco, An Ecolab Company Townsville, Australia ,Kevin Brown, Nalco, An Ecolab Company, Christchurch, New Zealand, and Ray Robinson, Nalco, An Ecolab Company, Kaikohe, New Zealand

Geothermal power generation is growing due to the need for clean renewable energy. Traditional dry steam generation plants have been in operation in countries where Geothermal dry steam is prevalent for several decades e.g., New Zealand, Iceland, Philippines. However as the cost and environmental impact of fossil fuel power generation is realized, more effort is being placed into more complex geothermal use such as low enthalpy power plants and EGS or Hot Rock technology plants. These latter technologies bring a raft of chemical complexity to power generation in particular Silica and metal Sulfides. Whilst Silica and Arsenic Sulfides are well researched, comparatively little is known about Antimony Sulfide. The absence of chemical inhibitors for the sulfide compounds has resulted in significant fouling of some geothermal plants causing losses of power output, thereby reducing the economic viability of these plants. Recent developmental work at the Ngawha Generation site in New Zealand has shown a significant step forward in the control of Antimony Sulfide deposition in binary plant heat exchangers. This plant was taking generation units off line for cleans every 12 weeks due to the loss of power production resulting from Antimony Sulfide scale. This paper outlines how these metal Sulfides have been prevented from depositing, providing improved power output, reduced need for cleaning and, subsequent, minimization of handling these toxics deposits.

There may be important implications for EGS technologies as the toxic metal Sulfides have presented a barrier to consistent power production in at least one test site.

9:25 AM Discusser: Greg Behrens, P.E., URS Corporation, Austin, TX

9:35 AM Floor Discussion & Closure

9:50 AM Break

10:20 AM **IWC 14-75: SELECTING WATER TREATMENT EQUIPMENT AND PREPARING A COMPREHENSIVE WATER BALANCE FOR NEW FACILITIES**

Brad Buecker, Kiewit Power Engineers, Lenexa, KS USA

Water and steam are the lifeblood for most power plants and many industrial facilities. Yet, proper raw water quality data collection and subsequent water treatment equipment selection and treatment programs are often given inadequate attention by developers and owners of new facilities. These oversights can easily lead to equipment that underperforms or even fails during plant startup. Also, accountants often focus solely upon least cost when it comes to bid evaluations, but least cost may be far from best cost when it comes to actual equipment reliability and longevity. And, there is no such thing as "baseline" water chemistry when selecting proper water treatment processes and developing a plant water balance. This paper examines a number of the most important concepts with regard to water and wastewater treatment equipment selection for the many new combined-cycle power plants planned throughout the country. Many of the techniques outlined in this paper also apply to other industries.

10:45 AM Discusser: Bryan Hansen, P.E., Burns and McDonnell, Centennial, CO

10:55 AM Floor Discussion & Closure

11:10 AM **IWC 14-76: PLANNING TO ACHIEVE ELG COMPLIANCE IN A PERIOD OF UNCERTAINTY**

Kristen Jenkins, P.E., Christina Joiner, CH2M HILL, Atlanta, GA, Dennis Fink CH2M Hill, Oakland, CA, and Dr. Thomas Higgins, CH2M Hill Chantilly, VA

In the face of growing regulatory and litigation pressures, utilities are reviewing options for using ponds for wastewater treatment and ash disposal. Selecting a strategy that complies with the new drivers is a complex process. Conducting an effective alternatives evaluation requires a rigorous methodology, tools to make the evaluation efficient, and treatability testing (in some situations). Development of an alternative that minimizes cost and risk also requires innovative application of treatment and reuse technologies.

11:35 AM Discusser: Matthew Kirk Ellison, Southern Company, Birmingham, AL

11:45 AM Floor Discussion & Closure

12:00 PM Conclusion

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WORKSHOPS

The workshop program is designed to provide practical information that includes a basic understanding of the topic as well as detailed case studies. They are presented by experts in the field and are loaded with technical content, not for sales information. Each workshop will provide an opportunity for a technical exchange between the students, the instructor and other workshop participants. The workshop will provide attendees 4 professional development hours (PDHs) and a certificate of completion. A separate fee of $250 is required. All workshops are scheduled based on minimum reservations; please inquire at the conference registration desk about the current status of any of the workshops. Discounts are given for multiple registrations.

Wednesday, Nov. 19, 1:00-5:00 PM

W1: Industrial Boiler Water (up to 1800 PSIG/ 120 Bar)

The course is intended for those interested in industrial steam systems operating at pressures up to 1800 psig. While some basic theory is covered, the main focus of the course is to provide practical information that can be used to avoid common system problems. The course covers deaerators, boilers, steam turbines and condensate systems from both mechanical operation and chemical treatment aspects. The causes of deposition and corrosion as well as water quality and monitoring guidelines and chemical treatment options are discussed in an informal atmosphere.

James Robinson, GE Betz, Trevose, PA

W2: Water Treatment 101*

This workshop is a great introductory course covering the basic concepts of water treatment for industry. It will address unit operations (clarification, filtration, lime/soda ash softening, iron and manganese removal, membrane filters, and roughing demineralizers) used in water preparation for industry with emphasis on power, chemical industry, and refineries. It was include treatment of makeup water for cooling water systems as well as boiler water makeup. Wastewater generated by these unit operations and their treatment and disposal will be discussed. Basic water chemistry requirements for low, medium, and high pressure boilers will be considered with chemical conditioning as required.

Dennis McBride, Fluor Enterprises, Greenville, SC

W3: Introductions to Cooling Tower Water Systems and How to Develop a Cooling Tower Water Treatment Program 101

This workshop discusses the problems commonly found in Cooling Tower Water systems and the various water treatments that can be used to control or prevent those problems. Specific water treatment chemicals are discussed and their advantages and disadvantages are presented. These specific chemicals are for corrosion, scale, fouling, and microbiological control. They are identified generically and include the most recent developments. The preparation of the complete water treatment program is provided in easy to apply steps. This workshop is excellent for operators, utility mangers, and water treatment suppliers both new on the job and great as a refresher for others.

Paul Puckorius, Puckorius & Associates, Inc., Arvada, CO

W4: Treatment of Water for Steam Generation in SAGD Enhanced Oil Recovery Plants

"Once you know the fundamentals, acquiring experience is just a matter of time." This course explores the theories and fundamental practices for treating de-oiled produced and brackish waters to generate high pressure steam for use in SAGD enhanced oil recovery operations. We will explore hot and warm lime softening, filtration and ion exchange options such as strong acid versus weak acid cation softening including in-situ versus external regeneration.

Robert Holloway, Holloway Associates, Etobicoke, ON Canada

W5: Thermal Zero Liquid Discharge Processes

This course is designed to give a basic understanding of the information required for the selection and design of an evaporation system in a wastewater application. It will include the impacts of chemistry, equipment selection and energy source selection as well as provide case studies based on real world applications in a variety of industries.

J. Michael Marlett, P.E., P.Eng. Aquatech International Corp., Hartland, WI

W6: Treating Produced Water with Ion Exchange Technologies

General introduction on Softening with Ion Exchange. Description of the nature of SAC resin and of WAC resin. Influence of TDS on selection of which resin to select. Advantages to consider SAC-SAC systems. Why single WAC are able to produce soft water ($<$0.1ppm) on water with up to 25000ppm TDS. Why WAC Primary followed by WAC Polisher should be considered. Potential foulants of ion exchange resins in the process of softening Produced Water, and how to deal with them. All data presented is based on actual plant experience!

Guy Mommaerts, Ion Exchange Services (Canada) Inc., Elimira, ON Canada

W7: Arsenic and Selenium in Wastewater Treatment

Changes in regulations in the coal-fired power industry and existing standards in the mining industry are but two examples of increased regulatory focus on arsenic and selenium. These ions have not been the focus of emphasis for widespread industrial treatment in the past. Numerous new technologies have been promoted for use in the treatment of arsenic and selenium. However, it is difficult for the environmental personnel responsible for making intelligent decisions in this area to assess the real potential of treatment technologies to cost-effectively achieve the desired goals. This course will provide the background necessary for those concerned with arsenic, selenium or both to make sound decisions about the technical direction of treatment options.

John Schubert, P.E., HDR Inc., Sarasota, FL

Thursday, Nov. 20, 8:00 AM - 12:00 Noon

W8: HRSG and High Pressure (>900 PSIG/60 BAR) Boiler Water Treatment and Operation

This workshop will cover the water quality required for high pressure (>900 psig/60 bar) steam boilers including the various treatments being used and new developments relative to protection from scale and corrosion. The course will also cover treatment issues related to pre-boiler systems and the condensate systems and a discussion of controls and troubleshooting techniques. Operators, utility plant supervisors, managers, and engineers can all benefit greatly from the practical information provided in this course.

David Daniels, Mechanical & Materials Engineering, Austin, TX

W9: Water Treatment 201

This workshop reviews the topics covered in Water Treatment 101 and build on those to provide design and technical details on designing water treatment systems using supplier's equipment information. Unit processes covered in this course are pretreatment softening using lime and soda ash, sodium cycle ion exchange for softening, demineralization of pretreated raw water using cation/anion/ mixed-bed ion exchange systems, reverse osmosis, and EDI. Boiler water chemistry guidelines and chemicals feeds for boiler chemistry control for high pressure power plant boilers, combined cycle plants, and industrial boilers (up to 1500 psi) will be discussed. Advanced wastewater treatment concepts for power plants, industrial plants, and refineries will be included with recycle and reuse when feasible.

Kumar Sinha, Consultant, Frederick, MD

W10: Advanced Ion Exchange

This workshop is designed to build on basic ion exchange principals and will provide the opportunity to acquire an in depth knowledge of how ion exchange resins can be used in applications other than traditional softening and deionizing applications. Presented in four sections:

- Ion exchange fundamental theories and a review of the four basic types of ion exchangers, how their properties differ, and how they are used.
- Capacity calculations for any virtually any ion and solution and how to make preliminary calculations to determine if ion exchange is feasible and/or practical.
- Trace ion removal, principal of concentration difference, an over view of selective resins, and brief discussion of how some of the more common trace contaminants can be treated.
- Identification of problems causes, troubleshooting approaches, cleaning strategies, and how to set up spreadsheet models of operating ion exchange systems that normalize operating data.

In order to get the most out of this workshop, students will need to bring laptops that have MS Office software including Excel.

Peter Meyers, ResinTech, Inc., West Berlin, NJ

W11: Reverse Osmosis Back to the Basics, Design and Operation*

The application of reverse osmosis (RO) has grown rapidly over the last 15 year. However, some of the basics have been lost in shuffle. Furthermore, many times professionals and operators familiar with ion exchange are now faced with operating RO systems with little or no training. This Workshop covers the basics of RO, from sound design to proper operating techniques. Fouling and concentration polarization, data collection and normalization, cleaning and storage are just some of the topics included in this Workshop. This workshop is intended for all who need to understand the basics of RO.

Jane Kucera, Nalco Company, an Ecolab Company, Naperville, IL

W12: Cooling Water Treatment Programs and Guidelines when switching from Fresh to Reuse Water Makeup 201

This workshop will cover guidelines to be used in developing a cooling water treatment technology going from fresh to recycle waters as makeup. These guidelines will identify possible concerns and potential benefits with recycle water. A step by step approach is provided for existing cooling tower water systems and new systems that can handle almost any recycled waters. Attendees are encouraged to bring not only any questions but also details on their cooling tower water systems and the recycle water quality being considered. A must workshop for operators, utility managers, and for water treatment suppliers.

Paul Puckorius, Puckorious & Associates, LLC, Arvada, CO

W13: Wastewater Treatment for Energy and Chemicals

Subjects discussed:

1. Identification of wastewater streams
2. Selective segregation of wastewater streams
3. Pretreatment of segregated streams
4. Terminology & Microbiology of wastewater treatment
5. Primary wastewater treatment unit operations
6. Secondary wastewater treatment unit operations
7. Solids production, its treatment and disposal management

Rafique Janjua, Fluor Enterprises, Inc., Sugarland, TX

W14: Fundamentals of Evaporative Water Treatment for Steam Generating EOR Processes

Evaporative water treatment may seem complex at surface-level, but once the underlying principles are understood, evaporation system design and operation become very straightforward. This course is designed to explore everything from the fundamentals of evaporator technology to its integration into various EOR processes: steam injection processes such as SAGD and CSS. Course matter will cover the basics of producing water suitable for steam generation (either drum boilers or OTSG's) and maximizing water recycle by employing concentration and crystallization systems. A particular emphasis will be placed on water chemistry design implications and unit operations such as falling film evaporation and crystallization will be covered in-depth. Several real world case studies will be examined to reinforce theoretical principles.

Greg Mandigo, Aquatech International Corp., Hartland, WI

Thursday, Nov. 20, 1:00 - 5:00 PM

W15: IX Technology and Practical Operating Practices*

This workshop provides a detailed review of the various ion exchange processes for softening and demineralizing water as well as preparation for boilers, cooling, and process applications. A section on how to evaluate systems, their resin, operation, and water quality of ion exchange units is an excellent troubleshooting and informative portion of this workshop. A review of the different ion exchange resins available along with the newest developments and how those can be applied to provide specific water quality is a must for water treatment system operations. Ask questions and solve problems!

Wayne Bernhal, W. Bernahl Enterprises, Ltd., Elmhurst, IL

W16: Electrodieonization (EDI) Presents

Electrodeionization (EDI) is a time proven process which combines semi-permeable membrane technology with ion exchange media to provide a highly efficient

Self-regenerated unit that provides demineralized water without chemicals. This workshop will be broken down into two sections. The 1st section will explore the design and operation of EDI modules from different manufacturers of EDI membranes. A typical feed water source shall be reviewed and EDI projections will be presented from different EDI membranes manufacturer(s). The 2nd section will cover their system design approaches and effluent water quality; provide a simplified

EDI - P&ID print of the system designed, present recommended membrane data collection parameters, cleaning protocol, review a typical autopsy report and the system operating cost. This workshop provides one stop shopping for all your EDI needs.

Greg Osen, AVANTech, Inc., Columbia, SC

W17: Proper Designs for Ion Exchange Softeners in SAGD or Cyclic Steam Operations

Ion exchange in SAGD waters, both brackish and produced, is usually limited to softening for OTSG make-up. Both are usually lime softened, and often contain high TDS levels, low hardness to TDS ratios and foulants such as oil. This course will explain the two different processes, WAC or SAC ion exchange, reasons for picking one or the other, cleaning and regeneration methods, as well as compare capital and operating costs. It will be useful to both design engineers and operators.

Don Downey, The Purolite Company, Paris, ON Canada

W19: De-oiling Produced Water for Insitu Oilsands

Upstream of "Produced Water Treatment" in SAGD or CSS, water that has been separated from the bulk bitumen/dilbit phase, contains varying amounts of hydrocarbon. If not removed from the system this hydrocarbon will negatively impact the performance of Boiler Feed Water pre-treatment equipment such as Lime Softening, Ion Exchange and Evaporators. This introductory course looks at the fundamentals of the De-oiling system. We will explore the purpose and system design, of specific equipment such as Skim Tanks, Induced floatation (ISF and IGF), as well as Oil Removal Filters (ORF's). We will also discuss industry standards, chemistry, and lessons learned.

Chris Graham, C.G. Consulting Inc., Calgary, AB Canada

W20: Water and Wastewater Treatment for Natural Gas Development

The ongoing development of the unconventional natural gas market was made possible by developments in the fields of directional drilling and hydrofracturing.

Hydrofracturing requires large volumes of water, processing of that water to use in hydrofracturing, and handling of the return water from the well after completion of hydrofracturing. As hydrofracturing water comes in contact with shale, some of the soluble shale constituents dissolve into the hydrofracturing water. Current options for handling of hydrofracturing water include treatment for reuse, treatment for discharge, and deep well disposal. The focus of this course is to provide a foundational understanding of the use of water in hydrofracturing, and the disposition of return water (flowback and produced water) from hydrofractured wells.

Areas of emphasis include hydrofracturing water preparation, treatment of flowback water for reuse, evaporation-crystallization of hydrofracturing water, and overall economics of water management. The course serves as a sound introduction to the area for those wishing to learn about shale gas development, and provides detailed information for professionals who may be working with shale gas water.

John Schubert, P.E., HDR Inc., Sarasota, FL

W21: UF, RO and EDI Maintenance and Cleaning

Presentation of common practices in the maintenance of ultrafiltration, reverse osmosis and deionization systems, including best practices for off line clean in place process as well as on site membrane cleaning practices membrane and system life and minimizing operations cost. For ultra-filtration and reverse osmosis the training review will cover preventive maintenance practices, spares replacement frequencies, and non-scheduled maintenance repairs. There will be a detailed discussion of membrane maintenance practices, including why cleaning is important, when CIP or onsite site cleaning should be triggered, the common foulants, preparation of cleaning solutions, standard cleaning procedures, tips and shortcuts, and when off-site membrane cleaning should be considered.

Attention will be focused on the key performance indicators for RO/NF membranes and hollow fiber ultrafiltration membranes that should trigger a membrane cleaning process and the variation in procedures and solutions for onsite cleaning for RO/NF membranes for removal of silt, biological materials, naturally occurring organics, calcium carbonate, iron and silica as well as UF membranes for removal of biological materials, silt, naturally occurring organics, and iron. There will also be discussion of membrane autopsies, when they are needed and how to interpret the results.

With the increasing use of electrodeionization technology such as continuous deionization the instructor will also touch on best practices in determination when unit cleaning is required as well as proper chemical cleaning and off site cleaning practices.

Robert Cohen, Evoqua, Rochester, NY

Exhibitors

IWC EXHIBIT HALL

The IWC Exhibit Hall features countless different opportunities to learn about practical and innovative solutions for the industrial water treatment industry from industry leaders. The Exhibit Hall is located inside and outside Salons A, B, C & D of the Rivercenter Hotel. The Exhibit Hall hours of operation are:

- Sunday, November 16 from 5:00 - 7:00 PM
- Monday November 17 from 11:30 AM - 1:30 PM and 4:00 - 6:00 PM
- Tuesday November 18 from 11:30 AM - 1:30 PM and 4:00 - 6:00 PM

Be sure to join us for lunch on Monday and Tuesday, as well as the evening receptions Sunday, Monday, and Tuesday. Luncheons and receptions are open to all registered attendees. A listing by booth number of all 2014 IWC Exhibitors is provided below. On the following pages, you will find a detailed description of these Exhibitors, including contact information and company description.

102 LANXESS Sybron Chemicals
104 Advanced Inspection Technologies
106 Avista Technologies, Inc.
108 ASA Analytics
110 & 112 Evoqua Water Technologies
118 Johnson March Systems, Inc.
120 Wiley
122 newterra
124 CHEMetrics
126 BWA Water Additives
201 Sentry Equipment Corp.
202 Aquatech International Corp.
203 SAMCO Technologies, Inc
204 Mitsubishi Electric Automation
205 OLI Systems, Inc.
206 MPW Industrial Services
207 Justeq LLC
208 Solar Bee/ GridBee
209 Astral Industrial (Fluidra USA)
210 & 212 Nalco, an Ecolab Co.
211 WesTech Engineering, Inc.
215 DOW Water and Process Solutions
216 Milton Roy
217 LGA Chemical Solutions, Inc.
218 Frontier Water Systems
219 Jacobi Carbons, Inc.
220 Athlon Solutions
221 Alcoa/ Bauer
222 Honeywell Process Solutions
223 & 225 Neptune Chemical Pump Co./ Fluid Dynamics
224 ProChem, Inc.
226 Turner Designs Hydrocarbon Instruments, Inc.
301 Severn Trent Water Purification, Inc.
302 Veolia Water Technologies
303 Parkson Corporation
304 METTLER TOLEDO Thornton
305 U.S. Peroxide
306 BKT
307 Zequanox by MBI
308 Brenntag North America
309 Ahlstrom Filtration LLC
310 & 312 Purolite Company
311 AVANTech, Inc.
315 French Creek Software, Inc.
316 Baker Hughes Process & Pipeline Service
317 UOP, A Honeywell Company
318 AMSA, Inc.
319 & 321 H2O Biofouling Solutions
320 Illinois Water Technologies
322 Cosun Biobased Products
323 & 325 Degremont Industry
324 Shandong Taihe Water Treatment Co.
326 QUA Group, LLC
401 Graver Water Systems/ Ecodyne Water
402 ResinTech, Inc.

Exhibitors

EXHIBITOR LISTING, CONTINUED

403 Genesys International, Ltd.
404 Waters Equipment Co.
405 Southern Research Institute
406 Federal Screen Products Inc
407 WaterTectonics
408 Howden North America
409 MIOX Corporation
410 Hach Company
411 ChemTreat, Inc.
412 Solenis
415 Chemtrac, Inc.
416 & 418 GE Power & Water
417 Delta Pure Filtration
419 BigMembrane.com
420 Itochu Chemicals America Inc.
421 Stenner Pump Company
422 BluMetric Environmental Inc.
423 Watersurplus
424 BlueInGreen
425 U.S. Water Services
426 Ovivo USA, LLC
501 Schreiber, LLC
502 Eco-Tec Inc.
503 Swan Analytical USA
504 Bowen Engineering Corp.
505 FilterBoxx Packaged Water Solution Inc.
506 Aeration Industries International
507 GRUNDFOS Pump Corporation
508 Global Chem-Feed Solutions
509 MAR Systems, Inc.
510 Advanced Sensors Limited
511 Golder Associates, Inc.
512 & 514 H2O Innovation
515 Thermax, Inc.
516 American Water Chemicals
517 Lechler Inc
518 TriSep Corporation
519 Atlantium Technologies
520 Taylor Technologies
521 & 523 Wigen Water Technologies
522 Craftsmen Industries
524 Aqua-Chem, Inc.
525 Burns and McDonnell Engineering Company, Inc.
526 PSI/ MicrOclor
Table 4 H-Tec
Table 5 WaterColor Management
Table 6 CLO2 Services, LLC

Exhibitors

ALPHABETICAL LISTING

ADVANCED INSPECTION TECHNOLOGIES

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Phone 321-258-5901
Email paul@aitproducts.com
Website www.aitproducts.com

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ADVANCED SENSORS LIMITED

Booth 510
Contact Duane Germenis
Phone 281-433-5002
Email duane.germenis@advancedsensors.co.uk
Website www.advancedsensors.co.uk

Advanced Sensors is the leading global supplier of Oil in Water analyzers to the Oil and Gas Industries. We provide innovative solutions that guarantee our analyzers are self-cleaning, reliable and durable. We combine technologies such as ultrasonics, fluorescence and video microscopy to ensure analyzers stay clean and provide precise readings.

AERATION INDUSTRIES INTERNATIONAL

Booth 506
Contact Todd Martin
Phone 800-328-8287
Email aii@aireo2.com
Website www.aireo2.com

Aeration Industries International is the the world's largest manufacturer of surface aeration equipment. We supply high quality treatment systems and advanced AIRE-O2 Triton process aerator/mixers to provide solutions for the challenging industrial wastewater industry, including the petroleum segment. Since 1974, over 70,000 aerators have been delivered throughout the U.S. and in more than 92 countries.

AHLSTROM FILTRATION LLC

Booth 309
Contact Rodney Komlenic
Phone 616-486-6401
Email Rod.komlenic@ahlstrom.com
Website www.ahlstrom.com

Ahlstrom Filtration is a high performance filtration company producing a wide range of specialty filter materials. We will be exhibiting our Disruptor® electroadsorbent filtration technology. This technology is capable of reduce a wide range of submicron contaminants and membrane biofoulants. Organic contaminants include: virus, bacteria, cell debris, polysaccarides and organic acids. In addition the technology can reduce many trace pharmaceuticals, PBB's, endocrine inhibitors.

ALCOA/ BAUER

Booth 221
Contact Yatin Thaker
Phone 713-699-7626
Email Yatin.Thaker@bauer.de
Website www.bauerenvironment.com www.alcoa.com

Alcoa and Bauer have partnered to deliver state-of-the-art wetland based wastewater treatment systems with a focus on enabling sustainable water use and reuse. With solutions suitable for a wide range of sanitary, industrial, produced, and other wastewaters, the Alcoa / Bauer team offers world class water management technology to industrial and municipal customers worldwide.

AMERICAN WATER CHEMICALS, INC.

Booth 516
Contact David Russell
Phone 951-216-0240
Email drussell@membranechemicals.com
Website www.membranechemicals.com/

American Water Chemicals, Inc. (AWC) is an international ISO 9001:2008 certified company specializing in advanced chemical solutions and analytical services for membrane separation processes. AWC manufactures membrane antiscalants, antifoulants, and cleaning chemicals for reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), and microfiltration (MF) membrane purification systems. AWC is an industry pioneer of advanced membrane autopsy techniques and investigative services and supports both public and private business sectors. Our services are designed to help identify operational problems by improving membrane system performance and reducing cost through scientifically engineered solutions.

AMSA, INC.

Booth 318
Contact Janice Shawl
Phone 989-662-0377
Email sales@amsainc.com
Website www.amsainc.com

AMSA Inc. manufactures DTEA II™ an organic deposit cleaner, penetrant and dispersant used in industrial cooling water systems. DTEA II™ is also used in geothermal utilities to inhibit and remove sulfur deposits. Outside the USA DTEA II™ is sold as a biocide.

Exhibitors

ALPHABETICAL LISTING

AQUA-CHEM, INC.

Booth 524
Contact Michael Pudvay
Phone 865-318-1086
Email mpudvay@aqua-chem.com
Website www.aqua-chem.com

Water scarcity, increasing water and wastewater costs, and tightening environmental regulations are forcing a shift in how Industrial users think about water. In response to that shift, AQUA-CHEM has developed water treatment solutions to maximize water efficiency and reduce water costs for a wide range of industries and applications. Aqua-Chem's ECOCYCLE waste water reclamation and reuse system is a GREEN technology which allows you to reclaim and reuse your waste water and waste heat.

AQUATECH INTERNATIONAL CORP.

Booth 202
Contact Patrick Randall
Phone 724-746-5300
Email aic@aquatech.com
Website www.aquatech.com

Aquatech is a global leader in water purification technology for industrial and infrastructure markets with a focus on the treatment of produced water, desalination, water reuse, and zero liquid discharge. They have global sourcing, EPC, O&M, and onsite services capabilities to suit logistics of project sites worldwide and also the capability to deliver projects on a

ASA ANALYTICS

Booth 108
Contact Scott Kahle
Phone 262-717-9500
Email skahle@chemscan.com
Website www.activtracanalyzers.com

For over 20 years ASA Analytics has designed and manufactured analyzers for water and wastewater monitoring. The ActivTrac single parameter analyzers from ASA provide reliable and accurate measurement of Polymer, Molybdate, Ortho Phosphate, Silica, Copper, Hexavalent Chrome, Chlorine, Sulfite, Manganese, Chloramine, Ammonia and more. The analyzers are designed for minimal maintenance with only quarterly reagent refresh. The device complements the multiple parameter, multiple sample line ChemScan analyzers manufactured by ASA Analytics.

ASTRAL INDUSTRIAL (FLUIDRA USA)

Booth 209
Contact Carme Marine
Phone +34 608209886
Email cmarine@fluidra.com
Website www.fluidra.us

FLUIDRA USA is the manufacturing company of pressure filters from reinforced fiberglass. Thanks to our 4 production facilities, one in Jacksonville, Florida and 3 in Spain, we have a large production capacity. The filters can be supplied with lateral system or with nozzle plate. We can produce both vertical and horizontal equipments of different sizes with different connections. Our filters can be used for swimming pools, aquaculture, mining, irrigation, water treatment, desalination and other industrial applications. They are suitable for mechanical filtration, ion exchange, activated carbon filtration, biological filtration, denitrification or remineralisation.

ATHLON SOLUTIONS

Booth 220
Contact Samir Shah
Phone 226-673-2436
Email Samir.Shah@athlonsolutions.com
Website www.athlonsolutions.com

Athlon Solutions provides water, process treatment and finished fuel additives to the Refining, Petrochemical, Fertilizer and Power industries. Athlon, derived from the Greek, "competition for a prize", is our new name for the downstream water and process solutions groups that were part of the outgrowth of the recent sale of Champion Technologies. Our 50 year history in process fouling, corrosion control, and desalting, offers an experienced approach to address process and industrial water challenges.

ATLANTIUM TECHNOLOGIES

Booth 519
Contact Dennis Bitter
Phone 941-923-9960
Email dennisb@atlantium.com
Website www.atlantium.com

Atlantium's Hydro-Optic™ Technology can significantly lower Operating costs through increased efficiencies, better heat transfer and improved productivity. A "new era" in water treatment, Hydro Optic™ Science is a cutting edge, environmentally-friendly, disinfection solution based on new generation UV technology. Systems are compact easy to install with lower Capital and Energy costs then traditional UV technology. Atlantium Technologies, Ltd. Is a proven solution for chemical free dechlorination to protect RO membranes and macro (AIS) and micro bio fouling.

Exhibitors

ALPHABETICAL LISTING

AVANTECH, INC.

Booth 311
Contact Steven R. Gagnon
Phone 803-467-4774
Email sgagnon@avantechinc.com
Website www.avantechinc.com

AVANTech is a global leader that delivers innovative technology solutions and services that client valve and trust. We build every system to order and offer clients powerful, operator-friendly systems at competitive prices. Our creative solutions dramatically improve operations in industrial, power and nuclear application. Our technical service team supports our equipment with comprehensive operations and maintenance manuals along with as-built drawings. Information is available through our virtual private network, accessible from our website. Our goal is service second to none!

AVISTA TECHNOLOGIES, INC.

Booth 106
Contact Mike Graver
Phone 215-859-0752
Email mgraver@avistatech.com
Website www.avistatech.com

Avista Technologies is a trusted expert in membrane system chemistry and global technical and laboratory support for Reverse Osmosis and Micro/Ultra Filtration membrane systems and Multimedia Filtration. Reverse Osmosis products include: Vitec® antiscalants, RoClean and AvistaClean® membrane cleaners and RoCide® biocides. A Green line of proven antiscalants and cleaners are free of phosphate, phosphonate, and EDTA. AvistaClean® MF are one-step cleaners formulated to restore MF/UF membrane performance when generics are no longer effective.

BAKER HUGHES PROCESS & PIPELINE SERVICE

Booth 316
Contact James Booth
Phone 484-390-0511
Email james.booth@bakerhughes.com
Website www.bakerhughes.com/products-and-

Baker Hughes AVIA™ water treatment solutions consist of engineering services, chemicals, and equipment. When using water for heating, cooling, stripping, or as a carrier, we help reduce operating costs using safe and environmentally compliant solutions. When searching for your water treatment provider, you need one big enough to handle all needs, agile enough to respond to changes, and experienced enough to be proactive. Baker Hughes AVIA water treatment solutions give you all that and more.

BIGMEMBRANE.COM

Booth 419
Contact Dan Pasulka
Phone 910-612-6700
Email danp@easternro.com
Website www.bigmembrane.com

BigMembrane.com, aka Eastern RO, is a stocking distributor of GE filters, Code line vessels and multiple brands of RO membranes. We have partnered with dealers, OEMs, municipalities and global industry to provide just-in-time membranes and other parts from our expansive inventory.

BKT

Booth 306
Contact Joon Min
Phone 714-576-0676
Email jhm@bkt21.com
Website www.bkt21.com

BKT provides treatment technology for various types of wastewater including FGD, produced and flowback, along with industrial wastewaters.
The antifouling membrane system, FMX, specializes in the liquid-solid separation for high density, high viscosity, and high solid applications. FMX can successfully achieve significant removal of contaminants and need can meet strict discharge limits with downstream reverse osmosis. BKT provides biological wastewater treatment, membrane filtration, and energy solutions to clients, including many global Fortune 500 companies.

BLUEINGREEN

Booth 424
Contact Greg Gaffney
Phone 713-392-7665
Email greg.gaffney@BlueInGreen.com
Website http://blueingreen.com/

All sidestream gas dissolution and injection systems operate off the same fundamental principles. Generally speaking, Henry's Law governs the dissolved gas concentration of sidestream solutions while fundamental hydraulics govern pumping and energy requirements for a given volume or mass of gas. Our technology supersaturates a sidestream of liquid with a particular gas. This supersaturated stream is then reinjected into a larger body of liquid (ie. basin, pipe, lake, river, etc.)

Exhibitors

ALPHABETICAL LISTING

BLUMETRIC ENVIRONMENTAL INC.

Booth 422
Contact Gary Black
Phone 613-818-4611
Email gblack@blumetric.ca
Website www.blumetric.ca

BluMetric Environmental solves complex industrial wastewater treatment challenges with innovative and cost effective solutions. Whether pre-treatment prior to sewer or direct discharge to the environment, we utilize our experience to provide efficient biological, chemical and physical technologies to solve today's most complicated wastewater problems. Leveraging our partnership with LG, we bring state-of-the-art membrane technology to our Membrane BioReactor (MBR). Let BluMetric provide a turnkey solution for your facility.

BOWEN ENGINEERING CORP.

Booth 504
Contact Michael Soller
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Email msoller@bowenengineering.com
Website www.bowenengineering.com

Bowen is a self-performing general contractor delivering owners strong EPC and self-perform construction services including site, civil, structural, boilermaker and mechanical construction. With 47 years serving the Water/Wastewater and Energy/Industrial Markets, Bowen is your nationwide Industrial Water, CSO, ELG, MATS, and CCR construction expert.
Bowen has constructed over 1,000 treatment facilities, and has strong physchem, biological, evaporator experience. We are your most resourceful, and responsive construction company bringing you the best results.

BRENNTAG NORTH AMERICA

Booth 308
Contact Barbara Nothstein
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Email brenntag@brenntag.com
Website www.brenntagnorthamerica.com

Brenntag Water Additives your partner in Solutions for Industrial, Commercial and Municipal Water Treatment. Experienced and dedicated team members apply knowledge from Brenntag's global network to meet local needs. Brenntag is a full line chemical distributor with over 140 stocking locations in the US and Canada. Our broad product line includes coagulants, flocculants, biocides, scale inhibitors, corrosion inhibitors, defoamers, permanganates, filtration media, NSF certified products and facilities, as well as products for heavy metal removal and odor control.

BURNS AND MCDONNELL ENGINEERING COMPANY, INC.

Booth 525
Contact Scott Strawn
Phone 816-823-7153
Email sstrawn@burnsmcd.com
Website www.burnsmcd.com

Founded in 1898, Burns & McDonnell is a full-service engineering, architecture, construction, environmental and consulting solutions firm. With the multidisciplinary expertise of more than 4,300 employee-owners in more than 30 offices, Burns & McDonnell plans, designs, permits, constructs and manages facilities worldwide with one mission in mind – to make our clients successful.

BWA WATER ADDITIVES

Booth 126
Contact Melissa Goeren
Phone 678-802-3050
Email americas@wateradditives.com
Website www.wateradditives.com

BWA Water Additives is the leading global provider of specialty chemical solutions for the oil & gas, desalination, and industrial water treatment markets. BWA antiscalant, corrosion inhibitor and microbiocide technologies provide customers with the essential elements required to meet today's water management challenges. Our brands: Belclene®, Belcor®, Belgard®, BromiCide®, Bellasol®, Belsperse®, Bellacide® and Flocon® are recognized worldwide for the highest quality and superior technical performance. Visit our website at www.wateradditives.com

CHEMETRICS

Booth 124
Contact Chris Christiansen
Phone 800-356-3072
Email marketing@chemetrics.com
Website www.chemetrics.com

CHEMetrics manufactures test kits and instruments for more than 50 water quality analysis parameters. All kits feature self-filling reagent ampoules that simplify water quality testing. Applications for the products include pure water, drinking water, wastewater and environmental water testing. Industries served include water treatment, food and beverage, power generation and aquaculture.

Exhibitors

ALPHABETICAL LISTING

CHEMTRAC, INC.

Booth 415
Contact chemtrac@chemtrac.com
Phone 770-449-6233
Email chemtrac@chemtrac.com
Website www.chemtrac.com

Chemtrac, Inc. designs and manufacturers instrumentation for coagulation/clarification/filtration/disinfection optimization, as well as for steam/condensate monitoring. Chemtrac is a global leader in providing streaming current technology, and offers particle counters and monitors for continuous filter performance evaluation. Chemtrac also provides analyzers for chlorine, ozone, pH, ORP, biofilm, and organics monitoring.

CHEMTREAT, INC.

Booth 411
Contact Ray Post
Phone 804-935-2000
Email rayp@chemtreat.com
Website www.chemtreat.com

ChemTreat, a subsidiary of Danaher, is one of the world's largest providers of water treatment products & services. We offer sustainable solutions with improved operating efficiencies, minimized expenditures, reduced carbon footprints, and improved energy and water management delivered through the most experienced sales and service team in the industry. ChemTreat Customers throughout the world save millions of gallons everyday as a result of properly engineered water management technologies.

CLO2 SERVICES, LLC

Booth Table 6
Contact Arlen Meng
Phone 214-393-5009
Email Arlen@CLO2Services.net
Website www.CLO2Services.net

CLO2 Services, LLC is an industrial service provider of Chlorine Dioxide disinfection solutions utilizing a state of the art generation process to minimize risk to equipment while maximizing the amazing inherent benefits that CLO2 brings as a world class biocide and sanitizer. CLO2 Services, LLC offers a wide range of generators for every application. Our process is not a batch process, so no storage is required, and we produce an inherently safe CLO2 solution with NO CHLORINE or OZONE in the product.

Exhibitors

ALPHABETICAL LISTING

COSUN BIOBASED PRODUCTS

Booth 322
Contact Robert Nolles
Phone 408-455 5672
Email robert.nolles@cosun.com
Website www.cosunbiobased.com

Cosun Biobased Products is the world's leading manufacturer of CMI (brand name: Carboxyline® CMI), a biobased RO antiscalant. CMI is a threshold scale inhibitor for carbonate and sulfate scaling with excellent calcium tolerance, high water solubility, low viscosity and does not contribute to biofouling. CMI is P- and N-free, biodegradable and is safe for the aquatic life. NSF Standard 60 certification makes it suitable for drinking water

CRAFTSMEN INDUSTRIES

Booth 522
Contact Mike Mathon
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Email mmathon@craftsmenind.com
Website www.craftsmenindustrial.com

Craftsmen Industries supplies containerized solutions for water treatment systems. The company customizes containers for the integration of water treatment equipment and much more. In-house capabilities and expertise include: degreed structural and mechanical engineers, FEA testing and analysis, certified data stream installers, HVAC certified technicians, in-house quality control systems, MIG & TIG welding, hydraulic design & engineering, 55 & 120 Ton workers and 45' and 65' paint booths. Stamped and engineered drawings are available.

DEGREMONT INDUSTRY

Booth 323 & 325
Contact Hollie Scott
Phone 801-608-8675
Email hollie.scott@a-wpt.com
Website www.degremont-technologies.com

Degremont Industry (SUEZ Environnement) is purely devoted to the needs of industrial customers. It combines all of Degremont's industrial activities around the world. Degremont Industry is a global player in the optimum and comprehensive management of the industrial water cycle. From raw water to discharge, Degremont Industry can meet all industrial needs thanks to a broad portfolio of technological solutions and innovative services that combine both economic and environmental performance.

DELTA PURE FILTRATION

Booth 417
Contact Jay Bernsley
Phone 804-798-2888
Email jbernsley@deltapure.com
Website www.deltapure.com

Delta Pure Filtration is an Ashland, Virginia USA based manufacturer of cartridge filters for water and chemicals. Our product range includes: DMB and DMC series melt blown filters for RO prefiltration; EcoWound™ economic and ecological produced water filters; DW series precision wound filters for RO prefiltration, ion exchange prefiltration, sediment removal, brine fluid filtration, and chemical filtration; Fusion™ series activated carbon filters; and economical stainless steel filter housings.

DOW WATER AND PROCESS SOLUTIONS

Booth 215
Contact Jane Smith
Phone 952-897-4364
Email jasmith2@dow.com
Website www.dowwaterandprocess.com

Dow Water & Process Solutions has a 50+-year legacy of providing innovative water and process solutions to homes, communities and industries alike. Dow products and expertise span the range of reverse osmosis (RO) & nanofiltration (NF) elements, ultrafiltration (UF) modules, ion exchange (IX) resins, and high solids filtration to fuel business opportunities, conserve energy resources, produce high quality drinking water, and address water scarcity issues by helping reduce demand on fresh

ECO-TEC INC.

Booth 502
Contact Mandepp Rayat
Phone 905-427-0077 ext. 266
Email mrayat@eco-tec.com
Website www.eco-tec.com

Eco-Tec develops, designs, and manufactures advanced high purity water treatment and produced water treatment systems. Our high purity water filtration system provides excellent pre-filtration for packed bed ion exchange or reverse osmosis systems. Eco-Tec's ion exchange demineralizers provide high purity water for power generation and process steam industries. Our produced water filtration system provides greater removal of oil and solids compared with more traditional filters. Eco-Tec's advanced ion exchange systems for produced water can soften water for feeding to steam generators or for polymer or ASP flooding more economically than traditional softening equipment.

EVOQUA WATER TECHNOLOGIES

Booth 110 & 112
Contact Douglas Gillen
Phone 415-613-7597
Email douglas.gillen@evoqua.com
Website www.evoqua.com

Evoqua Water Technologies is a leader in water and wastewater treatment products, solutions and services for industrial and municipal customers. We deliver reliable treatment equipment, solutions and services to add value for customers, enable environmental compliance and uninterrupted quantity and quality of water, and reduce energy use.

FEDERAL SCREEN PRODUCTS INC

Booth 406
Contact Greg Colman
Phone 905-677-4171
Email Greg@Federalscreen.com
Website www.Federalscreen.com

FEDERAL SCREEN PRODUCTS, manufactures Wedge Wire screen and fabricated Wedge Wire products for straining, screening, filtering and media retention in water purification, conditioning and waste water equipment. Custom designs include Nozzles, Header and Lateral assemblies, Radial Hub assemblies, Flat Panels and Strainer baskets. We manufacture to our customer's drawings and specifications in materials such as 316L SS, 304L SS, Alloy 20, Hastalloy C-276, Monel, Super Duplex, Zeron 100 and Titanium. Federal Screens takes pride in their high quality products, reliable customer service, prompt deliveries and competitive pricing.

FILTERBOXX PACKAGED WATER SOLUTION INC.

Booth 505
Contact Steve Kroll
Phone 403-203-4747
Email steve.kroll@filterboxx.com
Website www.filterboxx.com

FilterBoxx is a recognized leader in the design and supply of packaged and modular water and wastewater solutions. These include both industrial water and wastewater treatment systems for a broad range of industries. We have also provided drinking water systems and sanitary wastewater treatment packaged units in plants, facilities and camps around the globe.

FRENCH CREEK SOFTWARE, INC.

Booth 315
Contact Baron Ferguson
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Email baronferguson@frenchcreeksoftware.com
Website www.frenchcreeksoftware.com

French Creek develops and markets software tools for water treatment professionals including WaterCycle® for cooling water, DownHole SAT® for oil field brines, hyd-RO-dose® for membrane systems, MineSAT™ for process waters, and WatSIM™ for potable water. French Creek also provides laboratory studies for the modeling of scale and corrosion inhibitors on a select basis. Serving water treatment professionals since 1989.

FRONTIER WATER SYSTEMS

Booth 218
Contact Launa Zanella
Phone 619-981-9023
Email launazanella@frontierwater.com
Website www.frontierwater.com

Frontier Water Systems develops, designs, and manufactures specialty engineered equipment for the treatment of water and wastewater associated with power generation andmining. Frontier systems employpatent pending and proprietary biological treatment processes, which provide unparalleled efficiency in terms of equipment footprint and water quality. We continue to build upon the most applied experience in effective and practical industrial biological solutions though a culture of collaboration and innovation. Our advances in biological metals removal technology are saving heavy industry hundreds of millions of dollars today, while providing the cleanest water possible to our lakes and rivers.

GE POWER & WATER

Booth 416 & 418
Contact Renee Twardzik
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Email renee.twardzik@ge.com
Website www.gewater.com

With operations in 130 countries and employing nearly 8000 worldwide, GE Power & Water, Water & Process Technologies brings together experienced professionals and advanced technologies to solve the world's most complex challenges related to water availability and quality, increased productivity and cost reduction, and environmental regulations.

GENESYS INTERNATIONAL, LTD.

Booth 403
Contact Ursula Annunziata
Phone +44 79 808 32553
Email uannunziata@genesysro.com
Website www.genesysro.com

Genesys manufactures speciality membrane antiscalant and cleaning chemicals for RO/NF and UF systems. We have built a team of industry experts and a network of over fifty distributors. New innovations include: GENAIRCLEAN™, RO membrane cleaning incorporating Micro-bubbles and effervescent reagents to enhance deposit removal. MEMBRANE MASTER 4™ antiscalant prediction software.

GLOBAL CHEM-FEED SOLUTIONS

Booth 508
Contact Don Crawford
Phone 215 675 2777
Email donc@globalchem-feed.com
Website www.globalchem-feed.com

Global Chem-feed Solutions (GCS) is a supplier of custom skid mounted chemical injection systems as well as wet dust suppression systems for Electric Generating, Hydrocarbon Petrochemical and other Heavy Industrial Manufacturing Facilities. These custom systems are engineered for the injection of chemicals into boiler water, cooling water, and waste water systems, as well as a wide variety of process applications. Wet dust suppression systems are fabricated for material handling and storage pile applications. Additionally, GCS manufactures Chlorination Systems and Ammonia Storage feed systems.

GOLDER ASSOCIATES, INC.

Booth 511
Contact Paul Pigeon
Phone 303-980-0540
Email Paul_Pigeon@golder.com
Website www.golder.com

As a global, employee-owned organization with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. From more than 180 offices worldwide, our over 8000 employees deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy. For more information, visit golder.com.

Exhibitors

ALPHABETICAL LISTING

GRAVER WATER SYSTEMS/ ECODYNE WATER

Booth 401
Contact Robert Applegate
Phone 908-516-1404
Email rapplegate@graver.com
Website www.graver.com

Graver Water Systems, LLC designs and manufacturers water and wastewater treatment equipment and systems. Graver's engineers are knowledgeable in pretreatment, degasification, hot lime softening, boiler make-up, condensate polishing, wastewater treatment, cooling water treatment, and oil/water separation for industrial plants and electric

GRUNDFOS PUMP CORPORATION

Booth 507
Contact Michael Salvato
Phone 505-264-9362
Email msalvato@grundfos.com
Website www.grundfos.us

Grundfos is committed to delivering innovative products that ensure the efficient management of water. Pumps currently account for 10 percent of global electricity consumption – Grundfos works to reduce that number that by manufacturing the most efficient and technologically advanced products on the market. High on the company's corporate agenda is an active commitment to improving the environment. Grundfos contributes to global sustainability by pioneering technologies that improve quality of life for people and care for the planet.

H2O BIOFOULING SOLUTIONS

Booth 319 & 321
Contact Jess Fike
Phone 337-857-7203
Email jfike@watermaker.com
Website www.watermaker.com

H2O's Ecodosing method uses information gathered at your site to calculate the most effective dosing method to control the costly and corrosive effects of Biofouling in cooling water systems. Based on experience, a 30-60% chemical reduction can be gained. In addition a significant (up to 50%) reduction on environmental impact will be achieved. Our services can be effectively applied with any Biofouling control product, including all oxidizing or non-oxidizing biocides you are currently using.

H2O INNOVATION

Booth 512 & 514
Contact Gabrielle Roy
Phone 418-688-0170
Email gabrielle.roy@h2oinnovation.com
Website www.h2oinnovation.com

H2O Innovation designs, manufactures and assembles water treatment systems. Each project is customized by our multidisciplinary team with extensive knowledge of water treatment and membrane filtration. This knowledge added to our capacity to think outside the box allows us to provide unique solutions that truly meet your requirements whether it is the production of drinking water or wastewater treatment, treat process water or even recycle water. H2O Innovation also offers complete technical & maintenance service in order to support your system's operation on a continuous basis.

HACH COMPANY

Booth 410
Contact Ken Kuruc
Phone 330-723-0220
Email kkuruc@hach.com
Website www.hach.com

Hach Company manufactures and distributes analytical instruments and reagents used to test the quality of water and other liquids. Hach systems are designed to simplify analysis, and offer:

- Complete, easy-to-follow methods
- High-quality prepared reagents
- Accurate portable, laboratory and online instrumentation
- Life-time technical support.

HONEYWELL PROCESS SOLUTIONS

Booth 222
Contact Vickie Olson
Phone 678-372-0242
Email hpsmarketing@honeywell.com
Website www.honeywellprocess.com

Honeywell is a leading supplier of process control instrumentation, including a broad range of analytical instrumentation. Conductivity, pH, ORP and dissolved oxygen analysis systems are available for high purity water and other industrial and municipal liquid applications.

Exhibitors

ALPHABETICAL LISTING

HOWDEN NORTH AMERICA

Booth	408
Contact	Jason Stoklosa
Phone	716-845-0900
Email	Jason.stoklosa@howden.com
Website	www.howden.com

Howden people live to improve our products and services and for over 160 years our world has revolved around our customers. This dedication means our air and gas handling equipment adds maximum value to your operations. We have innovation in our hearts and every day we focus on providing you with the best solutions for your vital operations.

H-TEC

Booth	Table 4
Contact	Christopher Shirazy
Phone	770 818 0670
Email	cshirazy1@icloud.com
Website	h-tec.us

H-TEC, Inc. proudly distributes innovative and high quality valves and fittings for potable water and sewage pipe systems. Our products are precision manufactured in Germany and parts of the European Union. These state-of-the-art products are benchmarks in terms of functionality, corrosion resistance and long-term cost savings for the pipeline operator.

ILLINOIS WATER TECHNOLOGIES

Booth	320
Contact	Paul Byrd
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Email	paulb@illinoiswatertech.com
Website	www.illinoiswatertech.com

Illinois Water Technologies is a service provider for industrial and commercial water treatment providers. Our services include start up and commissioning, installation management,system integration and general service support. We have a experienced staff of Field Service Engineers that are available for short and long term assignments throughout the world.

ITOCHU CHEMICALS AMERICA INC.

Booth 420
Contact Fred Ghanem
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Email fred.ghanem@itochu-ca.com
Website www.itochu-purification.com

ITOCHU Chemicals America Inc. has been involved in the separation and purification industry within North and South America for over 11 years. We represent Mitsubishi Chemical Corporation which is a leader in the ion exchange resin world for use in the water, specialty water, and food industry. With high lot to lot reproducibility and with unique ion exchange resin functionality and scope, Mitsubishi Chemical can assist in most of your purification needs. We also represent Mitsubishi Rayon to provide hollow fiber membranes for your MBR requirement in waste treatment application. Please stop by to also learn more about our DMI65, our manganese/iron removal filtration media with high efficiency and life.

JACOBI CARBONS, INC.

Booth 219
Contact Matt Potok
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Email matt.potok@jacobi.net
Website www.jacobi.net

Jacobi Carbons is one of the leading global activated carbon manufacturers that has expanded into the ion exchange resin marketplace. Resinex is the division of Jacobi Carbons that offers a complete portfolio of high quality ion exchange resins. This division has hundreds of different ion exchange, adsorbent, and catalyst type products for a variety of applications. Jacobi and Resinex continue to be on the leading edge of carbon and resin technology by adding more products to solve unique applications every day.

JOHNSON MARCH SYSTEMS, INC.

Booth 118
Contact John Sands
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Email john.sands@johnsonmarch.com
Website www.johnsonmarch.com

Johnson March Systems, Inc. is a worldwide leader, custom designing and fabricating Chemical Dosing Systems, Steam / Water Sampling Panels, Ammonia Feed Systems, Electrolytic and Gaseous Chlorination Systems, Mercury Reduction Systems, ASME Code Tanks, Pre-Fabricated Chemistry Lab Shelters, Dust Suppression Systems , any miscellaneous "Skid Mounted " Packages, and Electrical Control Panels. All projects are completed in our engineering / fabrication facilities in Ivyland Pennsylvania, to the highest quality standards, meeting or exceeding the project specifications. JMSI is ISO 9001-2008 certified. We are Canadian Weld Bureau Certified.

JUSTEQ LLC

Booth 207
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Phone 847-656-8626
Email justeq@gmail.com
Website justeq.com

Justeq LLC is the producer of a new water treatment biocide, Justeq07. Justeq07 is a chlorine based biocide that is more effective and economical than chlorine bleach or any other water treatment biocide. Justeq07 is much less corrosive than bleach. In addition, the amount of Justeq07 needed is only 1/3 to 1/5 of the amount of bleach that is needed. This combined with the fact that the need for supplemental biocides is greatly reduced, or even eliminated, makes Justeq07 significantly more cost

LANXESS SYBRON CHEMICALS, INC.

Booth 102
Contact Edward Nace
Phone 609-845-1550
Email edward.nace@lanxess.com
Website www.lanxess.com

LANXESS Sybron Chemicals Inc offers the most technically advanced ion exchange resins today. We have over 60 years of experience in ion exchange, developing essential products, processes and application technology. We offer a full range of products that cover water treatment, the food industry, catalysis/ chemical processes and many other specialty markets. The products are sold world-wide under the brand name Lewatit and most recently our Reverse Osmosis Membrane LEWABRANE.

LECHLER INC

Booth 517
Contact Diana Lent
Phone 630- 377-6611
Email Dianalent@lechlerusa.com
Website www.LechlerUSA.com

Lechler is a global leading supplier of technical solutions in applications of spray nozzle injection systems, pump-valve skids and controls for SCR, SNCR, WetFGD, semi-dry FGD (CFB and SDA) and semi-dry evaporator (SDE) processes. For IWC, we will be presenting our Thermal ZLD process that can treat wastewater in an evaporator using a spray dry evaporator (SDE). Our unique LOC® System is the key success for maintenance free performance of the SDE and achieved a very significant cost savings in both operation and maintenance.

LGA CHEMICAL SOLUTIONS, INC.

Booth 217
Contact Bernardo Vega
Phone 210-888-0497
Email info@lgachemsol.com
Website www.lgachemsol.com

LGA Chemical Solutions Inc. based in San Antonio, Texas since 2010, is the brand new division of Omega Chemicals S.A. de C.V., a reputable and trusted chemicals manufacturer that over 40 years has served the Mexican and International markets. LGA Chemical Solutions Inc.brings to your attention a dedicated line of products specifically designated for the water treatment industry. We focused on them to show you our commitment to consistently deliver quality chemical products.

MAR SYSTEMS, INC.

Booth 509
Contact Richard Stuebi
Phone 440-505-0962
Email rstuebi@marsystemsinc.com
Website www.marsystemsinc.com

MAR Systems' Sorbster® Media removes mercury, selenium, arsenic and other metals from contaminated waters. Sorbster® Media offers an effective and economic solution to clients that must remove metal contaminants from their wastewater discharges down to ultra-low levels.

METTLER TOLEDO THORNTON

Booth 304
Contact Peggy Banarhall
Phone 781-301-8822
Email peggy.banarhall@mt.com
Website www.mt.com

METTLER TOLEDO Thornton is a leader in pure and ultrapure industrial water monitoring instrumentation used in microelectronics, power & pharmaceutical applications. Thornton has a full portfolio of innovative sensors and analyzers for in-line measurement of conductivity/ resistivity, TOC, dissolved oxygen, Sodium, Silica and pH. Thornton products include a new line of revolutionary, digital sensors with integrated intelligent sensor management technology with unique diagnostic tools that provide sensor health information and simplify installation & maintenance. Several new products will be highlighted at the show including our intelligent optical dissolved oxygen & pHure LE sensors, specifically designed for power

Exhibitors
ALPHABETICAL LISTING

MILTON ROY

Booth 216
Contact Kurt Gaebel
Phone 215-293-0436
Email info@lmi.com/info@miltonroy.com
Website www.lmipumps.com www.miltonroy.com

LMI is the leading manufacturer of electronic and motor-driven chemical metering pumps, controllers, and accessories for the water industry. Products range from simple chemical addition to complete systems, including control conductivity, pH, and ORP. Our trademark yellow and black products are the standard for water treatment professionals around the

MIOX CORPORATION

Booth 409
Contact Cem Candir
Phone 505-224-1017
Email cem.candir@miox.com
Website www.miox.com

MIOX's on-demand chemistries for water disinfection improve safety, lower general corrosion rates up to 80%, increase performance, and save money. MIOX on-site chemical generators improve workplace safety by eliminating the handling and storage of hazardous chemicals while maintaining steady disinfection residuals.

MITSUBISHI ELECTRIC AUTOMATION, INC.

Booth 204
Contact Pam Summers
Phone 847-478-2415
Email mitsubishi-electric@meau.com
Website https://us.mitsubishielectric.com/fa/en

Mitsubishi Electric provides solutions for a wide range of applications in the water industry ranging from small booster pumps to large municipal pumps and wastewater treatment facilities. Our broad range of technologies allows us to provide a single-source solution from field-level devices, VFDs, controls, to SCADA and network integration. Built-in features for energy savings lower the total cost of ownership (TCO), while our focusing on quality and years of experience lead to greater equipment uptime.

MPW INDUSTRIAL SERVICES

Booth 206
Contact Angela Rolfe
Phone 740-927-8790
Email arolfe@mpwservices.com
Website www.mpwservices.com

MPW Industrial Services is the leading provider of integrated, technology-based industrial cleaning, facility management, water purification and container management services in North America.

NALCO, AN ECOLAB COMPANY

Booth 210 & 212
Contact Kathy Schillinger
Phone 630-305-1239
Email kschillinger@nalco.com
Website www.nalco.ecolab.com

Nalco and Nalco Champion, both Ecolab companies, are "reinventing the way water is managed," a critical component of our customers' businesses. Nalco's expertise and innovation helps them manage their water and measure success one drop at a time. Nalco Champion provides specialty chemistry programs, problem solving and the application of innovative technologies for upstream, midstream and downstream oil and gas operations, delivering sustainable solutions that overcome complex challenges. For more information, visit www.nalco.ecolab.com or www.nalcochampion.ecolab.com.

NEPTUNE CHEMICAL PUMP CO./ FLUID DYNAMICS

Booth 223 & 225
Contact Thomas R. O'Donnell
Phone 215-699-8700
Email tom.odonnell@psgdover.com
Website www.Neptune1.com

Neptune is a manufacturer of chemical metering pumps, portable mixers and chemical feed systems. Neptune offers a full line of water treatment products including bypass feeders, filter feeders, sample coolers, injection quills and corporation stops. Neptune designs and builds semi-custom and custom chemical feed systems for boiler and cooling tower water treatment. Fluid Dynamics is a manufacturer of both liquid and dry polymer make down

NEWTERRA

Booth 122
Contact Kristy Feeley
Phone 800-420-4056 x1121
Email kfeeley@newterra.com
Website www.newterra.com

newterra is a leading provider of decentralized water and wastewater treatment solutions to the industrial and municipal markets. With its suite of patented and proprietary technologies, newterra offers a broad range of solutions to the world's most demanding industrial end users including mining, oil & gas, and food & beverage companies. newterra's capabilities – from design & engineering to manufacturing in its own facilities – allow the company to maintain full control over the quality of its systems while achieving on-time delivery. With operations in Canada, the United States, Germany, and the UK, newterra can address its customers' needs on a global basis. newterra is a distinguished recipient of Deloitte's 50 Best Managed Companies for the past six consecutive years. For more information, visit www.newterra.com

Exhibitors
ALPHABETICAL LISTING

OLI SYSTEMS, INC.

Booth 205
Contact Pat McKenzie
Phone 973-998-0240
Email pat.mckenzie@olisystems.com
Website www.olisystems.com

OLI is a technology company with a core competency in electrolyte thermodynamics. OLI delivers its technology through rigorous, first-principles software that predicts the properties and chemical composition of multi-phase aqueous and non-aqueous system. OLI software and consulting technology is used in oil and gas production, chemical process, electricity generation, and other industries where water and non-aqueous electrolyte processes are involved. For more information contact us at oli.info@olisystems.com , visit us at www.olisystems.com, or call us at +1-

OVIVO USA, LLC

Booth 426
Contact Guy Beauchesne
Phone 801-931-3113
Email ovivo.energy@ovivowater.com
Website www.ovivowater.com

Ovivo is a world leader Solution Provider for high quality water treatment for all your water requirements within your process; we aims to help you maximize your output, meet the regulatory requirements of your local sites and minimize your environmental impact. Whatever your water needs, Ovivo has the solutions for your Raw Water intake, Boiler Feedwater, Produced Water, Desalination and Wastewater treatment by means of physical, biological and chemical treatment.

PARKSON CORPORATION

Booth 303
Contact Ted Leshinski
Phone 954-917-1886
Email tleshinski@parkson.com
Website www.parkson.com

With 25,000 installations in its over 50 years of existence, Parkson Corporation is a leading provider of advanced solutions in water recycling and treatment and is committed to providing clean water for the world. Parkson treats over seven trillion gallons of water per day. Headquartered in Fort Lauderdale, with offices in Chicago, Montreal, Kansas City and Dubai, Parkson is an Axel Johnson Inc. company. To learn more, visit www.parkson.com.

Exhibitors

ALPHABETICAL LISTING

PROCHEM, INC.

Booth 224
Contact Barry Shelley
Phone 540-268-9884
Email bshelley@prochemwater.com
Website www.prochemwater.com

ProChem, Inc. provides products and services for the industrial wastewater treatment market. ProChem's products include physical chemical wastewater treatment systems, ion-exchange systems, and reuse systems specifically designed for industrial wastewater applications. ProChem's services include treatment process development, chemical treatment programs, and treatment facility contract operations and support.

PSI/ MICROCLOR

Booth 526
Contact Thomas Mooney
Phone 215-530-9200
Email tomooney@4psi.net
Website www.4psi.net

MicrOclor established in 2003 is dedicated in providing cost effective disinfection solutions to municipal water and wastewater facilities and industrial process water and wastewater facilities. The MicrOclor team has over 130 years of combined electro-chlorination experience that has driven the development of a more robust yet simpler technology for generating bleach on site.

PUROLITE COMPANY

Booth 310 & 312
Contact Don Downey
Phone 800-343-1500
Email don.downey@purolite.com
Website www.purolite.com

Purolite is more than a resin company. It's a solutions company. Purolite has evolved over the past 32 years from a small domestic importer of ion exchange resins to the premier manufacturer and innovation leader in the world. As time and technology have changed, so has Purolite. Our dedication to research and innovation is paving the way for new opportunities and endless applications

Exhibitors

ALPHABETICAL LISTING

QUA GROUP, LLC

Booth 326
Contact VJ Nathan
Phone 877-782-7558
Email nathanv@quagroup.com
Website www.quagroup.com

QUA® is an innovator of advanced membrane technologies that address the most demanding water challenges. Headquartered in the USA, QUA's products enable its OEM partners to provide cutting-edge solutions to end users in industrial and infrastructure markets worldwide. The company's diverse product portfolio includes FEDI® (fractional electrodeionization), Q-SEP® (hollow fiber ultrafiltration membranes), CeraQ™ (Ceramic Filters), and EnviQ™ (flat sheet submerged ultrafiltration membranes).

RESINTECH, INC.

Booth 402
Contact Larry Gottlieb
Phone 856-768-9600
Email lxresin@resintech.com
Website www.resintech.com

ResinTech is a manufacturer and supplier of ion exchange resins and activated carbon. This year ResinTech is showcasing their line of products for the power generation industry, including demineralization, condensate polishing, treatment of oilfield produced water, and nuclear radwaste treatment. Specialty medias include selective resins for the removal of antimony, silica, and chromate.

SAMCO TECHNOLOGIES, INC

Booth 203
Contact Robert Bellitto
Phone 716-743-9000
Email bellittor@samcotech.com
Website www.samcotech.com

Process design, engineering and manufacturer of industrial water, waste and process separation system for the chemical, chlor alkali, oil/gas, lithium and mining sectors. Specializing in custom ion exchange and membrane processes, demineralization, physical chem, filtration and biological processes. Solutions for purification, recoveries and concentration of industrial brine streams. Portable produced water system for treatment of boron, chlorides, sulfates, TDS and other process and recycling inhibitors. Licensed for DOW Amberpack, Advance Amberpack and UpCore

SCHREIBER, LLC

Booth 501
Contact Bill Kunzman
Phone 205-655-7466
Email billk@schreiberwater.com
Website www.schreiberwater.com

Serving Industrial & Municipal markets since 1979, Schreiber LLC solves wastewater treatment problems through the application of energy-efficient, innovative, and proprietary equipment/process technology. Schreiber offers a complete system from head works to tertiary filtration. Our patented treatment processes such as the Continuous Sequencing Reactor® and compressible media filter "Fuzzy Filter®" combine effectiveness and efficiency to produce the industry's highest quality products. The "Fuzzy Filter®" is an adjustable pore size filter to 4 microns that operates at 5 times the rate and uses1/4 the wash water of granular media filters.

SENTRY EQUIPMENT CORP.

Booth 201
Contact Jeff McKinney
Phone 262-567-7256
Email jeffm@sentry-equip.com
Website www.sentry-equip.com

Sentry Equipment Corp designs, manufactures and services systems and equipment used to sample gases, liquids, slurries and bulk solids; enabling safe, simple and repeatable samples for power generation and process industries worldwide. Our combined steam and water products and brands – Sentry®, AquatiPro™, Waters Equipment ™ - make Sentry Equipment Corp a worldwide leader in power sampling technology and products.

SEVERN TRENT WATER PURIFICATION, INC.

Booth 301
Contact Charles Guzelli
Phone 412-841-2399
Email info@severntrentservices.com
Website www.severntrentservices.com

Severn Trent Services is a supplier of disinfection systems including; sodium hypochlorite generators (seawater and brine), chlorine dioxide generators, gas feed instrumentation, UV and filtration systems including; arsenic and other inorganic removal, biological processes including BOD / CBOD reduction, denitrification, particle filters for TSS, oils and greases; MF / RO for process and high purity water and continuous I/X with the Higgins Loop. We offer system process audits, filter rebuilds and filter conversions plus complete control system upgrades. We serve both the Industrial and Municipal (wastewater and potable) Markets.

SHANDONG TAIHE WATER TREATMENT CO.

Booth 324
Contact Joanna Cheng
Phone +86-632-5113066
Email export@thwater.net
Website http://www.thwater.net/

Taihe is the leading professional manufacturer of water treatment chemicals in China. By end of September, 2014, Taihe's turnover has reached 120 million US dollars while sales volume almost 200,000,000lbs. Compared to the sales volumes in corresponding period of last year, the growth rate is 46.5%.

The main products capacity is as follows:
HEDP 88,200,000lbs;
PBTC 66,200,000lbs;
ATMP 55,100,000lbs;
HPMA 22,100,000lbs;
Benzalkonium chloride 55,100,000lbs;
Polyepoxysuccinic Acid (PESA) 18,000,000lbs;
Other Polymers 33,000,000lbs

SOLAR BEE/ GRIDBEE (MEDORA, CO.)

Booth 208
Contact Bert Hibl
Phone 303 862 0889
Email bert.hibl@medoraco.com
Website http://medoraco.com

Medora corp. provides solar, electric and air powered mixers/circulators for controlling blue-green algae in reservoirs, energy savings and process improvement in wastewater treatment, eliminating temperature stratification and THMs in potable water, clear wells and storage tanks.

SOLENIS

Booth 412
Contact Kenneth Dunn
Phone 508-341-0841
Email kmdunn@solenis.com
Website www.solenis.com

Solenis is a leading global manufacturer of specialty chemicals for the pulp, paper, oil and gas, chemical processing, mining, biorefining, power and municipal markets. The company's product portfolio includes a broad array of process, functional and water treatment chemistries as well as state-of-the-art monitoring and control systems. These technologies are used by customers to improve operational efficiencies, enhance product quality, protect plant assets and minimize environmental impact. Headquartered in Wilmington, Delaware, the company operates 30 manufacturing facilities strategically located around the globe and employs a team of 3,500 professionals in 118 countries across five continents. For additional information about Solenis, please visit www.solenis.com.

SOUTHERN RESEARCH INSTITUTE

Booth 405
Contact Jay Wos
Phone 205-581-2502
Email wos@southernresearch.org
Website www.southernresearch.org

Since 1941, the people of Southern Research Institute have contributed to mankind's quality of life through advancements leading to life-saving drugs, safer space exploration, cleaner air and energy production, and enhanced national defense. Southern Research is a not-for-profit, 501(c)(3) organization conducting basic and applied research in Alabama, Maryland, and North Carolina in the areas of drug discovery, preclinical drug development, advanced engineering, and environmental protection.

STENNER PUMP COMPANY

Booth 421
Contact Steve Sullivan
Phone 904-641-1666
Email ssullivan@stenner.com
Website www.stenner.com

Established in 1957, Stenner manufactures reliable peristaltic metering pumps for water treatment or injecting additives into a process. The variable speed SVP accepts a 4-20mA signal for automatic dosing with outputs in 1% increments. The Classic is a versatile electro-mechanical pump in adjustable or fixed models. All Stenner pumps are self-priming up to 25 ft and can run dry without damage. The patented pump head offers easy tube replacement. Visit the booth for hands-on demonstrations.

SWAN ANALYTICAL USA

Booth 503
Contact Bob Langie
Phone 847-229-1290
Email info@swan-analytical-usa.com
Website www.swan-analytical-usa.com/

Swan Analytical manufactures online continuous monitoring analytical instruments for high purity water, and potable water. Measurements include TOC, Conductivity/Resistivity, pH/ORP, trace D.O., trace sodium, trace silica, phosphate, nitrate, ammonium, hydrazine, chlorine, bromine, fluoride and turbidity. Swan's analyzers deliver high precision with ease of

Exhibitors
ALPHABETICAL LISTING

TAYLOR TECHNOLOGIES

Booth 520
Contact Chris Golden
Phone 800-837-8548
Email customerservice@taylortechnologies.com
Website www.taylortechnologies.com

An ISO 9001:2008-certified manufacturer, Taylor Technologies has produced reliable, reasonably priced water-testing supplies for industrial water treaters since 1930. Offerings include the field-tested TTi® 3000 Colorimeter, as well as test kits, reagents, standard solutions, labware, and electronic meters. The TTi 3000 comes preprogrammed to test 30+ water quality parameters most encountered in commercial/industrial settings, life-time free upgrades, and a 5-year warranty. Its portability and data-logging capabilities make this device suitable for field or laboratory use.

THERMAX, INC.

Booth 515
Contact Cindy Gresham
Phone 856-630-2037
Email cgresham@thermax-usa.com
Website www.thermaxindia.com

Thermax is a leading manufacturer of a wide range of ion exchange resins that are sold globally for use in the field of water treatment and process water technologies. The portfolio of resins include adsorbents, catalyst and chelating resins.

TRISEP CORPORATION

Booth 518
Contact Lyndsey Wiles
Phone 805-964-8003
Email sales@trisep.com
Website www.trisep.com

TriSep Corporation is a specialty membrane manufacturer focused on delivering customized products to solve unmet customer needs. To meet a wide range of water purification and process application requirements, TriSep offers a variety of reverse osmosis, nanofiltration, ultrafiltration, and microfiltration membranes. TriSep manufactures spiral wound membrane elements, flat sheet membranes, and support chemicals while utilizing a technical sales team to offer customers exceptional service.

TURNER DESIGNS HYDROCARBON INSTRUMENTS, INC.

Booth 226
Contact Monisha Edwards
Phone 559-253-1414
Email medwards@oilinwatermonitors.com
Website www.oilinwatermonitors.com

Turner Designs Hydrocarbon Instruments, Inc. is the worldwide leader in the application of field portable, laboratory and on-line continuous process monitors for measuring and monitoring hydrocarbons in water. We are in the exclusive business of making laboratory, field portable and on-line instruments based in UV fluorescence technology. Our customers enjoy the benefits of our worldwide exposure, product development and distribution network. We have more UVF instruments in service for oil in water measurement than all UVF competition combined.

U.S. PEROXIDE

Booth 305
Contact Lovella Hebert
Phone 404-352-6070
Email lhebert@h2o2.com
Website www.h2o2.com

US Peroxide provides wastewater treatment solutions and rapid response to many large U.S. companies and refineries. Our turn-key programs include H2S removal, supplemental DO, cooling tower cleaning, BOD/COD removal, high strength wastewater, NOx, and more. Our full-service, "hands-off" solutions include chemical treatment application, storage and dosing systems, and technical expertise. For refineries, we also offer 27% H2O2 - a safer H2O2 concentration, Class 1 Oxidizer. View our Case Studies at http://www.h2o2.com/project-gallery.aspx.

U.S. WATER SERVICES

Booth 425
Contact Jaclynn Peterson
Phone 303-579-5000
Email jak.peterson@uswaterservices.com
Website www.uswaterservices.com

U.S. Water gets to the root cause of problems to eliminate them at their source by utilizing an integrated water management approach that combine engineering, equipment, chemicals and services. We help industries find cost-effective and environmentally friendly solutions for their most challenging water, energy and compliance problems. Our customer focused approach enables our staff to work as an extension of your team making your goals our goals so you can focus on what's important – running your facility.

Exhibitors

ALPHABETICAL LISTING

UOP, A HONEYWELL COMPANY

Booth 317
Contact Jana Sterk
Phone 847-391-2000
Email UOPwater@honeywell.com
Website http://www.uop.com/processing-solutions/water/

For 100 years, Honeywell's UOP has been a leading contributor to the innovation and development of contaminant removal solutions that help our customers meet performance requirements and promote operational efficiency. With more than 40 years of experience in the water treatment industry, UOP provides total solutions that meet customers' industrial wastewater treatment needs and successfully removes impurities such as radionuclides, heavy metals and organics from a wide range of waste and groundwater streams.

VEOLIA WATER TECHNOLOGIES

Booth 302
Contact Kati Ardaugh
Phone 815-609-2000
Email katherine.ardaugh@veolia.com
Website www.veoliawaterstna.com

Veolia is committed to Resourcing the World by developing access to resources, preserving and replenishing them. Focusing on this mission, Veolia Water Technologies provides specialized water and wastewater solutions that enable recycle, reuse and replenishment of water and energy resources. We have developed solutions for accessing and utilizing these resources more responsibly and more efficiently. Through standard systems and design-build projects, Veolia serves all major industries including Oil & Gas, Power and Mining.

WATERCOLOR MANAGEMENT

Booth Table 5
Contact Donald Cleveland
Phone 256-260-0412
Email info@WaterColorManagement.com
Website www.WaterColorManagement.com

WaterColor Management has been underwriting insurances for Water Treatment and Water Handling Businesses since 1986. The range of insureds within our group of companies varies from one-person water businesses to worldwide organizations with thousands of employees. WaterColor Management aims to write the most specialized insurance contracts for the Water Treatment and Water Handling Industry, and to keep our water industry clients' losses to a minimum by offering risk management and loss control services.

WATERS EQUIPMENT CO.

Booth 404
Contact Mark Gerschke
Phone 262-443-6565
Email markg@watersequipment.com
Website www.watersequipment.com

The Waters Equipment proven sample conditioning and analysis solutions are purposely designed for utility, refinery or industrial boiler chemists and engineers seeking to optimize their industrial water chemistry program for water & steam purity and corrosion control. Unlike sampling system integrators, the Waters Equipment brand enables maximum production output, ensures employee safety and protects plant assets at a lower cost

WATERSURPLUS

Booth 423
Contact Craig Hall
Phone 815.636.8833
Email chall@watersurplus.com
Website www.watersurplus.com

Watersurplus is a full service water treatment solution provider offering a wide range of capabilities including the rental of mobile reverse osmosis trailers and skids; the purchase and sale of remanufactured RO systems and membrane elements; the sale of new RO equipment, media filtration systems, media and components; startup and consulting services and

WATERTECTONICS

Booth 407
Contact Lauren Jansson
Phone 866-402-2298
Email lauren.jansson@watertectonics.com
Website www.watertectonics.com

WaterTectonics designs and manufactures water treatment solutions for clients in oil & gas, mining, industrial, and construction applications. We specialize in innovative electrocoagulation and electrochemical technologies and integration within larger solutions. A comprehensive suite of services includes treatability research, industrial design, and project delivery field services. From the mountains of Colorado to the jungles of Colombia to the deserts of Oman, we have treated water in some of the most challenging places in the world.

WESTECH ENGINEERING, INC.

Booth 211
Contact Marshall Palm
Phone 801-265-1000
Email mpalm@westech-inc.com
Website www.westech-inc.com

For cooling water, hydrofracturing, mine water, raw water pretreatment, and industrial wastewater treatment, WesTech is your independent source for reliable industrial and municipal process treatment equipment designed, engineered, and built for long lasting efficiencies. For new plants, design build, and retrofits, WesTech offers the process manufacturing and project management experience required for system reliability. Employee-owned since 1973 and ISO 9001 certified, WesTech provides reliable treatment process systems for myriad liquid-solids separation challenges.

WIGEN WATER TECHNOLOGIES

Booth 521&523
Contact Steve McSherry
Phone 800-240-3330
Email steve.mcsherry@wigen.com
Website www.wigen.com

Since its inception in 1965, Wigen Water Technologies has become a leading manufacturer of custom water treatment systems. We specialize in application-specific, cost-effective and reliable solutions for industrial, municipal and ultrapure clients. WWT purifies water for manufacturers making cutting edge medicines, brand name food and beverage producers feeding the world, power districts providing electricity, hospital and university laboratories requiring re-agent grade water and semi-conductor/nanoscience fab floors at the cutting edge of technology.

WILEY

Booth 120
Contact Claire Kelly
Phone 207-748-6000
Email info@wiley.com
Website www.wiley.com

Wiley is the leading society publisher. We publish on behalf of more societies and membership associations than anybody else, and offer libraries and individuals 1250 online journals, thousands of books and e-books, reviews, reference works, databases, and more. For more information, visit www.wiley.com, or our online resource: onlinelibrary.wiley.com. Stop by booth 120 to learn about what's new at Wiley and receive 20% off your order!

ZEQUANOX BY MBI

Booth	307
Contact	Michael Toth
Phone	651-888-0843
Email	mtoth@marronebio.com
Website	www.zequanox.com

Zequanox® is a bio-based, non-chemical product used to control aquatic invasive zebra and quagga mussels in both enclosed and open water treatment applications. Approved by the EPA and PMRA, Zequanox is environmentally safe to all land and aquatic species and provides high levels of mortality, shorter treatment times compared to chemicals, requires no detoxification before discharge, low risk to workers, and minimal regulatory restrictions.

GET YOUR DUCKS IN A ROW

With over 25 years of experience in the water industry ResinTech has the best products and technical services you need to ensure the highest water quality.

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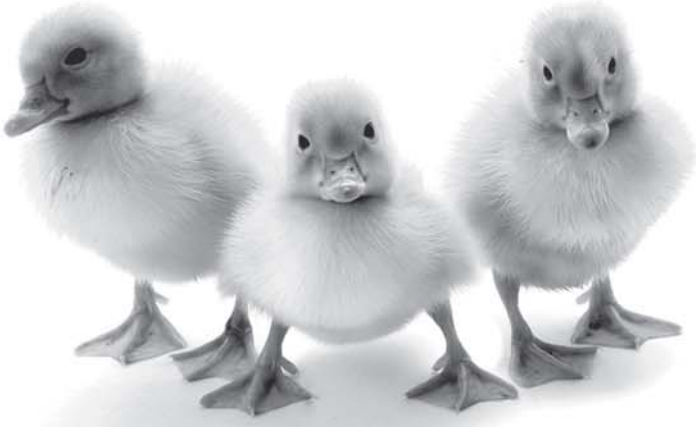
ACTIVATED CARBON
TECHNICAL AND LABORATORY SERVICES



As a proven leader in water filtration technologies, ResinTech Inc. offers the highest quality products and technical expertise available in the industry. Our technical department will assist you in recommending the best solutions for your projects, assuring customers get the most cost-effective approach to achieving their process goals.

SEE THE DIFFERENCE QUALITY AND EXPERIENCE CAN MAKE.

RESINTECH

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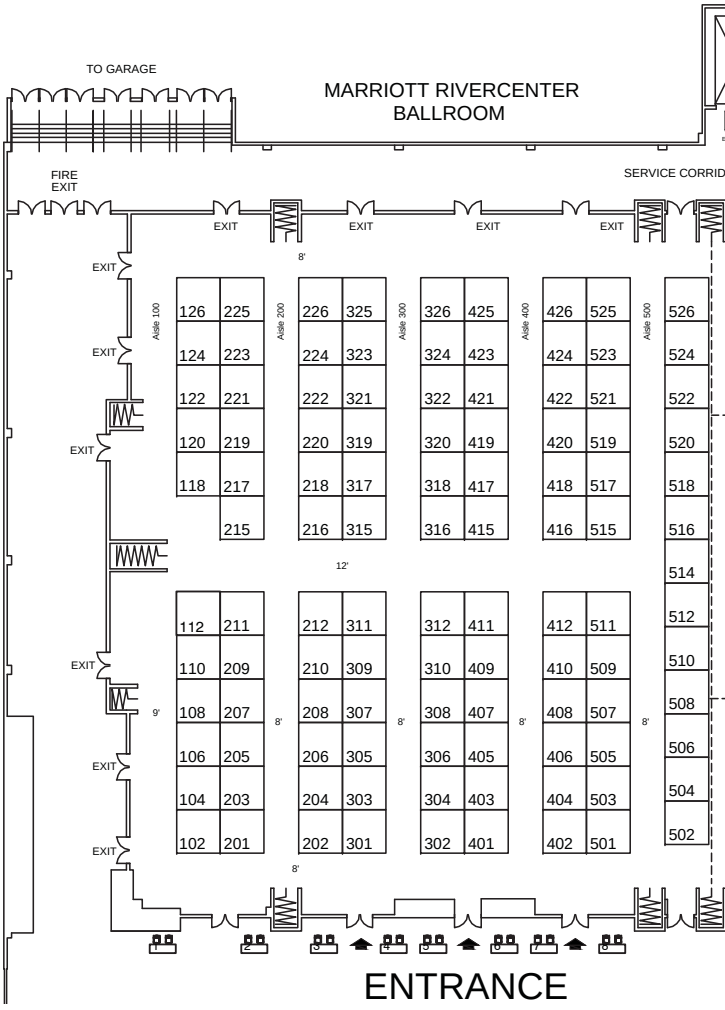
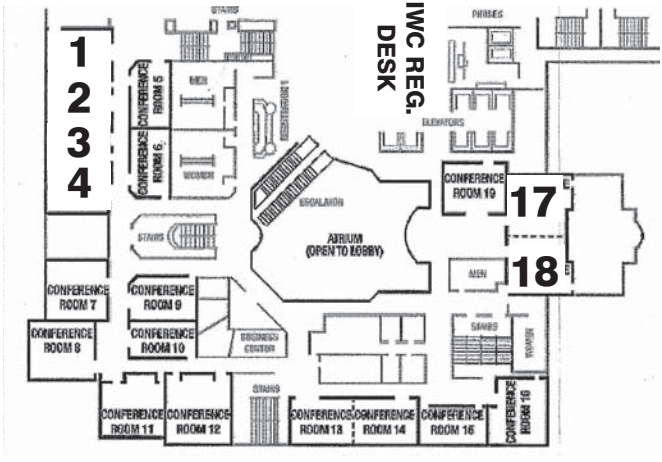
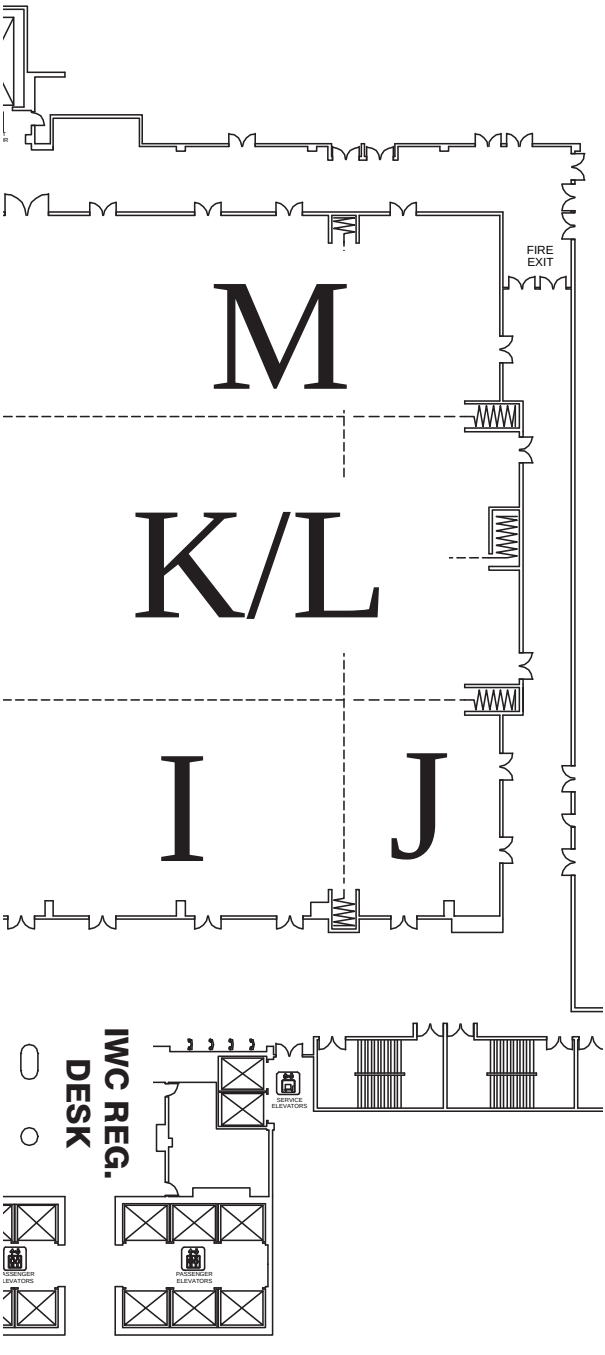
West Berlin New Jersey, USA



ADDITIONAL MEETING ROOMS NOT-TO-SCALE




FIRE
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Uniform depth of functionality.

Every bead reacts at the same rate.

Unique. It's the perfect word to describe our Shallow Shell Technology (SST) ion exchange resins. With an inert core and functionalized outer shell, SST resins soften, dealkalize and demineralize with:

The Highest Performance. Our SST resins deliver the same throughput with reduced chemical regenerant usage and ultra-low leakage, shortening the length of the diffusion path and creating more rapid ion exchange.

The Best Economics. Regeneration is more complete requiring less regenerant to do the same job. The result is a group of resins with unsurpassed regenerant efficiency, lower leakage, and up to 40% increased rinse savings.

Minimum Environmental Impact. Systems using SST resins not only use less chemical regenerants they generate less waste.

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