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CHAIRMAN'S WELCOME

John T. Lucey, Jr., P.E.
Heckmann Water Resources
2011 IWC General Chair

Welcome to the 72nd annual International Water Conference® (IWC). The Engineers' Society of Western Pennsylvania (ESWP), the IWC Advisory Council, and the IWC Executive Committee are very proud to provide the IWC as a very important source for the most up to date technical information and training on the most relevant topics in the industrial water and wastewater industry. Our market continues to evolve with much focus today on treating water and wastewater for an ever changing energy industry. You will find our technical program filled with relevant energy topics such as wastewater treatment for the shale gas industry; produced water treatment for the oil and gas industry; selenium removal, fluidized gas desulfurization, and zero liquid discharge systems for the coal burning power plants, You will also note that we have continued to provide excellent technical papers on topics such as ion exchange, cooling water treatment, recycle/reuse, and membrane treatment. We believe that our conference is the best technical conference in the US. We hope that you each learn something that helps you advance your career and our profession. We also hope that you tell a friend and colleague about us and invite them to join us at our 73rd IWC next year , when we return to San Antonio.

We always do our best to eliminate any schedule conflicts where 2 papers of similar subject interest are being presented at the same time. However, with a large program and the varied interests of the attendees it is impossible to eliminate conflicts for everybody. Therefore, all papers that are received by the due dates will be available for sale electronically on flash memory sticks and in hard copy at the registration desk.

Our conference also offers the opportunity to attend many workshops, which provide Continuing Education Credits. They are designed for both newcomers to the water and wastewater industry as well as professionals who have been involved in the industry for years. The workshops are held on Wednesday afternoon and Thursday. Registration for the workshops is open at the registration desk during the conference if you did not pre-register.

We have again sold out our Exhibit hall which will be our largest in history. The exhibits display the latest technological developments in water and wastewater treatment. Take advantage of this opportunity to meet directly with industry experts. Lunches and refreshments will be supplied in the exhibit hall and all conference registrants are welcome.

We are fortunate to have Mr. John Veil as our keynote speaker. We always strive to have our keynote address complement our technical program by being an educational and informative presentation on a highly relevant topic. We believe that you will find Mr. Veil's presentation about water usage in the energy industry, and particularly the shale gas industry, to be a perfect fit for our 72nd IWC.

Of course, a conference of this size does not get put together without the hard work of a lot of people. I want to especially thank the ESWP staff: David Teorsky, Michael Gaetano, Stephanie Mueller, and Cori Stellfox for their hours of hard work. One of them will be at the registration desk during operating hours to answer any questions and provide any help that you might need.

General Information

Every Executive Committee member is a volunteer and has spent hours coordinating sessions, exhibits, workshops, and marketing to make sure the conference runs smoothly. Dennis McBride had the unenviable task of being our 2011 IWC Technical Program Chairperson. This is one of the most time consuming positions on the IWC Executive Committee and I want to thank Dennis for the fine job he did in putting together the 2011 IWC technical program.

I would also like to thank the representatives of the Advisory Council companies that offer their expertise and advice to keep the conference current and interesting for all. The companies of the Advisory Council also sponsor various events like the coffee breaks, fellowship evenings, and other items that help make the conference better for all of us. Please thank the members of the Advisory Council for their efforts in helping to make the 2011 IWC a success. If you have any interest in becoming a member of the Advisory Council, please see a staff member at the registration desk.

There are so many people directly involved in the conference, Session Chairs, Discussion Leaders, Discussers, and Authors. They put in much time and effort to make the IWC one of the best technical conferences for those in the business of water and wastewater treatment. This is our goal and what we strive to achieve every year. Thank you to all.

I hope that you enjoy this year's conference. I look forward to meeting many of you during our time in Orlando. We also welcome your feedback. We begin each year's planning by reviewing the feedback we receive from the previous year's conference. We are dedicated to listening to your feedback to improve this conference every year.

Sincerely,

John

John T. Lucey, Jr., P.E.
Heckmann Water Resources
2011 IWC General Chair

EXECUTIVE COMMITTEE

The International Water Conference® (IWC) is sponsored by the Engineers' Society of Western Pennsylvania (ESWP), a membership based, not-for-profit organization, based in Pittsburgh, PA. Learn more at www.eswp.com. The IWC is planned mainly through the volunteer efforts of these top industry professionals who make up the IWC Executive Committee and IWC Advisory Council Company representatives. The ESWP extends a sincere thank you to the entire Executive Committee for their efforts in planning this year's conference. A very special thanks goes to the General Chair of this year's conference, John Lucey!

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IWC ADVISORY COUNCIL

The IWC Advisory Council is comprised of a group of companies that provide ongoing support for the planning of a successful conference. Membership is open to companies that have an interest in industrial water & wastewater treatment, and are willing to make a commitment to participate in two meetings thru the year to plan the IWC. In addition to promotional benefits for your firm, AC reps are entitled to one complimentary conference registration. For more information about the IWC, see any member of the IWC Advisory Council, IWC Executive Committee or contact the ESWP office.

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Ultra Pure Water Journal www.ultrapurewater.com

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Water Utility Infrastructure Management Online (UIM) www.uimonline.com

Chemical Processing www.ChemicalProcessing.com

Chemical Engineering http://www.cpievent.com/

General Information

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 600 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!

ASME CO-MEETINGS

- The ASME Executive Subcommittee will meet on Sunday, November 13 from 7PM-9PM.
- The Produced Water Task Group will meet on Tuesday, November 15 from 5:20PM-7:30PM.
- The ASME Main Committee meeting will be on Wednesday, November 16 from 2PM-3PM.
- The ASME Water Technology Subcommittee will meet Wednesday, November 16 from 3PM-5PM and again on Thursday, November 17 from 8AM – NOON.

All meetings will occur on the Mezzanine Level. All are welcome!

CONFERENCE PROCEEDINGS

All registered attendees (except Exhibit Only) will receive a CD containing the Official Conference Proceedings of the 72nd 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 2012 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.

General Information

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 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 in other states as well. Please go to the registration desk in order to receive a form or at www.eswp.com/water. Return it to the Registration desk at the end of the conference. The ESWP staff will produce letters within the next month after the conference.

ATTENDEE RECEPTIONS

To help you enjoy your stay in Orlando during the 2011 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 welcomed to attend the Welcome Reception on Monday and Tuesday evening 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! We work hard to allow attendees and exhibitors to attend technical sessions AND enjoy exhibit hall time without time conflicts...please enjoy!

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.

MESSAGE BOARD

As a service to conference registrants, a message board will be located at the Registration Desk. The board will be maintained by the conference staff from 8:00 AM Monday through noon on Wednesday. Messages will be retained until the end of each day.

SPOUSES' WELCOME BREAKFAST

For spouses who are traveling with conference registrants, the IWC will host a Welcome Breakfast on Monday, November 14 at the Hilton 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 26th Annual IWC Fun Run in Orlando! This event, sponsored by ResinTech, is open to all runners and walkers attending the conference and T-shirts will be awarded to all participants. Join us on Tuesday Morning, November 15 at 7:00 AM sharp; meet in the Hilton Hotel lobby at 6:45 AM. Distance: 3 miles – flat and easy course.

General Information

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 $25 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 personalizing 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 16. 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.

FUTURE CONFERENCE DATES

See you next year on November 4-8, 2012 at the Crowne Plaza on the Riverwalk in San Antonio, TX, USA.

2011 AWARDS OF DISTINCTION

The Annual Awards are presented at the opening Keynote Session on Monday, November 14 at 11:15 AM in Salon 4 and 5. Please join us 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: Debbie Bloom, Nalco Company, Naperville, IL.

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 presentations in the field of power systems water technology that was presented at the 71st Annual International Water Conference®. This year, we honor Robin Kluck of GE Water and Process Technologies in Trevose, PA for the presentation IWC 10-61: "Experiences Using Neutralizing Amines to Control pH and Minimize FAC in a Combined-Cycle Power Plant".

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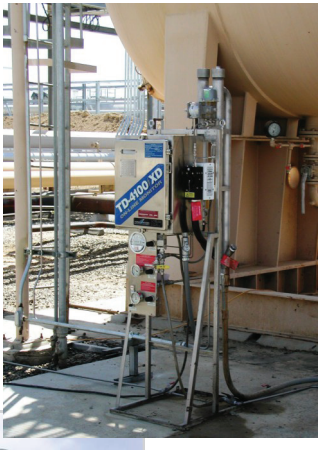

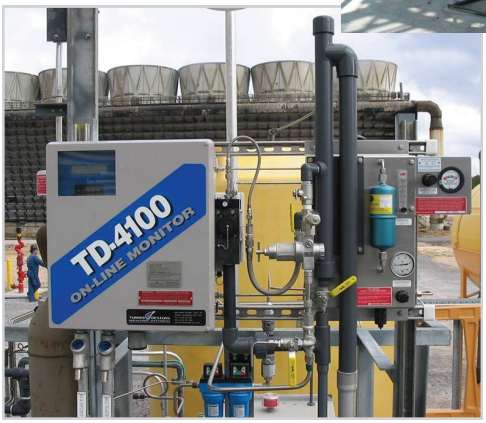

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WATER MANAGEMENT – RECYCLE/REUSE

Date: Monday, November 14
Time: 8:00 - 11:00 AM
Room: Salon 1

Water, is our life line to our very survival and better water management including water/wastewater minimization, water recycle and reuse and becoming key factors in design and operation of industrial and power plants. Typical treatment schemes can produce high quality water involves pretreatment, physical-chemical and membrane technologies such as ultrafiltration (UF), reverse osmosis (RO), and deionization. Municipal wastewater treated by activated sludge, MBBR and MBR processes can offer an attractive and cost effective option for recycle and reuse as an alternative source of makeup water to new and existing plants.

This session shall deal with several approaches to water recovery, treatment and reuse. It shall present a design to recover a significant portion of the water vapor contained in flue gases. The water recovered by this system is of a quality similar to that of a reverse osmosis system. Also, this session shall explore the various side-stream wastewater sources and illustrate the associated technical challenges that need to be recognized and overcome by the industries. The session will outline the role of tubular membrane microfiltration and its viability as a technology for recovering and recycling the secondary water sources to complement the existing treatment operations.

IWC Representative: Steve Gagnon, AVANTech, Columbia, SC
Session Chair: Mike Preston, Black & Veatch, Overland Park, KS
Discussion Leader: Rafique Janjua, Fluor Enterprises, Inc., Sugar Land, TX

Session Introduction **8:00 AM**

Mike Preston, Black & Veatch, Overland Park, KS

IWC 11-01 **8:10 AM**

PRINCIPLES OF A LIQUID DESICCANT DEHUMIDIFICATION SYSTEM (LDDS) FOR WATER EXTRACTION FROM COMBUSTION GASES

Bruce Folkedahl, Ph.D., Energy & Environmental Research Center, Grand Forks, ND

It is clear that fossil fueled power plants and combustion systems consume vast quantities of water while the demand for water resources increase faster than replenishment technologies can match. This paper describes a novel technology that enables the recovery of water vapor contained in combustion flue gas streams. The Energy & Environmental Research Center (EERC) has successfully completed a U.S. Department of Energy (DOE) supported pilot-scale program firing natural gas and coal to produce a flue gas for dehumidification. The testing has proved the viability of the system to recover a significant portion of the water vapor contained in flue gases. The water recovered by this system is of a quality similar to that of a reverse osmosis system outlet (RO Out). This water can be used for plant needs as recovered or can receive minimal treatment so it can be used as direct cycle makeup. This paper provides a detailed description of the pilot-scale system and process conditions, presents the reportable results of the recent pilot-scale test program, and discusses the expected commercial characteristics.

Discusser: William Moore, Aquatech International Corp., Canonsburg, PA..... 8:35 AM
Floor Discussion & Closure.....8:45 AM

IWC 11-02 **9:00 AM**

RECOVERY AND RECYCLING OF INDUSTRIAL SIDE-STREAM WASTEWATER

Michael Chan, Duraflow, LLC, Tewksbury, MA

For most industrial water and wastewater treatment operations, a substantial quantity of "side-stream" wastes as by-products is generated from the treatment processes.

These side streams may include RO reject (brine) from treatment of plant process water and wastewater, backwash from UF or multi-media filtration, regeneration wastes from deionization, and blow-down from cooling tower water treatment. These streams are characterized by their high concentrations in dissolved solids, suspended particles, difficult-to-treat chemicals and organic substances. Recent studies have identified side streams as one of the major causes of performance problem when not properly managed in a treatment operation. As the national water scarcity crisis is escalating to the next level, industries have started looking into recycling of the secondary or less desirable water sources, such as the side-stream wastewater, as a long-term sustainable solution to the problem. This presentation shall explore the various side-stream wastewater sources and illustrate the associated technical challenges that need to be recognized and overcome by the industries. The discussion will outline the role of tubular membrane microfiltration and its viability as a technology for recovering and recycling the secondary water sources to complement the existing treatment operations and maximize the overall water recycling goal. Case studies are presented for selected pilot studies and full scale side-stream recycling systems.

Discusser: Arun Mittal, Aquatech International Corp., Canonsburg, PA..... 9:25 AM
Floor Discussion & Closure.....9:35 AM
Break.....9:40 AM

IWC 11-03 **10:10 AM**

MUNICIPAL WASTEWATER AS AN ALTERNATIVE FEED SOURCE FOR INDUSTRIAL WATER NEEDS

Katariina Majamaa, Dow Chemical Ibérica, S.L., Tarragona, Spain; Gregg Poppe, The Dow Chemical Company Edina, MN

Industrial processes consume large quantities of water and lack of fresh water sources in many places drives the search for alternatives. Reuse of treated municipal wastewater offers an attractive and cost-efficient option for those seeking an alternative source. Typical treatment schemes to produce high-quality industrial water involve membrane technologies including ultrafiltration (UF), membrane bioreactors (MBR), and reverse osmosis (RO). Compared to conventional brackish water sources, the concentration of certain species like NH4+, NO3-, and total organic carbon (TOC) can be much higher in municipal water effluent and, thus, they can become the most stringent quality limit. The applicable membrane technologies are discussed, including certain features that help them operate successfully despite the challenges presented by purifying wastewater. Due to the high fouling potential of membranes with wastewater, strategies to control bio fouling are integrally important for successful long-term operation with membranes and selected strategies are also discussed.

A reference list of at least ten recent wastewater reuse installations spanning the globe is presented. These plants not only range in geographic location, but also in size, industry segment, type of pretreatment, and the purpose for which the recovered water is used.

In particular, successful performance of two plants is provided, demonstrating consistent product flow and quality from integrated membrane systems treating wastewater for industrial use. Experience from these plants, especially regarding topics of disinfection and preventative cleaning, has contributed to the knowledge base of the wastewater treatment industry.

Discusser: Robert Bradley, Veolia Water Solutions & Technologies, Houston, TX.....
.....10:35 AM
Floor Discussion & Closure.....10:45 AM
Conclusion ..... 11:00 AM

ION EXCHANGE, ADVANCES TO EXISTING TECHNOLOGIES

Date: Monday, November 14
Time: 8:00 - 11:00 AM
Room: Salon 2

This ion exchange session focuses on recent advances in ion exchange technology and use. The first paper discusses the important issue of contaminant contribution from resins caused by the use of amines and resultant impact of the organics on steam cycle chemistry. The authors of the second paper will present ion exchange theory and case studies quantifying the efficacy of using ion exchange resins to remove molybdate from cooling tower waters. The third paper in this session returns the discussion to a relatively new wrinkle to commercially available softening resin. The resin offers an improvement in operation when using seawater as the regenerant. The unique resin used in the process also reduces rinse water requirements while improving operating efficiency.

IWC Representative: Jim Sabzali, Aldex Chemical, Granby, QC
Session Chair: Peter Meyers, ResinTech, West Berlin, NJ
Discussion Leader: Ed F. Sylvester, Jr., ChemTreat, Springfield, IL

Session Introduction **8:00 AM**

Peter Meyers, ResinTech, West Berlin, NJ

IWC 11-04 **8:10 AM**

AMINE CHEMISTRY – UPDATE ON IMPACT TO RESIN

Gregory Bachman, Technology and Lab Services, Rockford, IL; Doug Kellogg, Siemens Industry Inc. – Water Technology Division Rockford, IL; Marty Wilkes, Siemens Industry Inc. – Water Technology Division Rockford, IL

Impurity removal in the Steam Cycle and the associated prevention of corrosion and/or fouling of system components is the goal of ion exchange resins. However, in many instances (such as a switch to amine chemistry or a change in product specifications), resins do not remove, and in fact, contribute impurities to the steam cycle. This paper will review recent data compiled to determine the effects of amines on ion exchange resins used in the Power Industry.

Discusser: Jim Wiegand, P.E., ChemTreat, Inc., Davenport, IA ..... 8:35 AM
Floor Discussion & Closure ..... 8:45 AM

IWC 11-05 **9:00 AM**

MOLYBDATE REMOVAL BY ION EXCHANGE

Andrew Bishop and Peter Meyers, ResinTech West Berlin, NJ

Use of molybdate in cooling tower treatment can be problematic due to skyrocketing costs and limits on discharge to sanitary sewers. Closed loop cooling systems that once depended on molybdate chemistry are switching to other types of chemical treatment. Prior to making a switch it may be necessary to remove molybdate from the system. Ion exchange is in many cases the best available technology for molybdate removal. This paper discusses the requirements for a successful molybdate removal system and disposal or regeneration options for various ion exchange resins, and systems that are used to remove molybdate.

Discusser: Claude Gauthier, P.Eng., The Purolite Company, Toronto, ON, Canada ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break ..... 9:40 AM

IWC 11-06 **10:10 AM**

SEAWATER REGENERATION OF PUROLITE® SST80™ SHALLOW SHELL SAC RESIN

Donald Downey, Purolite Company, Paris, ON

Efficiently using seawater to regenerate strong acid cation resins used in softening applications has been a long sought after alternative vs. using excessive and costly amounts of concentrated sodium chloride (NaCl) brine to drive the regeneration reaction.

The limitations for using sea water have been isolated to the inefficiencies of the ion exchange bead matrix. Early studies show that upwards of 150 USG/ft3-R could provide 22 Kgr/ft3-R of operating capacity (OC) to a 2 PPM leakage end point 1. Normal softening requires 50 USG/ft3-R for the same OC and leakage. In present day operations the need for higher regeneration efficiency not only drives the economics of the ion exchange process but also increasingly, has become a limitation on new ion exchange considerations because of restrictions on regenerant waste disposal. Recent developments in the resin bead functionalisation technique have lead to a new family of resins with improved regenerant utilization and reduced waste volume discharge. This paper presents a combined lab and field study carried out at a remote oil facility in 2008. The study used seawater ranging from 1.9% to 3.6% to regenerate Purolite SST80, a shell and inert core resin. The study showed a 40 Kgr/ft3-R of operating capacity (OC) to an endpoint of $<$ 10% leakage using 48 USG/ft3-R.

Discusser: Dave Dally, Lanxess, Birmingham, NJ ..... 10:35 AM
Floor Discussion & Closure ..... 10:45 AM
Conclusion ..... 11:00 AM

HYDRAULIC FRAC FLOWBACK WASTE WATER TREATMENT METHODS

Date: Monday, November 14
Time: 8:00 - 11:00 AM
Room: Salon 3

Unconventional oil and gas energy reserves commonly called the shale plays have gained media attention in recent times, both for their potential and the associated waste water problems resulting from hydraulic fracturing, a technology widely used to tap into the shale rock buried deep into the earth's crust. The shale oil and gas has now been discovered nationally and internationally and is being actively explored for cost effective production. Environmental impacts and associated cost of the hydraulic frac flow back waste water treatment for disposal or reuse has put a damper on the pace of shale development. The oil and gas industry is facing protest and regulations around frac flowback waste water and the waste water treatment industry is working fast to provide cost effective regulation compliant treatment methods. This session will cover a sampling of challenges and treatment methods including potential to reuse the treated frac flowback water.

IWC Representative: Joe Loftis, Consultant, Pittsburgh, PA
Session Chair: Devesh Mittal, Aquatech International Corp., Canonsburg, PA
Discussion Leader: John Schubert, HDR, Sarasota, FL

Session Introduction **8:00 AM**

Devesh Mittal, Aquatech International Corp., Canonsburg, PA

IWC 11-07 **8:10 AM**

NORM REMOVAL FROM HYDROFRACTURING WATER

James Silva, Ph.D., General Electric Global Research, Niskayuna, NY; Hope Matis and William Kostedt IV, and Vicki Watkins, GE Global Research Center Niskayuna, NY

Naturally occurring radioactive material (NORM), particularly 226Ra, is often found in hydro fracturing flow back water and produced water (both referred to as "frac" water)

from shale gas wells. A key frac water disposal option is to thermally recover clean water by evaporation and a salable salt product by crystallization. In order to avoid radium contamination of the salt product and to minimize worker exposure to radium, it is desirable to remove radium from the frac water. Commercially available radium-specific complexing (RSC) ion exchange resins are effective for removing radium from well water and softener regeneration brines. However, frac water typically contains very high levels of dissolved salts, including barium, which interferes with radium removal by such resins. Using RSC resin as a benchmark, we screened a variety of adsorbents and ion exchange resins for their effectiveness in radium removal from frac water. This paper describes both equilibrium and column breakthrough test results for several promising adsorbents under a variety of conditions. Barium sulfate, montmorillonite, and manganese oxide (adsorbents) as well as strong acid cation exchange resins were found to be effective at removing radium from certain frac waters. Both ionic strength and barium concentration were found to be key factors in determining radium sorption or exchange capacity for a given material.

Discusser: Jerry Penland, Chester Engineers, Moon Township, PA ..... 8:35 AM
Floor Discussion & Closure ..... 8:45 AM

IWC 11-08 **9:00 AM**

EVALUATION OF BRACKISH GROUNDWATER TREATMENT FOR USE IN HYDRAULIC FRACTURING OF THE BAKKEN FORMATION, NORTH DAKOTA

Bethany Kurz, Daniel Stepan, John Harju,Brad Stevens, and Robert Cowan, Energy & Environmental Research Center Grand Forks, ND

The Northern Great Plains Water Consortium® (NGPWC) is a partnership between the Energy & Environmental Research Center (EERC), the U.S. Department of Energy, and key stakeholders in the north-central region of the United States. The overall goal of the NGPWC is to assess, develop, and demonstrate technologies and methodologies that minimize water use and reduce impacted water discharges from a range of energy technologies. One of the NGPWC's current activities is to evaluate potential sources of water for use in hydraulically fracturing the Bakken Formation of North Dakota. Because of the current high costs for acquisition and transportation of existing water resources in western North Dakota, treatment of nontraditional water supply sources may be economically feasible. To evaluate the feasibility of treating nonpotable groundwater as a means of providing freshwater supply for hydraulic fracturing of the Bakken Formation, the EERC teamed with a major oil producer in the state to conduct a pilot treatment project using reverse osmosis (RO) to treat brackish groundwater. The success of the pilot has led to plans to build a full-scale, 1-million-gallon-per-day RO treatment plant. This paper will discuss the RO system performance, economic comparability to alternate water supply sources, and applications for other industries with water supply issues.

Discusser: Daniel Dudek, Siemens Industry, Inc., Warrendale, PA ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break ..... 9:50 AM

IWC 11-09 **10:10 AM**

THE REAL COST OF ZLD FOR SHALE GAS FRAC WATER IN THE MARCELLUS SHALE PLAY

William Shaw, P.E., HPD, LLC, a Veolia Water Solutions & Technologies Company, Plainfield, IL

In the Marcellus Shale play in particular, both surface and underground disposal of the frac water are not options, and re-use of the brine in further fracturing operations is limited. Zero liquid discharge is the apparent long-term solution to the problem, using evaporators and crystallizers to concentrate the brine, crystallize out the salts and recover

clean distilled water for re-use or direct discharge to the environment. Evaporation is a very energy-intensive process, but the energy consumption can be made less onerous by the use of such techniques as mechanical vapor recompression (MVR). Some companies have designed mobile evaporators to deploy at the drilling sites. These machines, we are told, can recover and recycle up to 75% of the frac water at a total cost, including energy, which is less than the of transportation and tipping fees to a POTW, an option that used to be available in Pennsylvania, but no longer. Crystallizers are proposed to recover the remaining water and produce a solid waste for landfill disposal from the concentrated brine, at least 25% of the total frac water volume. But crystallization is even more energy intensive than evaporation, and MVR is often not possible. Extensive chemical pretreatment of the brine may be necessary to keep the energy consumption reasonable and to remove constituents which may make the solids a hazardous waste. Because of these limitations, crystallization is not practical to do at the drill site with mobile units. By focusing on the chemistry of frac water and the physics required to transport, treat, evaporate, crystallize, and dispose of the solids, this paper will calculate the true costs of a complete ZLD solution for Marcellus Shale frac water.

Discusser: John Schubert, HDR Engineering, Inc., Sarasota, FL.....10:35 AM
Floor Discussion & Closure.....10:45 AM
Conclusion ..... 11:00 AM

MINE WATER MANAGEMENT

Date: Monday, November 14
Time: 8:00 - 11:00 AM
Room: Salon 7

Across the United States, several thousand miles of waterways are impaired for aquatic life, fisheries and drinking water uses, due to discharges of heavy metals, acids and dissolved salts from historical mining activities. Mining industry, government and citizen-led programs are targeted at cleaning up these impacts. Current-day mining operators are confronted with challenging water-quality protection programs in their regions and states and resultant discharge limits for their operations are quite stringent. They are issued permits the size of a medium-sized city phone book containing effluent limitations and monitoring requirements for a large slice of the Periodic Table of elements. Mining is still a very prominent industry in North America, with some sectors significantly increasing in activity due to market conditions, such as precious and rare earth metals, coal, oil sands and uranium. The current climate of environmental protection, citizen action and increasing demand for mining products has led to technological innovations and mine water management strategies designed to lessen the environmental footprint of historical and current mining activities. We have the opportunity to hear about three such innovation ideas in this session, which should generate some lively discussion both during this session and afterwards, about the relative merits of various new developments in mine water management.

IWC Representative: Mike Ryder, Chester Engineers, Moon Twp, PA
Session Chair: Paul Pigeon, Golder Associates Inc., Lakewood, CO
Discussion Leader: Dave Reisman ,EPA,

Session Introduction **8:00 AM**

Paul Pigeon, Golder Associates Inc., Lakewood, CO

IWC 11-10 **8:10 AM**

MINE WASTE CLEAN-UP WITH NOVEL HYBRID ORGANIC-INORGANIC MATERIALS

Edward Rosenberg, Ph.D., and Carolyn Hart, University of Montana (UM)/Purity Systems Inc(PSI) Missoula, MT

In the past 10 years the University of Montana in collaboration with Purity Systems Inc, both located in Missoula, MT have been developing a new class of chelator composite materials that have some specific advantages over conventional polymer and silica based ion exchange materials. Previous presentations at IWC focused on the synthesis, characterization and bench scale applications. Since that time the technology has been successfully commercialized and is being used in the mining industry to recover copper, nickel and cobalt from acid mine drainages and solvent extraction raffinates. A description of the industrial scale circuits in which these materials have been employed and the problems encountered in these projects will be presented. Future directions in the manufacture of these materials and other potential applications will also be discussed.

Discusser: Tom Rutkowski, Golder Associates Inc., Lakewood, CO ..... 8:35 AM

Floor Discussion & Closure ..... 8:45 AM

IWC 11-11 **9:00 AM**

SULFATE REMOVAL FROM ACID MINE DRAINAGE FOR POTENTIAL WATER RE-USE

David Kratochvil, Ph.D., P.Eng, BioteQ Environmental Technologies, Vancouver, BC, Canada; Alex West, BioteQ Environmental Technologies Inc Vancouver, BC, Canada; Phil Fatula, Lanxess Sybron Chemicals Inc Pittsburgh, PA

Sulfate is a common by-product of the mining process. Coal and most metals are won from ore bodies containing sulfur-based minerals that oxidize to sulfate during mining, metal extraction or from natural oxidation in waste rock, tailings and rock surfaces exposed to elements in open pits. Sulfate is easily mobilized and reports to wastewater streams such as mine drainage. Once considered harmless and a non-regulated substance, sulfate in treated or untreated mine drainage released into the environment is now subject to discharge limits ranging from 250 to 1000 mg/L depending on the receiving environment and/or applicable Total Dissolved Solids (TDS) limits. Furthermore, the presence of sulfate in mine drainage often limits the potential re-use of water by agriculture or industries that require make-up water with low sulfate content to prevent scaling. An innovative ion exchange based technology has been developed to reduce sulfate levels in mine drainage to meet regulations and allow for effective water re-use by a number of industries. This water treatment solution is a two-stage process using commercially available cationic and anionic resins to remove calcium or magnesium in the cationic stage and sulfate in a subsequent anionic stage. The products of the process are treated water with compliant levels of sulfate and TDS, and clean solid gypsum. This process consumes little energy and delivers water recovery rates up to 99%, reducing the impact on fresh water supplies. This paper will profile the ion exchange process and provide case studies of the technology applied at mining operations.

Discusser: Joseph Swearman, Consol Energy, Canonsburg, PA ..... 9:25 AM

Floor Discussion & Closure ..... 9:35 AM

Break ..... 9:40 AM

IWC 11-12 10:10 AM

AMD REUSE AND OTHER SUSTAINABLE TECHNOLOGIES

Scott Quinlan, P.E., C.B.C., GAI Consultants, Inc., Homestead, PA; Allison McCurdy, GAI Consultants Pittsburgh, PA; Gary Van Balen, P.E., Sci-Tek Consultants, Inc. Penn Hills, PA; Joseph Fedor, P.E., ALCOSAN Pittsburgh, PA

At the Grandview Golf Course located in North Braddock Borough, Pennsylvania, Acid Mine Discharge (AMD) has been combining with local runoff and entering the Allegheny County Sanitary Authority (ALCOSAN) sewer system in North Braddock. A program was developed for removing the AMD from the combined sewer system and remediating the AMD for reuse as irrigation water for the golf course. When irrigation water is not needed, the treated AMD will be piped to a newly constructed municipal storm sewer and discharged to Turtle Creek. As part of this project, the team is designing an alternative energy supply source for the golf course. Field data is currently being collected for evaluating the installation of a wind-driven generator to power the facility. Additionally, a micro-hydroelectric generator driven by AMD is being evaluated for feasibility. This project is being partially funded through a Pennsylvania Department of Environmental Protection Growing Greener Watershed Protection Grant.

Discusser: Louiza Bell, Applied Remediation Technology, Rossland, British Columbia, Canada ..... 10:35 AM
Floor Discussion & Closure ..... 10:45 AM
Conclusion ..... 11:00 AM

KEYNOTE SESSION

Date: Monday, November 14, 2011
Time: 11:00 AM - 12:00 NOON
Room: Salons 4 & 5
Session Chair: John Lucey, Heckmann Water Resources, Pittsburgh, PA
CHAIRMAN'S WELCOME
PRESENTATION OF ANNUAL AWARDS
KEYNOTE ADDRESS: WATER ISSUES AND CHALLENGES ASSOCIATED WITH SHALE GAS PRODUCTION

John A. Veil, Veil Environmental, LLC, Annapolis, MD, USA

John A. Veil

Tens of thousands of wells are being drilled each year in several large gas shale formations in the United States. Shale gas development is also beginning in other countries and will likely increase rapidly. All U.S. shale gas wells must be fractured to allow sufficient gas to be produced to make the wells economically viable. In order to conduct fracturing operations, gas companies must obtain several million gallons (5,000 to 20,000 m3) of water for each well from local sources. In some areas, the available freshwater supplies are limited, creating a challenge for the gas companies. After the frac job is finished, a portion of the frac fluid that was injected returns to the surface over the next few days. This "flowback water" is considerably saltier than the original frac fluid, plus it often contains elevated concentrations of metals, radionuclides, and other contaminants.

This paper describes the water needs for making up the frac fluids for each well and how the necessary volume compares with other existing water uses in those regions. The steps in the shale gas process in which water is used and wastewater is generated are discussed with numerous photos. Management or disposal of the flowback water and smaller volumes of ongoing produced water from the shale formation are described. Various chemical additives are mixed with water and proppants to make frac fluids. The paper will describe the general categories of chemicals that are used and will provide information on the Frac Focus chemical registry developed to provide public access to the names and quantities of chemicals actually used in the frac fluids for many U.S. shale gas wells.

John Veil founded Veil Environmental, LLC, a consulting practice specializing in water issues affecting the energy industries, upon his retirement from Argonne National Laboratory in January 2011. Mr. Veil spent more than 20 years as the manager of the Water Policy Program for Argonne National Laboratory in Washington, DC, where he was a senior scientist. He analyzed a variety of energy industry water and waste issues for the Department of Energy.

Mr. Veil has a B.A. in Earth and Planetary Science from Johns Hopkins University, and two M.S. degrees -- in Zoology and Civil Engineering -- from the University of Maryland.

Before joining Argonne, Mr. Veil managed Maryland's programs for industrial water pollution control permitting through the National Pollutant Discharge Elimination System (NPDES) and Underground Injection Control (UIC). Mr. Veil also served as a faculty member of the University of Maryland, Department of Zoology for several years.

Mr. Veil has been recognized by the Society of Petroleum Engineers as a Distinguished Lecturer in 2008-2009, and as the recipient of the 2009 international award for Health, Safety, Security, Environment and Social Responsibility.

Mr. Veil has published many articles and reports and is frequently invited to make presentations on environmental and energy issues.

TRADITIONAL AND INNOVATIVE PRETREATMENT TECHNIQUES

Date: Monday, November 14
Time: 1:30 - 5:20 PM
Room: Salon 1

Pretreatment covers a very broad subject area dealing with the upstream treatment required for the successful operation of downstream processes. This session will provide the opportunity to learn more about the traditional technologies of lime softening and chloramine removal as well as some new technologies dealing with forward osmosis and a new technique to study the scaling process.

IWC Representative: Jim Dromgoole, Fort Bend Services, Strafford, TX
Session Chair: Michael Sheedy, Eco-Tec, Pickering, Ontario
Discussion Leader: Bob Applegate, Graver Water Systems, New Providence, NJ

Session Introduction **1:30 PM**

Michael Sheedy, Eco-Tec, Pickering, Ontario

IWC 11-13 **1:40 PM**

FORWARD OSMOSIS APPLIED TO DESALINATION AND EVAPORATIVE COOLING MAKE-UP WATER

Peter Nicoll, Modern Water plc, Guildford, Surrey, UK

Modern Water is one of the few companies that have developed and deloyed forward osmosis processes on a commercial scale, for a variety of different applications. This paper outlines the progress made to date on the development and commercial deployment of two of these processes applied to desalination and evaporative cooling tower make-up water.

Operational results taken from a commercial scale forward osmosis desalination plant operating alongside a seawater reverse osmosis plant, located in Oman, utilizing a common pre-treatment system are outlined. The forward osmosis plant demonstrated significant advantages in performance, both in energy consumption and in particular very low fouling. The plant operated over a year long period without any chemical cleans, whereas the conventional plant had numerous chemical cleans, a change of membranes and showed a marked decline in productivity over the same period. The manipulated / forward osmosis plant also demonstrated the inherent capability for higher boron rejection than conventional membrane plant.

Manipulated osmosis may also be applied directly to provide make-up water for evaporative cooling towers. Modern Water has successful developed and demonstrated this new process. This new technology shows significant promise in allowing various raw water sources, such as seawater or treated sewage effluent, to be used directly in the manipulated osmosis step, thus releasing the use of scarce and valuable potable water for other more important uses. The paper presents theoretical and operational results for the process, where it is shown that the process can produce make-up water at considerably lower opex than conventional processes. Manipulated osmosis may also be applied directly to provide make-up water for.

Discusser: Donald Kirk, Ph.D., University of Toronto, Toronto, Canada ..... 2:05 PM
Floor Discussion & Closure ..... 2:15 PM

IWC 11-14 **2:30 PM**

MONOCHLORAMINE REMOVAL BY ACTIVATED CARBON – DESIGN, OPERATING AND MAINTENANCE CONSIDERATIONS

William Collentro, Worcester Polytechnic Institute, Plymouth, MA

Over the last several years, municipal water treatment systems with feed water from a surface source or ground water source influenced by surface water have attempted to

minimize production of carcinogenic disinfection byproducts such as trihalomethanes. Addition of ammonia to chlorinated water for secondary microbial control in distribution systems is frequently employed, producing monchloramines. Activated carbon removal of monochloramine in industrial water purification presents unique challenges. Design, operating, and maintenance consideration will be discussed. The impact of feed water temperature, pH, Total Organic Carbon concentration, activated carbon media selection, and multivalent caption concentration on empty bed contact time will be presented.

Discusser: Stephanie Carr, Calgon Carbon Corporation, Pittsburgh, PA.....2:55 PM
Floor Discussion & Closure.....3:05 PM
Break: ..... 3:20 PM

IWC 11-15 **3:40 PM**

ACHIEVING COMPLETE LIME SOFTENING IN A DEEP WELL SALINE WATER SOURCE VIA SOLIDS CONTACT PROCESS TREATMENT IN THE PRESENCE OF NATURAL ORGANIC MATTER UNDER COLD WEATHER CONDITIONS

John Williamson and P. Temple Ballard, Infilco Degremont Inc., Richmond, VA; Ramesh Sharma, ConocoPhillips, Houston, TX; Sudhir Parab, ConocoPhillips, Alberta, Canada

Deep, non-potable aquifers containing significant concentrations of salinity, total hardness, and silica, though unsuitable for drinking water supplies, are considered viable water sources for use in various industrial applications such as boiler feed make-up in Steam Assisted Gravity Drainage (SAGD) facilities. Pre-treatment is typically required due to the scaling potentials associated with both total hardness and silica, which is detrimental to boiler operations.

Cold lime softening (CLS) was evaluated using solids contact process treatment in laboratory batch tests to demonstrate the advantage of high-efficiency solids contact clarification by introducing previously precipitated calcium carbonate solids back into the reaction zone that act as a "seed" due to the existing calcium carbonate crystal surface (solids contact effect) that can stimulate additional calcium hardness removal while providing increased surface area adsorption for Total Organic Carbon removal.

Initial test results demonstrated that a lime dosage slightly above the calculated stoichiometric dosage was able to yield effluent total hardness concentrations below 40 mg/L as CaCO3 under cold weather conditions near 5° C. Further tests spiking natural organic matter (NOM) up to 33.5 mg/L were found to initially exert inhibitory affects on complete total hardness removal. Implementing solids contact process treatment demonstrated that the inhibitory affects from the spiked NOM could be overcome and reach effluent total hardness concentrations below 40 mg/L as CaCO3 under cold weather conditions.

Experience has shown that high salinity and NOM play an important role in achieving efficient calcium carbonate precipitation and crystal growth. The laboratory evaluation demonstrated NOM can exert varying degrees of inhibitory affects on calcium carbonate precipitation. The physical and chemical properties associated with the multitude of molecular configurations that constitute NOM will greatly dictate the ability to treat and limit its affects on calcium crystal inhibition, particularly at low temperatures. High-efficiency solids contact process treatment is considered a viable treatment approach to limit these effects and yield total hardness removal below theoretical expectations (25 – 50 mg/L as CaCO3) when under the influence of certain NOM and saline conditions via CLS. This pre-treatment approach continues to provide reliable performance through proven success both in the laboratory and real-world applications when operating in cold weather environments.

Discusser: Diane Martini, Sargent & Lundy, Chicago, IL.....4:05 PM
Floor Discussion & Closure.....4:15 PM

IWC 11-16 **4:30 PM**

STUDY OF THE SCALING PROCESS BY THE FAST CONTROLLED PRECIPITATION METHOD: APPLICATION TO RAW RIVER WATER

Olivier Horner, Guillaume Gautier, and Olga Alos-Ramos, EDF R&D Chatou, France

Scaling phenomenon is a major concern which can reduce efficiency in condenser cooling circuits of power plants fed with raw river water. In order to ensure an optimum, safe and sustainable process, it is of vital importance to study the mechanisms of the scaling phenomenon and to find effective ways to prevent or fight it. In a water circuit, scaling is essentially related to the formation of calcium carbonate. The Fast Controlled Precipitation method (FCP), developed by the Ecole Nationale Supérieure des Arts et Métiers (ENSAM Paris), is among the newest techniques to study the scaling process and allows to characterize the heterogeneous nucleation of CaCO3 via the measurement of conductivity and pH under continuous degassing of CO2. The variation of dissolved carbon dioxide concentration is the driving force of the system evolution, generating scaling. The FCP method was chosen to study the scaling process of raw river waters with the ambition to recreate faster the scaling phenomenon in industrial circuits supplied with river waters. It was applied toraw river waters from the Seine, the Rhone and the Moselle (France) over a large period of time. This gave some insight into the scaling potential of these waters, depending on the season. The possible correlations with the quality water (e.g. suspended matter) were explored. The possibility to use these data to optimize the acid injections as anti-scaling agent will be discussed.

Discusser: Barbara Moriarty, Nalco Company, Naperville, IL..... 4:55 PM
Floor Discussion & Closure.....5:05 PM
Conclusion ..... 5:20 PM

INNOVATIVE TECHNOLOGY APPLICATIONS FOR POWER PLANT STEAM CYCLE, CONDENSATE, AND RADIOACTIVE WASTE TREATMENTS

Date: Monday, November 14
Time: 1:30 - 5:20 PM
Room: Salon 2

This power plant specific session examines the experiences and knowledge acquired by the application of new technology for trace ion monitoring in the steam cycle, alternative technology for condensate polishing, and the new direction of mobile equipment as opposed to permanently installed equipment for the treatment of radioactive waste. The authors/presenters have firsthand experiences with the technologies and techniques discussed and will share the pros and cons of traditional and alternative approaches for their specific topic. Please join us for an exciting round of discussion following the presentation of each new technique.

IWC Representative: Dan Rice, DBR Consulting, Sault Ste. Marie, MI
Session Chair: David Franciamone, Pall Corporation, Timonium, MD
Discussion Leader: Dave Malkmus, ResinTech, West Berlin, NJ

Session Introduction **1:30 PM**

David Franciamone, Pall Corporation, Timonium, MD

IWC 11-17 **1:40 PM**

MONITORING OF TRACE LEVELS OF IONS IN THE STEAM CYCLE BY MICROCHIP CAPILLARY ELECTROPHORESIS

Kenneth Ogan, Ph.D., Advanced MicroLabs, Fort Collins, CO; Jonathan Vickers and Matthew Heim, Advanced MicroLabs, LLC Fort Collins, CO

EPRI has shown that monitoring trace levels of selected ions in the water is essential for the efficient and safe operation of thermoelectric generation plants. Furthermore, on-line

monitoring is strongly recommended wherever feasible. Sensitive on-line monitors exist for very few of these ions, so ion chromatography (IC) systems have been adapted to operate in on-line modes, with mixed success. We report on an alternative approach to on-line monitoring of trace levels of key ions, based on microchip capillary electrophoresis (MCE). Rather than using a fused-silica capillary as in conventional CE analytical systems, the capillary channel is embossed in a plastic microchip, thus providing a more rugged element, in a smaller footprint, as well as a lower replacement cost. This system offers rapid assays (on the order of 10 minutes), minimal reagent use and waste stream, yet with detection limits comparable to ion chromatography, or better. Our initial application of this MCE system has been to tracking the chemistry in various process streams in the steam cycle, monitoring a suite of ions, including sodium, potassium, magnesium, calcium, chloride, sulfate and nitrate.

Discusser: Dave Silverman, Advanced Water Engineering, Indian Harbour Beach, FL..... 2:05 PM

Floor Discussion & Closure ..... 2:15 PM

IWC 11-18 **2:30 PM**

OPERATING EXPERIENCE WITH AMINE FORM CONDENSATE POLISHING

Lewis Crone, Dominion Nuclear Connecticut, Inc., Waterford, CT

Millstone Power Station seeks to update its experience with full flow operation of deep bed condensate polisher resins chemically configured in the amine form. The operating experience will address areas such as the effects of elevated hydrazine and its decomposition product ammonia on resin kinetics and steam generator and balance of plant chemical compositions; resin stationary phase and secondary cycle ethanolamine behavior as a function of time; effects on iron transport and polisher iron removal efficiency; mechanical resin cleaning and contamination control; behavior during a condenser tube ingress; and the effect on steam generator non-volatile impurities. These attributes will be discussed from the perspectives of open cycle blow down, which is employed at Millstone 2, and closed cycle blow down, utilized at Millstone 3.

Discusser: ..... 2:55 PM

Floor Discussion & Closure ..... 3:05 PM

Break ..... 3:20 PM

IWC 11-19 **3:40 PM**

UPGRADE OF CONDENSATE WATER FILTRATION SYSTEM WITH HIGH EFFICIENCY DISPOSABLE FILTERS

Ramraj Venkatadri, Ph.D., Pall Corp., Port Washington, NY

A 1,000 MW power plant in North Italy was using back-washable metal filter cartridges with a cellulose based filter-aid for the filtration of condensate water. The filtration system, consisting of 403 metal filter cartridges, treated 760 tons / hr (3000 GPM) of the condensate. There were a number of operational problems with the filtration system including inconsistent particulate removal efficiency, frequent, labor intensive and time consuming back-wash cycles that generated a waste stream and consumed water and energy. Following the testing during the plant start-up and normal operation using a side stream of the condensate, a filtration system using disposable filter cartridges was proposed and accepted by the plant. The back-wash filtration system was replaced with a compact, high surface area, disposable cartridge filtration system. The 60" long, polypropylene made filter cartridges engineered for high flow capacity and high particle removal efficiency (99.98% efficient for particles 4.5μm and larger) were installed in a horizontally oriented filterhousing that contained 34 cartridges. Experience with the new filtration system over a period of 30 months since installation on one system and

for 27 months on a second system, has shown a consistent and improved contamination removal and substantial cost savings for the plant. The presentation discusses the experience of the plant with the two filtration systems.

Discusser: Tom Snyder, B&W, Knoxville, TN ..... 4:05 PM
Floor Discussion & Closure ..... 4:15 PM

IWC 11-20 **4:30 PM**

USE OF MOBILE TECHNOLOGIES IN THE DESIGN OF LIQUID AND SOLID RADWASTE TREATMENT SYSTEMS FOR NUCLEAR POWER PLANTS

Jeanette Shoemaker, Steven Shapiro, Kumar Sinha, Bechtel Power Corporation Frederick, MD

New generation nuclear power plants are incorporating the use of mobile (trailer-mounted or skid-mounted) processing systems to treat and package low-level radioactive liquid and solid waste. In contrast to the permanently installed radwaste treatment systems originally included in the design of the majority of the current operating fleet of nuclear plants, the radwaste treatment systems proposed for the new generation of nuclear reactors serve to reduce the complexity and size of the radwaste treatment system through the use of vendor supplied and optimized mobile systems. Benefits of this strategy include lower capital and operating costs resulting from the use of standardized and compact hardware designs and increased efficiency of current waste processing technologies. As further advancements in waste treatment technologies become available, these new generation plants will also have the flexibility to upgrade their current mobile systems to newer methods for waste treatment.

Liquid and solid radwaste system designs in existing nuclear plants will be compared with the systems and technologies planned for use in new reactor designs. Mobile treatment options currently available or considered for liquid and solid radioactive waste processing will be discussed, including ion exchange, reverse osmosis, precoat filtration, sludge dewatering and waste solidification. An overview of emerging treatment technologies for application in radwaste systemssuch as electrodeionization (EDI) and nanofiltration will be provided. Emphasis will also be placed on the advantages of incorporating mobile treatment systems in the early stages of engineering design of new nuclear facilities. A discussion of issues such as interfaces with permanently installed equipment, plant layout and shielding considerations, and allocation of design and operational responsibilities between equipment suppliers, design engineers and plant

Discusser: James Braun, AVANTech, Columbia, SC ..... 4:55 PM
Floor Discussion & Closure ..... 5:05 PM
Conclusion ..... 5:20 PM

REFINERY AND OIL SANDS WASTEWATER APPLICATIONS

Date: Monday, November 14
Time: 1:30 - 5:15 PM
Room: Salon 3

The refining industry is faced with ever increasing and demanding environmental regulations to protect the environment. Wastewater from the refining process contains hazardous hydrocarbons, phenol, amines, ammonia nitrogen, BTEX compounds, heavy metals, total dissolved solids and other hazardous compounds. Reuse of treated wastewater effluent is gaining momentum not only to comply with the complex regulatory requirements cost effectively but also to relieve the demand on the scarce raw water supply. This session presents cutting edge trends in technology such as Macro Porous Polymer Extraction (MPPE) to remove toxic dispersed and dissolved hydrocarbons, enzymatic removal of selenium from sour water stripper bottoms, pilot testing methodologies to determine suitable technologies for water reuse based on end user water quality requirements, and use of ceramic membranes to improve de-oiling efficiencies.

IWC Representative: George Abrahim, Veolia Water Solutions & Technologies, Moon Twp, PA
Session Chair: Ramesh Kalluri, Kalluri Group, Inc, Houston, TX
Discussion Leader: Jay Farmerie, Cyrus Rice, Pittsburgh, PA

Session Introduction **1:30 PM**

Ramesh Kalluri, Kalluri Group, Inc, Houston, TX

IWC 11-21 **1:40 PM**

PILOTING CONVENTIONAL AND EMERGING INDUSTRIAL WASTEWATER TREATMENT TECHNOLOGIES FOR THE TREATMENT OF OIL SANDS PROCESS-AFFECTED WATER

Richard Mah, Rodney Guest, Ph.D., and Pritesh Kotecha, Suncor Energy Inc. Calgary, AB, Canada

Piloting is a key stage in the design process for water and wastewater treatment systems, especially for unconventional wastewaters such as those generated by oil sands mining and extraction operations. The nature of the constituents in process-affected tailings water and the scale of operations provide some challenges for conventional industrial wastewater treatment technologies. The organic constituents found in tailings water differ from typical refinery wastewaters, and gaining insight on fouling characteristics, removal efficiencies, and toxicity of the water is important in determining potential end-uses for tailings water. A close examination of the potential end-uses for treated water, required treatment objectives, and real-world unit-process performance is required in order to select suitable treatment technologies for tailings water. In 2010-2011, Suncor Energy (on behalf of the Oil Sands Leadership Initiative) piloted several conventional and emerging industrial wastewater treatment technologies on tailings water. Among the technologies examined were Dissolved Air Floatation, Ultrafiltration, and Reverse-Osmosis, Advanced Oxidation (Ozone-Peroxide based), suspended-growth biological systems and attached-growth biological systems. This paper reviews the challenges and performance observed over the course of this pilot.

Discusser: Jeff Easton, WesTech Engineering, Inc., Salt Lake, UT ..... 2:05 PM
Floor Discussion & Closure ..... 2:15 PM

IWC 11-22 **2:30 PM**

CHALLENGES AND PROMISES FOR REFINERY WASTEWATER: CASE STUDIES IN UPGRADING THE WWTP under Many Constraints

John Christiansen, M.S., P.E., CDM, Houston, TX; William Xu, Ph.D, CDM Houston, TX

Market forces and increased regulatory demands have produced significant operational challenges for refiners and wastewater generated by their operations. These market forces include varying sources of crudes and increased usage of "unconventional" crudes like those from frac flow back and heavy crudes. At the same time, the NPDES discharge permit renewal process is prompting the reduction of the presence of trace contaminants in water discharges. There have also been many refinery specific orders based on air permits and global settlements that have prompted refineries to close up their wastewater collection systems and treatment units to reduce air emissions. These challenges must be met to maintain compliance and operate profitably and safely. This often requires utilizing both new technology and new applications of existing technology. Current wastewater systems are also often increasingly complex and use on-site chemical parameter monitoring and automated decision processes to achieve higher performance than the previous manual systems could provide.

This paper details some of the most significant challenges facing today's refiners and presents the technical approaches and equipment being employed to address them. Some of the challenges described include treating new chemicals from shipments of crude from unconventional sources that enter the wastewater system and affect its operation. Implementing effective VOC control from existing collection and process systems, achieving nitrification-denitrification, and addressing ultra-low effluent requirements benzene and selenium removal. The cases described show the chemical characterization of refinery wastewaters when processing heavy crudes and crudes recovered from frac flowback sources, considerations when closing up the wastewater system to reduce air emissions, effective cooling strategies for hot process wastewaters, innovative soluble organic removal, and removal of trace metals.

Floor Discussion & Closure ..... 2:55 PM

Break: ..... 3:20 PM

IWC 11-23 **3:45 PM**

CERAMIC MEMBRANES, COMMERCIALLY AVAILABLE ALTERNATIVES, OPERATING PERFORMANCE, SUCCESSES AND FAILURES

R. Gay-de-Montella, M.Sc P.Eng., Worley Parsons Canada, Calgary, AB, Canada; T. Harding, The University of Calgary Calgary, AB, Canada; V. Martez, Applied Research and Innovation, SAIT Calgary, AB, Canada

The ceramic tubular membranes demonstrate de-oiling efficiencies better than conventional polymeric oil removing filters because of their superior physical integrity, chemical resistance, tolerance to moderate pressures and high operating temperatures, regeneration ability and long service life. This paper provides an overview of select commercially available ceramic membranes, materials, pore sizes, and reviews the performance of the membranes comparatively under a variety of operating conditions for de-oiling produced water. It also addresses the success in separating oil, crudes, solids and Naphthenic acids, and challenges related to flux recovery, cleaning efficiency and membrane regeneration.

Discusser: Rick Szilagyi, WesTech Engineering, Rockford, IL ..... 4:05 PM

Floor Discussion & Closure ..... 4:15 PM

IWC 11-24 **4:30 PM**

ENZYMATIC REMOVAL OF SELENOCYANATE FROM SOUR WATER STRIPPER BOTTOMS

Greg DeLozier, Ph.D., Novozymes A/S, Bagsvaerd, Denmark; Yakup Nurdogan, Ph.D., P.E., Bechtel Pueblo, CO

Sour water stripper bottom streams of oil refineries processing seleniferous crudes contain high concentrations of soluble selenium present primarily as selenocyanate (SeCN-), but relatively low flow rates. The current biological and physicochemical selenium removal technologies are not effective in reducing SeCN- concentrations in these source streams without effective pretreatment processes. Specific enzymes engineered to maintain optimal activity in the presence of toxic compounds found in sour water stripper bottoms may offer a cost-effective alternative to the existing selenium treatment technologies. Unlike biological processes, this technology is not affected from toxicity of wastewater and does not require nutrient addition. In laboratory trials, a monocomponent recombinant enzyme was added to refinery stripped sour water samples to ascertain the effectiveness of enzymatic reactions on selenium species. Selenium speciation and dissolved selenium concentration were determined by ion chromatography inductively coupled plasma dynamic reaction cell mass spectrometry (IC-ICP-DRC-MS) and inductively coupled plasma dynamic reaction cell mass spectrometry (ICP-DRC-MS), respectively. Soluble SeCN- concentrations were reduced from 1,000-1,500 ppb to 30 ppb with 98% removal efficiency. The removal efficiencies for total selenium were greater than 90%. During the bench-scale testing, parameters such as type and quantity of enzyme, treatment time, pH, and temperature were varied. Ideally, the enzymatically-treated sour water stream bottom streams will be diluted by other refinery process effluents with much higher flow rates and low or no selenium content. The combined refinery wastewater stream should easily comply with increasingly stringent selenium discharge limits imposed on oil refineries.

Discusser: John Christiansen, CDM, Inc., Houston, TX.....4:55 PM
Floor Discussion & Closure.....5:05 PM
Conclusion.....5:20 PM

NUTRIENT CONTROL AND CONTAMINANT REMOVAL

Date: Monday, November 14
Time: 1:30 - 5:05 PM
Room: Salon 7

This session include four interesting papers which address nutrient and contaminant removal to achieve increasingly stringent effluent limitations. The papers will discuss nutrient control of discharges from industrial water systems; experience in Florida removing nitrogen from wastewater using deep bed filtration; treatment techniques for removal of soluble metals and organic contaminants using nanoalumina fiber filters; and biological remediation using an immobilized cell bioreactor.

IWC Representative: John Lucey, Heckmann Water Resources, Pittsburgh, PA
Session Chair: Ray Post, ChemTreat, Inc., Langhorne, PA
Discussion Leader: Charles Guzelli, Severn Trent Services, Pittsburgh, PA

Session Introduction **1:30 PM**

Ray Post, ChemTreat, Inc., Langhorne, PA

IWC 11-25 **1:40 PM**

NUTRIENT CONTROL - THE KEY TO A LOW ENVIRONMENTAL IMPACT COOLING WATER PROGRAM

John Richardson, Ph.D., Helen Cerra, Richard Tribble, ChemTreat Ashland, VA

Nutrients in surface water sources are coming under increasing scrutiny from an environmental standpoint. High levels of phosphorus and nitrogen in water can lead to eutrophication resulting in low oxygen levels which can impact both fresh and sea water organisms. Cooling tower operation can exacerbate the issue since evaporation leads to increased concentrations of nutrients. This increase in nutrients causes problems for the operation of the tower and can have an adverse impact on resulting waste streams. This paper discusses methods to improve the environmental profile of evaporative cooling systems and introduces new corrosion and scale inhibitor technologies which are designed to contribute minimum additional nutrient value to the recirculating water.

Discusser: Bob Goltz, The DOW Chemical Company, Midland, MI..... 2:05 PM
Floor Discussion & Closure.....2:15 PM

IWC 11-26 **2:30 PM**

FILTRATION OF SOLUBLE METALS AND ORGANIC CONTAMINANTS BY NANOALUMINA FIBER FILTERS

F. Tepper, L. Kaledin, Argonide Corporation Sanford, FL, H. Mowers, Ahlstrom Filtration LLC Mt. Holly Springs, PA

At the last IWC meeting, a nano alumina non-woven media was described that is capable of retaining sub-micron particles including metal oxides. The filtration mechanism relies on the high positive zeta potential that attracts and retains particles in water and polar fluids. The filter was benchmarked against many non-woven as well as membrane filters, exceeding other filter media in virtually all attributes. This paper focuses on filtering soluble contaminants by chemisorption and physical absorption.

Metal contaminants are often toxic even at ppt concentrations (e.g- Cr VI). Breakthrough curves (ppm challenges) will be presented showing the retention of several soluble metals including copper, lead, tin, and silver, Fe++, Cr+++ and Cr VI on a single layer of the nano alumina media. A version of the nano alumina media embodies powdered activated carbon ("PAC"), capable of a high efficiency in both particle adsorption and physical absorption. This media was challenged by organic pollutants representative of endocrine disruptors including trace pharmaceuticals and phenolic monomers. Dynamic absorption data will be presented for Penicillin G, Bisphenol A and Flumequine, showing that a single layer of PAC is an effective absorber of such organics while in the ppm to low ppb billion range. The filter was challenged by a mixture containing 209 PCB's (a known carcinogen) and tested in accordance with EPA Method 1668A (detection limit 0.25-0.75 ng/L). At a challenge of 20,797 ng/L, the filter retained eight of the ten cogener PCB groups to less than detectable, with a total retention of 3.21 ng/L for all groups combined. (Beta coefficient $\sim$ 6400).

Discusser: John Coccaro, Siemens Industry, Inc.....2:55 PM
Floor Discussion & Closure.....3:05 PM
Break.....3:20 PM

IWC 11-27 **3:45 PM**

THIRTY YEARS OF SUCCESSFUL NITROGEN REMOVAL USING DEEP BED DENITRIFICATION FILTERS IN FLORIDA

David Pickard, David Pickard Consulting, Tampa, FL

Florida requires Advanced Wastewater Treatment for discharges to coastal waters on the West Coast of Florida. The permitted discharge limits for surface water discharge in the

Tampa Bay area are 5 mg/l Biochemical Oxygen Demand (BOD5), 5 mg/l Total Suspended Solids (TSS), 3 mg/l. Total Nitrogen (TN), and 1 mg./l. Total Phosphorus (TP). Deep Bed Denitrification Filters have been used successfully to meet the TN standard since 1979 at Tampa and many other plants in Florida and nationwide. Data will be presented demonstrating thirty years of successful denitrification at the City of Tampa Howard F. Curren AWT PI! ant and other facilities in the state. Total nitrogen discharge levels have averaged 2.2 mg/l consistently. The methanol to NO3-N ratios has averaged slightly below the published standard s for the denitrification process. Since coastal and estuarine waters in Florida are largely nitrogen limited, deep bed filter denitrification is largely responsible for greatly improved water quality in the bays and estuaries of the West Coast of Florida. Locations in the state that have chosen to meet the stringent discharge limits by utilizing a total reuse scheme have also used the deep bed filters to achieve the stringent standard for TSS required in the reclaimed water regulations. Forty percent of all reuse water produced in the state of Florida has been treated using a deep bed monomedia filter.

Discusser: John Schubert, HDR Engineering, Sarasota, FL ..... 4:05 PM
Floor Discussion & Closure ..... 4:15 PM

IWC 11-28 **4:30 PM**

DESIGN OF THE BIOTREATMENT PROCESS FOR CHEMICAL AGENT HYDROLYSATE BY IMMOBILIZED CELL BIOREACTOR

Yakup Nurdogan, Ph.D., Bechtel National, Inc., Pueblo, CO; Craig Myler, Ph.D., Bechtel National, Inc. Frederick, MD; George Lecakes, Battelle Pueblo, CO; Paul Usinowicz, Ph.D., P.E., BCEE, Battelle Columbus, OH; Eric Blumenstein, P.E., Golder Associates, Inc. Lakewood, CO

The Pueblo Chemical Agent Destruction Pilot Plant is being constructed for demilitarization of chemical weapons stored at the Pueblo Chemical Depot, Pueblo, Colorado. The stockpile of munitions at Pueblo contains the vesicants Distilled Mustard (HD) and the mixture HT. The process chosen for demilitarization involves collection of the chemical agent, water hydrolysis of the agent to produce a hydrolysate, biological treatment of the hydrolysate to reduce organic content and treatment to separate salts and recover water for reuse. The biological process selected for hydrolysate treatment is Immobilized Cell Bioreactors. This paper will describe the design of these systems for use at the Pueblo Chemical Agent Destruction Pilot Plant. The design is based on laboratory and pilot testing, which provided determination of organic loading rates, hydraulic retention times, aeration requirements, nutrient requirements, operational parameter ranges and controls (temperature, dissolved oxygen, and especially pH), salinity considerations, and biodegradation mechanisms and biodegradation products. Their incorporation into the design will be presented and discussed.

Discusser: Jill Sonstegard, GE Water, Salt Lake, UT ..... 4:55 PM
Floor Discussion ..... 5:05 PM
Conclusion ..... 5:20 PM

COOLING TOWER WATER-BIOLOGICAL GROWTH, SCALE AND CORROSION INHIBITION STRATEGIES

Date: Tuesday, November 15
Time: 8:00 - 11:00 AM
Room: Salon 1

Maximizing and maintaining efficiency of heat transfer in cooling water systems is of primary concern to plant operations. Equally important is maintaining the mechanical integrity of cooling towers, heat exchangers and circulating water piping through limiting corrosion. However, there is a delicate balance between inhibiting corrosion and scale formation, while limiting biological growth in the system. The cooling tower water system provides a challenging environment to maintaining this balance. The papers presented in this session address pre-start up corrosion of cooling tower water systems, biocide delivery and behavior, as well as monitoring and controlling corrosion, scale and biofilms. When applied, these concepts can reduce chemical usage, while increasing equipment lifecycle time and operation efficiency.

IWC Representative: Paul Puckorius, Puckorios & Associates, Inc, Arvada, CO
Session Chair: Scott Quinlan, GAI Consultants, Homestead, PA
Discussion Leader: Mary Wolter, Glass Mexel USA, LLC, Arlington, VA

Session Introduction **8:00 AM**

Scott Quinlan, GAI Consultants, Homestead, PA

IWC 11-29 **8:10 AM**

IMPORTANT CONSIDERATIONS FOR PRE-STARTUP OF COOLING TOWER WATER SYSTEMS TO MINIMIZE WATER CONTACTED EQUIPMENT DETERIORATION

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

Pre-startup considerations of cooling tower water systems are often not performed for various reasons. These various reasons are discussed in detail. If not done this can cause initial corrosion of cooling towers heat exchanger tubes, and circulating water piping that will greatly reduce the life expectancy of this equipment, so who is responsible? Specific case histories are provided as examples of where little or no pre startup occurred. They will be reviewed as to what has happened with the requirements that should have been used. A guide outlining what should have been done for pre-startup water treatment provided for each of the cooling tower, the heat exchangers, and for the piping.

Discusser: Rick Kreuser, RTK Technologies Inc., Baton Rouge, LA ..... 8:35 AM
Floor Discussion & Closure ..... 8:45 AM

IWC 11-31 **9:00 AM**

NOVEL BIOCIDE DELIVERY FOR IMPROVED CONTROL OF BIOFILM ORGANISMS

Dorothy Reynolds, Charles Ascolese, Gloria Tafel, Linna Wang, Juan Jiang, Bob Semet, GE Power & Water, Water & Process Technologies Trevose, PA

A variety of disinfectants, biocides and dispersants are used to control microbial populations in cooling systems. Sessile microbes - those attached to wetted and submerged surfaces - form biofilms that, if uncontrolled, result in biofouling. Biofouling impedes heat transfer, promotes corrosion and increases the potential for illness associated with water-borne pathogens such as Legionella. Biofouling reduces productivity, increases operating and capital costs and adversely affects profitability. The safety of the cooling tower work environment is also compromised. Controlling biofilm organisms with traditional disinfectants usually requires higher concentrations than for control of planktonic (free floating, bulk water) organisms. This is partly because slower diffusion, as opposed to rapid, turbulent transport in the bulk water, plays a major role determining the rate at which disinfectants move into the biofilm and the residuals to which biofilm organisms

are exposed. To effectively drive traditional disinfectants into the biofilm, a sufficient concentration gradient must first be established by applying a high concentration of disinfectant to the bulk water. In effect, the bulk water must be "over-treated" to control organisms in the biofilm.

Development and evaluation of a novel biocide delivery material are described. This material enhances delivery of biocide to biofilms and achieves a high concentration of active biocide in the film without resorting to similar levels in the bulk water. Lab studies show the new material allows a significant reduction in applied biocide levels compared to a traditional biocide. At the same time, a higher degree of control over biofilm organisms is achieved.

Discusser: Tom Armon, H-O-H Water Technology, Palmetto, FL.....9:25 AM
Floor Discussion & Closure.....9:35 AM
Break.....9:50 AM

IWC 11-32 **10:10 AM**

INNOVATIVE MONITORING AND CONTROL SYSTEM OPTIMIZES COOLING WATER TREATMENT EFFECTIVENESS

Bruce Chamberlain, Darcy Dauterive, Bruce Tibbott, Ashland Hercules Water Technology Wilmington, DE

Efforts to optimize water treatment performance in preventing fouling have often been limited to laboratory or empirical approximation of scale and corrosion conditions. The system presented in this paper uses an accurate deposit monitoring device, corrosion inserts, and microprocessor controls which adjust inhibitor feed in response to elevated deposition or corrosion in an operating industrial cooling system. This "smart" control enables cost performance of water treatment programs to be fine-tuned. Inhibitor feed adjustments are made not on the basis of chemical residual tests, but instead are auto-controlled based on results related to key performance indicators. This technology was used in laboratory simulations to validate and compare performance of cooling water inhibitors under extreme conditions for deposition control, and used in actual field situations to determine optimum dose-response and control inhibitor application. The end users were able with this data to maximize performance and reduce cost of their chemical treatment programs. Laboratory and user data are presented which demonstrate the application of the system algorithms.

Discusser: Ray Post, ChemTreat Inc., Langhorne, PA..... 10:35 AM
Floor Discussion & Closure.....10:45 AM
Conclusion .....11:00 AM

DEALING WITH TODAY'S FGD WASTEWATER TREATMENT PROBLEMS WHILE LOOKING FOR TOMORROW'S SOLUTION

Date: Tuesday, November 15
Time: 8:00 AM - 12:00 NOON
Room: Salon 2

The predominant method for treatment of FGD wastewater has generally been biological. This method has centered on heavy metals removal. Three of the four papers in this session deal with the removal of selenium. The issues associated with selenium removal drive us to constantly look for new solutions due to feed variability, microorganism requirements for substrate sources, and methods to prevent conversion of selenium to a form that is not amenable to existing biological treatment removal methods.

Non-biological treatment methods, including thermal/ZLD and physical/chemical methods, are also currently being used to treat FGD wastewater and remove contaminants. These other methods still offer the engineer/end user many options for processing, disposal and reuse, but have their own operational issues. The fourth paper in this session examines the challenges presented by the thermal technologies available for treatment of FGD wastewater today.

IWC Representative: Colleen Layman, Bechtel Power, Frederick, MD
Session Chair: Mike Marlett, Aquatech International Corp., Milwaukee, WI
Discussion Leader: Patricia Scroggin, Burns & McDonnell, Kansas City, MO

Session Introduction **8:00 AM**

Mike Marlett, Aquatech International Corp., Milwaukee, WI

IWC 11-33 **8:10 AM**

EVALUATION OF CARBON SOURCES FOR THE ANAEROBIC TREATMENT OF FLUE GAS DESULFURIZATION (FGD) WASTEWATERS FOR HEAVY METALS REMOVAL

Antonio Lau, Ph.D., Infilco Degremont, Inc., Richmond, VA; Rudy Labban and Sunil Mehta, Degremont North America R&D Laboratory, Richmond, VA; A. Paul Togna, Ph.D., Environmental Operating Solutions Richmond, VA

An evaluation of carbon sources was conducted to find a suitable compound that could be used in the anaerobic treatment of flue gas desulfurization (FGD) wastewaters for the biological removal of heavy metals, such as selenium, chromium, vanadium, etc. The major criteria used to evaluate the carbon sources included: (1) heavy metals removal performance, (2) ease of use of the chemical in full-scale operations and (3) cost-effectiveness. Laboratory-scale studies were conducted using sugar (dextrose) and a proprietary liquid carbon source called MicroCg. Previous experiments indicated that methanol, a well-known carbon source for denitrification reactions, would not work effectively for this application. These carbon sources were fed into the patent-pending iBIO® anaerobic wastewater treatment system to test their performance. The iBIO® biological reactor system uses suspended growth activated sludge microorganisms in a two-stage continuously stirred-tank reactor. Results indicated that sugar and MicroCg achieved the desired degree of denitrification ($>$99.9% removal) and effluent selenium target concentration of $<$30 ppb. An overall evaluation of the use of these materials for full-scale treatment indicated that due to handling issues, MicroCg was preferred over the granular sugar. This paper will discuss the results and provide more details on the implications of using these carbon sources for full-scale treatment.

Discusser: William Kennedy, P.E., Orion Engineering, PLLC, Charlotte, NC..... 8:35 AM
Floor Discussion & Closure.....8:45 AM

IWC 11-34 **9:00 AM**

DEMONSTRATION TEST OF IRON ADDITION TO AN FGD ABSORBER TO ENHANCE FLUE GAS SELENIUM REMOVAL

Thomas Higgins, CH2M HILL, Chantilly, VA; Karen Meade, CH2M HILL Santa Ana, CA; Dennis Fink, CH2M HILL Oakland, CA

This paper documents results of laboratory, and two full-scale demonstration tests of iron addition to forced oxidation flue gas desulfurization (FGD) scrubbers. Prior to the adoption of forced oxidation FGD systems, selenium in power plant wastewaters has been predominately in the chemically reduced selenite form. Selenite can be removed using chemical (iron salt addition) and physical (solids removal) technologies. With forced oxidation FGD systems, there has been a tendency for a significant portion of the selenium to be in the selenate form. Selenate is not amenable to iron addition treatment. Currently the only demonstrated technology for selenate removal from FGD wastewater has been biological treatment, something that adds to the complexity and cost of FGD wastewater treatment. The paper presents results that show that addition of an iron salt to the absorber vessel (supplementing iron already added as a constituent in limestone), results in precipitation of iron hydroxide, and the absorption of selenite before it can be oxidized to selenate, lowering the soluble selenium in the FGD wastewater, and allowing removal of the particulate selenium in simple solids removal processes.

Discusser: Kristin Collier, Burns & McDonnell, Kansas City, MO ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break ..... 9:50 AM

IWC 11-35 **10:10 AM**

CASE STUDY ON SELENIUM REMOVAL FROM A COMBINED FGD WASTEWATER AND LANDFILL LEACHATE FOR A POWER PLANT ON THE OHIO RIVER

Michael Soller, P.E. C.P.C., Bowen Engineering Corporation, Indianapolis, IN; James Harwood, GE Water & Process Technologies Oakville, ON, Canada; Tim Pickett, GE Water & Process Technologies Salt Lake City, UT

Selenium concentrations in FGD wastewater discharges are targeted for reduction by regulatory agencies in many states throughout the Ohio River Valley. Power utilities are being forced to respond to the regulatory requests while federal and state limits are being debated and evaluated at national and state levels. Additionally, the regulatory agencies are requiring power utilities to capture and treat other commonly discharged variable waste streams such as ash landfill leachate and treat them prior to discharge. To respond to the demands of the agencies, power utilities need to deploy efficient and reliable advanced treatment technologies in relatively short time frames. This paper describes the process developed to address the variability of influent quality while preserving sufficient design treatment margin to consistently remove particular constituents. In addition, this paper describes the design development and construction method of delivery that was used to achieve completion of the facility in the face of looming regulatory compliance deadlines.

Discusser: Vince Como, Black & Veatch, Overland Park, KS ..... 10:35 AM
Floor Discussion & Closure ..... 10:45 AM

IWC 11-36 **11:00 AM**

EVALUATION OF THERMAL ZLD TREATMENT OF FGD PURGE WATER OPTIONS REV 3

Herman Nebrig and Xinjun (Jason) Teng, Southern Company Services Birmingham, AL; David Downs, Southern Company Services Birmingham, AL

Since Flue Gas DesulphurizationSince Flue Gas Desulphurization (FGD) systems have been installed in coal fired power plants the wastewater produced is under more scrutiny from

regulators. As a result Southern Company is conducting a serious evaluation of applying ZLD technology to solve this problem. ZLD systems have been used in power plants and other industries to treat cooling water and low volume wastes for several years. This process appears to have a potential to treat FGD wastewater as well, however, there are only 6 full scale ZLDs in the world that are specifically used for FGD wastewater and all of them have very short running experiences .

This paper will discuss the following issues: reliability, operation and maintenance, how system metallurgy fits the high Cl and high TDS water, are volatile metals such as mercury remit into the air or into the recycled water, power and steam consumption, cooling water needs, process selection such as brine concentrator + ash conditioning or brine concentrator+ crystallizer or brine concentrator + crystallizer + ash conditioning, pretreatment requirements, foaming and scaling, conventional thermal ZLD or COLD ZLD, cleaning processes and effect, mist eliminator positions, effect of variable feed water, the best way to use the purified water (can it be used for boiler makeup?)
Discusser: Bill Shaw, Veolia Water Solutions & Technologies, Pewaukee, WI ..11:25 AM
Floor Discussion & Closure .....11:35 AM
Conclusion ..... 11:50 AM

INNOVATIVE ADVANCEMENTS IN WATER & WASTEWATER MANAGEMENT IN OIL SANDS INDUSTRY

Date: Tuesday, November 15
Time: 8:00 AM - 12:00 NOON
Room: Salon 3

Since the beginning of this century, due to ever increasing energy demand, unconventional oil resources such as Oil Sands have gained lot of attention. Exploiting Oil Sands brings along with it the challenges to manage the scarce water resources including produced water. The papers in this session will focus on new and innovative advances in the treatment and management of water and wastewater in Oil Sands Industry

IWC Representative: Brad Wolf, Berkeley Research Group, LLC, Pittsburgh, PA
Session Chair: Arun Mittal, Aquatech International Corp., Canonsburg, PA
Discussion Leader: Don Downey, The Purolite Company, Paris, ON

Session Introduction **8:00 AM**

Arun Mittal, Aquatech International Corp., Canonsburg, PA

IWC 11-37 **8:10 AM**

PRODUCED WATER SOFTENER REGENERATION USING BOILER BLOWDOWN

Stephen Moylan and Francis Boodoo, The Purolite Company, Bala Cynwyd, PA

Produced water softeners usually require substantial quantities of salt for regeneration in order to achieve the sub-ppm levels of hardness needed for the downstream OTSGs. High TDS produced waters usually contain enough salt but at much lower concentrations than the typical 10%to 20% needed. This Technical Report examines the feasibility of using the blowdown from the downstream OTSG to effectively regenerate such softeners.
Discusser: George Crits, Aqua-Zeolite Sciences, Ardmore, PA..... 8:35 AM
Floor Discussion & Closure .....8:45 AM

IWC 11-38 **9:00 AM**

FILTRATION PROCESS REVIEW IN SAGD PRODUCED WATER

Ramesh Sharma, ConocoPhillips Company, Houston, TX; Travis Dinsdale, ConocoPhillips Canada Limited Calgary, AB, Canada; Kris Bansal, ConocoPhillips Company Houston, TX

Turbidity is one of the key performance indicators for Steam Assisted Gravity Drainage (SAGD) produced water treatment.

Currently, most SAGD producers rely on multiple "grab" samples for performance monitoring, which by itself is not enough to adequately detect the episodic process upset conditions. On-line turbidity meters are available commercially, but most of them are rated to perform below ~50 degrees C. A new high temperature on-line turbidity meter was pilot tested successfully at a ConocoPhillips Canada's SAGD site. During a 60-day trial, the new probe performed satisfactorily under severe and varying process conditions without requiring any manual cleaning or maintenance. Importantly, the probe was able to provide real time data on process upsets and performance fluctuations on produced water streams with temperature varying between 80-85 °C. Throughout the test period, the new probe performance was found to be strongly correlated to the existing on-site hand-held turbidity meter. Based on the success of the trial, the new probe was integrated into the plant operation to monitor turbidity levels downstream of warm-lime softening unit, and boiler feed water tank, respectively. In our knowledge, this is the first installation of high temperature turbidity probe for SAGD produced water monitoring.

Discusser: Rudy Tamayo, Husky Energy, Calgary, AB, Canada ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break: ..... 9:50 AM

IWC 11-39 **10:10 AM**

AN INNOVATIVE SOLUTION TO SAGD BLOWDOWN WATER---BLOWDOWN BOILER TECHNOLOGY

Susan Sun, P. Eng., New Technology Oil Sands Cenovus Corp., Calgary, AB, Canada; Mike Wasylyk, Cenovus Calgary, AB, Canada

The treatment of blowdown water from boilers is critical to the overall water management performance in heavy oil industry. It has significant impact on the water recycle ratio and the water treating costs. The target recycle rate for fresh makeup water, regulated by EUB, is 90% or higher. Also brackish makeup water, that is not currently regulated, may eventually be included in the plant water recycle rate. To improve the operation, several scenarios of blowdown treatment have been developed, reviewed and evaluated. The idea of using a blowdown boiler is to feed the boiler blowdown to Once Trough Steam Generators (OTSGs) without any water treatment. Economic evaluation shows it has the lowest CAPEX and OPEX with the water recycle rate of approximately 90%, when compared to other possible solutions for blowdown treatment. However until this test it was an unproven process since it has never been done before. The purpose of the blowdown boiler pilot test was to verify the feasibility of this idea. A substantial amount of research has been done before set up, including discussions with industry experts, meetings with vendors, visiting other operators and conducting engineering studies. The first steam was generated on May 22, 2007 using blowdown water as feed water to OTSGs. Until the end of June 2008, the blowdown boiler ran for 166 cumulative days without any operational problems. All monitored parameters were normal. Two scheduled mechanical inspections were conducted in the test including x-ray, hardness, UT inspections and laboratory analysis of two sections of piping. Overall the results show the boiler is in good condition with minor corrosion/pitting, which may have been present prior to the test. Only very minor differences between the latest and the original readings were detected. As well, the boiler inspection confirmed there was minimal (if any) scaling. The pilot has been completely successful. After the pilot a commercial OTSG was converted to blowdown boiler and started up running with blowdown water in 2010. This concept has also been incorporated into commercial designs.

Discusser: Steve Portelance, Worley Parsons Canada, Calgary, AB, Canada .....10:35 AM
Floor Discussion & Closure .....10:45 AM

IWC 11-40 **11:10 AM**

SOLIDIFICATION: A NEW APPROACH TO ZERO LIQUID DISCHARGE (ZLD) IN THE SAGD INDUSTRY

Scott Tavaglione, Robert Solomon, Butch Britton, Lanny Weimer, GE Water and Process Technologies Bellevue, WA

As the economics and environmental risks associated with the disposal of liquid waste from SAGD projects become less desirable, Zero Liquid Discharge (ZLD) process solutions are gaining momentum with heavy oil producers. The two existing SAGD projects that achieve ZLD utilize evaporation, crystallization, and drying technologies to eliminate liquid discharges. The evaporation and crystallization processes operate well at numerous SAGD facilities in Alberta, However, the drying process has been difficult to operate and maintain due to the nature of the solids present in SAGD produced water. While the drying process is improving through on-site modifications and research & development (R&D) efforts, an alternative technology that offers a number of benefits has been developed by GE. This paper will present technical details of GE's patent-pending solidification process, including bench and pilot test data, comparisons versus drying, and preliminary design information. Solidification is a technical and economical alternative to drying and GE is in the process of designing and supplying the first commercial solidification system for the SAGD industry.

Discusser: Peter Midgley, Degeremont Technologies, Dundas, ON, Canada .....11:25 AM
Floor Discussion & Closure .....11:35 AM
Conclusion .....11:50 AM

TRACE CONTAMINANT REMOVAL

Date: Tuesday, November 15
Time: 8:00 AM - 12:00 NOON
Room: Salon 7

The human impact on the earth's hydrologic cycle has just begun to be recognized. This impact is accelerating with industrial expansion, population growth, population shifts to more arid regions and legacy chemical pollution from poor industrial practices. Because the impact is well recognized regulators have continued to create more stringent standards for industrial discharges and drinking water standards.

These changes have resulted in a renewed focus on specific contaminants that don't meet the standard. Identifying and optimizing the treatment processes for these specific contaminants has always been a challenge. Contaminant Removal will focus on these challenges and the advancements that are occurring. Specifically Arsenic, Chrome, Mercury, and Advanced Oxidation technologies will be reviewed and discussed.

IWC Representative: Dan Rice, DBR Consultanting, Sault Ste. Marie, MI
Session Chair: Jim Braun, AVANTech, Columbia, SC
Discussion Leader: Bob Goltz, Dow Water & Process Solutions, Midland, MI

Session Introduction **8:00 AM**

Jim Braun, AVANTech, Columbia, SC

IWC 11-41 **8:10 AM**

CHROMATE REMOVAL AT THE HANFORD SITE

Dean Neshem, CH2M HILL Plateau Remediation Company, Richland, WA; Peter Meyers, ResinTech, West Berlin, NJ

Remediation of groundwater containing hexavalent chromium has been in progress at the Hanford site for more than 15 years. Although the early systems used type I (gel) strong- base anion exchange resin and off site regeneration, the most recent systems use

a long-life single-use resin. Use of the long-life resin is projected to result in significant operating costsavings. This paper explores the history of the chromate remediation efforts at the site, a review of more than 15 years' operating experience with strong-base resin, and the operating results with the long-life resin.

Discusser: Terry Heller, The Purolite Company, Bala Cynwyd, PA ..... 8:35 AM
Floor Discussion & Closure ..... 8:45 AM

IWC 11-42 **9:00 AM**

ADVANCED OXIDATION PROCESS WITH A NEW NANSTRUCTURED MATERIAL

Ivano Aglietto, Ph.D., Michele Marcotti, and Beatrice Sardi, SA Envitech Caenago di Brianza, Italy

Graphene is considered a two-dimensional carbon nanofiller with a one-atom-thick planar sheet of sp2 bonded carbon atoms that are densely packed in a honeycomb crystal lattice. It is regarded as the "thinnest material in the universe" with tremendous application potential. Graphene is predicted to have remarkable properties, such as high thermal conductivity, superior mechanical properties and excellent electronic transport properties. These intrinsic properties of graphene have generated enormous interest for its possible implementation in a myriad of devices. RECAM® is a new mesoporous nanostructured material, that exploits the special properties of graphenes and is produced on an industrial scale, having extraordinary properties in terms of reactivity and crystallinity, with excellent results proved for removal of recalcitrant compounds from wastewater, recently introduced into the market. The application of most innovative developments in the field of nanotechnology, and particularly the use of RECAM®, enables to emphasize and fully develop the benefits of advanced oxidation and contaminants absorption processes, reaching levels of efficiency and economy much higher than traditional water purification approaches. Main benefits are possible to treat almost every kind of wastewater and a wide range of contaminants, no sludge production, system configuration that is both simple to build and modular, low investment costs, chemicals used only for pH corrections. In the present paper are reported the fundamentals and case studies of application of RECAM® for advanced oxidation process with electroxidation and nanophenton.

Discusser: Barbara Schilling, Ozonia N.A., Leonia, NJ ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break: ..... 9:50 AM

IWC 11-43 **10:10 AM**

ABSORBENT TECHNOLOGY FOR REMOVAL OF SOLUBLE MERCURY AT THE TRACE CONTAMINANT LEVEL (Low Part Per Trillion)

Gina Sacco, MAR Systems Inc., Solon, OH; Cheryl Soltis-Muth, Northeast Ohio Regional Sewer District Cleveland, OH

Reduction of trace amounts of mercury of 2.0-3.5 parts per trillion (ppt) down to Reduction of trace amounts of mercury of 2.0-3.5 parts per trillion (ppt) down to 1.3 ppt or less has been successfully demonstrated by a metropolitan sewer district on water collected prior to the effluent stream. The technology employed is an alumina-based adsorption media. The water contacts the media in a fixed bed for a relatively short amount of time, approximately 3.5 minutes. An average removal of 66.5% of the mercury was observed. This application showed a removal of 8.8 ng of mercury per gram of media. The testing was stopped at 80 liters of throughput, greater than 5000 bed volumes, and the media had not reached exhaustion. The media has shown capability of removing mercury up to 75% of its weight in laboratory testing.

Discusser: Bob Goltz, The Dow Chemical Company, Midland, MI ..... 10:35 AM
Floor Discussion & Closure ..... 10:45 AM

IWC 11-44 **11:00 AM**

IRON OXIDE EMPLACEMENT ON SAND MEDIA FOR GROUNDWATER ARSENIC REMOVAL

T.S. Abia II, C. Wang, and Y.H. Huang, Texas A&M University – Biological and Agricultural Engineering Dept., College Station, TX

Iron oxide-bearing minerals have long been recognized as an effective reactive media for arsenic-contaminated groundwater remediation. This research aims to develop a technique that can achieve in situ oxidative precipitation of Fe3 + in a soil (sand) media to create a subsurface iron oxide-based reactive barrier that can passively immobilize arsenic (As) and other dissolved metals in groundwater. Our bench scale column tests showed that our unique in situ iron oxide sand coating process is feasible and the resultant iron oxide-coated sand (IOCS) media can effectively remove large quantities of arsenic from contaminated groundwater before requiring refresh coatings. In contrast to conventional excavate-and-fill treatment technologies, this technique could be used to in situ replace a fresh iron oxide blanket on the sand media and rejuvenate its treatment capacity for additional arsenic removal. The competition for adsorption sites from other groundwater constituents such as carbonates (C032-), sulfates (S042-), and silicates (Si032-) could potentially hinder the efficiency of arsenic uptake and ultimately reduce the overall as treatment life of the subsurface iron oxide-coated sand. Although refresh coatings could be repeated multiple times, the life cycle of the in situ FeOx reactive barrier may also be limited by the gradual loss of hydraulic conductivity induced by the accumulation of FeOx and other deposits in the pores over time.

Discusser: Jim Knoll, Graver Technologies, New Providence, NJ..... 11:25 AM
Floor Discussion & Closure.....11:35 AM
Conclusion ..... 11:50 AM

NEW DEVELOPMENTS IN COOLING WATER TREATMENT

Date: Tuesday, November 15
Time: 1:30 - 5:25 PM
Room: Salon 1

Traditional cooling water programs would cover the basic concepts of corrosion, scaling, fouling and microbial growth. Overall cooling system performance includes many other variables - make up water quality, chemical efficacy, cycle / blow down control, monitoring capabilities, system metallurgy, off line protection, heat exchangers and finally the cooling tower.

The four excellent papers in this session provide insights into both new development areas as well as traditional subjects. The first paper covers the use of sea water and its challenges while the second paper outlines a process for scale control in ZLD systems. The third paper reviews bromide activation chemistry and the last paper concentrates on minimizing scaling / fouling in the cooling tower.

IWC Representative: Paul Puckorius, Puckorius and Associates, Inc., Arvada, CO
Session Chair: Ken Dunn, Ashland Water Technology, Wilmington, DE
Discussion Leader: Don Holt, Ashland Water Technology, Ajax, ON, Canada

Session Introduction **1:30 PM**

Ken Dunn, Ashland Water Technology, Wilmington, DE

IWC 11-45 **1:40 PM**

CHALLENGES WITH THE USE OF SEA WATER FOR COOLING AND DEVELOPMENT OF A NOVEL TREATMENT AND MONITORING CONTROL

Jasbir Gill, Ph.D., Nalco Company, Naperville, IL; Geoff Townsend, Ph.D., Nalco Netherlands BV Leiden, Netherlands; Paloma Lopez Serrano, Nalco Netherlands BV Leiden, Netherland

Water is essential to many industrial processes, used primarily for cooling. Using impaired water in place of fresh water is a potentially attractive solution to the problems of water scarcity and competing demands. As the population increases, good fresh quality water is much more needed for human use including growing food. Tertiary sewage treated water has been successfully used in many industrial applications for cooling. The use of seawater is becoming quite popular for cooling applications in many coastal areas of the world. Although sea water provides an alternate source of cooling water but it poses its own limitations in terms of corrosion, scaling, biofouling both micro and macro. In addition these limitations there are also penalties due to higher salinity such as approach temperature, heat transfer coefficient, and pumping cost. The paper discusses the development of a novel treatment to mitigate fouling due to the use of sea water in cooling applications. The results of a field trial in Italy are also presented.

Discusser: Vickie Olson, Honeywell, Sandy Springs, GA..... 2:05 PM
Floor Discussion & Closure.....2:15 PM

IWC 11-46 **2:30 PM**

A NOVEL ANTI-SCALING METHOD AND ITS USE IN ZERO LIQUID DISCHARGE MODE IN COOLING TOWER OPERATION

Jie Lu, Ph.D., World Minerals, Inc., Lompoc, CA; Mujun Pan, Wylton (China) Chemical Co. Ltd. Fuquan, Guizhou, China; Bosheng Fu, Wylton (China) Chemical Co. Ltd. Fuquan, Guizhou, China

A novel anti-scaling mechanism and methods for preventing scale formation is described here. The method is based on a new adsorption/co precipitation mechanism and the use of a diatomaceous earth based, synthesized adsorbent for the adsorption, dispersion and carrying away of the nucleation centers or microcrystalline seeds of scalants, thus to achievethe prevention of scale formation on water processing equipment. The new adsorbent is engineered to a unique structure with high surface area and high affinity toward the nucleation or microcrystalline seeds of a variety of scalants. Both laboratory and field stud! ies showed that the new method can sustain a very high cycles of concentration (CoC) for waters of high or ultra-high hardness (>160 ppm). The new anti-scaling method was successfully demonstrated in industrial trials with a 500 m3 water capacity cooling tower of a sulfuric acid plant and achieved essentially zero liquid discharge for more than 90 days, while the conventional method can only sustain for 3 to 5 day (or 3 to 5 CoC). The advantages of this new method and the problems associated with conventional cooling tower operation will be discussed.

Discusser: Emmanuel Quagraine, Ph.D., Saskatchewan Power Corporation, Estevan, SK, Canada ..... 2:55 PM
Floor Discussion & Closure ..... 3:05 PM
Break: ..... 3:20 PM

IWC 11-47 **3:45 PM**

A REVIEW OF THE COOLING WATER METHODS FOR SODIUM HYPOCHLORITE ACTIVATION OF SODIUM BROMIDE INTO HYPOBROMOUS ACID BIOCIDE

Elizabeth Harrelson, Jonathan Howarth, Courtney Mesrobian, and Todd Shaver, Enviro Tech Chemical Services, Inc. Modesto, CA

The use of sodium bromide in conjunction with a source of sodium hypochlorite bleach to generate a hypobromous acid biocide has been a standard cooling water practice for decades. The suppliers of sodium bromide recommend effecting the activation by directing the sodium bromide and sodium hypochlorite solutions to a residence tank containing make water. Upon activation, the mixture is introduced to the cooling water to be treated. However, few water treaters adhere to this practice because it is cumbersome and more convenient ways of using the two products have evolved over the years. These include feeding sodium bromide and sodium hypochlorite solutions to a common tee before directing the mixture into the recirculating water; or introducing sodium bromide and sodium hypochlorite independently to the cooling water to effect the activation under more dilute conditions. This review examines the efficiencies of all three methods, in terms of % utilization of sodium bromide and sodium hypochlorite in addition to the relative rates of bromide ion activation. The benefits and limitations of all three activation methods will be discussed.

Discusser: Bruce Chamberlain, Ashland Water Technologies, Baton Rouge, LA . 4:10 PM
Floor Discussion & Closure ..... 4:20 PM

IWC 11-48 **4:35 PM**

FILLL SELECTION AND CHEMICAL TREATMENT METHODS TO MINIMIZE SCALING/FOULING IN COOLING TOWERS

Brad Buecker, Kiewit Power Engineers, Lenexa, KS; Ray Post, P.E., ChemTreat Langhorne, PA; Rich Aull, P.E., Brentwood Industries Reading, PA

As restrictions become tighter on the use of once-through cooling, power plants, refineries, and other industrial facilities may be looking at cooling towers as an alternative cooling process. Proper selection of cooling tower fill and chemical treatment programs is vital towards efficient operation of cooling towers and prevention of fouling-related structural failures. This paper outlines state-of-the art developments with regard to cooling tower fill selection and chemical treatment programs.

Discusser: Tony Selby, Water Technology Consultants, Inc., Evergreen, CO ..... 5:00 PM
Floor Discussion & Closure ..... 5:10 PM
Conclusion ..... 5:25 PM

ONE CAN NEVER GET ENOUGH SOLUTIONS FOR FGD WASTEWATER TREATMENT

Date: Tuesday, November 15
Time: 1:30 - 5:20 PM
Room: Salon 2

Learn about a wide variety of treatment process for flue gas desulfuriztion (FGD) wastewater including evaporation, solidification, constructed wetlands, and treatment specifically for selenium removal.

IWC Representative: John Lucey, Heckmann Water Resources, Inc., Pittsburgh, PA
Session Chair: Brian Heimbigner, KalKris LLC, Cumming, GA
Discussion Leader: Terry Laprise, Aquatech International Corp., Canonsburg, PA

Session Introduction: **1:30 PM**

Brian Heimbigner, KalKris LLC, Cumming, GA

IWC 11-49 **1:40 PM**

CONCEPTS IN ZERO-LIQUID DISCHARGE

Jan de Gest and Matthias Loewenberg, Ph.D., GEA Process Engineering Inc., Columbia, MD; Dipl.-Ing. Christian Melches and Dipl.-Ing. Günter Hofmann, GEA Messo PT Duisburg, Germany

Recent developments in environmental regulations require more stringent emission control system for various industries. In the United States, industrial treatment standards are set by the Environmental Protection Agency (EPA) as National Categorical Standards. These are industry-specific limits that are technology-based. Being technology based, each limit associated with a specific treatment technology that is 'economically achievable.' These limits form a baseline treatment technology for each industry. In addition to these standards, many areas of the country have added water quality based standards to protect specific bodies of water.

In particular the coal fired power plants waste water discharge streams receive great attention due to the volumes and the complex composition of these waste waters. One of the largest waste water streams is generated by flue gas desulfurization (FGD) scrubber systems. Various solutions from deep well injection to zero-liquid discharge are currently considered depending to plant specifics and location. ZLD technology includes evaporation of the industrial effluent until the dissolved solids form crystals in solution. The crystals are removed and dewatered and the condensate from evaporation is condensed and returned to the process. This process may include pretreatment, membrane filtration, evaporation, followed by crystallization. Due to the volumes of FGD blow-down,

	SALON 1 (I)	SALON 2 (II)	SALON 3 (III)	SALON 7 (VII)
SUNDAY, NOVEMBER 13				
5:00-7:00 PM	GET ACQUAINTED RECEPTION IN THE EXHIBIT HALL - INTERNATIONAL BALLROOM			
MONDAY, NOVEMBER 14				
8:00-11:00 AM	WATER MANAGEMENT RECYCLE/REUSE	ION EXCHANGE ADVANCES TO EXISTING TECHNOLOGIES	HYDRAULIC FRAC FLOWBACK WASTE WATER TREATMENT METHODS	MINE WATER MANAGEMENT
11:00 AM-12:00 NOON	KEYNOTE SESSION IN SALON 4 AND 5			
12:00 NOON-1:30 PM	EXHIBIT HALL LUNCHEON IN THE EXHIBIT HALL - INTERNATIONAL BALLROOM			
1:30 PM-5:00 PM	TRADITIONAL AND INNOVATIVE PRETREATMENT TECHNIQUES	INNOVATIVE TECHNOLOGY APPLICATIONS FOR POWER PLANT STEAM CYCLE	REFINERY AND OIL SANDS WASTEWATER APPLICATIONS	NUTRIENT CONTROL AND CONTAMINANT REMOVAL
5:00-7:00 PM	RECEPTION IN THE EXHIBIT HALL - INTERNATIONAL BALLROOM			
TUESDAY, NOVEMBER 15				
8:00 AM-12:00 NOON	COOLING TOWER WATER	FGD WASTEWATER TREATMENT PROBLEMS	WATER & WASTEWATER MGMNT IN OIL SANDS INDUSTRY	TRACE CONTAMINENT REMOVAL

	SALON 1 (I)	SALON 2 (II)	SALON 3 (III)	SALON 7 (VII)
TUESDAY, NOVEMBER 15				
12:00 NOON-1:30 PM	EXHIBIT HALL LUNCHEON IN THE EXHIBIT HALL - INTERNATIONAL BALLROOM			
1:30 PM-5:00 PM	NEW DEVELOPMENTS IN COOLING WATER TREATMENT	FGD WASTEWATER TREATMENT	ON-SITE TESTING FOR PRODUCED WATER STEAM SYSTEMS	ADVANCED MEMBRANE SOLUTIONS
5:00-7:00 PM	RECEPTION IN THE EXHIBIT HALL - INTERNATIONAL BALLROOM			
WEDNESDAY, NOVEMBER 16				
8:00 AM-12:00 NOON	DEIONIZATION: NEW APPROACHES & MONITORING METHODS	WATER TREATMENT TECHNIQUES FOR ZLD	GUARDING PROFITABILITY	TRENDS IN MODELING FOR PLANT PERF.
1:00-5:00 PM	CONTINUING EDUCATION WORKSHOPS - SEE PAGES IN BACK OF GUIDE FOR DETAILED SCHEDULE			
THIURSDAY, NOVEMBER 17				
8:00 AM-5:00 PM	CONTINUING EDUCATION WORKSHOPS - SEE PAGES IN BACK OF GUIDE FOR DETAILED SCHEDULE			

pretreatment has a tremendous impact on the operational costs and is therefore in many cases replaced by larger evaporation systems. Since evaporation systems remove volatile components (mainly water) from the waste water, all other components increase in concentration. Depending on the discharge method various components can accumulate and influence the crystallization process.

Discusser: Brad Buecker, Kiewit Power Engineers, Lenexa, KS.....2:05 PM
Floor Discussion & Closure.....2:15 PM

IWC 11-50 **2:30 PM**

THE USE OF CONSTRUCTED WETLANDS IN THE TREATMENT OF FLUE GAS DESULFURIZATION WASTEWATER

Jared Morrison, Westar Energy, Inc., Topeka, KS; Christopher Snider, P.E., P.G., and Dennis Haag, CWB, CPESC, Burns & McDonnell Kansas City, MO

Constructed wetland treatment systems use natural biological processes to reduce the concentrations of constituents in the wastewater and have demonstrated promise for the treatment of flue gas desulfurization wastewater. However, limited industry and academic research has been conducted and very few full scale applications have been undertaken. Constructed wetland treatment systems have been used effectively for the treatment of other industrial and municipal wastewaters but widespread use in the power generation sector has not yet developed due to lack of research and project experience. A major power producer has decided to undertake a constructed wetland treatment system pilot project to evaluate the technology. The constructed wetland, currently in operation, is approximately 2 acres in size and treats approximately 7 percent of the plant FGD wastewater stream. A pilot project of this scale in an area of the country without a round-year growing season has yet to be undertaken in the U.S. This presentation will cover the design, construction, and operation of the pilot wetland treatment system as well as initial performance results.

Discusser: Dan Sampson, Worley Parsons, Folsom, CA.....2:55 PM
Floor Discussion & Closure.....3:05 PM
Break.....3:20 PM

IWC 11-51 **3:45 PM**

SOLIDIFICATION OF FGD WASTEWATER WITH FLY ASH: FEASIBILITY AND FATE ANALYSIS

Mark Owens, P.E., Degremont Technologies, Richmond, VA; Rudy Labban, P.E., and Denise Horner, Degremont North American Research & Development Richmond, VA

As regulations governing the discharge of Flue Gas Desulfurization (FGD) wastewater grow more and more stringent, zero liquid discharge becomes more appealing. Zero Liquid Discharge generally includes evaporation, crystallization and dewatering. However, some facilities are considering 'Partial ZLD' which involves concentrating the wastewater to reduce the effluent volume and mixing it with flyash to make a solid which can be landfilled. Infilco Degremont, Inc. along with the Degremont Technologies North American R&D Center (DENARD) recently completed a study of this process, proving that flyash can be used to solidify FGD wastewater while producing a nonhazardous landfillable solid waste. This study included the determination of how much flyash is required to 'solidify' a liter of concentrate. Additionally, a fate analysis was performed to determine what portion of the contaminants removed is simply transferred to the landfill leachate. Several potential additives such as quicklime and Portland cement were studied both for their effect on the flyash volume as well as their effect on the fate of the contaminants.

Discusser: Patricia Scroggin, Burns & McDonnell, Kansas City, MO..... 4:10 PM
Floor Discussion & Closure.....4:20 PM

IWC 11-52 **4:35 PM**

SELENIUM CONTROL IN WET FGD SYSTEMS

Katherine Searcy, Trimeric Corporation, Buda, TX; Mandi Richardson, URS Corporation Austin, TX; Gary Blythe, URS Corporation Austin, TX; Paul Chu, EPRI Palo Alto, CA; Chuck Dene, EPRI Palo Alto, CA; Dirk Wallschlager, Trent University Peterborough, ON, Canada

Selenium in flue gas desulfurization (FGD) liquor may be found in many forms and oxidation states. The various selenium species respond differently to wastewater treatment processes, and the selenium species present may drive the selection of treatment processes for FGD chloride purge water. The general assumption is that forced oxidation wet FGD systems will produce selenate as the primary selenium species, which is difficult to remove with traditional wastewater treatment (WWT) processes. However, field measurements show that a wide range of selenium species may be present. Research programs sponsored by the Electric Power Research Institute and the U.S. Department of Energy have studied the factors impacting selenium speciation and phase partitioning in limestone forced oxidation (LSFO) wet FGD systems.

Over 50 bench-scale tests conducted from late 2008 through late 2010 have measured the impacts of operating parameters, such as oxidation reduction potential (ORP), and key FGD constituents on selenium behavior at the bench scale. Strategies to control selenite oxidation and phase partitioning have included control of operating parameters and application of scrubber additives; these strategies have successfully demonstrated the avoidance or decrease of selenite oxidation in synthetic FGD liquors at the bench scale. Pilot-scale testing, scheduled for mid-2011, will test selenium management approaches developed at the bench scale. This paper will discuss results from the bench- and pilot-scale scrubber test campaigns as well as ongoing efforts to develop improved sample handling methods for measuring selenium species.

Discusser: Arun Mittal, Aquatech International Corp., Canonsburg, PA.....5:00 PM
Floor Discussion & Closure.....5:10 PM
Conclusion.....5:25 PM

THE CHALLENGE OF ON-SITE TESTING FOR PRODUCED WATER STEAM GENERATION SYSTEMS: A PANEL DISCUSSION SPONSORED BY THE ASME RESEARCH AND TECHNOLOGY COMMITTEE ON WATER AND STEAM IN THERMAL SYSTEMS

Date: Tuesday, November 15
Time: 1:30 - 5:20 PM
Room: Salon 3

Successful control of the water chemistry in steam generation requires that accurate on-site testing be done on key parameters. In systems using steam for thermal enhanced oil recovery, the water frequently contains compounds which significantly interfere with traditional test methods. This informative panel will discuss issues with field measurements for total iron, dissolved silica, alkalinity, and total petroleum hydrocarbon or oil-in-water testing. The subsequent open-floor discussion period will allow ample time for attendees to receive responses to their comments and questions about on-site testing in produced water applications.

IWC Representative: Colleen Layman, Bechtel Power, Frederick, MD
Session Chair: Debbie Bloom, Nalco Company, Naperville, IL

Session Introduction 1:30 PM

Debbie Bloom, Nalco Company, Naperville, IL

IWC 11-53 1:40 PM

EXPERIENCES AND CHALLENGES FOR MEASURING TOTAL IRON IN PRODUCED WATER

Ivan Morales, MEG Energy, Calgary, AB, Canada; Christopher Graham, MEG Energy Calgary, AB, Canada

The determination of different constituents in Produced Water is a challenge due to the diversity and quantity of interferences present. Many of the test methods available for clean potable and surface waters fail to give accurate results when used for testing in Produced Water systems. Recognition of this has led to the development of a credible "total iron" field test method that is comparative with more advanced analytical methods like ICP.

IWC 11-54 2:05 PM

ON-SITE LABORATORY METHODS FOR DETERMINATION OF SILICA AND ALKALINITY FOR STEAM GENERATORS FOR IN-SITU BITUMEN RECOVERY

Sudhir Parab, P.E., ConocoPhillips Canada, Calgary, AB, Canada; 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 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 SAGD produced water.

The primary focus of this paper will be on identification of suitable on-site analytical methods for quantification of dissolved silica and alkalinity in boiler feed water for Once through steam generators and drum style boilers. In addition, the paper will provide a review of various analytical procedures, identify various interferences affecting the measurement, and document best industry practices for silica and alkalinity measurements in SAGD environment.

IWC 11-55 **2:30 PM**

ANALYTICAL METHODS FOR STEAM GENERATORS USED IN ENHANCED OIL RECOVERY (EOR)

E. J. Van Doorn, Ph.D., Baker Hughes Inc., Houston, TX

The manufacturers of steam generators used in the EOR industry have set maximum feed water quality limits for the concentration of petroleum hydrocarbon that can be tolerated for steam generation; therefore, the accurate measurement of this contaminant is crucial to the successful operation of the steam generators. This presentation discusses the various test methods used to differentiate various organic species and measure the concentration of total petroleum hydrocarbon (TPH) in produced waters. Also discussed in this presentation is the use of on-line analyzers to measure oil-in-water continuously.

IWC 11-56 **2:55 PM**

NEW NO SOLVENT METHOD FOR FAST, FIELD OIL IN WATER SAMPLE MEASUREMENT

Duane Germenis, Gary Bartman, Dale Brost, Ph.D., Amy Foster, Michael Holmes, Turner Designs Hydrocarbon Instruments, Inc. Houston, TX

Traditional field methods for oil-in-water analysis of produced water require the oil to be extracted into an organic solvent prior to measurement. Many of the organic solvents used for extraction are either flammable, hazardous to human health or both. The chlorinated hydrocarbons are expensive and must be either recycled or have disposal issues. All major airlines and many helicopter services consider the risk so serious that it is difficult to transport the solvents in aircraft. The new No Solvent Method from Turner Designs Hydrocarbon Instruments, Inc. has addressed these issues. The methodology uses a small amount of a special surfactant making oil in water measurement possible with an extraction solvent. The surfactant converts the dispersed oil in the sample into an optically clear micro emulsion that is ideal for direct fluorescence measurements. Unparalleled repeatability of results from different operators is achieved because this method eliminates the volume measurement of water and solvents. This method can measure Water Soluble Organics independent from Free and Emulsified Oils. It can be shipped without hazardous identification labels and can be carried on commercial airlines and helicopters without declaration.

Break ..... 3:20 PM

IWC 11-57 **3:45 PM**

OPTICAL BASED SOFTWARE TECHNIQUES FOR REAL-TIME ANALYSIS AND CLASSIFICATION OF PRODUCED WATER

Kent Peterson, Fluid Imaging Technologies, Inc., Yarmouth, ME

Optical instrumentation has many advantages over other technologies for the analysis of oil content and particles in produced water. The rapid microscopic characterization of particles sets itself apart from other rapid particle characterization via its morphological advantages. As well as measuring suspended oil in water concentrations (PPM), Optical techniques coupled with advanced data analysis and pattern matching can be used to effectively distinguish and then classify two particles of identical size and shape from one another. This paper illustrates the efficacy of various imaging techniques for use in the real-time characterization and quality assurance of produced water

Panel Discussion ..... 4:10 PM

Conclusion ..... 5:20 PM

ADVANCED MEMBRANE SOLUTIONS

Date: Tuesday, November 15
Time: 1:30 - 5:25 PM
Room: Salon 7

Reverse osmosis (RO) has been commercially available for 50 years. While facing initial resistance to replacing "conventional" desalination technologies, RO has recently enjoyed status as Best Available Technology for many applications. However, as high-quality feed water sources become scarcer, membrane fouling and scaling concerns are becoming more critical to the success of RO as applied to these challenging feed water sources. This session addresses the issues of fouling and scaling head-on. Two papers cover pretreatment issues including membrane pre-filtration for seawater RO (SWRO) systems and a new chemical antiscalant to address silica scaling. The other two papers cover mechanical manipulation of the RO system using vortices and permeate suction to minimize membrane fouling.

IWC Representative: Dennis McBride, Fluor Enterprises, Inc., Greenville, SC
Session Chair: Jane Kucera, Nalco Company, Naperville, IL
Discussion Leader: Jeff Tate, Agape Water Solutions, Inc., Harleysville, PA

Session Introduction **1:30 PM**

Jane Kucera, Nalco Company, Naperville, IL

IWC 11-58 **1:40 PM**

MEMBRANE PRETREATMENT CONSIDERATIONS WITH SEAWATER REVERSE OSMOSIS

Jonathan Dietrich, P.E., Dietrich Consulting Group, LLC, Charlotte, NC

One significant basis for the definition of success at a seawater membrane desalination facility is the capability of the pre-treatment system to provide acceptable, reliable, and consistent quality to a seawater reverse osmosis (SWRO) membrane. One common thread amongst many SWRO membrane pre-treatment systems is the inability of the pre-treatment system to meet these requirements on a consistent basis.

Conventional multi-media filtration is a standard pre-treatment step for many plants. Operation of these systems can be onerous at best in order to maintain a suitable and reliable feed water quality to a downstream SWRO facility. Other types of "conventional" pre-treatment include dissolved air flotation, flocculation/sedimentation, and precoat diatomaceous earth filtration. These pre-treatment methods are primarily installed for reduction in colloidal matter, suspended solids, and turbidity in order to meet SWRO membrane feedwater quality requirements. Membrane pre-treatment offers the potential to eliminate some of the operational and filtrate quality challenges that can plague many conventional media filtration systems treating seawater using a physical membrane barrier for reduction or removal of suspended material, log-reduction of bacteria, zooplankton, and even rejection of viruses.

Pilot and demonstration tests have taken place to better quantify the effects of seawater on the downstream SWRO membrane, and the pretreatment membrane itself. Although the choices among various membrane pre-treatment configurations may initially appear very simple, the designer must pay significant consideration to the suspended solids, organics, and biomass content of the feedwater prior to selecting a preferred configuration. Feedwater constituents of material significance pose operating challenges t and can lead to unexpected results.

Discusser: Kelly Lange-Haider, P.E., Dow Water and Process Solutions, St. Paul, MN ..... 2:05 PM
Floor Discussion & Closure ..... 2:15 PM

IWC 11-59 **2:30 PM**

ANTI-FOULING MEMBRANE SYSTEM FOR INDUSTRIAL WASTEWATER TREATMENT AND RECOVERY

Joon Min, Ph.D., BKT, Anaheim, CA; Daeik Kim, BKT United Anaheim, CA; Young Eum, BKT United Anaheim, CA; Gi Park, FMC Daejon, Korea; Sang Kim, FMC Daejon, Korea; Jang Kim, BKT Korea Seoul, Korea

One of the main challenges of implementing membrane technology for the industrial wastewater is fouling. BKT's anti-fouling membrane system called FMX was developed to address these issues. FMX membrane system has been in full-scale operation for methylcellulose treatment, anaerobic digester effluent for the biogas plant, and livestock waste treatment. The technology has also been tested in dozens of industrial and commercial sites including motor oil waste treatment, nano silver recovery, beer fermentation process recovery, landfill leach ate treatment, food waste treatment, latex manufacturing wastewater treatment, algae biomass harvesting for biogas production, wine stillage waste, or any application where conventional membranes cannot be used. FMX uses any membrane material including MF, UF, or NF from various suppliers.

In 2004, BKT started development of a reliable membrane system to be used for methylcellulose wastewater from Samsung Fine Chemicals (SFC) manufacturing facility, where all previous treatment systems failed. BKT developed a vortex generating system that prevented membranes to foul in high viscosity and high solids loading in the feed water. SFC now operates 6 full-scale FMX systems and 2 additional units will be installed this year. The membranes installed in the first FMX unit at SFC lasted for 5 years without being replaced. In 2009, 3 full-scale FMX units were also installed in Netherlands to treat anaerobic digester effluent at a biogas plant owned by Mosch Thermische Installaties (MTI), where FMX system improved the biogas generation rate by 30%. These case studies and background on the FMX will be presented in this paper.

Discusser: Doug Frick, Porex Filtration, Fairburn, GA ..... 2:55 PM
Floor Discussion & Closure ..... 3:05 PM
Break ..... 3:20 PM

IWC 11-60 **3:45 PM**

USING PERMEAT SUCTION TO REDUCE CONCENTRATION POLARIZATION IN SPIRAL WOUND NANOFILTRATION MODULE

Awad El-Shamy, Ph.D., Crane Environmental, Inc., Venice, FL; Robert Carnahan, Mahmoud Nachabe, Mark Ross, Ayden Sunol, and Ahmed Said, University of South Florida Tampa, FL

Fouling in a nanofitration membrane module is usually a result of concentration polarization. The effect of permeate suction on the slightly negatively charged spiral wound nanofiltration membrane is investigated. According to the film theory, the mass transfer coefficient is inversely proportional to concentration polarization. The effect of permeate suction destabilizes the boundary layer. This will decrease the concentration polarization layer, and consequently will increase mass transfer through the membrane's surface.

To validate the hypothesis, experiments were carried out on a NF membrane that can be described by the solution-diffusion model. This model has coefficients that can be measured experimentally. Using the membrane wall concentration in this model instead of the bulk feed concentration can help estimating the mass transfer coefficient more appropriately.

Two experimental studies were carried out, one with a standard high pressure pump, and another one with the added effect of suction pressure applied to the permeatecollector tube.

Three different concentrations of binary dilute solutions of NaCl , MgSO4 , and MgCl2 , at three different pressures (low, medium, and high) were tested.For all tested solutions, permeate suction increased the diffusive Peclet number as a function of the feed concentration. With the increase of the Peclet number, it was observed that the concentration polarization decreased, and both the product flow and the product quality were improved. It was concluded that permeate suction reduced concentration polarization, increased product flow rate, and improved product quality. Thus, adding permeate suction has beneficial consequences because it reduces membrane fouling and

Discusser: Peter Waldron, Toray Membrane USA, Yarmouth, MA.....4:10 PM
Floor Discussion & Closure.....4:20 PM

IWC 11-61 **4:35 PM**

FACTORS IMPACTING SILICA/SILICATE CONTROL AGENT PERFORMANCE IN INDUSTRIAL WATER SYSTEMS

Zahid Amjad, Ph.D., and Robert Zuhl, P.E., Lubrizol Advanced Materials, Inc. Cleveland, OH

The formation and control of silica/silicate-based deposits presents enormous operational challenges for industrial water systems including brackish water reverse osmosis, evaporative cooling, and geothermal systems when silica super saturation levels exceed saturation limits. Water technologists typically maintain silica levels below 180 mg/L in absence of silica inhibitor to avoid silica-based deposition because once formed silica scale is extremely difficult to remove and often requires the use of mechanical and/or chemical cleaning methods. Water shortages, increasingly poor quality water supplies, and environmental regulations that limit wastewater discharges have resulted in more silica/silicate limited industrial water systems. Consequently, there is a growing need for effective chemical treatments to minimize silica/silicate-based fouling. Effective silica/silicate chemical treatments should both (a) effectively inhibit crystalline scale forming salts and (b) function as amorphous silica inhibitors. This study focuses on the effects of water hardness levels, system temperature, and pretreatment chemicals on the performance of a new silica/silicate control agent in comparison to other commercially available inhibitors. Silica-based deposits formed in both the presence and absence of inhibitors is characterized.

Discusser: Jasbir Gill, The Nalco Company, Chicago, IL .....5:00 PM
Floor Discussion & Closure.....5:10 PM
Conclusion ..... 5:25 PM

DEIONIZATION – NEW APPROACHES AND MONITORING METHODS

Date: Wednesday, November 16
Time: 8:00 AM - 12:00 NOON
Room: Salon 1

Deionization technology is used to produce anything from ultrapure water to purified wastewater. This session includes four papers of various topics covering the entire range of deionization applications.

IWC Representative: Wayne Bernahl, W. Bernahl Enterprises, Inc., Elmhurst, IL
Session Chair: Gregg Poppe, The Dow Chemical Company, Edina, MN
Discussion Leader: Peter Meyers, ResinTech, West Berlin, NJ

Session Introduction **8:00 AM**

Gregg Poppe, The Dow Chemical Company, Edina, MN

IWC 11-62 **8:10 AM**

ADVANCED ON-LINE SODIUM MEASUREMENT

David Gray, Mettler-Toledo Thornton, Inc., Bedford, MA

Water treatment performance and determination of purity have depended on sodium measurement for nearly four decades. Monitoring cation exchange performance and the purity of makeup water, steam and condensate has benefitted from measurement of this key parameter. This ion-selective electrode method has been refined for these applications over the period. Described here are yet further improvements to sodium measurement technology including a unique combination electrode system that measures pH as well as sodium to assure proper reagent delivery. The system design minimizes reagent consumption and reduces maintenance requirements well below current practice. The new sodium system uses a particularly simple automatic calibration method and also provides the ability to measure grab samples easily. Its implementation with an operator interface common to other parameters including conductivity, dissolved oxygen, pH and ORP makes it especially convenient for installation and operator training.

Discusser: Jim Cairns, ThermoFisher Scientific, Beverly, MA ..... 8:35 AM
Floor Discussion & Closure ..... 8:45 AM

IWC 11-63 **9:00 AM**

DOUBLE PASS ELECTRO-DEIONIZATION

Steven Gagnon, AVANTech, Inc, Columbia, SC; Troy Gill, AVANTech, Inc Columbia, SC

This paper will review the lessons learned in designing, commissioning and operating a water treatment system consisting of second pass reverse osmosis system, complete with an antiscalant feed, sodium bisulfate feed system and cartridge filters as pretreatment; followed by a membrane degasifying system, polishing electro-deionization; followed by a second pass polishing electro-deionization system for a combined cycle co-generation power plant. This paper shall provide background on equipment selection, unit operation, water quality issues, system rework, operational problems, and system profiling and validation protocol. Special consideration will be placed on profiling the reverse osmosis system (ROS) and electro-deionization (EDI) system performance due to radical changes in feed water quality and system operation.

Discusser: Michael Snow, Ph.D., SnowPure Water Technologies, San Diego, CA 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break ..... 9:50 AM

IWC 11-64 **10:10 AM**

IN SEARCH OF THE HIGHEST PURITY RESIN AVAILABLE STRETCHING THE LIMIT OF ION EXCHANGE IN MICROELECTRONICS

Alan Knapp, Siemens Industry, Inc. Water Technologies, Portland, OR; Slava Libman, Air Liquide, Balazs NanoAnalysis Freemont, CA

The impurity levels of such common impurities as sodium, TOC, Silica and Boron continue to be driven down to detection levels. As micro circuitry is measured in the NANO scale the need for ever purer deionized water is understandable. This paper will review recent data compiled to evaluate resins used in the Microelectronics Industry using parameters such as rinse time and baseline impurity levels. In addition, recent resin product developments to support the Semiconductor Industry's ITRS (roadmap) will be reviewed. The ability to reuse these high quality resins in downgraded uses will be discussed in keeping with sustainability initiatives.

Discusser: Peter Yarnell, Ph.D., Graver Technologies, Glasgow, DE.....10:35 AM
Floor Discussion & Closure.....10:45 AM

IWC 11-65 **11:00 AM**

CARBON ELECTRODE-BASED DEMINERALIZATION AT A WASTEWATER FACILITY

John Barber, Ph.D., GE Power and Water, Guelph, ON, Canada; Hai Yang, GE Global Research Shanghai, China

Electrochemical demineralization using high surface area carbon electrodes has been an area for interest since the pioneering work of Murphy and Johnson in the 1960's. A study of this process which included several field pilots was undertaken in order to look at the performance and cost of this technology vs. commercially available electrodialysis and reverse osmosis systems. Electrode and stack configuration for the capacitive DI unit are key parameters that affect the overall performance of the device. Specifically, the nature of the ion selective layer adjacent to the electrode surface controls both the overall energy consumption and the current efficiency. These parameters will be discussed in light of the results from the pilot trials at a municipal wastewater facility.

Discusser: Frank DeSilva, ResinTech, Los Angeles, CA ..... 11:25 AM
Floor Discussion & Closure.....11:35 AM
Conclusion ..... 11:50 PM

WATER TREATMENT TECHNIQUES FOR RE-USE AND ZERO LIQUID DISCHARGE

Date: Wednesday, November 16
Time: 8:00 AM - 12:00 NOON
Room: Salon 2

Industrial water treatment systems for Water Re-Use or Zero Liquid Discharge have challenges that vary by industry and facility location. The papers in the session will overview some processes and solutions in Power, SAGD, and Sugar & Enzymatic production. The treatment technologies include Sodium Hypochlorite Generation, Organic removal by Granular Activate Carbon, and UF & RO pretreatment.

IWC Representative: Manoj Sharma, Aquatech International Corp., Canonsburg, PA
Session Chair: Chip Westaby, Turner Designs Hydrocarbon Instruments, St. Louis, MO
Discussion Leader: Diane Martini, Sargent & Lundy, Chicago, IL

Session Introduction **8:00 AM**

Chip Westaby, Turner Designs Hydrocarbon Instruments, St. Louis, MO

IWC 11-66 **8:10 AM**

HYDRODYNAMIC CAVITATION FOR COOLING WATER TREATMENT: A TECHNOLOGY UPDATE
Philip Vella, Ph.D., VRTX Tech, Schertz, TX

Membrane processes, such as reverse osmosis, ultra-filtration, and nano-filtration are an increasingly popular technology in chemical processing, water purification, and wastewater treatment. Scaling and fouling of membranes are an on-going performance issue for most applications. Scaling interferes with membrane performance, requires that the membrane be chemically cleaned, and can significantly shorten the service life of the membrane.

A manufacturing facility produces sugars and enzymatic products. Part of the wastewater load (approx. 10%) is pretreated in an ultrafiltration (UF) unit followed by reverse osmosis (RO). In practice, reverse osmosis has failed due to the rapid and permanent fouling of the membrane likely due to precipitation of dicalciumphosphate dihydrate. Therefore, the removal of calcium with Controlled Hydrodynamic Cavitation (CHC) treatment could assist the RO system with calcium and phosphorus removal before biological treatment. CHC technology has been demonstrated in cooling towers to precipitate calcium that can be easily removed from the treated water by filtration.

This paper will describe the CHC technology and the information presented will demonstrate the effectiveness of CHC as a membrane pretreatment technology for calcium and phosphorus removal. The data will show that:

1. Precipitating the calcium with phosphate by the CHC system made it possible to use RO filtration.
2. Phosphorus removals was enhanced
3. All the filtration systems that were tested gave higher flux rates after CHC treatment
4. CHC was easily implemented into the existing filtration systems
5. The technology is suitable for reverse osmosis and nanofiltration systems and in some occasions for ultrafiltration systems.

Discusser: Jeri Penrose, Sargent & Lundy, LLC, Chicago, IL ..... 8:35 AM
Floor Discussion & Closure ..... 8:45 AM

IWC 11-67 **9:00 AM**

ON-SITE SODIUM HYPOCHLORITE GENERATION SYSTEM IMPROVES SAFETY, RELIABILITY, AND REDUCES COST

Luis Diaz, NextEra Energy, Juno Beach, FL

On site sodium hypochlorite generation (OSG) is not new. In fact, OSG has been in existence since the early 1900. What makes this technology a viable alternative to gaseous chlorine and commercial bleach is the technical advances made in the last few years which have reduced cost, increase reliability and safety of the generation equipment. OSG systems use salt, water and electricity to produce a low concentration bleach solution. Bleach produced by OSG is identical in properties and effectiveness in controlling biological activities as gaseous or commercial bleach applications. Since most facilities have eliminated gaseous chlorine in favor of commercial bleach, this paper will only compare the benefits of OSG to commercial bleach. A case study of bleach treatment for a reclaimed water facility will be examined in details to illustrate the benefits of each system including safety, operation and cost.

Discusser: Michele Funk, P.E., Bechtel Power Corporation, Frederick, MD ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break ..... 9:50 AM

IWC 11-68 **10:10 AM**

SAGD ZLD APPROACHES

Mark Nicholson, P.E., HPD, a Veolia Water Solutions & Technologies company, Plainfield, IL

In recent years, evaporation has been successfully applied for SAGD water treatment in Alberta. One of the lingering technology gaps in applying the evaporative approach is handling the evaporator blowdown waste. Evaporator concentrate has proven to be difficult to treat for deep well disposal or Zero Liquid Discharge (ZLD) treatment systems. A single ZLD approach, as has been done in the power industry, is not acceptable as each SAGD producer has different requirements and environmental limits to work within. Several ZLD solutions are required as the industry requires flexible disposal options for future con! sideration.

In recent years, there have been fundamental advancements with established alternate process steps to make ZLD a practical and reliable approach to evaporator concentrate treatment. This paper discusses the various ZLD process options that are presently available for evaporator concentrate treatment. Both existing and future systems will be discussed with emphasis on what has been tried, what is achievable, and what can be expected to be the future focus of this technology.

Discusser: Prit Kotecha, P.E., M.E., Suncor Energy, Calgary, AB, Canada ..... 10:35 AM
Floor Discussion & Closure ..... 10:45 AM

IWC 11-69 **11:00 AM**

ORGANIC REMOVAL WITH GRANULAR ACTIVATED CARBON (GAC) FROM DISTILLATE WATER WITH BIO-FOULING TENDENCY, AND ASSOCIATED ISSUES: A FOLLOW-UP REPORT ON A POWER PLANT CASE-STUDY

Emmanuel Quagraine, Ph.D., Saskatchewan Power Corporation, Shand Power Station, Estevan, SK, Canada

At IWC-2009, results of a case study evaluating organic removal options for a zero liquid discharge power plant was presented [IWC-09-27] and subsequently published in Power Plant Chemistry [2010, 12(1), 22]. For the conditions at this site, GAC was best suited and was hypothesized that the mechanism of organic removal was via mainly adsorption at the early stages of operation, but dominated by biodegradation of organics as GAC

bed ages. With this notion, two GAC beds previously operated in parallel were switched to series to take advantage of organic removal via biological degradation with the upstream bed, whilst reducing excessive microbial growth on the downstream bed-the principle of biological activated carbon. The upstream bed was to be changed every 2 years and switch valves to allow the newest bed as last (downstream) in series before the mixed beds. Thus, carryover of bio-fouling potential from the carbon bed to mixed beds would be minimized. It is over 2-years now that the beds were run in series and this report is to provide an update of performance since and provide evidence to support the mechanism of organic removal from the distillate water. Discussions will include; comparing organic removal data (TOC, haloacetic acids (HAAs) and trihalomethanes (THMs)) bythe beds in series versus parallel, evaluation of cessation of glutaraldehyde disinfection and implementation of more frequent backwash on beds' performance (including reducing slime formation), and lastly impact on the performance of the mixed beds and how silica may be related.

Discusser: Rafique Janjua, Fluor Enterprises, Inc., Sugar Land, TX .....11:25 AM
Floor Discussion & Closure .....11:35 AM
Conclusion .....11:50 AM

GUARDING AND EXPANDING PROFITABILITY IN TODAY'S COMPLEX MARKET ENVIRONMENT

Date: Wednesday, November 16
Time: 8:00 - 11:00 AM
Room: Salon 3

Lower margins and profitability in today's marketplace demand that firms provide quality products with value added services in addition to the "old norms". Guarding profitability is a conventional value-added benefit derived from a well organized and executed safety program as is expanding profitability through the time tested practice of monetizing patents and adopting a holistic water management approach to changing power plant regulations. Margin squeeze and competition have exposed new avenues of opportunity in recent years – forming public-private partnerships for sharedsuccess in projects, and; participation in the regulatory arena to help legislators make decisions that make sense when considered as part of a macro system and benefit not only the public and industry, but also firms who do business in these areas. These subjects, old and new, are discussed in this unique session hosting diversified technical papers.

IWC Representative: Colleen Layman, Bechtel Power, Frederick, MD
Session Chair: Jeff Cadman, GAI Consultants, Cranberry Township, PA
Discussion Leader: John Coyne, GAI Consultants, Homestead, PA

Session Introduction 8:00 AM

Jeff Cadman, GAI Consultants, Cranberry Township, PA

IWC 11-71 8:10 AM

USING PATENTS TO MONETIZE INNOVATIVE IDEAS

Clifton McCann and Lars Genieser, Venable LLP Washington, DC; Jennifer Vanderhart, Exponent, Inc. Washington, DC

Patents provide an effective tool to turn innovative ideas into money that can help finance related research and development. In addition to providing for a limited monopoly that can result in increased sales and prices, patents can provide access to otherwise inaccessible markets through licensing, provide leverage in securing cross-licensing agreements and negotiating partnering ventures, attract venture capital, and indicate technical superiority which can in turn attract consumers. Compared to trade secrets, patents are more robust and flexible for realizing return on research and development.

Strength. Across the board.

The rapid expansion of technology is creating tremendous opportunities in the water industry. At the same time, the laws governing intellectual property continue to evolve. It's crucial that your technology edge - whether chemical, electrical, mechanical or software/business method - is effectively protected so you can profit from your development efforts.

Venable's deep experience and exceptional track record allow our patent professionals, transactional lawyers and litigators to deliver creative, pragmatic and fully integrated solutions grounded in the reality that matters most — yours.

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To maximize the value of a patent throughout its life cycle, from the initial filing of an application through the expiration of the patent's term, the patentee should have clearly defined business goals, pursue these goals through specific features of the patent, and be aware of milestone events in the patenting process. Patent drafting, patent prosecution, marketing, and enforcement strategies can be essential in the successful development of an intellectual property portfolio and the achievement of business goals. This paper and presentation describes and explains the above principles.

Discusser: Thomas C. McThenia, Jr., GrayRobinson, P.A., Orlando, FL..... 8:35 AM
Floor Discussion & Closure.....8:45 AM

IWC 11-72 **9:00 AM**

PUBLIC- PRIVATE PARTNERSHIP PROJECTS INFLUENCE ON COST AND PERFORMANCE FOR SEAWATER DESALINATION PROJECTS

Javier Gaztelu, Alfredo Andres, INIMA-OHL Group Miami, FL

A variety of Public-Private Partnership (PPP) projects exist depending upon many factors such as: public entity involvement, finance responsibility, project ownership, design, environmental management, permitting and risk management. These types are Build-Own Operate (BOO), Build-Operate-Transfer (BOT), Buy-Build-Operate (BBO), Design-Build-Operate (DBO), Build-Develop-Operate (BDO) and Design-Build-Operate-Transfer (DBOT). Recent regulation opens the door to a new source of funds from the Federal Administration for PPP projects. This low interest funding will certainly boost the number of these types of projects on U.S territory in the future. Public-Private Partnerships are certainly one of the most common approaches worldwide for the Sea Water Desalination application due to the highly specialization required to undertake these projects.

An integrated DBO process creates the best environment to develop cost and performance benefits from the preliminary design to the O&M period rewarding the outcome of these projects. As a result, increased efficiency, cost reductions, public health benefits, are among many of the benefits of any PPP process. In a Seawater RO treatment project these benefits are for example low energy cost configurations, appropriate material selection, reliable post-treatment solutions. Operating experience is the most valuable feedback designers can obtain for a successful outcome as well as the technical background of the O&M personnel ensures the most efficient operation. Also economics of scale play an important role in seawater desalination projects through worldwide agreements between suppliers and DBO firms.

Four of the latest Seawater RO treatment plants Design-Build-Operate (DBO), Alicante II (Spain), Mostagamen (Algeria) and Los Cabos (Mexico), and Design-Build-Operate-Finance (DBOF), Taunton (US), show consistency in affordable capital and operating costs.

The Alicante II Sea Water Desalination Plant is capable of treating 17 MGD and was commissioned in 2008. We were involved in the Design, Construction and is currently Operating this plant. Some peculiarities of this plant include a mixed ground and surface water supply. The client for the project was the local 'Mancomunidad de Canales del Taibilla' subsidiary of the Spanish Environmental Ministry and worked on this DBO project ensuring that current and future water needs in the tourism dependant region of Alicante are met.

Los Cabos Sea Water Desalination Plant is capable of producing 5.5 MGD and serves the Baja California Region in Mexico being the first Municipal Desalination Plant in the country. A creative PPP solution through a DBOOT (Design-Build-Operate-Own-Transfer) contract was key to accomplishing this project.

Recently commissioned, Mostaganem Sea Water Desalination Plant is a great example of how public entities can partner with private companies. The Algerian govern-

ment holds in this project a 49% through public Sonatrach and the Bank of Algeria is also the involved in the financing of the project.

Based on the acquired experience this paper shows why the total cost of water, including capital and operational costs of seawater desalination is a cost effective technology and a good alternative for future water needs and challenges.

Discusser: Jonathan Shimko, GAI Consultants, Inc., Homestead, PA ..... 9:25 AM
Floor Discussion & Closure ..... 9:35 AM
Break ..... 9:50 AM

IWC 11-73 **10:10 AM**

A HOLISTIC WATER MANAGEMENT APPROACH TO CHANGING POWER PLANT REGULATIONS

Michael Preston, Black & Veatch, Overland Park, KS

The world of power plant regulations is evolving quickly. Many of these new and proposed regulations will significantly affect how power stations view and utilize water resources and address wastewater discharge. Often the temptation is to simply address these as isolated issues that are created in the wake of these new and proposed regulations. However, the new regulations offer many utilities an opportunity to take a more holistic approach to their water management plans. The process is initiated by a thorough study of the existing facility water management approach followed by proposed modifications to address new regulations or improve water efficiency. It is expected that this approach results in superior and more sustainable utilization of water resources and minimization of additional treatment. This is particularly true for facilities built prior to the current concerns for water resources and availability and wastewater discharge. This paper provides a framework for performing a typical facility water management review and describes several cases where this was performed and the results.

Discusser: Stephen Frank, P.E., GenOn Energy, Canonsburg, PA ..... 10:35 AM
Floor Discussion & Closure ..... 10:45 AM
Conclusion ..... 11:00 AM

TRENDS IN MODELING FOR IMPROVED PLANT PERFORMANCE

Date: Wednesday, November 16
Time: 8:00 AM - 12:00 NOON
Room: Salon 7

The papers presented in this session will address current challenges found in optimizing plant operations in the face of difficult conditions. The topics covered include: a discussion of comprehensive water management at a utility, control of scaling in industrial boilers, a study of predictive fouling in the treatment of high to extreme TDS brines, and a paper on the use of chlorine dioxide in membrane applications.

IWC Representative: Mike Gottlieb, ResinTech, West Berlin, NJ
Session Chair: Tom Vanden Heuvel, Crane Environmental, Venice, FL
Discussion Leader: Virginia Durham, Ashland Water Technologies, Media, PA

Session Introduction **8:00 AM**

Tom Vanden Heuvel, Crane Environmental, Venice, FL

IWC 11-75 **8:10 AM**

BOILER DEPOSIT CONTROL - INFORMED SELECTION IMPROVES BOILER PROTECTION

James Robinson, and Dennis Dyer, GE Power and Water, Trevose, PA

Numerous chemicals have been used to control deposition in industrial boilers. While nearly all of these chemicals have been successful in certain situations, understanding where and how to use each chemical is critical to achieving long-term reliable plant

operation. This paper will review the benefits and limitations of individual treatment chemicals to enable informed treatment selection based on plant operating conditions. In addition, with the trend to higher purity feedwater for low-pressure boilers, the need to address the potential for flow accelerated corrosion (FAC) as well as deposit control is discussed.

Discusser: Robert Barrtholomew, Sheppard T. Powell Associates LLC, Baltimore, MD..... 8:35 AM

Floor Discussion & Closure ..... 8:45 AM

IWC 11-76 **9:00 AM**

DEVELOPMENT OF AN INTERACTIVE WATER MANAGEMENT PROGRAM FOR ORLANDO UTILITY COMMISSION'S CURTIS H. STANTON ENERGY CENTER

Dustin Mobley, Black & Veatch, Jacksonville, FL; Kenneth Weiss, Black & Veatch Corporation Jacksonville, FL; Eric Costello, Orlando Utilities Commission Orlando, FL; Alan Planeta, Orlando Utilities Commission Orlando, FL

Orlando Utilities Commission (OUC) Stanton Energy Center site in Orange County, Florida includes two 465 MW (nominal) coal fired units and a 633 gas-fired combined cycle plant. An additional 300 MW combined cycled facility currently is being constructed. The Stanton Energy Center (SEC) is a very unique plant from a water and wastewater operations standpoint. The SEC includes both coal and gas fueled units, a number of water supply sources, various drainage and flow equalization ponds, and advanced wastewater treatment systems to achieve zero liquid wastewater discharge. Recycle and reuse of wastewaters is extensively used. With such complexity, it has been challenging to predict all the impacts of various operational regimes and weather events.

With possible development of new environmental regulations, OUC may also desire to change its fuel mix in the future, which could have direct impact on water and wastewater management at the SEC. Therefore, OUC decided that better tools were needed to ascertain the impact of various operational scenarios and environmental events on water management. OUC determined that an interactive computer program approach using the detailed plant water mass balance diagram as the basis was needed. A program has been developed using Microsoft © Office Excel 2003 and Microsoft Visual Basic 6.5. The program utilizes an interactive process flow diagram that utilizes the Visual Basic user forms for entry of operational parameters for plant unit operations specific to the Stanton Energy Center. Detailed water management calculations are performed "behind the scenes" and displayed on a user-friendly interface.

The program is able to model the water balance impacts of present and future events, such as rainfall, equipment outages, changes in projected unit load, changes in coal properties, scrubber operational changes, and maintenance events. Inputs include daily rainfall amount and duration, expected capacity factor for each unit, water management pond levels, chemistry of makeup water sources, water usage flow rates for each plant subsystem, cooling tower operation including chemistry control limits, seasonal evaporation rates, coal quality, FGD scrubber operational parameters, and similar factors.

Discusser: Loraine Huchler, MarTech Systems, Lawerenceville, NJ ..... 9:25 AM

Floor Discussion & Closure ..... 9:35 AM

Break ..... 9:40 AM

IWC 11-77 **10:10 AM**

MINERAL SCALE PREDICTION AND CONTROL AT EXTREME TDS

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

Traditional methods for predicting mineral scale deposition and optimizing scale inhibitor dosages are not effective in high ionic strength brines such as shale fracturing flowback

fluids. This paper discusses techniques for modeling scale formation and its inhibition in high to extreme TDS brines. The technology discussed is applicable to fracturing operations, produced waters, seawater membrane systems, and zero discharge industrial environments. The advantages and disadvantages of traditional and viral equation approaches are discussed on a practical basis. The thermodynamics and kinetics of mineral scale prediction and dosage optimization are discussed. Implications of open and closed systems, reducing and oxidizing environments are also covered.

Discusser: Michael Bluemle, Ashland Water Technologies, Wilmington, DE.... 10:35 AM
Floor Discussion & Closure.....10:45 AM

IWC 11-78 **11:00 AM**

FIELD TRIAL EXPERIENCE USING CHLORINE DIOXIDE AS A CLEANER FOR BIOFILM CONTROL IN AN RO APPLICATION

George Dimotsis, Dripping Wet Water, San Antonio, TX

Biofilm is the last great challenge in reverse osmosis system design and operation. Technological advances have increased flux and rejection, brought down costs, and increased membrane life, but biofilm remains a problem. It decreases flux rate, which causes energy costs to rise and production to suffer. It decreases the time between membrane cleanings, because it cannot fully be removed so that the membranes re-inoculate themselves with their own bacteria. It shortens membrane life, because it causes the membranes to reach a point where they can just no longer be cleaned. In other words, biofilm is the enemy of reverse osmosis membranes. This paper will describe results from a field trial comparing chlorine dioxide with DBNPA on two 500 gpm RO systems where biological fouling has been an ongoing operational issue. The discussion will include purity requirements for safe use of the chlorine dioxide with TFC membranes, the method of chlorine dioxide application and performance of the chlorine dioxide relative to DBNPA. Chlorine dioxide was found to be much more effective than DBNPA without damaging the membranes

Discusser: Sam Renfrow, Chemtreat, Mariatta, GA.....11:25 AM
Floor Discussion & Closure.....11:35 AM
Conclusion .....11:50 PM

Workshops

CONTINUING EDUCATION WORKSHOPS

This year's workshops will cover relevant topics such as Water and Wastewater Treatment for Natural Gas, Frac Water, Reverse Osmosis, Ion-Exchange Technology and a special package of 3 basic water treatment courses. 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. Advance registration and 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.

W1: HRSG AND HIGH PRESSURE (>900 PSIG/60 BAR) BOILER WATER TREATMENT AND OPERATION

DATE: Wednesday, November 16
TIME: 1:00 - 5:00 PM

This workshop will cover the water quality required for high pressure (>900 psig) steam boils, the various treatments being sued and new developments relative to protection from scale and corrosion. The course also covers treatment issues related to pre-boilers and the condensate systems. The course includes 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.

Instructor: David Daniels, *Mechanical & Materials Engineering,* Austin, TX

W2: REVERSE OSMOSIS MEMBRANE CLEANING

DATE: Wednesday, November 16
TIME: 1:00 - 5:00 PM

Cleaning of reverse osmosis systems Effective cleaning of reverse osmosis systems is dependent on several key parameters. These key parameters include RO system design, membrane selection, cleaning skid design, operation, and membrane chemicals and cleaning procedures. Information on these key parameters and their impact on effective cleaning will be discussed in detail. Troubleshooting of reverse osmosis systems Troubleshooting is necessary when cleaning does not restore the RO performance or when performance problems occur during the start-up/commissioning of new RO membrane elements. Different methods are discussed that can be used to identify and locate the performance problem in the RO system. Guidelines on the interpretation of results generated by these tools will be provided. Examples of 4 -6 plants with performance.

Instructor: Jantje Johnson, *OrangeBoat,* Eden Prairie, MN

W3: TREATMENT OF WATER FOR STEAM GENERATION IN SAGD ENHANCED OIL RECOVERY PLANTS

DATE: Wednesday, November 16
TIME: 1:00 - 5:00 PM

"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 vs weak acid cation softening including in-situ vs external regeneration. We will look at the different requirements imposed on system choices for wet steam generation in once through generators as opposed to "dry" steam generation in water tube power boilers.

Instructor: Robert Holloway, *Holloway Associates*, Etobicoke, ON Canada

W4: WATER TREATMENT 101*

DATE: Wednesday, November 16
TIME: 1:00 - 5:00 PM

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 including treatment of makeup water for cooling water systems, and boiler water makeup. Wastewater generated by these unit operations and their treatment & disposal will be discussed. Basic water chemistry requirements for low, medium, and high pressure boilers will be considered with chemical conditioning as required.

Instructor: Dennis McBride, *Fluor Enterprise*, Greenville, SC

W5: COOLING WATER TREATMENT AND REUSE WATER TECHNOLOGY

DATE: Thursday, November 17
TIME: 8:00 AM - 12:00 NOON

This work shop will cover the current cooling water treatment technology with fresh and recycle waters as makeup. Guidelines for identifying concerns with recycle water will be discussed with case histories of water treatments needed for success.

Instructor: Paul Puckorius, *Puckorious & Associates, Inc.*, Arvada, CO

W6: INDUSTRIAL BOILER WATER (UP TO 1800 PSIG/120 BAR)

DATE: Thursday, November 17
TIME: 8:00 AM - 12:00 NOON

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.

Instructor: James Robinson, *GE Betz*, Trevose, PA

W7: REVERSE OSMOSIS - BACK TO THE BASICS*

DATE: Thursday, November 17
TIME: 8:00 AM-12:00 NOON

The application of reverse osmosis (RO) has grown rapidly over the last 15 years. 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.

Instructor: Jane Kucera, *Nalco Company,* Naperville, IL

W8: WATER TREATMENT 201

DATE: Thursday, November 17
TIME: 8:00 AM-12:00 NOON

An in depth look at what resins can and can't do. 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. The workshop is divided into four sections. Section one covers ion exchange fundamental theories and a review of the four basic types of ion exchangers, how their properties differ, and how they are used. In section 2 students will learn how to perform capacity calculations for any virtually any ion and solution and to make preliminary calculations to determine if ion exchange is feasible and/or practical. Section 3 covers trace ion removal. Section 4 covers troubleshooting approaches and how to set up spreadsheet models of operating ion exchange systems that will help normalize operating data.

Students will need to bring laptops that have MS Office software including Excel.
Fundamental Theory of ion exchange selectivity
How the four basic types of ion exchangers differ in properties

Instructor: Peter Meyers, *ResinTech,* West Berlin, NJ

W9: WATER AND WASTEWATER TREATMENT FOR NATURAL GAS FRAC WATER

DATE: Thursday, November 17
TIME: 8:00 AM-12:00 NOON

The Marcellus well field is one of several deep shale formations in the US holding substantial reserves of natural gas. It runs from central New York through Pennsylvania and West Virginia, and extends into Kentucky, Virginia, and Ohio. Estimated reserves exceed 50 trillion cubic feet of natural gas. To extract the gas requires sophisticated drilling techniques. Hydro fracturing is required to form channels in the shale to allow the gas to flow to the well. This course provides detailed information on water use in the hydro fracturing process, from the water supply side as well as the treatment of flowback water from the frac'd well. The quality requirements for water supply will be reviewed from theoretical and practical perspectives. Data will be presented identifying the nature of water recovery from the hydrofractured well, both for quantity and quality. Treatment options, including thermal treatment options, will be reviewed, and where available design criteria will be noted.

Instructors: John Schubert, P.E., *HDR Engineering,* Sarasota, FL; Joseph Swearman, *CONSOL Energy, Inc.,* Canonsburg, PA

W10: BIOLOGICAL TREATMENT OF REFINERY AND CHEMICAL PLANT WASTEWATERS

DATE: Thursday, November 17
TIME: 1:00-5:00 PM

This workshop provides a review of the basic design and operating considerations for aerobic and anaerobic treatment technologies that are applied to industrial wastewater treatment for the food, refinery, chemical, power and other industries. The workshop will address basic concepts for organic BOD and COD removal and will introduce concepts for biological nutrient removal. This workshop provides practical design and operational information on the various types (SBR, MBR, MMBR, activated sludge, etc.) of biological wastewater treatment technologies in use today for industrial wastewaters.

Instructor: Enos Stover, Ph.D. P.E., D.E.E., *The Stover Group*, Stillwater, OK

W11: ELECTRODEIONIZATION (EDI) PRESENTS

DATE: Thursday, November 17
TIME: 1:00-5:00 PM

Electrodeionization (EDI) is a time proven process which combines semi-impermeable membrane technology with ion-exchange media to provide high efficiency self-regenerated demineralized water without chemicals. This workshop will explore the design and operation of different EDI modules from four-(4) different manufacturers of EDI membranes.A 100 gpm feed water source shall be provided to each EDI manufacturer and they will model the system, present their design, present effluent water quality and discuss the advantages of their system as designed. The program shall also provide a simplified P&ID of the system and operating cost summary. This workshop provides one stop shopping for all your EDI needs.

Instructor: Steve Gagnon, *AVANTech*, Columbia, SC

W12: ION EXCHANGE TECHNOLOGY AND PRACTICAL OPERATING PRACTICES*

DATE: Thursday, November 17
TIME: 1:00-5:00 PM

This workshop provides detailed review of the various ion exchange processes for softening and demineralizing water 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 operations. This is a great opportunity to ask questions and solve problems.

Instructor: Wayne Bernahl, *W. Bernahl Enterprises, Ltd.*, Elmhurst, IL

W13: WATER TREATMENT BASIC TRAINING

Includes these 3 workshops at a Package Price $550:

- Water Treatment 101 (W4)
- Reverse Osmosis – Back to Basics (W7)
- Ion Exchange Technology and Practical Operating Practices (W12)

See separate listings (above) for descriptions and times of these workshops.

Info-Share Suites

AQUATECH

Room: Lily/Kahili
Hours: Monday, 9:00 PM - Midnight
Contact: Amy Bloom
Telephone: 724-746-5300
E-mail: blooma@aquatech.com
Web: www.aquatech.com

Join Aquatech to celebrate the IWC - Vegas Style. Try your luck at winning various prizes while enjoying drinks, appetizers, and desserts. Come and relax after the first day of the conference!

SOUTHWEST ENGINEERS

Room: Gardenia/Fuschia
Hours: Monday, 8:00 AM - 5:00 PM; Tuesday, 8:00 AM - 5:00 PM; Wednesday, 8:00 AM - 11:00 AM
Contact: Juanita Windetz
Telephone: 985-643-1117
E-mail: mailswe@southwestengineers.com

Southwest Engineers, as an industrial water treatment company, was founded in 1985 on the basic premise that a more professional approach to treatment was needed in the industry. Hence, the maxim, A Professional Approach to Water Treatment, not only appears as a trademark on our letterhead, but stands as our commitment to excellence in products and services.

VEOLIA WATER SOLUTIONS & TECHNOLOGIES

Room: Magnolia
Hours: Monday, 7:00 AM - 9:00 AM; Tuesday, 7:00 AM - 9:00 AM
Contact: Katherine Ardaugh
Telephone: 815-609-2025
E-mail: katherine.ardaugh@veoliawater.com
Web: www.veoliawaterstna.com

Join Veolia Water Solutions & Technologies for Breakfast at 7AM in the Camelia meeting room and learn more about our latest water treatment solutions:
Monday November 14 – OPUS® II Technology: Advanced Produced Water Treatment
Tuesday November 15 – What it Means to be Green in Industrial Water Treatment
Space is limited! Reserve your spot by emailing katherine.ardaugh@veoliawater.comor stop by Veolia Water Solutions & Technologies Booth 36 to make your breakfast reservations!

Exhibitors

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 the International Ballroom across from the Conference Registration Desk. The Exhibit Hall Hours of Operation are:

- Sunday, November 13 from 5:00 PM-7:00 PM
- Monday, November 14 from 11:30 AM-2:00 PM and 4:30 PM-7:00 PM
- Tuesday, November 15 from 11:30 AM-2:00 PM and 4:30 PM-7:00 PM

Be sure to join us for lunch on Monday and Tuesday, also for the evening receptions on Sunday and Monday and Tuesday. Luncheons and receptions are open to all registered attendees. A listing by booth number of all 2011 IWC Exhibitors is provided below. On the pages that follow you will find a detailed listing of these Exhibitors that includes contact information and a company description.

1-2 Degremont North America
3 SWAN Analytical USA Inc.
4 Graver Water Systems, LLC
4 Ecodyne Limited
5 Chemtech Division of Champion Technologies
6 DOW Water & Process Solutions
7 Advanced MicroLabs, LLC
8 MAR Systems Inc.
9 Golder Associates, Inc.
10 H2O Innovation
11 OrangeBoat
12 LANXESS Sybron Chemicals Inc.
13 Pall Corporation
14 & 15 GE Power & Water
16 Neptune Chemical Pump Co.
17 Schreiber LLC
18 ProMinent Fluid Controls, Inc.
19 CEDA International Corporation
20 SAMCO Technologies, Inc.
21 & 22 EKA Chemicals
23 ResinTech, Inc.
24 Westech Engineering
25 Chemtrac Systems, Inc.
26 Avantech, Inc.
27 BJ Process and Process Services
28 Ashland Water Technologies
29 Water Tectonics
30 Illinois Water Technologies
31 Sentry Equipment Corp.
32 Diamond V
33 Mettler - Toledo Thornton
34 Purolite Company
35 Parkson Corporation
36 Veolia Water Solutions & Technologies
37 French Creek Software
38 Siemens Water Technologies Corp.
39 Genesys North America/ Genesys International
40 Dionex-Part of Thermo Fisher Scientific
41 Danfoss VLT Drives
42 Energy & Environmental Research Center (EERC)
43 Industrial Analytics Corp.
44 QUA Group LLC
45 US Water Services
46 Milton Roy Americas
47 Thermax Inc.
48 Thermo Scientific - Water Analysis
49 Aquatech International Corporation
50 Honeywell
51 Sanosil International
52 Water Quality Association
53 Duraflow
54 Turner Designs Hydrocarbon Instruments, Inc.
55 Eco-Tec Inc.
56 Waters Equipment
57 Solar Bee, Inc.
58 ChemTreat
59 Bowen Engineering Corporation
60 Severn Trent Water Purification, Inc.
61 & 62 Nalco Company
63 Marrone Bio Innovations
64 SA Envitech, a.s.
65 Justeq LLC
66 Powell Water Systems Inc.
67 Chemical Publishing Company
68 Aggeko Cooling Tower Services
69 CHEMetrics, Inc.
70 Environmental Operating Solutions, Inc.
71 Larox Flowsys Inc./ MicrOclor
72 Ovivo USA, LLC
73 Johnson March Systems
74 Mitsubishi Electric Automation
FOYER Pollution Equipment News/ Rimbach Publishing Inc.

Exhibitors

ADVANCED MICROLABS, LLC

Booth: 07
Contact: Ken Ogan
Phone: 970-492-4383
Fax: 866-657-3691
E-mail: djohnson@advancedmicrolabs.com
Website: www.advancedmicrolabs.com

Advanced MicroLabs LLC is a chemical analytical instrumentation company decidated to poineering MicroChip Electro Chromatography measurement techniques. Since 2003, AvancedMicroLabs has been operating as a research stage company; beginning in 2010, Advanced MicroLabs entered the commercialization stage for Ion Analysis in the Industrial Clean Water Market.

AGGEKO COOLING TOWER SERVICES

Booth: 68
Contact: Billy Childers
Phone: 1-800-AGGREKO
Fax: 281-985-8201
E-mail: Billy.Childers@aggreko.com
Web: www.aggreko-cooling-tower-rentals.com

With 24-hour availability and the largest fleet of modular cooling towers in the industry, Aggreko Cooling Tower Services can help address emergencies, maximize production, and keep your operations running smoothly.

AQUATECH INTERNATIONAL CORPORATION

Booth: 49
Contact: Patrick Randall
Phone: 724-746-5300
Fax: 724-746-5359
E-mail: randallp@aquatech.com
Web: www.aquatech.com

Established in 1981, Aquatech International Corporation is a global leader in water purification technology for industrial and infrastructure markets with a focus on desalination, water reuse, and zero liquid discharge. Aquatech's product groups include Raw Water Treatment, Ion Exchange, Membrane Processes (UF/RO/MBR), Thermal Desalination (MED/MSF), Wastewater/Effluent Treatment and Zero Liquid Discharge.

ASHLAND WATER TECHNOLOGIES

Booth: 28
Contact: Kenneth Dunn
Phone: 614-790-4068
Fax: 614-790-3426
E-mail: tlhanson@ashland.com
Web: www.ashland.com

For nearly 100 years, Ashland Hercules Water Technologies has been a leading provider of a wide array of innovative process and water treatment specialty chemicals. Our extensive global expertise, on-site management approach and seasoned team of application experts enable us to partner with you to deliver high-value solutions. Combined with our commitment to environmentally sustainable initiatives, we work with you to protect our world for future generations. At the core of every Ashland water treatment program is our technologically advanced specialty chemicals and equipment that ensure your water and energy use is efficient, your system reliability is maximized and your capital assets are

not compromised. To ensure optimum chemical feed without interruption under constantly changing conditions, Ashland's automated OnGuard™ monitoring systems, controllers and data management software are recommended to ensure trouble-free operations.

AVANTECH, INC.

Booth: 26
Contact: James Braun
Phone: 803-467-4774
Fax: 803-407-1215
E-mail: sgagnon@avantechinc.com
Web: www.avantechinc.com

AVANTech, Inc. is a comprehensive industrial water treatment solutions provider. Our extensive experience in engineering process systems enables us to create integrated solutions that can dramatically improve operations in industrial, commercial, power, and nuclear power applications.

BJ PROCESS AND PROCESS SERVICES

Booth: 27
Contact: Derek Clark
Phone: 832-519-2000
Fax: 832-519-2001
E-mail: derek.clark@bjservices.com
Web: www.bjservices.com

Pre-commissioning and turnaround services. Chemical cleaning, boiler and pipe systems. Flowmac flushing of lube and hydraulic systems. Air and nitrogen drying. Accelerated cooldown processes with N2 and Co2. Laboratory and development facilities.

BOWEN ENGINEERING CORPORATION

Booth: 59
Contact: Michael Soller
Phone: 317-842-2616
Fax: 317-841-4257
E-mail: msoller@bowenengineering.com
Web: www.bowenengineering.com

Bowen is a self-performing, employee owned, general contractor focused on water, wastewater and power construction. Headquartered in Indiana, Bowen is working throughout the Central and Eastern United States. As a leading design-builder in the country, our ability to listen and collaborate with our partners and clients has made us their contractor of choice. Let's fix it together.

CEDA INTERNATIONAL CORPORATION

Booth: 19
Contact: Todd Anderson
Phone: 780-377-4959
Fax: 780-449-2889
E-mail: bshupac@cedagroup.com
Web: www.cedagroup.com

CEDA International Corporation is a global leader driven by talented and passionate people who are committed 24/7 to delivering world class industrial maintenance, turnaround and construction services through innovative technologies, equipment and processes, safely every time. Since 1973, clients have relied on CEDA International Corporation to deliver outstanding technical services that optimize their investments, improve their competitive position and increase their long-term success.

CHEMETRICS, INC.

Booth: 69
Contact: Bob Hruska
Phone: 540-788-9026
Fax: 540-788-4856
E-mail: bhruska@chemetrics.com
Web: www.chemetrics.com

CHEMetrics manufactures water analysis test kits and instruments for over 50 essential parameters. Available tests include dissolved oxygen, nitrite, iron, phosphate, etc. The kits and instruments utilize self-filling reagent ampoules that simplify and speed water quality testing and are ideal for field and lab use. CHEMetrics offers personalized customer support that is a phone call or an e-mail away.

CHEMICAL PUBLISHING COMPANY

Booth: 67
Contact: Ban Carr
Phone: 888-439-3976
Fax: 888-439-3976
E-mail: info@chemical-publishing.com
Web: www.chemical-publishing.com

Founded in 1934 in New York City, Chemical Publishing Company has consistently provided the best in applied science and reference publications. Our Water Technology authors include, Colin Frayne, James McCoy, Donald R. Baker and Natarajan Manivasakam.

CHEMTECH DIVISION OF CHAMPION TECHNOLOGIES

Booth: 05
Contact: Gretchen Blank
Phone: 713-590-7006
Fax: 713-627-9363
E-mail: GBlank@chemtechllc.com
Web: www.champ-tech.com

Chemtech is a specialty chemical and engineering service division of Champion Technologies, Inc., providing a full line of industrial water treatment chemicals and field engineering services. Champion Technologies is the fastest growing specialty chemical company, having one of the largest teams of research scientists and technologists dedicated to the oil, gas, refining, chemical and power industries. With over 50 years of specialty chemical experience, our commitment to research and development has produced a broad scope of high performance technology and expertise around the world.

CHEMTRAC SYSTEMS, INC.

Booth: 25
Contact: Robert Bryant
Phone: 770-449-6233
Fax: 770-447-0889
E-mail: chemtrac@chemtrac.com
Web: www.chemtrac.com

Chemtrac Systems, 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 monitoring technology for coagulant feed control, and offers online particle counters and particle monitors for continuous filter performance evaluation. The particle counters/monitors are also used in the steam generation cycle for corrosion product transport monitoring, condenser leak

detection, and steam purity monitoring. Chemtrac also provides analyzers for chlorine, ozone, turbidity, and organics monitoring.

CHEMTREAT

Booth: 58
Contact: Sydney Mosley
Phone: 804-935-2182
Fax: 804-965-6974
E-mail: sydneym@chemtreat.com
Web: www.chemtreat.com

ChemTreat, Inc. is the nation's largest and fastest growing specialty chemical company dedicated solely to industrial water treatment. For the best products and world-class service, you've come to the right place. We have over 500 associates working throughout North and South America, the Caribbean, and some areas of Asia/Pacific regions. Our entrepreneurial spirit not only helps drive our company's success, but also carries over into our customer's facilities. We help our customers' facilities. We help our customers save millions of dollars every year, enabling us to achieve unparalleled growth in the water treatment industry.

DANFOSS VLT DRIVES

Booth: 41
Contact: Joe Halliday
Phone: 315-427-3036
Fax: 315-546-2128
E-mail: joehalliday@danfoss.com
Web: www.danfossdrives.com

Danfoss VLT Drives is a manufacturer of Variable Frequency Drives (VFD's) andSoftstarters designed specifically for Water/Wastewater and Irrigation applications. Danfoss can also provide engineered panels for VFD's and soft starters to include bypass and harmonic solutions in a variety of NEMA ratings to maximize energy efficiency.

DEGREMONT NORTH AMERICA

Booth: 01 & 02
Contact: Anthony Fuhrman
Phone: 804-756-8423
Fax: 804-756-7643
E-mail: sylvie.roy@degremont.com
Web: www.degremont-technologies.com

Degremont NA - The world's most respected leader in:

- Zero Liquid Discharge
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- Wastewater Treatment
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DIAMOND V

Booth: 32
Contact: Michael Spacil
Phone: 800-373-7034
Fax: 864-502-2626
E-mail: mspacil@diamondv.com
Web: www.diamondv.com

Diamond V®, headquartered in Cedar Rapids, Iowa, USA, is a bioscience company specializing in fermentation technology. The Company manufactures all-natural nutritional products that optimize microbial efficiency. Since 1943, Diamond V® has been committed to advancing nutrition and health in the animal industry and has expanded to human nutrition and, more recently, water and soil remediation. Our commitment to innovation, technology and quality has earned Diamond V® a global reputation of trust and reliability. We help our customers succeed by sharing knowledge, innovation and capability. The benefit is real because the Diamond V® investment and commitment is real. As the global population continues to grow, and the demand for fresh water increases, water quality is crucial. AquaSmart™, a new product innovation from Diamond V®, can aid in the effort to treat many wastewaters and provide cleaner, safer discharge for many industries.

DIONEX-PART OF THERMO FISHER SCIENTIFIC

Booth: 40
Contact: Angie Jinks
Phone: 408-481-4275
Fax: 941-426-3958
E-mail: angie.jinks@thermofisher.com
Web: www.thermoscientific.com/dionex

Dionex, now part of Thermo Fisher Scientific, will showcase IC and UHPLC products and applications for complete water analysis. As leaders in the analysis of water contaminants, we bring you the latest technology for full compliance monitoring of all metals, inorganic, and organic contaminants. The combination of system technology, application notes, and full instrument support provides a complete water analysis solution. Our instruments are also used for process analysis to optimize your treatment regime.

DOW WATER & PROCESS SOLUTIONS

Booth: 06
Contact: Becky Ersfeld
Phone: 952-914-1002
Fax: 952-835-4996
E-mail: BErsfeld@dow.com
Web: www.dowwaterandprocess.com

Dow Water & Process Solutions offers a broad portfolio of ion exchange resins, reverse osmosis membranes, ultrafiltration membranes and electrodeionization products, with strong positions in a number of areas, including industrial applications. More information about Dow Water & Process Solutions can be found at www.dowwaterandprocess.com.

Exhibitors

DURAFLOW

Booth: 53
Contact: Bill Matheson
Phone: 978-851-0447
Fax: 978-851-7459
E-mail: billmatheson@duraflow.biz
Web: www.duraflow.biz

Duraflow manufactures Tubular, Crossflow, Microfiltration Membrane filters in their in Tewksbury, MA facility. These membrane modules are the key components of water and wastewater treatment systems built by Duraflow's trained and authorized OEM manufacturers. These systems are mostly for either recycling industrial wastewater or for prefiltration processes in front of Reverse Osmosis systems. Duraflow membrane modules are recognized as the perfect pretreatment to RO.

ECODYNE LIMITED

Booth: 04
Contact: Paul Kitchen
Phone: 905-332-1404
Fax: 905-332-6726
E-mail: info@ecodyne.com
Web: www.ecodyne.com

Ecodyne Water, an ISO 900 company, is a worldwide leader in custom designed water treatment systems. We bring over 50 years of experience to the design, manufacturer and service of your water treatment equipment including; ultrafiltration, high rate filters, countercurrent packed bed demineralizers, reverse osmosis, mixed bed polishers and deaerators.

ECO-TEC INC.

Booth: 55
Contact: George Di Falco
Phone: 905-427-0077
Fax: 905-427-4477
E-mail: gdifalco@eco-tec.com
Web: www.eco-tec.com

Eco-Tec develops, designs and manufactures innovative water treatment systems particularly adapted to boiler feed, condensate polishing and produced water treatment. Featured products are Spectrum Micro Media filtration and Recoflo®/RecoPur® short, packed-bed ion exchangers.

EKA CHEMICALS

Booth: 21 & 22
Contact: Gary Charles
Phone: 770-321-4109
Fax: 770-321-5847
E-mail: gary.charles@akzonobel.com
Web: www.purate.com

Eka Chemicals is a business unit within AkzoNobel. We are a leading supplier of technology, chemicals and systems to the global pulp and paper and selected other industries. The Purate Division is part of Eka Chemicals' Specialty Products division. With more than 40 years successful experience designing, building, and operating chlorine dioxide systems the Purate technology has become the world leader in providing small-scale chlorine dioxide generation units for municipal and industrial applications.

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

Booth: 42
Contact: Derek Walters
Phone: 701-777-5113
Fax: 701-777-5181
E-mail: dwalters@undeerc.org
Web: www.undeerc.org

The EERC is a world leader in developing cleaner, more efficient energy and environmental technologies to protect and clean our air, water, and soil. The EERC is a high-tech, nonprofit division of the University of North Dakota, which pursues an entrepreneurial, market-driven approach to research and development to successfully demonstrate and commercialize technologies.

ENVIRONMENTAL OPERATING SOLUTIONS, INC.

Booth: 70
Contact: Michael Starr
Phone: 508-743-8440
Fax: 508-743-8443
E-mail: mstarr@eosenvironmental.com
Web: www.eosenvironmental.com

Environmental Operating Solutions, Inc. (EOSi) provides green chemicals and technical services for biological contaminant removal applications in water and wastewater treatment systems. The company's agriculturally derived products provide a non-hazardous and environmentally sustainable alternative to methanol or other chemicals. The company's MicroCT line of products (MicroCm®, MicroCg® and MicroCglycerinT) address contaminants including nitrogen, phosphorous, selenium and perchlorate. MicroCT products are also used as BOD supplements to sustain biomass during maintenance at industrial wastewater facilities and establish biomass for new plant startups. EOSi currently provides more than 400 wastewater treatment plants with a safer, more effective, and environmentally sustainable solution compared with methanol and other carbon sources. In addition, EOSi offers highly specialized technical expertise and support to help plant engineers and operators optimize the use of its products and achieve their effluent performance objectives. EOSi is also engaged in research and development efforts focused on bringing the next generation of biological contaminant removal solutions to the market. EOSi was established in 2003 and is based in Bourne, Massachusetts.

FRENCH CREEK SOFTWARE

Booth: 37
Contact: Baron Ferguson
Phone: 610-935-8746
Fax: 610-935-1008
E-mail: baron@frenchcreeksoftware.com
Web: www.frenchcreeksoftware.com

French Creek develops and markets scale and corrosion software tools for water treatment professionals. Standard packages include industry standard WaterCycle® for cooling, hyd-RO-dose™ for membrane systems, WatSim™ for potable, MineSAT™ for mining and waste water, DownHole SAT for oil field. Private label available. Windows DLLs and UNIX libraries available for controllers, web apps, and in-house applications.

GE POWER & WATER

Booth: 14 & 15
Contact: Bob Holt
Phone: 215-942-3288
Fax: 215-953-5524
E-mail: robert.holt@ge.com
Web: www.ge.com/water

GE Water & Process Technologies is a leading global supplier of industrial water and wastewater treatment solutions. GE delivers customer value with advanced solutions incorporating ultrafiltration, reverse osmosis, EDR, ion exchange, MBR, ZLD and Advanced Biological Metals Removal (ABMet) for the power, microelectronics, pharmaceutical, hydrocarbon and chemical processing industries.

GENESYS NORTH AMERICA/ GENESYS INTERNATIONAL

Booth: 39
Contact: Ursula Annunziata
Phone: 952-949-6535
Fax: 360-435-7373
E-mail: uannunziata@genesysro.com
Web: www.genesysamericas.com

Genesys North America specializes in high performance membrane chemicals and services for reverse osmosis and nanofiltration systems. The membrane chemicals include anti-scalants and cleaning chemicals. The products and expertise of Genesys North America allow customers to reduce the total cost of their RO/NF operation.

GOLDER ASSOCIATES, INC.

Booth: 09
Contact: Paul Pigeon
Phone: 303-980-0540
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E-mail: ppigeon@golder.com
Web: www.golder.com

Golder Associates is an employee-owned, global group of companies specializing in ground engineering and environmental services. From offices worldwide, our employees work with clients who want to manage their environmental and engineering activities in a technically sound, economically viable and socially responsible manner.

GRAVER WATER SYSTEMS, LLC

Booth: 04
Contact: Robert Applegate
Phone: 908-516-1404
Fax: 908-516-1401
E-mail: rapplegate@graver.com
Web: 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 utilities on a global basis.

H2O INNOVATION

Booth: 10
Contact: Marie-Eve Juneau
Phone: 418-688-0170
Fax: 418-688-9259
E-mail: marie-eve.juneau@h2oinnovation.com
Web: www.h2oinnovation.com

H2O Innovation is a complete water treatment solutions company providing custom designed water treatment systems along with operating and maintenance solutions.

HONEYWELL

Booth: 50
Contact: Vickie Oslon
Phone: 623-203-8623
E-mail: vickie.olson@honeywell.com
Web: www.honeywell.com

Honeywell is a leading supplier of process control instrumentation. The NEW DirectLine™ Sensor Module is a unique architecture for analytical measurements. The DirectLine™ sensor modules save time with installation, wiring, and calibration.

ILLINOIS WATER TECHNOLOGIES

Booth: 30
Contact: William Helmanr
Phone: 815-636-8884
Fax: 815-636-8883
E-mail: billh@illinoiswatertech.com
Web: www.illinoiswatertech.com

Illinois Water Technologies is an independent service and retrofit provider of water treatment equipment. We also stock ion exchange resin, filter media and provide custom replacement parts as well as common vendor supplied components. Our customers enjoy 24-hour availability, commitment to service, and cost savings that IWTech brings to the marketplace

INDUSTRIAL ANALYTICS CORP.

Booth: 43
Contact: Nick Afragola
Phone: 203-245-0380
Fax: 203-245-3698
E-mail: nafragola-IAC@sbcglobal.net
Web: www.industrialanalyticscorp.com

Industrial Analytics has been in the UPW market providing on-line water analysis for over 20 years. IAC is proud to introduce its own line of instrumentation built in the USA at our facility. Parameters include sodium, silica, phosphate, water hardness and (a soon to be released) dissolved oxygen.

JOHNSON MARCH SYSTEMS, INC.

Booth: 73 (back wall)
Contact: John Sands
Phone: 215-364-2500
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Web: www.johnsonmarch.com

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MAR SYSTEMS INC.

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NALCO COMPANY

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ORANGEBOAT

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QUA GROUP LLC

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QUA is a manufacturer of advanced membrane products for water, wastewater, and water reuse applications. Extensive R&D activities for over a decade have resulted in a range of cutting edge membrane products. These products are sold and serviced through a network of qualified equipment manufacturers around the world.

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SA ENVITECH, A.S.

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SA Envitech is an active company which focuses on the research, development and industrialization of nanotechnologies and nanostructured materials for waste treatment, contaminated site remediation, wastewater treatment and alternative energy. SA Envitech invented and developed RECAM® on an industrial level, an innovative nanostructured carbon material with a high efficiency for the treatment of contaminated water. SA Envitech holds several international patents for the application of RECAM® in water purification and remediation of contaminated sites. SA Envitech is an independent company, highly innovative and characterized by the ability to solve complex problems with principles and processes that are developed and industrialized on the basis of specific customer requirements.

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THERMAX INC.

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WATER QUALITY ASSOCIATION

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The Water Quality Association (WQA) is a not-for-profit international trade association representing the residential, commercial, industrial, and small community water treatment industry. WQA maintains a close dialogue with other organizations representing different aspects of the water industry in order to best serve consumers, government officials, and industry members.

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