Report on the PowerPlant Chemistry Forum in Bangkok, Thailand

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ABSTRACT

This contribution is a report on the fourth PowerPlant Chemistry Forum, held in Bangkok, Thailand, on October 11–12, 2017. The forum consisted of six sessions covering different aspects of water/steam cycle chemistry: life-cycle chemistry optimization, film forming amines, condensate polishing, zero liquid discharge, case studies, and monitoring and analytics were the topics covered during the two days. Each session consisted of two to three presentations given by an expert in the field, followed by open floor discussions at the end of each day. A short summary of each presentation is given in this report.

INTRODUCTION

In the past five years, Waesseri GmbH has organized more than 20 Power Cycle Instrumentation Seminars (PCISs) around the world with the mission of expanding the knowledge of cycle chemistry and the understanding of analytical instruments [1–5], with the most recent seminar held in Bogota, Columbia, in March 2017. This series will be continued in the future – in April 2018 the event series will stop over in South America again. More information on the upcoming events can be found on our webpage (www.ppchem.net).

Based on the feedback from the past seminars, Waesseri GmbH decided to start a new series of events – PowerPlant Chemistry Forums (PPCFs) – with even more time for the participants to discuss and to share knowledge and experience with their colleagues from other power plants and with the international experts. The main focus of the forum also changed slightly as it does not concentrate on sampling and instrumentation only but instead includes a wide variety of power plant chemistry topics. The first PPCF was held in Johannesburg, South Africa, in March 2016 [6] and its success convinced the organizers to continue with this new format.

In 2017, four PPCFs were organized by Waesseri GmbH: in Buenos Aires, Argentina, on March 13–14; in Beijing, China, on April 22–23; in Bangkok, Thailand, on October 11–12; and in Dubai, United Arab Emirates, on October 15–16. This report will give a short overview of the PPCF held in Bangkok, Thailand.

SESSION 1: LIFE-CYCLE CHEMISTRY OPTIMIZATION

How to Choose the Right Chemical Operating Regime for the Individual Power Plant

The first session was opened by Michael Rziha, principal key expert at Siemens AG. Michael is the chairman of the International Association for the Properties of Water and Steam (IAPWS) Power Cycle Chemistry (PCC) Working Group, a member of several VGB PowerTech (VGB) workgroups, and a member of the PowerPlant Chemistry Journal's International Advisory Board.

Michael's first presentation at this forum was on how to choose the right chemical operating regime for the individual power plant. For the water/steam cycle, boilers, and turbines there are local and international guidelines available. Several organizations issue such guidelines, for example VGB, IAPWS, and the Electric Power Research Institute (EPRI) [7]. The main message was that there is no single "golden" standard and that guidelines cannot replace detailed knowledge of the individual plant – the optimum choice of the cycle chemistry is specific to each power plant. And even more important, optimizing cycle chemistry is an ongoing process – modifications may be necessary from time to time. Some aspects to be considered were pointed out in his presentation, such as the boiler design and operational aspects that influence the selection of water chemistry. Thus, optimum cycle chemistry already starts when the plant is in the engineering stage. Cycle chemistry can be a major reason for forced outages and will save money if properly applied and controlled.

Conversion of a Coal-Fired Unit from AVT(R) to AVT(O)

The next presentation was given by Randy Turner, technical director of SWAN Analytical Instruments, USA. Randy is the chairman of the American Society of Mechanical Engineers (ASME) Power Plant and Environmental Chemistry Committee, an advisory board member for the International Water Conference, a member of the IAPWS PCC working group, and he is on the American Water Works Association (AWWA) Online Monitoring Committee.

In his first presentation at this forum, Randy showed how a coal-fired power plant changed its chemical regime from all-volatile treatment under reducing conditions (AVT(R)) to all-volatile treatment under oxidizing conditions (AVT(O)).

The plant under discussion is a coal-fired unit with a controlled circulation drum boiler, copper condenser tubes, and copper alloy feedwater heaters. The originally implemented treatment system was AVT(R) with the appropriate monitoring equipment recommended by EPRI [7]. The following problems occurred:

- The chemistry for neither metal (carbon steel and copper alloys) could be optimized, which resulted in increased corrosion of both iron and copper and finally to more frequent boiler chemical cleanings.
- Steam drum liner cracks occurred, which resulted in increased mechanical carry-over and finally in turbine deposition.

After an assessment, the plant operator decided to make some modifications in the metallurgy as well as the chemistry of the unit. It was decided to:

- replace the drum liner,
- replace copper alloy feedwater heaters with stainless steel feedwater heaters,
- change the chemistry regime from AVT(R) to AVT(O).

The decreased mechanical carry-over due to the repaired drum liner resulted in reduced turbine deposition (copper, sodium, silica). Replacing the copper alloys in the feedwater heaters allowed the cycle chemistry regime to be changed to AVT(O), which reduced iron corrosion and therefore reduced chemical cleaning frequency.

Continuous Optimization of Cycle Chemistry over the Lifetime of a Power Station

Michael Rziha closed the session by reporting on continuous chemistry optimization over the lifetime of a power station. With three case studies from the field he showed that without proper implementation and control of the cycle chemistry the power plant operators will face high economic costs due to efficiency losses and unplanned outages. The three case studies included stress corrosion cracking in relation to hydrogen embrittlement, heavy deposits on turbine blades, and heavy silica deposits – all three cases having the same route and outcome although they were in different plants. The economic costs for the operators can be avoided by remembering these simple rules:

- Changes in your plant may happen at any time.
- Changes in operational mode may change the chemistry.
- Trends and their analyses are essential.
- The denser the analytical data are, the better your diagnosis is.
- Limit values of guidelines are only recommendations to avoid the worst case.
- The optimum chemistry has to be worked out on an individual basis!

SESSION 2: FILM FORMING AMINES

Critical Aspects and Questions with Respect to the Application of Organic Treatment Chemicals

The second session was again opened by Michael Rziha. His presentation introduced the topic and discussed recent developments in the field. There is a huge variety of single components, and even more mixtures are available. The organic agents can basically be classified into five categories although this does not cover all compositions used. Many of the products available on the market are multicomponent proprietary mixtures containing constituents from more than one of the following categories:

alkalizing amines, oxygen scavengers, chelants, dispersants, and film forming amines. Before applying these products in the water/steam cycle, power plant chemists should ask the following questions:

- How can the behavior of these mixtures be predicted under the different operating conditions?
- What, where, and how should they be monitored?
- How can the ingress of critical impurities be detected?
- Is there an impact on the condensate polishing plant?
- What happens in the case of over-dosage?

During last year's annual meeting of IAPWS in Dresden, Germany [8], a new technical guidance document (TGD) [9] for the application and use of film forming amines (FFAs) and film forming amine products (FFAPs) was approved and released. This TGD covers the application of FFAs and FFAPs in fossil, combined cycle, and biomass power plants and answers some of the important questions regarding the application of these products in water/steam cycles.

But some questions are still unanswered, among them the following:

- What will be the effect of acidic decomposition products on the turbine material (acetic acid may enhance the risk of stress corrosion cracking [10])?
- Is there possible shifting of the so-called Wilson line (higher wetness of exhaust steam)?
- FFAs and FFAPs are often used for conservation. Is the required film really everywhere?

Neutralizing Amine Test for ACC Conditioning

The second presentation in this session was given by Ken J. Galt, senior engineering consultant for power plant chemistry at ESKOM, South Africa. He is a member of the VGB Technical Committee Chemistry and the American Chemical Society AWWA.

His first presentation introduced a neutralizing amine test for the conditioning of air-cooled condensers (ACC) in South Africa. South Africa is officially classified as a water-scarce country – it receives about half the world's average rainfall per annum with its western parts drier than the eastern parts. There have been a number of initiatives to reduce water use at power plants. A zero liquid effluent discharge philosophy for power plants was adopted in the late 1980s, and the first power plant with an ACC was commissioned in 1989/91. Currently there are four power stations with an ACC; the biggest one is in a newly built power station, consisting of six units consisting of 64 fans (11 m diameter) per unit, grouped into 8 streets of 8 fan modules each, with a total footprint of 72 252 m^2.

The power station where the test will be conducted was originally commissioned on an all-volatile treatment under reducing conditions (AVT(R)). After two-phase flow-accelerated corrosion (FAC) occurred in the ACC, the treatment was changed to an all-volatile treatment under oxidizing conditions (AVT(O)) in the early to mid 1990s. Finally, the treatment was changed to an oxygenated treatment (OT) with an elevated pH of 9.4 around the year 2000. Due to continuing issues of FAC in the ACC, the pH was elevated to 9.8 by dosing 5.1 $mg \cdot L^{-1}$ ammonia. The higher ammonia dosing, coupled with ammonium-form cation operation and high condensate temperatures (> 80 °C), impacted the condensate polishing plant (CPP) through several mechanisms, the effects of which were briefly explained. In short, the dilemma is between reducing the ammonia concentration, which again increases the FAC risk in the ACC, or not reducing the ammonia concentration, which increases the risk of chloride attack on the turbine.

Lessons learnt from other power plants have shown that there are other amines to elevate the pH that have less impact on the CPP performance. The two amines selected for testing are ethanolamine (ETA) and dimethylamine (DMA). ETA was the first choice, because prior experience with ETA at nuclear units regarding handling of the chemical and decomposition could be taken into consideration, while DMA was considered at the suggestion of EPRI. Ken explained in detail the setup of the test and how the results will be used to decide on future changes in the treatment regime. The tests haven't yet been conducted due to several delays during the implementation of the project.

Practical Experience with and Benefits of Cetamine® Film Forming Amine Technology in Water/Steam Cycles

The third presentation on FFAs was delivered by Junichi Takahashi, senior technical advisor at Kurita (Singapore) Pte. Ltd. on practical experience with and benefits of FFA technology in water/steam cycles.

After a short introduction to the topic, a case study on experiences with FFAs in a triple-pressure combined cycle gas turbine (CCGT) power plant in cycling mode was presented. In recent years, the station's operating regime varied considerably, with between 1 and 4 units running with daily start-ups and shutdowns, and a maximum stand-by period of up to 4 weeks. Units must remain available with short start-up times, leading to the following preservation challenges:

- It is not possible to protect all plant areas with conventional methods due to the plant design.
- The established preservation methods are difficult to implement without compromising start-up times.

- The steam turbines are not routinely preserved unless there will be more than 2 weeks on stand-by (need to connect dehumidifiers).

A new treatment concept with FFAs was evaluated; the tests showed that the applied FFA could be detected on both water- and steam-touched surfaces, including the high-pressure (HP) evaporator, reheater, and low-pressure steam turbine cylinders. A cleaning effect was evident in the Unit 4 HP evaporator – i.e. removal of loose iron oxides but not the magnetite layer was observed. The tested FFA is in accordance with steam quality requirements and shows protection of components throughout the water/steam cycle, including areas that could not be preserved by nitrogen capping or dehumidified air circulation. Only minimal manpower for preservation is needed compared to nitrogen capping or dehumidification.

SESSION 3: CONDENSATE POLISHING

Design Considerations for an Optimized Condensate Polishing System

The session was opened by Moataz Khalifa, manager of the Water Technology Group at the Power Generation Engineering and Services Company, PGESCo, Egypt. Moataz is a registered engineer in Egypt, a member of the IAPWS PCC WG, a member of the International Desalination Association (IDA), a member of the American Membrane Technology Association (AMTA), and a member of the Project Management Institute (PMI).

His presentation discussed design considerations for an optimized condensate polishing system. The goal of the presentation was to provide some design aspects of condensate polishing systems, discuss key factors that impact the optimization of condensate polishing system design, and to provide support to the decision-making process for adding condensate polishing systems in a power cycle, as well as to discuss monitoring parameters and performance testing requirements in CPPs. The presentation focused on the deep bed-mixed bed condensate polishing system as it is widely used in fossil and CCGT power plants, which have many issues that require discussion.

The implementation of CPPs becomes mandatory in power plants with supercritical design or where a high-performance chemistry program is applied. But for other plant configurations (drum type boilers and CCGT), the decision to add a CPP involves a debate about its cost and its benefits. Although it is clear for power cycle chemistry professionals that the addition of a polisher is technically justified, often a cost/benefits analysis is required to justify adding a polisher.

In the beginning of a new power project and after deciding to consider a CPP, there are a lot of questions about the design of the CPP and how an optimized design can be achieved to avoid oversizing (high cost) or undersizing (fewer functions).

Factors to be considered in a CPP design:

- power cycle configuration
- condenser cooling system
- heat balance analysis
- design pressure and temperature
- flow rate
- system metallurgy
- cycle chemistry program
- inlet water quality
- silica level
- throughput (service run)

By discussing a case study, it was shown that optimization of the CPP design can be achieved by performing many trials to cover ranges of ionic loads at different service run times. An evaluation of selected design performances during off-design cases (such as condenser leaks) is very important. A performance testing program should be arranged with the vendor at an early stage to avoid underperforming systems.

Design of CPP for a Once-through Power Plant with ACC

The second presentation was given by Ken Galt on CPP design for once-through power plants with ACC in South Africa. Experiences at Station A were discussed, and their impact on the design for a newly built power plant was shown.

In Station A, the CPP was designed as a separate bed system to allow bypass of the anion resin bed if the condensate temperature is > 60 °C. On hot summer days, the ambient air temperature is frequently above 40 °C (maximum > 45 °C), which leads to high condensate temperatures > 80 °C. Degradation of the anion resin starts at temperatures > 60 °C, which leads to a loss of strong base functionality. But bypassing the anion resin bed led to higher sulfate levels in the superheated steam, which led to the decision to keep the anion resin bed in service at all times.

Based on the experiences at Station A and to avoid similar problems in the newly built power plant, the new CPP design consists of the following:

- The condensate flow to be treated in the CPP is 1 740 $m^3 \cdot h^{-1}$ (or 110 % of the nominal condensate flow at 100 % turbine maximum continuous rating (97 % boiler maximum continuous rating)).

- The CPP is located on the side-stream between the ACC condensate collecting tank and the condensate extraction pump – this requires booster pumps, but the CPP is unaffected by rapid changes in the main circuit flow.
- There is a minimum of 10 % recycle to the head of the CPP.
- A cation to anion ratio of 1:1 volumetric was chosen because of main contaminant (CO_2) ingress (with air) via the ACC.
- After discussions with the resin supplier and taking into account resin transfer distances to regen stations, an 8 % divinylbenzene macroporous strong acid cation resin type was selected.
- The target linear velocity was set at 82 $m \cdot h^{-1}$ (a typical CPP ≈ 120 $m \cdot h^{-1}$). An adjusted design gave 72 $m \cdot h^{-1}$ (close to the recommended minimum of 70 $m \cdot h^{-1}$) to improve carbonate species removal.
- Sodium (for the cation resin bed), chloride, and sulfate (for the anion resin bed) loading were set by steam limits – all ≤ 1 $\mu g \cdot L^{-1}$.
- The carbonate species maximum set by the conductivity after cation exchanger (CACE) limit at the CPP inlet minus the contribution from chloride and sulfate was 122 $\mu g \cdot L^{-1}$ for HCO_3^- and 36 $\mu g \cdot L^{-1}$ for CO_3^{2-}.

After a final plenary discussion, the first day's official program ended and the participants were invited to join for dinner in the hotel, where they took the opportunity to discuss the day's presentations.

SESSION 4: ZERO LIQUID DISCHARGE

Dry vs Wet Ashing: Reducing Water Consumption and Achieving ZLD in Eskom

The second day was opened with two presentations on zero liquid discharge (ZLD). The first presentation, by Ken Galt, compared dry and wet ashing and discussed the potential to reduce water consumption in Eskom's power plants by the adoption of dryashing.

In South Africa, water savings is an important topic as many areas are confronted with dry climate, rapid urbanization, and deteriorating water quality, all of which are increasing the cost of treatment. Major infrastructure projects have been undertaken in the past decades to assure future water supplies to power stations, including catchment basin transfer schemes and pumping schemes that can reverse the flow of rivers. Additionally, Eskom introduced its "zero liquid effluent discharge" (ZLED) policy in 1987. ZLED is not quite the same as ZLD; ZLED is a more precise definition and makes it clear that only effluent may not be discharged. All effluent generated on site is recycled, recovered, and reused as far as practicable.

The principle of a cascading hierarchy of water usage is quite simple:

- wherever possible higher quality water is used for its design purpose;
- effluent from this process is then used for a second process that requires water of a lower quality and so on.

On conventional wet-cooled plants with recirculating cooling water systems (cooling towers), the cooling system blowdowns equate to the largest volume of effluent generated, regardless of the type of cooling water treatment. Therefore a very effective way to reduce water consumption is to change the cooling system from wet-cooled to an indirect or direct dry cooling system.

Other challenges to achieving ZLED are:

- acid mine drainage (AMD) – Eskom is currently taking in AMD effluent at 2 stations, with more to follow in the near future. It will be necessary to construct/modify treatment plants (membrane-based) to accommodate AMD.
- legislational changes – There are limitations on brine co-disposal on ash (this mostly affects the disposal of the spent regeneration effluent from ion exchangers).
- flue gas desulfurization (FGD) waste water streams – One of two new plants is fitted with FGD and runs to 30 000 $mg \cdot L^{-1}$ chloride before bleedoff; the other is to be backfitted. Some older plants will also be backfitted.
  - o The second of the new plants will be fitted with standard settling/chemical precipitation softening clarifier, brine concentration, and crystallization with recovery of distillates. The first of the new plants will likely be backfitted with the same technology.
  - o For older plants, alternative technologies and/or hybrid systems are being considered to reduce the volumes sent to brine concentrators and crystallizers.

Review of Different Demineralization Technologies for Low Salinity Water in the Power Generation Industry

Moataz Khalifa's presentation gave an insight into PGESCo's experience with different demineralization technologies in power plants in Egypt. The raw water supply from low salinity resources represents a significant percentage in the power generation industry (about 60–70 % of the power plants in Egypt). Surface water (such as from the Nile River) as well as ground water supplies low salinity raw water to power plants. High purity demineralized water is essential in power generation.

The power industry has stringent water quality requirements in order to protect boilers/HRSGs, turbines, and other plant components, and traditional (conventional) demineralization technologies cannot easily fulfill the continuously improved water quality requirements.

The technical assessment focused on evaluating specific technical aspects; these included product water quality, operation and consumptions, footprint and construction requirements, and waste disposal. Each aspect was discussed for each treatment stage.

The aim of the economic analysis was to provide a comparative discussion of the alternatives (conventional vs membrane based). It was based on annual worth calculation in the form of equivalent annual uniform cost. The economic analysis included capital expenses, operating expenses, chemical consumption, power consumption, media replacements, and spare parts. Cost estimates were based on actual contract prices demanded in Egypt.

The technical and economic review came to the following conclusions:

- Ultrafiltration (UF) and reverse osmosis (RO) have better performance than conventional demineralization technologies regarding the challenging water quality requirements in the power industry.
- UF and RO perform better regarding waste disposal, footprint, and operation flexibility.
- RO is sensitive to the pretreatment system.
- The overall costs of membrane-based technologies can be considered very competitive with those of conventional technologies or may even be better.

SESSION 5: CASE STUDIES

Cycle Chemistry Improvement: Control of Impurity Ingress from Ammonium Hydroxide Solution

The first case study was presented by Yudatomo, head of quality assurance, chemistry, and environment at PT YTL Jawa Timur. Yudatomo has been in the power generation sector for 17 years, where he has been involved in various project improvements for cycle chemistry, energy and water conservation, coal combustion, and flue gas cleaning systems.

Paiton II Power Plant (owned by Jawa Power and operated by YTL Jawa Timur) is a 2 x 610 MW subcritical coal-fired thermal power station. The boiler is a drum type, forced circulation, balance draft and is fueled by pulverized coal. AVT(O) is used for the cycle chemistry treatment. The basis of the AVT(O) treatment is an elevated pH in all cycle streams, where ammonia is used as the common alkalizing agent. The treatment requires constant vigilance to prevent impurity ingress since the ammonia has little or no buffering capacity to neutralize anions like chloride and sulfate.

The power plant is equipped with a CPP which was not designed to serve for continuous full flow condensate polishing. The CPP is usually operated only for the duration of four hours, when impurity levels in the water and steam stream rise close to the allowable limits. CACE measurement is used to detect impurities in the main steam, reheat steam, and condensate. If CACE exceeds 0.15 $\mu S \cdot cm^{-1}$, the operator has to put the CPP in service and open the continuous boiler blowdown (CBD) valve.

Under normal operating conditions, the interval for CPP operation and boiler blowdown is twice a week. However, sometimes, an increase in CACE is much faster than the normal interval so that the frequency of putting the CPP in service and opening the CBD increases significantly. Grab samples are taken during these occasions and laboratory analysis by ion chromatography has confirmed that the concentration of chloride in the samples is too high. A series of tests was conducted to find the possible source of impurity ingress on such occasions and it was revealed that the main source was ammonium hydroxide (NH_4OH). The alkalizing agent is supplied in 200 L drums with an NH_4OH concentration of 25 %. The laboratory successfully developed a practicable and accurate measurement procedure to check the impurities level in the ammonia solution sample delivered by the supplier. The procedure has been tested, verified, and validated. It is now being used to check all delivered drums, and is used as an acceptance criterion/rejection limit on the chemical supply contract.

Ground Water Investigations for Sustainable Raw Water Supply in Remote Power Plants

The second case study was presented by Moataz Khalifa, showing PGESCo's experience with ground water investigations for sustainable raw water supply in remote power plants.

Thermal power plants are normally located near a surface body of water (ocean, river, lake, etc.) to provide a sustainable supply of water to cover the plant needs (cooling, make-up, etc.). In the last 10 years, the design of combined cycle plants has implemented a dry cooling (air-cooled condenser) method to replace water-cooled condensers. This was a great development for gas turbine plants located in arid areas and has allowed some of these plants to be upgraded to add combined cycle/HRSGs and enhance plant efficiency and power output.

The presentation provided insights into challenges faced in one of Egypt's power projects by explaining the implemented methodology to secure for the plant a sustainable water supply from ground water and its implications for the waste water management. In the discussed project, installing pipelines from a river or canal was very complicated from both a social and an economic perspective, and therefore it was decided to start studies for securing a ground water supply.

First it is necessary to make a ground water assessment covering water availability, quality, and sustainability. A first step can be to take samples from existing wells in neighboring areas (framing wells). Laboratory analysis was conducted to investigate the ground water quality for starting a conceptual water treatment plant design. An assessment should cover data collection and sampling (local and regional), geological and geophysical surveys (field surveys), exploration and testing in exploratory wells, hydrological modeling to determine sustainability of the aquifer, well field optimization, and drilling specification.

Generally, in all power plant projects the management of waste water in order to meet the continuously improved environmental regulations can be a challenge. In arid areas, the problem becomes complicated because of the absence of bodies of water that can receive plant effluent streams. Therefore, consideration of waste water management should be involved from the beginning of projects.

SESSION 6: MONITORING AND ANALYTICS

Process Monitoring – What Really Matters

The last session was opened by Michael Rziha, who introduced process monitoring and quality assurance for online water/ steam analyzers. The difference between key and diagnostic parameters and its implications for quality assurance was explained in detail.

Key diagnostic parameters are used to control whether the cycle chemistry is within normal operational limits, and therefore require permanent online monitoring. These parameters require more attention from the operator and need adequate quality assurance (QA) measures. Both online QA and offline QA measures are mandatory.

Diagnostic parameters are parameters that do not require permanent online monitoring. They can be measured online in order to reduce routine lab tasks and enhance monitoring scope. They are typically required for troubleshooting/problem localization purposes. For these parameters, only a periodic verification is required and offline QA measures are sufficient.

Online QA requires a self-diagnosis capability of online analyzers such as status information on sample flow, reagents, sample temperature, etc. to determine whether alarms are true or false, and therefore if the measurement values may be used or not. Self-diagnostics performed automatically by the online instrument include permanent, intermittent, or triggered verification of elements of the measurement chain, local interpretation of conditions, remote signaling, and data logging.

Offline QA requires the use of proper reference instruments with equivalent or superior precision. It represents a periodic verification of an instrument by an operator with procedures and methods for each instrument. A plant specific QA plan

is required together with logging and monitoring of QA activities.

Microfluidic Capillary Electrophoresis: A Case Study for Online Chloride and Sulfate Measurement

Akash Trivedi, product manager at Mettler Toledo Thornton, Inc., continued the session on monitoring and instrumentation. Akash has more than 14 years of experience in product marketing and business development in process analytics and water treatment.

Power plants constantly combat corrosion caused by chlorides and sulfates under high-pressure water and steam conditions. Due to this corrosion, unplanned shutdowns as well as repair and replacement costs of the most expensive components in the power plant have hurt power generation and profitability. As a result, monitoring of chloride and sulfate at very low levels ($\mu g \cdot L^{-1}$) has been specified as part of cycle chemistry guidelines and turbine warranty requirements.

This presentation provided a case study of online chloride and sulfate measurement using an analyzer based on microfluidic capillary electrophoresis (MCE) technology. It provided data from the measurement of chloride and sulfate in the main steam at Nearman Creek Power Plant, Kansas City, KS (USA).

The measurements were compared to cation conductivity, which is elevated beyond EPRI-defined limits due to breakdown products of the amines used, thus masking the real levels of corrosive contaminants. The presentation discussed actions taken by the plant after analysis of the data, the changes made to instrumentation, as well as contaminant monitoring in the future.

Conventional Resin Cation Exchangers versus EDI for CACE Measurement in Power Plants

Randy Turner's second presentation at this forum introduces the latest developments in conductivity measurement. CACE measurement in power plants was introduced soon after 1950 by Larson and Lane. Because of the simple measuring principle, the sensitivity, and its high reliability, CACE has become the most commonly used analytical method in power plants with steam generators. With the advent of reliable electro-deionization devices (EDI), it's now possible to replace the conventional cation exchange resin filled column with an EDI arrangement.

An article on the newly developed instrument by Swan was published in this journal [11] and Swan has since installed numerous prototypes and studied the long-term stability of the EDI alkalization removal. In the first part of the presentation, details of the EDI method used in the instrument were explained. In the second part, current long-term field tests in various power plants and industrial water/steam cycles and at different sampling points were presented.

Electro-Regeneration Type Cation Exchanger by Monolith Resin – Application Example for Seawater Leakage Detector

Motoki Tanaka, Organo Corporation, gave the final presentation of these two days.

CACE measurement is used to detect seawater leakage into condensate water cycles in thermal and nuclear power plants. In alkaline-controlled chemistry cycles with seawater cooling, seawater leakage is detected by conductivity after passage through a bead type cation exchange resin in the hydrogen form. The cation exchange resin is routinely regenerated by hydrochloric acid or sulfuric acid.

High-AVT (all-volatile treatment) is applied to some combined cycle plants, with the pH shifted to higher (8.5 ~ 10.3) than the conventional pH (8.5 ~ 9.7). In these cases, conventional CACE instruments using bead type cation exchange resin need to be regenerated more frequently.

Therefore, Organo has developed a "monolith resin" with electric regeneration of the exchange resin. The presentation explained the outline of the instrument, water flow test results, and the effectiveness of the new system.

The newly developed CACE instrument using "electric regeneration type cation exchanger by monolith resin" can achieve continuous operation under high pH chemistry and contribute to the reduction of waste, for example of chemical agents.

CONCLUSION

The PPCF in Bangkok attracted over 50 station chemists, instrument technicians, designers, and C&I-engineers from Thailand and neighboring countries. Linked to participation was a free e-paper subscription to the PowerPlant Chemistry Journal for the next year.

The feedback from the audience was very positive and this reaffirmed the organizers' decision to repeat this kind of event on a regular basis. New events are already being planned and we will publish detailed programs in the upcoming issues of this journal.

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Tapio Werder is the current editor of the PowerPlant Chemistry journal. He started his work for the journal in 2014 as editorial assistant when Albert Bursik, founder and editor of the journal, retired and took a seat on the journal's International Advisory Board (IAB). In 2015 the responsibility for finding appropriate submissions and for the production of the journal as the editor was handed over to him completely. Since 2015 he has been the secretary of the Swiss Committee for the Properties of Water and Steam (SCPWS) – the Swiss national committee of IAPWS.

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