Report on the PPCHEM Forum South Africa 2024

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ABSTRACT

For the third time in the history of these events, the PPCHEM Forum (PPCF) series stopped over in South Africa. The PPCF South Africa 2024 in Pretoria was held under the patronage of PPCHEM AG, with financial sponsorship from SWAN Analytical Instruments, Switzerland, and Sentry Equipment Corp., USA.

The PPCF series offers valuable insights into power plant chemistry objectives and tasks, covering essential topics such as water chemistry, proper sampling techniques, corrosion science, and more. It's designed to be understandable not just to chemical experts but also to those without a chemistry background. The various operating regimes, the relevant industry guidelines and standards, and the correct and optimum selection and application in relation to the individual plant design are discussed, as well as the necessary considerations for the operational monitoring concept.

This report summarizes the two days of the PPCHEM Forum South Africa 2024.

INTRODUCTION

Plant chemistry in many facilities, including those with water/steam cycles, is unfortunately often simplified to routine tasks like sampling and analysis. This is true for large utilities, industrial steam generators, and various other steam cycles, including thermal solar plants around the world. Too often there is a common lack of comprehensive evaluation of chemical data and timely diagnosis. Even when a correct diagnosis of chemical issues is reached, organizations frequently face uncertainty and confusion about the necessary actions to take. Delays in addressing these issues often lead to significant damage or disruptions in plant operations. It is crucial to have a deep understanding of how water quality, materials, processes, and system conditions interact within a power plant to prevent such impacts and enhance economic benefits.

The PPCHEM Forum (PPCF) series offers valuable insights into power plant chemistry objectives and tasks, covering essential topics such as water chemistry, proper sampling techniques, corrosion science, and more, not only to chemical specialists, but also to the "non-chemist." The first PPCF was held in Johannesburg, South Africa, in March 2016 [1] and its success convinced the organizers to continue with this new format and organize more PPCFs around the globe. A report on the PPCF held in Bangkok, Thailand, in 2017 and in Delhi, India, in 2018 have been published in this journal as well [2,3].

The PPCF South Africa 2024 was held on February 13–14, 2024, in Pretoria, South Africa, in the Capital Menlyn Maine Hotel under the patronage of PPCHEM AG, with financial sponsorship from SWAN Analytical Instruments, Switzerland, and Sentry Equipment Corp., USA.

Over the two days, selected experts from South Africa, Switzerland, and the United States gave valuable insights into the various important aspects of power plant chemistry. The different possible operating regimes, the relevant most up-to-date guidelines [4], and the correct and optimum selection and application in relation to the individual plant design were demonstrated, as well as the necessary considerations for the operational monitoring concept.

Data evaluation and process-related diagnosis were the second major topic, followed by a demonstration of appropriate actions for the

various chemical events. Also, the different parameters that play a key role in this respect were introduced and discussed.

The Forum also provided insights, hints, and tips about the most common root causes for chemical upsets, such as air in-leakages, cooling water ingress, upsets in water treatment plants, contaminated process steam return condensate, improper control of dosing, and many more.

This report will give a short overview of the PPCF in Pretoria, South Africa, and a short summary of each presentation.

DAY 1

Michael Rziha, PPCHEM AG, Switzerland, started the two-day conference with an introduction to the importance of water chemistry control in power plants, illustrated with case studies of damage and impairments caused by chemistry. The main takeaway from these cases was clear: without strict and continuous water chemistry control, carbon steels – a crucial alloy in power plants – corrode quickly, leading to heavy deposits that decrease equipment lifetime, efficiency, power output, and plant availability, resulting in significant financial losses.

Through the numerous field examples, Michael demonstrated the importance of permanently monitoring and adjusting the chemical conditions within the unit and taking immediate action in response to any deviations or excursions in chemical operating values and situations. In summary, avoidance of deposits and corrosion in the water/steam cycle is realized by using fully demineralized water of the highest purity, controlling the pH-value, controlling oxygen levels (≠ eliminating oxygen), applying the right chemistry by knowing the design details of the unit, and using proper standstill protection.

In the latter part of the morning session, the focus shifted to the fundamentals of power plant chemistry. As Michael already indicated in his first presentation, the damage caused by chemistry issues can quickly lead to high financial costs. Furthermore, there are potential risks of fatal accidents, for example caused by turbine blade rupture or boiler tube failures. In light of the above, the key objectives of power plant chemistry include: 1) avoiding/minimizing corrosion, 2) preventing deposits, 3) reducing operational costs, 4) ensuring compliance with environmental regulations, and

5) maintaining plant efficiency. The following three main topics were discussed by Michael in more detail during his presentation:

- General water chemical principles
- Materials, corrosion, and deposits
- Flow-accelerated corrosion (FAC)

The morning session closed with a Q&A session and open floor discussion.

Following the lunch break, Michael resumed presenting, leading the audience through the complexity of the "policy jungle." Not all references or directives from operators or manufacturers in norms and standards are guaranteed to be valid or technically accurate, and therefore a few rules need to be followed in order to find the way though the "policy jungle."

For the water/steam cycle, boilers, and steam turbines, there are international guidelines [4] available. The optimal choice of water chemistry always needs to be plant specific; there is no single "golden" standard. Detailed knowledge about the specific plant is required for a careful selection. The guidelines cannot replace an understanding of chemistry and plant cycle chemistry, which is an evolving science, therefore modifications may be necessary over time.

A few important questions for selecting the appropriate water/steam chemistry are:

- Is your plant truly a 100 % "standard" plant?
- Are there unique design features?
- Is the plant operated in baseload or cycling mode?
- Does the monitoring concept align with the applied chemistry?
- Is the chemical operating regime up to date, or is it outdated and still used due to tradition?

This list is by far not complete, but can help to find the right guidance.

The next presentation by Michael discussed the impact of boiler types and designs on plant chemistry requirements. Key takeaways included understanding the factors and design features that influence optimal chemistry selection, recognizing the risks of using incorrect or inadequate chemistry, and ensuring that the chemical operating regime is truly tailored to the individual plant.

There is a wide variety of boiler designs and types, ranging from drum boilers to once-through boilers, ultra super critical boilers, heat-recovery steam generators, flame-tube boilers, and electrode-boilers. Consideration should be given not only to design features but also to the materials used, operating pressures, and modes (such as frequent start-stop operations versus continuous operation). Additionally, operating pressure and heat flux density play crucial roles in chemical issues and the development of corrosive conditions. Considerations to keep in mind include:

- Addressing limitations on pH-values in process steam
- Handling mixed metallurgy situations, like having a condenser made of cupric material, which requires strict pH-value limitations that may not align with boiler requirements
- Addressing the need for fast load changes in the plant and how to manage phosphate chemistry accordingly
- Recognizing that while lower water quality may be acceptable for certain boiler types and pressures, high steam purity requirements, such as in superheat and turbine operations, necessitate precise adherence to water quality and chemistry standards.

Dan Quigley from Sentry Equipment Corp., USA, presented the minimum requirements for sampling systems. The primary goal of a sampling system is to transport and condition a sample without altering its key characteristics. Control of velocity, pressure, and temperature are crucial system parameters. Dan Quigley highlighted typical sample points in the process and emphasized that sample point selection depends on system design, constituent materials, chemical treatment, and specific system challenges. Sample points include makeup water, condenser, polisher effluent, deaerator inlet/outlet, feedwater/economizer inlet, steam generator, saturated steam, superheated/hot reheat steam, and feedwater heater drains.

The session elaborated on the concept of isokinetic sampling, emphasizing the importance of matching the fluid velocity in the sample probe/nozzle with that in the main pipeline, which is especially essential for saturated steam sampling. Key guidelines for sample transportation are as follows: utilizing short lines to reduce distance, selecting small line diameters to minimize lag time and sample composition changes, sizing lines based on the specified velocity for condensed liquid samples, and ensuring sample lines are sloped at 80 mm per linear meter. The session concluded with an overview of common misconceptions related to sampling and sample conditioning.

DAY 2

Sharon Cronje and Marcus du Preez from Eskom, South Africa, shared insights from an upgrade of sample conditioning and online analyzer systems in one of the power plants of the fleet, highlighting the lessons learned. The key challenges encountered included complexities in design and process when combining multiple subprojects, the decision-making between one large project versus smaller subprojects, and managing the scale of a retrofit project, which was a first for the organization, resulting in new complications. They also faced challenges related to high technical resource turnover and managing last-minute scope additions and record-keeping.

Next, Stephanie Marais, Eskom, South Africa, introduced a guide to troubleshooting high levels of dissolved oxygen in the condensate. A practical troubleshooting guide was developed to address high condensate dissolved oxygen levels, aimed at assisting chemists and engineers in identifying and resolving issues efficiently. The guide helps rule out common causes and narrow down the search to specific areas, including scenarios such as high demineralized water makeup, air extraction system inefficiencies, and air ingress above or below the water level. By streamlining the troubleshooting process, the guide reduces time and resources spent on investigations, enhances success rates, boosts confidence among team

members, and supports quicker resolution of chemical excursions, ultimately reducing plant risks.

At the end of the first session, Lukas Staub from Swan Analytical Instruments in Switzerland discussed enhancing the reliability of degassed conductivity after cation exchange measurement using electrodeionization technology. First, it was explained how the electrodeionization (EDI) module works in a conductivity after cation exchange (CACE) measurement, and operational experience with EDI/CACE measurement was shared. One frequent question about EDI/CACE measurement is the expected lifetime of the EDI module. The EDI module lifetime depends on sample quality. Substances known to shorten the lifetime are corrosion products and film-forming substances. Afterwards, degassed conductivity after cation exchanger (DCACE) measurement was discussed and important design criteria for reliable DCACE measurement combined with an EDI module were highlighted. The presentation concluded with field test examples illustrating DCACE measurement with EDI technology.

After a coffee break, Michael discussed the intricacies of measuring total iron, emphasizing its importance in monitoring corrosion products to evaluate the effectiveness of the cycle chemistry treatment applied. Compliance with standards from IAPWS, EPRI, and VGB necessitates monitoring corrosion products, which encompass dissolved and particulate oxides circulating throughout the water/steam cycle. By highlighting common pitfalls in sampling and monitoring, especially under varying load conditions, Michael demonstrated the need for an additional trend monitoring method. Utilizing online turbidity measurement for corrosion product trend monitoring is crucial in validating chemistry treatment efficacy and enabling optimization if needed, particularly in detecting flow-accelerated corrosion (FAC). This tool also aids in developing maintenance strategies related to control valve wear, particle issues, and deposit problems. The correlation between turbidity and corrosion product concentration is dependent on particle characteristics that may evolve over time. Therefore, the turbidity measurement cannot completely replace the analysis of total corrosion products in the laboratory.

Sabelo Khanyile from Eskom, South Africa, presented strategies for optimizing cycle chemistry monitoring through the utilization of a data management system. The focus was on effectively visualizing data obtained from directly measured parameters in a simple and clear manner. Utilizing modern data management systems such as EtaPRO [5] offers user-friendly functionalities for generating both straightforward diagnostics charts and detailed chemistry reports. The software can, for example, provide ammonia concentration and pH levels calculated from conductivity measurements, which enables continuous monitoring of these critical parameters. Another highlighted application was the monitoring of condensate polisher effectiveness, a crucial component in cycle chemistry control.

At the end of the morning session, a podium discussion took place on the usefulness of monitoring the different parameters in the water/steam cycle. Besides the well-known and "classic" parameters, like CACE, pH-value, dissolved oxygen, etc., other parameters are also available on the market. Examples are chloride, sulfate, or phosphate concentrations, oxidation/reduction potential, and more. The questions discussed during the podium were:

- Where, when, and why should these parameters be measured?
- Does it make sense to also measure the "classic" parameters, such as pH-value, at each and every location (e.g., pH-value in steam)?
- What should be done with all the data?

In his final presentation, Michael talked about the typical chemical issues in cycling plants. Cycling operation poses significant chemical risks and challenges compared to constant operation. The importance of vigilant chemical supervision and control was emphasized, reflecting the increased complexity of cycling operations. Sampling and monitoring systems are integral and must be tailored to their specific purposes. Adapting the applied chemical operating regime and its monitoring in response to cycling operation needs is essential. And last but not least, it is crucial to prevent standstill corrosion under all circumstances.

In her presentation, Nomaninzi Msumza from Eskom, South Africa, discussed the organization of cleanliness control during plant outages. Prior to the outage, it is crucial to define roles and responsibilities of stakeholders through pre-outage meetings. During the outage, multidisciplinary job observations are essential to ensure task requirements are met, and housekeeping measures must be reinforced as work progresses. Implementing a foreign material exclusion (FME) program is necessary to prevent foreign materials from entering the plant and systems. Additionally, an inspection process should be established, identifying the type of sampling, analysis parameters, and acceptance criteria for each analysis parameter.

The final presentation of the Forum featured Sabelo Khanyile, who addressed the chemistry requirements during unit start-up. The objectives of unit start-up chemistry include creating a chemical environment that minimizes deposition and corrosion in the water/steam cycle, ensuring long-term plant health. Additionally, the goal is to minimize unit start-up time by appropriately preparing the unit, thereby reducing water and fuel oil wastage during reinstatement. The clean-up requirements during commissioning of the units are based on the assumption that initial post-maintenance activities have been completed. Detailed discussions covered possible contaminant sources and their implications for the condensate system, low-pressure feedwater system, high-pressure feedwater system, and boiler.

CONCLUSION

The PPCF South Africa 2024 provided insights into power plant chemistry objectives and practices, covering essential topics like water chemistry, accurate sampling, corrosion science, and more. The discussions were tailored not only for chemistry experts but also for non-specialists. The event showcased different operating regimes, up-to-date guidelines, and the selection and application within individual plant designs, emphasizing the importance of operational monitoring concepts. Attendees gained valuable knowledge, tips, and guidance on common causes of chemical upsets, including issues like air in-leakage, water ingress, water treatment anomalies, contaminated process steam, and dosing control errors.

The PPCF in Pretoria, South Africa, drew over 120 attendees, including station chemists, instrument technicians, designers, and C&I-engineers. Linked to participation was a free e-paper subscription to the PPCHEM journal for the following year. The feedback from the audience was very positive, fueling motivation for new events. Further PPCF dates and details will be announced in this journal once finalized.

REFERENCES

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[4] EPRI: https://www.epri.com/;

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[5] EtaPRO LLC, Amherst, NY, USA: https://www.etapro.com.

THE AUTHOR

Tapio Werder is the current editor in chief of the PPCHEM® journal.

He started his work for the journal in 2014 as an editorial assistant, and in 2015 the responsibility for finding appropriate submissions and for the production of the journal as the editor in chief was handed over to him completely.

As a member of the management at PPCHEM AG he is responsible for all administrative tasks and the organization of the international conferences and seminars.

From 2015 to 2022 he was the secretary of the Swiss Committee for the Properties of Water and Steam (SCPWS) – the Swiss national committee of IAPWS. In 2022, SCPWS merged with the German national committee of IAPWS to form the German-Swiss Association for the Properties of Water and Steam – GSAPWS, where Tapio Werder acts as the 2nd deputy on the board of the association.

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