

PPCHEM

The Journal of All Power & Plant Chemistry Areas

2024's Scientific and Technical Contributions

PPCHEM® Journal, January/February 2024, 26(1), 4–13

STEAM TURBINE DEPOSITS – HOW THEY OCCUR, THEIR EFFECTS AND HOW THEY CAN BE ELIMINATED

Frank Udo Leidich

During operation, impurities can enter the water-steam cycle (WSC) with the make-up water, through leaks or with the process condensate return and cause corrosion and deposits. Deposits can form at any point in the WSC, depending on the composition and local conditions (pressure, temperature, flow conditions). Deposits are formed from dissolved and suspended substances that are transported from the point of formation to the point of deposition in the WSC with the water or steam flow. The deposits formed on the turbine blades not only disrupt the flow around the blades, they also increase the pressure loss between the turbine inlet and outlet and thus reduce the efficiency of the overall process.

Three methods for removing turbine deposits have proven to be particularly effective, whereby each of the methods mentioned has specific advantages and disadvantages which will be discussed in this article.

PPCHEM® Journal, January/February 2024, 26(1), 18–22

FOAM CLEANING OF GAS TURBINE COMPRESSORS – A FAST AND EFFICIENT METHOD TO REESTABLISH PERFORMANCE AND EFFICIENCY

Frank Udo Leidich

Especially in industrial environments, gas turbines (GTs) suffer from performance losses and efficiency losses due to compressor fouling. Compressor fouling is caused by soot, dust, salt spray and other airborne contaminants that are drawn into the compressor with the combustion air and are not fully retained by the air intake filters. Another cause of deposits on the compressor blades is the water used for fogging or high fogging if the water quality does not meet the purity requirements according to the original equipment manufacturer (OEM) specifications.

Depending on the pollutant load in the combustion air, GT compressors must be cleaned regularly to remove all deposits and restore the efficiency of the compressor. There are various methods for cleaning. These methods are discussed here.

PPCHEM® Journal, January/February 2024, 26(1), 30–34

A BRIEF INTRODUCTION TO THE INTERNATIONAL ASSOCIATION FOR THE PROPERTIES OF WATER AND STEAM

Tapio Werder

This paper aims to offer a concise introduction to the International Association for the Properties of Water and Steam (IAPWS) in response to requests of PPCHEM readers. It briefly discusses the advancements in steam property research in the early 20th century and the establishment of international collaboration through the first international steam table conference held in London in 1929. Due to the limited space available, the article presents only a selection of the most important events and facts. It further outlines the organization's activities, which encompass annual meetings, international conferences, working groups, and the creation of formulations, guidelines, releases, and certified research requirements.

PPCHEM® Journal, January/February 2024, 26(1), 46–53

2023'S SCIENTIFIC AND TECHNICAL CONTRIBUTIONS

PPCHEM® Journal, March/April 2024, 26(2), 64–68

IMPURITIES IN WATER SUPPLIES (NATURAL AND RECLAIM) AND MODERN CONTROL METHODS FOR INDUSTRIAL PLANT MAKEUP – PART 2

Brad Buecker

Reducing industrial water consumption is a key aspect to conserving available fresh water sources. In the United States, as well as in other regions globally, project developers and design engineers for numerous power and industrial plants are opting for alternatives to fresh water for plant makeup. Effluent from municipal wastewater treatment plants, also known as "reclaim" or "grey" water, is becoming more popular as an alternative water source. The article discusses the problematic impurities found in effluent and suggests modern approaches to address these contaminants. It emphasizes the importance of careful evaluation and planning when designing industrial makeup water treatment systems, regardless of whether the water supply is fresh or an alternative source. Additional treatment might be needed to safeguard industrial plant water systems against microbiological fouling, scale formation, and corrosion.

PPCHEM® Journal, March/April 2024, 26(2), 70–74

REPORT ON THE PPCHEM FORUM SOUTH AFRICA 2024

Tapio Werder

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.

PPCHEM® Journal, March/April 2024, 26(2), 82–85

REPORT ON THE POWER CYCLE INSTRUMENTATION SEMINAR (PCIS) GERMANY 2024 IN GOSLAR, GERMANY

Tapio Werder

For the first time in the history of these events, the Power Cycle Instrumentation Seminar (PCIS) series stopped over in Germany. The PCIS Germany 2024 in Goslar was held under the patronage of PPCHEM AG, with financial sponsorship from SWAN Analytical Instruments and REICON Wärmetechnik und Wasserchemie Leipzig GmbH.

The PCIS series provides a well-proven mixture of theoretical background information on cycle chemistry, sampling, and monitoring as well as a deeper look into analytical methods and critical issues for each parameter, concerning operation, verification, and calibration.

This report summarizes the two days of the PCIS Germany 2024.

PPCHEM® Journal, March/April 2024, 26(2), 92

NEW VGBE-STANDARD PUBLISHED "FEED WATER, BOILER WATER AND STEAM QUALITY FOR POWER PLANTS/INDUSTRIAL PLANTS"

vgbe energy e.V. hereby presents a revised version of the VGB-Standard VGB-S-010 for "Feed Water, Boiler Water and Steam Quality for Power Plants/Industrial Plants". This revised vgbe-Standard replaces the former edition 2011.

PPCHEM® Journal, March/April 2024, 26(2), 96–98

IAPWS FILM FORMING SUBSTANCES (FFS) CONFERENCE, FFS2024 HIGHLIGHTS AND PRESS RELEASE

The seventh IAPWS FFS International Conference was held on the 26th–28th March 2024 in Prato, Italy chaired by Barry Dooley of Structural Integrity Associates, UK and David Addison of Thermal Chemistry, New Zealand. The FFS conferences are unique on a narrow topic in cycle chemistry control of power plants and steam generating facilities. In 2024 the conference attracted 50 participants from 16 countries from all over the world which included 10 plant operators / users and representatives from 12 FFS chemical suppliers.



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PPCHEM® Journal, May/June 2024, 26(3), 112–117

IMPROVING THE RELIABILITY OF DEGASSED CONDUCTIVITY AFTER CATION EXCHANGE MEASUREMENT WITH EDI TECHNOLOGY

Mar Nogales and Julia Gath

During the startup of a water-steam cycle, CO₂ is the primary contributor to increased conductivity after cation exchange (CACE) values. It is generally accepted that CO₂ is the least aggressive contaminant in a water-steam cycle. Therefore, it is essential to reliably demonstrate that the increased CACE is due to CO₂ and not to more harmful contaminants like chloride or organic acids. Elimination of the carbon dioxide contribution is possible via thermal degassing of the sample, and subsequent measuring of the degassed CACE (DCACE). The reproducibility of the degassing process is an essential prerequisite for reliable measurements.

A CACE measurement system utilizing an electrodeionization device (EDI) for the cation exchange was introduced to the market in 2016 and has proven to be dependable. This paper describes how this established technology has been enhanced with a reliable degassing unit, resulting in a DCACE measurement utilizing an EDI device for the cation exchange.

PPCHEM® Journal, May/June 2024, 26(3), 126–128

IAPWS EUROPEAN HRSG FORUM (EHF2024) HIGHLIGHTS AND PRESS RELEASE

The tenth annual IAPWS European HRSG Forum was held on the 13th–15th May 2024 in Prato, Italy. It was chaired by Barry Dooley of Structural Integrity and Bob Anderson of Competitive Power Resources. EHF2024 attracted 90 participants from 18 countries and included 40 users. The EHF2024 event was organized by Mecca Concepts, Australia. The 2024 EHF had 13 sponsors: Dekomte, NEM, John Cockerill, Tuff Tube Transition, Precision Iceblast Corporation, Altrad Babcock, TesTex, Arnold Group, Valve Pro/Conval, Advanced Valve Solutions, Cormetech, Groome Industrial Services and Metroscope.

PPCHEM® Journal, May/June 2024, 26(3), 130–143

NOVEL IDENTIFICATION METHOD FOR SEAWATER CONTAMINATION INTO WATER-STEAM CYCLES

Yuta Nakatsuchi, Akihiro Hamasaki, Haruka Kido, and Takayoshi Iwa

In the water-steam cycle of power plants, cation conductivity is measured to promptly detect contamination by impurities such as seawater and prevent corrosion damage to equipment and piping. Cation conductivity is obtained by measuring the electrical conductivity of the sample after the cation exchange pretreatment, making the highly sensitive detection of anion impurities possible. However, due to a policy of increased introduction of renewable energy, frequent start and stop operation of combined cycle power plants is increasing. As a result, interference with cation conductivity measurements by carbon dioxide which enters from the air during plant outages will increase, making the delayed detection of contamination by impurities a matter of concern. Therefore, a novel identification method for impurities based on the pH, specific conductivity, and cation conductivity, which are monitored conventionally in the water-steam cycle, has been investigated.

As a result of the calculation of impurity concentrations using the novel model of the simulated water quality of a water-steam cycle prepared by chemical equilibrium calculation software, it has been confirmed that the calculation error for carbon dioxide concentrations not from seawater is 0.0% to 18% more than 0.1 mg·L⁻¹, and that for seawater contamination is 0.0% to 20% more than 1·10⁻⁶ m³·m⁻³, which is regarded as good agreement. Additionally, the calculated results with measured data from two power plants are consistent with the assumed behavior based on the plant status. In conclusion, it is indicated that the amount of seawater can be precisely estimated even in the case of the presence of both carbon dioxide and seawater by using this novel method.

PPCHEM® Journal, May/June 2024, 26(3), 145

BIAPWS SYMPOSIUM 2024 HIGHLIGHTS AND PRESS RELEASE

The British and Irish Association for the Properties of Water and Steam (BIAWPS) hosted their 23rd Annual Power Plant Chemistry Symposium on 22nd–23rd May at Warwick University, Coventry, UK. The Symposium was attended by around 90 members of the UK and Ireland water/steam cycle chemistry community, with a good mix of Operators, Vendors, and Suppliers to the water treatment industry.

PPCHEM® Journal, July/August 2024, 26(4), 164–173

AMINE ANALYSIS AND MONITORING – A PRACTICAL APPROACH

Wolfgang Hater and Levie Lensun

Amines are used for three different purposes in a water/steam cycle (WSC): as reducing agents (reducing amines (RA)), to adjust the pH in the WSC (alkalising amines (AA)), and to protect the inner surfaces of the WSC by the formation of an adsorptive film on the metal surfaces (film forming amines (FFA)). Monitoring and control have to be chosen according to the purpose of use. The chemistry and selected properties that are important for the application and control of the amine groups are presented.

This article discusses the different approaches for monitoring and control of the three groups of amines together with the common methods of analysis. For the monitoring of RA and AA, standardised methods of analysis are available.

For FFA monitoring, two main methods are available, which are primarily applied for grab samples. They are well established; however, there is a limit of detection so that in some cases free residual FFA cannot be detected in the whole WSC, and, thus, the completeness of film formation is not proven.

A process for the upgrading of FFA to improve the limit of detection is proposed which is suitable for on-site application. Furthermore, several approaches for indirect analysis of FFA in water are presented in which test specimens are introduced into the WSC. Either the FFA adsorbed on the surface is measured or, alternatively, the FFA presence is proven via the change in surface properties due to the effect of FFA adsorption. In this way the completeness of film formation in the WSC can be demonstrated.

PPCHEM® Journal, July/August 2024, 26(4), 178–183

COOLING TOWER OPERATING AND WATER TREATMENT FUNDAMENTALS – PART 3

Brad Buecker

Cooling water systems are an integral component of many power plants and thousands of industrial facilities. The previous installment focused on microbiological fouling, as this phenomenon often causes the most prompt and severe difficulties in cooling systems. However, scale formation and corrosion (including corrosion caused by microbiological deposits) can also be very problematic if not properly monitored and controlled. Treatment programs for both are often interlinked, so this and the next installment highlight the most common corrosion and scaling mechanisms, followed by Part 5, which will examine modern corrosion/scale control chemistry.

PPCHEM® Journal, July/August 2024, 26(4), 184–187

2024 ELECTRIC UTILITY CHEMISTRY WORKSHOP HIGHLIGHTS AND PRESS RELEASE

The 2024 Electric Utility Chemistry Workshop again offered a broad range of important topics for steam generation chemists, engineers, and managers. This article offers several highlights from the event. A somewhat overlooked benefit of this conference is its potential value for those employed at co-generation and large industrial plants, where water and steam treatment issues are similar and equally as important as for the power industry. Accordingly, the planning committee is renaming the event the Electric Utility and CoGeneration Chemistry Workshop (EUC2W) to emphasize the workshop's value to diverse industrial personnel.

PPCHEM® Journal, July/August 2024, 26(4), 194–195

IAPWS HIGHLIGHTS 2024 – 18TH INTERNATIONAL CONFERENCE ON THE PROPERTIES OF WATER AND STEAM (ICPWS) & ANNUAL EXECUTIVE COMMITTEE AND WORKING GROUP MEETINGS

Continuing a series of conferences started in 1929, the 18th International Conference on the Properties of Water and Steam (ICPWS) was held in Boulder, Colorado, on June 23–28, 2024. The Conference is organized by the International Association for the Properties of Water and Steam (IAPWS) and for the first time was combined with another conference: the 22nd Symposium on Thermophysical Properties (STP). The STP is held in the U.S. every three years and brings together experts in the theory, modeling, and measurement of thermophysical properties of fluids and solids. The joint meeting allowed a wider community of researchers to be exposed to the work of IAPWS and gave people from IAPWS the opportunity to learn about leading-edge research and applications in fields outside water and steam. The combined conference attracted 440+ attendees from 29 countries.

PPCHEM® Journal, July/August 2024, 26(4), 196–199

MONITORING DISSOLVED HYDROGEN IN WATER-STEAM CYCLES

Michael Rziha

The idea of using the measurement of dissolved hydrogen to assess the formation of protective coatings is nothing new. As early as 1953 (!), H. Kiekenberg published an article in the German "VGB Mitteilungen" on hydrogen measurements in Benson and drum boilers, followed by further publications by other well-known authors in the following years. Corrosion occurs in the presence of water or steam in contact with iron at high temperatures. According to the Schikorr reaction, hydrogen is released as a by-product during the formation of a protective layer in a power plant. Hydrogen monitoring thus becomes important in corrosion monitoring for water-steam cycles; the hydrogen concentration is a very sensitive indicator of corrosion.

PPCHEM® Journal, July/August 2024, 26(4), 204–215

EFFECT OF ODACON® F ON CARBON STEEL CORROSION IN WATER-STEAM CYCLE CHEMISTRY WITH ETHANOLAMINE

Jaganathan Ulaganathan, Ute Ramminger, and Jörg Fandrich

Film-forming amine (FFA) applications are a recent strategy used by nuclear power plants for the corrosion protection of secondary-side components during outages and normal operation. Laboratory investigations of FFA applications are usually conducted in static autoclaves under conditions that are different from the field, where the conditions are dynamic with factors such as temperature and single-/two-phase flow varying throughout the water-steam cycle. To address this gap, the H3 Loop, a recirculating loop at Canadian Nuclear Laboratories was used to investigate the effect of ODACON® F, a commercial FFA, on the corrosion of pre-oxidized (PO) carbon steel (CS) tubing exposed to ethanolamine chemistry under two-phase flow conditions at 180°C and 15% steam quality. Post-test weight measurements showed negligible corrosion due to the preexisting oxides. Water beading tests and scanning electron microscopy examination demonstrated that the PO CS surfaces exposed to ODACON® F under different temperatures and single-/two-phase flow conditions were hydrophobic due to film formation and not the pre-existing oxides.

PPCHEM® Journal, September/October 2024, 26(5), 224–225

TRIBUTE TO PROF. WOLFGANG WAGNER

The German-Swiss Association for the Properties of Water and Steam e.V.

This issue includes a tribute to a highly respected member of the International Association for the Properties of Water and Steam (IAPWS) community who recently passed away. Professor Wolfgang Wagner's dedication, warmth, and significant contributions have left a lasting legacy within our field. He was a pioneer in improving data correlation techniques for the thermodynamic properties of water and steam. Under his leadership, IAPWS developed the current international formulations for the thermodynamic properties of water and steam. His presence will be deeply missed, and we honor him for his invaluable impact on our community. This tribute is from the joint national committee of Germany and Switzerland, of which he was an honorary member.

PPCHEM® Journal, September/October 2024, 26(5), 226–237

INFERRED BOILER PH FROM CONDUCTIVITIES IN SOLUTIONS CONTAINING SODIUM PHOSPHATE, ALKALIZING AMINES, AND AMINE DECOMPOSITION PRODUCTS

Daniel Zinemanas and Eyal Keren

Accurate knowledge of the pH in boiler water is an important and central chemical parameter for the monitoring and control of the boiler chemical conditions and is critical to minimizing the corrosion processes. pH measurements, however, are not always easily or accurately measured, so alternative means of correctly estimating the boiler pH can be useful for achieving these goals. In certain situations, the conditions are even quite complex and challenging since the impurities which negatively affect the chemical parameters arise from the treatment chemicals themselves, such as, for example, the products of the thermal decomposition of organic alkalizing amines used for pH control. Thus, it is the purpose of the present study to show an alternative way by means of the calculation of the inferred pH from the specific conductivity and the conductivity after cation exchange and to describe its application, together with these conductivities, to the monitoring and control of the boiler water in relatively complex solutions in which sodium phosphates, alkalizing amines, and amine decomposition products are present. The methodology described in the paper is applied in a cogeneration plant with a dual pressure heat recovery steam generator equipped with an air-cooled condenser, where, as demonstrated, very good results were achieved. The study also emphasizes the main concerns and disadvantages regarding the use of organic alkalizing amines in water/steam cycle water treatment.

PPCHEM® Journal, September/October 2024, 26(5), 250–275

IAPWS TGD2-09(2024): INSTRUMENTATION FOR MONITORING AND CONTROL OF CYCLE CHEMISTRY FOR THE STEAM/WATER CIRCUITS OF FOSSIL-FIRED, COMBINED CYCLE, AND INDUSTRIAL POWER PLANTS

The International Association for the Properties of Water and Steam

This Technical Guidance Document was first issued in 2009 and revised in 2012 and 2015. This 2024 revision includes a small number of updates and clarifications. These do not constitute significant changes to the scope of the document or to the guidance contained.

In order to achieve suitable chemical conditions in steam/water circuits, it is essential to establish reliable monitoring of key parameters on every plant. This enables the demonstration of operation within cycle chemistry targets, and alerts the operators to the need to take corrective action when the target conditions are compromised.

This technical guidance document considers conventional fossil, combined cycle / HRSG, and industrial plants and identifies the key instrumentation and monitoring techniques required for each plant type and cycle chemistry treatment. It is emphasized that this is an IAPWS guidance document and that, depending on local requirements, the use of simpler instrumentation may be adequate, whereas more complex techniques and instrumentation may be necessary when specific issues arise.

PPCHEM® Journal, November/December 2024, 26(6), 288–297

SUPPLEMENTAL OXYGEN FOR ALL-VOLATILE TREATMENT UNDER OXIDIZING CONDITIONS

Jeremy B. Smith and D. Matt Craven

With aging fleets of fossil- and gas-fired units throughout the industry, flow-accelerated corrosion failures remain a major concern. Southern Company's water chemistry program strives to provide its fossil and gas fleet with the best innovative solutions to control water/steam cycle chemistry within the latest industry guidance. This paper explains the Southern Company Water Chemistry group's approach to achieving and maintaining the best control over the condensate and feedwater dissolved oxygen concentration for all-volatile treatment under oxidizing conditions (AVT(O)) chemistry programs.

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WATER TREATMENT OF FLUE GAS CONDENSATE – WHITE PAPER

Nordic IAPWS

Flue gas condensation is the cooling of flue gas below its dew point. It produces heat from the condensation of the water content of the flue gas and it produces flue gas (FG) condensate. The FG condensate must be treated for discharge or reuse, hence the term FG condensate treatment.

FG condensate treatment is a specialty of the Nordic countries, where it has been developed since the mid-1980s. Today, the technique is well established and widespread in this region. This white paper summarizes the experiences gained in the Nordic countries to provide best practices to current and new users and build a bridgehead for other countries that may use the technology in combined heat and power production.

REVIEW OF THE VGBE CHEMISTRY CONFERENCE 2024, 22–24 OCTOBER IN POTSDAM

This year, the traditional vgbe Chemistry Conference celebrated its 60th anniversary. From October 22 to 24, 2024, approximately 160 participants from Germany and abroad gathered in Potsdam to discuss and learn about the latest trends and challenges in power plant chemistry.

The vgbe Chemistry Conference team expresses its gratitude to all participants, speakers, and exhibitors for their contributions, which made this event a success. The team is already looking forward to the next vgbe Chemistry Conference, scheduled to take place in Kassel from October 28 to 30, 2025.



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