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Abstracts

Methods for Verification of Low Parts-per-Trillion Sodium Determination by On-Line ISE-Based Sodium Monitors

Steven West, Xiaowen Wen, and Charles Baer

As needs and capabilities for the production of ultrapure water advance, the analysis technology for determining contaminant levels is continuously challenged to keep pace. In water used for steam generation, maintaining the lowest possible levels of sodium ion is of great importance for the prevention of damage to turbine blades. Today, sodium levels in water and steam are being pushed lower and lower, making validation of readings from on-line analyzers increasingly difficult. In this paper, we compare two methods of validating on-line, ion-selective electrode-based analyzer performance at low ng/kg (low parts-per-trillion, ppt) sodium concentrations. Dynamic dilution and recovery and grab sample analysis by inductively coupled plasma mass spectrometry are applied to analyses by a recently introduced sodium monitor and to an existing monitor provided by another manufacturer. Verification studies in the range of 1 000 ng/kg down to less than 10 ng/kg are described. Results of this study and discussion of analyzer design features that enable such low-level analysis are presented, and techniques available to plant operators for on-site verification of low-level chemical analyzers are discussed.

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Monitoring Biofilms in Real Time for Control of MIC and Heat Exchanger Fouling

George J. Licina

Microbiologically influenced corrosion (MIC) of piping and heat exchanger materials in power plant cooling waters can cause expensive unplanned outages, the need for local repairs, and, in some cases, the need for complete system replacement. Biofouling of heat exchanger tubes also decreases overall plant efficiency and power output. The biocide additions necessary to mitigate biofouling and MIC increase costs, raise concerns over effluents, and can even increase corrosion.

In this paper, an electrochemical biofilm sensor with integrated data acquisition and data analysis capabilities for monitoring biofilm activity on metallic surfaces is presented. Power plant and other industrial experience with this tool, including biocide optimization projects in plants, is described.

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State of the Art in Flue Gas Analysis Technology for Emission Monitoring and Combustion Control

Thomas Kappes

The continuous monitoring of gaseous emissions of power plants is gaining more and more importance worldwide, not only in industrialized countries, due to stringent environmental legislation and the need for efficient use of resources. An outline of modern exhaust gas analysis instrumentation is given together with applications for emission monitoring as well as for the optimization of combustion and exhaust gas treatment processes in fossil- and biomass-fueled power plants. Further, an overview of the amendment to the German federal immission control regulations for large combustion plants and gas turbines is presented.

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Application of Electrochemical Noise Analysis in High Subcritical and Supercritical Aqueous Systems

Xueyong Guan, Ting Zhu, and Digby D. Macdonald

In this study, electrochemical noise analysis (ENA) is used to identify corrosion mechanisms and to analyze the effect of pressure on corrosion reactions in high subcritical and supercritical aqueous systems. Two corrosion mechanisms, "chemical oxidation" (CO) and "electrochemical oxidation" (EO), are used to describe the corrosion reactions in supercritical aqueous systems, depending upon the density and dielectric constant of the fluid. ENA is used to differentiate the two corrosion mechanisms by postulating that only the electrochemical mechanism gives rise to spontaneous fluctuations in current and potential. A rugged electrochemical noise sensor has been developed to monitor the fluctuations in the coupling current between two identical specimens. Experiments show that the electrochemical mechanism is the dominant corrosion process when the temperature is less than 350 °C and that it becomes of progressively lower importance as the temperature increases above the critical temperature (T_c = 374.15 °C). ENA is also used to explore the effect of pressure on the rate of corrosion of metals at supercritical temperatures. As predicted by the pressure-effect model, the experimental data demonstrate that the electrochemical corrosion rate increases with increasing pressure in low-density supercritical systems, corresponding to an increase in the density and the dielectric constant.

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Influence of Various Surface Conditions on Pitting Corrosion Resistance of Stainless Steel Tubes of Type EN 1.4404

Troels Mathiesen, Torben S. Nielsen, Jan Elkjær Frantsen, John Kold, and Anne R. Boye-Moeller

The pitting resistance of pickled, ground and electropolished surfaces of EN 1.4404 (AISI 316L) tubes was tested using cyclic polarization and ASTM G150 for determination of the pitting potential and critical pitting temperature, respectively. The materials were tested in chloride-containing solutions with 0.05 to 5.0 % chloride. Crevice corrosion was avoided using a flushed port cell with a specially cast gasket. A ground finish with low surface roughness shows no improvement over the coarse pickled finish, while an electropolished finish provides considerably higher resistance but at the same time scattered results. The two testing techniques give almost identical critical pitting temperatures that show only little dependence on chloride concentration. The variation in pitting resistance has been correlated to the surface morphology of the different surface conditions.

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Experience with Titanium Condensers in Belgian Nuclear Power Plants

Charles Laire, Raymond De Graeve, Yves Comptdaer, and Philippe Gilbert

In Belgium, five nuclear power plants are equipped with titanium condensers of different designs. At the Doel sites, where the cooling water is very corrosive, full titanium condensers have replaced the original condensers. The cooling water is brackish water; a cooling tower is installed for two units.

At Tihange, one unit is equipped with a replaced condenser in titanium, although the cooling water is less aggressive compared to Doel.

At some units, small leaks have occurred during service and the causes of these leaks could be related to the following mechanisms:

- Steam droplet erosion at the tube outer surface; inspections with eddy current and a visual inspection have drastically reduced the occurrence of small leaks at the Tihange 1 unit.
- Mechanical wear due to foreign objects blocking the tube entrance on the raw water side. Small debris coming from the cooling tower has generated wear and this type of degradation has resulted in the installation of protective short sleeves at one unit (Doel 4). After 8 years of operation with these sleeves, the absence of degradation was verified on pulled tubes. Despite the aggressive water, no corrosion under the sleeves has occurred, and erosion behind the sleeves – possibly due to local turbulence – has not been observed. This experience confirms the excellent corrosion resistance of titanium.

The paper summarizes the results of the different inspections and investigations on pulled tubes.

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