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Abstracts

Studies of Electrostatic Charge Effects Relating to Power Output from Steam Turbines

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This paper summarizes the work done in several recent studies concerning the effects of electrostatic charge imposed on the steam flow in a turbine exhaust environment. The purpose of these studies was to determine whether an electrostatic charge imposed on the turbine exhaust steam could increase turbine power output in a commercially useful manner.

Certain studies carried out in the Ukraine on this topic using a 50 MW utility turbine are considered first. The results of these studies indicated that electrostatic charging of steam could lead to a small but commercially useful increase in power output. Basic work was subsequently undertaken in the USA to study the influence of an electric field on wet steam in a laboratory chamber. A full-scale test program was also undertaken in the USA, in which electric charge was imposed on the steam flowing through the exhaust hood of a large (425 MW) utility turbine. Several grids of wire electrodes strung within the exhaust hood of the turbine were used in this test. These wires carried a high voltage of sub-corona potential.

In a separate program the electrostatic effects associated with a nucleating flow of steam within a two-dimensional cascade were examined. The measurements are of the electrical charges generated on first nucleation and of the effect of electrical charge on nucleation of steam droplets.

The paper describes the work undertaken in these programs, and it summarizes the results achieved to date. Conclusions drawn from the results are presented, with discussion.

PowerPlant Chemistry 2005, 7 (2)

Case Histories of Stress-Assisted Corrosion in Boilers

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Stress-assisted corrosion refers to attack at locations where applied and/or residual stresses are imparted to the metal. Case histories are presented from a variety of different boiler systems that illustrate the effects of stress-assisted corrosion, including environmental conditions that may promote attack. Methods that may be used to control stress-assisted corrosion are also outlined.

PowerPlant Chemistry 2005, 7 (2)

Water Chemistry Practice at German BWR Plants

Bernhard Stellwag and Ulrich Staudt

As visual examinations carried out in 1994 detected cracks in a German boiling water reactor (BWR) plant due to intergranular stress corrosion cracking in core shroud components manufactured from Nb-stabilized CrNi steel 1.4550, safety-related assessments and in-service inspections were subsequently performed for the other six German BWRs. No cracks were found in the core shrouds of these plants.

The second major event in the early 1990s was the detection of cracks at various German BWRs in piping systems made of Ti-stabilized CrNi steel 1.4541 caused by thermal sensitization in the heat-affected zone of welds. Comprehensive investigations resulted in a number of remedial measures (repair, replacement) implemented at piping in contact with reactor coolant of temperatures above 200 °C.

Thanks to the remedial measures and according to the analyses performed, cracking in the components in question due to the considered damage mechanisms need not be expected. German operators have therefore continued operating their BWR plants on normal water chemistry with an oxidizing environment. As a precaution, more stringent reactor coolant quality requirements have been specified and the limiting values of VGB Guideline R 401 J revised. This paper gives an overview of the trends in chemistry parameters at German BWR plants in the past 10 years. In addition, other relevant experience gained from the German BWR plants operating under normal water chemistry conditions is outlined: dose rates and collective doses, fuel performance, and results of periodic in-service inspections of major components of the reactor system. In the nearly 10 years of plant operation since implementation of the remedial measures, no cracks or other indications have been detected in any of the systems and components concerned.

PowerPlant Chemistry 2005, 7 (2)

Advances in High Temperature Water Chemistry and Future Issues

Peter J. Millett

This paper traces the development of advances in high temperature water chemistry with emphasis in the field of nuclear power. Many of the water chemistry technologies used in plants throughout the world today would not have been possible without the underlying scientific advances made in this field. In recent years, optimization of water chemistry has been accomplished by the availability of high temperature water chemistry codes such as MULTEQ. These tools have made the science of high temperature chemistry readily accessible for engineering purposes. The paper closes with a discussion of what additional scientific data and insights must be pursued in order to support the further development of water chemistry technologies for the nuclear industry.

PowerPlant Chemistry 2005, 7 (2)

Studies on the Local Reactions of Alkali Chloride Particles on Metal Surfaces

Sung Chul Cha and Michael Spiegel

During biomass combustion alkali chloride particles are formed, depositing on the metallic surface or on the already formed oxide layer. Subsequently, they react with the metal or the oxide layer and accelerate the oxidation process. To investigate these reactions equipment for particle deposition by impactor and thermophoresis was installed and optimized for homogeneous deposition. After deposition of KCl, iron samples were exposed to 800 $mL \cdot L^{-1}$ N_2-200 $mL \cdot L^{-1}$ O_2 and 799.5 $mL \cdot L^{-1}$ N_2-200 $mL \cdot L^{-1}$ O_2-0.5 $mL \cdot L^{-1}$ HCl atmospheres for short times at 300 °C. In 800 $mL \cdot L^{-1}$ N_2-200 $mL \cdot L^{-1}$ O_2, some deformation and local spreading of the particles were observed, probably by melt formation in contact with the metal. Oxidation with HCl addition led to a significant increase of chlorine and oxygen contents on the KCl deposited sample surfaces. Finally, thermogravimetric tests were conducted on deposits formed on iron at temperatures from 300 °C to 400 °C in 950 $mL \cdot L^{-1}$ Ar-50 $mL \cdot L^{-1}$ O_2 atmospheres with and without addition of 0.5 $mL \cdot L^{-1}$ HCl. In the case of HCl addition, mass gains increased rapidly in the beginning of oxidation. The iron chloride or chlorine-rich layer was formed directly at the metal scale and under the oxide layer.

PowerPlant Chemistry 2005, 7 (2)

Online Monitoring of Steam/Water Chemistry of a Fast Breeder Test Reactor

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Operating experience with the once-through steam generator of a fast breeder test reactor (FBTR) has shown that an efficient water chemistry control played a major role in minimizing corrosion related failures of steam generator tubes and ensuring steam generator tube integrity. In order to meet the stringent feedwater and steam quality specifications, use of fast and sensitive online monitors to detect impurity levels is highly desirable. Online monitoring techniques have helped in achieving feedwater of an exceptional degree of purity. Experience in operating the online monitors in the steam/water system of a FBTR is discussed in detail in this paper. In addition, the effect of excess hydrazine in the feedwater on the steam generator leak detection system and the need for a hydrazine online meter are also discussed.

PowerPlant Chemistry 2005, 7 (2)