

**Abstracts****The Solubility of Copper and Its Oxides in Supercritical Steam**

Frederick J. Pocock, Jr., and Jack W. Stewart

This paper contains a study of the solubility of copper and its oxides in supercritical steam which was undertaken because of difficulties experienced with copper deposition in the high-pressure turbine of the Ohio Power Company's Philo 6 supercritical steam-generating cycle. This study shows that copper has appreciable solubility in superheated supercritical steam. The extent of solubility is apparently a function of the oxidation state of the metal, with the highest state of oxidation (CuO) showing the greatest solubility. A slightly increased solubility was effected by increasing pH values from 7.5 to 9.5 with ammonia. It is also shown that copper solubility is principally a function of pressure over the narrow temperature range tested (900 °F to 1 150 °F) probably because this parameter has the greatest effect on specific volume.

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**Improving the Performance of ZLD Cooling Water System through Innovation in Chemistry and Control**

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An innovation in chemistry and control technology was deployed at Deseret power station to control corrosion, scale, and biofouling. A low phosphate molecule containing no heavy metals was used for both scale and corrosion control. The monitoring and control is based on several fluorescence-based probes to determine the optimum dose and monitor the treatment performance for scale, bio, and corrosion control. The new treatment in combination with the on-line 24/7 monitoring, control, and the ability to communicate performance via web or modem resulted in optimum performance and cost. The study was deemed successful and is currently deployed as a commercial technology.

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**Critical Processes to Model in Predicting Stress Corrosion Response in Hot Water**

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Structural materials have a fundamental susceptibility to stress corrosion cracking (SCC) in high temperature water, and extensive efforts have been made to quantify their specific response as a function of material and condition, water chemistry, temperature, stress, etc. There are many primary variables, and dozens of important factors, all of which are inter-dependent in establishing SCC response. The only comprehensive way of tackling this problem is to identify the underlying processes that control SCC, which provides a fundamental framework for understanding the myriad of interdependent factors. This paper discusses the processes that must be understood and modeled, and compares various approaches in this quest.

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**Minimizing Copper Pickup from Copper Alloys in the Feed Train by Control of pH and ORP: New Operating Limits**

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This paper reviews recent research, sponsored by EPRI, by which the amount of copper release from the copper alloys commonly found in the feed train of power stations has been determined. The investigations have been undertaken under carefully controlled laboratory conditions to simulate feedwater. Release rates are given for pure water as a function of the pH value and the oxidation-reduction potential (ORP). The ORP responds directly to the level of dissolved oxygen and is a sensitive indicator of whether the feedwater is oxidizing or reducing with respect to copper. For all conditions of exposure, the copper alloy surfaces have been characterized in terms of the morphology and composition of the surface oxides. The mechanism of release is discussed on the basis of the surface characteristics.

Measurements relevant to the LP heaters were made using a standard test temperature of 95 °C (203 °F). Under reducing conditions (defined by an ORP of -300 mV) the minimum release is found, for admiralty brass, 90/10 cupronickel and aluminum brass, to be close to a pH value of 9.5. Under fully oxidizing conditions (an ORP of +100 mV), the minimum is shifted to a lower pH value, in the range 7-8. Copper release decreases on reduction of oxygen concentration, but evidence is found for very high release rates in the ORP range -50mV to +50 mV, associated with the transition between Cu<sub>2</sub>O and CuO as the thermodynamically stable surface phase. In this region of instability, approximately between 0.1 and 1 mg · kg<sup>-1</sup> O<sub>2</sub> or -50 to +50 mV ORP, very high release rates may be found. It should be considered unsafe to operate in this range. Transitions through the range in either direction must be made promptly in order to minimize copper pick up by the feedwater. Measurements relevant to HP heaters were made using test temperatures up to 350 °C (660 °F). Release from 70/30 cupronickel followed a similar pattern to that observed for the LP train.

Based on these measurements, a new set of operating limits for these alloys under typical fossil fueled plant conditions has been incorporated into the latest revisions of the EPRI Guidelines for AVT, Phosphate Continuum and Caustic Treatment. These limits minimize copper pickup from copper alloy and mixed-metal feedwater systems.

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**Development of Electric Cation Exchanger for Measurement of High pH Secondary Water Quality in PWR Plants**

Masahiko Kurashina, Hideo Uzawa, Toshiaki Aoki, Li-Bin Niu, and Hiroshi Takaku

High pH operation is applied to the secondary water treatment of Japanese pressurized water reactor (PWR) plants. To reduce the maintenance frequency to as low as possible, an electric cation exchanger used with electric dialysis film as a substitute for the cation exchange resin was developed. Some tests conducted at an actual PWR plant as well as at our laboratory have confirmed that the performance of the developed electric cation exchanger may be promising for actual use.

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