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Abstracts

R. Viswanathan and W. T. Bakker
Materials for Ultra Supercritical Coal Power Plants
Part 2: Turbine Materials

The efficiency of conventional boiler/steam turbine fossil power plants is a strong function of the steam temperature and pressure. Research to increase both has been pursued worldwide since the energy crisis in the 1970s. The need to reduce CO_2 emissions has recently provided an additional incentive to increase efficiency. Thus, steam temperatures of the most efficient fossil power plants are now in the 600 °C (1112 °F) range, which represents an increase of about 60 °C (108 °F) in 30 years. It is expected that steam temperatures will rise another 50–100 °C (90–180 °F) in the next 30 years. The main enabling technology is the development of stronger high temperature materials, capable of operating under high stresses at ever increasing temperatures. Recently EPRI performed a state-of-the-art review of materials technology for advanced boiler/steam turbine power plants (ultra supercritical power plants). The results of this review pertaining to boilers were reported in a companion paper in the July issue of this journal. This paper describes the results relating to steam turbines.

Mrinal R. Pai, S. Varma, A. D. Belapurkar, and N. M. Gupta
Development of Catalysts for Mitigation of Hydrogen in Water Cooled Nuclear Power Reactors
Part 1: Preparation, Characterization, and Activity Measurements

Catalysts have been developed in the laboratory for the rapid reaction of the hydrogen and oxygen that may release in containments of nuclear power reactors under the postulated severe accident conditions. These catalysts are comprised of Pt and/or Pd noble metals dispersed finely on strips of corrosion resistant stainless steel wire gauze, and have been found to be very active for hydrogen-oxygen reaction under the ambient conditions of temperature, pressure and moisture, in both the bench and pilot plant scale measurements. The microscopic examination showed that the wire gauze-based samples were superior in terms of dispersion and binding of the deposited noble metal compared to those prepared with a metal plate as a support. The exothermicity of the $H_2 + O_2$ reaction resulted in a rise in catalyst temperature and hence in its self-sustained catalytic activity. The paper presents the data on activity and temperature rise of catalyst samples as a function of metal loading.

Albert Bursik
Boiler Tube Failures in Industrial Drum-Type Steam Generators
Part 1: Feedwater Treatment and Under-Deposit Corrosion Failures

Boiler tube failures in industrial drum-type steam generators are very frequent. The root causes of the most important BTF mechanisms occurring in industrial boilers (hydrogen damage, acid phosphate corrosion, and caustic gauging) are related to plant cycle chemistry. Excessive deposits have been identified as the main cause of such failures. The internationally accepted fossil cycle chemistry guidelines drawn up and published by VGB and EPRI do not reflect conditions typical in industrial steam generating installations.

This paper deals with the major differences between steam generation in utility boilers and in industrial steam boilers and other steam generating apparatus. The applicability of VGB or EPRI guidelines is evaluated and discussed. Particular attention is given to the usage of organic cycle treatment chemicals that are increasingly applied in industrial cycles. The industry experience is described and an evaluation of quality requirements for organic cycle additives as well as the development of a guideline for organic cycle treatment in industrial units is proposed.

Herman J. Quakkelsteijn
Helium Leak Detection in Condenser Systems During Operation

The Integrity of condensers is one of the most important precondition for the successful operation of both fossil-fired and nuclear power plants. Ingress of cooling water or air jeopardizes the fulfilling of cycle chemistry guidelines and has an unfavorable effect on cycle efficiency. This paper deals with tracing air and cooling water leaks with helium. Attention is given to both detecting and localizing condenser leaks. The helium method, which is markedly more sensitive than all other methods, is applied in the power industry. Helium testing substantially reduces the total testing period and losses in MWh.

J. P. Jensen, L. D. Fenger, and N. Henriksen
Cold-End Corrosion in Biomass and Waste Incineration Plants

Several biomass and waste incineration plants have been forced to replace heat exchangers situated in the cold end of the flue gas duct after less than two years of operation. The heat exchangers were corroded due to steam condensation of the flue gas caused by hygroscopic salts. Two approaches can be taken to avoid accelerating corrosion rates. More corrosion resistant materials can be used for the heat exchangers or the metal temperature can be raised by changing the design of and flow in the heat exchangers. The minimum metal temperature is suggested to be 90 °C for heat exchangers at a water content of 12% in the flue gas. For a water content of 20% in the flue gas the minimum metal temperature is recommended to be 95 °C. Enameled heat exchangers and coated surfaces are recommended where the metal surface temperature is below 90 °C.

Michael Hocquel, Sven Unterberger, and Klaus R. G. Hein

Understanding Mercury Behavior – A Contribution to Higher Removal Efficiencies

Mercury speciation measurements were performed at an electrically heated combustion reactor and a lab-scale flue gas cleaning system to evaluate the behavior of mercury in combustion and synthetic flue gases. A continuous emission monitor for mercury equipped with a specially designed sampling probe was used to determine particle bound mercury Hg(p) and the gaseous species $Hg^0(g)$ and $HgCl_2(g)$ in combustion flue gas at sampling temperatures between 500 and 570 K. CaO was observed to promote the conversion of already formed $HgCl_2(g)$ to $Hg^0(g)$ and thus has a negative effect on mercury oxidation. To demonstrate the influence of the acid gas components SO_2 and HCl on the speciation of mercury, synthetic gas mixtures of N_2, O_2, H_2O, HCl, SO_2, and Hg with and without additional CaO spiking were injected into the heated combustion reactor. Besides the effect of CaO, the results indicate that the presence of SO_2 promotes higher $Hg^0(g)$ concentrations. Results of laboratory tests at a catalytic converter with different gas compositions of HCl, H_2O, O_2, N_2, and Hg_{total} indicate a strong adsorption and oxidation effect of the catalyst for mercury depending on temperature and HCl concentration.

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