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Abstracts

Cleanliness Criteria to Improve Steam Generator Performance

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High steam generator performance is a prerequisite for high plant availability and for possible lifetime extension. The major obstacle to this is corrosion and fouling of the heating tubes. Such steam generator degradation problems arise from the continuous ingress of non-volatile contaminants, i.e., corrosion products and salt impurities which accumulate in the steam generators. These impurities have their origin in the secondary side systems. The corrosion products generally accumulate in the steam generators and not only form deposits in the flow restricted areas, such as on top of tube sheet and in tube support structures, but also build scales on the steam generator heating tubes. Whereas the deposits on top of tube sheet and in tube support structure crevices are responsible for the corrosion phenomena, the tube scales in general affect the steam generator thermal performance, which ultimately causes a reduction in power output. The most effective ways of counteracting all these degradation problems and thus of improving the steam generator performance is to keep them in clean condition or, if necessary, to plan cleaning measures such as mechanical tube sheet lancing or chemical cleaning. This paper presents a methodology of how to assess the cleanliness condition of a steam generator by evaluating all available operational and inspection data together, such as thermal performance and water chemistry data. By means of this all-inclusive approach the cleanliness condition is quantified in terms of a fouling index. The fouling index enables monitoring of the condition of a specific steam generator, allows comparison with other plants and, finally, can serve as a criterion for cleaning measures such as chemical cleaning. The application of the cleanliness criteria and some field results achieved with respect to improvements in steam generator performance are presented in this paper.

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Cost Savings in Power Plant Chemistry?

Hartmut Venz

Against the background of the reduction of greenhouse gases, the steadily increasing energy demand, and the main objective of supplying electricity at the lowest possible costs, the paper focuses on the function of chemistry today and in future power plants. The title question is answered with a strong NO. Cutbacks in power plant chemistry do not pay off. Cost benefits may be achieved with the aid of power plant chemistry, not by savings in power plant chemistry.

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Developments in Nuclear Power Plant Water Chemistry

Keith Fruzzetti and Christopher J. Wood

This paper reviews the changes in light water reactor water chemistry management that have occurred in recent years. Performance of nuclear power plants in most countries, measured by achieved capacity factors or other indicators (e.g., World Association of Nuclear Operators, WANO, indicators) has improved markedly, and advances in water chemistry have played an important role. No longer seen as the cause of materials degradation and fuel failures, water chemistry advances now represent the most effective methods for mitigating materials and fuel performance concerns. After a brief review of historical developments, this paper focuses on recent advances and inferences for continuing developments in the future.

Recent moves to increase plant output have brought about a new set of challenges, placing renewed emphasis on the need to optimize water chemistry between the sometimes conflicting requirements of materials and fuel, while maintaining the trend towards lower radiation fields. Mitigation of stress corrosion cracking of materials has been demonstrated (for example, zinc injection in pressurized water reactors, PWRs, and noble metal addition in boiling water reactors, BWRs), but the potential side-effects must continue to be evaluated. Fuel is being driven harder, with longer operating cycles, increased burn-up and increased duty, which has tended to reduce margins. As a result, water chemistries that were satisfactory a few years ago may no longer provide sufficient mitigation of fuel performance degradation and possibly fuel failures.

This paper illustrates the changing role of water chemistry in current operation of nuclear power plants. Water chemistry was sometimes perceived as the cause of materials problems, such as denting in PWR steam generators and intergranular stress corrosion cracking in BWRs. However, starting in the last decade, new chemistry options have been introduced to mitigate stress corrosion cracking and reduce fuel performance concerns.

In BWRs and PWRs alike, water chemistry has evolved to successfully mitigate many problems as they have developed. The increasing complexity of the chemistry alternatives, coupled with the pressures to increase output and reduce costs, have demonstrated the need for new approaches to managing plant chemistry, which are addressed in the final part of this paper.

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The Impact of Boiling on the Chemical Environment of Heating Surfaces in Nuclear Power Plants

Ivan D. Dobrevski and Neli N. Zaharieva

Possible consequences of boiling on the heating surfaces of fuel element claddings resulting in changes in chemical environment characteristics are evaluated for two surface conditions: with and without corrosion product deposits. The changes in chemical environment characteristics determine the corrosion attack on heating surfaces and finally eventually influence their performance.

Special attention is paid to the impact of boiling on the chemical environment of fuel claddings, including the synergetic influence of water radiolysis. The reason is the development of advanced operation concepts to achieve higher burnup and better fuel utilization, connected with increases in cladding temperature and a real possibility for the occurrence of sub-cooled nucleate boiling on fuel element cladding surfaces of pressurized water reactors.

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Designing HRSGs for Cycling

Lewis R. Douglas and Joseph E. Schroeder

With U.S. combined-cycle plants increasingly being cycled rather than being run continuously, as they were designed to do, owner/operators worry that units expected to last two or three decades may survive only a few years without an expensive overhaul. Cycling takes as much of a toll on heat recovery steam generators (HRSGs) as it does on gas turbines. Whether you are procuring a new HRSG or adapting an existing one for cycling service, robust design features should be considered.

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Investigation of a Persistent Episode of Drum pH Depression Experienced at Händelö Combined Heat and Power Plant

Phillip Smurthwaite, Britt-Marie Tureson, and Romel Makdessi

An investigation was undertaken into an episode of persistent pH depression that occurred at Händelö combined heat and power plant in Norrköping, Sweden. Chemical analysis undertaken during the incident revealed the presence of boron throughout the water/steam cycle, which is believed to contribute to pH depression as a result of boric acid ionisation.

Raw water for the process is obtained by the condensation of moisture released during combustion using a heat exchanger situated inside the flue gas stream. Prior to appropriate treatment, the flue gas condensate is heavily contaminated with trace species from various fuel streams. While the plant also fires coal, rubber, biomass, and industrial and municipal waste, it appears possible that boron was introduced into the raw water from construction wood waste fuel, which as a raw material is treated with boron-based compounds for fire protection. Chemical analysis demonstrates that the installed water treatment plant does not appear to be capable of removing boron from the raw water supply under normal operation.

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Eskom's Contribution to Good Chemistry Practice in the Generation of Electrical Power
Stéphanie D. M. Marais and Eric V. Maughan

Eskom, the largest electrical power producer in Africa, has always been serious about the quality of chemistry practiced at its power plants. To maintain this high level of power plant chemistry, Eskom has introduced an excellent management and performance control system, which includes, among other things, a definitive set of uniform analytical methods and compulsory standards, measurement and review of performance, education and effective pre-emptive chemistry control. In this paper, the authors give an overview of Eskom's system and share some of the reasons for its success.

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