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Abstracts

Experience with Water Treatment Applications at Ringhals

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The nuclear industry is considered to be a conservative industrial sector when it comes to replacing old or introducing new water treatment/purification systems to ensure a high water quality. Proven technology such as resin ion exchange, evaporation and once-through filtration still dominates in most applications, giving rise to high costs in materials, workload and for waste disposal. In other industries such as electronics and pharmaceuticals, new and supplemental technologies have been successfully introduced over the past decades, without their being fully accepted in the nuclear power plants (NPPs). In fact, rather little improvement seems to have been made in the new generation of light water reactors in this area. These issues need to be addressed to ensure that new as well as modernized existing power plants will be more competitive from environmental and economical points of view.

At Ringhals NPP in Sweden, some new technologies have been evaluated during the last years on a pilot scale as a part of various R&D projects and have sometimes been installed as full-scale systems. Examples are gas transfer membrane (GTM) systems to replace the use of hydrazine in closed cooling systems and to reduce the discharge of airborne ^{41}Ar, electro-deionization (EDI) systems for the recycling of steam generator blowdown and polishing of radioactive liquid effluents, electrochemical ion exchange (EIX) in the separation of boron and lithium, nanofiltration (NF) in the purification of radioactive wastewater and electrochemical oxidation (EO) to reduce organics in liquid concentrates.

This paper presents an overview of the objectives and results of the Ringhals experience and gives some additional proposals for possible applications where modern technology could already be considered useful in light water reactors (LWRs) or needs to be further developed.

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The Effect of Carbon Dioxide and Organics in a Steam Turbine

Robert Svoboda

Power plants are designed to run with pure water and steam. For simple cycles (no export steam) no other products are necessary. If organic additives are used in plants with process steam applications, the possible side effects have to be carefully addressed.

Organic oxygen scavengers, dispersants, and chelants as well as organic impurities generally produce volatile acidic degradation products but with no cation for counterbalance. Therefore, such products must be considered as potentially corrosive. Ammonia or hydrazine provide only limited protection against acidic pH in the early condensation zone of the turbine.

Organic amines produce volatile acidic degradation products, but the amine provides cations for counterbalance.

In power plants only conditioned with ammonia and/or hydrazine the level of organics should be kept very low. Especially with low-level ammonia treatment (pH ≤ 9.0), the cation conductivity of steam should be kept less than 0.2 $\mu S \cdot cm^{-1}$ (30 $\mu g \cdot kg^{-1}$ acetate).

High alkalizing feedwater treatments, for example ammonia with pH ≥ 9.6, or morpholine or hydrazine treatment, are more tolerant to acetate. The contribution of organic acids to cation conductivity should in such cases be kept less than 0.5 $\mu S \cdot cm^{-1}$ (80 $\mu g \cdot kg^{-1}$ acetate).

Carbon dioxide, up to 2 $\mu S \cdot cm^{-1}$ in steam, does not influence the pH of the early condensate significantly.

Investigations with three current commercial polyamines did not show a pronounced positive effect on steam turbine efficiency.

Any organic matter in the steam/water cycle brings the risk of detrimental side effects and should thus be avoided unless necessary, for example in certain process steam systems.

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Industrial Steam Purity: Requirements, Proper Sampling and Practical Considerations

Anton Banweg

Steam purity is an important consideration in industrial steam generating systems. Deviation from the required steam purity of a system can cause deposition and/or corrosion situations that can result in efficiency losses, impact availability and in some cases create a safety concern. Unfortunately though, many times the purity of steam from a boiler may not be determined until a problem occurs. Typically isokinetic steam sampling nozzles are not installed in most boiler systems, and when installation is attempted the proper installation requirements for these nozzles may not be able to be met within the actual steam piping installed in the boiler system.

This paper will discuss steam purity requirements, steam sampling system requirements and practical applications.

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A Possible Use of Volatile Amines on Air-Cooled Fossil-Fired Boiler/Turbine Units

Michael A. Sadler, Denis Aspden, Frances M. Cutler, and James A. Mathews

Volatile amines have been used to condition boilers in the power industry for over 70 years. More recently they have been successfully used in minimising two-phase FAC (flow-accelerated corrosion) in nuclear power plants. For a variety of reasons, operators of high temperature and pressure fossil-fired boilers have been reluctant to adopt the use of amines. This is possibly because they have found that oxygenated treatment (OT) provides a simple but effective way of conditioning their steam/water circuits and do not see the need to use additional treatment chemicals. For its successful use, OT demands that steam conductivities be maintained at a low level. There is possibly also a concern that use of organic additives could cause these conductivities to rise above the levels advised for OT and the limits set by turbine manufacturers.

A growing number of new power stations are now being equipped with air-cooled condensers. One of the most commonly used designs employs a large area of finned carbon steel tubes that has been shown to be prone to corrosive attack. It is known, however, that this attack can be minimised by increasing ammonia levels in the bulk condensate to a pH of about 9.8–10. This paper considers the possibility of using a volatile amine with ammonia to ensure that the pH in the early condensate droplets formed in air-cooled condensers is high enough to suppress any corrosion.

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2008's Scientific and Technical Contributions

As every year, the January issue closes with abstracts of all the articles published in this journal in the previous year. I would like to remind you that back issues of our journal are – with few exceptions – still available and that you can receive PDF files of all articles by e-mail. The order forms may be downloaded from our homepage.

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PPChem 101 – Fossil Cycle Chemistry
Lesson 11:
Layup of Fossil Plant Cycles

In the February 2008 issue, we introduced our project PPChem 101 "Fossil Cycle Chemistry" with the first lesson (*What Is Plant Cycle Chemistry and Why Is It Important for Steam and Power Generating Plants?*). This – eleventh lesson – deals with preventative measures for protecting the plant cycle components during shutdown.

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