

**Abstracts****Katia S. Verheyden, Roger A. M. Ertryckx, Marc De Wispelaere, and Nancy Poelemans  
Belgian Experience with Film-Forming and Neutralizing Amines**

This report gives an overview of experience gained in Belgium with the use of a commercial mixture containing film-forming and neutralizing amines as a conditioning product for the water/steam cycle. The first application concerns the conditioning of two fossil-fueled drum type boilers with an operating pressure of 12.8 MPa; the second application concerns the conditioning of two waste incinerators with an operating pressure of 4.0 MPa. Data are given on the iron and copper concentrations in the water/steam cycle and the impact on the conductivities in the water/steam cycle.

Metallographic examination of a boiler tube extracted from one of the boilers revealed the presence of a very thin magnetite layer between 5 and 10  $\mu\text{m}$ .

The most positive effect of this type of treatment is the gain in startup time after a short stop of the units. The required steam and boiler water quality is reached remarkably quicker than with the conventional ammonia treatment.

**Michael A. Sadler, Frances M. Cutler, Eli Salem, and Kevin J. Shields  
Regeneration of Condensate Polishing Resins for Fossil Power Stations: Utility Requirements  
and Comments on Possible Regeneration Procedures**

The regeneration of ion exchange resins used in deep bed condensate polishing plants on fossil power stations is normally performed on-site by power station personnel. The use of specialist contractors to perform similar functions on other water treatment plants has in recent years become more widespread. Electric Power Research Institute is interested in the use of off-site regeneration of polisher resins as it could reduce the capital cost of condensate polishing plants and may possibly have other benefits for some fossil power stations. One large utility in the USA has already adopted the approach and others are showing interest. In this paper consideration is given to the necessary quality to which resins should be regenerated by specialist contractors so as to ensure satisfactory performance when in service. It is recognized that the two commonly used modes of operation of condensate polishing, the conventional H-OH mode and ammonium form operation, have different requirements. The suggested limits for the ionic impurity content of the resins, i.e., for sodium, chloride and sulfate, therefore cover both modes of operation. Possible procedures that supplement conventional regeneration processes are also described and discussed.

**John Babinec**

## **Copper Ion Treatment for Zebra Mussel Mitigation in House Service Water Systems**

We Energies utilizes copper ion technology to control zebra mussel infestation of its Oak Creek Power Plant service water system. The Oak Creek Power Plant, located in southeast Wisconsin along the western shore of Lake Michigan, first observed zebra mussels in plant raw water components in 1991. The mussels began to show up in quantity in 1992. Present infestation levels in the intake forebay are > 60 000 zebra mussels per square meter.

The Oak Creek Power Plant is a four unit, coal-fired plant totaling 1 140 MW. The plant has a once-through circulating water system with a common forebay, from which it draws both main condenser circulating and house service water. System design prohibits thermal treatment strategies and obtaining environmental permitting for molluscicidal treatments is difficult at best. Initial treatment strategies revolved around chlorination, using sodium hypochlorite, which proved to be marginally successful, or chlorine dioxide, which raised safety concerns.

MacroTech's ZM-15 copper ion generator was installed and started up in the spring of 1998 to treat the service water system. The copper ion generator controls zebra mussel macrofouling through the controlled dissolution of copper and aluminum anodes. The copper toxicity, at target levels of 10 ppb, causes mortality in mussel veligers and inhibits adult mussel settlement. The aluminum creates a flocculent which smothers veligers and discourages biofilm from forming, reducing microbe induced corrosion, and further inhibiting adult mussel settlement.

This paper discusses plant design, treatment history, environmental permitting issues, design and installation of a copper ion generator, problems encountered and solutions, operating and maintenance requirements, and results to date of copper ion technology at We Energies' Oak Creek Power Plant.

**Miroslav Št'astný, Olga Bláhová, and D. Šimůnek**

## **Copper Deposition on and Surface Structure of Steam Turbine Blades**

On the observed 200 MW turbine, thick deposits of copper oxides with a maximum thickness of 2.2 mm were found on the stages of HP part blades. The growth time of the deposits was 54 647 operational hours, without a turbine washing. The morphology of the deposits indicates that the deposits probably originated from the mechanical carryover, or from condensate used in the boiler for steam temperature control. Measurement of the blade surface structure with deposits was performed by means of a portable device. The evaluation of the measurements was done in agreement with the methodology of geometrical product specifications (GPS). Thick deposits on the convex sides of nozzle blades have the greatest roughness. Thick deposits on the convex sides of moving blades have a slightly lower roughness. Surface profiles of thick deposits are remarkable, with a large mean width of the elements of the roughness profiles. Thin deposits on the control stage and also on the concave parts of blades of other stages have a comparatively low roughness. The surface profiles of thin deposits are marked by a low mean width of roughness profile elements.

**Svend-Erik Therkildsen**

## **Water Chemistry Control and Monitoring Concept for Avoiding Chemistry-Related Failures in Small Combined Heat and Power Plants**

The number of boiler tube failures and breakdowns in power plants, and especially in the relatively new combined cycle plants with heat recovery steam generators, has been increasing since the middle of the 1990s (cf. [1,2]). Some of the factors are staff reductions and too little focus on water chemistry and new constructions (e.g., multi-pressure units, combined drum and once-through boilers, conversion of hot-water boilers to steam boilers), which may demand a specific individual adjustment in water chemistry. In Denmark we have also seen many new small-scale combined heat and power plants (CHP plants) in the last 15 years. The co-generation makes it possible to increase the efficiency to 85–95 % of the fired quantity of fuel. Many Danish small-scale CHP plants are located in small towns, primarily for the purpose of providing the local area with district heating. The consequences are for most of the plants 150 to 250 startups/shutdowns a year, even though heat accumulator tanks are used, because the high efficiency is only achieved at full-load operation. Typically, there is neither a laboratory in the plants nor staff with expertise in chemistry.

Wishing that our operating experience may be helpful to others, this contribution describes how Kyndby Power Station controls and maintains ENERGI E2's 11 small-scale CHP plants, in particular how the 6 staff members at the Kyndby Power Station laboratory monitor and control water chemistry conditions at Kyndby Power Station, the above-mentioned 11 small-scale CHP plants, 7 external waste-fired combined heat and power plants (waste incineration plants) and approximately 37 district heating systems. Even with the recommended water chemistry, we have seen 3 cases of failures in the water/steam cycle, which have necessitated repairs (2 failures in an ENERGI E2 plant and 1 failure in a waste incineration plant). All 3 failures were due to hidden design faults. 2 of the failures are being compensated by adjusting the water chemistry, while one design fault has been corrected.

- [1] Dooley, B., *Tube Failures in Conventional Fossil Plants and in HRSGs*, **2002**. Seminar Combined Cycles and Heat Recovery Steam Generators (Hockenheim, Germany). PowerPlant Chemistry GmbH, Neulussheim, Germany.
- [2] Bursik, A., *PowerPlant Chemistry* **2001**, 4(8), 459.

**Rolf E. Graf, Aleš Seitz, and Xia Fan Gao**

## **Advanced Large-Capacity Commercial Technology for Multi-Pollutant Control**

The presentation describes the application in commercial installations in Europe and China of circulating fluid bed (CFB) scrubbers of advanced GRAF/WULFF technology design, retrofitted to coal-fired steam boilers.

Details are presented of design and operating experience with installations of CFB scrubbers that efficiently remove diverse pollutants down to and below the required and permitted levels. The paper describes successful solutions to substantial operating problems encountered at a CFB scrubbing plant.

The described flue gas scrubbing plants of this simple system design clean the flue gases from boilers comprising units of a capacity of 100 to 300 MW using a single-train scrubbing system arrangement. Specifically, the simultaneous high rates of removal of multi-pollutants are, e.g.,  $\text{SO}_2 > 98\%$ ,  $\text{SO}_3 > 99\%$ , HF  $> 99\%$ , HCl  $> 98\%$ , mercury  $> 95\%$ , and particulate matter  $> 99.99\%$ . These pollutants are removed in a single scrubber module in combination, downstream, with baghouse or electrostatic precipitator means of dedusting.

Information is given on rates and design of a single-module, 660 MW system as would be applied to a coal-fired power plant facility.

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