Application Note AN-PAN-1044

Online trace analysis of amines in the alkaline water-steam circuit of power plants

Thermal power plants use the heat generated by combustion or nuclear fission to produce high pressure steam, which is fed into a turbine driving a generator that converts the mechanical energy into electrical energy. Downstream of the turbine, the steam condenses to water, forming a vacuum critical for the power plant efficiency. This water is returned to a feed tank from where it is pumped back into the steam boiler. Cooling water flows through the condenser in a separate circuit, removing the heat of condensation released by the steam via a heat exchanger.

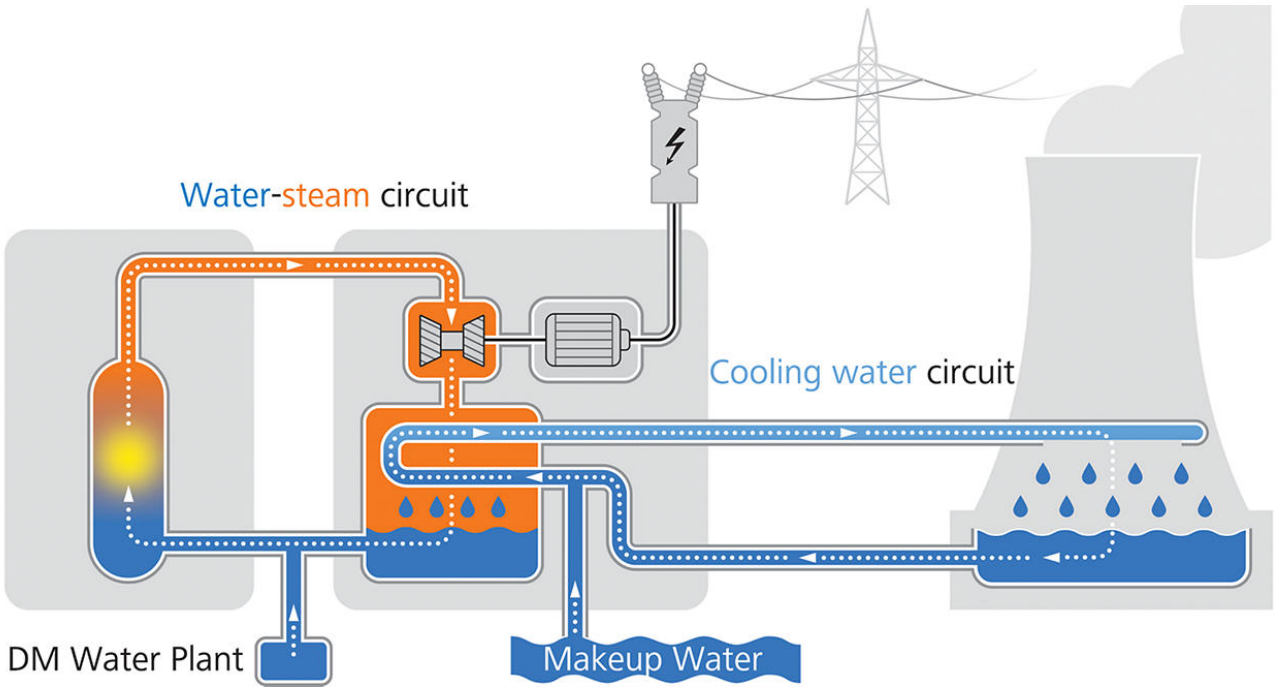

Figure 1. Diagram of a 2-water circuit power plant.

RÉSUMÉ

Unplanned maintenance can lead to costly and critical downtimes and corrosion is often the cause. Exceptionally low pH values increase the corrosion potential, whereas excessively high pH values destroy the protective layer on the metals. Adjustment of the pH value is challenging because the requirement for minimum corrosion and maximum protective layer leaves very little flexibility. To keep corrosion low, the pH value of the watersteam should be in a slightly alkaline range, frequently achieved with All-Volatile Treatment. In this treatment procedure, neutralizing amines such as morpholine, methoxypropylamine, and ethanolamine among others are added to the demineralized feed water to raise pH, inhibiting corrosion in steam condensate systems.

Frequent monitoring of the chemistry ensures safe and efficient power plant operation. Ion chromatography with conductivity detection provides an effective means to control amine addition in alkaline water-steam circuits of thermal power plants. Precise, reliable trace analysis requires the method to be automated as much as possible. Metrohm Process Analytics offers a complete solution for this task: the 2060 Ion Chromatograph (IC) Process Analyzer featuring the Metrohm intelligent Partial Loop Technique (MiPT) option.

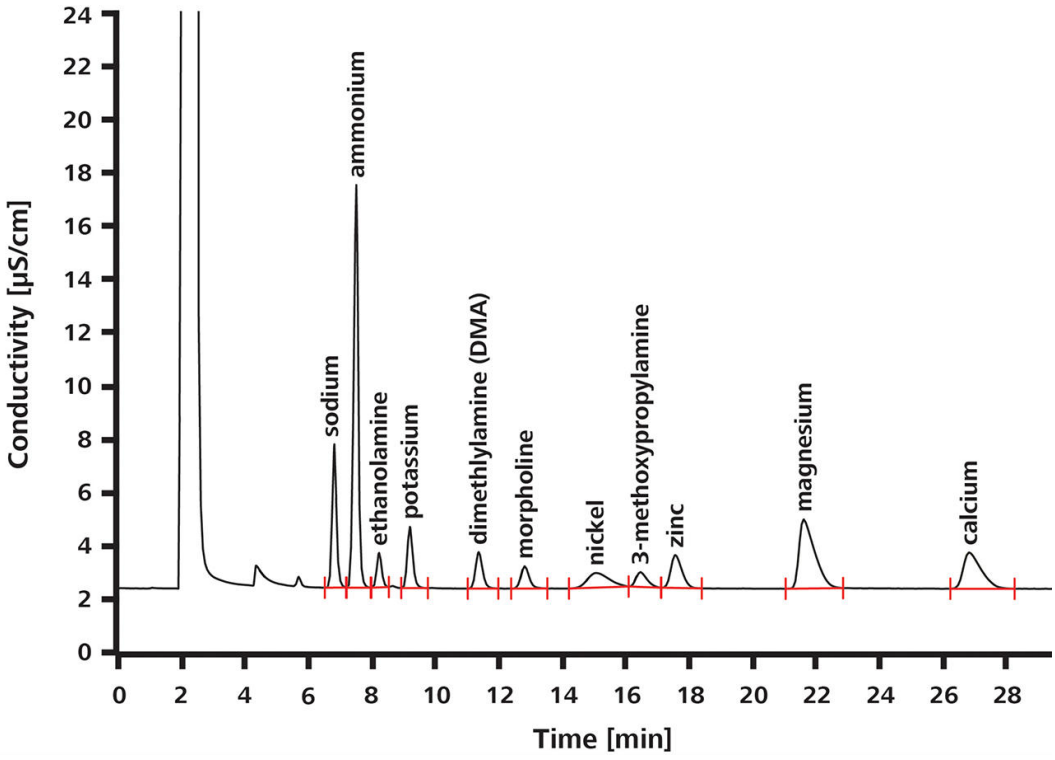

Figure 2. Chromatogram of a simulated water-steam circuit sample treated with 1 mg/L each: sodium, ammonium, ethanolamine, potassium, dimethylamine (DMA), morpholine, nickel, 3-methoxypropylamine, zinc, magnesium, and calcium; sample volume: 100 µL.

APPLICATION

In a single analysis, the 2060 IC Process Analyzer is able to measure numerous ionic compounds in aqueous media from ng/L to % concentrations. Most important is the sensitive determination of sodium next to the high ammonium or amine concentrations, because an increase thereof indicates that cooling water is seeping into the circuit. The analysis system is fed directly and continuously with samples via a bypass in the process. The Metrohm Partial Loop Technique allows, in addition to the automatic calibration feature, a working calcium and magnesium determination. Automated calibration guarantees excellent detection limits, a high reproducibility, and excellent recovery rates. Additionally, sequential cation suppression reduces baseline noise, considerably lowering the detection limits.

The analysis is carried out fully automatically. Analyte detection is by conductivity.

Figure 3. The 2060 IC Process Analyzer is available with either one or two measurement channels, along with integrated liquid handling modules and several automated sample preparation options.

REMARKS

The column oven should be used in this application to maintain analytical column stability above room temperature (up to 40 °C).

BENEFITS FOR IC IN PROCESS

- Inline eluent preparation ensures consistently stable baselines
- Safe working environment and automated sampling
- High precision analyses for a wide spectrum of analytes with multiple types of detectors
- Protect valuable company assets (e.g. pipes, PWR, and turbines, which are prone to corrosion)

FURTHER READING

Related application notes

AN-C-049 Trace cations in power plant feed water stabilized with 7 ppm monoethanolamine (MEA)

AN-CS-010 Traces of lithium and sodium besides monoethanolamine in water-steam circuits of thermal power plants

AN-C-139 Cations and amines in the water-steam cycle

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CONFIGURATION

2060 IC Process Analyzer

L'appareil d'analyse 2060 Ion Chromatograph (IC) Process Analyzer de Metrohm Process Analytics repose sur le concept de la plate-forme modulaire 2060. Cette architecture modulaire permet de séparer les armoires dans différentes zones d'un site et de connecter jusqu'à 20 flux d'échantillons en vue d'une analyse séquentielle à plusieurs endroits d'un site afin de gagner du temps.

Cet appareil d'analyse n'impose aucune restriction concernant le matériel, les logiciels et la personnalisation des applications. Du module de production d'éluant en continu aux modules par voie humide pour le conditionnement des échantillons, en passant par les multiples blocs de détection CI, le 2060 IC Process Analyzer offre toutes les options nécessaires pour toute application industrielle.

Le logiciel 2060 est une solution logicielle « tout-en-un » qui controle l'appareil d'analyse afin d'effectuer des analyses de routine selon différentes méthodes de maniement, différentes fiches horaires et différents graphiques de tendance. En outre, les protocoles de communication du processus (par ex. Modbus ou Discrete I/O) étant variés, le logiciel 2060 peut etre programmé pour envoyer automatiquement des retours d'information et des alarmes au système chargé de la procédure et pour prendre les mesures nécessaires (par ex., répéter la mesure d'un échantillon ou démarrer un cycle de nettoyage). Toutes ces caractéristiques assurent un diagnostic entièrement automatique de la procédure industrielle, 24 heures sur 24, 7 jours sur 7.