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

Summary

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.

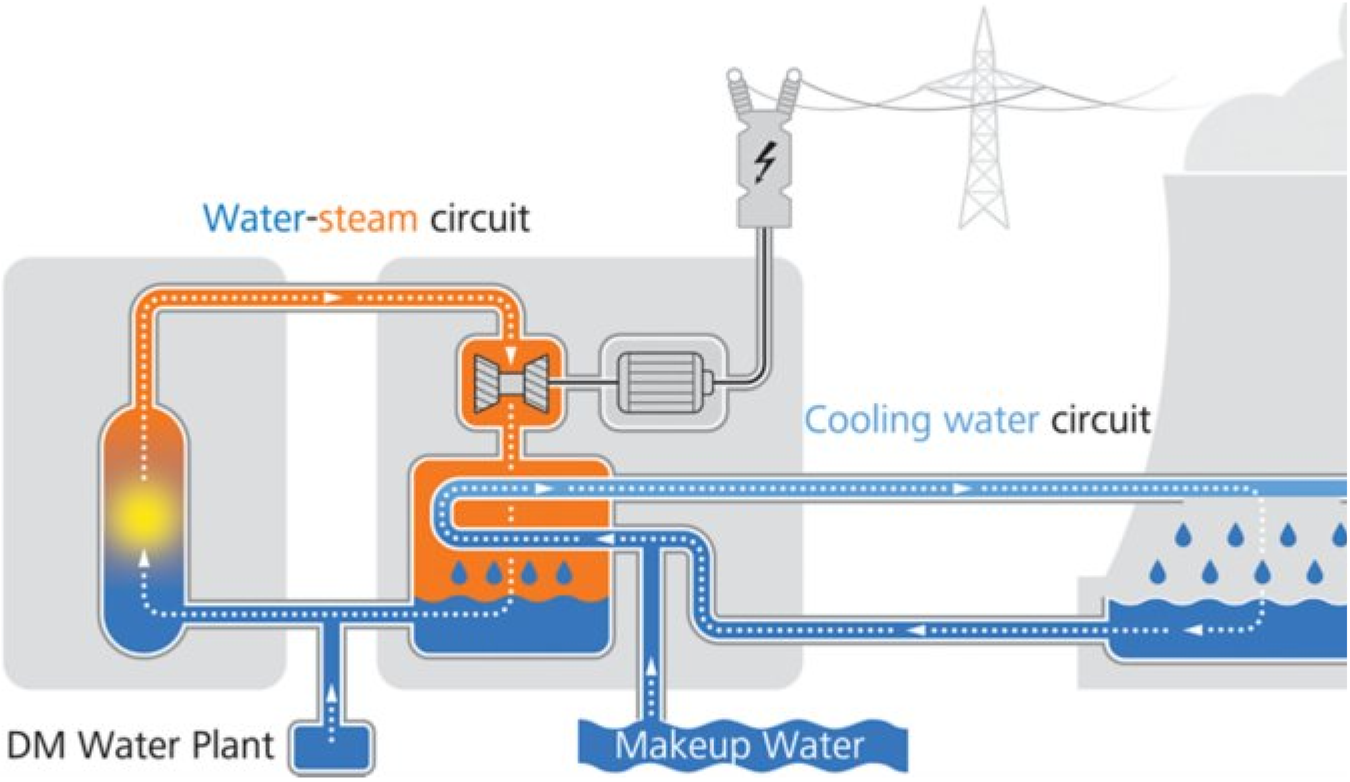

Figure 1. Diagram of a 2-water circuit power plant.

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.

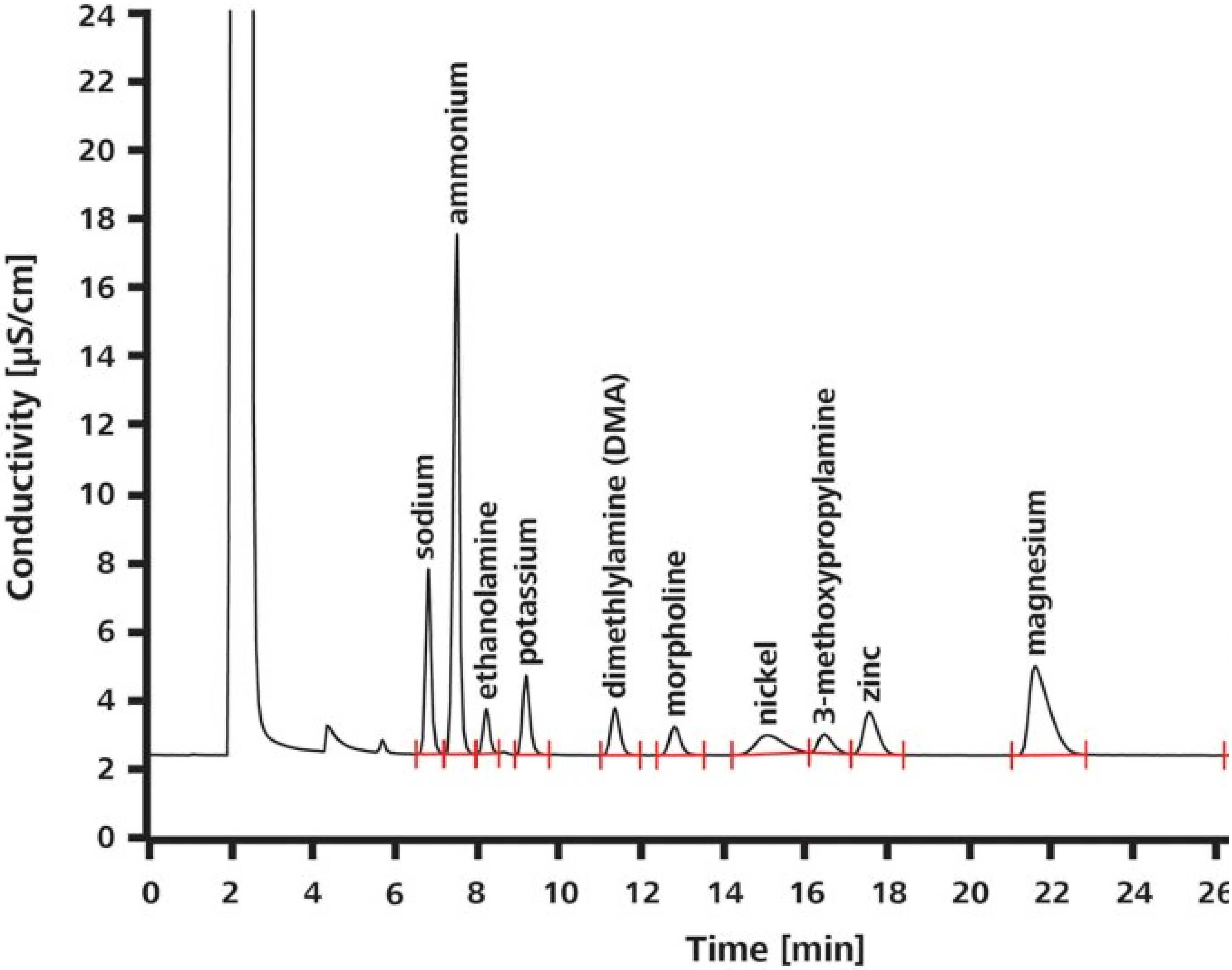

Figure 2. Chromatogram of a simulated water-steam circuit sample treated with 1 mg/L each: sodium, ammonium, ethanolamine, potassium, dimethylamine (DMA), morpholine, nickel, 3-methoxypropylamine, zinc, magnesium, and calcium; sample volume: 100 L.

Configuration

A402060011C - 2060 IC Process Analyzer

The 2060 Ion Chromatograph (IC) Process Analyzer from Metrohm Process Analytics is based on the modular 2060 platform concept. This modular architecture enables the separation of the cabinets in different locations around a plant and the connection to up to 20 sample streams for time-saving sequential analysis at multiple areas inside of a plant. This analyzer has no limits in terms of hardware, software, and applications customization. From continuous eluent production module, wet part modules for sample conditioning, and multiple IC detector blocks, the 2060 IC Process Analyzer has all the options for any industrial application.The 2060 software is an «all-in-one» software solution that controls the analyzer to perform routine analysis, with different operation methods, time sheets, and trend charts. Furthermore, thanks to the variety of process communication protocols (e.g. Modbus or Discrete I/O), the 2060 software is programmable to send automatic feedback and alarms to the process and take action if necessary (e.g., re-measure a sample, or start a cleaning cycle). All of these features ensure fully automatic diagnostics of the industrial process – around the clock, seven days a week.

Application

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.

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.

Remarks

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

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

Metrohm AG
Ionenstrasse
9100 Herisau
mailto:info@metrohm.com