Application Note
Power no. 03

Sodium Measurement in Power Plants

Introduction

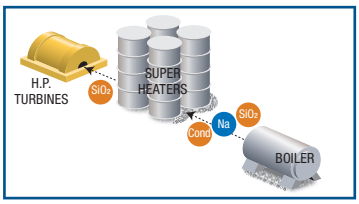
Water quality is critical to the efficiency and performance of a steam generation plant and to the longevity of its associated equipment.

Today, sodium concentration has become one of the most important indexes for water quality throughout the steam and water cycle in power plants. Due to the very high sensitivity of the sodium analyser, it provides an early warning on the water chemistry quality of the plant and therefore is a key tool to protect the value of your assets.

This document discusses the different applications in a power plant and the benefits of measuring sodium with on-line analysers.

Steam

Measurement of sodium in steam before the superheater is strongly indicative of possible stress corrosion.



Under the conditions of high pressure and temperature of today's power plant, the problem of steam solubility of inorganic compounds is increasingly important.

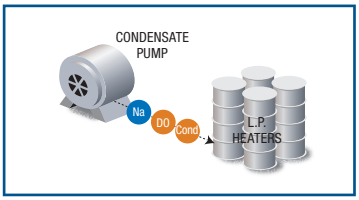
Of particular significance is the steam solubility (in addition to carry-over) of sodium salts, e.g. sodium chloride (NaCl) and sodium hydroxide (NaOH), because of the danger of stress cracking corrosion in the superheating section.

The measurement of sodium directly in steam, immediately before entering the superheater, is now recognised as being strongly indicative of possible stress corrosion in the superheater.
It should be noted that corrosion will occur only if sodium is present together with chlorides or hydroxide anions and not, for instance, with sulfates. Chlorides and hydroxides are corrosive, not the sodium. The latter serves only as the carrier.

The measurement of sodium in the steam is an excellent indication of mechanical carryover from the drum into the steam. Specifically for plants with low boiler pressure (40-80 bars), since non-volatile boiler treatments are typically sodium based (i.e. mixture of sodium phosphate tribasic and sodium phosphate di-basic).

Condensate

Sodium measurement should be the preferred option for early warnings of excursions on condensates to minimise associated risks.



Condensate polishing plays a vital role in power plant cycle chemistry, providing the means to reduce the transport of metal oxide and ionic impurities to the steam generator during all modes of operation, particularly during start-up and upset conditions.

The benefits of condensate polishing are:

- Reduced delays to commissioning and start-up as a result of chemistry transients
- Protection of the steam generator during impurity ingress such as with condenser in-leakage
- Improved steam purity resulting in less turbine deposition and phase transition zone corrosion
- Reduction in impurities fed to steam generators thereby minimising the frequency of chemical cleaning
- Chemically influenced boiler tube failures can be virtually eliminated
- The high degree of feedwater purity necessary for chemical regimes, such as oxygenated treatment (OT), for drum and once-through boilers

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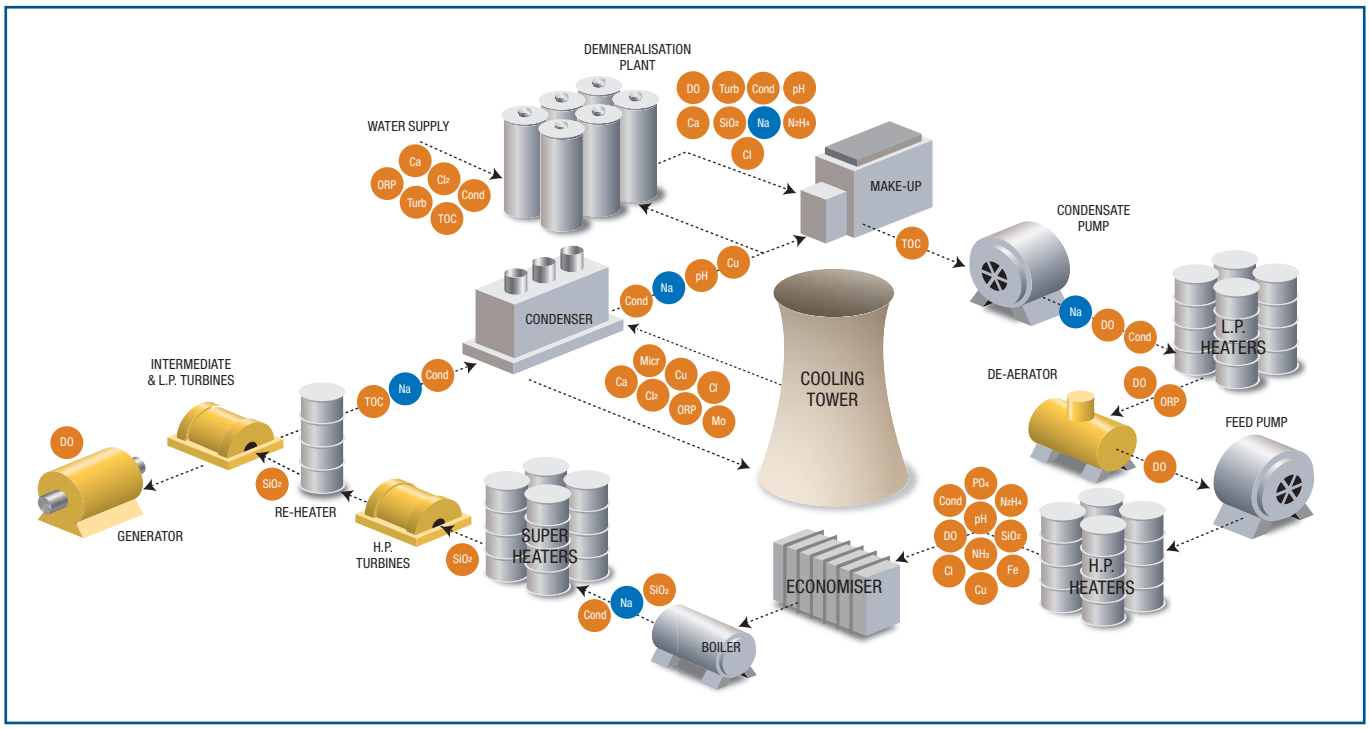


Locations for sodium monitoring

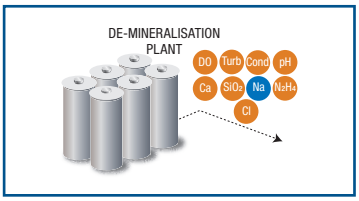
Although cation and specific conductivity are used frequently to detect excursions in water /steam loop, it is no longer sufficiently sensitive to measure the very small condenser leaks which have assumed greater importance in modern plants. In every day conditions, with possible temperature, pressure and flow upset or high conductivity background levels, the minimum meaningful variation will be 0.02 mS/cm. This corresponds to 11ppb sodium.

Sodium analysis is however much more sensitive.
A POLYMETRON 9245 sodium analyser can measure below 0.1 ppb accurately. 100 times more sensitive than conductivity measurements.
As water quality is critical, early warnings of excursions are also critical and sodium measurement should be the preferred option to minimise risk.

Steam purity can be more accurately assessed by measuring sodium concentration in both steam and condensate and, thus, determining the “sodium balance”. The two concentrations should be equal. A higher level of sodium in the condensate indicates a condenser leakage. A lower level of sodium in the condensate indicates deposition of sodium in the steam circuit (on heat transfer surfaces, on turbine blades, etc.)

De-mineralisation Plant

Cation resin bed exhaustion and their regeneration timing can be monitored with high sensitivity and reliability using on-line sodium analysers.



For a de-mineralisation plant, on-line sodium measurement is all about ion exchange resin management.

Benefits of the sodium measurement are:
- ▶ Better use of the resin capacity
- ▶ Minimise sodium breakthroughs
- ▶ Optimise acid rinse-out
- ▶ Optimise regeneration Cycles

Cation resins remove cations such as sodium (Na+). Sodium is the first cation that breaks through when the cation resin bed is exhausted.

Measuring sodium immediately after cation resins gives an early warning in case of breakthrough. Removal of the saturated resin bed and replacement by a new regenerated one protects the ion exchange capacity of the mixed-bed resins installed further down the stream.

On-line measurement of sodium allows regeneration of the cation resin as required.

After mixed bed resin, on-line sodium analysis ensures the quality of the demineralised water delivered to the make-up plant.

Mixed bed resin contains a mixture of both cation and anion exchange resins for a fine polish of the pure water. It reduces any contaminant left in the pure water. Nowadays contaminant ions down to 25 to 35 ppt for sodium can be achieved.

Here, sodium analysers are used to monitor and validate the final water quality, and acts as a final check of quality. POLYMETRON 9245 sodium analysers are used to check the quality of the final water down to 20 ppt levels. Warning comes much earlier and with higher precision with a sodium analyser than by measuring conductivity.

Which analyser version to choose?

Two versions of the analyser are available: The mono channel POLYMETRON 9245, and the multi channel POLYMETRON 9240.

The **POLYMETRON 9245** is recommended as the solution of choice when one of the following criteria is raised as a key requested feature:

- Response time must be lower than 3 minutes
- There is a strong need to separate channels and samples have a difference of sodium greater than 200 ppb
- Temperature difference may be greater than 20°C from one channel to the next
- Any sample with pH < 5. In this case analysers should be placed as close as possible to sample points (minimising piping length).

Alternatively, the **POLYMETRON 9240** is recommended when any of the following criteria is important:

- Minimise the initial cost, the cost of ownership (and spares), and the space occupied by the analyser
- Solution expandability, when it is planned to add new channels in the future and manage up to 4 sampling lines
- Simplified process visualisation and a single user interface is desired

Guidelines and common values

Organisations active in power plant water chemistry do provide several relevant recommendations.

For instance in Europe, the VGB guidelines (Technische Vereinigung der Großkraftwerksbetreiber e.V) are regularly published in combination with technology providers and users.

Fossil power plants have the following:

- Low pressure boilers (< 60 bar) will run with phosphate treatment and sodium levels are high (from 5 to10 ppb)
- Higher pressure boilers (> 60 bar) required stricter water/steam quality reflected by lower sodium levels (from 2 to 5 ppb).

Nuclear power plants and especially the secondary side require similar ranges as for fossil high pressure.

Sampling panel with a sodium analyser

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The solution from HACH LANGE: POLYMETRON 9240 Sodium Analyser

Trusted Data with Autocal and Grab Sample
Fully automatic calibration of the 9240 analyser avoids risk of contamination or human error. The system follows a multiple calibration step cycle to eliminate user variability and possible sample contamination. A convenient grab sample feature allows the user to check operation or measurement of a one-off process sample to reduce laboratory time. Unlike other analysers, a manual sample (250 mL) can be introduced without disconnecting any tubes. After sampling, the analyser automatically returns to on-line monitoring.

Low Maintenance
Maintenance of the 9240 analyser only requires reagent replenishment every 100 days and annual replacement of reagent tubing and the sodium electrode. Clear step-by-step instructions are provided to simplify maintenance operations.

Automatic Electrode Reactivation Optimises Operation and Response Time
To maintain the optimum response time, even when measuring continuously low sodium concentration, the 9240 analyser provides automatic electrode reactivation. Reactivation uses non-hazardous chemicals and eliminates the need for manual reactivation or electrode etching. The POLYMETRON 9245 has a 3 minutes response time.

Easy to Operate with Complete Menus
The system displays comprehensive information for each sample stream (up to 4 channels). A built-in data logger captures measurement readings, calibration results and alarm information for future access. A step-by-step menu and submenu guides the user through all configuration, maintenance, and troubleshooting.

System configuration

The POLYMETRON 9240 Multi-channel Sodium Analyser is delivered with reagents and mounting kit. Can be delivered as wall mount or panel version.

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