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TOC measurement of high-purity boiler feed water in power plants

application note

Description

High-pressure boilers require high purity feedwater to limit the effect of corrosion and deposits that damage steam circuits.

Typical corrosives are acid salts such as chlorides or sulfates, which form corrosive compounds. Chlorides are usually present in raw water, residual trace chlorine, and in the halo-organic form present in deionized water. The most common sulfate ion producer is the decomposition of sulfonic acid–based cationic resins.

Objective

The objective is to prevent sulfate ions generated in the demineralization plant or the condensate polishing plant from contaminating the high-purity circuit. Sulfate ion concentration is difficult to measure in a plant environment, especially in low µg/l levels. The only effective technology is ion chromatography, which does not respond quickly enough. However, if sulfates are a result of the decomposition of the resins, and the decomposition also causes a release of organic molecules, then TOC can be used as a tracer. This method will infer the presence of sulfates and detect the formation of corrosive carbon dioxide gas (caused by the destruction of organic molecules in the boiler).

An additional benefit of this approach is the ability to monitor the presence of contaminating lubricants. This alerts plant personnel of turbine or pump rotating seal leakage before the situation becomes critical.

The Zellweger Analytics solution

In a typical operation, it is assumed that a sulfate peak of about 5 to 6 µg/l occurs each time two resin columns are switched. This is verified in the lab using liquid chromatography. Therefore, TOC is also expected to increase proportionally. The UltraTOC 1500 confirms this assumption: a peak of about 10 µg/l TOC above background TOC was observed during a 20 minute period after switching from one resin column to another. The TOC peak and the duration of the rise may increase with the age of the resin.

In a nuclear plant installation, the UltraTOC 1500 analyzer verified that water quality in different parts of the piping system varied by 75%— from around 120 to 150 µg/l in one section to below 10 µg/l in a new condensate polishing installation.

Continuous monitoring is not necessary, except when the demineralization plant is in full production, and after removal of the decomposition products. However, because there are several boilers and demineralization plants in each power generating facility, at least one instrument should be installed in the main laboratory for analysis of boiler water samples. These samples can be obtained from the sampling panels at the boilers.

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The UltraTOC 1500 analyzer has several advanced features that facilitate boiler water analysis.

- **Unsurpassed response time** requiring less than 3 minutes for T90. This response time is not achievable by any other traditional laboratory TOC analyzer.
- **Versatility**—the two-channel feature enables the analyzer to simultaneously operate as an on-line analyzer on "sample 1 & 2 process inlet". Also as an on-demand laboratory analyzer by introducing a manual grab sample or validation standard on the "stream 3 single sample inlet".
- **Correct Calibration** without risk of water dilution errors using the TOC ADD software. The known addition method of calibration eliminates the problem of assessing calibration solution values. This is an important feature because calibration solutions in the 100 µg/l range are not being commercially available, and prepared solutions are unstable.
- **Reliable**, the UltraTOC 1500 is the only analyzer on the market capable of measuring TOC (in form of NPOC) in the µg/l level with 100 percent reliability. Other analyzers capable of measuring µg/l levels use the differential conductivity method (measuring TC and TIC, calculating the difference TC-TIC =TOC). This method combines the inaccuracies of the two measurements whereas the UltraTOC 1500 direct method removes the TIC from the sample prior to directly measuring the TOC, resulting in superior accuracy. Another error can ocurr when nonorganic chemical species, such as sulfide ion (S^{2-}), nitrite ion (NO_2^-), hypochlorous acid (HClO), and iodine (I_2), originally present in the sample or formed during the acidification stage, which have a disolved gas phase at low ph, will cross the membrane. Then they will be measured as TIC and subsequently will make the TOC measurement incorrect.

Recommended system

UltraTOC 1500 analyzer, 5 µg/l to 5000 µg/l.

One-year spare parts kit.

Purge gas: CO_2-free oxygen or air, 1 l/min maximum, 200 kPa bar (29 psi). If purge gas is not available, the use of the Zellweger Analytics AAS300 Purge Gas Generator is recommended.

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