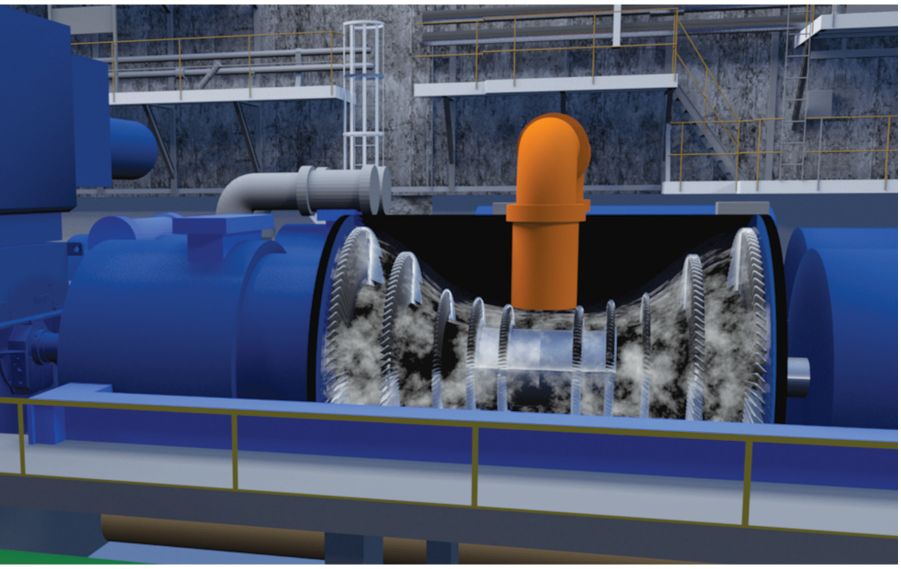
ABB MEASUREMENT & ANALYTICS | APPLICATION NOTE

Optimizing power plant performance through silica monitoring

Using ABB's Navigator 600 silica analyzer to reduce silica contamination



Boosting plant performance and minimizing failures through on-line silica monitoring.

Measurement made easy

—
On-line silica monitoring

Introduction

Extensive on-line chemical monitoring of both the water / steam cycle and water treatment plant on modern power stations is now a very well established practice. This enables careful control of the water chemistry, to achieve peak efficiency and minimize down time due to excessive boiler corrosion or scaling.

Achieving well-balanced water chemistry is vital to optimizing the efficiency and availability of boiler plant in power station applications. If the plant chemistry is allowed to vary from specified limits, expensive plant outages can occur, potentially incurring costs of over $1,000,000 per day.

Accurate and reliable monitoring of water quality across a range of parameters is therefore critical in ensuring continuous and efficient operation of power generating equipment.

The application

Power stations use a large amount of water at very high temperatures to generate steam to drive the turbines.

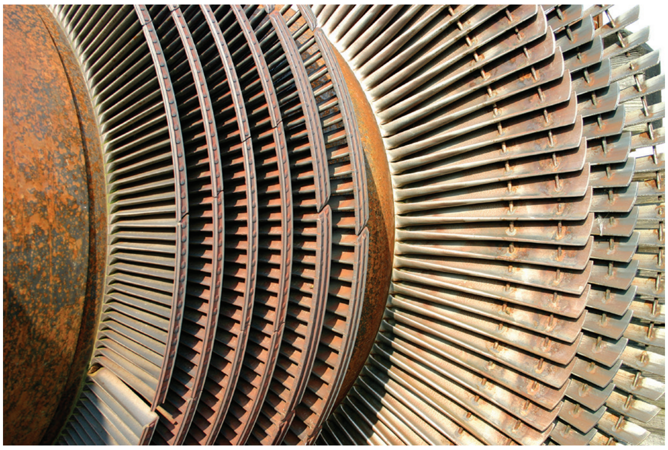
Plant managers must make sure the boiler and the steam lines are in good condition and not being damaged by contaminants in the water. Feed and boiler water chemistry is monitored and adjusted to prevent damage through the addition of certain chemicals.

If applied in overly-high quantities, these dosing chemicals can actually accelerate boiler corrosion, potentially resulting in premature boiler or condenser tube failure.

Careful monitoring of boiler conditions is necessary to prevent corrosion and build-up of scale, protecting the plant and making sure it is in good working order. Silica is often one of the main causes of reduced efficiency and failure of power plant and therefore must be kept under tight control.

The challenge

Silica is a major culprit behind the build-up of hard and dense scale inside the boilers and turbines of power generation plants.



Silica build-up on steam turbines can result in premature failure, leading to extensive unplanned downtime.

Silica forms a dense porcelain-like scaling that cannot be removed even with acid. Silica scaling also has a very low thermal conductivity. Due to its low thermal conductivity, even a 0.5mm build-up of silica can reduce thermal transfer by 28%, reducing efficiency, leading to hot spots and eventual rupturing, resulting in plant failure.

The only way to effectively control silica build-up is through effective monitoring.

The solution

A thorough monitoring regime should see silica being measured at multiple points around the steam generation and distribution cycle.

A starting point is the demineralization plant responsible for removing ionic contaminants from the make-up water. This removal is typically achieved in three ion exchange beds. First a cation bed removes positive ions such as sodium, calcium and ammonium and replaces them with an H^+ cation. An anion bed then strips out negative ions such as chloride, sulphate and nitrate, replacing them with hydroxyl ions (OH^-). Finally a mixed bed removes residual contaminant ions to leave highly purified water.

Reactive silica is present in water as a weakly charged anion, which can be captured by the anion bed. However, the silica anion is held relatively loosely by the ion exchange resin and is therefore among the first species to break through the bed when it nears exhaustion. Monitoring the breakthrough of silica at the outlet from the anion bed is therefore a good indicator of when a bed needs regenerating. Regeneration is achieved by passing an alkali solution through the resin to reinstate the hydroxylions.

Monitoring silica at the outlet of the mixed bed provides a useful check on the state of the anion exchange resin in the bed, as well as checking the quality of the water passing to the boiler as make-up water. The final level of silica in the boiler feedwater must be kept as low as possible to reduce the build-up within the boiler drum and the subsequent carryover in the steam.

In drum boilers, silica levels are also monitored inside the drum itself. Silica is distributed between the water and steam phases inside the drum, with the proportion in the steam rising as the temperature and pressure increase. In high-pressure boilers in particular, silica can be concentrated in the vapor and can be carried over and deposited on downstream equipment such as superheaters and turbine blades.

The level of silica in the drum is controlled using blowdown, but this wastes expensive treated water and energy each time it occurs. It's therefore important to monitor the build-up of silica to ensure the blowdown cycle is optimized.

Measuring silica in the steam from the boiler, either at the superheater or at the entrance to the turbine, gives a good indicator of overall steam purity. Provided that the silica concentration remains below 20ppb, the level of scale deposition should be minimal.

In addition to feed make-up water, the other main source of silica contamination is the water returning to the boiler from the condenser. The condenser cools the steam using locally sourced water that is not normally subjected to the same rigorous pre-treatment as process water. Condensers operate at near perfect vacuum as the steam condenses back into water. This increases the likelihood of contamination problems occurring if there is even a small leak between the process side and the cooling water.

Many condensers are therefore fitted with polishing plants. In the case of the condensate polishing plant however, the levels of contamination at the inlet are prone to wider fluctuations increasing the difficulty of predicting when the ion exchange beds will be exhausted. Only continuous silica monitoring can eliminate the need for frequent, labor-intensive manual sampling and testing.

What can ABB offer?

ABB's Navigator 600 Silica analyzer substantially cuts the costs and maintenance associated with silica monitoring in power generation and other large-scale steam and water-dependent applications.

The Navigator 600 Silica analyzer requires just four 2.5 liter bottles of reagents. This, coupled with the device's revised tubing arrangement, helps shrink reagent consumption to 90% of that of its predecessor, significantly reducing annual costs.

ABB has further decreased the Navigator 600 Silica's cost of operation by combining a carefully designed wet section with remote management, automatic calibration and cleaning functions, all helping to dramatically cut the amount of effort needed to maintain the device.

The Navigator 600 Silica features twice as many diagnostic messages as other units, making it much easier to identify potential problems and minimizing maintenance.

The Navigator 600 Silica provides accurate monitoring over a wide range of silica concentrations (0 to 5000ppb).

The analyzer is available in single or multi-stream configurations, enabling operators to use just one device to monitor up to six streams sequentially all with current loop, Ethernet or Profibus® outputs.

ABB's Navigator 600 silica analyzer

Navigator 600 Silica

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