MEASUREMENT OF SILICA IN THE STEAM/ WATER CYCLE AND DEMINERALISATION PLANTS

The development of modern power plants using new types of boilers has led to steadily higher operating pressures. This is led by power plants striving to attain efficiency of up to or above 50%. Additionally, for each 1% efficiency increase there is a 3% decrease in emissions.

Close monitoring of Silica concentrations in critical locations helps to manage power plant efficiency and reduce downtime by avoiding costly plant shutdowns and repairs.

What is Silica?

Silicon (Si) is a metalloid, the second most abundant element in the earth's crust. The degradation of rocks results in silicon dioxide found in natural waters. Silicon dioxide, also known as silica (from the Latin silex), is a chemical compound that is an oxide of silicon with the chemical formula SiO_2.

Among the many contaminants in the steam/water circuit, silica plays a special role because of its high solubility in the steam. Silica is a very weak acid and is not completely dissociated (ionized) at pH 10. 50% of the silica present in boiler water is undissociated. The undissociated silica is the part which is soluble in steam.

In the case of two phase water/steam, the solubility is dependent on the pressure – at a given pressure, equilibrium is established which results in a given concentration distribution of SiO_2 in the respective phases: steam and water.

What problems can Silica cause?

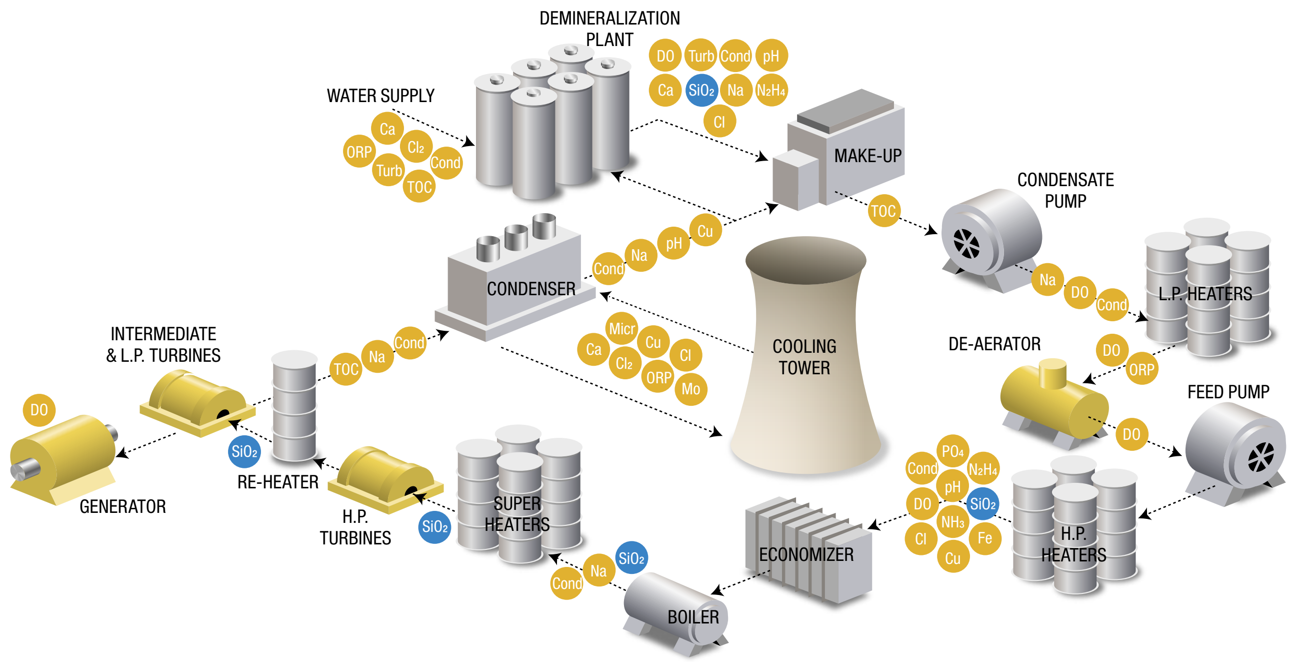
Silica generates a coating on surfaces which is very difficult to remove, even with acid, and can result in a loss of thermal process efficiency. A deposit of only 0.1 mm can reduce thermal transfer by 5%.

The steam, when passing through the turbine, comes into contact with the turbine blades and is cooled down and the silica dissolved in the steam deposits upon the blades. In the worst case scenario, a forced plant shutdown for repair or exchange of blades may be required.

Experience has enabled the industry to specify allowable concentrations of SiO_2 in steam to avoid turbine damage. At an operating pressure of 180 bar, the boiler water should not contain more than 100 ppb of SiO_2 in order to get a maximum of 5 ppb of SiO_2 in the steam, assuming ideal boiler conditions are met.

Once-through boilers require SiO_2 concentration to be lower than drum boilers, since all water (and the impurities it contains) is converted into vapor and there is no possibility for blow-down.

As explained above, excessive SiO_2 concentrations in the boiler water can have a dramatic impact on power plant efficiency so it is logical that this parameter needs to be closely monitored.



Silica measurement locations in a power plant

Silica monitoring at the demineralisation stage

The performance of anion exchangers and mixed-beds is generally monitored with SiO_2 being the indicative parameter. Both the resin efficiency and exhaustion (breakthrough) may be monitored with high sensitivity and reliability. The benefits of such a practice are considerable:

- Follow-up of the demineralisation process performance
- Better utilisation of the resin capacity
- Optimisation of regeneration cycles. Level output should be between 5 to 20 ppb

Boiler feedwater

The most critical measurement location is the boiler feedwater system. Guidelines set by the international power and heat generation association 'VGB' identify one normal and two alarm levels: normal operation <5 ppb, alarm 1: 20 ppb, alarm 2: 50 ppb. Several actions are recommended according to the concentration found above the normal value:

- 5 ppb < 20 ppb, monitoring of the circuit chemistry should be extended to diagnostic components to identify the possibilities for optimisation.
- 20 ppb < 50 ppb, action should be taken to find and eliminate the cause within one week. Further actions to minimise possible damage to the plant should be taken.
- > 50 ppb, action should be taken to find and eliminate the cause within one day. Further actions to minimise possible damage to the plant should be taken.

Boiler blowdown

The goal of the blowdown process is to remove the water from the boiler which removes several impurities like precipitated sludge and dissolved solids. To control blowdown properly, continuous monitoring of control parameters, such as silica, is needed to indicate the effectiveness of the water chemistry programme in the boiler. It also reduces large swings in boiler chemistries. In some cases, levels can go up to several thousand ppb of SiO_2.

Silica deposition on turbine blades is a critical issue

The solution from Hach®: Hach 5500sc Silica Analyser

3rd generation analyser with unsurpassed performances and benefits. On-line and grab samples made with this new analyser provides state of the art benefits.

90 days of continuous runtime
Only 2 litres of each reagent are required for the analyser to perform unattended for up to 3 months.

Save time on maintenance
High reliability – pressurised reagent delivery system, NO PUMPS, no wearing parts.

Avoid downtime
Predictive diagnostic tools, including Hach's proprietary Prognosys technology, warning LEDs, and high-visibility notification screens.

Clean, fast and easy reagent change
Re-designed reagent bottles and improved connection to the analyser saves time and gets rid of dripping reagents. Hach ready-to-use reagents are formulated for optimal accuracy and designed with convenient features like color-coded caps and sealed bottles allowing quick and clean reagent replacement.

Verify easily with Hach lab products – don't waste time second-guessing
Grab Sample In and Out features allow quick analysis of a grab sample poured into the analyser and facilitate easily taking a sample out of the analyser to verify in a lab test.

System configuration

5500.KTO.S0.XYZ	S0=Silica
	X=Power supply AC or DC
	Y=number of channels
	Z=EU (EU doc languages only) or US/ROW version (other languages)

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