HACH ULTRA
EXCELLENCE IN PROCESS ANALYTICS

Application Note

Power No. 09

Measurement of silica in the steam/water cycle and demineralization plants

Benefits

- Close monitoring of Silica concentrations in boiler water can help to manage power plant efficiency and reduce downtime by avoiding costly plant shutdowns and repairs.
- Automatic 2 point calibration eliminates risks of deviation due to human calibration error and maximizes instrument up-time.

Application description

The development of modern power plants using new types of boilers has led to steadily higher operational pressures, approaching and, in some cases, exceeding, the critical pressure of water.

Ignoring purely technical and design issues, a whole new spectrum of physical and chemical problems have come to the fore, concerning mainly the steam solubility of inorganic compounds that were irrelevant in the past.

Among the many contaminants in the steam/water circuit, silica (SiO_2) plays a special role because of its high solubility in the steam. SiO_2 is a very weak acid and, is not completely dissociated (ionized) i.e. at pH 10, 50% of the silica present in boiler water is undissociated. The undissociated silica is the part which is soluble into the 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.

The steam, when passing through the turbine, comes into contact with the turbine blades, is cooled down and the silica dissolved in the steam deposits upon the blades.

This coating is very difficult to remove and can unbalance the whole system resulting in a loss of efficiency or, worse, a forced plant shutdown for repair or exchange of blades.

Experience has enabled the industry to specify allowable concentrations of SiO_2 in steam to avoid turbine damage i.e. for a 180 bar operating pressure, in order to get 5 ppb max. of SiO_2 in the steam, the boiler water should not contain more than 100 ppb SiO_2 if ideal boiler conditions are met (these include drum boiler type, mechanical constraints, vaporous carry-over is not considered, and hide out effects in the boiler, water treatment plant and condensate polishing are not considered as factors).

Once-though boilers require SiO_2 concentration to be lower than drum boilers, since all water (and the impurities it contains) is converted into vapour 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 be closely monitored.

Silica concentration can be measured at the following process steps (which may vary from one plant to another depending on plant architecture and plant management methods):

- Boiler blowdown (drum boilers only),
- Economiser outlet,
- Steam,
- Make-up water,
- Condensate polishing,
- Demineralisation plant

Silica monitoring at the demineralization 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 (break-through) may be monitored with high sensitivity and reliability. The benefits of such a practice are considerable:

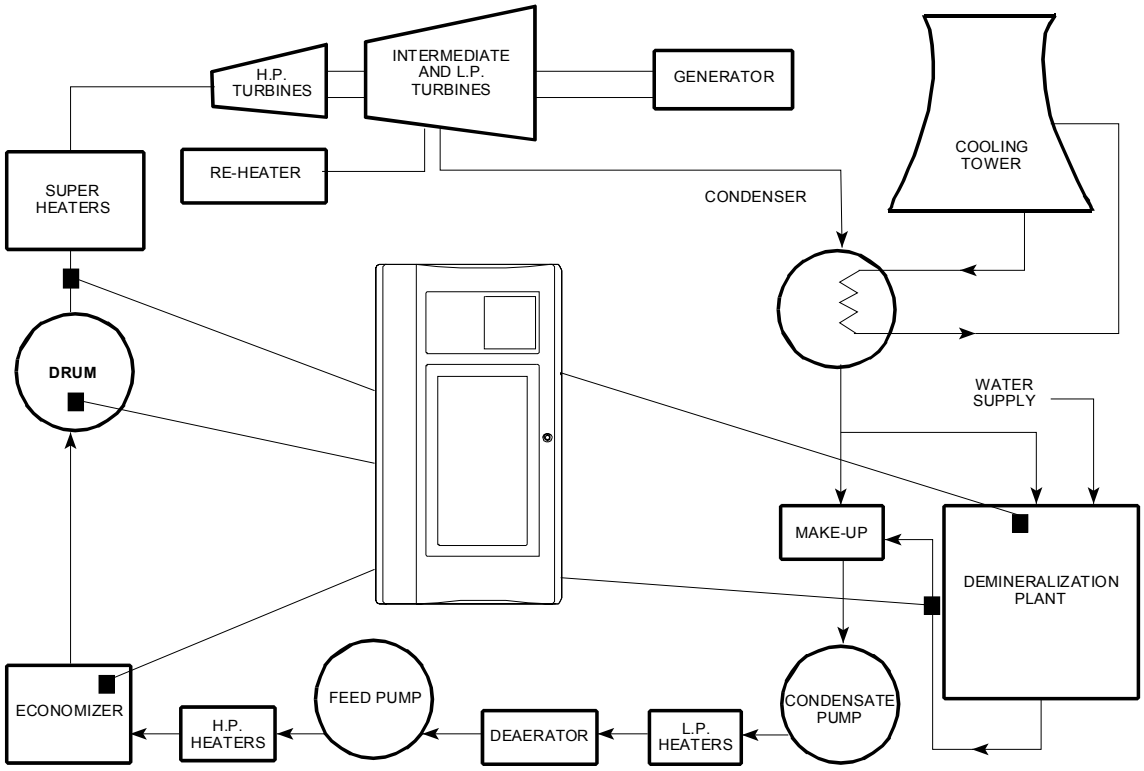
- Follow-up of the demineralisation process performance,
- Better utilisation of the resin capacity,
- Optimization of regeneration cycles.

Range of measurement

Normal operating conditions will generally result in SiO_2 concentrations of approximately:

- 5 to 20 ppb at the anion exchangers output,
- 2 to 5 ppb at the mixed-bed and economiser output,
- Less than 5 ppb in the steam,

In comparison, blowdown water can contain up to several thousand ppb of SiO_2.



Note: all these values depend on the technology used in the demineralisation plant, on the boiler type (low pressure, high pressure, once-through, nuclear ...) in addition to other parameters.

System configuration

Multi-channel SILKOSTAT Model 9210

On-line monitoring of dissolved silica in pure water and boiler water, presents high features as standard:

- Very low cost of ownership,
- No peristaltic pump,
- Reagents refilling every 45 days only,
- No interference from silica contained in the reagents or in the water used to prepare the reagents,
- Large display and easy menu driven programming.

Model	Description
09210=A=1001	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, 1 channel
09210=A=1002	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, 2 channels
09210=A=1014	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with RS485 option, 4 channels
09210=A=1015	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with RS485 option, 5 channels
09210=A=1016	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with RS485 option, 6 channels
09210=A=1021	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with Profibus DP option, 1 channel
09210=A=1022	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with Profibus DP option, 2 channels
09210=A=1023	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with Profibus DP option, 3 channels
09210=A=1024	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with Profibus DP option, 4 channels
09210=A=1025	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with Profibus DP option, 5 channels
09210=A=1026	9210 SILKOSTAT 0 ... 1000ppb SiO2, Panel version, with Profibus DP option, 6 channels
09210=A=1101	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, 1 channel
09210=A=1102	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, 2 channels
09210=A=1103	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, 3 channels
09210=A=1104	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, 4 channels
09210=A=1105	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, 5 channels
09210=A=1106	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, 6 channels
09210=A=1111	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, RS485 option, 1 channel
09210=A=1112	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, RS485 option, 2 channels
09210=A=1113	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, RS485 option, 3 channels
09210=A=1114	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, RS485 option, 4 channels
09210=A=1115	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, RS485 option, 5 channels
09210=A=1116	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, RS485 option, 6 channels

09210=A=1121	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, with Profibus DP option, 1 channel
09210=A=1122	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, with Profibus DP option, 2 channels
09210=A=1123	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, with Profibus DP option, 3 channels
09210=A=1124	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, with Profibus DP option, 4 channels
09210=A=1125	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, with Profibus DP option, 5 channels
09210=A=1126	9210 SILKOSTAT 0 ... 1000ppb SiO2, with wall-mount enclosure, with Profibus DP option, 6 channels
09210=A=5001	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, 1 channel
09210=A=5002	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, 2 channels
09210=A=5003	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, 3 channels
09210=A=5004	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, 4 channels
09210=A=5005	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, 5 channels
09210=A=5006	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, 6 channels
09210=A=5011	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with RS485 option, 1 channel
09210=A=5012	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with RS485 option, 2 channels
09210=A=5013	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with RS485 option, 3 channels
09210=A=5014	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with RS485 option, 4 channels
09210=A=5015	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with RS485 option, 5 channels
09210=A=5016	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with RS485 option, 6 channels
09210=A=5021	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with Profibus DP option, 1 channel
09210=A=5022	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with Profibus DP option, 2 channels
09210=A=5023	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with Profibus DP option, 3 channels
09210=A=5024	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with Profibus DP option, 4 channels
09210=A=5025	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with Profibus DP option, 5 channels
09210=A=5026	9210 SILKOSTAT 2 ... 5000ppb SiO2, Panel version, with Profibus DP option, 6 channels
09210=A=5101	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, 1 channel
09210=A=5102	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, 2 channels
09210=A=5103	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, 3 channels
09210=A=5104	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, 4 channels
09210=A=5105	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, 5 channels
09210=A=5106	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, 6 channels
09210=A=5111	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, RS485 option, 1 channel
09210=A=5112	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, RS485 option, 2 channels
09210=A=5113	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, RS485 option, 3 channels
09210=A=5114	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, RS485 option, 4 channels

09210=A=5115	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, RS485 option, 5 channels
09210=A=5116	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, RS485 option, 6 channels
09210=A=5121	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, Profibus DP option, 1 channel
09210=A=5122	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, Profibus DP option, 2 channels
09210=A=5123	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, Profibus DP option, 3 channels
09210=A=5124	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, Profibus DP option, 4 channels
09210=A=5125	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, Profibus DP option, 5 channels
09210=A=5126	9210 SILKOSTAT 2 ... 5000ppb SiO2, with wall-mount enclosure, Profibus DP option, 6 channels