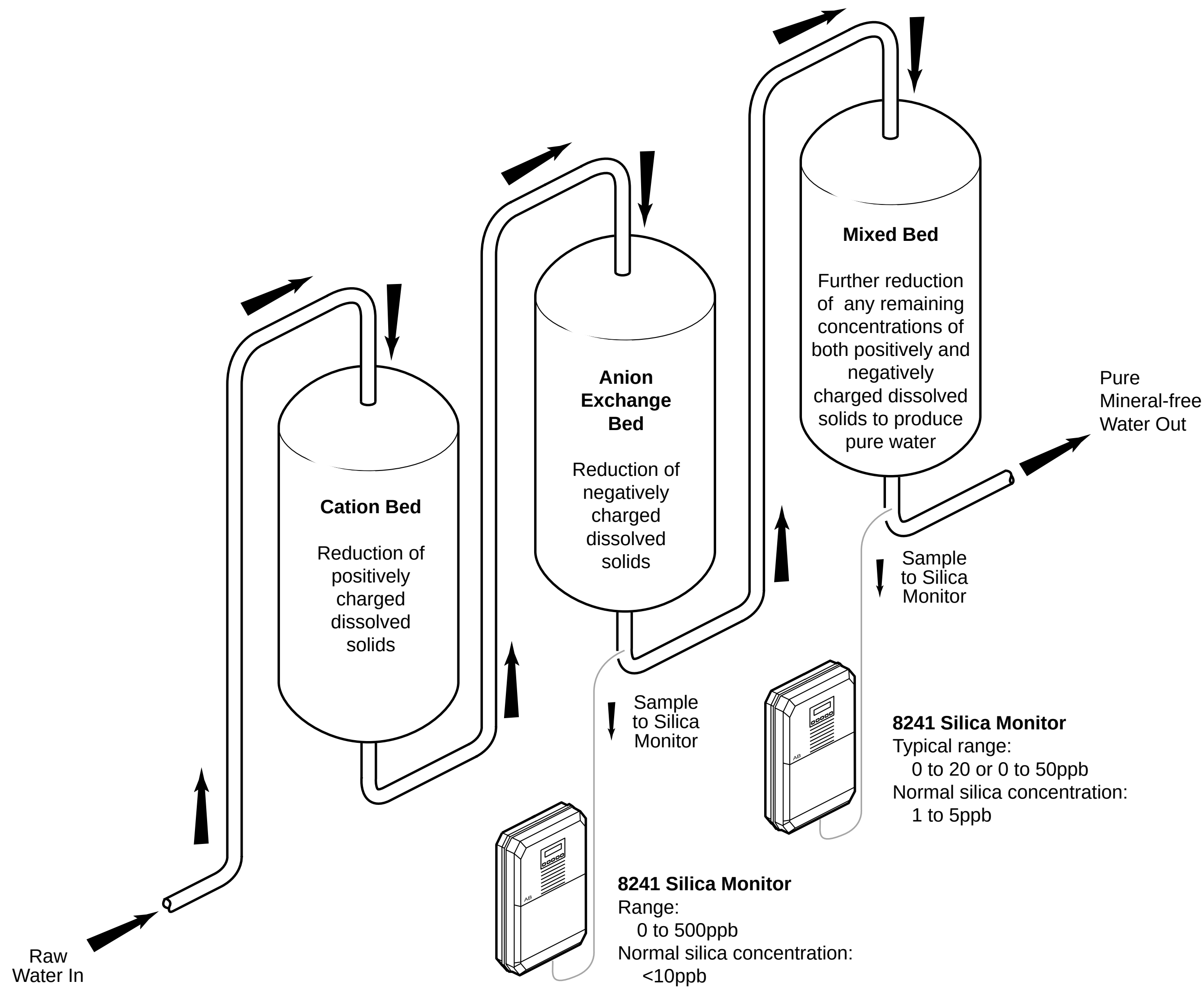
Application Guide

AG/AI–023_2

Silica Monitoring in Water Treatment Processes



The illustration above shows a simple demineralisation plant where anions are exchanged with hydroxyl ions and cations are exchanged with hydrogen ions (by the use of ion exchange resins) to produce pure, mineral-free water. ABB silica monitors are used for continuous monitoring of silica in the process water.

Why use Silica Monitoring in Water Treatment Processes?

The customer needs:

- To detect silica breakthrough and to ensure the process water is pure.
- To ensure the plant operates at the maximum efficiency.
- To allow the plant to be maintained to specified standards.

Why use the 8241 Silica Monitor?

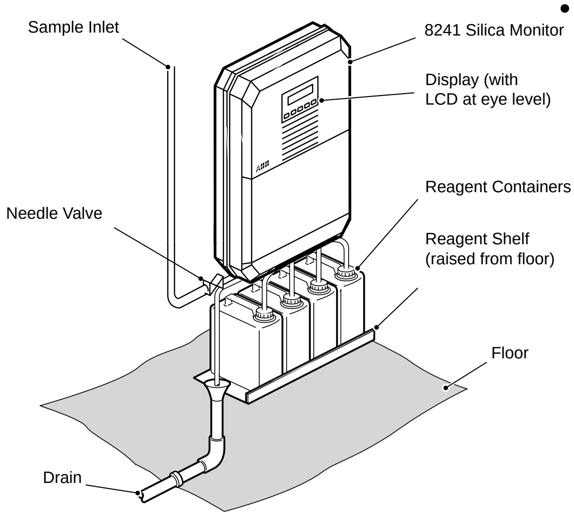
- Wide sample and ambient temperature tolerances as standard minimise the need for additional conditioning equipment (5°C minimum is important in water treatment plant).
- Continuous monitoring provides fast accurate results – rapid response time, less than 7 minutes.
- Manual sampling facility available,
- Automatic programmable two-point calibration,
- A multi-stream version of the 8241 is available with up to six streams – a compact/cost effective solution if there are multiple anion beds on site.
- Security coded to prevent unauthorised adjustments and improve the integrity of data.
- Reduced maintenance tasks and low maintenance costs – pump tubes replaced annually.
- In addition, ABB offer greater security at a lower cost by having:
    - A worldwide network of companies and agents to ensure backup in most countries.
    - Proven reliability – over 100 years of process instrumentation experience.
    - Full installation, commissioning and routine servicing facilities available.

Associated ABB Instrumentation Products

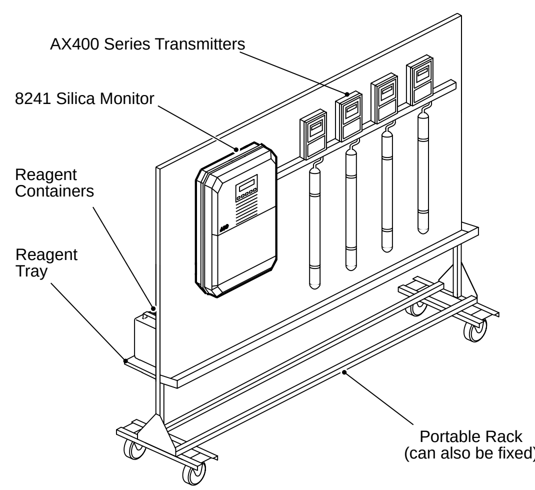
- **Analytical applications**
    - pH monitors.
    - Conductivity monitors.
    - Sodium monitors.
- **Industrial applications**
    - Recorders and recorder/controllers.
- **Flow applications**
    - MagMaster flowmeters,
    - Differential pressure transmitters.

Installation

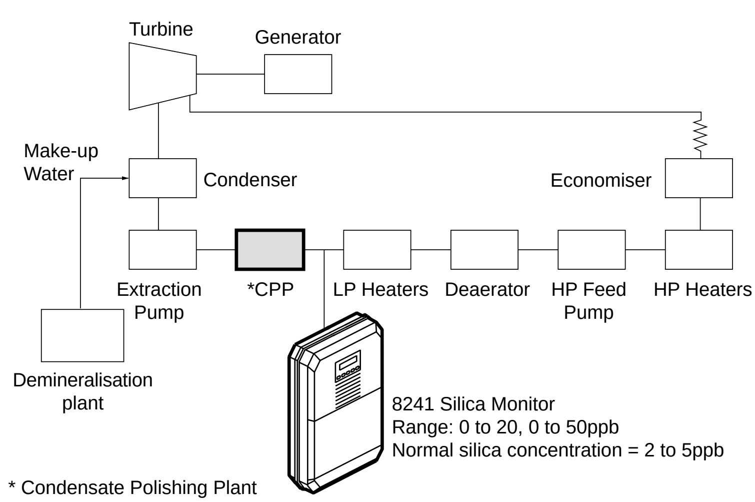
- ABB silica monitors are normally located inside the Water Treatment Plant on a rack – preferably in an air-conditioned room.
- Ensure the ambient temperature does not exceed 40°C.
- Samples are normally at ambient temperatures so sample cooling should not be necessary (even the polishing plant will be below 55°C).
- Fit a needle valve upstream to control the sample flow within required limits.
- Mount reagent bottles on a small shelf beneath or adjacent to the monitor (they can also be left on the floor below the monitor if necessary).
- **On Multi-stream Monitors**
  - Try to group samples of similar silica concentration together.
  - If samples to be monitored by one instrument vary in concentration considerably, try to group the highs in one group and lows in another group.
  - Monitor the high concentration samples first, then increase the monitor sampling time on the first low concentration sample after the monitor has measured the last of the high concentration samples.



Single wall-mounted monitor



Rack-mounted silica monitor with reagent tray at rear



Simplified schematic of 'once-through' boiler system showing location on CPP

Process Description

Basic Measurement/ Analysis Theory

All silica monitors use the colorimetric principle based on the Molybdenum Blue Method. The monitor is an automatic chemist and emulates the actions of a laboratory chemist by adding various reagents to the sample and allowing them to react. At the end of these reactions, the final solution develops a blue coloration. The intensity of the coloration is proportional to the concentration of silica in the original sample.

Concentration is measured by passing the reacted sample through a cuvette or measuring cell. The cuvette has a light source at one side and a photoelectric cell at the other side. The greater the intensity of blue coloration, the greater the amount of light absorbed and hence the smaller the signal from the photoelectric cell.

The system is calibrated by the use of a zero silica solution and a solution of known silica concentration to set the span.

Anion Exchange Bed

Anions are exchanged for hydroxyl ions in this bed until all the hydroxyl ions in the resin are removed. At this stage (known as resin or bed exhaustion) the levels of dissolved solids in the water from the bed outlet will increase. This is known as breakthrough. Silica in the form of the bisilicate ions is held loosely by the anion resin and therefore becomes the first impurity to breakthrough when the resin bed is near exhaustion.

Mixed Bed

The mixed bed contains a mixture of both cation and anion exchange resins to further reduce the dissolved solids content, and thus produce the quality of make-up water required.

Condensate Polishing Plant (CPP)

This type of plant is used mainly on once-through type boilers. It takes the condensate from the steam turbine/condenser and purifies or polishes it to reduce the concentrations of any impurities such as sodium, silica, chloride, sulphate etc. which may have entered the system via condenser tube leaks. Condensate polishing plants (CPP's) only normally remove small levels of contaminants, therefore only have a mixed bed stage (see illustration on previous page).

Measuring Points

Anion Bed Outlet

Monitoring the silica content of the anion bed outlet gives an early indication of bed exhaustion. Because silica is very weakly ionised it has a very low conductivity and cannot be detected by a conductivity monitor.

A colorimetric type silica monitor is the only way of detecting silica breakthrough. If silica is allowed to breakthrough without taking the anion bed off-line, the anion resin in the mixed bed will quickly become exhausted with the possibility of unacceptable silica levels in the make-up water.

Mixed Bed Outlet

Here again, silica monitors are used to check the quality of the final water and detect exhaustion of the anion exchange resin. It is essential that the silica concentration in the final water is kept as low as possible to minimize thermal losses due to blowdown.

Condensate Polishing Plant (CPP) Outlet

As with the complete demineralisation plant, the CPP has a silica monitor on the outlet from the mixed bed unit to detect exhaustion of the anion resin. This is particularly important on once-through boilers as any silica in the feed water after the CPP is deposited in the boiler, causing loss of thermal efficiency and premature shutdown of the system.

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