Application Note AN-PAN-1016

# 炉供水中的二化硅

Due to increasing industry demands for more efficient energy production as well as the increase in operating pressures in modern boilers, the necessity to measure and control silica (Si) concentrations is more crucial than ever. Excessive silica concentrations in the boiler feed water can lead to deposits on turbine blades and on boiler tubes. These deposits cause localized hot spots which reduce the heat-transfer efficiency and must therefore be avoided.

This Process Application Note details the online analysis of silica in boiler feed water. This is accomplished via differential photometry using a cutting-edge thermostatic cuvette module to avoid sample contact at the detector. This method offers different concentration ranges for silica: 0–50 g/L and 0–1 mg/L or higher.

In combination with the power plant's Distributed Control System (DCS), online monitoring of this analyte using a process analyzer ensures that scaling can be controlled before it affects the power plant efficiency, ultimately decreasing downtime and lowering maintenance costs.

## INTRODUCTION

Silica, known as silicon dioxide, comprises more than 10% by mass of the earth's crust [**1**]. It is used in a variety of applications from microelectronics (in wafer production) to components used in the food industry. In the power industry, silica is not so appreciated and is considered one of the major impurities to cause boiler scale and deposits on steam turbine blades. Boiler scale is caused by impurities precipitating out of the water and forming deposits on heat transfer surfaces. As the scale builds up over time, it reduces heat transfer rates. This leads to local hot spots which cause the boiler tubes to overheat and rupture, resulting in costly boiler outages. In addition, untreated boiler scale lowers the boiler efficiency by heat retardation and increases running costs by unscheduled and more frequent boiler blowdowns. Scaling on stator turbine blades causes changes in steam flow velocities and a reduction in pressure that decreases the efficiency and output capacity of a steam turbine.

Due to increasing industry demands for more efficient energy production and the increase in operating pressures in modern boilers, the necessity to measure and control silica concentrations is more crucial than ever. Boiler feed water is the most critical monitoring point, and the higher the pressure in the boiler, the lower the concentration of silica should be. Other sampling points (**Figure 1**) include the inside of drum boilers and water returning to the boiler from the condenser to ensure silica limits are within specification. Silica also plays an important process control role at the demineralization plant where demi-water is produced and polished from groundwater or surface water. An increase in silica concentration or a breakthrough of silica suggests an exhausted ion-exchange bed and is a control indicator for timely regeneration.

Metrohm offers a wide range of process analyzers that are suitable to monitor silica from low ppb (g/L) to high ppm (mg/L) levels. The 2029 Process Photometer from Metrohm Process Analytics (**Figure 2**) is the most straightforward and easy-to-use tool to do so online.

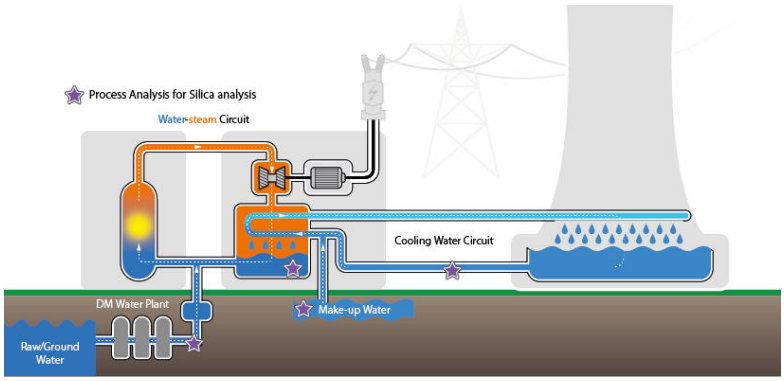


**Figure 1.** Schematic diagram of a thermal power plant with stars noting areas where online process analysis can be integrated into the system.


**Figure 2.** 2029 Process Photometer.

## APPLICATION

Online monitoring of the silica content is possible with either the 2029 Process Photometer (**Figure 2**) or the 2060 TI/2035 Process Analyzers (**Figures 3 and 4**, respectively) from Metrohm Process Analytics. Silica is determined by differential photometry with the molybdenum blue method. All of these process analyzers use a cutting-edge thermostated cuvette module to avoid sample contact at the detector.

**Figure 3.** 2060 TI Process Analyzer.


**Figure 4.** 2035 Photometric Analyzer.

**Table 1**. Silica measurement parameters for photometric analysis.

| Parameters | Range |
|---|---|
| **Silica** | 0–50 g/L (ppb) or 0–1 mg/L (ppm) |

## REMARKS

Process analyzers from Metrohm Process Analytics can be combined with smart, versatile accessories (e.g., sensors) for multi-parameter requirements: namely hardness, chlorine, chloride, sodium, ammonia, pH, conductivity, and metals like iron, aluminum, and copper, to name a few.

## RELATED APPLICATION NOTES

AN-PAN-1038 Power generation: analysis of the m-number (alkalinity) in cooling water

AN-PAN-1056 Online monitoring of sodium in industrial power plants

AN-PAN-1040 Ammonia in cooling water of thermal power plants

AN-PAN-1045 Online monitoring of copper corrosion inhibitors in cooling water

## BENEFITS FOR TITRATION IN PROCESS

- **Save money by reducing downtime:** analyzer sends alarms for out-of-specification values which inform the operator sooner
- Protect **valuable company assets** (e.g., pipes, PWR, and turbines, which are prone to scaling)
- **High accuracy** for lower detection limits of silica

## REFERENCES


1. Flörke, O. W.; Graetsch, H. A.; Brunk, F.; et al. Silica. In *Ullmann's Encyclopedia of Industrial Chemistry*; Wiley-VCH Verlag GmbH & Co. KGaA, Ed.; Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim, Germany, 2008; p a23_583.pub3. https://doi.org/10.1002/14356007.a23_583.pub3.


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## CONFIGURATION

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2060 Process Analyzer :

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### 2035 Process Analyzer Photometric

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## 2029 Process Photometer

2029 Process Photometer  ppb

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