Application Note AN-PAN-1016

锅炉供水中的二氧化硅

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 µg/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 (µg/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.

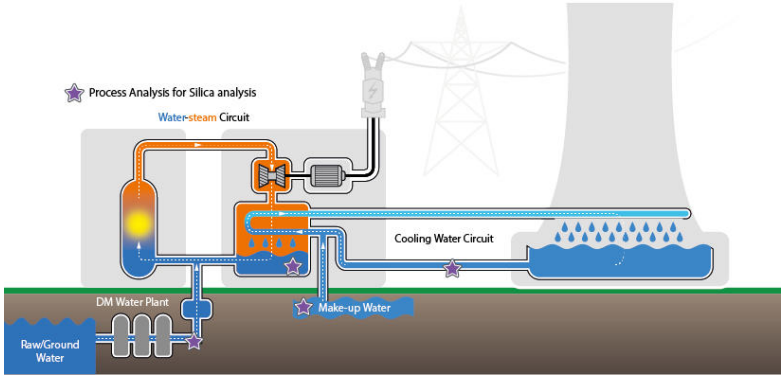

Figure 1. Schematic diagram of a thermal power plant with stars noting areas where online process analysis can be integrated into the system.

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 µg/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.

CONTACT

瑞士万通中国
北京市海淀区上地东路1号
院1号楼7层702
100085 北京
marketing@metrohm.com.cn

CONFIGURATION

2060 Process Analyzer

2060 Process Analyzer 是一种在线湿化学分析仪,适用于无数应用。此过程分析仪提供了一个新的模块化概念,由一个称为«主机柜»的中心平台组成。

主机柜由两部分组成。上部包含触摸屏和工业计算机。下部含有柔性取样部,其中放有用于实际分析的硬件。如果主取样部容量不足以应对分析挑战,那么主机柜可以扩展为多达四个额外的取样部机柜,以确保有足够的空间来应对具挑战性的应用。附加机柜的配置方式使每个取样部机柜可以与具有集成(非接触式)液位检测的试剂柜组合使用,以增加分析仪的正常运行时间。

2060 Process Analyzer 提供不同的湿化学技术:滴定法、卡尔费舍尔滴定法、光度测定、直接测量和标准添加入法。

为满足所有项目要求(或满足您的所有需求),可提供样品预处理系统,以确保分析解决方案可靠。我们可以提供任何样品预处理系统,如冷却或加热、减压和脱气、过滤等。

2035 Process Analyzer Photometric

适用于光度分析的 2035 Process Analyzer 过程分析仪,包括一个在较大浓度范围内均可十分稳定的紧凑型光度计模块,且可通过其搅拌功能保持恒温。可提供两种选择款型的分析仪:比色皿系统或光纤浸渍探头。比色皿系统紧凑小巧,可降低试剂消耗,但能够提供较长光路以确保较高灵敏度。光纤浸渍探头显著地扩展了我们的应用范围,通过使用内部样品稀释步骤使高浓度样品的准确测量更加方便,且具有短于比色皿系统的光路。

光度分析是一种广泛使用的常见技术,可以在饮用水甚至钙和镁的盐水溶液中测定离子成份如氨、锰和铁。不利的样品基质特性如样品颜色或浊度等可通过差分测量去除,测量前后加入显色剂。

2029 Process Photometer

2029 Process Photometer 在可见光范围内进行灵敏的光度吸收测量。低 ppb 范围内的指示极限使其成为各种应用的有吸引力的仪器。

分析仪的核心是高性能的紧凑光度计模块,可以进行 24/7 在线测量。它包括一个具有 3 cm 光路和 LED 技术的恒温比色皿,无论环境如何,都能保证稳定准确的测量。可使用差分吸光度测量方法自动检测显色稳定性。光度测定实验室方法可以轻松转移到 2029 Process Photometer,消除结果中的任何偏差,从而改进过程验证。

有几个市场与 2029 Process Photometer 很是契合:如化工, 环境, 半导体, 石化, 食品和饮料, 饮用水, 能源/电力。

选定的应用包括:

- 磷酸盐
- 二氧化硅
- 氯
- 镍
- 锌
- 铜
- 铬
- 氨
- 硝酸盐
- 亚硝酸盐
- 硬度
- 等等