**PROCESS DESCRIPTION**

Coal is the predominant fuel source for power generation in many parts of the world because of its abundance and relatively low cost.

During the combustion process, large volumes of fly ash and acid gases are generated. Without some means of removal, these would be exhausted directly to atmosphere in the effluent off-gases or “flue gas.” Two primary acid gases are of concern. The first is sulfur dioxide. When combusted, elemental sulfur contained in the coal at varying concentrations is oxidized to form sulfur dioxide.

Sulfur dioxide in turn decomposes in the presence of water to form sulfuric acid or “acid rain.”

The second gas is nitric oxide. The presence of atmospheric nitrogen introduced during the combustion process reacts to form NOx precursors. Both of these acids are highly corrosive to the plant as well as detrimental to the environment.
Most power plants employ either electrostatic precipitators (bag houses), dry scrubbers, or wet scrubbers to remove fly ash and acid gases. In a typical wet scrubber, lime (calcium hydroxide) or limestone (calcium carbonate) is injected as a slurry into the hot effluent combustion gases to remove entrained sulfur dioxide. The lime-based scrubbing solution reacts with SO$_2$ to form calcium sulfite:
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\text{SO}_2 + \text{CaCO}_3 \rightarrow \text{CaSO}_3 + \text{CO}_2
\]
Calcium sulfite precipitates out, and is either removed in sludge form or further treated to form calcium sulfate (gypsum), which can be sold.

APPLICATION CHALLENGE
Measurement and control of pH is critical to the efficient operation of a wet scrubber. Absorption of sulfur dioxide gas is dependent upon the pH of the scrubbing solution. If the pH is too low, the acidic sulfur dioxide gas is not absorbed. This results in corrosion and potential release of SO$_2$ to the environment. If the pH is too high, even though SO$_2$ will be absorbed, lime reagent is wasted, but worse, the excessive lime can cause scaling of recirculating systems and spray nozzles.

Typically, pH sensors are installed in line either directly on a circulation line or on a slip-stream from the process. Process fluid temperatures are generally around 120 °F at approximately 20 to 50 psig. Flow rates are usually very high, often in excess of 100 gpm. Additionally, the process fluid is saturated with lime, fly ash, and entrained solids. Though the control point is normally 5 to 7 pH, depending on the reagent, it is not uncommon to see pH values as low as 2 during startup and process upsets.

The greatest challenge of this measurement is the severity of the installation environment. Abrasion and fouling necessitate frequent cleaning and recalibration. Sensor life is often very short. Replacement of the sensor in just a few months is not uncommon.

Because of the perceived unreliability, multiple sensors are often installed at the same location, increasing the installed capital cost. On-line measurements are also usually validated through the use of a portable pH meter or grab samples which are subsequently analyzed by laboratory personnel. Many facilities dedicate a single person just to clean, calibrate, and maintain the pH systems on a daily basis. This further increases the overall system costs.

SOLUTIONS
An historical shortcoming of on-line pH sensors has been the susceptibility to fouling, abrasion, and breakage of the pH measuring and reference electrodes. The advent of ruggedized, flat glass pH sensors and intelligent field transmitters has drastically reduced the cost per measurement point, and has improved the reliability and confidence in the field measurement.

The 871A pH sensor has successfully demonstrated superior performance in this application. The flat, ruggedized glass design minimizes the potential for fouling and coating in especially “dirty” process streams. The low profile design and thicker electrode glass also make breakage less likely. The high flow rates typically associated with wet scrubber applications in fact improves the reliability of the sensor by helping to keep the sensor electrode face clean. Where previously installed equipment required daily cleaning and calibration, weekly cleaning and monthly calibration is more typical with the 871A.
One additional way that reduced maintenance is accomplished is through the use of the diagnostic capabilities of the 870ITPH Intelligent Transmitter. When interfaced with an intelligent pH sensor, multiple diagnostic tools can be employed to help determine when maintenance is required, as well as the overall health of the sensor. Key diagnostics include fouling of the reference junction, RTD failure, calibration required, glass aging, glass breakage, leakage of process fluid into the sensor body, preamplifier failure, etc. In addition, user configurable diagnostic settings can be programmed to tune the diagnostics to the user’s specific requirements. For example, the percent slope diagnostic set point, which is used to notify the user when the glass pH electrode has lost span, can be adjusted to notify the operator when the slope has fallen below a predetermined set point. By tuning this parameter up or down, the user can in effect alert the system when sensor replacement is actually required. Similar set points are available for fouling and coating of the sensor.

*Figure 1. Typical pH Sensor with Flat Sensing Surface*