APPLICATION NOTES

Foxboro pH Control System
Superphosphate Fertilizer Production

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FOXBORO®

Foxboro pH control system delivers long-lasting, accurate pH analysis in corrosive fertilizer plant

BENEFITS

- **Accurate, reliable pH measurement in extremely demanding application**
- **Improved emissions monitoring for environmental compliance**
- **Reduced maintenance and downtime with ease of sensor installation, replacement, and calibration**
- **Lower equipment costs with longer sensor service life in challenging application**

ABOUT THE FOXBORO pH CONTROL SYSTEM

The Foxboro 875PH intelligent analyzer and 871PH rebuildable sensors are a proven system for demanding pH measurement applications. The 875PH analyzer provides ease-of-use advantages such as two alarm relays, two 4-20 mA outputs, and an RS-232 serial port for remote configuration. The fast-response 871PH rebuildable sensors include a robust and continuously reusable sensor body with a field-replaceable measuring electrode. The 871PH rebuildable sensors can withstand extended exposure to temperature cycling applications up to 121° C (250° F).

TECHNICAL CHALLENGE

Given its extremely harsh production environment, the fertilizer industry is a fertile ground for process measurement and field instrumentation challenges. This is particularly true when producing single superphosphate (SSP) fertilizer, which involves mixing crushed phosphoric rock with a highly potent solution of 90 percent sulfuric acid.

The use of high-fluorine phosphate rocks coupled with intense process cleaning results in an extremely aggressive substance, hydrofluorosilicic acid (H_2SiF_6), in varying concentrations at varying temperatures. One of the most powerful oxidizing agents known, this acid attacks most metals and organic compounds, and etches glass — including glass pH electrodes, which complicates accurate pH measurement.

During acidulation, this type of phosphate gives off as gas 20 to 30 percent of the fluorine present in the rock. Granulation and drying stages give off up to another 5 percent of the rock-bound fluorine. This silicon fluoride is scrubbed with water and the resultant fluorosilicic acid is recycled to the phosphate rock/acid mixer and the granulation drum. While very little of the fluorine recycled to the drum outgasses, up to 80 percent of fluorine recycled to the mixer is emitted.

Unfortunately, this recycling reduces liquid throughput in the dense fluorine scrubbers, thereby raising fluorine concentration in the scrubbing systems. This in turn can lead to elevated levels of fluorine in the final scrubber stages — resulting in a breach of a plant's stack discharge license.

To help alleviate these difficulties, a leading international fertilizer producer employs a caustic control system that adds dilute liquid caustic (sodium hydroxide at 46 percent, diluted onsite to 30 percent) from a storage tank via a pump system to three separate scrubbers:

- Dryer area cross-flow scrubber — process temperature 122° F (50° C) with solids (dust carryover) content in liquor
- Mixing area cross-flow scrubber — at a hot 149° F (65° C) and with solids content (dust carryover and evolved silicon fluoride, SiF_4) present in liquor
- Hygiene scrubber (used for both dryer and mixing dens areas) — at 68°-86° F (20°-30° C) and very high in solids (heavy dust carryover)

"The Foxboro pH system delivers just what we hoped for: the highest reliability we could find for this very tough application."
— I&E technician from a leading international fertilizer producer

Control signals for the scrubbers are processed by a programmable logic controller (PLC), and then sent to a solenoid-operated caustic control valve. Precise control is critical to maintain pH level in each system at predetermined limits, keeping fluorine emissions from the plant's stack within government-mandated margins.

FOXBORO SOLUTION

A Foxboro pH system proved to be the essential ingredient for achieving the delicate emissions control balance required. The system comprises an 875PH intelligent analyzer and 871PH rebuildable sensors that provide the right components, construction, and materials to stand up to this extremely challenging application.

Readings go from the 871PH sensors to the 875PH analyzer, which sends a 4-20 mA pH signal back to the PLC. There, a comparator program controls caustic opening and closing times, maintaining the pH limits designated for each scrubber station.

The 875PH analyzer provides performance and ease-of-use advantages such as two alarm relays, two 4-20 mA outputs, and an RS-232 serial port for remote configuration, plus an optional metal field-mount enclosure rated NEMA 4X and IEC IP65. It also furnishes operators and maintenance staff with complete sensor and analyzer diagnostics, auto-buffer recognition for flawless pH calibration, and a history log.

The fast-response 871PH rebuildable sensors were chosen for their outstanding ease of installation, replacement, calibration, and maintenance. The sensors include a robust and continuously reusable sensor body with a field-replaceable measuring electrode. For this demanding application, Foxboro provided sensors with metallic antimony electrodes — specifically created for pH measuring applications containing hydrofluoric acids. The 871PH rebuildable sensors can withstand extended exposure to temperature cycling applications up to 250° F (121° C).

RESULTS

The sensors soon proved that they could stand up to harsh fertilizer plant conditions, but the instrumentation team had to deal with one minor problem first. When working with a particular rock blend, byproducts produced a small amount of other unexpected acids, for which the system was not specified. The acid proceeded to eat away the titanium retainer and clip of the electrode on the mixing den cross-flow scrubber system. The 871PH rebuildable design allowed plant personnel to promptly install a 316 stainless steel replacement that provided the desired lifespan.

That resolved, the Foxboro pH measurement system performed precisely as expected, providing accurate, reliable operation for the long term. A member of the company's instrumentation/electrical department sums it up. "The Foxboro pH system delivers just what we hoped for: the highest reliability we could find for this very tough application."

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