Process Controls SalesNet
pH Applications

pH Control in Flue-gas Scrubbing

Measuring and Controlling pH Levels to Meet Emission Standards

Background
Scrubbers for fossil fuel-fired boilers are used to attain the air pollution standards of the 1990 Clean Air Act. All scrubber systems rely on a chemical reaction with a sorbent (an alkaline/caustic reagent) to remove sulfur dioxide (SO_2) from flue gases. Scrubber systems are classified as either "wet" or "dry". The key difference is the production of a wet, solid by-product or a dry, free-flowing by-product. Typically, pH control is not critical in dry scrubbing systems and will not be addressed in this application note.

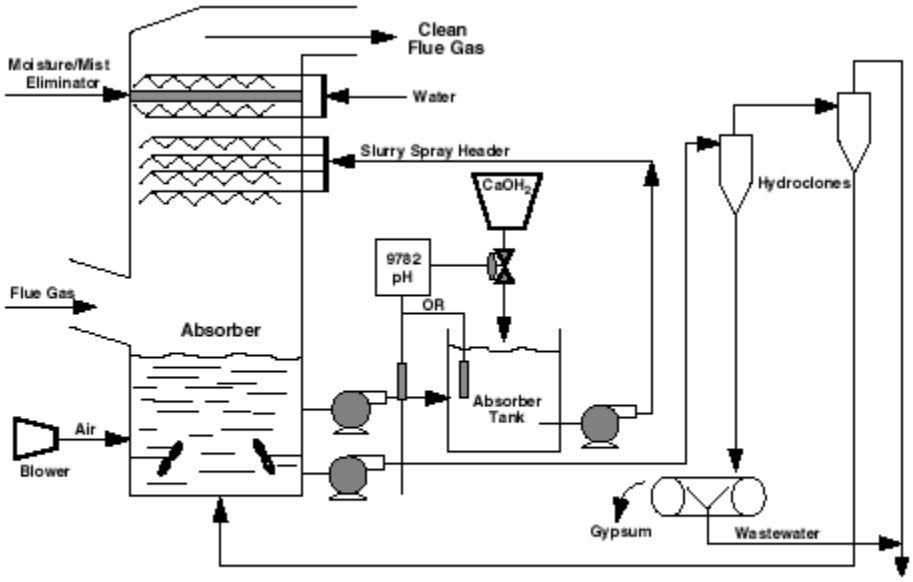

figure 1 - typical wet scrubbing process: limestone non-regenerable

Scrubbers also can be classified as regenerable or non-regenerable, based on the way the sorbent is treated after it has absorbed SO_2. In the more common non-regenerable, the SO_2 is permanently bound by the sorbent and is disposed of as waste or oxidized into a gypsum by-product that can be sold. In a regenerable system, the SO_2 is released in a regeneration process following the sorption process, and the regenerated sorbent is recycled back to the SO_2 absorber.[1]

The Wet Scrubbing Process
In the typical wet flue-gas desulfurization (FGD) processes, also known as scrubbers, flue gases containing SO_2 enter the absorber and come in contact with a sorbent liquid of controlled pH. The sorbent liquid, either lime (CaO_2) or limestone ($CaCO_3$), is mixed with water to form a slurry, which is then sprayed into the flue gases produced by combustion processes. SO_2 and other acid gases present are absorbed by the slurry and removed by the following reaction:

$$SO_2 + CaCO_3 \quad ---> \quad CaSO_3$$

The result is a wet, solid byproduct of calcium sulfite ($CaSO_3$) that precipitates out and is either removed as a sludge or oxidized and dewatered to form a gypsum byproduct that can be sold.

Measuring and controlling the pH levels in FGD can:

- Reduce use of chemical reagents, which can be extremely high in large operations (>600MW)
- Control scale build-up in recirculating systems and spray nozzles
- Help to meet air pollution requirements of regulatory agencies.

Wet System Applications

- Fossil fuel-fired utility boilers
- Hazardous and municipal solid waste projects (reagent utilization and/or heavy metal removal required)
- Refining processes

Magnesium Oxide Alternative
An alternative to the lime/limestone method is the use of magnesium oxide as the sorbent. The operation is very similar except that SO_2 is removed by a magnesium oxide slurry (MgO). The result is magnesium sulfite ($MgSO_3$). Oxygen from the flue gas oxidizes the magnesium sulfite ($MgSO_3$) to magnesium sulfate ($MgSO_4$). This slurry is recovered from an absorber bleed line and fed to a centrifuge and dryer. The dried sulfite/sulfate is decomposed in a fluid bed calciner to produce an SO_2-rich gas stream and MgO. The SO_2 can be converted to sulfuric acid or sulfur, and the regenerated MgO is recycled for reuse in the absorber system.

The Problem
In order to achieve efficient absorption of SO_2 and comply with regulatory emissions standards, the pH in the scrubber system must be carefully controlled. If pH is too low, SO_2 will not be absorbed (SO_2 emission>200 ppm), and corrosion results. If pH is too high, SO_2 will be absorbed (SO_2 emission <20 ppm), but excessive amounts of reagents are used, and the $CaCO_3$ will precipitate inside the scrubber, forming scale that tends to plug the scrubber. The pH control setpoint will change depending on the system employed as well as the quality of the sorbent used.

Approximate control points for the different sorbents are:

6.5 pH - 7.0 pH Lime

5.6 pH - 5.7 pH Limestone (organic acid may be used)

4.5 pH - 5.0 pH Magnesium Oxide

Since limestone is not as reactive as lime, an organic acid is sometimes added to help control scaling of the recirculation line and mist eliminator.

pH can be measured in the recirculation line of the absorber or the regeneration tank, where a pH controller controls the addition of scrubbing solution.

Honeywell's pH Solution
The 9782 pH/ORP Analyzer/Controller offers the widest available selection of advanced features in a reliable instrument. The monoplanar front panel incorporates a user-friendly display with specific diagnostic messages and offers a clearly labeled keypad with tactile feedback. A security lock feature allows viewing without access to setting-change and

calibration functions.

9782 Features

- Simultaneously measures pH, ORP, and temperature
- Menu driven displays
- Single and multiple display options
- Controls one or two reagents through current-, pulse-, or duration-adjusting proportional outputs for retention time > 15 minutes
- Up to four alarm relays
- Rated NEMA 4X and IP65
- Up to three 4-20 mA outputs
- Unattended, automatic electrode cleaning and calibration

9782 Benefits

- Ideal for uses ranging from measuring high-purity water to monitoring industrial wastewater
- Temperature compensation for both electrode output and solution ionization
- Can output readings to a recorder for permanent documentation

The 7084 controller is a unique full-function microprocessor-based analyzer/controller. This universal analyzer/controller provides measurement plus P.I.D. control¾ in feedback, feedforward, or adaptive configuration. Employing a superior combination of analog and digital techniques, the 7084 provides many innovations as standard features in one basic model.

7084 Features

- Displays pH, temperature, flow, and control output
- Characterizes pH to your process titration curve for retention time <5 minutes
- Built-in control flexibility, with field-selectable current, time-proportioned, and pulse-frequency outputs standard on all models
- RFI-shielded weatherproof case, rated NEMA 4X and IP65

7084 Benefits

- Handles every pH and ORP control strategy, including feedback, feedforward, adaptive, cascade, nonlinear, and flow-compensated

The 7773 pH electrode housing has the widest available range of electrode, automatic temperature compensator, and preamplifier options. The ultrasonic cleaner option of the 7773 mounting assembly is a plus for processes with scaling problems. The single-electrode mounting offers numerous configuration options, including in-line and immersion mountings.

7773 Features

- Corrosion-resistant polymer and 316 stainless-steel housing with integral preamplifier
- Ultrasonic electrode cleaning option
- Widest range of electrode options
- Available with either the Durafetâ non-glass solid-state pH electrode or Meredianâ glass pH electrodes

7773 Benefits

- Allows for either flow-through or submersion mounting
- Reduced maintenance costs related to fouling or coating of the electrode
- Double junction reference helps prevent contamination of the electrolyte and clogging of the porous frit

UDC 6300 digital process controller with 3 vertical bar graphs and 2 digital displays is ideal for continuous process applications.

UDC 6300 Features

- Popular HMI with two alpha-numeric displays and three bar graphs
- Multi-language prompts – English, French, German
- ACCUTUNEÔ II and Fuzzy Logic
- Two PID loops, internal cascade & feedforward
- Two math algorithms
- Two characterizes/1 Polynomial
- Totalizer

UDC 6300 Benefits

- Modular design allows the UDC 6300 to meet a broad range of applications from simple to complex at a competitive price
- Reduced set-up time through multi-language prompts and preconfigured algorithms
- Fast start-up and improved efficiency with ACCUTUNE II and Fuzzy Logic
- Price/performance leader due to targeted functionality and pricing
- Toll Free Technical Assistance and warranty support

Recommended Equipment List
9782 pH/ORP analyzer (retention time > 15 min.), Proportional, On/Off
7084 pH/ORP analyzer (retention time < 5 min.), PID control & titration curve.
Alternate 9782 + UDC 6300 process controller (retention time < 5 min.)
7773 pH electrode assembly with Durafet & double junction reference electrode

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