

Cost Effective and Accurate pH Measurement in Limestone-Gypsum Flue Gas Desulfurization Systems

pH/ORP Measurement

Introduction

In limestone-gypsum FGD (flue gas desulfurization) systems, online pH analyzers are used to control the consumption of a desulfurization agent (lime). The heavy lime scaling on the pH electrode is of great concern in the pH measurement. Frequent cleaning of the electrodes with acid is required to ensure accurate measurements, adding to the maintenance workload and cost. The SENCOM technology provides predictive maintenance, and FU20-FTS can withstand the harsh conditions of the scrubber. SENCOM™ features real-time diagnostics, sensor wellness for early detection of sensor failure and replacement, and proactive maintenance. So it saves both time and expense and, at the same time, ensures precise pH measurement over long periods.

Expected Benefits

- Improves the efficiency of a limestone-gypsum flue gas desulfurization system
- Ensures stable, continuous pH measurement
- Reduces operating costs
- Provides predictive maintenance

Process Overview

The limestone-gypsum flue gas desulfurization consists of two processes: absorption and oxidation.

Absorption process

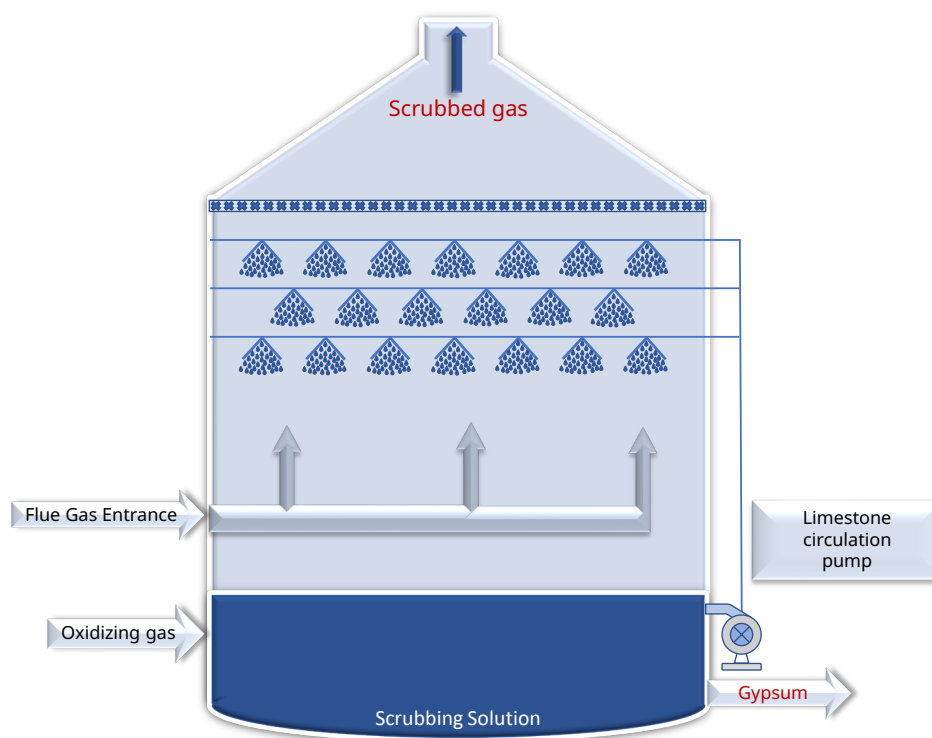
Reaction formula; $\text{Ca(OH)}_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$, $2\text{CaCO}_3 + 2\text{SO}_2 + \frac{1}{2}\text{H}_2\text{O} \rightarrow 2\text{CaSO}_3 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{CO}_2$
In this process, it is crucial to promote the reaction of calcium (Ca) and to achieve a target desulfurization rate. The liquid's pH, concentration, temperature, and liquid/gas ratio affect the absorption rate. When the pH of the absorbing solution is below 5, calcium hydrogen sulfite ($\text{Ca(HSO}_3)_2$) is generated. $\text{Ca(HSO}_3)_2$ is converted into sulfur dioxide (SO_2) in a reversible reaction, lowering the desulfurization rate. When the pH of the absorbing solution is 7 or higher, carbon dioxide (CO_2) in the flue gas reacts with calcium (Ca) to produce calcium carbonate (CaCO_3). This increases lime consumption. Since pH influences the subsequent oxidation process, the pH of the absorbing solution should be kept between 5 and 6.

Oxidation process

Reaction formula: $\text{CaSO}_3 \cdot \frac{1}{2}\text{H}_2\text{O} + \frac{1}{2}\text{O}_2 + \text{Aq} \rightarrow \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \text{Aq}$
In this process, calcium sulfite ($\text{CaSO}_3 \cdot \frac{1}{2}\text{H}_2\text{O}$) from the absorption process is oxidized with air to calcium sulfate (CaSO_4) under about 500 kPa pressure and 50 to 80 °C temperature. The pH of the absorbing solution in the absorber is around 6. It should be kept at about 4 by adding acid from the cooling tower.

Solution Details

Deposits of crystalline substances (e.g., CaCO_3) on electrodes in limestone-gypsum flue gas desulfurization systems decrease the accuracy of pH measurements. Because of the design of FU20 sensors, the lifetime of the sensors will be higher. And also, cleaning the electrodes and reducing maintenance time and cost are key points to consider when selecting a pH analyzer for the system. /HCNF option of FU20 sensors for cleaning can be suggested for easy maintenance. Acid cleaning is done with a 5% hydrochloric acid solution.



Product Recommendation

Transmitter

FLXA202 /FLXA21 2-wire pH/ORP measurement system; General purpose, Intrinsic safety
FLXA402 4-wire pH/ORP measurement system; General purpose

SENCOM™ Smart Adapter (optional)

The reusable smart adapter, SA11, offers full measuring parameter functionality of analog sensors equipped with a Variopin connector and Yokogawa ID chip. The SA11 automatically recognizes the installed sensor and prepares the proper configuration. SENCOM™ technology allows sensors to transmit and receive data when connected to a transmitter/analyzer or a PC. The SMART digital sensors maintain specific measurement and calibration data on an integrated chip that is an integral part of the sensor, providing easy plug-and-play solutions.

Sensor

Option 1: FU20-FTS Differential pH/ORP sensor

Differential sensor technology is unique to the industry. In this type of sensor, the reference cell is made of glass with no porous junction. No electrolyte is in contact with the process, ensuring a stable measurement and virtually maintenance-free. These sensors are intended for inline aggressive and harsh process control applications with some sodium content.

Key Features:

1. Extended sensor lifetime
2. Less maintenance requirement
3. No electrolyte depletion
4. Unaffected by the pressure changes
5. Less reliance on pH-regulating chemicals

*Calibration of differential pH sensors: A differential pH sensor needs pH buffers with the same ionic strength as the sodium reference because the sodium reference will change as the ionic strength changes. Yokogawa can supply these specific pH buffers, please check spare parts at [GS 12B06J03-05EN-P](#)

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Option 2: FU20-NPT pH/ORP Combination sensor

The FU20 combination sensor shows how Yokogawa applies the motto "Simply the best" to sensor technology. The wide body sensors (26 mm diameter) hold four unique elements in one unbreakable PPS40GF (Ryton™) or PVDF body. Installation is simple with the integrated industrial 3/4" tapered thread. The large volume of gelled electrolyte and the double junction reference system slow down depletion and poisoning, extending the lifetime. The system is targeted at those applications where simplicity will result in accurate and reliable pH- or redox measurements. This sensor will be an excellent choice in 90% of the known applications.


Configurations

2-wire/ 4-wire pH Measurement System without SENCOM		
Transmitters		
FLXA202/ FLXA21	2-wire Analyzer	General purpose, Intrinsic safety
FLXA402	4-wire Analyzer	General purpose
Sensors		
FU20-FTS	Differential pH/ORP sensor	with WU10-V-D
FU20-NPT	pH/ORP Combination sensor	fixed cable

SENCOM 2-wire/ 4-wire pH Measurement System		
Transmitters		
FLXA202	2-wire Analyzer	General purpose, Intrinsic safety
FLXA402	4-wire Analyzer	General purpose
Sensors		
FU20-FTS	Differential pH/ORP sensor	-VP variopin connector
FU20-NPT	pH/ORP Combination sensor	-VP variopin connector
Smart Adapter		
SA11	Digital SMART SENCOM™ Adapter	with WU11-...-S

* /HCNF option of FU20 sensors can be suggested for the easy maintenance

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FLXA402

SA11

FU20-NPT

FU20-FTS

A representation of 4-wire transmitter *FLXA402* + pH/ORP sensor *FU20* with SENCOM SMART ADAPTER *SA11*




FLXA202

SA11

FU20-NPT

FU20-FTS

A representation of 2-wire transmitter *FLXA202* + pH/ORP sensor *FU20* with SENCOM SMART ADAPTER *SA11*



FLXA21

FU20-NPT

FU20-FTS

A representation of 2-wire transmitter *FLXA21* + pH/ORP sensor *FU20*

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