

# pH Measurement in Tail Gas Clean-up

## BACKGROUND

Crude oil contains varying amounts of sulfur that must be managed in a refinery to produce products with acceptable environmental impact. During crude processing, the sulfur becomes hydrogen sulfide and organic sulfides, producing sour gas. These compounds are removed and recovered using first a Claus sulfur recovery unit (SRU) and later a tail gas cleanup unit (TGCU). Refineries can typically reclaim 99.9% of the sulfur present in the original crude.

The Claus unit recovers 96-99% of the sulfur by combining oxidized sulfur ( $\text{SO}_2$ ) with reduced sulfur ( $\text{H}_2\text{S}$ ) in the presence of a catalyst to produce pure elemental sulfur. These reactions take place at high temperatures and the gases are condensed in stages to maximize recovery of the sulfur. The uncondensed gas from the last stage is called tail gas.

In the TGCU, the tail gas is first heated in a reactor to maximize conversion of sulfide to hydrogen sulfide. The hot product gas is cooled in a heat exchanger to produce steam, quenched with water, and then contacted with a selective amine that removes the hydrogen sulfide. Maximum removal efficiency occurs at lower temperatures. Controlling pH in the quench tower protects the tower and the downstream units from corrosion. The sulfide compounds tend to accumulate in the quench water, increasing suspended solids and causing the pH of the water to drop.

## PROCESS

The hot gas enters near the bottom of the tower while a recirculating water quench is sprayed from above (Figure 1). Some of the quench water (now sour water) is removed for treatment and fresh make-up water is added as replacement. To prevent corrosion, the pH of the quench water is kept between 8 and 9 pH. The pH is controlled by the addition of amines (or caustic). The accumulation of dissolved sulfides and other ions in the quench water can pose a challenge

for some pH sensors, since sulfides can poison a silver-based reference electrode and cause premature sensor failure. In addition, the combination of hard water and sulfur can produce insoluble coatings that slow the sensor response and require frequent sensor cleaning. The key to keeping the pH sensor accurate under these circumstances is to use a versatile product that can be modified in the field. Continuous sensor diagnostics can prompt preventive measures such as replacing the reference junction on a coated sensor and refilling the reference electrolyte before chemical poisoning occurs. This puts the user in control of the pH sensor and keeps the pH sensor in control of the process.

## INSTRUMENTATION

The PERpH-X<sup>®</sup> Model 3500PR is the top recommendation for continuous pH measurement here since it includes a poison resistant electrolyte that reacts with the sulfide before it can damage the reference. The double junction design uses two layers of porous junctions to separate the process chemicals from the silver reference, and allows the outer reference solution to be conveniently refilled with a preloaded syringe. The PERpH-X design can be customized for different application situations and includes a titanium solution ground for complete diagnostics of the reference and glass portions of the sensor. The PERpH-X design is also available with the convenient VP connector and in a retractable metal housing (Model 3400), which allows sensor removal without shutting the process down.

Compatible pH analyzers include the Model 5081pH and Xmt-P DC-powered HART and FOUNDATION<sup>®</sup> Fieldbus Analyzers, the Model 1056 pH Analyzer, and the Model 54epH HART Analyzer/Controller. These analyzers include sensor diagnostics that can be used to alert the user to sensor coating or breakage. Consult the appropriate Product Data Sheet for complete details.

<sup>®</sup> PERpH-X is a registered trademark of Emerson Process Management, Liquid

## INSTRUMENTATION

### Model 5081 pH/ORP Smart Two-Wire Transmitter

- Hand-held infrared remote control link to activate all the transmitter's function.
- NEMA 4X (IP65) weatherproof, corrosion-resistant enclosure.
- Comprehensive pH glass and reference diagnostics.
- HART and FOUNDATION Fieldbus options.
- Hazardous area approvals.



## SENSOR

### Model 3500 High Performance pH Sensor

- Advanced on-line sensor diagnostics for use with all Rosemount Analytical analyzers and transmitters.
- High temperature design increases sensor life at elevated temperatures.
- Rebuildable double junction reference provides longer service life in a variety of processes by using specially formulated reference SOLUTIONS.

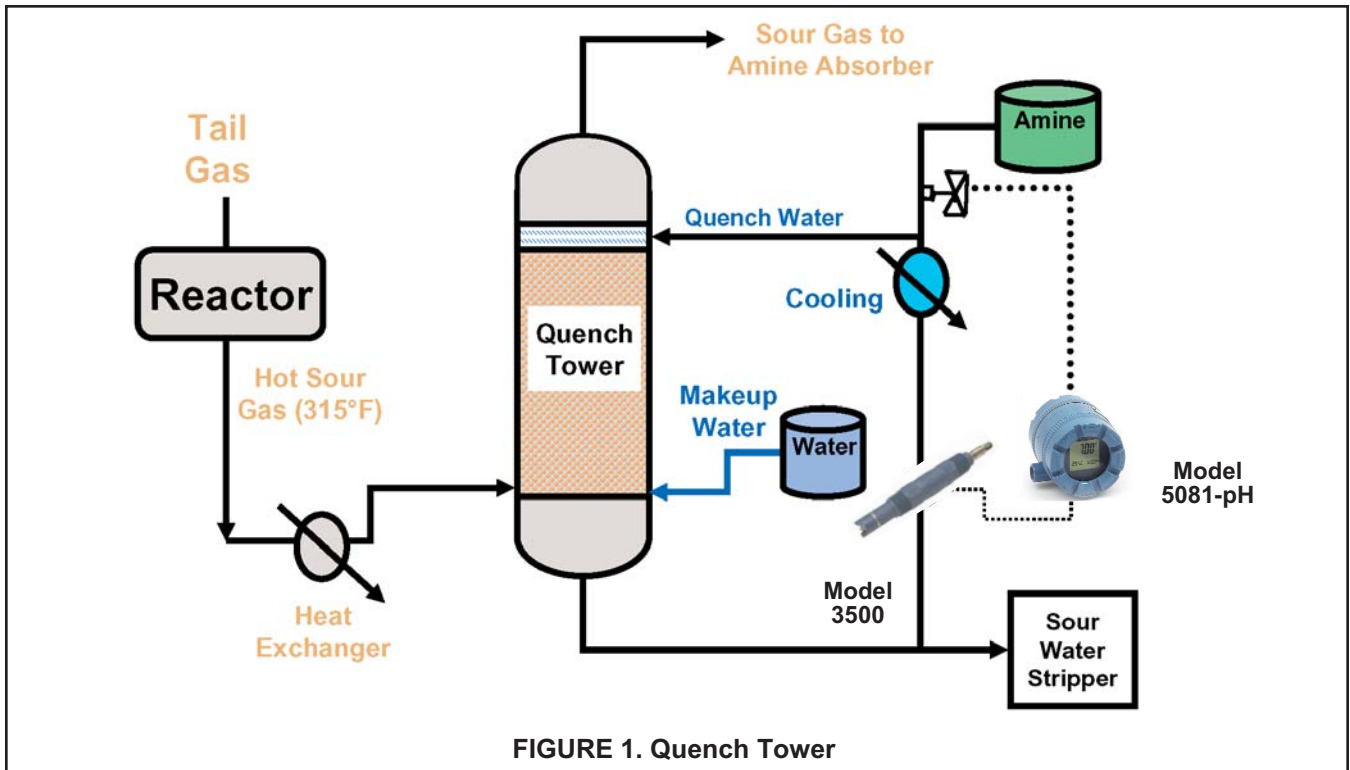
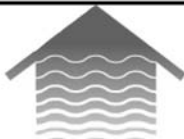


FIGURE 1. Quench Tower



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