pH Measurement in Refining Tail Gas Clean-Up

Process

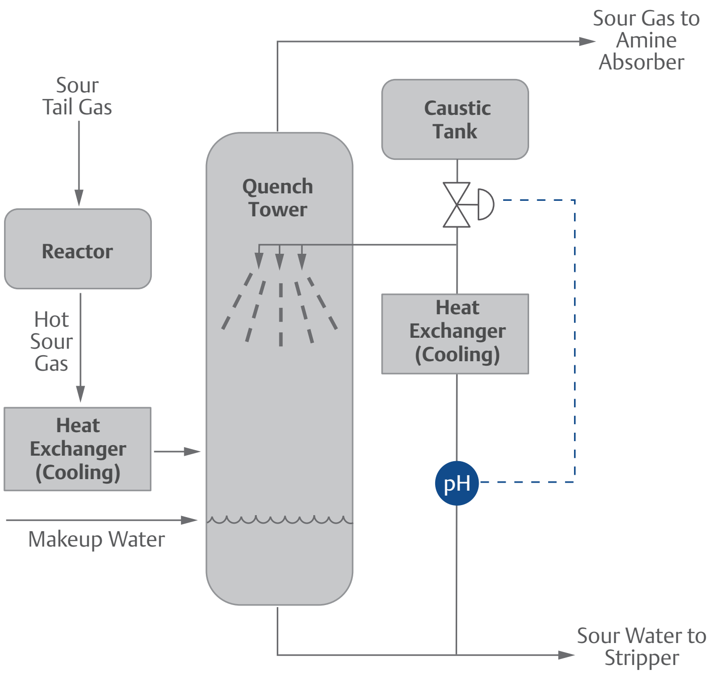
Crude oil contains varying amounts of sulfur that must be managed in a refinery to produce products with acceptable environmental impact. Sour gas is produced as a by-product when sulfur is converted into hydrogen sulfide and organic sulfides. The sulfur compounds are removed from the sour gas and recovered using first a 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 SRU recovers 96-99% of the sulfur by combining oxidized sulfur (SO_2) with reduced sulfur (H_2S) 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. The hot gas enters near the bottom of the quench tower while the water is sprayed from above (Figure 1). Some of the quench water (now sour water) is removed for treatment and fresh makeup water is added as replacement. Maximum sulfur removal efficiency occurs at lower temperatures.

Figure 1 -Tail Gas Clean-Up Process



pH Measurement

Controlling water between 8 and 9 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. The pH is controlled by the addition of amines (or caustic).

The accumulation of dissolved sulfides and other ions in the quench water poses a challenge for pH sensors because sulfides can poison the pH 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.

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The Emerson Solution

The Rosemount™ 3500P pH Sensor is the top recommendation for continuous pH measurement in this application because 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 reference electrode and allows the outer reference solution to be conveniently refilled with a preloaded syringe. The Rosemount 3500P design includes a titanium solution ground for complete diagnostics of the reference and glass portions of the sensor. This sensor is available with the convenient VP connector and in a retractable metal housing (Rosemount 3400), which allows sensor removal without shutting the process down.

The Rosemount 3500P pH sensor is compatible with all Rosemount liquid analysis transmitters including the Rosemount 5081 Explosion Proof Transmitter which features a rugged aluminum enclosure for the harshest industrial environments and diagnostics that can be used to alert the user to sensor coating or breakage.

Rosemount 3500 pH Sensor

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