ABB MEASUREMENT & ANALYTICS | APPLICATION DESCRIPTION

pH/ORP measurement
FCC scrubber pH measurement

Measurement made easy

Oil and gas
FCC scrubber pH measurement

Introduction

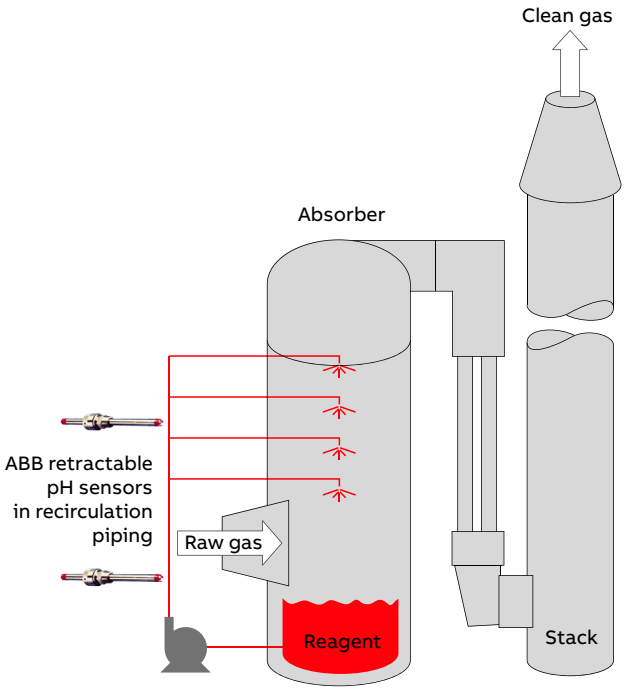
After initial distillation, Fluid Catalytic Cracking (FCC) is often the first step in modern crude oil petroleum refineries. ‘Cracking’ is a term that describes the breaking down of longer chain hydrocarbon molecules, such as heavy crude, into shorter chain molecules such as gasoline.

In the FCC process a zeolite-based catalyst combines with high temperatures and pressures to vaporize the incoming crude oil. Once vaporized, the oil travels to a distillation column that separates it into various end products such as naphtha and fuel oils of different weights. These distilled oils may undergo additional distillation or separation to refine them further.

A by-product of the catalyst reaction is a material called coke. Coke is burned off to provide the necessary heat to maintain the temperature needed for the process. The off-gas from coke burning is often used to generate electricity for the entire process as well as for other parts of the refinery. Prior to being released to the atmosphere, the off-gas passes through an electrostatic precipitator and a scrubber. The precipitator removes particulate matter and the scrubber removes sulfur compounds.

Releasing sulfur compounds

A refinery's FCC scrubber works in a similar manner to wet-gas scrubbers found in other industries. Hot flue gas containing sulfur compounds and residual catalyst fines flows into the absorber. The absorber consists of a large vertical tank containing an array of nozzles that spray a reagent into the incoming flue gas. The reagent neutralizes the sulfur compounds in the gas. The reagent chemical is often caustic (NaOH) or limestone compounds. The reagent and leftover catalyst fines collect in the bottom of the absorber. This liquid solution is recirculated to the spray nozzles so it can react further with the incoming flue gas. Once the flue gas has passed through the absorber column, it travels through a series of filters to catch any residual moisture. Finally the scrubbed gas, free of sulfur compounds and particulates, passes into the stack where it is released into the atmosphere.



pH measurement for FCC scrubbers

Control of pH is critical to monitor the recycled reagent. As the sulfur concentration builds up in the collected liquid at the bottom of the absorber, the pH turns acidic. The refinery operators try to maintain the pH close to neutral (typically 6.5 to 7 pH) to balance the higher pH reagent chemicals with the acidic effect of the sulfur collected from the flue gas.

Although the required pH is near neutral, the application can be quite difficult because:

- catalyst fines are highly abrasive and can damage the glass pH electrode
- the catalyst can plug the porous reference junction of the pH sensor, causing a loss of mass transfer between the sensor electrolyte and the process liquid
- sulfur compounds create hydrogen sulfide (H_2S) that can aggressively attack the silver chloride (AgCl) reference element and poison the pH sensor
- changes in the FCC feedstock crude oil can alter the concentration of sulfur compounds in the flue gas, changing the chemistry in the absorber

The ABB solution – retractable pH sensors

To cope with these pH measurement issues, ABB recommends hot-tap, retractable TB(X)5 sensors. TB(X)557, TB(X)587 and TB18 sensors have all been used in FCC scrubber applications. The measurement point is typically in the recirculation piping of the absorber, as shown. The flat glass electrode and Wood Next Step reference design best fit this application. The flat glass minimizes damaging abrasion from the catalyst fines. The Wood Next Step reference provides the most effective solution against sulfide attack and plugging of the junction. Commonly, ABB TB(X)5 sensors offer twice the lifetime of conventional double junction pH sensors. As redundant control is common, a typical FCC scrubber often measures pH at four to eight points. Many plants specify Hastelloy® hardware because of the corrosive nature of the process.

ABB's TB(X)557 linear retractable pH sensor (see Figure 1) is commonly used when retrofitting ABB sensors into existing pH measurement points.

The TB18 Safe-T-Clean Valve with TB561 sensor (see Figure 2) is best suited for new installations where the valve can be welded directly to the piping.

Figure 1 TB(X)557 retractable pH sensor

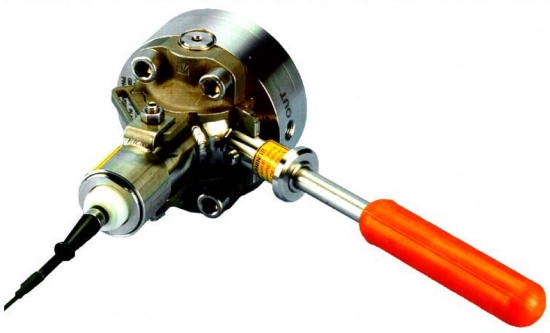


Figure 2 TB18 Safe-T-Clean Valve with TB561 sensor

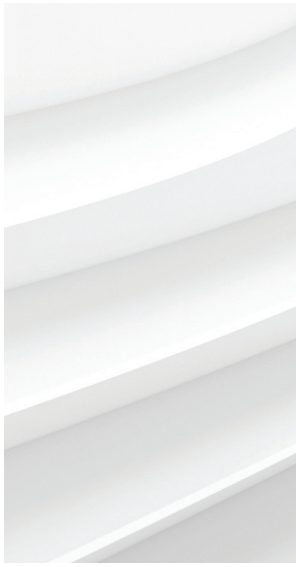
Acknowledgments

Hastelloy is the registered trademark name of Haynes International, Inc.

ABB Limited
Measurement & Analytics
Oldends Lane
Stonehouse
Gloucestershire GL10 3TA
UK
Tel: +44 (0)1453 826 661
Fax: +44 (0)1453 829 671
Email: instrumentation@gb.abb.com

ABB Inc.
Measurement & Analytics
125 E. County Line Road
Warminster, PA 18974
USA
Tel: +1 215 674 6000
Fax: +1 215 674 7183

abb.com/measurement



AD/ANAINST/005-EN Rev. A 02.2019