

ABB Analytical – pH/ORP FCC Scrubber pH Measurement

Industry: Oil and Gas

After initial distillation, Fluid Catalytic Cracking (FCC) is often the first step in modern crude oil petroleum “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.

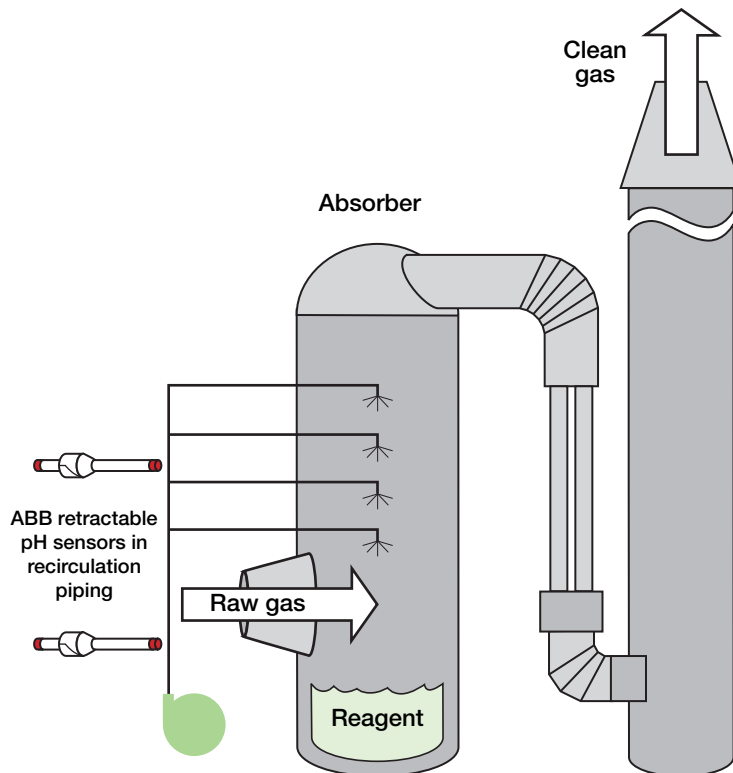
In the FCC process a zeolite-based catalyst combines with high temperatures and pressures to vaporize the incoming crude oil. Once vaporized the oil travels to a distillation column that separates it into various end products such as naphtha and fuel oils of different weights. These distilled oils may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

A byproduct 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

The FCC scrubber for a refinery 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 acts to neutralize 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 up to the spray nozzles so it can further react with the incoming flue gas. Once the flue gas has passed through the absorber column, it will travel through a series of filters to catch any residual moisture. Finally the scrubbed gas, free of sulfur compounds and particulates, will travel out the stack.



pH Measurement for FCC Scrubbers

Control of pH becomes critical to monitor the recycled reagent. As the sulfur concentration builds up in the collected liquid at the bottom of the absorber, the pH will turn acidic. The refinery operators will try and 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 desired pH is near neutral, the application can be quite difficult.

- Catalyst fines tend to be 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 will create hydrogen sulfide (H_2S), which 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.

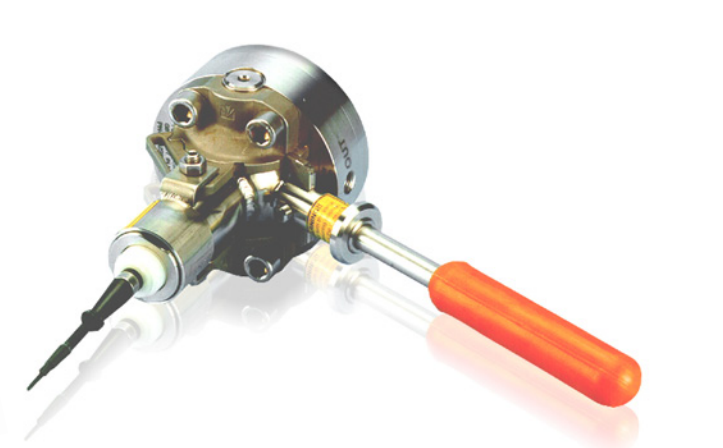
The ABB Solution: Retractable pH sensors

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.



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

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 will avoid damaging abrasion from the catalyst fines. The Wood Next Step reference provides the most effective solution against sulfide attack and plugging of the junction.



TB(X)557 linear retractable pH sensor is common for retrofit of ABB sensors into existing pH measurement points

Commonly ABB TB(X)5 sensors will offer twice the lifetime of conventional double junction pH sensors. As redundant control is common, a typical FCC scrubber will often measure pH at four to eight points. Many plants specify Hastelloy hardware because of the corrosive nature of the process.

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