ABB MEASUREMENT & ANALYTICS | APPLICATION DESCRIPTION

pH/ORP measurement
Crude oil distillation

Measurement made easy

Oil and gas
crude oil distillation

Introduction

Refineries separate crude oil into many different hydrocarbon products. Among them are kerosene, gasoline, asphalt, fuel oil and various flammable gases. A refinery distills the incoming crude oil to break it down into each usable component; a process commonly referred to as fractional distillation.

Each required hydrocarbon component has a different boiling point. In a fractional distillation process, the incoming crude is heated until it begins to vaporize. The vapor flows into the distillation tower and begins to separate out. Heavier hydrocarbon molecules with longer carbon chains settle towards the bottom of the tower. Lighter hydrocarbon molecules with less carbon atoms float to the top.

Crude oil also contains undesirable non-hydrocarbon components including water, salts of sulfur, chloride, ammonia and various metals. The contaminants tend to concentrate in the upper part of the tower together with a substantial amount of water vapor. The vapors from the top of the tower pass to a condenser (turning liquid) and then to a unit that separates the oil from the water. As the contaminants are more soluble in water than oil, they tend to collect in the separated water, turning it acidic. The hydrocarbons return to the tower for further processing (or travel on to another distillation tower).

Controlling corrosion

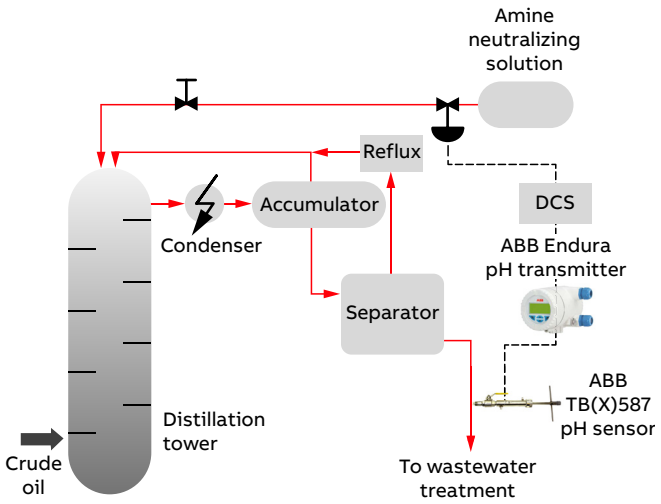
The resulting effect of water in the distillation tower is corrosion. Hydrochloric and sulfuric acids are common culprits, along with calcium, magnesium and sodium compounds. Left untreated, the acidic water causes pitting in piping, condensers and the upper portion of the tower.

To minimize corrosion, the refinery adds neutralization chemicals, typically organic amines, to the top of the tower. The pH measurement of water coming from the separator controls the rate of these additions. The required pH setpoint is generally between 5.5 and 7. A substantial lag exists between the formation of water vapor within the distillation tower and the pH reading following the separator, making control difficult.

Measurement challenges

Measuring the pH of water from the crude oil distillation process can be extremely demanding. Residual hydrocarbons mixed with the condensed water tend to block the porous reference junction used in most pH electrodes.

Hydrogen sulfide (H_2S) from sour crude distillation can poison pH electrodes by contaminating the reference electrolyte. Once the H_2S reaches the AgCl element it shifts the reference voltage, leading to measurement instability and loss of the probe. Refineries are often satisfied with a one- or two-week life-span from pH sensors in these installations.

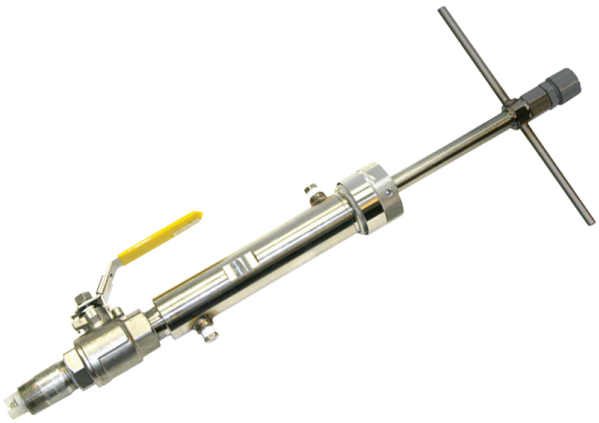


Schematic – example refinery plant

The ABB solution – TB(X)5 sensors with wood reference

Refineries often attempt to make the pH measurement directly in the process line downstream from the condenser where temperatures and pressures are high. When faced with this requirement, ABB recommends the TB(X)564 high-pressure hot-tap retractable pH system. This pH sensor is rated up to 300 psig (20 bar) at 140 °C (284 °F).

For longer sensor life, ABB highly recommends that refineries install a sample conditioning system to cool the condensed water and reduce its pressure. This not only increases sensor life, it also simplifies removal of the sensor for cleaning and calibration. Both the TB(X)551 and TB(X)587 suit applications with sample conditioning systems.



The TB(X)587 is ideal for retractable installations up to 150 psig (10 bar)

Regardless of the TB(X)5 probe style selected, ABB's patented Wood Next Step reference design should be specified. Wood resists plugging by hydrocarbons much better than PTFE and other man-made materials. The ABB 'J' glass electrode suits high pressure, in-line applications. For sample line installations with lower temperatures and pressures, the '1' flat glass electrode is a good selection.

For pH measurements made in hazardous areas, plants can select ABB TB82PH transmitters with intrinsic safety barriers or the new APA592 Endura transmitter with Exd housing.

The TB(X)551 can be mounted into 1 inch tees in sample line installations.

The TB(X)551 sensor uses a twist lock bayonet mounting style for use in sample lines

New APA592 Endura transmitter with Exd housing

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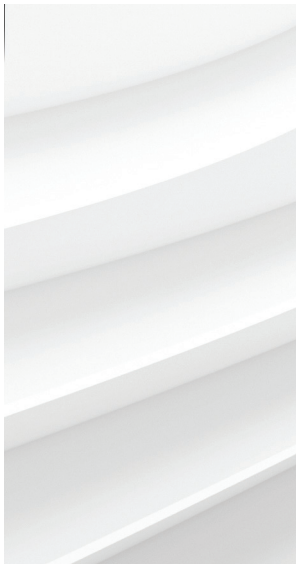

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