

Moisture measurement in continuous catalyst regeneration (CCR) reforming processes

Application background

In catalytic reforming processes used for the refining of petroleum products, heavy naphtha hydrocarbon mixes are chemically converted into high-octane liquids called reformates, which are components of petrol. A catalytic reformer operates by vaporising a mixture of naphtha and hydrogen, heating it to around 500°C and passing it into a reactor and over a bed of Platinum and/or Rhenium based catalyst. The vapour passes through two more reactors before being cooled and separated into its new constituents. Hydrogen mixing is essential to the main reactions in the reforming process.



The control of moisture content in hydrogen recycled gas is critical to ensure the efficient operation of the plant. It is desirable for the benefit of the catalytic reactions to maintain the moisture level within the 10 to 20ppm_v range. Controlled moisture in combination with 3 to 5 ppm_v hydrochloric acid maintains optimum acidity in the catalyst bed. If the moisture level decreases below this level, the catalyst will deteriorate, causing a loss of productivity. High moisture content will remove chloride from the catalyst, accelerating catalytic activity loss to the point whereby high octane levels can no longer be achieved. The effects of both these scenarios will result in the catalyst requiring replacement much more frequently than otherwise necessary, and it is extremely costly to replace. Hydrochloric acid is periodically injected into the process gas stream, to recondition and re-activate the catalyst.

Moisture measurement techniques

Quartz Crystal Microbalance (QCM) Sensor: QMA601

QCM is often specified for gas and petrochemical processing applications because of its proven track record for fast response and stable measurements.

Michell's [QMA601 process moisture analyzer](#) has an option designed specifically for CCR applications. This asymmetric cycling modification protects the sensor from corrosion from the hydrochloric acid, prolonging the life of the sensor and reducing maintenance costs for the operator.

- Lower detection limit: 0.1 ppm_v
- Response speed: T95 in less than 5 minutes
- Global hazardous certifications from ATEX, IECEx and cCSAus



The addition of a sample system option which includes a valve for isolation of sample to the sensor whilst allowing a filter drain/by-pass flow to continue to purge through the sample line.

This isolation/purge mode would be activated prior to analyser start-up or shut-down to dry the sensing system with inert gas before exposure to the potentially corrosive process gas. This mode is also selected in the case of semi-regenerative catalyst processes during/following catalyst regeneration until the process conditions are heading to normal (maximum 5ppmV HCl returned to 1 – 3 ppmv and high moisture content reducing).

Tunable Diode Laser Spectroscopy (TDLAS): OptiPEAK TDL600

Because TDLAS is a non-contact form of measurement, the analyzers are highly resistant to corrosive conditions, such as those found in CCR processes.

- Lower detection limit: 5 ppmv
- Response speed: Optical response in 0.2 seconds
- Global hazardous certifications from ATEX, IECEx, cMETus and TC TR Ex

The TDL600 sample system uses a combined coalescing and membrane filter to prevent ingress of entrained liquids, but no purge mode is required given the non-contact TDLAS principle and the materials of construction of the gas wetted parts of the system.



Michell Ceramic Moisture Sensor: Promet I.S or Promet EExd

Ceramic impedance moisture sensors are a variant of the aluminium oxide technology, which was introduced in the 1960s and is still going strong today. One of the reasons for its longevity is its versatility, which makes it suitable for many diverse processes. As well as being able to measure in very dry conditions – down to 1 ppbv – the sensors offer easy and cost-effective maintenance.

- Lower detection limit: 1 ppbv
- Response speed: T90 30 seconds dry to wet, 30 minutes wet to dry
- Global hazardous certifications from ATEX, IECEx, cSAus and TC TR Ex (Promet EExd); ATEX, FM, CSA, IECEx, GOST Ex, GOST-R and GOST-K pattern approval



Using the Michell Ceramic Moisture Sensor, the Promet I.S. or Promet EExd can be installed in a simple sampling system made from high-quality stainless-steel components. To protect the sensor at start-up and shut-down from exposure to highly corrosive trace HCl in combination with atmospheric moisture, the arrangement of the sampling system includes a 6-way ball valve (manually or remotely actuated) to facilitate shutting the sensor off from the process gas stream, and temporarily purging it with dry inert gas.



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