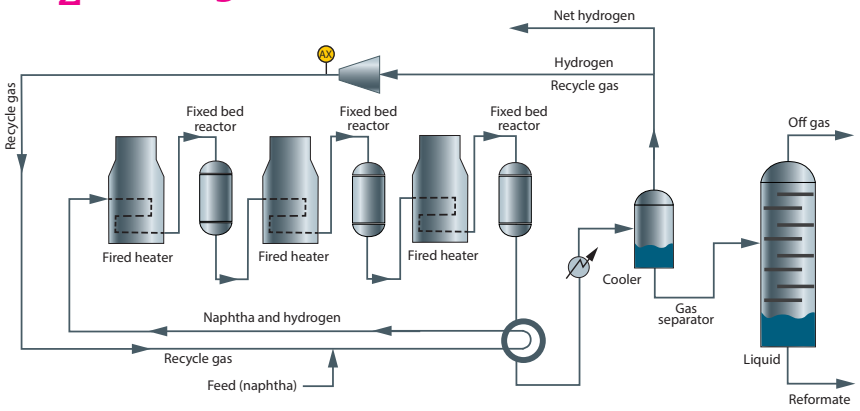
Refining: H_2O in hydrogen recycle for refinery catalytic reformer H_2 recycle streams

Benefits at a glance

- Fast response to H_2O concentration changes for process control and monitoring catalyst dry down
- Non-contact laser measurement avoids detector contact, corrosion and damage from HCl
- Laser-based measurement is highly selective and accurate for H_2O in catalytic reformer hydrogen recycle streams
- Dual analyzer calibration ranges support H_2O measurements for process control and tracking progress of catalyst dry-down



Semi-regenerative catalytic reformer

Catalytic reforming

A catalytic reformer unit converts naphtha into high-octane aromatic compounds termed reformates used in gasoline blending, and yields large quantities of hydrogen, which is recycled and used in other processes. A semi-regenerative catalytic reformer (SRR) unit has three fixed bed catalytic reactors employing a platinum/rhenium catalyst on a chloride alumina support. Water and a chloride compound are continuously injected to chlorinate the alumina and maintain acid sites needed to perform the conversion reactions. Excess levels of H_2O strip chloride from catalyst surfaces and form corrosive HCl which is transported throughout the process piping of the SRR. Catalyst activity in an SRR gradually decreases over time as coke is deposited on the catalyst. The SRR must be shut down periodically to burn off coke deposits and regenerate the catalyst.

On-line H_2O monitoring

On-line monitoring of the H_2O concentration in SRR hydrogen recycle streams enables refineries to control the chloride level required for optimum catalyst activity and helps minimize HCl formation which causes corrosion damage, process shut down for repairs, and lost production of reformate and hydrogen. Tracking the H_2O level in hydrogen gas recirculating through an SRR to dry down the catalyst following regeneration helps determine when end point H_2O conditions have been reached to restart the SRR unit.

Endress+Hauser's' solution

Tunable diode laser absorption spectroscopy (TDLAS) is a SpectraSensors technology proven highly effective in this critical measurement. The fast response of TDLAS analyzers to changes in H_2O concentration is advantageous for process monitoring and control during normal SRR operation and for monitoring catalyst dry-down following *in situ* regeneration. A single TDLAS analyzer is calibrated to perform both measurements; 0-50 ppmv for process control and 50-1,000 ppmv for catalyst dry down. Laser and detector components of a TDLAS analyzer are isolated and protected from HCl in the process gas stream that leads to corrosion and frequent replacement of devices using direct contact sensors.

Endress+Hauser

People for Process Automation

Application data	
Target component (Analyte)	Water in semi-regenerative reformer hydrogen recycle gas
Typical measurement ranges	0-50 ppmv (control) and 50-500 ppmv (trend)*
Typical repeatability	±1 ppmv (control) and ±10% of reading (trend)*
Measurement response time	1 to ~60 seconds*
Principle of measurement	Non-differential tunable diode laser absorption spectroscopy (TDLAS)
Validation	Certified blend of H_2O in pure N_2 or integrated permeation system

*Consult factory for alternate ranges.

Typical stream composition

Component	Minimum (Mol%)	Typical (Mol%)	Maximum (Mol%)
Hydrogen (H_2)	70	80	90
Methane (C1)	8	12	20
Ethane (C2)	3	5	10
Propane (C3)	0	2	5
i-butane (C_4H_{10})	0	1	2
n-butane (C_4H_{10})	0	<1	2
Pentane (C5)	0	0	1

The background stream composition must be specified for proper assessment, calibration and measurement performance. Specify the normal composition, along with the minimum expected values for each component, especially H_2O, the measured component. Other stream components may be allowable with approval from Endress+Hauser.