

Application Note

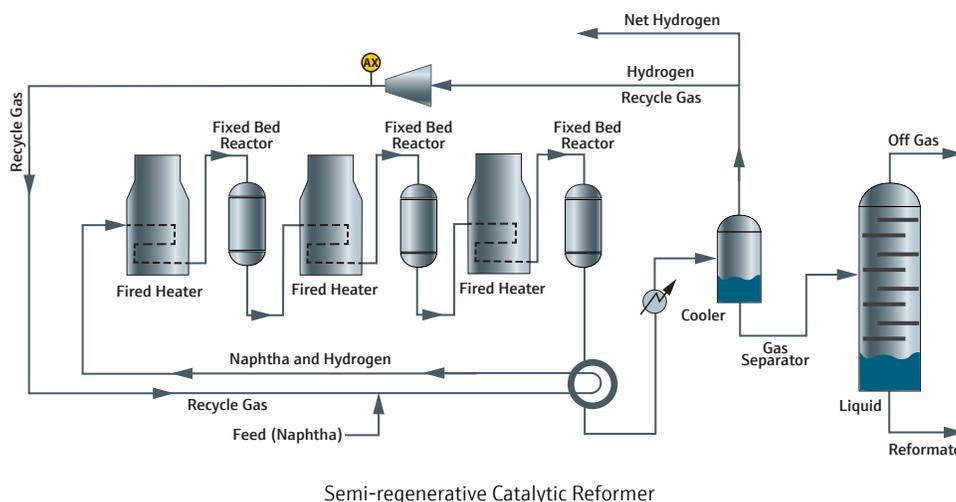
Water in semi-regenerative catalytic reformer hydrogen recycle streams

Industry:
Refining
Application Note 23101

Key Points

- Fast response to H₂O 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 H₂O in catalytic reformer hydrogen recycle streams
- Dual analyzer calibration ranges support H₂O measurements for process control and tracking progress of catalyst dry down

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 H₂O 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 H₂O monitoring On-line monitoring of the H₂O 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 H₂O level in hydrogen gas recirculating through an SRR to dry down the catalyst following regeneration helps determine when end point H₂O conditions have been reached to restart the SRR unit.

SpectraSensors' solution SpectraSensors' tunable diode laser absorption spectroscopy (TDLAS) analyzers have proven highly effective in this critical measurement. The fast response of TDLAS analyzers to changes in H₂O 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 ppm_v for process control and 50-1,000 ppm_v 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.

Application Data

| | |
|----------------------------|--|
| Target Component (Analyte) | Water in Semi-Regenerative Reformer Hydrogen Recycle Gas |
| Typical Measurement Ranges | 0-50 ppm (control) and 50-500 ppm (trend)* |
| Typical Repeatability | ±1 ppm (control) and ±10% of reading (trend)* |
| Measurement Response Time | 1 to ~60 seconds* |
| Principle of Measurement | Non-Differential Tunable Diode Laser Absorption Spectroscopy |
| Validation | Certified blend of H ₂ O 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 S) | 70 | 80 | 90 |
| Methane (C ₁) | 8 | 12 | 20 |
| Ethane (C ₂) | 3 | 5 | 10 |
| Propane (C ₃) | 0 | 2 | 5 |
| i-Butane (C ₄ H ₁₀) | 0 | 1 | 2 |
| n-Butane (C ₄ H ₁₀) | 0 | <1 | 2 |
| C ₅ | +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 H₂O, the measured component. Other stream components may be allowable with approval from SpectraSensors.

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