Refinery Saves Millions with Use of Specific Gravity Meter to Measure Hydrogen Purity in Reformer

RESULTS

- Estimated savings of 2.6M/yr by operating the reformer closer to its target H_2/HC ratio.
- Increased safety by eliminating manual sampling with an online inferred hydrogen purity measurement
- Enabled real-time continuous gas quality measurement for more efficient process control

Micro Motion Gas Specific Gravity Meter measures the specific gravity of the hydrogen recycle gas in real time

APPLICATION

A naphtha reformer converts naphtha into reformates used in gasoline blending. Hydrogen is an important byproduct of the reforming process. Part of the hydrogen is recycled back to the feed and part is sent to the gas plant and then utilized in the desulfurization processes. The recycled hydrogen is mixed with the naphtha feed to maintain the hydrogen partial pressure in the reactors to promote the desired reactions, and to minimize coking of catalyst and extend the catalyst life.

Hydrogen/hydrocarbon (H_2/HC) ratio is defined as the moles of recycle hydrogen per mole of naphtha charged to the unit. Recycle hydrogen is important in the unit operation due to it's impact on the catalyst stability. Catalyst stability is a measure of the coke formation on a given catalyst. For fixed bed reformers, stability is measured as deactivation rate, because the coke laydown requires that the weighted average inlet temperature be increased to maintain product quality. A decrease in the H_2/HC ratio will have a significant effect on the catalyst life.

The H_2 purity of the recycle stream of course affects the H_2/HC ratio. Measuring the H_2 purity on-line will significantly improve control of the H_2/HC ratio.

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CHALLENGE

The recycle stream off the high pressure separator, is typically made up of 70 - 80% hydrogen, and is then blended with high purity hydrogen to increase the purity to the 80 - 92% range. Optimizing the use of hydrogen is important because it is one of the most expensive utilities and can be constrained as refineries increase hydroprocessing capacity to meet clean fuel requirements. On the other hand, operating the reformer at too low of a H_2/HC ratio will impact catalyst life. Meeting the target H_2/HC ratio is therefore extremely important. Using traditional measurement technologies can make obtaining accurate hydrogen purity measurements challenging due to response time and safety concerns. One of those safety concerns is with manual sampling because hydrogen is extremely flammable in air. At this refinery, the readings from the legacy gas chromatograph were drifting and became unreliable, so the refinery moved to rely on only manual samples for lab analysis which resulted in inefficiencies, lag time in controlling the process, and increased safety risk from sampling the hydrogen. The refinery wanted an accurate, continuous monitoring of hydrogen purity in order to improve control of the process.

SOLUTION

The refinery installed a Micro Motion Gas Specific Gravity Meter to measure the specific gravity of the hydrogen recycle gas in real time. The specific gravity can be used to infer the purity of the gas. The continuous measurement resulted in extended run-time of the catalyst in the reactor, and optimized the the H_2/HC ratio to maximize reformate yield. Through the specific gravity measurement, it was possible to run much closer to the targeted H_2/HC ratio, extending the catalyst life.

For example, using typical refinery data, if the H_2 purity were increased from an average of 70%, closer to an average of 80%, the H_2/HC ratio would go from 6.3 to 7.0. This would result in a relative deactivation rate of .83, which would translate to an increase in catalyst life of 17%.

A 17% increase in the availability of the reforming unit could amount to a savings of $2.6M/yr, assuming a unit capacity of 22,000 BPD, and $2.00/BBL margins, but not accounting for increased hydrogen usage costs as this refinery has excess hydrogen available.

Emerson Automation Solutions
7070 Winchester Circle
Boulder, Colorado USA 80301
T +1 800-522-6277
www.Emerson.com

For more information:
www.emerson.com/density

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