



“With increasing demand for hydrogen in refining, effective hydrogen management is critical.”

Optimum hydrogen purity at the reactor inlet extends catalyst life by maintaining desulfurization kinetics at lower operating temperatures and reducing carbon laydown. Typical purity increases resulting from hydrogen purification equipment and increased hydrogen sulfide removal as well as tuning hydrogen circulation and purge rates, extending catalyst life up to about 25%.

James Speight, *The Chemistry and Technology of Petroleum, Fourth Edition*

How are you managing hydrogen usage to maximize outputs, extend catalyst life, and meet ULSD requirements?

You are under constant pressure to maximize output from your refinery. At the same time, you are receiving heavier, more sour feedstocks that require more processing, and you are facing more stringent regulations for low sulfur products. All of these facts mean hydrogen usage is increasing and managing that hydrogen is more critical than ever. Being able to monitor hydrogen purity (a critical input to a hydrogen management system) would allow you to maximize your output while increasing catalyst life, minimizing coke laydown, and increasing hydrogen partial pressure without requiring more compression or increasing temperatures.

Refinery managers we talk to tell us about challenges like these:

“I need better conversion from the hydrocracker.”

There is constant pressure to meet production volume targets, and reducing unconverted bottoms increases yield. Heavy streams can go to the hydrocracker for conversion to lighter products. Studies have shown that increasing hydrogen purity in the hydrocracker makeup stream can do just this.

“Hydrocracker throughput is limited by catalyst life.”

Catalyst life is a key driver in unit turnaround timing. In a hydrocracker, a hydrogen-rich environment minimizes coking, extending catalyst life and reducing the frequency of catalyst regeneration. You run the unit with excess hydrogen, but wonder if increased hydrogen purity might also limit coking.

“Increasing pressure in hydrocracking would improve conversion, but my compressors are already being used to capacity.”

Conversion increases with higher partial pressures of hydrogen. This can be accomplished one of two ways: increasing the overall pressure, or maintaining the overall pressure, but increasing the concentration of hydrogen. Increasing overall pressure isn't always a viable option when all compressors are being used to capacity. Monitoring hydrogen purity and effectively managing purge and recycle streams may be a better option.

What if...

- You could increase hydrocracker yields without changing temperature?
- You could extend catalyst life?
- You could reduce compressor costs by having higher hydrogen partial pressure?

HYDROGEN PURITY

Increase Hydrogen Partial Pressure

Hydrogen purity is a critical process variable in hydrocracking and hydrotreating feed streams. Effective management of hydrogen within a refinery starts with understanding the hydrogen purity of various feedstreams.

Many methods are used for determining the hydrogen purity, but Emerson's Micro Motion 3098 Specific Gravity Meter has several advantages. The meter uses a sample stream of the gas and gives almost continuous updates with response times in only seconds. The meter is virtually maintenance free and can provide specific gravity or molecular weight with an accuracy of +/-0.1% making it ideal for hydrogen purity measurement.



IMPROVE CONVERSION OF HYDROCRACKING

With faster visibility to changes in molecular weight (which correlates to the hydrogen purity), you have continuous awareness of hydrogen content. Armed with this knowledge, you can proactively optimize your feed gases to achieve your hydrogen purity target. This will allow you to maximize hydrocracking conversion.

INCREASE CATALYST LIFE AND THROUGHPUT

If insufficient hydrogen is being used in the hydrocracker, coking may cause a reduction in surface area of catalyst. This reduces unit throughput and conversion. In addition, excessive coking means the catalyst must be regenerated sooner, decreasing the interval between unit turnarounds. By measuring and optimizing hydrogen purity, coking can be reduced, extending catalyst life.

REDUCE COMPRESSOR COSTS

As the amount of hydrogen in the feed gas is reduced, the pressure of the feed must be increased to keep a constant partial pressure of hydrogen. Through the use of a hydrogen management program (starting with measurement of hydrogen purity), overall pressure can be reduced taking a load off compressors. This reduces maintenance needs, and eliminates bottlenecks.

In moving from 89% hydrogen purity to 100% hydrogen purity (of hydrocracker makeup feed), the following effects are noted:

- *full-range distillate yield is increased from 52.8% to 54.6%;*
- *heavy naphtha yield is increased from 16.6% to 19.4%;*
- *unconverted bottoms reduce from 17.8% to 11.3%.*

Source: Nick Hallale, Boosting refinery profitability through hydrogen management technology, www.airliquide.com/file/otherelement/pj/products/oil-gas/chem_engin_art59895.pdf

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