Question 47: How often do you replace your reformer catalyst? What is monitored, and what triggers the replacement? How has the increased spread between natural gas prices and liquid product prices impacted these decisions?

KOONTZ (HollyFrontier)

HollyFrontier operates five semi-regen reformers and two CCRs. There has not been a specific effort to replace catalyst in order to take advantage of the higher liquid product yield that is possible with newer catalyst. However, the spread between natural gas and liquids certainly impacts the decision when looking to upgrade. For two of the semi-regen units, the most recent catalyst replacements were installed after approximately 20 regen cycles, which included multiple dumping and screening events. HollyFrontier would generally only consider replacement during a turnaround, which is about every five years, because it would not be worth shutting down the unit.

Tracking liquid product yield as a function of octane over time is the most important factor used to justify new catalyst. Of course, today, with the large spread between gasoline and fuel gas, that breakeven point would probably be sooner, especially on high pressure units. Replacing relatively new catalyst with more advanced ones is also considered; however, we would be cautious about doing that because of the difficulty of comparing pilot plant data with operating data from our plants.

DUBIN (Axens North America)

We consider typical replacement levels to be six to eight years for moving-bed, eight to 10 years for fixed-bed, and three to seven years for cyclic units. Those ranges are based on typical regeneration frequencies and good quality regeneration, as well as proper hydrotreatment of the feed to the reformer. We know that surface area is lost with each regeneration; so, whatever your regeneration, you are going to lose yields relative to your initial yields. But as Mark
mentioned, replacement on lost yields relative to initial yields should not really be the only basis.

The most current catalysts on the market may offer improved economics. Due to a changing feed composition or product severity required, a newer generation catalyst may offer an economic incentive over your current load. A detailed evaluation should be conducted to determine the economic drivers at your particular site, in terms of hydrogen, its need, and its value. The same is true for the liquid products. This will help you determine if it makes economic sense to send the existing load to reclamation and purchase a new load of catalyst.

On the valuation of natural gas, we have seen that the reformer hydrogen is generally being devalued. Natural gas prices are so low that new steam methane reforming units are being brought on stream both for ULS (ultra-low sulfur) fuels production, as well as general upgrading. The hydrogen from hydrogen plants is preferred in both quantity and quality. In terms of total quantity available, you can build your hydrogen plant for whatever your need is going forward. The quality of the hydrogen from the hydrogen plants is near pure leading to improved partial pressures and potentially reduced equipment sizes.

RON MARRELLI (HollyFrontier)

Both of you mentioned a specific time between regenerations. Is time the main factor in determining frequency of regeneration or catalyst surface area? What is the best way to really determine when the catalyst needs to be changed?

DUBIN (Axens North America)

For a moving-bed, Axens recommends tracking surface area. In general, you should see that surface area will trend with yields. Tracking surface area can be done quite easily for moving-bed applications. For fixed-beds, it is not as easy on a continuous basis; but during any regeneration or dump-and-screen, you can track and note the surface area. Ultimately, it will be the yields that justify changing out the catalyst.

KOONTZ (HollyFrontier)

I agree with his statement.

MUEHLBAUER (Valero Energy Corporation – Benicia Refinery)

UOP's experience with units of similar age to ours has indicated that the key to maintaining long catalyst life and good performance is ensuring good platinum dispersion. If we can maintain good platinum dispersion, then product yields from the CCR Platformer unit, reformate production, and hydrogen production will remain flat over time. In some of the pressurized regenerators, CycleMax regenerators, and even atmospheric units, we have had up to a thousand regeneration cycles with no real loss and C5 plus yield or total aromatics yield. It is not as simple. Like the question before, there is not really one simple answer as there was with iron. If you want to talk more about it, feel free to stop by at the UOP suite. We can have a discussion.

KOONTZ (HollyFrontier Corporation)

HollyFrontier operates five semi-regeneration reformers and two CCRs. There has not yet been a specific effort to replace catalyst to take advantage of higher liquid product yield; however, this certainly impacts the decision process when looking to upgrade to a better catalyst. For two of the semi-regeneration units, the most recent catalyst replacements were after approximately 20 regeneration cycles (also included multiple dump and screen events). HF would generally only consider a catalyst replacement during a turnaround (about every five years). Tracking liquid product yield as a function of octane over time is the most important factor used to justify new catalyst. With today's large price spread between gasoline and fuel gas, the break-even point to replace catalyst is certainly sooner than in the past. Replacing relatively new catalyst with a more advanced catalyst is also considered. However, care must be taken to assure that a yield improvement prediction for a new catalyst is not due to different feed properties or operating conditions.

DUBIN (Axens North America)

Typical replacement levels are six to eight years for moving-bed applications, eight to 10 years for semi-regeneration units, and three to seven years for cyclic. The ranges are based on typical regeneration frequencies, good quality regenerations, as well as proper hydrotreatment of the reformer feed. A reduced catalyst life could be expected with increasing regeneration frequency as surface area is lost on the catalyst with each regeneration leading to a reduction in reformate yield relative to the initial yield.

Changing the reformer catalyst solely because the yields have decreased relative to the start of the run should not be the only basis for replacement. Replacing the existing catalyst due to advances in reforming catalyst technology, changes in unit severity, or changes in the unit feed composition, may still make economic sense even if the current catalyst load still has life left. A new load of catalyst could bring improvements in any number of economic drivers, reformate yield, hydrogen yield, increased cycle length, etc. If the combined improvements in the economics of the reformer provide a desirable rate of return, then it makes sense to send the existing load to reclamation. Axens has developed a tool with just this idea in mind. Looking at the key economic drivers in the reformer to help refiners understand whether a newer catalyst load will offer a greater profit than what their current operation is providing.

However, it must be noted that the very low prices of natural gas are leading to a de-valuing of the reformer hydrogen production. New steam methane reformers (SMR) are being built at a number of sites to help meet both ULS fuel production, as well as upgraders. The increased hydrogen production by SMR devalues the reformer hydrogen not just because of the increased quantity often available, but also because of the increased quality. The high purity hydrogen available by SMR can significantly improve hydrogen partial pressure for high pressure units, reducing costs, and further decreasing the value of reformer hydrogen production.

Tags

Catalysts

Hydrogen

Naphtha Hydrotreating

Octane

Operations

Process

Reforming

Regenerator

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