Question 22: How frequently do you change [or changeout?] the catalyst in reforming units? What are the appropriate economic criteria to evaluate?

FRY (Delek Refining)

With regard to reforming economics, the key criterion to determine catalyst condition is the surface area. As the surface area decreases, you will see yield loss on your unit, and you will have to raise the temperature in order to compensate for the lower surface area. Raising the temperature results in more cracking; so you will want to monitor the surface area. You will also want to monitor the volume loss across the unit, as well as monitoring your off gas rates.

There will come a point where you will save more in yield improvement by changing out the catalyst, and it will simply pay for itself. What that is will be unique to each facility.

LAMBIE (KBC Advanced Technologies, Inc.)

For semi-regeneration units, contamination, such as iron in the lead reactors, or unit upsets are more common issues. Skimming and catalyst replacement is a common practice to prevent downstream contamination. Skimming may occur every three to five years, depending on the effectiveness of the regenerations. Semi-regen units' catalyst surface area and activity are not as much of an issue these days as reformers are typically operating at low severities.

For CCRs, catalyst surface area and activity are typically limiting. As the surface area reduces, the ability of the chloride to be retained on the catalyst reduces, thereby requiring high chloride injection rates, which can lead to increased downstream salting and fouling issues.

Other issues more common with CCR units that may lead to a changeout would be poisoning of the catalyst from, say, silicon contained in coker naphtha or arsenic. Poor regenerator operation can lead to sintering of the catalyst. Increased fines production in the CCR can also lead to issues, but you have the ability to replace the catalyst online for CCRs.

From a cost standpoint, the cost of semi-regens versus yield improvements, in today's scenario where people are running very low severity reformers and getting long run-lengths, is frequently not the deciding factor. Often new catalyst formulations will come out with improved yields that may warrant a change in catalyst. Similarly for CCRs, yield improvements and activity are the deciding factors. Chloride handling costs become an issue as the surface area is reduced and more frequent changeouts of the chloride guard beds are required, which results in increased costs. And again, new catalyst formulations would improve yields and stability.

PATEL (Valero Energy Corporation)

So broadly, it depends on the operating severity. Due to lower severity operations and the fact that our CCR is a kind of noncontinuous regen type of operation we had, we changed our catalyst after 13 years of service. That catalyst change occurred during a scheduled unit inspection that required removal of the catalyst. This changeout during a reactor inspection was based on an economic evaluation. We were guaranteed C5 plus yield improvement by the licensor with the new catalyst.

KEVIN PROOPS (Koch Industries, Inc.)

If you have a semi-regen reformer, pay attention to your catalyst activity because the cycle length can very drastically. I know when I worked with Daryl years ago, one of the Conoco refineries had gotten some fairly old catalyst in a semi-regen unit; and by changing to new catalyst, it went from a six-month cycle to over a two-year cycle. So you can eliminate many of the regenerations by having a more active catalyst.

SCOTT LAMBIE (KBC Advanced Technologies, Inc.)

For semi-regenerative reformers, catalyst life is often dependent on contamination or upset-related issues. Lead reactors can become contaminated with iron, which ultimately affects the product yields. Skimming or possible replacement to prevent downstream contamination is a common practice. Depending on the regeneration procedures used, skimming may take place every three to five years.

Surface area reduction of the catalyst does not typically affect the yield loss across the unit. In extreme cases, surface area may be low and the catalyst activity affected. In some cases where good regenerations practices are followed, tail reactors may achieve up to a 10-year catalyst life.

Contaminants such as arsenic or silicon are permanent catalyst poisons for reformers and will have a detrimental impact on the catalyst activity if they are present in high enough quantities. These poisons should be managed in upstream hydrotreaters.

The main economic criteria for changing the catalyst are the cost and yields. In many refineries today, as a result of lower feed rates and/or lower operating severities, run-lengths are approaching two years and catalyst life is extending upwards of 10 years with only a relatively small change in yield loss. New catalyst formulations with improved yields and stability are increasingly dictating catalyst changeout decisions.

For CCR units, catalyst surface area reduction and activity loss are the main technical contributors to the decision to change the catalyst. The inability of the catalyst to retain chloride during regeneration results from the low surface area of the catalyst. Higher chloride injection rates and the resulting downstream fouling and corrosion become prohibitive to continuous operation for extended periods.

Contaminants such as arsenic or silicon will have a detrimental impact on the catalyst activity. These poisons should be managed in upstream hydrotreaters.

CCR units have more mechanical equipment and are more prone to potential failures or upsets that may affect the catalyst life than semi-regenerative reformers. Poor regenerator operation could lead to catalyst sintering or increased fines production. CCR units do have the capability to replace catalyst online which helps to maintain overall activity, but there is a cost associated for the lost catalyst. In some cases, consideration of the number of regeneration cycles weighs on the decision to change the catalyst.

Again, the main economic criteria for changing the catalyst are the cost and yields. The ability to control downstream fouling and corrosion resulting from increased chloride injection due to surface area loss may result in increased downtime and costs associated with water-washing and/or increased chloride bed changeout costs. New catalyst formulations in the market with improved yields and stability may justify a catalyst change.

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