Question 26: How are developments in hydroprocessing catalyst adjusting to changes in feedstock quality? Are the new developments able to cope with and provide high activity with varying feedstock severity?

AL-FUDHAIL (Saudi Aramco)

It is quite fitting for this question to follow the one before it. As we know, in feed to the hydrocrackers, hydroprocessing and hydrocracking are becoming more and more refractive and difficult. This challenge is leading to the need to increase the capability of the treating catalyst-to-hydrogenation capabilities. Of course, with the coker gasoil and the asphalted oil, hydroractive material increases in the fraction of the feed. Operating the light coker, as well as units with very low recycle, to reduce coke nick, heavy coker gasoil becomes highly refractive.

There are basically two ways of combating that new, elevated refraction. One, of course, is with catalyst development. Another is to adjust the catalyst reactor's loading. By means of layering your catalyst load, you will be processing Type I treating catalyst and Type II, as well as utilizing into immediate activity those catalysts, like light-cracking catalyst, which is used to denitrify and saturate the feed. Of course, Type II treating catalyst has a much higher hydrogenation function. This trend of using intermediate cracking catalyst to finish the pretreatment is gaining ground as opposed to using nearly amorphous silica and alumina catalyst, as was done in the past.

Modern cracking catalyst also uses a mix of traditional Y zeolite along with beta for optimum cetane with low cold-flow characteristics. This technique optimizes hydrogen consumption and reduces the cold flow properties for the distillate while maintaining optimal cetane index. That is a small point into the distillate cut.

Now when processing VGO from ebullated bed hydrocracking that is extremely aromatic, there will be a bulk-metal hydrotreating catalyst sandwiched between Type I and Type II. A treating catalyst is used to ensure that VGO is treated to meet feed quality for the FCC or second-stage catalyst in a maximum convergent unit. In such units, processing ebullated VGO second-stage catalyst requires high hydrogenation capabilities, which leads to the increased use of NovoMetal™ catalyst.

JOHNSON (Motiva Enterprises LLC)

In Motiva, we have seen advances in technology with the catalyst generations gaining more activity not only in VGO service, but also in distillates.

We have discovered that when evaluating a catalyst selection, depending on the unit configuration, we can unlock potential with not only catalyst, but also with hardware adjustments to extract more value

from the catalyst, in terms of cycle length and sustaining yield over the cycle. In short, we have not seen the issues where the catalyst companies are not keeping up with the changing feedstocks with which we are dealing.

SCHOELLKOPF (Advanced Refining Technologies)

I will basically echo much of what you have already heard. We are seeing more and more difficult molecules that need to be processed. Not only are there complicated molecules, but they are making up a higher percentage of the feed. Therefore, it takes some innovative approaches to the catalyst system design to resolve this challenge. The conventional methods are no longer necessarily sufficient. More of a good thing is not necessarily the optimal solution either. That is, you do not necessarily want to go for high HDN (hydro denitrification) or high alumina for HDN processing when you are also processing some other highly reactive feeds; for example, heavy coker gas oils. So, we generally just take feed from the refiner and tailor our loads based on what the refiner wants in the products.

PAPPAL (Valero)

I think there are a couple of universal rules in hydroprocessing or hydrocracking. You can never have too much reactor volume, and you can never have too much catalyst activity. As catalysts improve, refiners will take advantage of catalyst activity and reactor volume.

TRAVIS KIRK (Haldor Topsoe, Inc.)

I just want to stand and say that it is key for catalyst suppliers to keep up with the increasing demand on activity by making sure we have a fundamental understanding of the surface science. That way, you will be able to optimize the different parameters of the catalyst with respect to 1) pore size distribution, 2) pore volume of the catalyst, and 3) the catalyst surface area, such that you can tailor those parameters to the type of service for which you are designing the catalyst, as well as to the severity of the feed that you are treating.

Also, with the increase in the severity of feed, you will see an increase in the number of metals on the catalyst. So, you need good metals trap catalyst. We are seeing a lot of arsenic and silicon – even in straight-run components that are typically supposed to be the easier-to-treat streams. So, you can have all the activity in the world in your main bed catalyst; but if you do not also have a good guard bed to protect that high HDS/HDN activity, the catalyst load will not have very good stability.

STEVE ZINK (Honeywell UOP)

Catalyst development has focused on this very issue in its development of several of the highest activity

hydrotreating catalysts in the Unity™ hydrotreating catalyst portfolio. The catalyst support is engineered to facilitate less diffusion resistance in the same extrudate size/shape class relative to its peers, but with improved interaction between the active phase and the support, leading to greater relative effectiveness for HDN/HDS/HDA and for uptake of metals like vanadium and nickel. This feature allows for the refiner to, at times, process heavier, more difficult feeds during the cycle. Considerately bundling this with a relative minority fraction of hydrocracking catalyst and/or aromatics saturation catalyst downstream can be applied to target specific yields and qualities of finished products. Further advancements in alumina preparation – to effect greater relative surface area – have led to improved silica uptake. Combining this feature with improved metals finishing techniques allows for greater relative HDS/HDN activity compared to the former generation.

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