ALBEMARLE®

CATALYSTS

NEBULA® CATALYSTS

Economic benefits from unmatched catalyst activity

NEBULA catalyst technology has demonstrated near continuous growth in the volume and number of its applications (Figure 1). The key to its success is the economic value it brings to units that need its high activity. Albemarle continues to develop the NEBULA technology platform to open up more opportunities. Remarkably, nearly 80% of all the units that have tried NEBULA are still using it: nearly 40% of these in multiple cycles.

Since the initial applications of NEBULA technology, significant advances have been made to its product and how they can best be applied. This has expanded the application range and improved the economic returns. The improvements made to the NEBULA platform include:

- Lower-bulk density
- Increased strength
- Larger pores for heavier feeds
- Higher activity
- STAX® catalyst system design

The higher cost of NEBULA catalysts compared with conventional catalysts is offset by economic returns that may be difficult to accomplish otherwise. Generally, the economic return is generated through one of the following:

- Increased throughput at constant cycle
- Distressed feed processing at constant cycle
- Capital avoidance
- Higher-value product
- Increased volume by hydrogen addition

NEBULA's high activity for hydrodesulfurization (HDS), hydrodenitrogenation (HDN) and hydrogenation drives the efficient use of existing assets by pushing their limits. Most NEBULA applications are initiated by asking "what if?" When the only constraint to answering that question in the affirmative is catalyst activity, NEBULA is a potential champion.

NEBULA is used in applications ranging from refining to petrochemicals, but mostly for fuels: treating distillate to a very low sulfur and/or aromatics content, and pretreatment of feedstocks for hydrocracking.

Distillate hydrotreating

The application of NEBULA in distillate hydrotreaters is typically in units with >50-bar hydrogen partial pressure. Depending on the position of NEBULA in the reactor, a wide variety of targets is achievable. Several commercial operations have conventional NiMo catalyst at the top of the reactor, NEBULA in the middle section and a CoMo catalyst at the bottom. This approach exploits NEBULA's high HDN and HDS activity while avoiding a commensurate increase in hydrogen consumption.

- This positioning prevents excess hydrogenation of monoaromatics, which NEBULA might induce in a low-nitrogen environment, but it can be reversed when hydrogen consumption is desirable (density reduction, cetane uplift or aromatics reduction). For such a case, a catalyst system withNiMo catalyst at the top and middle of the reactor, and NEBULA at the bottom places NEBULA in a low-nitrogen environment where it can substantially increase the saturation of monoaromatics.

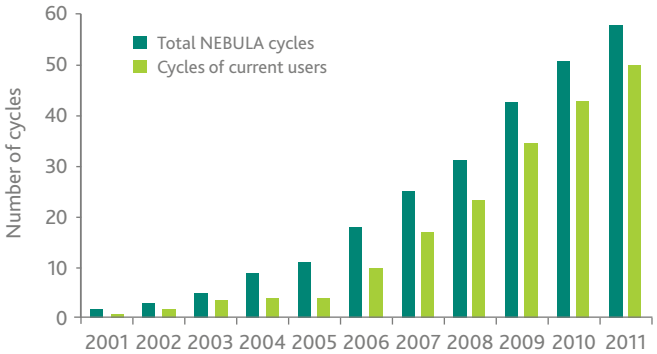

Figure 1: NEBULA applications are growing and user satisfaction is high

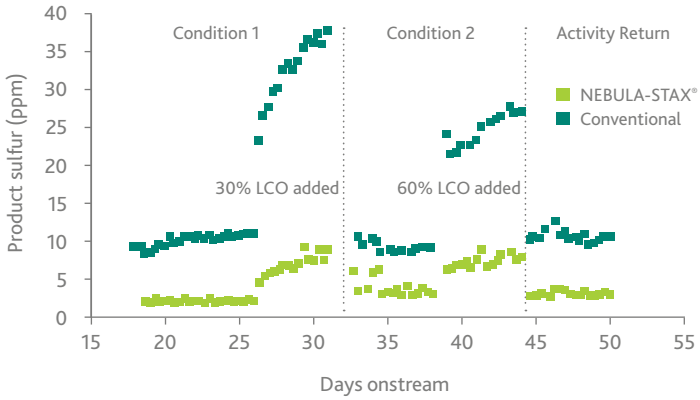

Figure 2: The effect of cracked feedstocks on NEBULA–STAX® and conventional catalyst systems

An example of the capabilities of NEBULA–STAX® loadings is shown in Figure 2. In this pilot plant test, the response of a conventional and of a NEBULA–STAX® catalyst system to increased cracked-feed addition were evaluated. It can easily be seen that the system containing NEBULA has substantially improved performance in all cases, but, most importantly, it can produce ultra-low-sulfur diesel (ULSD) in situations where the conventional catalyst could not. This benefit is consistently maintained, even with the activity return point condition at the end of the test, it clearly demonstrates NEBULA's stability.

Hydrocracking pretreatment

For hydrocracking pretreatment, the main goal is maximum HDN activity, and NEBULA is ideal for this. It is possible to exploit NEBULA's HDN activity for economic return in several ways. NEBULA could be used to maintain the same performance as a conventional catalyst while increasing throughput or to increase cycle length at same throughput. However, as most refineries already run at maximum throughput and have turnaround constraints, there are better ways to exploit NEBULA's activity.

Operating the pretreatment reactor for lower-nitrogen slip to the downstream cracking catalyst improves conversion through reduced inhibition of the cracking sites. One way to use the lower nitrogen slip is to increase the overall conversion using the same cracking catalyst and volume. Another option is to change the yield structure towards more distillate by using a more distillate-selective catalyst at constant conversion. Yet another opportunity is to change the feed diet to include distressed, lower-cost components and capture the increased cracking margin while maintaining throughput and cycle length.

Albemarle has considerable commercial experience with NEBULA in hydrocracking pretreatment operations. One notable case is a 150-bar mild hydrocracker where, through the use of NEBULA, it was possible to reduce the start-of-run weighted average bed temperature by 20°C (Figure 3). This enabled the refiner to practically double the cycle length. As with ULSD applications, a STAX® catalyst system design is always used. In a hydrocracker, this strategy protects NEBULA from fouling materials in the feed and tunes the NEBULA intake to control heat release and delivers the highest activity-per-volume to the refiner.

In addition to VGO hydrocracking pretreatment service, NEBULA has been widely applied in LCO hydrocracking pretreatment units.

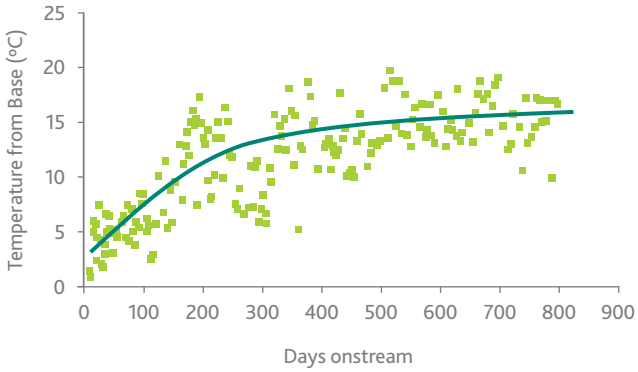

Figure 3: A NEBULA–STAX® system demonstrates outstanding stability

Commercial experience

Commercial experiences confirm the benefits of NEBULA–STAX® systems. After a first fill, NEBULA is often used for subsequent reactor loadings because it delivers significant economic returns.

The superior activity of NEBULA opens up many opportunities to capture economic return. In combination with Albemarle's STAX® technology, it is possible to obtain a significant performance enhancement with a relatively small NEBULA content, which reduces catalyst system expenditure and often reduces the payback time associated with the NEBULA investment to a few months.

Could you get better return on your hydrotreating assets with higher catalyst activity? If so, NEBULA may be the answer.

FOR MORE INFORMATION ON THIS OR OTHER ALBEMARLE PRODUCTS AND TECHNOLOGIES, PLEASE CONTACT YOUR ALBEMARLE REPRESENTATIVE.

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07-20