545DX: Higher Performance with a New NiMo Catalyst for ULSD

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Advanced Refining Technologies® continues to expand its line of ultra high activity DX® Catalyst Series in response to refiners’ demands for superior technology that delivers premium performance. This family of catalysts has exceeded expectations with its performance in demanding ULSD applications and the expansion of this line with 545DX will provide additional opportunities for refiners wanting additional capacity and increased yields without sacrificing cycle life. The ability to process difficult feed blends is one of the key advantages observed with this catalyst family. ART’s 420DX and NDXi have both demonstrated the benefits of this technology in ULSD units around the world, both as stand-alone catalysts and as part of a SmART® staged catalyst system.

545DX builds on this great success as shown in Figure 1, which compares the activity of several generations of ART NiMo catalysts. The figure shows that 545DX offers significant improvement in both HDS and HDN activity over NDXi. The feedstock used in this work contained 1.26 wt.% sulfur and 130 wppm nitrogen. 545DX has provided over a 25°F (14°C) advantage for HDS compared to NDXi as well as a 20°F (11°C) improvement in HDN activity.

Researchers at ART have been able to create a novel alumina support that was identified as a key property for improved catalytic performance. It is understood that there is a strong relationship between the role of increased surface acidity coupled with a tailored pore size distribution for improving the kinetic ability of the catalyst for reactions controlled through ring saturation, such as nitrogen and hard sulfur removal. This catalyst utilizes similar impregnation technology as NDXi using a chelate to bind to the nickel ions in the impregnation solution and reduce interactions with the alumina support. With some modifications to the manufacturing process, ART has been able to enhance this interaction allowing the chelate/ion complex to stay intact on the catalyst surface and promote the formation of significantly more Type II active sites.

In a concentrated effort to understand the improved activity of 545DX, ART has completed pilot plant testing over a wide variety of conditions and feedstocks, which clearly demonstrates the performance advantage available to refiners. Figure 2 shows the results of side-by-side testing of NDXi and 545DX at 775 psi hydrogen partial pressure and 2200 SCFB H₂/Oil ratio. At these conditions, 545DX clearly outperforms NDXi by over 20°F (11°C) at 10 ppm sulfur on a difficult feed containing 30% light cycle oil (LCO).
Additional benefits of 545DX are the improved HDN activity and increased aromatic saturation capabilities. This offers the flexibility for refiners to meet their HDS activity requirement while gaining additional volume swell. Figure 3 compares the additional API upgrade with 545DX relative to NDXi over a range of operating temperatures. As the chart shows, 545DX can provide upwards of one full number higher API upgrade when producing ULSD as compared to NDXi.

The need for refiners with lower pressure applications to be able to gain additional activity can present a kinetic challenge and is often addressed by utilizing predominantly CoMo type catalysts. The ability of NiMo catalyst to handle lower hydrogen pressure situations can be beneficial and can allow these refiners to increase throughput as well as see gains in cycle life. Figure 4 compares NDXi with 545DX at 580 psi hydrogen partial pressure over a range of LHSV, and it can be seen that, even as the process conditions become more severe, 545DX maintains its activity advantage over NDXi for ULSD.

The additional HDS activity combined with improved nitrogen removal and aromatic saturation allows refiners to utilize 545DX as a stand-alone catalyst for maximum upgrade in refinery markets demanding increased yields. 545DX can also be coupled with ART’s premium CoMo catalyst 420DX, in a SmART® Catalyst System, which is ideal for hydrotreaters that need to operate with controlled or minimized hydrogen consumption. These units are able to benefit from a lower start of run temperature, as well as being able to gain some additional yield improvements that are not often gained in a hydrotreater system of 100% CoMo.

Extensive pilot testing and expertise enable ART to provide the right catalyst system tailored for maximum refinery profit. 545DX will enable refiners to enhance their ULSD operation with either increased cycle length or additional use of opportunity feedstocks in order to maximize margin. The ability of 545DX to perform in different configurations provides a high level of versatility and makes it a top tier catalyst capable of exceeding refiners' needs in demanding ULSD applications.