Improved product yields and attrition resistance using ResidCrackeR FCC catalyst at Bayernoil Neustadt

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High catalyst losses from the FCC unit can have considerable consequences for refiners, such as contamination of slurry oil, erosion of slurry circulation pumps, required cleaning of heavy oil tanks due to catalyst build-up, failure to meet atmospheric particulate emissions regulations, premature failure of flue gas power recovery turbines, as well as loss of catalyst fluidity, leading to lower FCC unit throughput and worsening product yields. There are many operational factors that can cause increased catalyst losses from the FCC unit; however, they will not be discussed in this article.

High catalyst losses can also be the result of excessive attrition of the FCC catalyst in a fluid bed, which is caused by catalyst particles colliding at high velocity with other particles or solid surfaces. Therefore, one of the most fundamental features of a successful fluid catalytic cracking (FCC) catalyst is a high attrition resistance to enable it to be better retained within the FCC unit. Grace Davison FCC catalysts utilise a proprietary alumina sol (Al-Sol) binder system, which provides excellent attrition resistance and leads the industry in unit retention. This article will highlight how the ResidCrackeR catalyst has helped the Bayernoil Neustadt refinery to reduce particulate emissions, while providing improved product yields.

Bayernoil Neustadt refinery overview
The Bayernoil Neustadt refinery is located in the Bavaria region of southern Germany and, along with the nearby Bayernoil Vohburg refinery, contributes to a total capacity of 10.3 million tons per year. The two locations contain three crude units, two vacuum towers, two FCC units, one mild hydrocracker and hydrogen plant, one visbreaker, three reformers and one ether plant. The FCC unit at Neustadt is a stacked model and was built in the 1970s. It has a typical throughput of 150 tons per hour, operates in deep partial burn, and processes mild hydrocracker unconverted oil and atmospheric residue. The feedstock has a concarbon of 2.5 wt.%, and the e-cat metals levels are 5000 ppm vanadium, 5000 ppm nickel, 6000 ppm Fe and 4500 ppm sodium.

Reducing particulate emissions at Neustadt
In addition to third-stage cyclones, the Bayernoil Neustadt refinery has an electrostatic precipitator (ESP) to help control particulate emissions. ESPs have been used for the reduction of FCC particulate emissions since the 1940s, and modern ESPs can be designed to reduce particulate emissions to very low levels. ESP operation consists of three main steps: particle charging, particle collection and particle removal. The ESP at the Neustadt refinery was installed in the 1990s and was recently revamped in 2008. It has four zones, six dust hoppers and an inlet temperature of 220°C. ESP performance is generally affected by various factors. For example, a higher ESP voltage (typically between 20 to 80 kV) is desirable, and optimum performance also requires proper sizing of the precipitator (and of the electrodes). The flue gas nature (temperature, moisture content, composition) and the dust nature (electrical resistivity, particle size, temperature) also play a role, as does the gas velocity. At the Neustadt refinery, the key factors for achieving optimum particulate separation have been identified as having the proper ESP design, particularly with respect to size for a certain flow rate. The high availability of
all mechanical and electrical parts of the ESP has been important, likewise the low e-cat resistivity (helped by high metals content and ammonia injection). This is highlighted by Figure 1, which shows how ammonia injection has been used to control particulate emissions. The FCC catalyst has also been identified as playing a vital role. This can be clearly seen in Figure 2, which shows that prior to using a catalyst from Grace Davison ammonia injection was required to stay within the limits of particulate emissions. However, when the refinery moved to a Grace Davison catalyst in 2010, a dramatic reduction in particulate emissions was observed even without the use of ammonia injections. Other parameters were investigated to discover whether there could be other causes for the decreased particulate emissions, such as e-cat contaminant metals (which could affect e-cat resistivity), carbon on regenerated catalyst, as well as NOx concentration in the flue gas. However, none of these other factors were found to play a significant role in this case. The improved particulate emissions achieved have subsequently been attributed to the proprietary Al-sol binder used in the Grace Davison catalyst that provides improved attrition resistance. This is also supported by the fact that particulate emissions were not affected when the e-cat in the unit (from the Grace Davison catalyst) was replaced by external Grace Davison e-cat during a turnaround in Spring 2011.

**Improving product yields at Neustadt**

The catalyst that Bayernoil Neustadt switched to in 2010 was the ResidCracker catalyst from Grace Davison. ResidCracker catalysts are designed for resid processing and incorporate acidity modification, pore restructuring and metals
resistance functionalities from the EnhanceR Technology Platform. EnhanceR-based catalysts are manufactured with the proprietary Grace Davison Al-sol binder system, which ensures low particulate emissions due to its excellent attrition resistance. The ResidCrackeR catalyst is designed to give maximum intrinsic bottoms cracking with minimal or no coke penalty.

The yield improvements upon moving to a Grace Davison catalyst are shown in Table 1. The ResidCrackeR catalyst increased conversion by nearly 2 wt%, reduced slurry yield by approximately 3 wt%, and increased LPG and gasoline yield by approximately 2.5 and 1.5 wt%, respectively. In addition, dry gas was reduced by over 0.5 wt% and coke yield was similar. The improved metals tolerance and activity retention of the ResidCrackeR catalyst is highlighted by the e-cat evaluation graphs in Figures 3 to 5. Moving to the Grace Davison catalyst clearly provided lower coke and gas factors, as well as a higher stability/activity.

To summarise, when the Bayernoil Neustadt refinery moved to a Grace Davison catalyst in 2010, a dramatic reduction in particulate emissions was achieved due to the improved attrition resistance of the proprietary Al-sol binder used in the catalyst. In addition, the switch to the ResidCrackeR catalyst considerably improved product yields and allowed increased resid upgrading. This has resulted in a significant increase in FCC unit profitability as recognised by the refinery.

References