C2 – TK-561 BRIM™

Mild hydrocracking unit (at a European refinery)

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In May 2010, the Nickel Molybdenum based catalyst TK-561 BRIM™ was successfully installed in an existing mild hydrocracking unit at a European refinery. The loading replaced the Topsoe predecessor NiMo catalyst TK-559 BRIM™ after having completed a 24 months cycle. The mild hydrocracker operates as the FCC feed pretreater. The naphtha and diesel produced in the mild hydrocracker are separated from the hydrotreated VGO, before the VGO is fed to the FCC unit. The mild hydrocracker is operated at semi-high pressure and has a two-reactor configuration. Capacity is 28,000 barrels VGO per day.

TK-561 BRIM™ is based on Haldor Topsøe's proprietary BRIM™ Technology and is recognised for its enhanced hydrogenation activity and high stability under severe conditions. These features have been verified in industrial units where the BRIM™ catalysts have outperformed conventional hydrotreating catalysts.

When the refinery evaluated the future catalyst system and chose the TK-561 BRIM™ catalyst among the competition products, the decisive parameter was the stability of the new Topsøe catalyst system. The catalyst should be capable of providing maximum HDS activity and high VGO conversion activity in the entire cycle while operated under very harsh conditions, i.e. a difficult feedstock and high temperature.

At present, the TK-561 BRIM™ catalyst system has been in operation for 15 months, making it possible to conclude on the long-term catalytic capabilities for HDS, HDN and mild hydrocracking as well as on the stability of the catalyst. The operation is adjusted to meet a sulphur specification in the FCC naphtha of 18 wt ppm; this requires 300-500 wt ppm sulphur in the unconverted VGO (FCC feed). Along with the HDS, more than 60% nitrogen removal is also obtained (Figure 1). It is also desirable to convert as much VGO into diesel as possible (Figure 2). As a consequence of the challenging product qualities, the reactor temperature has been very high since start-of-run.

During the initial four months of the cycle, the quality of the processed feedstock was quite low. This was caused by fouling problems in the vacuum distillation, giving entrainment of resid in the vacuum gas oil fraction. This feed change is seen as a small but heavy tail end with significant amounts of asphaltenes and metals. The consequence was evident: very rapid deactivation caused by catalyst poisoning. The root to the problem was difficult to spot since most analyses appeared in spec. However, the analysis for Ni+V proved that the feedstock quality suffered heavily. After identifying the problem, the feed was initially undercut to make it lighter and to reduce nitrogen. After the vacuum distillation was given maintenance, the full-range feedstock quality improved dramatically. Since that change, the deactivation profile has been flat, and the operation very stable (Figure 3).

The feed properties and operating conditions are listed below.

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Table 1

Crude and feed type	North West Siberian Export Crude
VGO + LC finer fractions	
Density, kg/m3	932
API gravity	20.3
Sulphur content, wt %	1.54
Nitrogen content, wt ppm	2,400
Distillation (D-1160), °C/°F	
10%	365 / 689
50%	460 / 860
90%	550 / 1,022

Table 2

LHSV, hr-1	0.9
Hydrogen pressure, bar	83
Hydrogen pressure, psi	1,200
Operating temperature range, °C	370 - 395
Operating temperature range, °F	700 - 745

Figure 1 **% HDS/HDN with TK-561 BRIM™**

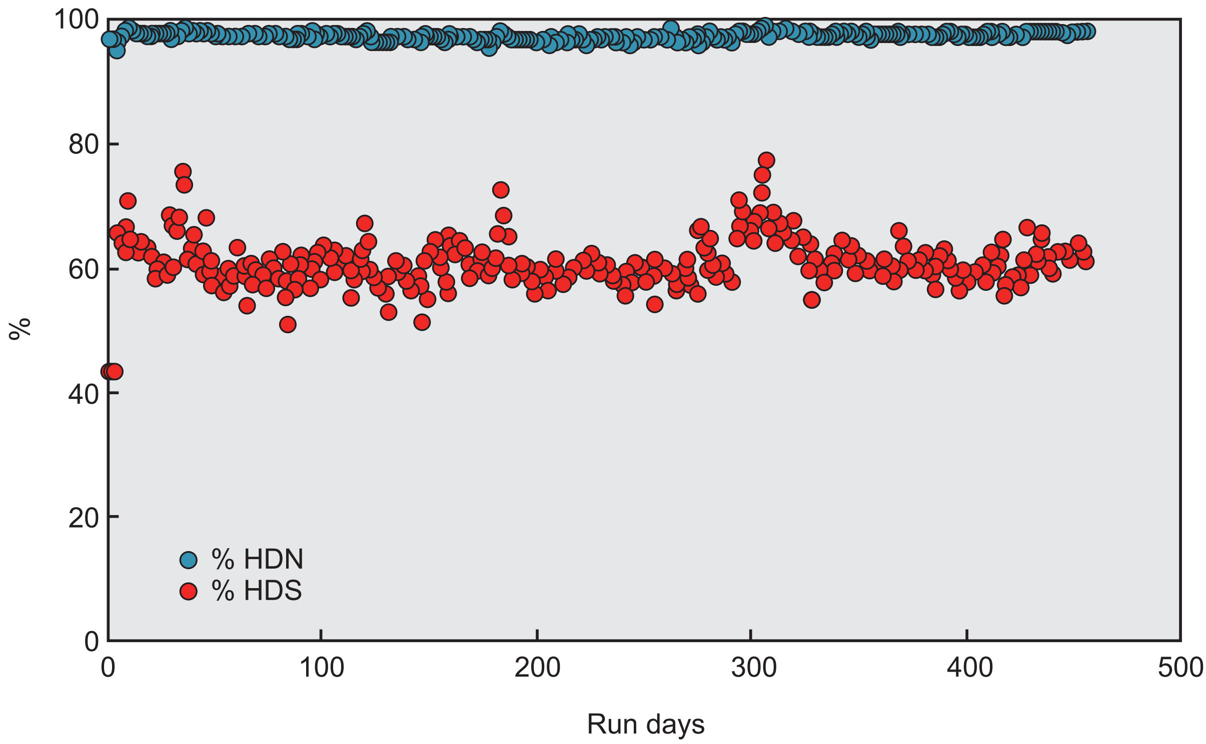

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Figure 2 **Gross conversion of 360°C+ with TK-561 BRIM™**

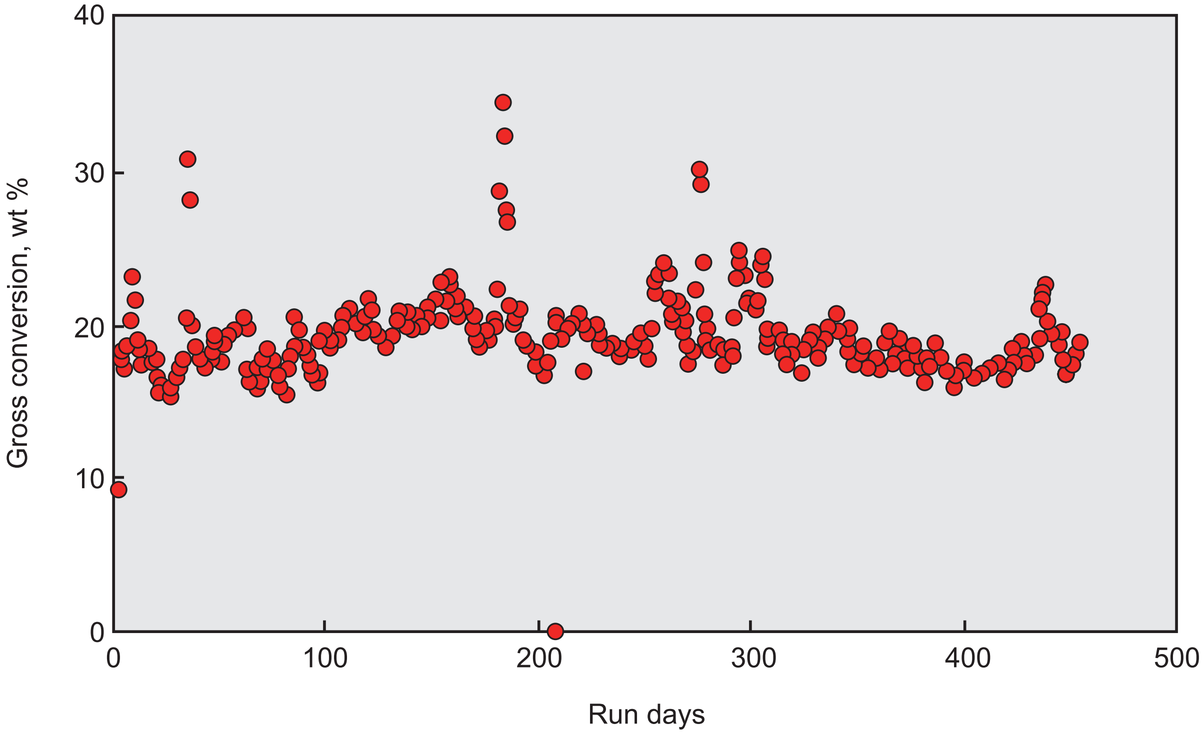

Figure 3 **HDS deactivation with TK-561 BRIM™**