Question 48: Can DAO (Deasphalted Oil) be processed in a full conversion hydrocracker and if so what concerns would need to be considered?

Kathy Wu and **John Baric** (Shell Global Solutions), **Deepak Agarwal** and **Deepak Rd** (Criterion Catalysts & Technologies)

Typical DAO stream composition metals (5 -100 wppm), Conradson Carbon (2 – 10 %wt), Asphaltenes (heptane insoluble of 500 -1000 wppm or more) and distillation endpoint (1300-1500 F or more) are detrimental to achieving economic catalyst life and conversion at hydrocrackers. There are several ways to reduce contaminants in the DAO stream. Once the process to reduce contaminant carry over is in place, effective use of catalysts is the key factor to success.

For new unit design, a separate guard reactor could be designed for contaminant removal. For an existing hydrocracker, a proper choice of the demet catalyst system will be required to handle the contaminants in the DAO stream. From a hydrocracking perspective, the ‘contaminants’ most detrimental to pretreat and cracking catalyst performance are metals and asphaltenes. Fortunately, both these show the sharpest partitioning in SDA units, with DAO, even from deep extraction, often having a lower C7-Insolubles (asphaltenes) value than the corresponding HVGO. With proper understanding of the DAO chemistry, a ‘demetallization’ catalyst system can be individually designed to protect the downstream hydrocracking catalysts.

It is important to know the level of removal of metals, heteroatoms, Conradson carbon residue (CCR) and asphaltenes. The feed composition and operating conditions determine the right catalyst choice. These variables determine the factors to tailor make catalyst systems that meet each refinery’s needs. In an existing unit with existing HCU reactors, there exists a fixed reactor volume available for the demet catalysts which then restricts the maximum amount of DAO that could be processed in the HCU feed based on the DAO quality.

The performance of Criterion’s demetallization catalyst system has been the key factor that enables ULSD and high-quality jet fuel to be produced directly from DAO with economic cycle lengths. In addition, Criterion has developed step out HDM/HDN/HDCCR catalysts with exceptionally high HDN and HDCCR activities, good contaminant metals tolerance and excellent stability. Using new innovative manufacturing technology, Criterion has additionally developed a new type of active sites that resists metal and coke deactivation. It has demonstrated stable activity at high metal deposition levels. Metal species compete with each other during demetallization and hence the effective use of customized layering of catalysts is vital to sustain effectiveness.

Vern Mallett (UOP)

DAO (Deasphalted Oil) or DMO (Demetalized Oil) can be processed in hydroprocessing units in varying

percentages of the total combined fresh feed to the unit. The design of the unit, configuration, operating pressure (and more importantly, hydrogen partial pressure), catalyst volume resulting in relatively low LHSV, expected product yield and quality, lead reactor catalyst type, and expected overall cycle length, are criteria for determining optimal DAO processing percentages.

Other criteria that must be taken into considerations are DAO quality. DAO properties, such as Conradson Carbon, asphaltenes, metals, and nitrogen, from a low lift Solvent De-Asphalting (SDA) operation versus DAO quality from a high lift SDA operation will also determine the percentage of DAO processed.

Catalyst selection especially for the lead reactor is paramount to a successful stable cycle. Evaluating the combined feed to be processed and the amount of DAO to be processed will determine the graded catalyst selection criteria. Sufficient large pore trap catalyst and demetallization catalyst are employed followed by relatively large pore hydrotreating catalyst or catalyst formulated for heavy feed stocks should be considered over traditional catalyst systems in the lead reactor(s). Subsequent reactor catalyst systems would have incorporated traditional hydrocracking catalyst systems tailored for yield selectivity, product quality and activity.

HPNA generated by processing DAO is also a concern at high conversions as little to nil unconverted oil is being removed to offset or balance HPNA generation. Conversion levels of 98+ percent are achieved by employing a combination of fractionation, separation, and adsorption to remove HPNA from the unconverted oil, especially in those units configured for recycle operation.

Tags

Catalysts

Distillation

Hydrogen

Operations

Process

Reactor Vessel

Resid Hydrocracking

ULSD

Year

2014