

UOP HYDROPROCESSING SOLUTIONS

Help Increase Distillate Yields Using UOP Hydrocracking Catalyst in Two Stage Units

Case Study





A refiner was processing difficult feed in two-stage operations and was unable to meet cycle length targets. Switching to UOP hydrocracking catalysts helped the customer increase distillate yields while improving cycle length.



Background

A customer in EMEA region processes highly refractory nitrogen-containing vacuum gas oil (VGO) feed in a hydrocracking unit. The VGO feed is pretreated in an upstream atmospheric residue desulfurization (ARDS) unit and then converted in a two-stage hydrocracking unit to either maximize jet fuel or middle distillate product. This unit was originally loaded with a competitor's catalyst and faced severe catalyst deactivation issues in previous cycles.

Objectives:

- Operate in flexible modes to maximize either jet fuel or distillate
- Maximize the unit throughput while minimizing the bleed rate
- Improve catalyst life

Challenges:

- High refractory nitrogen-containing VGO feed from ARDS unit
- High severity operation (more than 95% conversion in jet mode)
- High deactivation rates and reactor pressure drop observed in previous cycles

Feedstock

The feed is a blend of ARDS VGO and atmospheric gas oil (AGO) as shown in Table 1.

Table 1 - Feedstock

Component	Blend
Feed Type	VGO+AGO
API	26.88
Sulfur, Wt%	0.88
Nitrogen, wt-ppm	778
ASTM Distillation, °F	
IBP	363
50%	816
EP	1000

The nitrogen and sulfur levels are lower than in typical VGO feeds, as it is already pre-treated in an ARDS unit. Due to pre-treatment, the remaining sulfur and nitrogen in the VGO feed are challenging to remove, making this feed more difficult to process in the hydrocracking unit.

Solution

Cycle 1:

Based on pilot plant results, the refiner selected UOP first-stage pretreat catalyst HC-T, first-stage cracking catalyst HC-43LT and max distillate catalyst DHC-32LT in the second stage. After the reload, there was no pressure drop issue as in previous cycles and operation was extremely smooth over the entire cycle. The catalyst system provided by UOP exhibited good stability at 97% conversion level. To utilize the residual catalyst life, 10% of coker gas oil was processed for the first time in the unit since start-up. The new catalyst system achieved a 36 month cycle despite an operational upset early in cycle 1, which caused approximately half of the second-stage catalyst to become inactive. The refiner worked with UOP's technical service team to resolve this issue and adjust conversion in the two stages to meet and exceed their objectives.

Cycle 2:

After a successful first cycle, UOP proposed a more distillate selective hydrocracking catalyst in the first stage. To further improve unit performance, UOP recommended its DHC-32LT catalyst in both stages with less HC-T pretreat catalyst in the

first stage. DHC-32LT catalyst was selected for its ability to handle raw feed. Its denitrification and desulfurization ability on an ARDS pre-treated VGO is not an issue and deactivation rates are low. The cycle 2 catalyst system outperformed the previous cycle and has maintained the same relative stability as seen in the previous cycle shown in Table 2. Similar to the previous cycle, the coker gas oil was processed toward end of run to utilize the residual catalyst life.

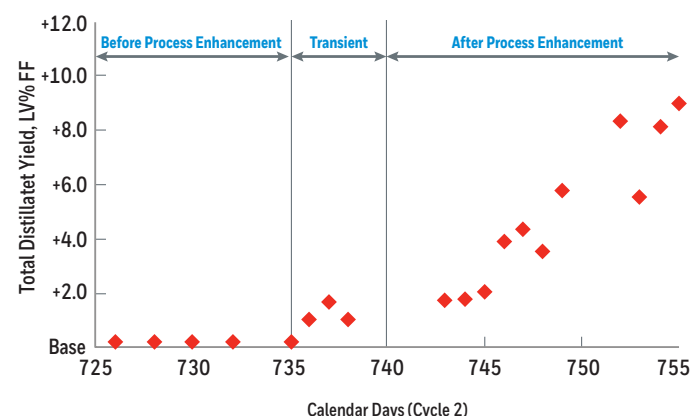
Table 2 - Comparison of Catalyst Performance (cycle 1 vs. cycle 2 reload)

Description	Units	Cycle 1	Cycle 2
Naphtha Yield	vol%	Base	Base-3.10
Distillate Yield	vol%	Base	Base+1.75
Cycle Length	Months	36	47

Process Enhancement in Second Stage

UOP also suggested a process enhancement in the second stage to further increase the distillate yields. This enhancement shifted the selectivity toward jet and reduced naphtha and light ends in the second stage reactor system. Figure 1 shows the impact of this process enhancement on the distillate product yields. As a result, distillate yield increased by 6-8 vol% in partial middle distillate mode. Depending on product price and demand, this process enhancement can provide flexibility in the hydrocracker product slate.

Figure 1 - Process enhancement impact on distillate yields



Cycle 3

For cycle 3, UOP proposed a new catalyst system to further improve unit performance. A more active type II pretreat catalyst was specified in addition to the DHC-32LT hydrocracking catalyst for the first stage which provides extra activity for denitrification of hydrotreated ARDS VGO. DHC-32LT stability and selectivity had been proven in previous cycles. For the second stage, UOP recommended its HC-115LT, a more distillate-selective catalyst.

DHC-32LT catalyst is formulated for use in hydrocracking units to be selective to jet or total distillate production and has been used in a variety of flow schemes. Due to its high hydrogenation activity, DHC-32LT produces high smoke point jet and high cetane number diesel. With this pretreat first-stage and second-stage catalyst configuration, the unit exhibited excellent stability with overall gross conversion between ~95-97 vol%.

Results

Since the first cycle with UOP catalyst, this unit is outperforming previous cycles that experienced higher deactivation rates and pressure drop issues. In collaboration with the customer, UOP's catalyst solution made cycle over cycle improvements in the unit's performance, setting new records for the unit history. UOP's catalyst system performed well despite the challenging feed (ARDS VGO) processed in this unit. A process enhancement in the second stage further increased distillate yield and unit profitability.

For more than 100 years, UOP has provided complete solutions to refiners and petrochemical producers worldwide. As a provider of hydroprocessing solutions, our goal is to minimize costs and maximize returns for our customers. UOP continues to innovate its catalyst and process technology offerings to maximize refinery profitability when processing challenging feedstocks.

For more information

For more information please contact your UOP representative or visit us online at www.uop.com.

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