

UOP HYDROPROCESSING SOLUTIONS

Increase Profitability by Processing Light Cycle Oil

Case Study





For refiners seeking to improve profitability by processing low value feedstock and meet ultra low sulfur diesel specifications, UOP's hydrocracking catalysts can help increase cycle length as well as diesel cetane and API gravity at lower conversion levels.



Background

An Asian refiner commissioned a new light cycle oil (LCO) hydrocracking unit designed to process 60,000 barrels per day of LCO from an FCC unit, while achieving 30-40 volume % conversion to 170°C minus products. The first cycle began with competitor catalysts and a cycle length of two years. The refiner then sought to enhance unit performance with the following processing objectives:

- Increase cycle length
- Produce ultra-low sulfur diesel (ULSD) with maximum cetane and improved API gravity
- Maintain heavy naphtha N+A > 90 Wt%
- Minimize light naphtha yields
- Retain maximum LCO in diesel range material

Feedstock

The hydrocracker processed LCO feed from two FCC units at the refinery. Characteristics of the LCO feed include:

- Aromatic-rich, middle distillate range material
- Exhibits considerably lower cetane value compared to straight run distillates derived from most of the world's crude sources
- Low blending quality due to very low cetane values, as well as sulfur and nitrogen contaminants

Table 1 shows a detailed analysis of the refiner's LCO feed. The feed quality is within the range of a typical LCO from most FCC units.

Table 1 – Feedstock Properties

FEED TYPE	LCO
API	13.2
Sulfur, Wt%	0.9130
Nitrogen, wt-ppm	1000
ASTM D976 Cetane Index	20.3
Bromine Number, g/100g	11.7
HPLC Aromatics, Wt%	84.11
Metals, wt-ppm	1.1
ASTM D86 Distillation	-
IBP, °C	203
50, °C	276
FBP, °C	362

For the given feed, the key product specifications that had to be met are given in Table 2.

Table 2 – Product Specifications

PRODUCT PROPERTIES	TARGET VALUE
Diesel Sulfur, ppm	< 8
Diesel Cetane, D976	> 26
Diesel Density, kg/m ³	< 900
Heavy Naphtha N+A, Wt%	> 90
Heavy Naphtha S & N, ppm	< 0.5

Catalyst Selection

The hydrocracking unit is typically the most profitable unit in a refinery. It not only upgrades low value feeds from various sources, but it also increases the overall volume produced. Proper operation and catalyst selection are critical to a refiner's profitability.

UOP prepared detailed yield estimates on this LCO feed to provide catalyst recommendations and improve previous cycle operations. Based on the feed contaminants, a robust graded bed design was selected, which provide protection against particulates in the feed with no incremental increase in catalyst pressure drop during the entire cycle.

Hydrocracking Catalyst

The hydrocracking catalyst was selected to retain maximum diesel range material in LCO and produce ULSD while maximizing volume swell within temperature limitations and achieving other target objectives over the

full cycle. With this in mind, UOP offered a combination of its HC-24L and HC-175LT catalysts for superior hydrogenation and good cycle length.

The hydrogenation capability of HC-24L catalyst provided high aromatic saturation to achieve targeted diesel product qualities.

HC-175LT catalyst selectively adds hydrogen to heavier products such as LCO. This minimizes naphtha aromatic saturation and produces high octane naphtha. This catalyst was replaced with UOP's HC-150LT catalyst for the subsequent cycle in an effort to further improve diesel selectivity and optimize operations. This catalyst change provided enhanced saturation and increased selectivity to heavier products to maximize the refiner's profits. The selection further reduced the diesel density and gave lower light naphtha yields to align with new objectives and offered improvement in product properties even at lower conversion levels.

Services

UOP's technical services team thoroughly reviewed and modified operating procedures to account for temperature targets and heat up rate changes, temperature rise limitations with cracking catalyst, emergency procedures and shutdown system. UOP also provided customized, onsite technology training for refinery operators and personnel to ensure safe operation.

Operating Data

Using the new UOP catalyst system, the following changes in unit performance were observed:

- A net 4 numbers increase in cetane index
- A net 4 numbers increase in API gravity
- ULSD specifications met with significantly lower product sulfur levels

Figure 3 shows a graph of feed and product diesel API gravities that depicts the density improvement achieved in this unit. Figure 4 gives a similar curve to plot the cetane boost. Figure 5 demonstrates heavy naphtha N+A, to show the selective aromatic saturation obtained with this catalyst system that is a key criteria for meeting other objectives of ULSD as well as density and cetane index enhancements.

Results

The refiner has been very pleased with UOP catalyst and service offerings and has selected UOP catalysts for multiple cycles.

The first UOP cycle used a combination of HC-24L and HC-175LT catalysts, which exceeded expectations for 3.5 years cycle length, compared to two years run with competitor catalysts. The second cycle was optimized with HC-24L and HC-150LT catalysts for further improvement in cycle length, diesel cetane and API gravity at even lower conversion levels.

UOP hydrocracking catalyst technology enabled the refiner to process a low value feedstock to produce a high quality blending material while improving 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.

Figure 3 – Feed and Product Diesel API Gravity

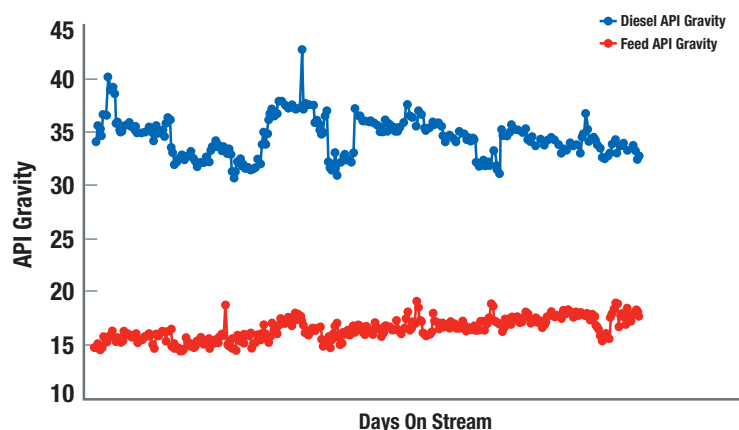


Figure 4 – LCO HC Feed and Diesel Cetane Index

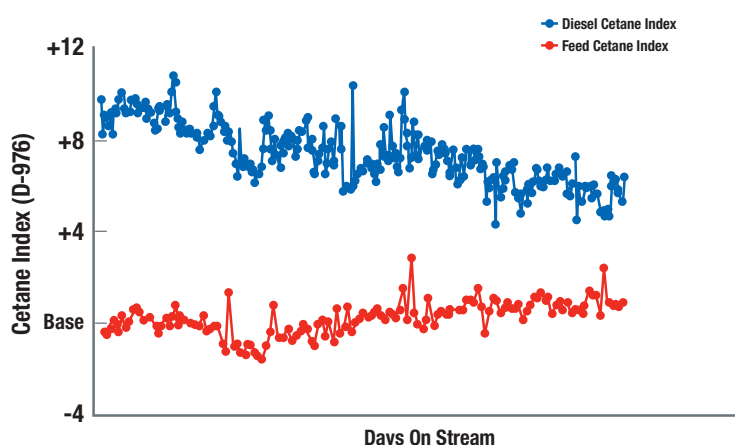
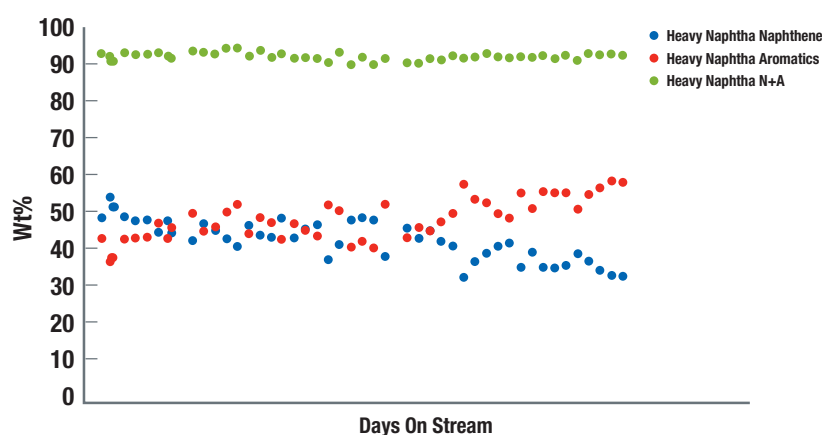


Figure 5 – Heavy Naphtha Naphthenes and Aromatics



For more information

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

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UOP7336
July 2016
Printed in U.S.A.
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