



## HyCycle Unicracking™ Process

### Refining

#### Application

The HyCycle Unicracking process is a step change in technology for maximum distillate hydrocracking. This process uses an optimized flowscheme for maximizing the yield of high-quality diesel fuel.

The key benefit of the HyCycle Unicracking process is higher selectivity to diesel product. Up to 5 vol-% more middle distillate yield with as much as a 15% shift toward diesel fuel can be achieved when compared to other full-conversion designs. This shift in selectivity, coupled with a more selective saturation of feed aromatics, results in as much as a 20% reduction in process hydrogen requirement. These benefits make the HyCycle process a perfect option for producing the next generation of transportation fuels.

A key feature of the process is reduced operating pressure, typically 25% lower, relative to prior processes. Several unique design features enable the hydrocracking reactor to operate at both lower pressure and higher space velocities than conventional designs without sacrificing catalyst life or distillate quality.

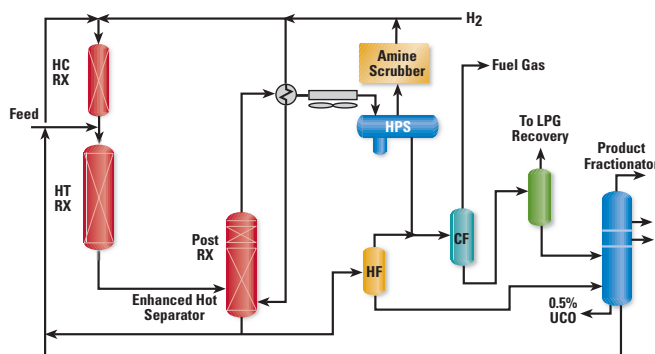
The HyCycle Unicracking process offers flexible, cost-effective options (LCO co-processing, staged investment, partial conversion, and FCC/HC integration) for meeting the market need for low sulfur, high cetane diesel fuel.

#### Process description

The HyCycle Unicracking process uses a combination of several unique, design features, including an enhanced hot separator, back-staged series flow reactors, and a novel split-wall fractionator configuration.

In the process, unconverted oil (UCO) and cracked products are separated at reactor pressure, and the latter are then immediately hydrogenated in the vapor phase. This unique processing step maximizes the quality of the distillate product for a given design pressure. It also provides a more efficient means of recycling UCO to the cracking reactor, enabling a less severe per pass conversion. The hydrocracking catalyst zone configuration is referred to as “back-staged” because recycle oil is first routed to a hydrocracking catalyst zone and then to a hydrotreating catalyst zone. The benefits include cleaner feedstock to the cracking catalyst and higher

#### HyCycle Unicracking Process

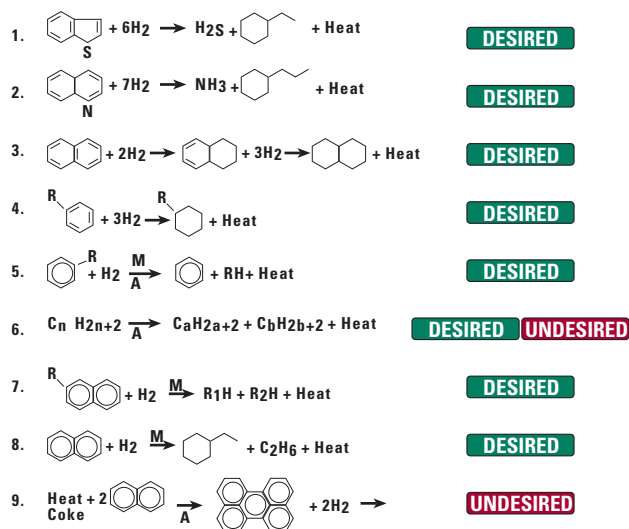


hydrogen partial pressure. The net result is higher catalyst activity per unit volume, hence, a lower catalyst volume requirement. The reactors use a common series flow recycle gas loop.

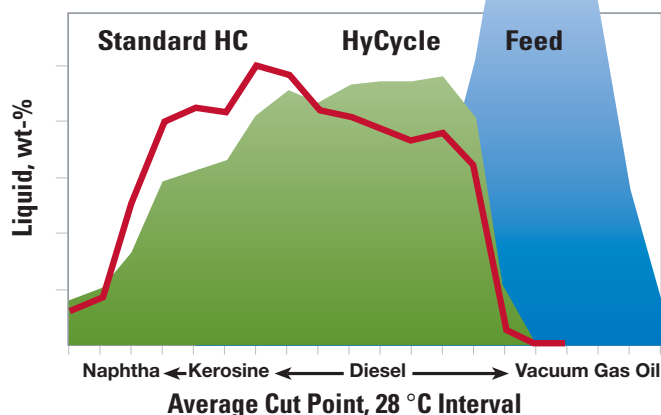
#### Process chemistry

The typical hydrotreating and hydrocracking reactions are listed on the next page. Aromatic saturation (3, 4) is the key to making high-quality distillate products. Some aromatic saturation reactions take place in the hydrotreating reaction zone, but the majority occur later in the conversion and post-treat sequence.

#### Typical Hydrotreating (1-4) and Hydrocracking (5-9) Reactions



## HyCycle Makes More High-Quality Diesel Fuel



The HyCycle Unicracking process uses low per pass conversion to minimize the undesired cracking reactions (6, 9). Selective ring opening reactions shift the equilibrium to a more favorable regime for producing high-quality diesel fuels at lower operating pressure. Less severe per pass conversion favors a heavier product distribution with less light and heavy naphtha production and more high cetane diesel fuel. By minimizing secondary cracking reactions, less hydrogen is chemically consumed and more of the hydrogen-rich paraffin compounds are retained in the middle distillate boiling range.

The improvement in diesel yield relative to previous Unicracking offerings varies from 5-15%, depending on product slate and product cut point.

### Full Conversion to 343 °C Cut Point

<b>Full Range Diesel</b>	<b>149–343 °C</b>	<b>204–343 °C</b>
Density at 15 °C, kg/m <sup>3</sup>	0.8189	0.8298
Cetane Index (D4737)	56	61
Sulfur, ppm	<10	<10
Poly Aromatics, wt-%	<0.2	<0.2

This chart provides properties of the diesel oil, which can be produced from an 80/20 blend of Light Arabian vacuum gas oil and coker gas oil at 120 barg operating pressure. The products meet all the envisioned EU 2005 specifications.

## Process Flexibility

The option of staging the investment in a full-conversion hydrocracker can be more attractive with the HyCycle Unicracking process. For example, a once-through partial conversion Unicracking unit can be installed as an initial investment. At a later date, the HyCycle enhanced separator and second reaction stage can be added to the unit to boost diesel yield and product quality. Using common equipment and lower design pressure minimizes pre-investment. About a third of the investment can be postponed until market conditions and product quality requirements justify investment in higher conversion.

Another synergistic benefit can be realized in those cases where secondary low-quality distillates are in need of upgrading. In this case, a secondary distillate such as light cycle oil (LCO) is charged directly to the HyCycle enhanced separator. The co-processed feed shares a common high-pressure loop with the hydrocracker without taking up any space in the cracking reactor. The secondary feed also enhances the separation of UCO and cracked products by providing a source of external reflux. The net result to the refiner is a single unit with increased production of high-quality diesel fuel.

## Experience

UOP has licensed more hydrocrackers than all other licensors combined. Over the past 40 years, more than 155 units have been designed by UOP.

## For more information

The HyCycle Unicracking technological services are available on request. For more information, contact your local UOP representative or contact our Des Plaines sales office:

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