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Maximize your product slate with diesel for cold climates

A white paper

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Maximize your product slate with diesel for cold climates

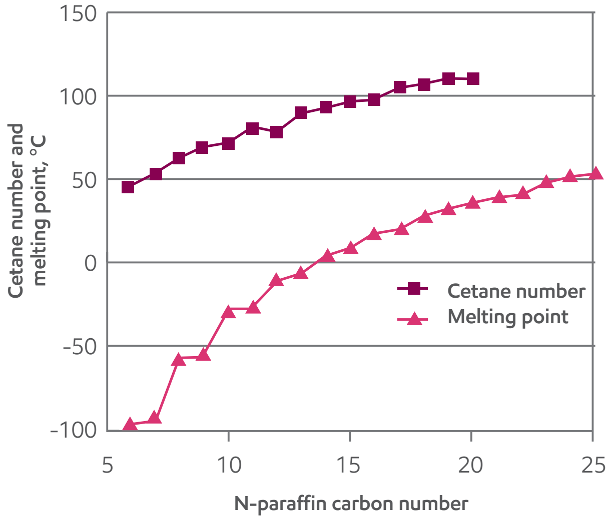
Refiners seeking a more profitable method for meeting cold-flow diesel specifications should consider the advantages of isomerization dewaxing technology.

In the global marketplace, demand for premium diesel fuels, including winter diesel, continues to increase. This trend offers refiners an opportunity for growth and greater profitability, provided stringent low-temperature specifications can be met. The three main specifications cover:

- Cloud point
- Cold filter plugging point (CFPP)
- Pour point

Cloud point measures the temperature at which wax crystals begin to form, creating a cloudy appearance in the distillate. CFPP is a simulation test measuring the temperature at which wax crystals grow large enough to plug a diesel fuel filter. Pour point is the temperature at which diesel solidifies.

Figure 1



To meet these specifications, refiners must find ways to manage waxy, high-molecular-weight n-paraffins in the feed that undermine performance in low temperatures. Managing n-paraffins isn't a matter of simply eliminating them, because long-chain paraffins offer beneficial properties, such as high cetane and low density **(Figure 1)**. Outright removal of n-paraffins also decreases diesel yield.

Traditional processing options

To manage n-paraffin content, refiners traditionally have used one of three common approaches. While each has its benefits, these approaches also have drawbacks that can significantly impact profitability.

1. **Blending kerosene** into the diesel pool is a common approach. Kerosene's low molecular weight dilutes the n-paraffin content to lower the cloud point. The simplicity of this process makes it attractive, but it also downgrades high-value kerosene to diesel, which can undermine profitability when the refiner has more lucrative options, such as selling kerosene for jet fuel.
2. **Undercutting diesel endpoint** cuts the high-boiling-range n-paraffins from the diesel by lowering the endpoint of the feed. This moves potential diesel molecules into the lower-value virgin gas oil (VGO) pool, which can have an impact on FCC and HDC units.
3. **Selectively cracking paraffin** uses a catalyst to crack the n-paraffins, converting it to naphtha or liquid petroleum gas (LPG). The n-paraffin is catalytically removed from the diesel. While the process can enhance feed flexibility, it does so at the expense of reducing cetane and increasing diesel density by the removal of n-paraffins.

Refiners seeking to increase the value of their yield instead limit profitability with these traditional options.

Isomerization is a better option

Fortunately, refiners can choose a different option to meet their winter targets of increased production of ultra-low-sulfur diesel (ULSD) with excellent cold-flow properties.

The ExxonMobil MIDW™ process technology uses a proprietary bifunctional molecular catalyst sieve for isomerization and shape-selectivity to convert n-paraffins to iso-paraffins. The iso-paraffins are retained in the diesel and have similar cetane and density to n-paraffins but markedly lower cold-flow properties. It is designed to produce higher yields of higher-quality, low-cloud diesels than paraffin-cracking technologies from a wide range of feedstock **(Figure 2)**.

Commercially proven in more than 15 units worldwide, including ExxonMobil hydrotreaters and hydrocrackers, MIDW catalyst technology allows refiners to retain high-cetane paraffin content through isomerization.

Refiners have used various grades of the MIDW catalyst dewaxing technology for over two decades, reducing cloud point by as much as 50°C. The technology is also used to increase diesel retention — achieving yields as high as 98 percent, depending on cloud point reduction.

The ability to retrofit an existing unit with MIDW technology to capture significant value makes this one of the most sought-after fuel technologies in the world today.

Unit flexibility

MIDW technology is a drop-in solution that is easily integrated with other technologies and existing plant equipment at diesel-producing refineries. Two potential reactor configurations are shown in **Figure 3**.

The process is flexible enough to be used alone, or it can be co-loaded with HDT and HDC catalysts to produce premium ULSD with a low cloud point. During warmer months, when refiners are not concerned about cloud point reduction, the MIDW bed is easy to quench to avoid reducing cloud point. This option allows refiners to maximize the value of their product slate while meeting their stringent winter targets.

Figure 2

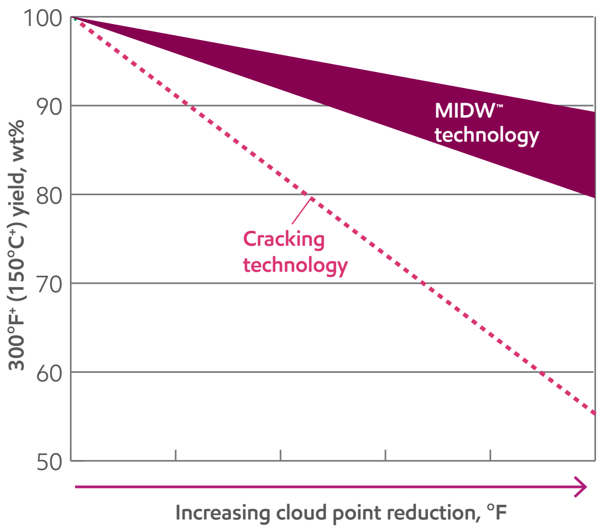
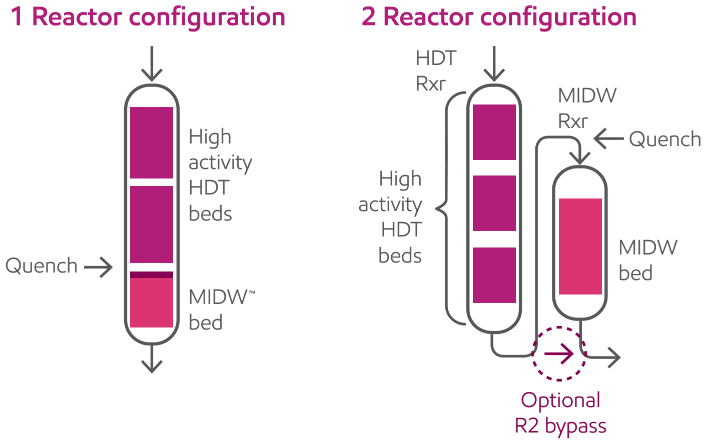


Figure 3



MIDW™ technology can:

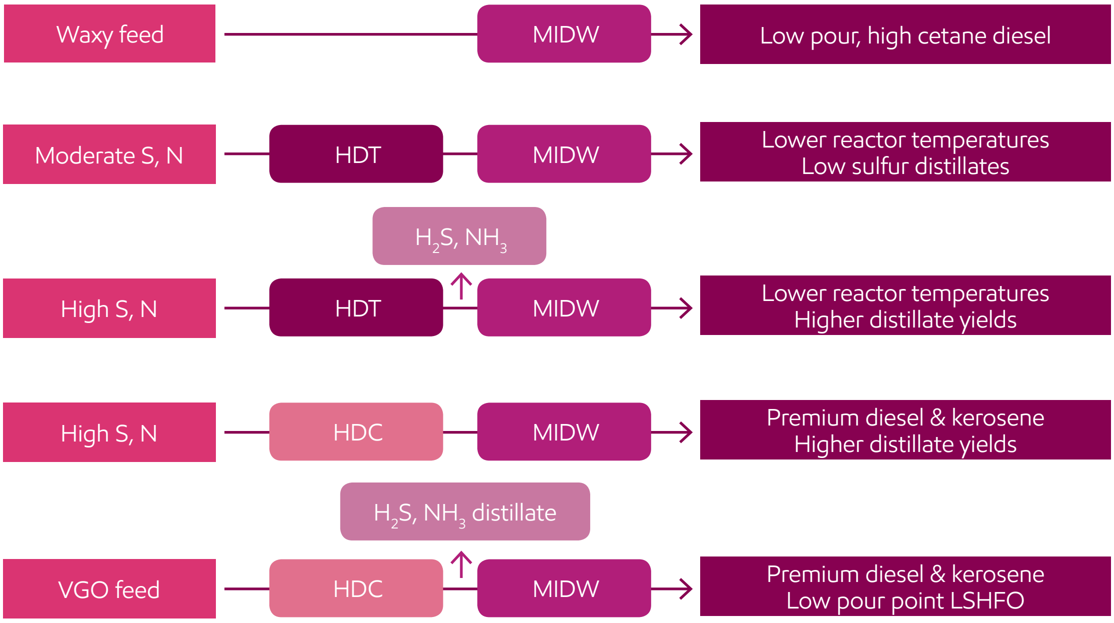
Reduce cloud point by as much as

↓50°C

Achieve yields as high as

↑98%

Figure 4



Five MIDW process configurations **(Figure 4)** have been commercialized, demonstrating the application's flexibility — which can be adapted to meet the refiner's particular needs and goals.

MIDW technology case study

To maintain profitable growth within a challenging market, Greek refiner Hellenic Petroleum needed to find new markets for its diesel product. Northern Europe offered opportunities, but Hellenic had to find a way to profitably produce ULSD that met cold-climate diesel specifications for cold-flow performance.

Specifications in Greece required CFPP of -5C° for winter and 5°C for summer, while more northern markets demanded -15°C or even lower in winter months. Hellenic Petroleum had to find a new process. The refiner tried using additives to reduce cloud and pour points, as well as CFPP, but still could not reliably meet specifications. Traditional processing methods — as well as nontraditional ones — were explored, but none proved able to practically and consistently achieve the specifications. Another method was needed to profitably produce ULSD for export to northern European climates.

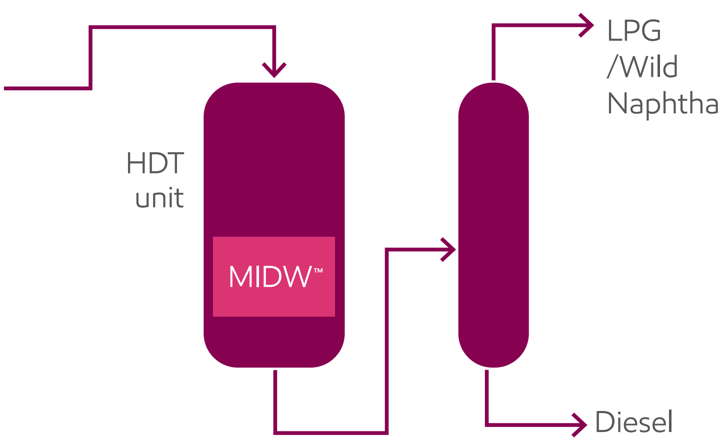
An opportunity arose at the sour service Heavy Atmospheric Gas Oil (HAGO) hydro-treater at Hellenic's refinery in Thessaloniki, Greece, which was designed to allow installation of an MIDW catalyst bed. After MIDW bed installation, the catalyst was loaded, replacing some of the hydrodesulfurization (HDS) catalyst **(Figure 5)**.

The installation required modifications, including:

- A treat gas quench line
- A quench nozzle in the inter-bed area of the reactor
- The MIDW catalyst

The modifications allowed for inter-bed quenching during summer months to "turn off" the dewaxing catalyst. The original design included allowances for additional treat gas flow requirements, additional naphtha production and increased liquid hourly space velocity (LHSV) for the HDS catalyst.

Figure 5



Using MIDW technology, Hellenic Petroleum achieved its goal of producing high-quality diesel that meets cold-flow specifications in their new, northern markets. The catalyst cycle exceeded 1,000 normalized days and 100Sm³/kg of catalyst **(Figure 6)**.

More than 30 percent of the refiner's total diesel production was exported as low CFPP ULSD, rather than as lower-value heating oil. By tapping into the advantages of MIDW technology, Hellenic Petroleum opened new, previously closed markets, achieving significant financial gains.

This opportunity to boost profitability is available to refiners around the world. MIDW technology has proven successful for increasing production of high-quality ULSD to meet specifications and market demands. Due to the capabilities of the technology, today's increasing use of waxy crudes is not an obstacle for refiners to achieve new levels of profitability in the evolving marketplace.

Figure 6