



# Refinery catalysts

## Navigating an uncertain future

Refinery catalyst makers say demand has been solid. Demand drivers such as a stronger economy and tightening restrictions on sulfur content in fuels should extend that trend into 2018. Vehicle electrification is expected to take a chunk out of transportation fuel demand longer-term, although forecasts vary as to when the effect might take hold.

Rebecca Coons

**T**he outlook for refinery catalyst demand is mixed, with tailwinds such as population and economic growth, low-sulfur regulations, and cheaper feedstocks being mitigated by higher fuel economy standards, biofuels, and, eventually, increased penetration of electric and hybrid vehicles.

Refinery catalyst makers expect positive demand drivers to more than offset headwinds in the near-term. “The population around the world continues to grow, and GDP continues to increase. So demand for transportation fuels continues to rise,” says Mike Cleveland, global senior business director/catalysts, adsorbents and specialties, refining at Honeywell UOP. In the United States, low oil prices are pushing up vehicle miles. “So even though we’ve implemented CAFE standards in the US, gasoline demand has been relatively stable. We see small increases in US fuels demand over the next

five years, which seems reasonable.”

Diesel demand, which is tied to economic activity, has also been healthy, Cleveland says. “Strong economic growth means more trucks on the road, which means more diesel. From a US standpoint, we’re a large fuels exporter to Mexico and South America. So that’s pushing up operating rates.”

Lars Skyum, vice president/refinery catalysts for Haldor Topsøe, characterizes demand as “pretty good” for the last three years, and expects continued growth in 2018. “We have an order book that is at a record high, actually. We can still deliver, but the lead time has become longer.”

Silvio Ghyoot, president/refining solutions at Albemarle, also reports healthy demand in 2017, and expectations that the trend will continue in 2018. “The world is buying more cars and traveling more, requiring more fuels, and also demanding that those fuels be cleaner.”

Jim Chirumbolo, vice president for refining catalysts BASF, says steady population and

economic growth in North America will continue to drive fuel demand, only to be dampened by fuel efficiency improvements and increased fuel substitution options like biofuels. “Thus far, vehicle miles traveled has outpaced new light-duty vehicle fuel efficiency improvements; however, we do not believe that the trend will continue,” he says. Detleff Ruff, senior vice president for process catalysts at BASF, says growth will come predominantly from developing economies as urbanization and standard of living improvements lead to increased transportation fuel demand.

Skyum notes that growth markets like India, Southeast Asia, and China are developing similarly to the United States and Europe 15 years ago, when regulators began to implement limits on sulfur in diesel and gasoline. “That’s good for the catalysts business, because you require more and higher-quality catalysts to produce the same amount of diesel with low sulfur compared to high sulfur. If you have demand growth in



**HIGH ACTIVITY:** Alkermat produces FCC and HPC catalysts at its Amsterdam site.

diesel, the actual growth in catalysts could be 2–3 times as high,” Skyum says.

But while demand for refined petroleum products remains tied to macro trends such as how quickly economies are growing and trucking miles driven, there is a big “externality” surrounding the penetration of electric and hybrid vehicles, says John Murphy, president of The Catalyst Group Resources (TCGR; Spring House, Pennsylvania). “So the question becomes, when does this cause demand for liquid fuels to stop growing at 1–2% per year and hit 0–1% or less?”

W.R. Grace, a supplier of fluid catalytic cracking (FCC) catalysts and additives, and hydrotreating and hydrocracking catalysts through its ART joint venture with Chevron, believes that, over the long term, market penetration of electric vehicles (EVs) will dampen the growth rates of transportation fuels. This will be particularly true of gasoline demand, which is expected to eventually flatten or even slightly decline globally, says Tom Petti, president, refining technologies for W.R. Grace. “However, it is not yet clear whether that plateau will be in 2030, 2035, or beyond. We are confident that the refining industry will continue to see investment by our customers in the 2018–25 timeframe, particularly in emerging regions where transportation fuel demand will continue to increase, leading to continued demand growth for our catalysts.”

Forecasts for EV and hybrid penetration vary. Shell expects demand for gasoline could peak by the 2030s due to fuel-efficient cars and EVs. BP expects this to happen some time in the 2040s. Many studies peg penetration at around 7.5% of the automotive pool by 2025.

“It’s not going to happen as fast as some of the wild forecasts you see out there, for some simple reasons,” says Clyde Payn, CEO at The Catalyst Group. “There will be individual countries, like Sweden, where it might be higher, but the charging infrastructure for these vehicles is not in place, and is not easy to put in place.”

Over the next five years, electrification will have a negative effect on transportation fuel demand, but it likely will not have a significant negative impact until 2040 or so, Payn adds.

Honeywell UOP’s forecast shows demand growth for gasoline and diesel through 2035. “EV adoption rates have been slower than people expected, but the wildcard for that is, what happens when a government dictates that you have to buy EVs? So far there’s been a hodgepodge of regulations in specific countries,” Cleveland says. “So our forecast shows demand growth for gasoline and diesel even out through 2035.”

Haldor Topsøe is seeing EV penetration in Europe, particularly in northern regions like Norway. “If you look 20 years ahead, we expect global gasoline consumption will actually be lower than today,” Skyum says. “So that will have an impact for sure. But, on the other hand, jet fuel and transportation fuels for trucks will still be increasing.”

Ghyoot believes that EVs and internal combustion engines will coexist and both grow substantially. “Over the next 10 to 15 years, consensus is that EVs will replace only a small part of fossil fuel growth—estimated at about 1 million barrels of oil per day by 2030. Any plateau of fossil fuel demand growth would likely not occur until later, he adds.

### Renewables and regulations

Renewable fuels, on the other hand, have been a relatively small portion of the global transportation fuels market outside of niche markets with good local economics, such as Brazil. The biofuels RIN (Renewable Identification Number) system in the United States, which provides refiners with proof of purchase for mandated volumes of biofuels for blending, has been a pricey regulatory requirement for US refiners. The expense of RINs was even cited by Philadelphia Energy Solutions as the main cause of its recent bankruptcy filing, sparking a political battle over the future of the US Renewable Fuels Standard.

“The RIN system is a big question mark for the US at the moment,” Payn says. “There has been quite a kerfuffle over the last two or three years about the credits, which make it economically viable to incorporate biofuels into the gasoline pool.” Increasingly, the RIN system is seen as unmanageable at best and, at worst, easily frauded, with a number of blenders and suppliers having been caught falsifying the numbers, he adds. “And the whole idea of being able to move to second-generation biofuels by using lignin-based, woody materials has proven to be somewhat of a scientific disaster,” Payn says. “Bioethanol just isn’t an ideal component for blending, both for octane as well as for properties. Biofuels have been shifting toward other biobased octane enhancers like biobutanol, and in Europe, biobased MTBE

and ETBE.”

Meanwhile, the International Maritime Organization’s Marpol regulations—which aim to reduce sulfur content in marine fuels—will continue to be a driver of hydroprocessing and hydrotreating catalyst demand.



**RUFF:** Growth will come mainly from developing economies.



**GHYOOT:** Collaborating more closely with customers.

“IMO implementation of MARPOL’s 0.5% [sulfur limit in] marine fuels on a broader basis globally means that you’re going to see more resid upgrading and more hydrotreating to get down to those low-sulfur limits,” Payn says. “This will have some impact on the transportation fuel sector globally, but we are already seeing decisions by some, particularly Middle Eastern refiners like Kuwait Refining and Adnoc, announcing investments to specifically address it,” Payn says. This isn’t surprising, given the region’s high export activity in fuels and chemicals. “They are going to have to meet these standards for lighter fuels faster than most,” he adds.

There are several approaches seafaring vessels can use to address MARPOL, but adding scrubbers to a ship’s exhaust stack or retrofitting its engine to substitute for liquid natural gas are both capital-intensive, The Catalyst Group’s Murphy notes. “Switching to low-sulfur fuel is going to become the preferred route to addressing MARPOL,” he adds.

Honeywell UOP’s Cleveland expects that this will create some opportunities for refiners and catalyst makers. “Between now and 2020, demand for residual fuel could go down significantly, and it will become a stranded stream, and potentially sold at a significant discount. There’ll be some good margins available for refiners who can process high-sulfur crude oil or stranded residual fuel oils.”

### Changing slates

Meanwhile, changing feedstock slates like the increasing availability of lighter oils, condensates, and natural gas liquids (NGLs) is changing competitiveness in both fuels and chemicals.

“Crude oil composition will vary depending on the region,” BASF’s Ruff says. “North American crude is expected to be lighter and with lower sulfur content as a result of the increased production of tight oil, whereas in the rest of the world, crude will be heavier and dirtier.”

Increased availability of light feedstocks is driving a need for on-purpose propylene, and already, Dow Chemical and Enterprise Products have built propane dehydrogenation

units in the United States. “We can see this happening globally and across the chain, such as on-purpose butylene,” TCGR’s Payn says.

A recent report by TCGR also revealed that increased interest in producing chemicals like olefins and aromatics directly from crude oil could blur the line between refiner and chemical producer.

Aramco and SABIC are developing a \$20-billion fully integrated crude-to-chemicals manufacturing complex in Saudi Arabia. It will be based at Yanbu and will process 400,000 b/d of crude oil and include a vacuum gasoil platform with capacity to produce approximately 9 million metric tons/year of chemicals and base oils. It is expected to start operations in 2025. These investments, and the joint development agreement, are part of Saudi Arabia and Aramco’s push to move downstream and get more value out of a barrel of oil, company executives say.

Aramco has also signed a three-party joint development agreement with CB&I and Chevron Lummus Global for the development, commercialization, and marketing of crude-to-chemical technologies. “This is a disruption in the typical relationship that a refiner would have to serving the petrochemical markets,” Payn says. “You could have a chemical company who may not be back-integrated into refining considering the possibility of going direct oil-to-chemicals without being dependent on

naphtha relationships upstream. That does have an indirect and a direct impact on how a refiner operates, and therefore, an impact on refining catalyst demand.”

### Upgrade opportunity

The need for high activity catalysts and understanding hydroprocessing reactions and are important when refiners see an opportunity to use cheaper, or “opportunity” crudes, Haldor Topsøe’s Skyum says. “That has an impact on operation of the hydrotreaters,” Skyum says. “Processing an opportunity crude may require a different catalyst load. There are more poisons, more difficult sulfur and nitrogen. So we provide more service and guidance to the clients that process these

‘opportunity’ crudes. We have a lot of experience working with these crudes. It’s an opportunity for the refiner, but cheap crude can also end up being more expensive for them if they are not aware of the operational implications.”

Petti says that changing feedstocks typically present an opportunity for both W.R. Grace and its customers. “As our customers process these new feedstocks, they typically enjoy higher margins, but also experience new processing challenges,” he says. “These challenges can often be addressed through catalyst solutions. Catalysts can be specifically designed to overcome the new obstacles, whether they be new contaminants, reduced octane, or increased residue.” Grace has introduced several FCC catalysts for shale oil-derived feedstocks and for improved bottom-of-the-barrel upgrading. “In addition, many FCC units are now targeting production of high levels of propylene and butylene for petrochemical feedstocks,” Petti says. “This strategy has been a growth driver for our catalysts and additives.”

Petti adds that Grace is making “significant investments” in R&D because its customers expect the company to consistently innovate. “It’s not uncommon for our FCC customers to change their catalyst at least once per year, and our HPC [hydroprocessing catalyst] customers typically move to a new catalyst system with each refill,” Petti says.

Customers often look for high catalyst activity for more efficient operations, Skyum says, so that they can, for example, process more feed or more difficult feeds with the same volume of catalyst. Customers also look for service when faced with processing challenges. “They like the knowledge we have. Processing more difficult feeds requires knowledge.”

Albemarle is working more and more closely with customers in the development of new catalysts technologies. “We are teaming up with customers, involving them early in the value chain, and working with them for early and rapid discovery and ramping up,” Ghyoot says.

Ultimately, petroleum in transportation fuels is not going to go away over the next two-plus decades, Payn says. “Rather, what you’re seeing is a smaller piece of the pie versus higher-growth areas that are supplying energy needs, such as natural gas. These will continue to increase, as will alternatives like wind and solar moving into the mix. Refiners will have to work smarter and more efficiently.” ■



**PETTI:** Changing feedstocks an opportunity for Grace.



**CHIRUMBOLE:** Miles traveled outpace efficiency gains.