

Ensuring success beyond peak gasoline

Catalyst suppliers focus on innovation amid stable demand, changing refinery landscape

INTEGRATION: Business case for both high-propylene FCC configurations and PDH units.



▸ Rebecca Coons

Refinery catalyst suppliers expect slightly lower growth rates in 2020, as cooling GDP leads to weaker demand for transportation fuels.

“Globally, conditions for refinery catalyst suppliers have been better than anticipated for longer than anticipated,” says John Murphy, president of The Catalyst Group Resources (TCGR; Spring House, Pennsylvania). “Any time you have an economy that continues to grow on a global basis for as long as it has, you don’t take anything for granted. Demand for transportation fuels is in unusually good shape, but people are beginning to plan for what’s around the corner—tempered growth in 2020 and beyond. It hasn’t been overwhelming, but we’re seeing and hearing signs of some slowing.” TCGR is, however, forecasting flat or miniscule demand growth for refining products in the US in 2020 and continued shrinkage in Europe.

“Nobody is expecting a major recession in 2020,” adds Clyde Payn, CEO at The Catalyst Group. “But 2021 looks less certain.”

Suppliers are forecasting a steady demand in the near term. Tom Petti, president/refining technologies at W. R. Grace & Co., says demand drivers are stable. “In [fluid catalytic cracking] FCC we see a few new units coming on stream over the next few years. Most of these units present excellent catalyst opportunities, as they target the production of significant amounts of

petrochemical feedstocks, principally propylene, in addition to transportation fuels.” In hydroprocessing, Grace sees continued investments in units to upgrade resid, driven by IMO 2020 regulations. To meet demand, the company’s ART Hydroprocessing joint venture with Chevron will start up a new world-scale hydroprocessing catalyst (HPC) plant in Lake Charles, Louisiana, in the second half of this year.

Need for innovation

Detlef Ruff, senior vice president, process catalysts at BASF, says the refining catalyst market continues to experience growth as urbanization and improved standards of living lift demand for transport fuels and petrochemicals. The need for innovation by catalyst makers remains historically high, Ruff says. “Today’s refineries must make challenging decisions based on several market factors, such as increasingly complex regulations impacting, for example, feedstock selection, which impacts overall refinery profitability and product slate; sulfur in fuels and air emissions targets; lower oil prices that impact operations, capital investments and overall profitability; and varying regional constraints.” The catalyst industry will meet refiners’ changing needs with new technologies as refiners focus on maximizing overall performance, he adds.

Per Zeuthen, fellow and refinery catalyst specialist at Haldor Topsoe, says the company, a leading producer of hydroprocessing catalysts, is debottlenecking

production capacity in Houston, Texas, and Frederikssund, Denmark, to shorten lead times, which now stand at nine to twelve months. Demand drivers are economic growth in emerging markets and regulations requiring low-sulfur fuels. “South America, India, China, Southeast Asia, and Russia are still moving toward ultra-low-sulfur diesel, and targeting 10 [parts per million] ppm,” he says. While not at the same volumes, growth is also being seen for ultra-low-sulfur gasoline. “We have focused on diesel and gasoline since these legislations started back in 2000 in Europe and North America,” which has positioned the company well, he adds. “We have a global installed market share in ULSD units at about 40–50%.”

Stefan Brejc, head of business segment specialty catalysts at Clariant, expects fuel upgrading catalyst demand to be rather stable. The company’s fuel upgrading portfolio includes catalysts for de-waxing, isomerization, chlorine traps, and oligomerization of FCC olefins. Brejc sees car fleet efficiency and consumer behavior as the main headwinds for the category. “Tailwinds include higher ultra-low-sulfur diesel demand, and further out there might be growth from converting plastics to gasoline and diesel using pyrolysis,” he adds.

Keeping an eye on China

Although the outlook appears solid, market participants are closely watching the situation in China, where the deadly outbreak of coronavirus has some cutting 2020 GDP forecasts. “China is the second-largest economy in the world, so if they slow down more precipitously than anticipated, that would have a noteworthy impact on the demand outlook,” Murphy says. “But this is somewhat mitigated by the fact that increasingly China has become more self-sufficient in the production of these fuels. Grassroots refineries have been built there, using state-of-the-art technologies. So, the impact would be noticeable, but not as noticeable as it might have been ten or fifteen years ago.”

China is adding, on average, two refineries a year. Catalyst suppliers and

technology licensors still have opportunities to tap into the Chinese market, but increasingly local assets are turning to Chinese providers, Murphy adds.

Peak gasoline

Although demand for transportation fuels will continue to grow along with emerging



RUFF: The need for innovation by catalyst makers remains historically high given current market challenges.

markets, fuel economy improvements, electrification, and, to a lesser extent, renewable fuels will eventually cause the industry to hit peak gasoline. Refining utilization in North America and Europe is already in decline.

Margins for transportation fuels are in decline, and the price of oil will not provide any relief in the short-term, Payn adds. “We’re awash with oil right now.”

Further integration into chemicals manufacturing and exploitation of opportunity crudes are among the few levers refiners have to maintain profitability.

“Long-term, we believe that market penetration of EVs [electric vehicles] will dampen the growth rates for transportation fuels,” Petti says. “However, it’s not yet clear when that plateau will be reached—2030, 2040, 2050? There are different views. What is clear is the FCC unit’s value to the refiners is not tied only to transportation fuels. Even at that point, the FCC unit will remain the most flexible and profitable unit in the refinery, and our customers will continue to invest in new and expanded FCC units to refine crude for various applications including the production of petrochemical feeds, principally propylene, but also C4s and aromatics.”

At a recent investor day, Albemarle president/catalysts Raphael Crawford said the company is “positioned to win the market for catalysis beyond peak gasoline” by growing in

emerging markets where gasoline demand is growing and by delivering innovations that deliver higher chemicals output. “The world is still expanding in gasoline and diesel demand, but it’s not happening here, it’s happening in Southeast Asia, India, Middle East, and soon Africa,” Crawford said. “So those are the markets where we put our attention to make



ZEUTHEN: Debottlenecking capacity with view toward shortening catalyst lead times.

sure that we have infrastructure in place, people in place, to be able to address their needs and grow in those markets.”

Grace also expects refinery investment in Asia, India, and the Middle East, with lower gasoline and diesel demand pressuring refineries in regions like Western Europe. “As a result, we anticipate a few closures of less-competitive, lower complexity refineries in our longer-term plan,” Petti says. The company is adding technical service resources in Asia, the Middle East, and India, where it expects new units to continue to be constructed, he added.

Feedstock shifts

The propylene deficit remains an issue, and the shortfall is being exacerbated by exports of low-cost ethane from North America into Europe, Payn says. Several propane dehydrogenation (PDH) units have been built globally, and many more announced, but Payn notes that whether the solution comes from refiners or on-purpose production is a matter of regional economics. “We’re seeing more PDH units in Europe, where refineries are continuing to close and therefore the ability to maximize propylene output through FCC is shrinking.” Ineos, for example, is building a world-scale PDH unit at Antwerp.

Payn also noted the large movement globally to address the plastics waste crisis through increased recycling. “This will eventually, in five to ten years, have some impact on demand

for polypropylene and polyethylene resins, depending on the volumes that can eventually be recycled at scale.”

Crude-to-chemicals looms

The threat of peak gasoline is also driving the move toward crude-to-chemicals schemes, in which crude oil refineries are optimized to produce chemical feedstocks rather than fuels and are seamlessly integrated into massive downstream units.

“All refiners and even chemical producers are looking at the oil-to-chemicals trend, and realizing that there is going to be a long-term shift in that direction,” Payn says. “Units in China are already coming onstream. For catalyst and additive suppliers, this will mean demand for solutions that improve integrated refinery margins by producing more chemicals out of necessity.”

Brejč expects crude-to-chemicals projects to put pressure on older refineries, “some of which will be pushed out of the market.” Of the announced crude-to-chemicals projects, some employ high-propylene FCC configurations, while others incorporate PDH units. “There’s a business case for both,” Brejč says. Nevertheless, Clariant, a leading provider of PDH process catalysts, sees on-purpose propylene production to be an ongoing trend. “Most PDH projects are separate from refineries and tied closely to propane feedstock or PP production downstream.”

Changing crude compositions are also challenging refiners, who lean on catalyst suppliers to maximize profits. Tight oil crudes in the US are highly reactive feeds that require tailored, high-activity catalysts. Globally, however, the refiners’ feedstock is turning increasingly heavy and sour.

Increasing refinery complexity—which helps refiners take advantage of opportunity crudes and shift their outputs—is increasing demand for technical service, Crawford says. “That’s a sweet spot for us because of the flexibility of our catalysts and the technology that we bring,” he adds.

BASF says its technologies enable refiners to push the adaptability of the FCC unit. “Refiners are trying to manage fuel demand growth, a trend toward heavier feedstocks, and a shift in product mix globally from gasoline to diesel,” Ruff says. This environment requires the company to work closely with refiners to understand their economic objectives, feed characteristics and operating constraints to tailor the FCC catalyst design and drive the best value, he adds.

The trends toward opportunity crudes and ultra-low-sulfur diesel both benefit Clariant's de-waxing business, Brejc says. "When refiners switch to cheaper feedstocks, they typically require more sophisticated catalytic treatment to achieve sulfur specification as well as cold flow properties of Diesel," he adds. The same is true for sulfur removal.

Petti says Grace's refining customers "are very sophisticated" and always looking to improve refinery profitability. "Our customer-specific catalyst design and world-class technical support have been shown to increase unit profitability by 10–15%," he says. "One key way they do that is through continuous improvement in their catalytic processes and that's where we come in. It's not uncommon for our FCC customers to change their catalyst at least once per year to respond to changing economics, and our hydroprocessing customers typically move to a new catalyst system with each refill to improve performance. We are constantly innovating to keep delivering more value to our customers."

Ultimately, suppliers that can deliver the most flexibility and the best economics to margin-chasing refiners will be successful.

"How HPC and FCC are used within a refinery is really important to the profitability of those refineries," Crawford says. "Those catalyst companies that can deliver the highest yields relative to the market demands are those catalyst companies that will be successful. Albemarle has a history of technical service and expertise to be able to help our customers make those decisions, pick the right catalyst and be successful with their FCC units."

Zeuthen notes that increasing sales of Haldor's high-performance catalysts are linked to the ongoing industry drive for revenue increments. "More and more refiners have realized that, due to the very tight specifications, and thus a shorter cycle length, downtime is very, very costly," Zeuthen says. If utilizing a high-performance catalyst can help increase cycle length and reduce downtime, refiners are willing to pay for it. "They also recognize that it is equally important to have the best reactor internals to ensure the best possible conditions for the catalytic reactions," he adds.

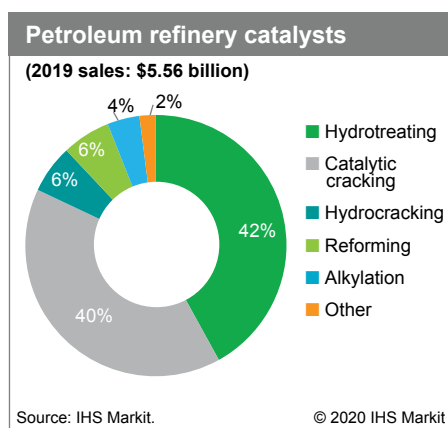
Clariant has been in the refining business for several decades, so "we know our customers well and have strategic, long-term relationships," Brejc says. Innovation drivers include efficiency, better upgrading of refinery waste streams, and lower energy

consumption. We collaborate closely with licensors to develop optimized process technology for our end users."

Regulatory drivers

More stringent regulatory and environmental requirements continue to be another important driver of refinery catalyst demand and R&D.

"Fuel sulfur requirements continue to tighten, and fuel economy standards are being increased which has resulted in an increased demand for octane—both to meet the need for higher octane engine requirements and to restore the octane often lost as sulfur is removed," Ruff says. "Butylene selective catalysts are an important part of this shift in the Americas as propylene has lower value today yet high-octane blending components from alkylation units are highly valued. BASF has several new products based on the Multiple Framework



Topology (MFT) technology entering the market to support needs for improved butylene selectivity."

Implementation of the IMO 2020 standard is another challenge that is solvable with next-generation catalysts. The regulation, which went into effect last month, requires bunker fuel to drop from 3.5% sulfur to 0.5% sulfur. "To meet this requirement, the shipping industry had three choices: purchase slightly higher-priced low-sulfur marine oils at 0.5 weight percentage; add scrubbers; or use alternative fuels, like LNG [liquefied natural gas] or biodiesel," Payn says. "A year ago, there was a lot of uncertainty around how the shipping market would meet the regulation. Today I think it's much clearer: most refiners see low-sulfur marine oil being used. There will be cost premiums over the shorter term as they ramp up capacity to supply."

There have also been negative press around scrubbers. "A number of countries have banned the use of scrubbers because you are essentially scrubbing out the sulfur and dumping it back into the sea."

Petti says Grace is working with its refinery customers to "identify new catalysts for any number of scenarios, including higher severity hydroprocessing, new hydroprocessing unit investments, and upgrading bottoms to low sulfur cycle oil in the FCC, to help them capture the value created by IMO."

Low-sulfur goes global

Crawford notes that the low-sulfur regulatory trend is global. "It's already happened in Western markets and now is expanding around the world," he said. "[L]ow sulfur diesel will play a major role in the product slate to be able to address the demand for low sulfur fuels, distillate, and, in other words, diesel and gasoline."

Renewable hydroprocessing is also growing, driven by legislation, Zeuthen says. "This trend began in North America and Europe and has moved into Southeast Asia because of the region's access to palm oil. Many are looking for ways to move away from crude oil and process various types of biofuels, including a variety of waste products like used cooking oil, lignocellulose, plastic, municipal solid waste, and many other second or third generation biocrudes in more CO₂ neutral processes."

Topsoe's HydroFlex solution has been in operation at commercial scale for such processes since 2011, Zeuthen adds. The technology can be used for both co-processing fossil and renewable feedstocks simultaneously or for 100% renewable feedstock. "To some extent, the technology and chemistry is similar to conventional hydrotreating, but renewable feedstocks contain a lot of oxygen, which makes them highly reactive, and also contain a lot of catalyst poisons not present in crude. But Topsoe entered this area at an early stage, and we are among the very few companies that have developed the experience, catalysts, and proprietary equipment that convert biomass and waste into renewable or truly green diesel, jet fuel, and gasoline."

Just last month, HollyFrontier (Dallas, Texas) chose HydroFlex to produce renewable diesel from various feedstocks in New Mexico. The contract was awarded after an in-depth feasibility study involving competing technologies. ■