Preparing for a Changing Petrochemical Supply Landscape

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Since 2008, it has been apparent that the petrochemical supply landscape will be changing worldwide as feedstocks and technologies evolve—and we are certainly seeing that happening today.

The supply landscape is changing on several fronts, starting with North America. The use of unconventional technologies to develop shale resources is increasing gas availability and reducing gas prices significantly in this region. In addition, the shift of North American refineries to more paraffinic crudes is causing aromatics to be more expensive.

Meanwhile, the commercialization of coal-to-olefins (CTO) and methanol-to-olefins (MTO) technologies in China is adding a new olefin supply source. And in the Middle East, we are seeing limits to future gas supplies, as well as a push toward refinery-based chemicals.

These factors will affect each petrochemical chain differently. This paper explores some of the changes taking place in the ethylene (the largest volume olefin) and aromatics arenas, but there will be an impact on methanol, propylene, ammonia and other chemicals as well. This means that across the board, petrochemical companies will need to think about adopting new business models for this shifting supply landscape.
Ethylene oversupply?

With the rapid increase in unconventional hydrocarbons production (e.g., shale oil and gas), North America has a surplus of natural gas, giving the region a significant cost advantage in ethylene production (steam cracking). There are at least four new crackers in the advanced stages of planning in the region. Another 11 or so are under evaluation, and at least nine are under study for, or in the process of, being expanded. If all the new capacity comes online, that would bring a 64 percent increase in North American capacity by 2023.

A key concern for companies building these plants is the potential global oversupply of ethylene. According to our analysis, the demand for final ethylene products is expected to grow at about two percent per year in North America—perhaps more if the trend toward North American re-industrialization continues, but still far below the 64 percent increase in capacity. Therefore, there is likely to be significant North American oversupply, with net derivative ethylene-equivalent exports expected to be in the eight million metric tons (mmt) range by 2023. The nature of most of this derivative capacity has not yet been announced, but good candidates are polyethylene, polystyrene, ethylene glycol and other easily transported products.

Looking at China, there is considerable unease over the country tapping its large coal reserves to produce low-cost ethylene using CTO/MTO technologies. China has low-cost brown coal in its inland regions, but the cost of rail transport to the coast is prohibitive, making the price of coal attractive to local users. Reports suggest that 60 to 100 of these types of plants have been announced for inland regions. Only a few will go forward, with about 700 thousand metric tons per year (kmtpy) of capacity expected to be running this year. Perhaps another 10 plants, averaging less than 300 kmtpy each, are likely to be completed in the following few years.

However, there are potential obstacles to these projects, including:

- **Water supply.** The CTO/MTO processes are water-intensive and China’s coal resources tend to be in arid regions of the country.

- **Environmental issues.** These plants can produce significant carbon dioxide emissions, an area which the Chinese government stated it is committed to reducing.

- **Scale.** The Chinese government is only encouraging the approval of large-scale plants, but most announcements are for plants under 500 kmtpy in size (less than one-half the size of a large-scale naphtha cracker).

- **Capital.** These plants are capital intensive and obtaining financing can be difficult as China slows money supply growth.

- **Logistics costs.** Plants would be located in northern and western China, far from major derivative-consuming locations.
Perhaps the greatest issue is that the development of such new plants in China may not continue past the next decade. This is because China’s coal reserve position may be short lived. Even though China has one of the world’s largest coal reserves, it is also consuming coal rapidly. It is now estimated to be a meager 33 years—substantially below the worldwide average or the average for any large region of the world (see Figure 1).

If all the likely ethylene expansions around the world come to fruition by 2023, the global supply will still be short by about 32 mmt, based on expected global final derivative demand.

Furthermore, even if all the announced less likely North American cracker expansions (including the ones that do not seem likely) are completed, the additional 11 mmtpy of ethylene that would result would still not be sufficient to cover growing world demand. Taking this a step further, if all the China CTO/MTO projects with only some chance of approval succeeded, they would add only an extra 3 mmtpy of capacity—and China’s ethylene-equivalent deficit would not be overcome (see Figure 2 and end note).

Beyond infrastructure itself, there is another factor that may affect supply: the war for talent. As many as 50,000 skilled petrochemical construction craft workers may be needed in the US Gulf Coast region alone in the 2014-2015 timeframe. If companies cannot find enough talent or manage scarce talent more effectively, this shortage may impair production.

Altogether then, it seems that today’s concerns about oversupply in the next decade may well be unfounded. And it appears that incremental supply to meet Asia’s growing needs will continue to come from the Middle East and increasingly North America.
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Will aromatics be left behind?

Aromatics (benzene, toluene and xylene, which are ultimately used in products such as foam insulation, polyester and textiles) are sourced primarily from by-product streams in liquids steam cracking (typically, naphtha, gas oil or other refinery-sourced feeds) and refinery catalytic reforming. The Middle East and Asia are expected to play larger roles in aromatics production, with North America experiencing countervailing forces on supply.

North American aromatics production is being negatively affected by a number of factors, which have resulted in reductions of more than 20 percent of production:

- As natural gas prices have declined in North America relative to crude oil, ethylene operators have emphasized gas cracking rather than liquids cracking. Gas cracking produces far less in aromatics streams. Aromatics from this source have been reduced by more than 50 percent since the drop in natural gas prices began in 2008.
- North America is producing greater amounts of lighter, more paraffinic crude oil, which yields less aromatics in refining. Before the increased production of unconventional oil, US refiners used naphtha (primarily from crude distillation) with about 40 percent naphthene and aromatics (both destined for aromatics during the reforming process). This decreased to 35 percent with the shift to a lighter crude slate.
- Low natural gas prices also have had a negative impact on reformer economics because 12 to 16 percent of the volume of reformer co-product (hydrogen, ethane, propane, butane) credits are typically based on natural gas prices. This can have a negative impact on aromatics supply, depending on the relative prices of naphtha feed and gasoline.

Refinery adjustments to the new supply landscape are still evolving. This means that North American refiners may adopt new hardware and operating variables that could change the availability of aromatics going forward.

The Middle East presents a different picture. Here, there are significant aromatics and propylene supply opportunities. The region’s feedstock situation is changing due to several factors:

- Natural gas has become less available since 2006-2007.
- Ethane prices are expected to rise from $0.75/per million BTUs (MMBtu) to possibly the $1 to $2/MMBtu range.

Middle East countries have changed their petrochemical focus away from gas and towards liquids, building large-scale refineries with associated chemicals complexes. Saudi Arabia, Oman, Abu Dhabi and Kuwait, for example, have been pursuing projects along these lines. Liquids-based production is not as advantaged as gas-based chemicals in the Middle East because crude oil and naphtha can be shipped inexpensively, and World Trade Organization (WTO) standards discourage uncompetitive feedstock discounts. However, advantages are likely to come from scale, new hardware, technology and gas-based olefins linkages in downstream chemicals. In this environment, non-ethylene base chemicals are likely to rise from a 42 percent share of Middle East base chemical capacity in 2013 to a 46 percent share by 2023. These facilities are well positioned to serve the Asian market (see Figure 3).
Figure 3. Middle East capacity development—Ethylene vs. other base petrochemicals.

Source: Accenture Research; ICIS Consulting.
There are many uncertainties that have the potential to alter significantly the scenarios described above. These include:

A possible substantial decline in crude oil prices

More hydrocarbon resources are being developed and interchanged. For example, on a global basis, power plants are fueled by liquids, natural gas, coal and other materials and a long term lower price in any of them would encourage fuel switching and, in turn, pressure to lower prices on the competing fuels. Furthermore, US crude production rose to 7.5 million barrels per day in July 2013—the highest level since 1991—and it is expected to keep rising. Mexico is also showing signs of allowing foreign investment to help increase oil and gas production. With enough of this development globally, there may be downward pressure on oil prices. Depending on how low prices go, this could affect gas cracking and CTO/MTO economics, as well as make the internal Middle East feedstock percentage-based discounts less competitive.

China’s shale resources

China is believed to have considerable shale gas resources, but the current industry consensus is that these will not have a meaningful impact for at least another decade. However, that could change if China implements a more open foreign-investment regime, which could result in increased production in the near term.

Coal prices

Coal competes most directly with natural gas, and low natural gas prices have brought coal prices down and increased coal availability in North America. Coal can be cost-effectively shipped overseas, and low coal prices may make CTO/MTO technology viable in other regions as well—and even in the US, if clean technology is economical.

A possible decline in world economic growth

This could be driven by a further downshift in China’s economic growth; continued growth in government debt; and burdensome tax/regulatory policies.
A shrinking and connected planet

It is clear that North America will be exporting olefin derivatives to Asia. In the past, export markets represented a low-price alternative to North American domestic markets, and North American producers exported opportunistically. Now, domestic market-share battles are likely to occur and those companies that offer the most innovative, value-added products at cost-effective prices will be the domestic market winners, with the remainder being exporters.\(^8\)

On the brighter side, China’s raw material needs are shifting to more value-added grades of polymers, and North American producers are well positioned technologically to supply these. Commodity grades also will still be needed.

Finally, the expansion of the Panama Canal, scheduled for completion in 2015, will translate to shorter transit times (and inventory costs) and likely lower freight rates for US Gulf Coast products going to Asia, further encouraging the marketing of US gas-based chemicals overseas.
New business models required

As world-scale capacity comes online, exporting producers will need to develop business models that assume a smaller world—one in which Asian markets, which are already linked to Middle East supply lines, become more connected to North America as well. This model should include:

- Efficient, optimized US Gulf Coast-to-Asia supply chains. These may need to include shared-services (for the back office) and shared-assets approaches to gain economies of scale in inventory storage and shipping, particularly as waterborne sales increase in importance.
- Strategic sales and marketing approaches. These will need to be supported by customer relationship management systems that enable a clear understanding of cost-to-serve for specific customers globally.
- Market-facing connectedness at the global level. As China increases its presence in value-added durable goods manufacturing, there will be strong links to global chemical customers (i.e., finished goods manufacturers) in this market. Therefore consistent policies, levels of service, and products will be needed as are present in North America, Europe and Japan.
- Advanced analytics to optimize various global price/cost points.
- In the Middle East, a position of maximum competitiveness, using economies of scale, refinery integration and low cost chemical building blocks (such as in PET, which is based on aromatics and olefins, but where lower cost gas-based ethylene in the region can add to its competitiveness) can be leveraged, as Asia continues to ramp up refining capacity to meet its own fuels demand.
- In Asia, greater integration of refining and petrochemicals at scale.
- In Europe, a constant vigilance on developing innovative products, services and business processes to be the supplier of choice to less price sensitive technology-leading finished goods manufacturers.
- Optimized large scale capital project administration to effectively manage and leverage scarce talent in North America.
- The ability to monitor and exploit global megatrends. These trends affect each region differently. This ability may require globally-oriented R&D/application development, the in-sourcing of strategic and innovative thinking, and access to external sources for additional thought capital and objective opinions.

It is clear that the supply landscape for petrochemicals is changing—sometimes in ways that are counterintuitive—and that many variables are at work in driving that change. For petrochemicals companies, the keys will lie in understanding and monitoring that change; in being able to identify and exploit emerging opportunities early; and in adopting business models that take advantage of these new realities to build sustained results and high performance.
About the author

Paul Bjacek, a senior manager in Accenture Research, leads global chemicals and natural resources research. He has more than 25 years of experience in chemicals strategy development and research, from base chemicals to specialty chemicals and polymers. Paul also frequently speaks and writes about issues affecting the global materials industry. He is based in Houston. His blog can be found at: www.accenture.com/us-en/blogs/cnr paul.bjacek@accenture.com

End notes

1 See “Global shifts in investment mean new opportunities for materials,” which discusses the re-shoring of chemical customer industries.

2 Coal prices for inland China are $25/mt, versus $57/mt on international markets (in ~1Q 2013).


5 Ibid.

6 Ibid.


8 See previous blog on “Global shifts in investment mean new opportunities for materials,” which discusses the value-added demands of the North America market.

Note: Final derivative demand was calculated from the final disposition (as opposed to production, which can distort the understanding of supply chain drivers) of major ethylene derivatives for each region, covering 90 percent of ethylene volume and including the final sales, adjusted to ethylene equivalents, of LDPE, LLDPE, HDPE, PVC (excl. acetylene process), ABS, SAN, PS, EPS, SBR, SBL, acetaldehyde, ED (excl. EG), EG (excl. PET), PET film, polyester fiber, PET resins, ethyl acetate, EVA copolymers and linear olefins.
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