



# Can shale gale save the naphtha crackers?

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**AS US PETROCHEMICAL PRODUCERS GO ALL OUT ON ETHYLENE PRODUCTION, AND WITH SHALE GAS EXPLORATION EXPANDING INTERNATIONALLY, THE DYNAMICS OF THE GLOBAL OLEFINS AND POLYOLEFINS MARKETS ARE ABOUT TO CHANGE DRAMATICALLY. JIM FOSTER INVESTIGATES**

**In the United States**, the current economics favor converting ethane to ethylene, as the influx of ethane from shale gas discoveries has helped soften ethane prices. At the same time, stronger oil and naphtha prices have left naphtha-based crackers out of the money. Short-term prospects for those producers – mostly in Europe and Asia – look grim. But a closer look at byproduct credits from naphtha-based crackers can provide a longer-term positive outlook for those producers. And those credits could be enough to keep naphtha cracking not only a profitable enterprise but also maintain a large share of the olefins markets.

**THE US SHALE GAS DYNAMIC**

According to a report from Platts unit Bentek, over the five-year period to 2016, the development of shale gas exploration in the United States is expected to increase natural gas liquids production by more than 40% – from 2.2 million b/d in 2011 to more than 3.1 million b/d in 2016. It is that increase in NGLs production that is breathing new life into the US petrochemical industry.

The average composition of this “Wet Gas” (a gas with a high NGL composition) from the Marcellus shale play is about 75% methane, 16% ethane, 5% propane and 1% for butane, pentane, hexane and other gases. The methane from that stream is sold at natural gas prices. With Houston Ship Channel spot natural gas values averaging near \$2.50/MMBtu in 2012, there is little financial incentive to explore for only methane. In fact, the methane recovered would not generate enough revenue to continue drilling into the shale.

Instead, natural gas exploration is being supported by the remaining 25% of that natural gas stream – mostly the 16% ethane. Unlike propane, which can be sold as fuel or a feedstock for petrochemicals, ethane’s primary use is as a feedstock for ethylene. And when one unit of ethane is cracked, it produces about 0.78 units of ethylene, compared to less than 0.03 units of propylene and Crude C4s.

Since December 2008 – following the global energy price collapse and market correction – ethylene prices have more than doubled. In mid-September, US ethylene prices were just below \$900/mt, compared to \$377.50/mt on December 1, 2008. During that same period, US natural gas prices have fallen more than 50%, while ethane prices have fallen nearly 20%.

That increase in ethylene prices coupled with falling ethane prices has resulted in US ethane cracking margins widening to more than \$1,000/mt of ethylene produced. During the same period, light naphtha cracking margins have fluctuated on either side of zero, relying on co-products such as propylene, Crude C4 and pygas to stay out of the red.

**THE RISK OF OVERBUILDING**

The potential wide margins available to ethylene producers cracking ethane has resulted in seven new ethane-based cracker projects being announced in the US, with most capacity coming online by the end of 2017.

Based on a Platts analysis, those seven crackers – if all are built – would boost US ethylene capacity by 8 million mt/year. On top of the new projects, another 1.75 million mt of additional ethylene capacity in the US is planned through expansion of existing units. That additional ethylene capacity would require more than 12 million mt of additional ethane feedstock per year.

That increase in demand, though, will happen gradually, up until the new cracker projects are completed in 2017. Based on the Platts analysis, ethane surpluses in the US are expected to continue to build, reaching a peak near 5.5 million mt in 2015. And while the surplus is expected to extend into 2016, the new cracker capacity planned to be online in the US in 2017 could result in an ethane deficit in the US. If all seven new crackers are built, and all expansions are completed, the ethane deficit in the US could reach more than 3.5 million mt per year.

An ethane deficit would potentially erode any competitive feedstock advantage the US currently enjoys in the US olefin markets, a Houston-based producer said last year.

“Our big fear – everyone’s biggest fear – is that we won’t be disciplined with what we build,” he said. “There’s a very real chance that we’re going to overbuild – and everyone will lose.”

The senior vice-president of a major engineering firm echoed that fear earlier in 2012, saying “If the petrochemical industry knows anything, it’s how to overbuild.” He followed his comment, though, by saying he expects only four or five of the seven new cracker projects to be built.

A world-scale ethylene plant would consume about 1.5 million mt/year of ethane. If two of the proposed crackers are not built – and the two canceled projects are for world-scale crackers – the ethane deficit would be minimized, which could protect some of the strong ethylene margins.

An industry consultant last summer suggested that a small ethane deficit could be eliminated by flex cracker operators choosing to use less ethane feedstock and more propane, which would provide more byproduct credits for those producers able to make the switch.

"I don't think there will be enough ethane for everyone to build," the consultant said. "If there is a shortage [of ethane] I'd expect the flex [crackers] to take advantage of higher co-product costs."

If an ethane shortage does happen, producers could be faced with selling ethylene at lower prices in an oversupplied market while watching their feedstock prices erode their once healthy margins. A dramatic shift in prices would be required to turn ethane to ethylene margins negative, though. Even if the current ethane price doubled, and ethylene prices were cut in half, ethane cracking would still be profitable, though at only a fraction of the margins currently seen in the market.

### **MAKING MONEY WITH HEAVIER FEEDS**

The shift to ethane-based olefins production also is taking a toll on the co-products coming out of heavier-feed crackers. While one unit of ethane feed into a cracker produces 0.78 units of ethylene and 0.03 units of propylene, one unit of propylene produces 0.42 units of ethylene and 0.17 units of propylene.

The amount of propylene being produced in crackers in the US has been reduced by 50% as more producers turn to ethane, according to one industry consultant. This has taken about 1.5 million mt/year of propylene out of the market. Another 2 million mt of propylene would be needed each year to keep up with growing demand.

In response, five new North American on-purpose propylene units have been announced. A majority of the new projects are expected to be propylene dehydrogenation, with one possible metathesis unit planned. Those five units are expected to pump another 2.75 million mt of propylene into the US market, which closes the expected demand gap to 750,000 mt/year.

The higher cost of running a propylene dehydrogenation unit – and the anticipated propylene shortage in the US – could provide a price push for propylene, rewarding those able to crack heavier feeds with higher co-product credits. Both propane and light naphtha produce about 0.16 units of propylene for each unit of feedstock, compared to less than 0.03 units of propylene per one unit of ethane feedstock.

What would really make the difference for light naphtha crackers, though, will be aromatics and butadiene prices. A light naphtha cracker produces nearly 10 times the amount of pygas – which can be converted into aromatics – than an ethane cracker. The light naphtha cracker produces more than 2.5 times the amount of pygas that a propane-fed cracker does.

A light naphtha cracker also produces nearly three times as much Crude C4 – which can be used to produce butadiene – as an ethane cracker. The light naphtha cracker will produce nearly twice as much Crude C4 as a propane cracker.

Since the start of 2009, benzene prices in the US have climbed from 85 cents/gal (\$254/mt) to more than 400 cents/gal. Butadiene's price growth has been less stable, but has shown periods of extreme highs during times of supply shortages. The US butadiene price at the start of 2009 was near 30 cents/lb, compared to a mid-September price of 78 cents/lb (\$1,719/mt). In mid-2011, the US butadiene price climbed as high as 225 cents/lb, and the price in 2012 climbed as high as 165 cents/lb.

To capitalize on the butadiene price spikes, at least one US producer is considering building an on-purpose butadiene plant in the US Gulf region. TPC Group, which in August entered a merger agreement with First Reserve Corporation and SK Capital Partners, in 2011 announced its plans to explore on-purpose butadiene and on-purpose isobutylene. The capital costs of those two projects were cited by the company as a reason for moving forward with the merger.

"If we do see on-purpose butadiene built, we're admitting that the butadiene price is going to go higher and stay higher," a European-based butadiene trader said in June. "[On-purpose butadiene] is expensive. A high [spot] price is needed to justify getting a project like that built."

### **SHALE GAS AS A GLOBAL PHENOMENON**

The shift from heavier to light feedstocks in the North American olefins markets provides a glimpse of what could happen globally as more countries expand their shale gas efforts. According to estimates by the US Energy Information Administration, China has more than 2.5 times the amount of shale gas the US does. Mexico, Argentina, Europe and South Africa also have reserves matching or exceeding those in the US.

The future balances of olefins and polyolefins globally will be dictated by how these countries – and others like them – decide to use their shale gas in the future.

"What we're seeing in the US now is only the start," a US-based Crude-C4 processor said last year. "The excess ethylene, the shortage of propylene, the shortage of butadiene. It could all happen in regions around the world."

If it does happen, the olefins producers able to capture the higher-value coproduct credits – such as those provided by naphtha – could be in a position to see their margins widen as excess ethylene globally eats away at the margins currently enjoyed by ethane crackers today.

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