What's Crackin with Steam Crackers?

Petrochemical Markets, Feedstock Selection and NGL Prices

- **Margins for US steam crackers running light feedstocks are at all-time highs, driven by low ethane, propane and normal butane prices, combined with a high price for ethylene.**
- **As the prices of these light NGLs declined due to the U.S. Shale Revolution, the prices of other steam cracker feedstocks, including natural gasoline, naphtha and gas oil have held relatively constant. Margins for these feedstocks are well below steam cracker margins for light NGLs.**
- **Consequently US steam crackers have shifted their slates from running about 70% light NGL feedstocks to 92% light NGLs. That percentage will continue to increase as new ethane based steam crackers come online over the next few years.**
- **As NGL and refinery markets continue to evolve, so will steam cracker margins. Feedstock decisions will drive both steam cracker profitability and future feedstock prices.**
- **The RBN Steam Cracker Feedstock Selection Model calculates these margins based on feedstock prices, petrochemical prices, cracker yields, and other factors. A model download is included with this report.**

The margin for ethane as a Gulf Coast steam cracker feedstock recently hit an all-time high. A steam cracker (a.k.a., petrochemical cracker or ethylene cracker) produces ethylene and other petrochemicals from liquid hydrocarbon feedstocks, including natural gas liquids (NGLs), refinery naphthas and gas oil. The profitability of a steam cracker is dependent on the margin between the feedstock cost and the market price of ethylene as well as the value of byproducts produced from the manufacture of ethylene. In recent weeks, the margin for certain feedstocks, especially ethane, lightest of the NGLs – have been extremely attractive.

On September 19, 2014, the margin for a representative Gulf Coast steam cracker running ethane hit a record high of 70.4 cents per pound. A number of factors combined to drive that margin sky high, but the most important were a very low price for ethane (24 cents per gallon) and a very high price for ethylene of 76.5 cents per pound. The combination of low feedstock prices and high product prices combined to produce extremely high margins. On the same day, the margin for a steam cracker running natural gasoline (another NGL) was only 47.3 cents per pound. Also an attractive margin, but only 67% of the ethane margin.

The relative value of different feedstock margins is the most important factor that influences which feedstocks that steam crackers choose to run. As a general rule, the higher the margin, the more favored the feedstock. But there is much more to that margin calculation than just the difference between the feedstock cost and the price of ethylene. That is because of byproducts. When a steam cracker produces ethylene, it also produces a range of byproducts like propylene, butadiene and benzene. Each feedstock has a different yield of ethylene and byproducts. So the product yield and the prices of the byproducts also weigh into the margin calculation.

Over the past ten years, the relative value of feedstock margins has undergone a significant shift. At one time, the margin for heavier feedstocks such as naphtha and natural gasoline were higher than margins for lighter feedstocks like ethane and propane, and consequently steam crackers tended to maximize runs of those heavier feedstocks. But that was before the Shale Revolution resulted in lower gas prices, which in turn encouraged production of "wet" high-BTU natural gas containing more higher-value NGLs that ultimately resulted in surpluses of light NGLs which consequently drove prices for those light NGLs down.

Today with margins for producing ethylene from light NGLs in the stratosphere, it is not surprising that petrochemical companies with crackers processing ethane are enjoying healthy returns or that these companies are maximizing the volume of ethane they are running. Petrochemical firms have been investing heavily to minimize their runs of heavy feedstocks like natural gasoline, refinery naphtha and gas oil while increasing their runs of lighter feedstocks, including ethane and propane. Billions in new U.S. cracker investment are in the works, planned for completion in the late 2017 to 2020 time frame. Even European petrochemical companies are getting into the act with players like Ineos and Sabic planning to convert European naphtha crackers to use cheap U.S. ethane shipped from the East and Gulf coasts.

All of these developments have huge implications for the 36 steam crackers operating in the U.S. that collectively produce about 60 billion pounds of ethylene per year. Overall the feedstock slate of these crackers is about 65% ethane, 20% propane, 7% butane and 8% a combination of natural gasoline, naphtha and gas oil. As recently as 2008, natural gasoline, naphtha and gas oil made up 30% of the steam cracker slate. As new ethane crackers come online in a few years, that weighting toward light feedstocks will only increase. At least that is the expectation.

However, these new domestic crackers, plus new ethane exports from the US for European crackers will certainly tighten the ethane market, increasing prices. Similarly, propane prices have increased over the past year in response to growing US export volumes. As new NGL dock capacity is completed, exports of both propane and butane will increase further, also tightening those markets. What will these developments mean for steam cracker margins? What is the relationship between petrochemical prices, feedstock prices and margins? Exactly how are steam cracker margins calculated?

This RBN Energy Drill-Down Report addresses these and many other questions regarding the future of NGLs and other steam cracker feedstocks in the context of recent market developments. The analysis begins with a review of petrochemical industry fundamentals, outlines current NGL market developments and describes the use of NGLs as petrochemical feedstocks. The remainder of this report then reviews:

- Trends in steam cracker margins for each major feedstock and the process of steam cracker feedstock decision-making
- A brief history of the ethylene industry and how advances in that industry are now playing into current market developments
- Steam cracking chemistry, the cracking reaction and process
- The RBN Steam Cracker Feedstock Selection Model – downloadable spreadsheet and detailed instructions on input variables, calculations and interpretation of outputs

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