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Abstract

The widespread commercialization of hydraulic fracturing (fracking) combined with horizontal drilling in hydrocarbon-containing shale formations has resulted in an enormous increase in natural gas and natural gas liquids (ethane, propane, and butane) production, as well as the production of petroleum condensate (light crude oil). Although these processes have been initially commercialized in the United States and Canada, other regions of the world will soon (as of 2015) receive the same low-cost hydrocarbon economic benefits, either through the importation of natural gas liquids from the United States, or through hydrocarbon production from their own domestic shale formation reservoirs.

Globally, nearly half of ethylene production is based on naphtha steam cracking (liquids cracking), where the naphtha is priced at nearly parity with crude oil (annual average approximately $US50/bbl in 2015). Natural gas liquids produced via fracking are being sold in 2015 at an annual average of around $US3/MMBtu, equivalent to an oil price of $US16–17/bbl, providing an enormous feedstock cost advantage for producing ethylene via steam cracking. The downside is that natural gas liquids steam cracking (gas cracking) produces a smaller amount of the heavier by-products (butadiene, isobutylene, n-butenes, pyrolysis gasoline) used in derivative petrochemicals production. Where fracking is widespread (predominantly in the United States and Canada in 2015), chemical operating companies have announced significant grassroots projects to build world-scale ethylene steam crackers (gas crackers) that are designed to feed these low-cost shal-derived feedstocks in order to capture the cost advantage of natural gas liquids production from shale reservoirs.

In China, regionally competitive coal-to-olefins and methanol-to-olefins technologies have been commercialized. These routes take advantage of an unconventional but locally abundant and inexpensive carbon sources.

In this process summary, we review the current ethylene production processes. Features and differences between processes are summarized. The current ethylene process licensors and their offerings are compared. Updated process economics for different ethylene processes are presented. The process economics include estimated capital costs, variable costs, and plant cash costs. The review also discusses recent technology development based on patent reviews. A brief market overview summarizes the global supply and demand and end-use markets and demand drivers.

This process summary will also highlight the new iPEPSpectra™ cost module. The cost module, attached with this process summary on the PEP website, provides a powerful interactive tool for interpreting data in a flexible manner by generating pivot tables and corresponding charts. In this review, the iPEPSpectra™ cost module is demonstrated with historical economics for the ethylene processes for different regions of the world. Until now, most process economics were presented as snapshot comparisons. Due to fluctuation and variation of feedstock and utility prices over time and in different regions, ranking of the processes using a snapshot comparison can be misleading. An iPEPSpectra™ historical economics comparison provides a more comprehensive assessment of competing technologies, leading to a more sound investment decision.

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