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Chemical Value Chain Production Economics

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Abstract

In the global chemical industry, the manufacturing of thousands of chemical products can be divided into eight major value chains:

1. C_1 chemicals based on syngas, including methanol and ammonia-derived chemicals
2. C_2 chemicals based on ethylene
3. C_3 chemical based on propylene
4. C_4 based chemicals, including butadiene and isobutylene
5. Benzene-based chemicals
6. Toluene-based chemicals
7. Xylene-based chemicals
8. Chlor-alkali–based chemicals

Each value chain can start from one or more basic feedstocks, such as natural gas (including natural gas liquids, or NGLs), crude oil (through naphtha), coal, salt (for the chlor-alkali industry), and biomass. Major chemical value chains are illustrated in the introduction.

To produce a downstream chemical—taking polypropylene from the C_3 value chain, for example—a producer can start from propylene purchased from the market or choose to integrate with propylene production from different feedstocks, such as naphtha (through steam cracking), propane (by dehydrogenation), or methanol (through methanol-to-propylene processes). Methanol, in turn, can be produced by natural gas reforming or coal gasification. A polypropylene producer is constantly facing the question whether it is better to operate a stand-alone or an integrated plant. If the latter, then which basic feedstock should be chosen? The answers depend on the comparative economics (production costs and capital investment costs) of a stone-alone versus an integrated plant to different basic feedstocks.

Traditionally, the IHS Chemical Process Economics Program (PEP) analyzes production economics based on a stand-alone plant by comparing competing processes. At this time, the PEP database contains the production economics of about 1,600 processes. In this review, we start to develop a methodology to connect production economics of individual processes along the value chain. This methodology provides a foundation for developing value chain production economics for a wide range of downstream chemicals in the next several years.

To establish this methodology, we chose two examples—the production of polypropylene (PP) back-integrated to coal, and low-density polyethylene (LDPE) back-integrated to ethane. The production economics of the intergrated PP and LDPE plants are compared with a respective stand-alone plant based on second quarter 2016 (PEP Cost Index = 1089) feedstock, raw material, and utility prices. We further impart the price history of the feedstocks, raw materials, and utilities to present the effect of price fluctuation on the comprative economics of integrated plants versus a stand-alone plant in an iPEP™ Spectra data module.

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