



PERP Report 2017S1: Coal to Olefins Processes

“Coal to Olefins Processes” is one in a series of reports published as part of the 2017 Process Evaluation/Research Planning (PERP) Program.

Overview

Since the first methanol to olefins (MTO) plant started up in 2010, an enormous amount of capital investment has been made in coal-based MTO projects in China as the country aimed to improve its self-sufficiency with respect to ethylene and propylene by making use of its rich coal resources in the western part of the country. Over the next seven years, 13 coal-to-olefins (CTO) plants started up. In addition, as a less capital intensive alternative to integrated coal-based methanol, developers also began building stand-alone MTO plants based on purchased methanol of either imported or a combination of imported and local coal-based methanol. The first stand-alone MTO plant was commissioned in 2012 and by the end of 2017 a total of 11 stand-alone MTO plants were in operation.

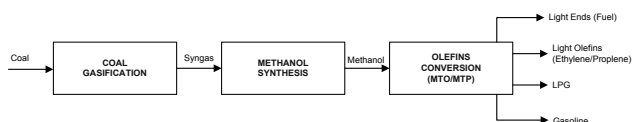
CTO has proven to be an attractive means of monetizing inland coal reserves, producing high-value, and transportable products such as polyolefins from low-value coal.

This PERP report provides an overview of the process technologies available for coal gasification, methanol synthesis, and methanol to olefins conversion. The following questions are addressed in the report:

- What are the different types of coal gasification technologies, methanol synthesis processes, and methanol to olefins offerings?
- Who are the major licensors and what technologies do they offer?
- How do the process economics of producing light olefins from coal compare to alternative routes of production such as steam cracking or propane dehydrogenation (PDH)?
- What are the key cost drivers for each technology?
- Which technology offerings provide the lowest cost of production, and which regions in the world provide attractive investment opportunities for olefins production?

Commercial Technologies

The coal to olefins process consists of three distinct steps: coal gasification, methanol synthesis, and olefins conversion.



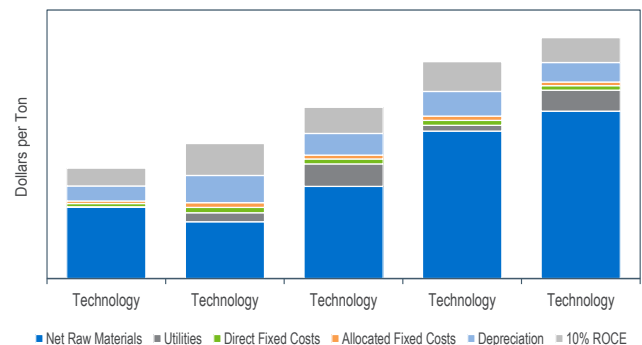
The coal gasification process is a partial oxidation process that produces a mixture of primarily carbon monoxide and hydrogen known as synthesis gas. Synthesis gas is then catalytically converted to methanol over a copper catalyst, and methanol conversion to olefins is achieved over a zeolite based catalyst to

produce both ethylene and propylene. Depending on the zeolite catalyst used and other process variations offered by technology licensors, the mix of light olefins produced can vary. Major methanol to olefins licensors and technologies reviewed in this report include offerings from Honeywell/UOP, Air Liquide/Lurgi, SYN Energy, Sinopec, and Tsinghua University.

Process Economics

Detailed cost of production estimates are presented for the production of ethylene and propylene by integrated coal-based MTO technologies, stand-alone MTO that rely on purchased methanol, conventional steam cracking, and propane dehydrogenation. Coal-based production economics are focused on inland China, while stand-alone MTO, steam cracking, and PDH technologies are based on coastal China as well regional locations such as the United States, Middle East, and Western Europe.

PROPYLENE COST OF PRODUCTION COMPARISON



Commercial Market Review

Global ethylene consumption in 2016 reached 145 million tons. Polyethylene continues to lead demand for ethylene with this derivative segment accounting for 62 percent of consumption followed by demand into ethylene oxide and ethylene dichloride. Global propylene consumption in 2016 reached 101 million tons with polypropylene leading demand for propylene and accounting for 63 percent of consumption followed by demand into propylene oxide, acrylonitrile, and cumene. The PERP report provides an overview of the supply, demand, and trade of the light olefins ethylene and propylene on both a global and regional basis.

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