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Crude Oil Conversion to Chemicals

PEP Report 303D

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Abstract

Crude oil refineries are being designed for increasing levels of chemicals production. Some of the recently commissioned large COTC projects convert 30–55% of feed crude to chemicals. These complexes have a much higher conversion capacity to enhance the production of olefins and light and heavy naphtha from the heavier fractions of the crude barrel. Complexes are even being planned, with almost no fuels production and conversion to chemicals of 70% or higher.

This trend is being driven by the higher and more stable price margins of petrochemicals relative to transportation fuels and the diminishing demand for fuels. However, a higher conversion to high-value products comes with a cost. These high conversion complexes are capital intensive and the impact of increasing crude conversion on capital investment and production economics is not well established. This report tries to address this gap and answer the following questions.

- Can margins and ROI rise all the way to full crude conversion to chemicals with no liquid fuels production, or is there a point of diminishing return?
- What is the impact of refinery crude capacity on margins and ROI for high-conversion complexes?
- What is the impact of chemical price margins over fuels and crude oil on these trends?

This report looks at four refinery configurations with progressively higher levels of integration and conversion to chemicals starting from Arab Light crude oil using resid, gasoil, and distillate hydrocracking conversion technologies. Each refinery configuration is integrated with an associated light naphtha/C_2–C_4 MFSC, heavy naphtha reforming, and an aromatics block. The conversion of crude to chemicals for these cases ranges from 27% to 76% on a feed crude basis. A fuel-only configuration is included in the analysis and is used as a base case for comparison. SMR-based hydrogen generation is considered for all the cases to meet refinery hydrogen demand.

The analysis presents unit-level detail of each integrated refinery configuration. Intermediate and final product yields, and unit level and complex-wide utility consumptions are estimated and compared. Based on this we develop ISBL and OSBL investment costs, production economics, margins, and ROI for each configuration for USGC and mainland China locations. Impact of crude capacity, in the range of 5.8–20 MMtpa, which is equivalent to 116,000–400,000 b/d, on production economics is also presented.

Sensitivity to chemical product price variations vis-à-vis fuel product and raw material prices of the margin and ROI trends with increasing crude conversion to chemicals are examined.

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