Process Economics Program (PEP): Steam Cracking of Crude Oil

PEP Report 29J Prospectus
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Introduction

Can olefins from crude oil outcompete conventional steam cracking of naphtha? How do these processes work? What are the economic drivers?

This report covers the technology and costs of manufacturing ethylene from crude oil via steam cracking. Ethylene is the world’s most important petrochemical, and steam cracking is by far the dominant method of production. However, the use of crude oil as feedstock is a novel and recent development.

Two processes are presented. Section 5 gives the ExxonMobil process. This process feeds crude oil directly to modified cracking furnaces. The cracked gas from these furnaces is further processed in a traditional steam cracking front-end depropanizer facility. Section 6 gives the Saudi Aramco process. In this process crude oil is fed directly to a hydrocracker. The hydrocracker products include naphtha, distillate, and vacuum gas oil cuts. The naphtha and distillate are co-cracked in traditional steam cracking furnaces. The vacuum gas oil is sent to a newly developed, proprietary, high-severity fluid catalytic cracking (FCC) unit. We present preliminary engineering designs for both the ExxonMobil and Aramco processes.

In addition to these two engineering designs, we present in Section 4 a review of the applicable steam cracking and hydrocracking technologies. We also discuss therein details of the novel ExxonMobil flash pot system as well as the new Aramco high-severity FCC technology.
Abstract

In January 2014 ExxonMobil officially opened in Singapore a novel steam cracker that produces olefins directly from crude oil. The Saudi Arabian Oil Company (Aramco) has discussed plans to build a crude-to-olefins complex. SABIC is another company that has looked into direct crude-to-olefins. In this report we examine some of the technologies required to support the direct production of olefins from crude oil. We present process design studies for the ExxonMobil and Aramco processes.

We look at capital and production costs for a facility in Singapore using the ExxonMobil process and compare that process in detail with traditional naphtha cracking. In particular, we lay out side by side crude oil vs. naphtha comparisons of yield sets, major equipment sizes, and process economics. Our analysis indicates that the ExxonMobil process achieves a $100-$200/ton cost advantage vis-à-vis naphtha cracking with only a modest increase in capex.

We also present capital and production cost estimates for a facility in Saudi Arabia using the integrated Aramco crude-to-olefins process. The Aramco route benefits from a significant by-product value uplift and an advantageous feedstock price spread. These result in a cash cost advantage to the Aramco process of over $200/ton compared to conventional naphtha cracking. Capex is significantly higher, however. These two factors largely cancel one another out. We conclude that the Aramco process shows equivalent to slightly advantageous economics compared to naphtha cracking.

Key Questions Addressed in the Report

- How does the ExxonMobil process work?
- What is the feedstock that ExxonMobil is using?
- What are the olefins yields from their process?
- Can olefins from crude oil really outcompete naphtha steam cracking?
- What is the Aramco process layout?
- Will Aramco implement their technology?
- What drives olefins from crude oil vs naphtha cracking process economics?

Deliverables

The narrative report will be delivered in PDF format. We will provide process flow diagrams and major equipment lists for the ExxonMobil and Aramco processes. Class 3 capex and opex estimates will be given for the ExxonMobil process on a Singapore basis and for the Aramco process on a Saudi basis. We will supply for both processes side-by-side comparisons of crude oil cracking yield sets vs. those for naphtha cracking. A side-by-side comparison of major equipment size differences between the ExxonMobil process and a naphtha cracker will be furnished. IHS experts will be available to answer questions about the report content.
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Meet the Authors

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Michael Arné has 36 years of industry experience in chemical engineering consulting, chemical manufacturing, and related positions. Has authored numerous PEP reports on topics bearing on process design and capital and operating cost estimation for polyolefins, and petrochemicals and is the ongoing technical lead and co-author of the “Greenhouse Gases Handbook”.

Michael’s areas of expertise include Chemical Engineering Design, Capital Cost Estimation, and Technoeconomic Analysis and his Domain Knowledge includes Olefins from Liquids, Carbon Accounting, Chemicals and Fuels from Bio-Sources.

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Gajendra Kumar works with IHS’s PEP program and is responsible for Refinery & C1 process economics studies. He has 12 Years Industrial Experience in Refinery & Petrochemicals in Plant Operations, Process Engineering, Start-up and process simulation studies.

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