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PERP 2016-8: Butadiene/Butylenes

“Butadiene/Butylenes” is one in a series of reports published as part of the 2016 Process Evaluation/Research Planning (PERP) Program.

Report Overview

Components of the C₄ stream are used to make synthetic rubber, polyethylene co-monomer, specialty chemicals, engineering plastics, and solvents. C₄ molecules are consumed either as contained streams or as pure components. The major components in the mixed C₄ stream are butadiene, isobutylene, butene-1, butene-2, and butanes.

The majority of producers extract butadiene from the mixed C₄ stream and obtain raffinate-1 as byproduct. Isobutylene contained in raffinate-1 is further processed to other products such as MTBE, ETBE, or polymers and specialty chemicals. Butene-1 is extracted for use as a polyethylene co-monomer or other specialty applications like polybutene-1. The *n*-butenes can be used to produce alkylate, or used as feedstock for propylene production, amongst other uses. The butanes are recycled as co-cracking feedstock or consumed as fuel.

This PERP report provides an overview of the industry structure, technology holders, commercial and developing technologies, process economics and markets for butadiene, isobutylene, and butene-1. The following issues are addressed in the report:

- What are the major features of the processes for the processing of the mixed C₄ stream, and production of butadiene, isobutylene, and butene-1?
- Which technology holders offer their technology for license and how do their processes differ?
- How do the process economics compare for the different processes to produce C₄ components across different geographic regions?
- What are the current market environments for butadiene, isobutylene and butene-1? Which applications will drive demand and which regions will show the highest growth?

Commercial Technologies

Almost 95 percent of butadiene is obtained from extractive distillation of the mixed C₄ stream obtained as a byproduct of steam cracking. Recent butadiene price volatility resulted in significant research and development of “on-purpose” butadiene production routes, with a lot of capacity being added in China recently. Although these units are idled or run at low rates, interest in developing on-purpose routes continues to guard against future volatility.

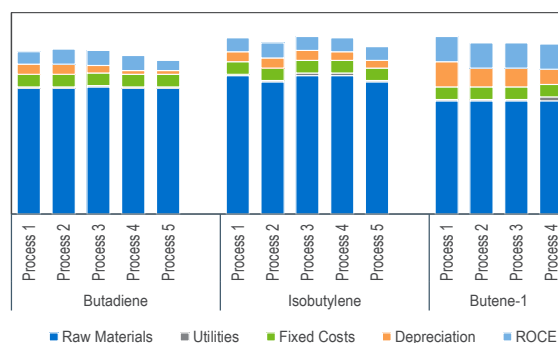
Isobutylene is produced via four major routes. The first is via MTBE cracking as part of an integrated MTBE complex, while the second is the decomposition of TBA obtained as a byproduct of propylene oxide production. Isobutane can also undergo dehydrogenation to make isobutylene, while isobutylene can also be obtained from cold acid extraction of the raffinate-1 stream.

Butene-1 is commercially produced via several routes. It is produced as part of an alpha olefins mixture from ethylene oligomerization. In regions with an abundance of C₄ streams, it can be extracted and distilled. Butene-1 can be also recovered from these streams by molecular sieve adsorption. In areas like the Middle East with limited access to C₄ streams, butene-1 is made “on-purpose” by ethylene dimerization. Butene-1 can also be produced through selective hydrogenation of diolefins and acetylenes, and subsequent fractionation of the C₄ raffinate byproduct from a MTBE unit.

Process Economics

Detailed cost of production estimates for deriving maximum value from the mixed C₄ stream, as well as different commercial and developing technologies for the production of butadiene, isobutylene, and butene-1 are presented for the U.S. Gulf Coast, Western Europe, Middle East, China, Southeast Asia, and South Korea. In addition, different schemes for optimization/integration of a C₄ site are evaluated across the same regions. A sensitivity analysis is also conducted to evaluate the impact of feedstock, byproduct or capital expenditure variations on the cost of production.

COSTS OF PRODUCTION OF BUTADIENE, ISOBUTYLENE, AND BUTENE-1



Commercial Market Review

Global butadiene consumption reached almost 11 million tons in 2015, driven by demand from the automotive segment, while butene-1 demand globally reached almost 1.9 million tons, driven by demand as polyethylene co-monomer. This PERP report provides an overview of the commercial applications and supply sources for the mixed C₄ stream, with near term global and regional market projections for butadiene and butene-1. A capacity listing is also provided.

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