



Biorenewable Insights: Butadiene

Butadiene is one in a series of reports published as part of NexantECA's 2024 Biorenewable Insights program.

Overview

Recent developments have resulted in a tightening of the butadiene markets, particularly with deficits observed in C4 crude in regions like North America. Additionally, spikes in energy prices have negatively impacted European cracker economics, resulting in reduced production of both ethylene and butadiene. While the tightening of butadiene markets is favorable for the commercialization of bio-butadiene, the higher production costs pose challenges in terms of competitiveness when compared to current market prices. Presently, the supply of steam cracker crude C4 exceeds the forecasted butadiene consumption. However, in Europe, a shift towards lighter feedstock and the establishment of new, more sustainable plants, such as the INEOS cracker in Belgium, suggests ongoing opportunities for the development of bio-butadiene.

Given the historical full commercialization of both the Coperbo and Lebedev processes, coupled with the fact that feed ethanol, the world's largest bio-based chemical, has experienced a consistent decrease in production costs and is rapidly advancing in commercialization from non-food sources, opting for either of these processes for bio-butadiene appears to be the lowest risk alternative. Both are about as attractive as any other alternative globally and are the most economically attractive in Asia. In a significant stride towards advancing upscale operations in the bio-butadiene industry, the BioButterfly™ partnership, comprising Michelin, IFP Energies Nouvelles, and Axens, marked a milestone in January 2024 by unveiling the inaugural industrial-scale demonstrator plant dedicated to butadiene production from bioethanol. With a production capacity of 20 to 30 tons per year, the plant marks a major step in securing major volumes of renewable butadiene.

Technologies

Several technologies are profiled in this report:

- Direct Fermentation to butadiene as developed by:
 - Genomatica
 - Global Bioenergies

- Fermentation to BDO, followed by dehydration to butadiene, as developed by:
 - Genomatica and Scientific Design for sugars feedstock
 - LanzaTech and Invista for CO/syngas feedstock
- Ethanol Butadiene
 - The Lebedev process, a one-step conversion of ethanol to butadiene – as practiced in the former USSR
 - The Coperbo (AKA Ostermilinsky Reaction) a two-step conversion of ethanol to butadiene – as practiced in Brazil
- Processes with Feedstock Constraints and little progress in the market:
 - Fermentation to succinic acid, hydrogenation of succinic acid to BDO, dehydrated to butadiene, as above.
 - Fermentation to n-butanol, dehydration of butanol to butenes, and Oxidative Dehydration Process to produce butadiene.

Process Economics

Cost of production models for USGC, Brazil, Western Europe and China are shown for butadiene from:

- Direct Fermentation of Sugars
- Sugar to BDO to Butadiene
- Carbon Monoxide to BDO to Butadiene
- Ethanol to Butadiene:
 - Lebedev Process
 - Coperbo Process

Commercial Impact

This report offers a catalogue of existing and planned renewable butadiene capacity and profile projects as well as analysis of the implications for conventional technology currently in the market, including the strategic implications.

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