NexantECA

Technology and Costs

Biorenewable Insights: Isoprene and Isoprenoids

Isoprene and Isoprenoids is one in a series of reports published as part of NexantECA's 2016 Biorenewable Insights program.

Overview

Isoprene is produced in small quantities by many types of organisms, including the human body (about 17 mg/day for the average person). Most industrially produced isoprene is consumed in the production of polyisoprene, via polymerization of the isoprene monomer. Polyisoprene (Isoprene Rubber, IR), is similar in structure and properties to natural rubber. Polyisoprene is largely used in the manufacture of vehicle tires.

Industrial biotechnology has vastly grown in the last decade, with increased interest in finding alternatives routes for various chemical processes. Even at a point in time where crude oil prices have fallen to a year low, leading to attractive economics of many conventional pathways, the conjecture of drivers and breakthroughs in synthetic biology has kept companies still exploring the possibilities of biologically sourced chemicals and petrochemicals.

The petrochemical industry is conservative by nature. It is therefore expected that to break through the perception barrier, drop-in chemicals (i.e., chemicals that already have an existing base in the industry, such as adipic acid, caprolactam, butadiene, and isoprene, are most likely to be the first to enjoy wide-spread commercial success. For substitute bio-chemicals (chemicals with end-uses/ applications for which the industry is currently manufacturing from petrochemical sources, such as lactic acid, succinic acid, or polycarbonate derived via isosorbide rather than BPA, the task is relatively more complex. "New" materials have to substitute established chemicals with well-defined value chains. An efficient market penetration strategy is needed to focus on the specific application areas in which the performance of bio-derived materials is significantly better than the current material, or at least offers alternative desirable properties that are better or not currently offered by the existing and established material.

Drop-in chemicals such as isoprene will benefit from the existing downstream industry. With bio-derived isoprene, the existing downstream rubber industry needs only to switch its isoprene monomer suppliers, without any further changes in their operations.

Technologies

Isoprene and isoprenoid production from biomass feedstock has been the focus of recent commercialization studies involving several companies. Examples of companies at different development stages of fermentative processes for isoprene and isoprenoids are as follows:

- Amyris in collaboration with Michelin and Braskem
- Genencor (division of DuPont) in collaboration with Goodyear
- Global Bioenergies
- Aemetis
- LanzaTech
- Ajinomoto
- GlycosBio
- Each company employs their own unique biochemistry processes

Process Economics

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

- Fermentation via MVA Pathway
- Fermentation via DXP Pathway
- Fermentation via Optimized MVA Pathway
- Amyris Process Technology

Cost of productions for farnesene and limonene via Amyris' process technologies are also modelled in this report.

Capacity

NexantECA has catalogued existing isoprene and isoprenoid production and capacity and includes profiles of projects.

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Technology and Costs comprises the Technoeconomics – Energy & Chemicals (TECH) program, the Biorenewable Insights program (BI), and the new Cost Curve Analysis. These programs provide comparative economics of different process routes and technologies in various geographic regions.

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