NexantECA

Technology and Costs

Biorenewable Insights: PEF to Replace PET

PEF to Replace PET is one in a series of reports published as part of NexantECA's 2016 Biorenewable Insights program.

Overview

"Green chemical" building blocks have been experiencing enormous development growth over the past decade as a result of growing concerns over sustainable production, decline in fossil hydrocarbon resources and GHG emissions. In the chemical industry, the market volume of plastics is by far the largest. While raw materials for the chemical sector still mainly have a petrochemical origin, and renewable feedstock production is often just a fraction of the petrochemical market, bio-plastics have been thriving. New market developments are underway around these building blocks, particularly building blocks that can be used in many different polymer groups, such as FDCA, due to their promising chemical structures. PEF is currently well-poised, and can be produced competitively with PET, though returns are quite modest. If oil prices were to increase this competitiveness would improve, as would the returns.

In contrast, novel bio-based chemicals are not direct substitutes for existing petrochemical versions, and hence involve higher risks. But they may offer a set of unique characteristics that are unattainable with fossil-based alternatives. Despite that, the introduction of new green chemicals can be challenging due to several prohibitive issues including overall cost, commercialization times, and concerns over single-source supply, premature technology development, pricing, performance against petrochemical alternatives, and in many cases, regulatory and/or market qualification barriers. Moreover, resistance to change or ever hard-edged competitive response may be faced from other industrial players in the value chain.

In the chemical industry, plastics have by far the largest market volume. While raw materials for the chemical sector still mainly have a petrochemical origin, and renewable feedstock production is often just a fraction of petrochemical supply, bio plastics have been thriving. New market developments are underway around their building blocks, particularly those that can be used in many different polymer groups, such as 2,5-furandicarboxylic acid (FDCA), which is produced from renewable resources, and is particularly aimed at producing polyethylene furanoate (PEF) resin.

Technologies

FDCA (or FDME in the case of ADM/DuPont) is the bio-based monomer that makes PEF novel.

FDCA (2,5-furandicarboxylic acid) can be produced several ways:

1. Sugar catalysis to an intermediate furan such as HMF (or HMF derivative such as MMF which is more stable), then catalytic conversion to FDCA
2. Sugar catalysis to an intermediate furan such as HMF (or HMF derivative such as MMF, which is more stable), and next biological conversion to FDCA, whether by whole organism or exogenous enzymes.
3. Sugar catalysis to FDME, which is the dimethyl ester of FDCA.
4. Biomass conversion to cellulosic sugars, which are converted to FDCA as previously described.
5. Biomass conversion directly to HMF, which can be converted to FDCA as previously described.

Process Economics

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

- FDCA/FDME
  - FDCA—Chem Catalytic
  - FDCA – HMF Biotransformation
  - FDCA – Cellulose Based
  - FDME – Fructose Based
- PEF
  - Sugar Catalysis to FDCA and conversion to PEF Integrated
  - Cellulose to FDCA and conversion to PEF Integrated
  - Fructose to FDME and conversion to PEF Integrated

Capacity

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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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