

**Technology and Costs** 



## **Biorenewable Insights: PDO and PTT**

# PDO and PTT is one in a series of reports published as part of NexantECA's 2016 Biorenewable Insights program.

### **Overview**

Green building blocks have been experiencing enormous development growth over the past decade as a result of growing concerns over sustainable production, decline in fossil fuel reserves and CO<sub>2</sub> GHG emission reductions. The intention to reduce dependency on petroleum-based driven consumer demands products has environmentally-friendly products and, in some cases, the willingness to pay a premium for them. Biomass-based building blocks are divided into drop-in chemicals and new bio-based chemical molecules. The so called dropins are partly or completely bio-based chemicals that are identical to their petrochemical counterparts, requiring adaption only at the outset of the value chain. Therefore, they can immediately be used in existing infrastructure, allowing faster access to markets and lower associated risks. Their market entry is mainly restricted by their cost competitiveness. Novel bio-based chemicals are not direct substitutes for existing petrochemical versions, and hence involve higher risks, but may offer a set of unique characteristics that are unattainable with oil-based alternatives. Despite that, the introduction of new green chemicals can be challenging due to several prohibitive issues including overall cost, commercialization times, premature technology development, pricing and performance against petrochemical alternatives, and in many cases, regulatory and/or market gualification barriers. Moreover, resistance to change may be faced from other industrial players in the value chain.

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 1,3propanediol, due to their promising chemical structures.

### **Technologies**

1,3-Propanediol (trimethylene glycol, 1,3-PDO) has a number of specialty uses in the production of lubricants for use at high pressures, pharmaceuticals, dyes and in the manufacture of light-stable polyesters. DuPont is a producer of PET, PBT, and PTT. DuPont has a dominant market position in life sciences and through previous collaboration with Genencor and Tate & Lyle, DuPont is able to make 1,3-PDO from renewable resources. Biological routes to the formation of 1,3-PDO are known and could utilize cheap carbon feedstocks and fairly mild processing conditions. Based on publication activity over the last two decades, the bulk of the research into improving the productivity and economics of 1,3-PDO production by fermentation has been largely undertaken by the following distinct groups, namely:

- The DuPont- Tate & Lyle JV
- METabolic Explorer, SA (METEX)
- Gesellschaft f
  ür Biotechnologische Forschung mbH (GBF, Braunschweig)
- University of Göttingen (Gottschalk and coworkers)

Polytrimethylene terephthalate (PTT) is an aromatic polyester produced from 1,3-PDO and terephthalic acid (PTA) via polycondensation, similar to the way commercial polyester is produced from ethylene glycol and PTA.

The polymerization chemistry involves two major reaction steps:

- Esterification of terephthalic acid to bishydroxypropyl terephthalate (bis-HPT)
- Polycondensation of bis-HPT to PTT

### **Process Economics**

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

- PDO via
  - Glucose-based fermentation
  - Glycerin-based fermentation
  - Ethylene Oxide-Based fermentation
- PTT via PDO and PTA
- PTF via PDO and FDCA

### Capacity

NexantECA has catalogued existing PDO and PTT 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.

NexantECA serves its clients from over 10 offices located throughout the Americas, Europe, the Middle East, Africa, and Asia.

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