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Technology and Costs

TECH 2021S6: Amorphous High Temperature Engineering Thermoplastics

Amorphous High Temperature Engineering Thermoplastics is one in a series of reports published as part of NexantECA's Technoeconomics – Energy & Chemicals (TECH) program.

Overview

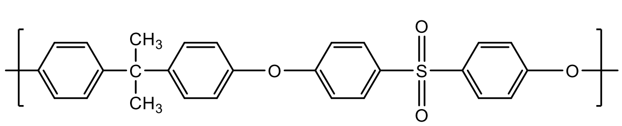
This report discusses the most common high temperature amorphous thermoplastics commercially available today. These materials rely on complex chemistries, mainly incorporating aromatic residues in their polymeric backbones. While their aromatic features increase glass transition temperatures and thus heat resistance, they also hinder melt flow, making processing and fabrication more difficult. Nevertheless, these polymers have found widespread utility in a variety of applications requiring their thermal resistance or other unique properties. The polymers discussed herein, which are actually families of materials with common chemical characteristics, include:

- Polysulfones (PSO)
- Polyetherimides (PEI)
- Polyphthalamides (PPA)

Polyphthalamides are included in this report even though the range of commercial products includes both semi-crystalline as well as amorphous materials.

The family of sulfur-containing polymers which incorporates two essential elements - the SO_2 group and an ether bridging -O- moiety – is termed polysulfones. This family contains a range of polymers including polysulfone itself (PSU or PSF), polyethersulfone (PES), polyarylsulfone (PAS), and polyphenylsulfone (PPSU). The first commercialized polysulfone product was UDEL®, developed by Union Carbide.

Polysulfone Repeating Unit



A discussion of the chemistry for PES, PEI and the PPAs is also included in this report.

Commercial Technologies

The production of these amorphous polymers is complex, requiring a number of carefully controlled process steps. With the complex chemistry involved, it has been a challenge for producers to develop processes that deliver polymers of consistent properties and performance. Process innovations have been needed to improve color by ensuring the correct solvent systems are used and that the production of oligomers is suppressed. Control of polydispersity and average molecular weight are also important in dictating polymer properties, and so precise temperature control is needed as well as an absence of oxygen. Finally, the chemical possibilities to make these materials are essentially infinite, with an incredibly large and diverse number of potential monomers.

U.S. patent history was reviewed to incorporate the process improvements developed over the past 20 years into the Process Descriptions contained in the report, which are then the basis for the following Process Economics.

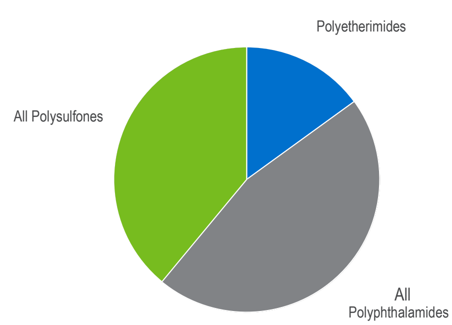
Process Economics

The economic assessment was developed for world scale PSU, PES, PEI and PPA polymerization facilities located in USGC, W. Europe, and Coastal China (SEA for PEI). These economics incorporate the key polymerization process improvements as identified in the patent literature.

Commercial Overview

Common end-use applications for PSU, PES, PEI and PPAs are discussed. Global demand by polymer family (i.e., all polysulfones, all PEIs and all PPAs) and separately by region is provided for 2021 and a five year forecast provided.

Global Demand by Resin Type, 2021



A list of major suppliers of these materials and their capacities (as available) is also provided.

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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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