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Report Abstract

Polybutylene Terephthalate (PBT)
PERP07/08S1

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Nexant

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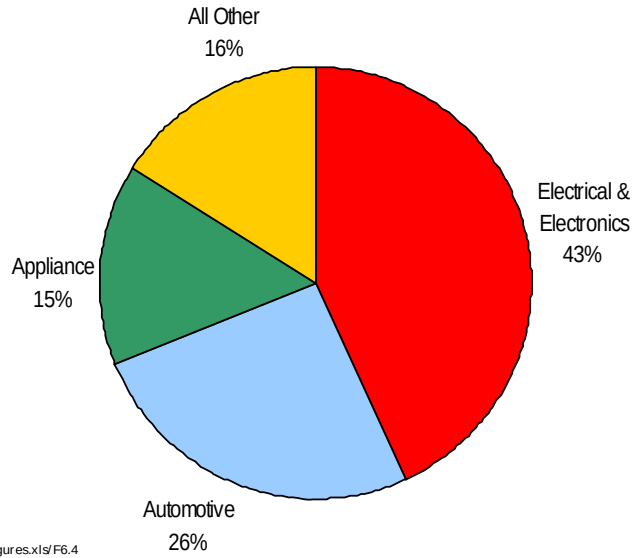
INTRODUCTION

Polybutylene terephthalate (PBT), also known as polytetramethylene terephthalate (PTMT), was originally developed and brought into the market in 1970 by Hoechst Celanese. It is a semi-crystalline thermoplastic polyester that is classified as a medium performance-engineering polymer.

PBT offers a valuable combination of technical properties with its exceptional resistance to heat, creep and chemicals, good processability and good economics for a variety of applications. Initially, PBT was first used in the textile industry. In the textile sector, PBT is spun into fibers and used in the carpet sector. However, today due to competition with polyamides, PBT is mainly used as a substitute for metals, thermoset resins, and engineering plastics. The most important applications of PBT are for products used in the automotive, electrical, electronics, telecommunication, as well as precision engineering sectors. With excellent electrical properties, PBT is often regarded as having the best overall performance profile for electrical/electronics (E/E) applications of all the engineering thermoplastics (ETPs). Hence, it is not surprising that global demand for PBT in E/E applications accounts for nearly half of the entire PBT demand. Additionally, PBT is also employed in home appliances and in medical applications. The vast majority of PBT sold commercially is a compounded product with much of this glass filled. The global PBT market breakdown by application is illustrated below.

Global PBT Demand by Application



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In addition to compounding, additives such as flame retardants and antioxidants are used to improve material properties as well as to facilitate fabrication processes. The PBT automotive end-uses include sockets, fuse boxes, and junction systems. In the electronics and electrical market, PBT is used in connectors, capacitors, cable enclosures, etc. Other end-use applications include pump housings, sprinkler and showerheads.

Hitachi, Uhde Inventa-Fischer, and Lurgi Zimmer AG are the main licensors of PBT technology and cover the full spectrum of process variations. Detailed reviews & comparisons of the technical features of modern commercial processes offered by these major licensors are given in this ChemSystems PERP report.

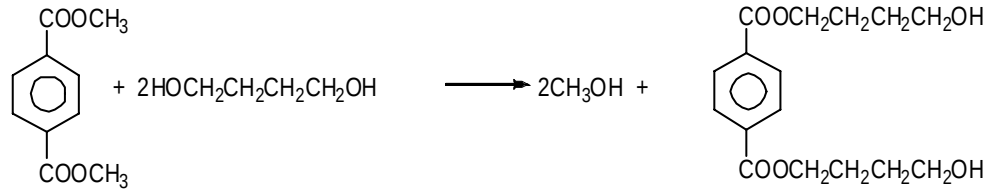
The technology for producing PBT today is considered to be quite mature. However, every one of the many steps used in PBT production has been the subject of numerous improvements over the years, and important developments are constantly being made with respect to process and equipment design, and catalysts improvements. This report includes a discussion of recent improvements.

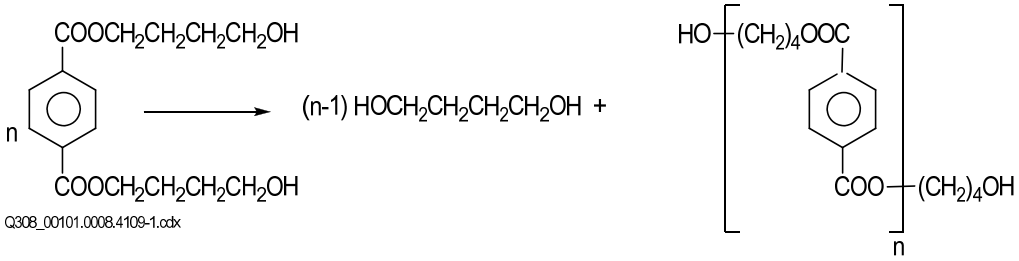
The main raw materials used to manufacture PBT are 1,4-butanediol, dimethyl terephthalate, purified terephthalic acid and catalysts. The choice of raw material depends entirely on the chemical route. Particularly stringent requirements are placed on the purity of raw material because impurities can either interfere with polycondensation via chain termination or branching (e.g., mono- or polyfunctional compounds), or can lead to undesirable side reactions and discoloration under the high reaction temperature. The chemistry of the production process routes are discussed in the report – a general overview is given below.

CHEMISTRY & PROPERTIES

PBT resin is manufactured by one of three basic process routes:

(1) batch production process via transesterification of 1,4-butanediol (BDO) with dimethyl terephthalate (DMT) followed by polycondensation of the resulting bis-hydroxybutylterephthalate (bis-HBT) – as shown by the two-step reaction scheme below:





(2) a continuous production process involving transesterification of BDO with DMT, followed by a pre-polymerisation step, and finally polycondensation;

(3) a continuous production process involving direct esterification of purified terephthalic acid (PTA), followed by pre-polymerisation and polycondensation steps.

Mechanical properties, chemical resistance, electrical properties, dimensional stability, thermal properties, tribological properties, fire behavior, storage & transportation, additives & fillers (glass fibers, fire retardants, mineral fillers), and polymer blends for manufactured PBT resins are detailed in this report.

PBT attains a relatively low melt viscosity during normal processing temperatures, thus allowing it to be easily molded into intricate, thin walled parts (e.g. electrical connectors). In competing against thermosets (especially in electrical applications), PBT scrap may be reground and reprocessed with only a moderate loss of properties, whereas scrap from thermosets cannot be reused for their original purpose and must often be discarded. In general, PBT can be processed by all fabrication methods known for thermoplastics. The main methods which come into consideration are injection molding and extrusion. These aspects are also discussed in the report.

ECONOMIC ANALYSIS

Two continuous processes have been modeled, both based on major licensor technology. One process production produces PBT from BDO and DMT, whereas the other uses BDO and PTA as the starting materials. A production capacity was selected that is representative of a world scale facility, based on the average size of new facilities recently constructed by leading PBT producers.

To complete the assessment, batch PBT process economics have also been developed. Only the BDO/DMT route has been modeled, since there is almost no batch production of PBT base resin using the BDO/PTA route. To evaluate this alternative, the same plant production capacity was kept to be consistent with both continuous processes, but unlike them, a batch plant of this size would comprise multiple separate polymerization lines as opposed to one line.

The investment figures used in this assessment were developed from information supplied by major licensors and Nexant's own analyses.

To test the impact of plant size on the economics of continuous units, a sensitivity analysis was performed. In the chemical industry, feedstock integration is an important consideration in assessing the competitive position of participants in a given value chain, therefore effect of back integration is also discussed in this report, as well as the impact of lower PBT production costs on PBT pricing.

MARKET OVERVIEW

PBT faces inter-material competition from other engineering thermoplastics. Polyacetal can be used instead of PBT in small parts. In the automotive industry, nylon 6 and nylon 6,6 is a main competitor, particularly for under-hood components. In electronics and electrical applications, PBT competes with PET. PC/PBT blends compete with alternative bumper designs utilizing compounded polypropylene. Additionally, PBT faces new competition from polytrimethylene terephthalate (PTT), which exhibits performance and processing characteristics similar to high-performance PBT.

This report gives in depth market analysis, new developments in PBT markets – supply/demand and future demand projections for North America, Western Europe, China and Japan.

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