Abstract

Process Economics Program Report 227

1,3-PROPANEDIOL AND POLYTRIMETHYLENE TEREPHTHLATE

(December 1999)

As an engineering thermoplastic, polytrimethylene terephthalate (PTT) combines the rigidity, strength, and heat resistance of the polyethylene terephthalate (PET) resins with the good processability of the polybutylene terephthalate resins. Currently, nylon carpet fiber is known for its resiliency, but it does not accept a wide variety of dyes (limiting the colors that can be provided) and tends to generate static charges. PET carpet fibers can be easily dyed but have neither the extreme wearability nor the resiliency of nylon. PTT fibers, on the other hand, have the dyeability of PET and also are static-resistant. In addition, PTT fibers appear to have resilience and wearability equivalent to that of nylon.

The recent commercial availability of polymerization-grade 1,3-propanediol (PDO) allows commercialization of polypropylene terephthalate (commonly called polytrimethylene terephthalate, or PTT). PTT has recently been introduced in developmental quantities, and full-scale commercial facilities are now on stream with substantial expansions expected in the next few years by both Shell and DuPont. In addition to applications as an engineering molding and extrusion resin, PTT has remarkable properties as a fiber.

This report examines the technology and economics of producing both PDO and PTT. We find that on a cost-per-pound basis PTT can compete favorably with nylon even in nylon's current severely price-depressed state. On a volume basis, however, the higher density of PTT will put it at a small economic disadvantage to nylon. Competition with PET will be based on superior properties at a significant cost premium for the PTT.

Currently, DuPont (using Degussa technology) is producing PDO by hydration of acrolein and Shell is producing PDO by hydroformylation of ethylene oxide (EO). In addition, DuPont, in cooperation with Genencor, has a process under development to produce PDO from glucose (corn-based) using biosynthesis (fermentation).

We have examined the technology and economics of these three PDO routes and found that the two chemical routes differ widely, with the acrolein process having a lower capital cost but a much higher raw material cost. Although both processes are currently commercial, the EO route will have the best long-term economics of the two. To remain competitive, the acrolein route must rely on integration back to propylene and the elimination of some crude acrolein purification steps. The third route, biosynthesis, is currently not commercial. The economics of the anaerobic route analyzed in this report are superior to those for the acrolein route but inferior to those for the EO route. If the newer aerobic route being developed by DuPont/Genencor meets the performance targets outlined in this report, it will be competitive with the EO route and could have a cost advantage when fully developed. The process is expected to be commercial by 2003 to 2005.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Concluded)

FIGURES

TABLES

TABLES (Continued)

TABLES (Concluded)