This report, which is the seventh in a series on high-temperature polymers, reviews manufacturing processes, presents preliminary process designs, and estimates capital and production costs for two new polymers: polyphthalamide and polyethylene naphthalate (PEN). In addition, recent patents for liquid-crystal polymers (LCPs) are reviewed, and their manufacturing economics are updated (they were previously treated in PEP Report 86C).

In the process evaluated here, polyphthalamide is made by reacting hexamethylenediamine with a mixture of three acids (terephthalic acid, isophthalic acid, and adipic acid) to form a semicrystalline polyamide that has excellent physical and mechanical properties, outstanding dimensional stability, and good processing characteristics. The economics of making both unfilled and glass-filled grades of polyphthalamide are evaluated.

PEN is chemically related to polyethylene terephthalate (PET), but has mechanical, thermal, and gas barrier properties that are superior to those of PET. PEN is made by a process that is analogous to that used for making PET, starting with ethylene glycol and dimethyl 2,6-naphthalenedicarboxylate.

Introduced several years ago, liquid crystal polyesters have outstanding properties and tractable processing characteristics. The growth rate of these expensive polymers has been lower than predicted, however. We evaluate here two types of LCPs that are made from p-hydroxybenzoic acid: one type uses 6-hydroxy-2-naphthoic acid as the other raw material, and the other type uses both terephthalic acid and 4,4i-dihydroxydiphenyl. (These polymers are similar to Vectra® liquid crystal polyester made by Hoechst Celanese and to Xydar® liquid crystal polyester made by Amoco, respectively.) Both unfilled and glass-filled versions of each polymer are evaluated. In addition, we update the economics of making the monomers p-hydroxybenzoic acid, 6-hydroxy-2-naphthoic acid, and 4,4i-dihydroxydiphenyl.

This report will be useful to present and future producers and users of polyphthalamide, PEN, and LCPs, and of other high-temperature polymers with which they compete. In addition, researchers in LCP products will find the extensive summary of recent patents useful.
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**CAPITAL AND PRODUCTION COSTS, PEN FROM NDC AND EG**

- Capital Costs
- Production Costs
- G&A, Sales, and Research Expense
- Relative Importance of Production Cost Items
- Return on Investment

**PRODUCTION COST FOR PEN FROM NDA AND EG**

**POLYBUTYLENE NAPHTHALATE MANUFACTURING COSTS**

### 7 LIQUID CRYSTAL POLYESTERS

#### REVIEW OF PROCESSES

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- LCP from HBA and HNA

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