PERP Program
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Chem Systems' Process Evaluation/Research Planning program has published a new report, ***PET Fiber Spinning Technology (97/98S13)***.

The idea of spinning polyester fibers dates back to the original W.H. Carothers (DuPont) patents and papers from the 1930s. However, the use of polyester fibers did not become commercially feasible until the 1950s when J.R. Whinfield and J. T. Dickson of the Calico Printers Association made polyethylene terephthalate (PET) from terephthalic acid. This polyester has a higher melting point and improved hydrolytic stability than the aliphatic polyester discovered by Carothers.

Today, polyester fibers are used in everything from textiles to automobiles. Polyester fiber production accounts for over half of all synthetic fiber manufacturing. Polyester fiber and fabric manufacturing has been refined so that the resulting fabrics have better drape, hand, and feel. Polyester is a popular synthetic fiber because of its versatility, ease of production, and favorable economics.

PET resin is produced by the transesterification of purified terephthalic acid (PTA) or dimethyl terephthalate (DMT) with monoethylene glycol (MEG). Fibers are formed by forcing this molten resin through holes or capillaries drilled through a metal spinneret. Fiber formation is also called "spinning." The fibers are separated just long enough for them to solidify (~0.2 m from spinneret) to prevent the fibers from sticking together. After the fibers leave the spinneret, they are cooled and subjected to several post-processing steps. These steps are used to optimize fiber properties for specific end uses.

Older fiber plants are no longer competitive with plants using newer technology. Newer technology can produce more fiber per line by increasing spinning speeds and decreasing fiber breakage and quality problems that can occur at high speeds. For example, Zimmer has introduced a ring spinneret that can produce 200 tons per day of polyester fiber. Equivalent conventional spinning operations can produce around 75 tons per day. This higher output decreases the required capital investment per kg of fiber.

Spinning research has focused on two areas: commercialization of high speed processing, and producing specialized fibers. Fibers are being modified to withstand the tensions of higher spinning speeds by the addition of copolymers, oiling agents, or targeted heat treatments. Specialized fibers include those with noncircular cross-sections, or conjugate polymer construction.

Process economics for polyester fiber spinning are not complicated. Raw material generally accounts for 50 to 80 percent of production costs, depending on the throughput per line achieved. Between PTA and DMT, PTA is becoming the preferred choice for raw material selection. This is partly due to the fact that you need less PTA than DMT to produce an equal amount of fiber. For 1 ton of PFY only 0.88 tons of PTA are required, whereas 1.2 tons of DMT would be required. DMT use also requires a methanol recovery unit. The high contribution of raw material costs to production costs has motivated fiber producers to integrate raw material production into their operation. Producing raw materials assures a consistent available supply and allows for some control over cost fluctuations.

It has been shown that the output of fiber per spinning position and the capacity of downstream processing units are also major factors in fiber economics. Basically, if you double the capacity of a fiber operation, you can almost halve the fixed costs associated with the production. This is the motivation behind the development of high speed processing. Consistent quality needs to be realized with high speed spinning operations for the full cost-savings potential to be reached. Staple and fiber production lines have been shown to be the most economical at a capacity of more than 200 tons per day. Industrial fibers are made from higher molecular weight resins. Since these fibers need to be stronger than staple or filament, they must be processed at slower rates. A combination of these factors prevents high throughputs at industrial fiber facilities. Industrial fiber is produced at plants with capacities as low as 4,000 tons per year and as high as 40,000 tons per year

A comparison of the cost of production economics for integrated and nonintegrated filament and integrated staple is presented. A case is also given for a stand-alone staple plant for the sake of comparison, though this is no longer considered economically viable. Tire cord economics are also presented.