Tertiary PET Recycling (92S7)

There are several approaches to dealing with the problem of plastics waste disposal: source reduction, recycling, incineration, and landfilling, the usual order of preference on the part of environmentalists, regulators, and the public at large. Source reduction is accomplished by generating less packaging in the first place and/or reusing it in the same service. These options can be categorized as primary, secondary, and tertiary.

Primary recycling refers to remelting and reusing industrial scrap in prime products. Secondary recycling consists of physical/mechanical means of reusing plastics, sometimes in lower valued end uses. Clean PET obtained from soda bottles and film is recycled by secondary methods into fiber products such as carpets and fiberfill. Tertiary recycling includes thermal and chemical techniques.

Thermal techniques use pyrolysis or hydrogenation to break down a mixed plastics feedstock into hydrocarbon products suitable for fuels or petrochemical feedstock. It is most often used on addition polymers. Chemical techniques, suitable only for condensation polymers, break down waste plastics of a single polymer type into oligomers or monomers that can be purified and repolymerized for high value end uses. This is the technology highlighted in this report. It can be accomplished by three distinct processes - glycolysis, methanolysis, and hydrolysis.

Glycolysis treats high quality PET flake with ethylene glycol to convert it to bis-hydroxyethyl terephthalate (bis-HET) or low molecular weight oligomers. It is the reverse of the polycondensation reaction used to convert bis-HET to PET. Shell Chemical Company, Polyester Business (formerly Goodyear) has 50 million pounds per year of glycolysis capacity in Point Pleasant, West Virginia. DuPont operates a 100 million pound per year glycolysis unit in Kinston, North Carolina, for recycling of primarily in-process fiber wastes; and a 20,000 metric ton per year glycolysis plant in Uentrop, Germany. Hoechst has a glycolysis unit in Offenbach, Germany that consumes both internal and post-consumer feeds. In Japan, Teijin processes 10,000 metric tons per year of PET fiber scrap by a combined glycolysis/methanolysis process.

Methanolysis produces the monomers, dimethyl terephthalate and ethylene glycol, from lower quality PET flake, and is simply the reverse of the usual PET production process wherein dimethyl terephthalate (DMT) is transesterified with ethylene glycol to give bis-HET, which is subsequently polycondensed to PET. Eastman Kodak operates a 50 million pound per year methanolysis plant in Rochester, New York, which is designed to handle PET that contains copolymers. DuPont has a pilot plant operation in Old Hickory, Tennessee. DuPont plans a commercial scale unit in 1995.

Both methanolysis and glycolysis economics were developed. Two methanolysis cases have been considered for this study - a stand-alone 30,000 metric ton per year unit and a 30,000 metric ton per year unit linked to a DMT plant of 120,000 metric tons per year capacity. Glycolysis can only be meaningfully evaluated when integrated with a conventional PET production process, because the only real use for the bis-HET produced by glycolysis is as feed to the polycondensation section of a PET plant. PET flake supplies one fourth of the feedstock requirement and amounts to 28 percent of the total raw material cost.

Legislation, instigated by consumer attitudes, to stimulate markets for recycled resins is likely to be the primary means of gaining economies of scale in the United States. However, this will be less important in Europe. Open-loop recycling of PET into the fiber industry is a good alternative use and is likely to continue to be important in the United States and Europe. The size of a tertiary recycling plant capacity for good economics is thought to be 100 to 150 million pounds per year. All four players (Eastman, DuPont, Shell, and Hoechst Celanese) have stated intentions to build plants in this capacity range. Obviously, not all these plants are likely to come to fruition, since they would be competing for available feedstock supplies.

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