AP42 Section 6.6.2

Background Report:

Title: Background Documentation for Poly(ethylene terephthalate)

AP42 Section 5.13.2

September 1991

only background documentation available

# BACKGROUND DOCUMENTATION FOR

# POLY(ETHYLENE TEREPHTHALATE)

# AP-42 SECTION 5.13.2

September 1991

Prepared for:

Emission Inventory Branch
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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I. PET - DIMETHYL TEREPHTHALATE PROCESS

A. Raw Material Storage

VOC Emission Factor: 0.1 lbs/1,000 lbs product
Particulate Emission Factor: 0.165 lbs/1,000 lbs product

SOURCE: Reference 1

B. Mix Tanks

No emission information was available on mix tanks at facilities using the DMT process. Information on a TPA process facility states that emissions are believed to be negligible (Reference 2). This statement was used for the DMT process.

C. Methanol Recovery System

1. Reference 3 reports an emission factor of 0.15 lbs VOC/1,000 lbs product for this stream. The stream, which originates from the esterifier, carries methanol byproduct vapors primarily and steam, and is processed through both cooling water and refrigerated condensers. The emission factor is reported as part of a description of a batch process.

2. VOC Emission Factor: 0.3 lbs/1,000 lbs product

SOURCE: Reference 1.

D. Recovered Methanol Storage

1. Reference 3 reports an emission factor of 0.09 lbs VOC/1,000 lbs product, based on refrigerated condensers controlling the recovered methanol storage tanks. Reference 3 reports an uncontrolled VOC emission factor of 0.29 lbs VOC/1,000 lbs product.

2. VOC Emission Factor: 0.096 lbs/1,000 lbs product.

SOURCE: Reference 1.

Both emission factors are very close to each other. The emission factor from Reference 1 contains compounds other than methanol. An emission factor of 0.09 lbs/1,000 lbs was used.

El. Prepolymerizer Vacuum System

VOC Emission Factor: 0.009 lbs/1,000 lbs product

SOURCE: Reference 1.

E2. Polymerization Reactor Vacuum System

VOC Emission Factor: 0.0005 lbs/1,000 lbs product

SOURCE: Reference 1.

E3. Cooling Tower

The emission estimates were "borrowed" from those estimated specifically for cooling towers at plants using the TPA process.

F. Ethylene Glycol Process Tanks

VOC Emission Factor: 0.0009 lbs/1,000 lbs product

SOURCE: Reference 1.

G. Ethylene Glycol Recovery Condenser

VOC Emission Factor: 0.01 lbs/1,000 lbs product

SOURCE: Reference 1.

H. Ethylene Glycol Recovery Vacuum System

VOC Emission Factor: 0.0005 lbs/1,000 lbs product

SOURCE: Reference 1.

I. Product Storage

Particulate Emission Factor

Uncontrolled: 0.4 lbs/1,000 lbs product
Controlled: 0.0003 lbs/1,000 lbs product

SOURCE: Reference 1.

J. Sludge Storage and Loading

VOC Emission Factor: 0.02 lbs/1,000 lbs product

SOURCE: Reference 1.

## II. PET - TEREPHTHALIC ACID PROCESS

### A. Raw Material Storage

The TPA process and the DMT process both use ethylene glycol and methanol. No emissions information was available for raw material storage at a facility using the TPA process. Reference 3 states that these emissions "are believed to be negligible, but have not been sampled or estimated." The raw material storage VOC emission factor calculated for the DMT process was assumed to be applicable to the TPA process.

### B. Mix Tanks

This emission point is a vent line from the paste mixer. Venting is to the atmosphere at ambient temperature. Emissions are believed negligible, but have not been sampled for.

SOURCE: Reference 2.

### C. Esterification

Stack sampling was conducted on the condenser vent, measuring di-iso-propyl-amine (DIPA) and acetaldehyde. Emission rates of 0.0008 and 0.037 lbs TOC/1,000 lbs of product were reported. The latter emission rate is associated with the outlet vent after a condenser on the esterifier, but before any additional control. The former is the emission rate for the outlet of a second condenser (in series) to the first condenser on the esterifier.

SOURCE: References 4 and 5.

### D1. Prepolymerizer Vacuum System

Since no emission information was available for a facility using a TPA process, the emission factor for the DMT process was used.

### D2. Polymerization Reactor Vacuum System

Since no emission information was available for a facility using a TPA process, the emission factor for the DMT process was used.

### D3. Cooling Tower

The 0.2 lbs/1,000 lbs product was calculated based on an average ethylene glycol concentration of 0.32 percent (by weight), an evaporation rate of 1.5 percent of the circulation rate, a windage rate of 0.2 percent of the circulation rate, and a circulation rate of 1,510 gallons per minute. This information was provided by Fiber Industries. The calculations are shown in Attachment 1. Total ethylene

glycol emissions from the cooling tower are estimated to be 0.193 lbs/1,000 lbs product. The Fibers Industries plant uses condensers immediately off of the polymerizers.

Reference 7 reports that the estimated cooling tower emissions are 3.4 lbs/1,000 lbs of product, which was generated from plant trials. This plant does not use condensers immediately off of the polymerizers.

E. Ethylene Glycol Recovery Process Tanks

Since no emission information was available for a facility using a TPA process, the emission factor for the DMT process was used.

F. Ethylene Glycol Recovery System

Since no emission information was available for a facility using a TPA process, the emission factor for the DMT process was used.

G. Product Storage

Since no emission information was available for a facility using a TPA process, the emission factor for the DMT process was used.

REFERENCES


1. Written communication from D.O. Quisenberry, Tennessee Eastman Company, Kingsport, TN, to S. Roy, U.S. Environmental Protection Agency, Research Triangle Park, NC, August 25, 1988.

2. Written communication from R. K. Smith, Allied Chemical, Moncure, NC, to D. R. Goodwin, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 27, 1980.

3. Polymer Industry Ranking By VOC Emissions Reduction That Would Occur From New Source Performance Standards, Pullman-Kellogg, Houston, TX, August 30, 1979.

4. Written communication from A. T. Roy, Allied-Signal, Petersburg, VA, to K. Meardon, Pacific Environmental Services, Inc., Durham, NC, August 18, 1989.

5. Telephone communication between K. Meardon, Pacific Environmental Services, Inc., Durham, NC, and A. Roy, Allied, Petersburg, VA, August 18, 1989.

6. K. Meardon, "Revised Costs for PET Regulatory Alternatives," Docket No. A-82-19, Item II-B-90. U.S. EPA, Air Docket Section, Waterside Mall, 401 M Street, SW, Washington, DC, August 20, 1984.

7. Written communication from J. W. Torrance, Allied Fibers and Plastics, Petersburg, VA, to J. R. Farmer, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 4, 1984.

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## Part III

# Environmental Protection Agency

**40 CFR Part 60**

**Standards of Performance for New Stationary Sources; Polypropylene, Polyethylene, Polystyrene, and Poly(ethylene terephthalate) Manufacturing Industry; Final Rule**

*High viscosity poly(ethylene terephthalate)* means poly(ethylene terephthalate) that has an intrinsic viscosity of 0.9 or higher and is used in such applications as tire cord and seat belts.

*Incinerator* means an enclosed combustion device that is used for destroying VOC.

*In-situ suspension process* means a manufacturing process in which styrene, blowing agent, and other raw materials are added together within a reactor for the production of expandable polystyrene.

*Intermittent emissions* means those gas streams containing VOC that are generated at intervals during process line operation and includes both planned and emergency releases.

*Liquid phase process* means a polymerization process in which the polymerization reaction is carried out in the liquid phase; i.e., the monomer(s) and any catalyst are dissolved, or suspended in a liquid solvent.

*Liquid phase slurry process* means a liquid phase polymerization process in which the monomer(s) are in solution (completely dissolved) in a liquid solvent, but the polymer is in the form of solid particles suspended in the liquid reaction mixture during the polymerization reaction; sometimes called a particle form process.

*Liquid phase solution process* means a liquid phase polymerization process in which both the monomer(s) and polymer are in solution (completely dissolved) in the liquid reaction mixture.

*Low density polyethylene (LDPE)* means a thermoplastic polymer or copolymer comprised of at least 50 percent ethylene by weight and having a density of 0.940 g/cm$^3$ or less.

*Low pressure process* means a production process for the manufacture of low density polyethylene in which a reaction pressure markedly below that used in a high pressure process is used. Reaction pressure of current low pressure processes typically go up to about 300 psig.

*Low viscosity poly(ethylene terephthalate)* means a poly(ethylene terephthalate) that has an intrinsic viscosity of less than 0.75 and is used in such applications as clothing, bottle, and film production.

*Material recovery section* means the equipment that recovers unreacted or by-product materials from any process section for return to the process line, off-site purification or treatment, or sale. Equipment designed to separate unreacted or by-product material from the polymer product are to be included in this process section, provided at least some of the material is recovered for reuse in the process, off-site purification or treatment, or sale, at the time the process section becomes an affected facility. Otherwise such equipment are to be assigned to one of the other process sections, as appropriate. Equipment that treats recovered materials are to be included in this process section, but equipment that also treats raw materials are not to be included in this process section. The latter equipment are to be included in the raw materials preparation section. If equipment is used to return unreacted or by-product material directly to the same piece of process equipment from which it was emitted, then that equipment is considered part of the process section that contains the process equipment. If equipment is used to recover unreacted or by-product material from a process section and return it to nother process section or a different piece of process equipment in the same process section or sends it off-site for purification, treatment, or sale, then such equipment are considered part of a material recovery section. Equipment used for the on-site recovery of ethylene glycol from poly(ethylene terephthalate) plants, however, are not included in the material recovery section, but are covered under the standards applicable to the polymerization reaction section (§ 60.562–1(c)(1)(ii)(A) or (2)(ii)(A)).

*Operating day* means, for the purposes of these standards, any calendar day during which equipment used in the manufacture of polymer was operating for at least 8 hours or one labor shift, whichever is shorter. Only operating days shall be used in determining compliance with the standards specified in § 60.562–1(c)(1)(ii)(B), (1)(ii)(C), (2)(ii)(B), and (2)(ii)(C). Any calendar day in which equipment is used for less than 8 hours or one labor shift, whichever is less, is not an "operating day" and shall not be used as part of the rolling 14-day period for determining compliance with the standards specified in § 60.562–1(c)(1)(ii)(B), (1)(ii)(C), (2)(ii)(B), and (2)(ii)(C).

*Polyethylene* means a thermoplastic polymer or copolymer comprised of at least 50 percent ethylene by weight; see low density polyethylene and high density polyethylene.

*Poly(ethylene terephthalate) (PET)* means a polymer or copolymer comprised of at least 50 percent bis-(2-hydroxyethyl)-terephthalate (BHET) by weight.

*Poly(ethylene terephthalate) (PET) manufacture using dimethyl terephthalic* means the manufacturing of poly(ethylene terephthalate) based on the esterification of dimethyl terephthalate (DMT) with ethylene glycol to form the intermediate monomer bis-(2-hydroxyethyl)-terephthalate (BHET) that is subsequently polymerized to PET.

*Poly(ethylene terephthalate) (PET) manufacture using terephthalic acid* means the manufacturing of poly(ethylene terephthalate) based on the esterification reaction of terephthalic acid (TPA) with ethylene glycol to form the intermediate monomer bis-(2-hydroxyethyl)-terephthalate (BHET) that is subsequently polymerized to form PET.

*Polymerization reaction section* means the equipment designed to cause monomer(s) to react to form polymers, including equipment designed primarily to cause the formation of short polymer chains (oligomers or low polymers), but not including equipment designed to prepare raw materials for polymerization, e.g., esterification vessels. For the purposes of these standards, the polymerization reaction section begins with the equipment used to transfer the materials from the raw materials preparation section and ends with the last vessel in which polymerization occurs. Equipment used for the on-site recovery of ethylene glycol from poly(ethylene terephthalate) plants, however, are included in this process section, rather than in the material recovery process section.

*Polypropylene (PP)* means a thermoplastic polymer or copolymer comprised of at least 50 percent propylene by weight.

*Polystyrene (PS)* means a thermoplastic polymer or copolymer comprised of at least 80 percent styrene or para-methylstyrene by weight.

*Post-impregnation suspension process* means a manufacturing process in which polystyrene beads are first formed in a suspension process, washed, dried, or otherwise finished and then added with a blowing agent to another reactor in which the beads and blowing agent are reacted to produce expandable polystyrene.

*Process heater* means a device that transfers heat liberated by burning fuel to fluids contained in tubular coils, including all fluids except water that is heated to produce steam.

*Process line* means a group of equipment assembled that can operate independently if supplied with sufficient raw materials to produce polypropylene, polyethylene, polystyrene, (general purpose, crystal, or expandable) or poly(ethylene terephthalate) or one of their copolymers. A process line consists of the equipment in the following process sections (to the extent