REPORT OF PLANT VISIT TO
FIBER INDUSTRIES, INC.

Polyester Plant
Salisbury, North Carolina

Regarding the Development of New Source Performance Standards for the Polymers and Resins Industry (ESED Project No. 78/24)

I. Purpose

To view Fiber Industries' polyester operation from the standpoint of emissions control.

To exchange technical information on VOC emissions from polyester producing processes.

II. Place and Date

Fiber Industries, Inc.
Route 70 (P.O. Box 4)
Salisbury, North Carolina 28144
September 29, 1982

III. Attendees

Ed Vincent, EPA/CPB
Ken Meardon, Pacific Environmental Services, Inc.
Paul Siebert, Pacific Environmental Services, Inc.
Jim Serne, Pacific Environmental Services, Inc.
Dow Perry, Fiber Industries, Inc., Environmental Health & Safety Superintendent
Bruce Bowyer, Fiber Industries, Inc., Environmental Supervisor
Frank Reid, Fiber Industries, Inc., Quality Control Group Leader

IV. Discussion

At the beginning of the plant visit a brief discussion of the objectives of the visit was presented by Mr. Meardon and Mr. Vincent. The agenda and schedule for the visit were agreed upon by the participants. A confidentiality agreement prepared by Fiber Industries, Inc., was signed by Pacific Environmental Services, Inc.

Mr. Dow Perry of Fiber Industries opened the discussion with a description of the terephthalic acid (TPA) polyester process used at the Salisbury Plant. Two main types of poly (ethylene terephthalate) (PET) polyester product are made at the Salisbury Plant. Staple PET, which is cut and baled for use in textile applications, and high denier industrial yarn (PET), which is used in tires and other industrial applications, are produced at the plant.

Fiber Industries operates five PET plants in the United States. The Salisbury plant uses the TPA process only. A batch dimethyl terephthalate (DMT) process is used at some of the other Fiber Industries plants for PET production. It was pointed out by Mr. Perry that to his knowledge the DMT process is less economical and less technologically advanced than the continuous TPA process and, as such, is not likely to be utilized in any new PET plants.

Mr. Perry then described the process and equipment used at the Salisbury Plant. A direct esterification, four stage, continuous process is used. The four process stages occur in separate vessels or reactors- primary esterifier (PE), secondary esterifier (SE), low polymerizer (LP), and high polymerizer (HP). The CLAIMED CONFIDENTIAL separate process lines at the plant can be operated independently. All reactions, esterification and polymerization, are endothermic, thus requiring heat input. A Dowtherm heating system is used on all vessels. The Dowtherm heaters are normally gas-fired; however, oil can be fired if gas supplies are curtailed.

Mr. Perry distributed hand drawn sketches of each of the 4 vessels and their related condensers, heat exchangers and vacuum producing equipment. He indicated that a process flow diagram would be prepared subsequent to the plant visit for submittal to EPA as part of the 114 letter response. For purposes of the plant visit report, PES has prepared a process flow diagram from the plant meeting and tour notes. (See attachment.)

Raw materials are brought into the plant by rail. Terephthalic acid (TPA or TA) powder is unloaded by bottom dumping in an enclosed dump shed and stored in four silos. Glycol is stored in a tank farm.

The primary esterifier (PE) is a closed, pressurized reactor that is operated at about 30-50 psig and 240-260°C (460-500°F). Terephthalic acid, a white powder, is mixed with glycol forming a paste which is fed into the PE vessel. TA emissions are controlled by a small bag filter on each line.

Vapors, primarily water (steam) and glycol, are vented to a reflux column. A heat exchanger cools the vapors. Recovered glycol is returned to the PE vessel. The glycol receiver vent to the atmosphere is inside the building and was observed during the process tour. Reportedly there are negligible VOC emissions from the vent. Only a slight odor could be detected right at the vent. The water vapor is condensed using 29°C (85°F) cooling water in a shell-and-tube condenser. The condensed water vapor is discharged to the water treatment plant, which when tested had a glycol concentration of less than 1 percent so that recovery would be uneconomic. The reactants remaining and monomer formed in the PE vessel are pumped to the secondary esterifier vessel.

The secondary esterifier (SE) vessel is operated at atmospheric pressure and at temperatures of about 250-270°C (480-520°F). The vapors, primarily water vapor, from the SE vessel are vented to a spray condenser. The spray condenser is vented to the atmosphere using a 3-in. pipe equipped with a flame arrestor. The water is cooled by cooling water in a shell-and-tube heat exchanger and recycled. Small amounts of grayish-white vapors, presumably with a high steam content, were observed being emitted from the receivers.

One difference between the staple and the filament SE vessels is the manhole (or rotary valve on some lines) present on the staple SE vessels. Chips and reworked yarn pellets can be recycled into the staple process through this manhole. Water vapor and monomer were emitted from the manholes; monomer sublimates on the piping near the manhole. The manhole is not present on the filament SE vessels.

Monomer from the SE vessel is pumped to the low polymerizer (LP) vessel. The LP vessel is operated under a vacuum created by steam jet ejectors. The normal vessel operating conditions are 20 to 40 torr and 270-290°C (520-550°F) for staple PET and 10 to 20 torr and 280-300°C (540-570°F) for industrial filament PET. The difference in conditions produces a longer molecule with greater intrinsic viscosity and tenacity for industrial fiber.

Polymerization occurs in the LP vessel. Glycol released in the polymerization process and excess or unreacted glycol are drawn into a contact spray condenser (glycol spray). The glycol emissions from the LP stage are the greatest for any stage of the process. The low and high polymerizer (LP & HP) spray condensers each have four spray nozzles with rods to clear blockage by solidified polymer at 90° intervals. Care is taken to ensure that the spray pattern and flow are maintained. A two stage ejector with barometric intercondenser is used to evacuate the LP vessel. Recovered glycol is pumped to a central glycol recovery unit (a distillation column). The ejector discharges to the hot well for the ejector cooling water system.

The ejector cooling water was tested between 5 and 8 years ago for glycol content. At that time an effort was being made to reduce glycol losses and the cooling tower was suspected of being a possible glycol recovery source. Analysis of the cooling water indicated a very low glycol concentration (as recollected, 0.1-0.2 percent, but definitely less than 1 percent). Mr. Perry was asked during the plant visit to submit the cooling water glycol analysis results to EPA. Due to the recovery value of glycol and problems with glycol serving as a nutrient for algae in the cooling tower, extensive efforts are made to minimize any glycol build up in the cooling water system.

The polymer from the LP vessel is pumped to the adjacent high polymerizer (HP) vessel, a horizontal vessel. The HP vessel is operated at a low absolute pressure (high vacuum), around 0.1 to 1.0 torr and about 290-300°C (550-570°F). In the HP vessel the short polymer chains formed in the LP are lengthened. Vapors including glycol evolved in the HP vessel are drawn through a glycol spray condenser. Recovered glycol is collected in a receiver and pumped to the central glycol recovery (distillation) unit. Chilled water between -3.9 and 1.7°C (25-35°F) is used on the heat exchanger associated with the HP spray condenser.

Vapors from the spray condenser, which reportedly contain a negligible amount of glycol, are drawn through a five-stage steam jet ejector system. Glycol would foul the ejectors if carried into the ejector system. After the first three ejectors there is a barometric intercondenser. Another barometric intercondenser is located between the fourth and fifth ejectors. The ejectors discharge to the cooling water hot well.

As an alternative to the last two ejector stages, vacuum pumps were installed that can be used in place of the last two ejectors when necessary. The vacuum pumps were installed as part of an energy conservation program and are used at the operator's discretion. The vacuum pumps are operated about 50 percent of the time. The vacuum system was designed for a maximum vapor load of about 20 lb/hr. If the vacuum is lost or is insufficient in the HP or LP vessels, off-specification product results. Each of the process lines has a dual vacuum system. One five-stage ejector/vacuum pump system is maintained as a standby for each industrial filament process line. The staple lines have a standby ejector system but have only one vacuum pump per process line. Steam ejectors reportedly recover faster from a slug of liquid carryover than do vacuum pumps; however, the spare system is used in either case.

The determinants of intrinsic viscosity are the HP operating conditions of (1) vacuum level, (2) temperature, (3) residence time, and (4) agitation (mechanical design). It was stated that the vacuum could not be lowered enough from normal requirements to alone achieve industrial filament specifications.

The PET product from the HP vessel is pumped at high pressure through an extruder spinerette forming polyester filaments. The filaments are air cooled and then either cut into staple or wound on spools. Product can also be pumped out to form blocks as it cools and solidifies. The blocks are then cut into chips, which are remelted at other locations for end-product fabrication.

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Miscellaneous

The Palmetto Plant is newer and uses the TPA process.

The Shelby Plant is an old plant using the DMT process.

Fiber Industries is owned 62.5 percent by American Celanese and 37.5 percent by I.C.I. Fiber Industries is operated as a part of American

Celanese, which provides marketing services. Fiber Industries was formed in the 1960's when DuPont's exclusive U.S. rights to the I.C.I. original PET process (DMT) expired. Fiber Industries is now technologically self-supporting.

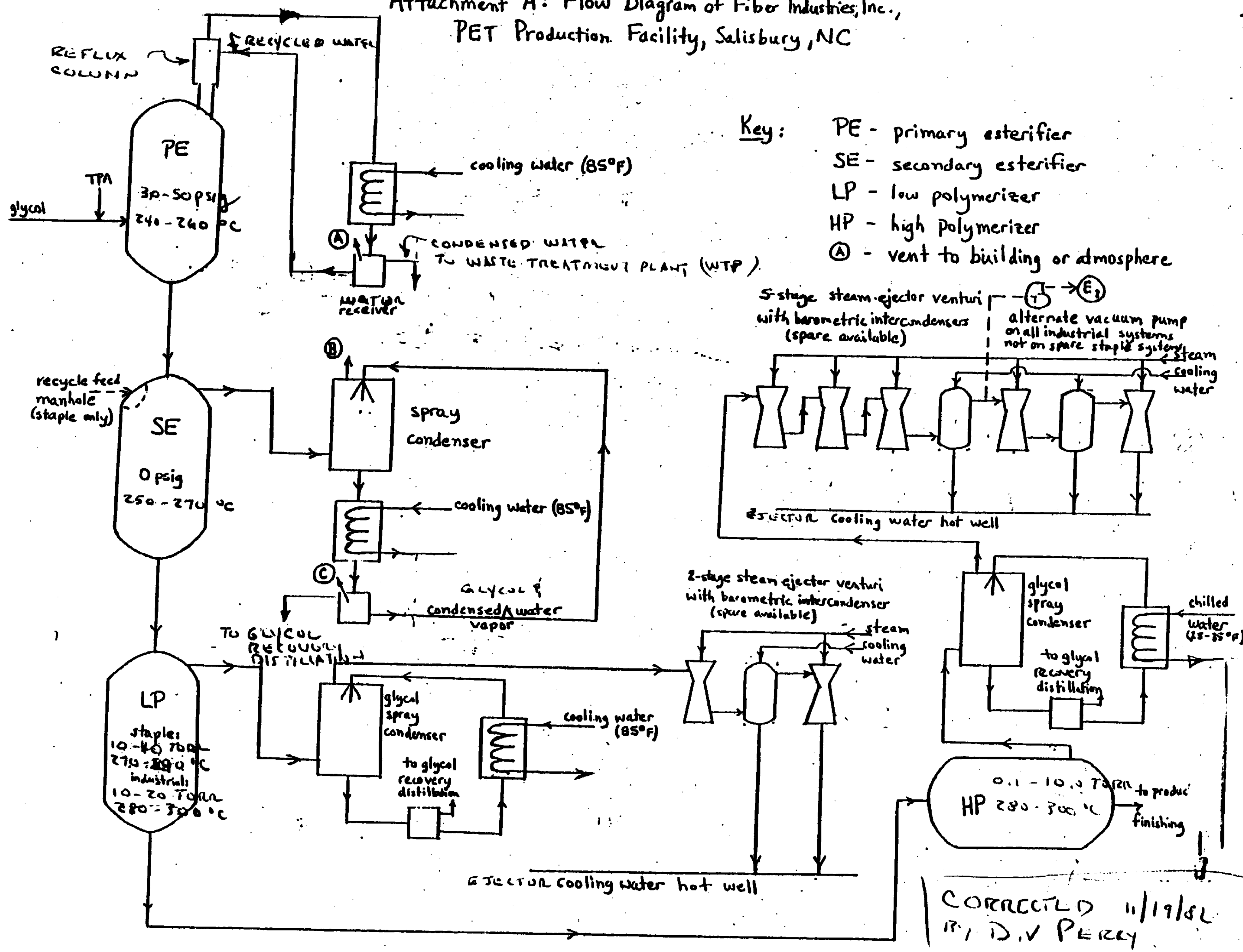
Fiber Industries will submit:

(1) results of the coolng water analysis;

(2) vacuum pump engineering analysis; and

(3) finalized, approved flow sheet indicating all recycle, recovery and disposal streams, etc.

Attachment A: Flow Diagram of Fiber Industries, Inc., PET Production Facility, Salisbury, NC



CORRECTED 11/19/86 BY D.V PERRY