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PET  
AP-42  
Section 5.13.2  
Reference Number  
12

■■■■■  
FIBER INDUSTRIES, INC.

DVP:58:82

November 22, 1982

Kenneth Meardon  
Pacific Environmental Services, Inc.  
1905 Chapel Hill Road  
Durham, North Carolina 27707

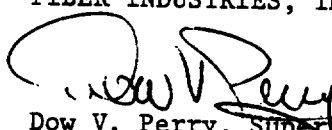
SUBJECT: CLEAN AIR ACT - POLYMER MANUFACTURING PERFORMANCE STANDARDS

Dear Mr. Meardon:

In response to your plant visit of September 29, 1982, I have reviewed the draft of Mr. Edwin Vincent's trip report. As requested, I have noted corrections and have identified all confidential information. All information in the report relative to total plant production capacity, capacity per process line, number of process lines and number of process lines per product type is confidential. In addition, information requested on page 5 of his report is attached. Composition of air emissions and liquid waste streams is taken, where available, from tests used for process control. Please contact me if you need additional information.

Sincerely,

FIBER INDUSTRIES, INC.



Dow V. Perry, Superintendent  
Environmental, Health & Safety Affairs

DVP:bb

Attachments

- #1 Response to EPA trip report
- #2 Response to "Request for Information"  
Enclosure 1, EPA letter dated Sept. 20, 1982
- #3 Corrected copy of E. Vincent's trip report
- #4 Process Flow Drawing SKK-S-1378

cc: H. C. Weaver - FII - w/o Attachments  
E. J. Vincent - EPA - w/o Attachments  
J. R. Dunkley - FII - w/o Attachments

ATTACHMENT #1

1. VACUUM EJECTOR COOLING WATER GLYCOL CONTENT

The average glycol content during September, 1982 was 0.32%. One sample per 8 hour shift was obtained and analyzed using the sodium thiosulfate titration method. A total of 90 samples were tested.

2. VACUUM PUMP INSTALLATION

A review of Fiber Industries files shows the following significant information:

- a. The incentive to replace steam vacuum ejectors with vacuum pumps was an economic one. There was an energy conservation cost reduction based on reduced steam usage.
- b. The decision to use a hybrid vacuum system (i.e., steam ejectors and vacuum pumps in series) was based on the belief that the steam ejector barometric intercondensor would be necessary to prevent solids carryover from the process into the vacuum pump.

POLYMERS & RESINS PROCESSING  
REQUEST FOR INFORMATION

A. General Information

1. Polyester Terephthalate
2. Fiber Industries, Inc. Salisbury, NC Plant
3. Dow V. Perry, Superintendent  
Environmental Health and Safety Affairs  
Fiber Industries, Inc.  
P. O. Box 4  
Salisbury, NC 28144
4. November 19, 1982

B. Overall Process Information

1. ( ~~CLAIMED CONFIDENTIAL~~: CAPACITY ) - no seasonal variation
2. Polyester man made fiber for industrial and textile end use
3. See attached drawing SKK-S-1378 and EPA's Mr. E. J. Vincent trip report dated October 19, 1982
4. None

C. Polymerization Process

1. See drawing SKK-S-1378 attached
2. See drawing SKK-S-1378 attached
3. See drawing SKK-S-1378 attached
4. Laboratory tests
5. Manual sample procurement from open vessels using standard titration analytical procedures for glycol

D. Materials Recovery/Separation Process

1. Recovery of glycol evolved from process is by standard design glycol distillation column
2. N/A
3. N/A
4. N/A
5. N/A

E. Engineering Description of Control Devices

N/A

11/19/82  
Dow V. Perry

ENCLOSURE 1

POLYMERS AND RESINS PROCESSING

REQUEST FOR INFORMATION

A. GENERAL INFORMATION

1. Polymer name and type.
2. Company's name, location of the plant.
3. Person EPA should contact regarding information supplied in this "Request for Information", including mailing address and telephone number.
4. Date "Request for Information" completed.

B. OVERALL PROCESS INFORMATION

1. Process capacity (not production rate), state seasonal variation if any.
2. Process name and type.
3. Overall process block diagram with emission points, control devices, and brief description of the process.
4. Number of pumps, compressors and valves which handle volatile organic compounds (VOC).

C. POLYMERIZATION PROCESS

1. Polymerization section process flow sheet with emission points shown. (For example; polymerization reactor, seal oil compressor, vent gas compressor, and any other polymerization unit operations.)
2. Emissions (composition and flow) from the polymerization section (from the emission points shown in C.1). Please specify temperature and pressure of the streams. If exact composition of the stream is not known please give representative molecular weight. Volatile organic compounds (VOC) should be described as fully as possible.
3. Describe composition variation if any.
4. Method used to determine composition and flow, state accuracy level.
5. Sample procedure, ease of sampling, analytical procedure if any.

D. MATERIALS RECOVERY/SEPARATION PROCESS

1. Materials recovery/separation process flow sheet with emission points shown. (For example; process deactivation/decanting, diluent recovery, solvent recovery, polymer drying, catalyst drying, devolatizing and other similar unit operations.)
2. Emissions (composition and flow) from the material recovery/separation section. (From the emission points shown in D.1.) Please specify temperature and pressure of the streams. If exact composition of the stream is not known please give representative molecular weight. Volatile organic compounds (VOC) should be described as fully as possible.

3. Describe composition variation if any.
4. Method used to determine composition and flow, state accuracy level.
5. Sample procedure, ease of sampling, analytical procedure if any.

E. ENGINEERING DESCRIPTION OF CONTROL DEVICES SPECIFIED IN B.3

Please include sketches, dimensions, operating conditions, and capital and operating costs of the control devices.

PROCESS FLOW  
for  
CONTINUOUS POLYMERISATION  
  
SHOWING  
EMISSION SOURCES  
  
and  
RECOVERY STREAMS

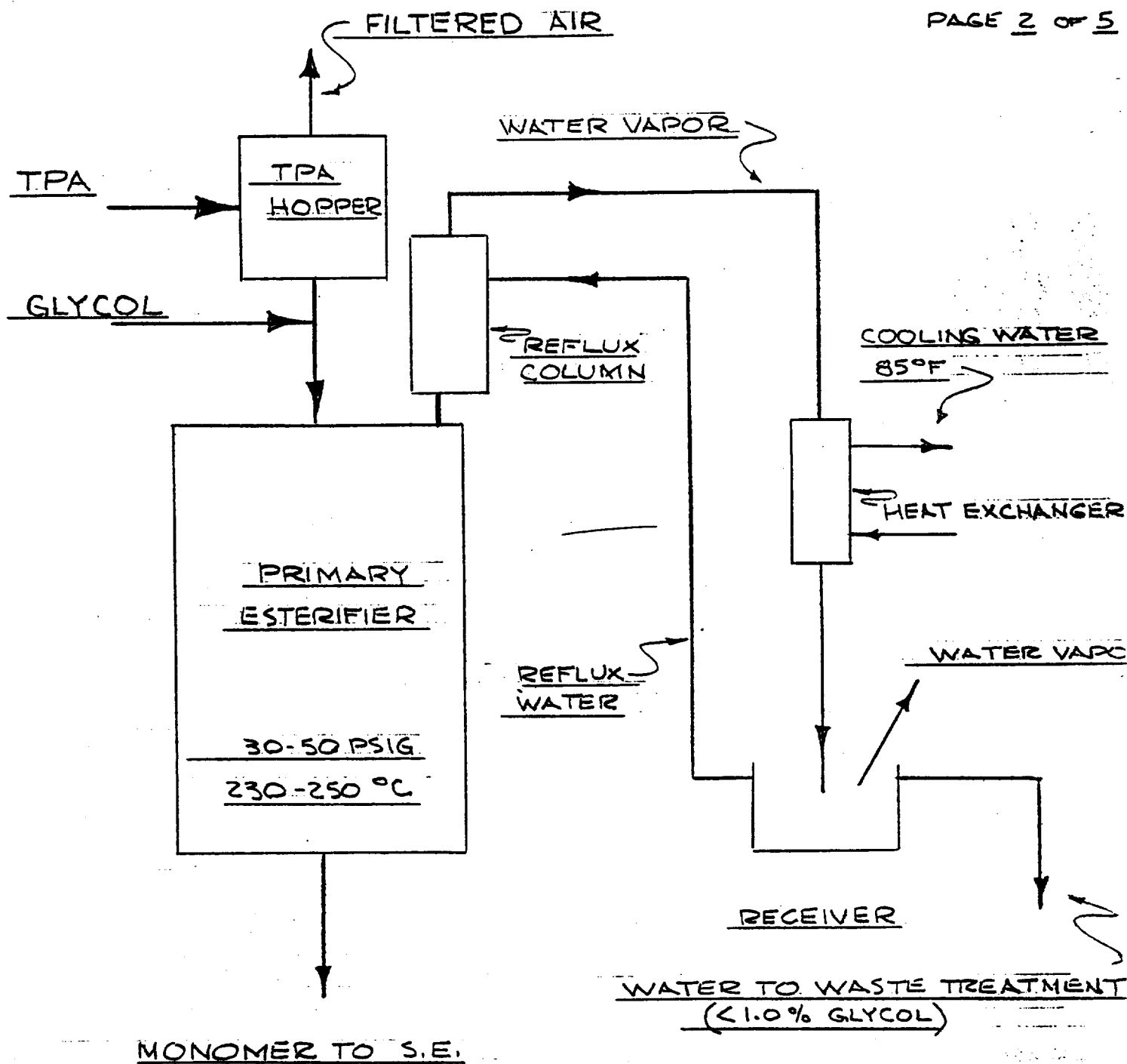
FIBER INDUSTRIES INC.

SALISBURY  
NORTH CAROLINA

PROJECT ENGINEERING

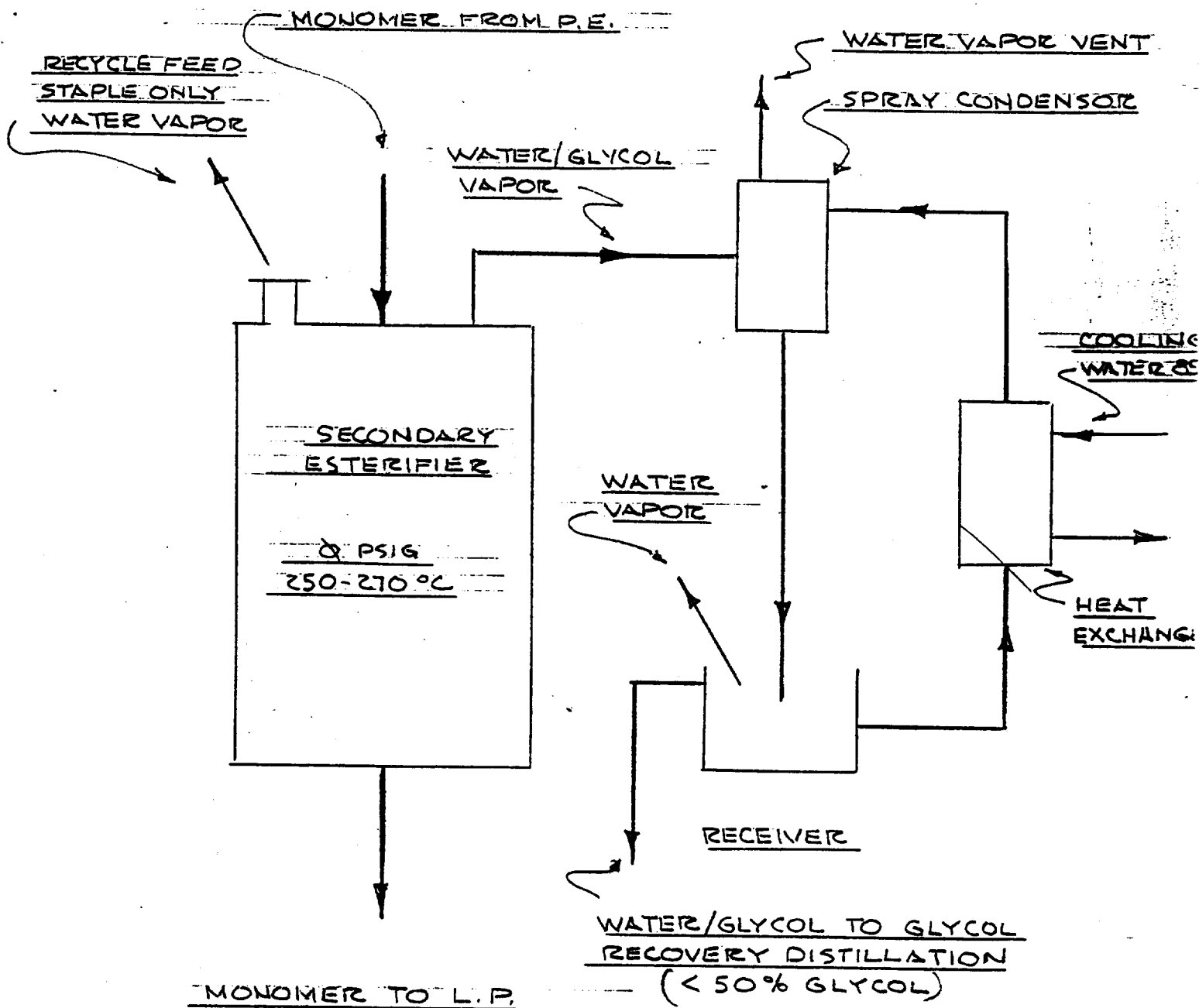
DRAWN BY: DOW V. PERRY

DATE: 11/19/82 SKETCH NO. SKK-S-1378



PRIMARY ESTERIFIER

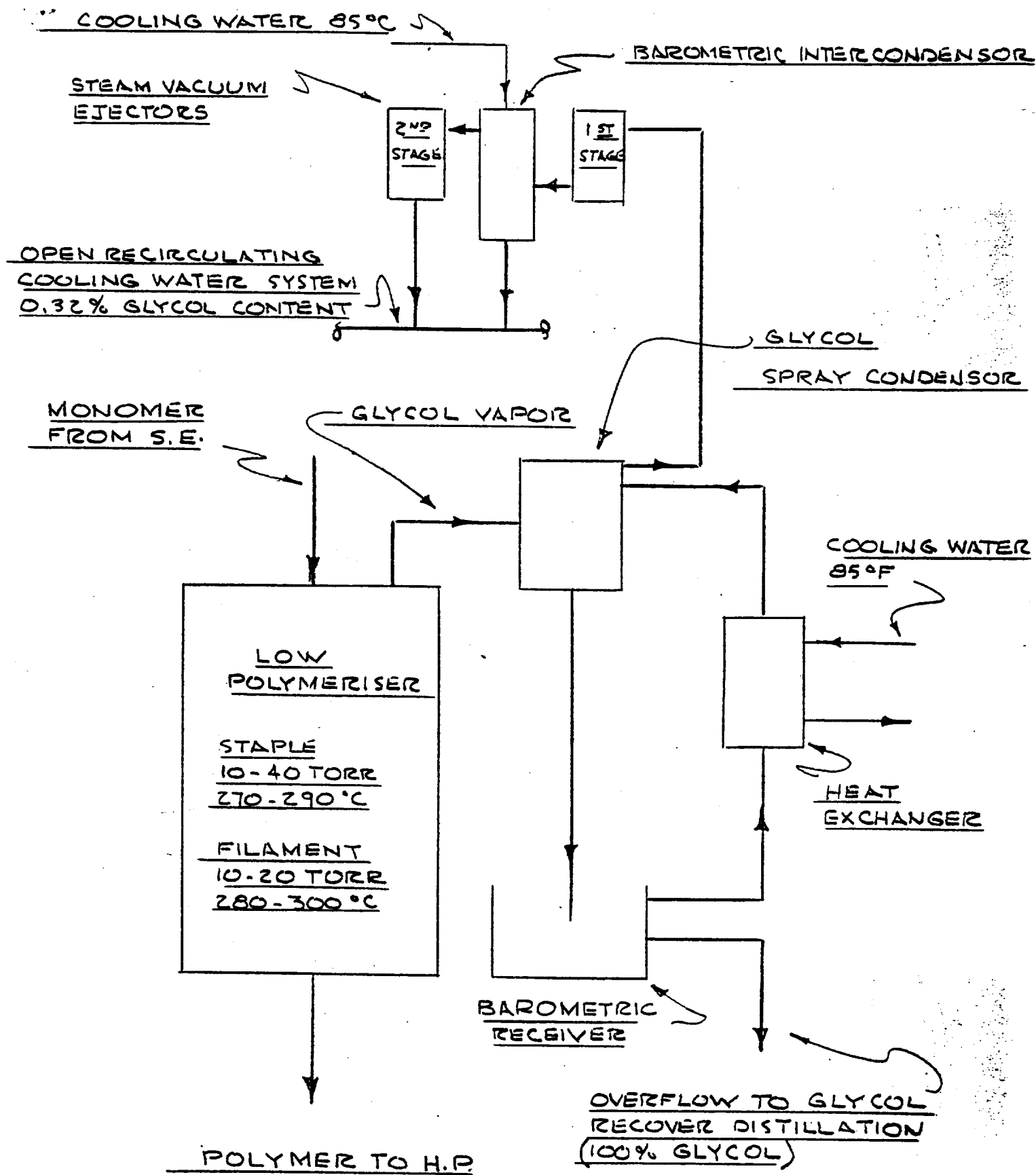
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 DATE: 11/19/82  
 DRN BY: D.V. PERRY



## SECONDARY ESTERIFIER

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DRN BY:	D.V. PERRY
PAGE	3 of 5

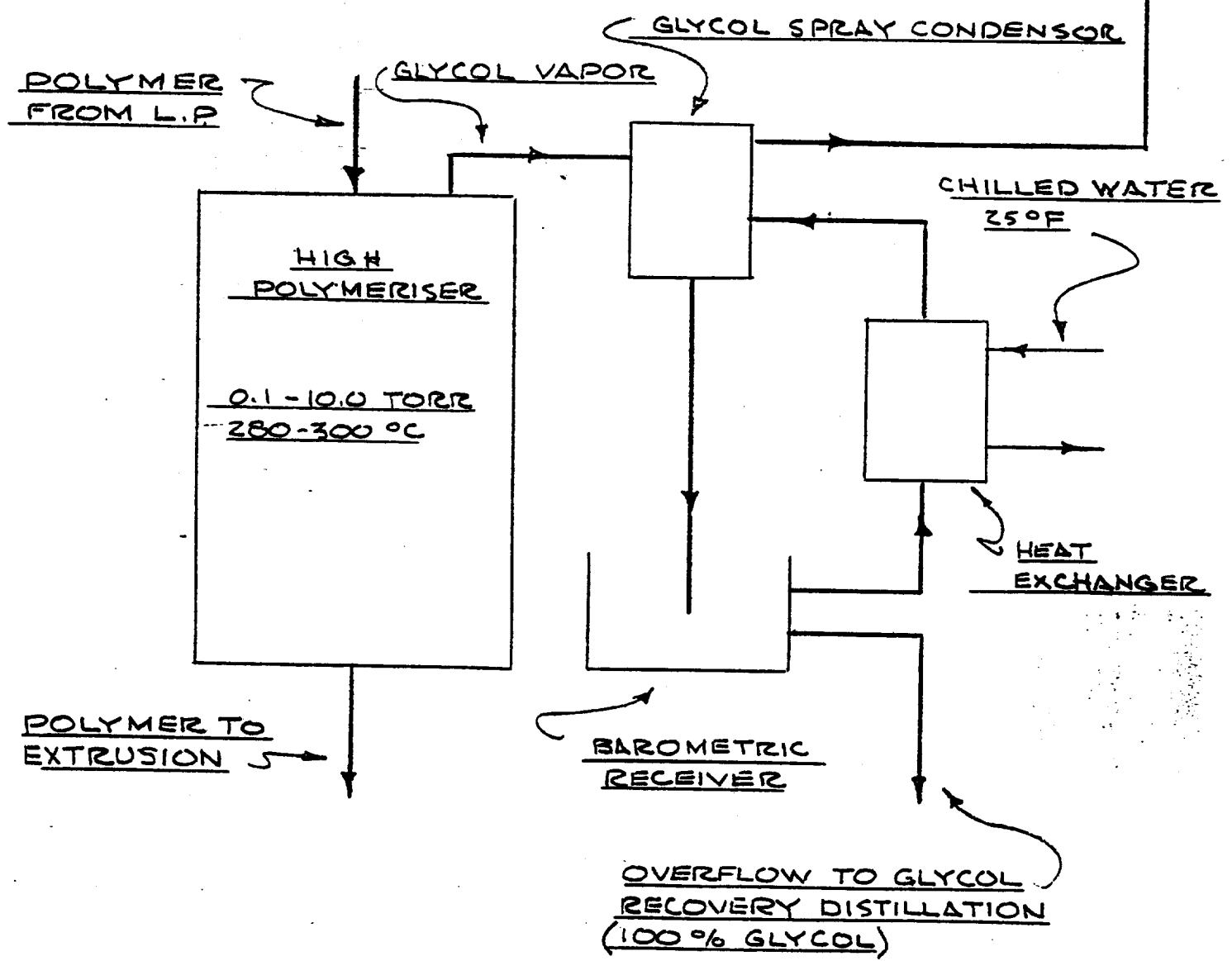
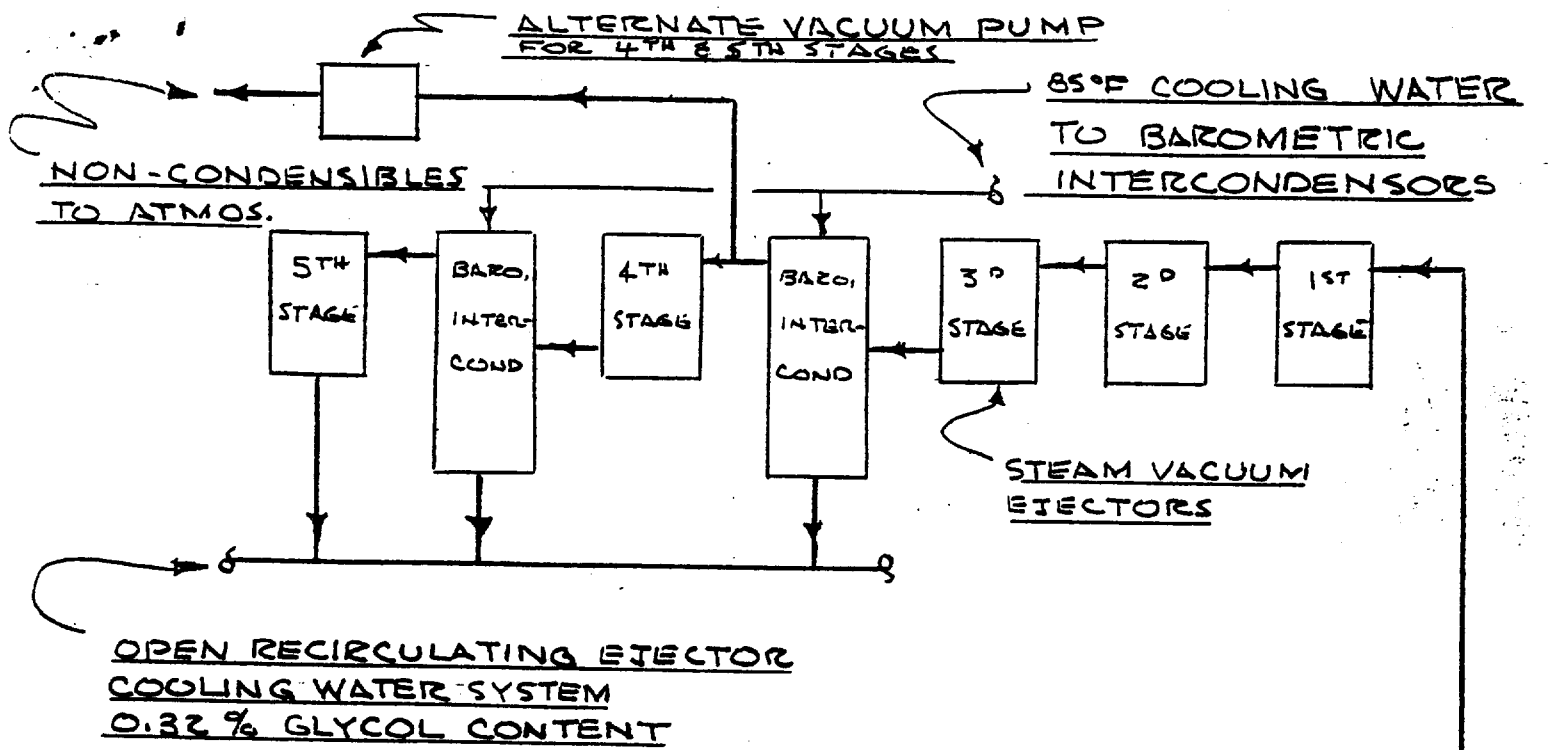




LOW POLYMERISER

PAGE 4 OF 5

DWG: SKK-S-1378  
 DATE: 11/19/82  
 DRN BY: D.V. PERRY



HIGH POLYMERISER

**DRAFT**

OCT 8 1982

REPORT OF PLANT VISIT TO  
FIBER INDUSTRIES, INC.Polyester Plant  
Salisbury, North Carolina

CORRECTED

11/19/82

B. D. V. PERRY

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 Leader

GROUP

## 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 ~~staple~~ PET production. It was pointed out by Mr. Perry that to his knowledge the DMT process ~~can be accomplished only as a batch process and, thus,~~ 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.

\* CONFIDENTIAL 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). ~~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.

~~30-50 psig~~ ~~240-260 °C~~  
The primary esterifier (PE) is a closed, pressurized reactor that is operated at about ~~40~~ psig and ~~250°C~~ (482°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.

COLUMN Vapors, primarily water (steam) and glycol, are vented to a reflux ~~condenser~~. 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 ~~cooling water system~~, 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.

WASTE TREATMENT PLANT

250 - 270°C

The secondary esterifier (SE) vessel is operated at atmospheric pressure and a temperature of about 250°C (500°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 25 to 35 torr and 275 to 280°C (527 to 536°F) for staple PET and 10 to 15 torr and 285 to 290°C (545 to 554°F) for industrial filament PET. The difference in conditions produces a longer molecule with greater intrinsic viscosity and tenacity for industrial fiber.

270 - 290°C

280 - 300°C

20 - 40

10 - 20

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 cooling water system.

EJECTOR

EJECTOR

The 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 295 to 300°C (563 to 512°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

290 - 300°C

recovery (distillation) unit. Chilled water between  $-3.9$  and  $1.7^{\circ}\text{C}$  ( $25$ - $35^{\circ}\text{F}$ ) 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 operators discretion. The vacuum pumps are operated about 50 percent of the time. The vacuum system was designed for a maximum vapor load of 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 spinnerette 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.

## CLAIMED CONFIDENTIAL

### Miscellaneous

The Palmetto Plant is newer and uses the TPA process.

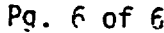
The Shelby Plant is an old plant using the DMT process.

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 cooling water analysis;
- (2) vacuum pump engineering analysis; and
- (3) finalized, approved flow sheet indicating all recycle, recovery and disposal streams, etc.

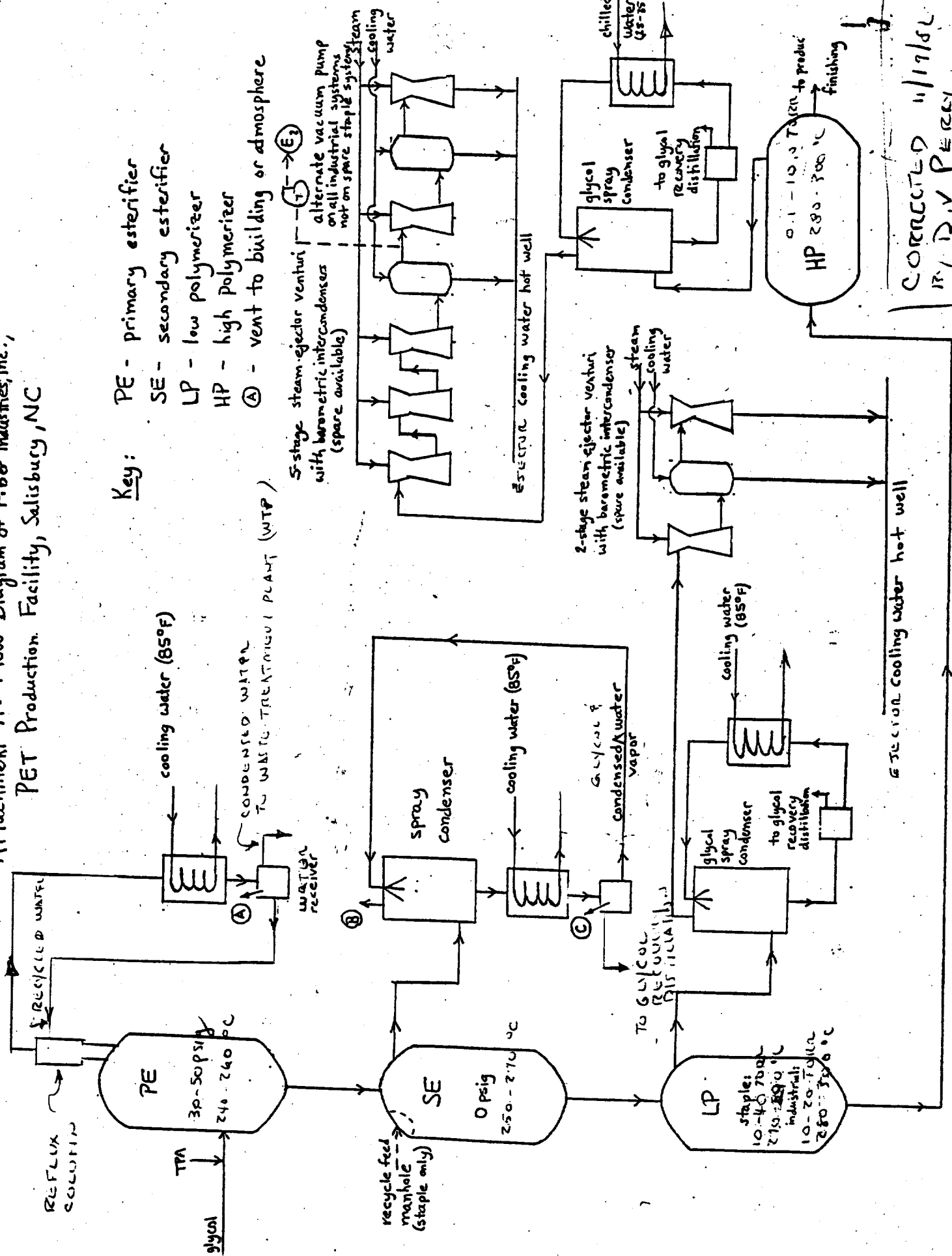


cooling water hot well



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

Key: PE - primary esterifier  
SE - secondary esterifier  
LP - low polymerizer  
HP - high polymerizer  
Ⓐ - vent to building or atmosphere



CORRECTED 11/17/82  
R. D. V. P. E. R. E. V.