PET
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Section 5.13.2
Reference Number
5

ESTABLISHING NEW SOURCE PERFORMANCE STANDARDS FOR AIR POLLUTANTS EMITTED FROM THE POLYMERS AND RESINS INDUSTRY

TRIP REPORT FOR TENNESSEE EASTMAN COMPANY

Prepared for:

OFFICE OF AIR QUALITY PLANNING AND STANDARDS
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NORTH CAROLINA

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1. PURPOSE OF PLANT VISIT

To gain a better understanding of the processes, pollutants and control techniques found in the polymers and resins industry and to observe actual plant operations, a series of plant visits have been planned and organized. These visits are an essential component in compiling information used to write a background information document (BID), which will be used to develop new source performance standards (NSPS) for this industry. This information, along with analogous information from other companies, will be used to assess the significance of emissions from the polymers and resins industry, to define the current status of emission control, and to assess the environmental, energy, and economic impacts associated with installation and operation of feasible emission control techniques.

The information will also be used for a preparation of a control techniques guideline (CTG) document for the industry. This document is intended to aid the States in the preparation of their State implementation plans (SIP's) in 1982 for compliance with the national ambient air quality standard (NAAQS) for ozone (O_3). As part of this study, 11 polymers facilities are being visited by Energy and Environmental Analysis, Inc. (EEA), personnel. The Tennessee Eastman Company operation was one of the facilities selected.

2. PLANT LOCATION AND PARTICIPANTS

2.1 PLACE AND DATE

On October 2, 1980, EEA representatives visited Tennessee Eastman Company's polyester resin plant at the following location:

Tennessee Eastman Company
Post Office Box 511
Kingsport, Tennessee 37662
Telephone: (615) 246-2111

2.2 ATTENDEES

The following personnel participated in the meeting and plant tour during EEA's visit to Tennessee Eastman:

- Rhonda Carpenter,
  Tennessee Eastman Company
- Robert Coleman,
  EEA
- R.A. Cooper,
  Tennessee Eastman Company
- M.D. Eckart,
  Tennessee Eastman Company
- W.J. Litz,
  Tennessee Eastman Company
- Asdakorn Limpiti,
  EEA
- C.E. Swanson,
  Tennessee Eastman Company
- D.R. Stokely,
  Tennessee Eastman Company
- J.D. Thomas,
  Tennessee Eastman Company
- C.M. Vandergriff,
  Tennessee Eastman Company

3. DISCUSSION OF PLANT VISIT

3.1 PROCESS DESCRIPTION

Tennessee Eastman Company (TEC) produces polyester resin (polyethylene terephthalate, PET) from ethylene glycol (EG), and dimethyl terephthalate (DMT). The process in which DMT is used as raw material is called "DMT process". TEC has captive raw material DMT; thus the company produces PET resins by the DMT process.

The continuous DMT process viewed during the plant visit can be separated into the following sections: (1) raw materials, intermediate product methanol, and spent EG storage; (2) ester exchange, (3) polymerization reactors; (4) alcohol recovery; and (5) EG recovery. DMT, EG and catalyst are fed to the esterifier (ester exchange reactor) where the first reaction step takes place at an elevated temperature between 170°C (338°F) to 230°C (446°F) at above atmospheric pressure to produce the intermediate bis-(2-hydroxyethyl)-terephthalate (BHET) monomer, and methanol. The methanol vapor must be removed to shift the conversion to produce more BHET. The vent from the ester exchange (mostly methanol vapor) is fed to methanol column where methanol is separated by distillation, condensed, and sent to methanol storage. Vapor from the top of methanol column is sent to a cold water (river water 15-20°C (59-68°F)) condenser which is a simple u-tube heat exchanger where condensate returns to the methanol column and noncondensables are purged with nitrogen before being emitted to the atmosphere (B). The bottom product of methanol column (mostly EG) from the column's reboiler is reused (see Attachment C).

The monomer BHET along with other products from the ester exchange reactor, is fed to prepolymerization reactor where the temperature is increased to about 285°C (545°F) and the pressure is reduced to an absolute pressure of 100-200 mm Hg. At these operating conditions methanol and EG are vaporized and the reaction resulting in the production of PET resin starts. Product from the prepolymerization is fed to a polymerization reactor where temperature is further increased to about 300°C (572°F); the pressure is reduced further to an absolute pressure of around 4-5 mm Hg.

The vapor EG, methanol, and other trace hydrocarbon from the prepolymerization reactor and polymerization reactor are scrubbed by spent EG. The EG is recirculated in the scrubber system. Part of the spent EG from the scrubber system is sent to store in process tanks. EG condensate from these process tanks is sent to EG recovery system (see Attachment D). EG recovery system (distillation system) consists of a low boiler column and a refining column. The EG condensate is fed to the low boiler column, top product is sent to a low boiler condenser where methanol is condensed and sent to methanol storage. The noncondensable vent is purged with nitrogen and sent to the atmosphere (C). The bottom product of the low boiler column goes to its reboiler, vapor is recycled back to column and the underflow goes to the refining column. The refining column is under vacuum. Top product from the refining column goes through a condenser. The condensate is collected in a reflux tank. Part of the condensate (EG) returns to the refining column. The remaining liquid goes to EG storage. The reflux tank is purged with nitrogen. The purge vent (D) to the atmosphere consists of only nitrogen. The bottom product of the refining column goes to a reboiler, vapor returns to the column, and the remaining is a sludge by-product.

The vacuum conditions in prepolymerization reactor and polymerization reactor are created by multi-stage steam jet ejector systems. Vent (A) from this system goes to atmosphere. The vents (A) to (D) mentioned are continuous.

3.2 VOC EMISSIONS

- Vent (A), from the vacuum jet ejector, is continuous to atmosphere through a barometric seal leg. The vent is at 25°C (77°F) and atmospheric pressure with the flowrate of 50 scfm. The stream consists of 220 lb/hr nitrogen and 0.0091 lb/hr methanol.

- Vent (B), from the methanol column condenser, emits relatively high VOC concentration stream (48.5 weight percent methanol, with nitrogen) to the atmosphere at a very low volumetric flowrate of 1.2 scfm. The vent has a relief valve with a low-pressure setting. The vent is practically continuous and mass flowrate of methanol is about 3.7 kg/hr (8.2 lb/hr).

- Vent (C) from the low boiler column condenser has a relief value pressure setting at 2" H_2O, practically is a continuous vent to the atmosphere. The vent has some VOC components (15.3 weight percent) with nitrogen. (VOC components are 2-Methyl-1,3-Dioxolane and methanol.) Some white deposit at the vent were observed.

- Vent (D), from the reflux tank, is open to the atmosphere without a relief valve. The vent consists of purge nitrogen.

3.3 VOC CONTROL

The only VOC control for this process is cold water condenser. The methanol recovery and EG recovery systems mainly exist because of economic reasons to recover methanol and EG. The EG recovery system apparently has a very high efficiency. VOC emission from the system is relatively low. There is no flare used in this process.

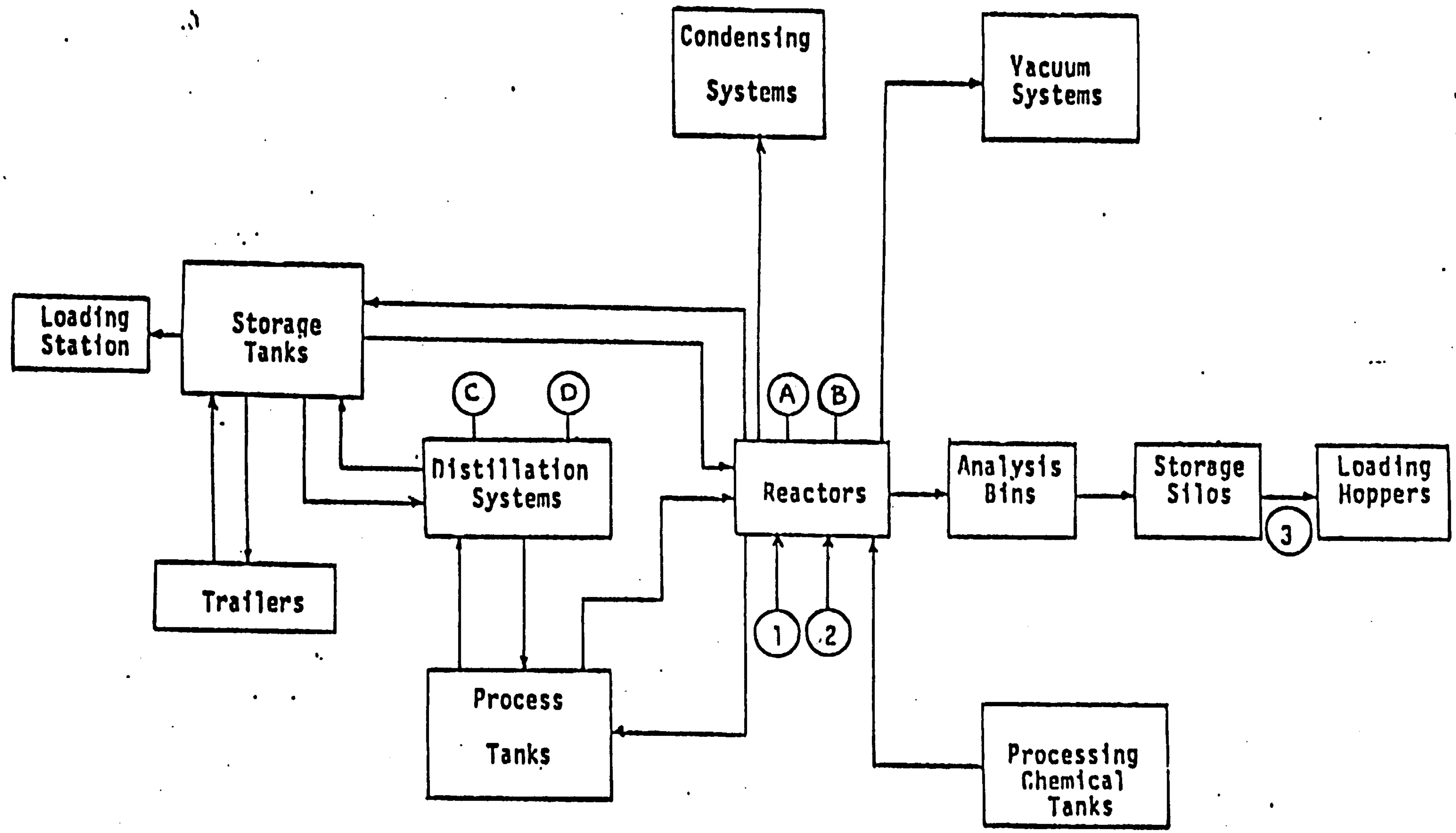
4. GENERAL COMMENTS

General housekeeping of the plant is excellent. Some odor is detected from the cooling tower resulting from the biological growth. Part of the water from the cooling tower is piped to a main water treatment plant.

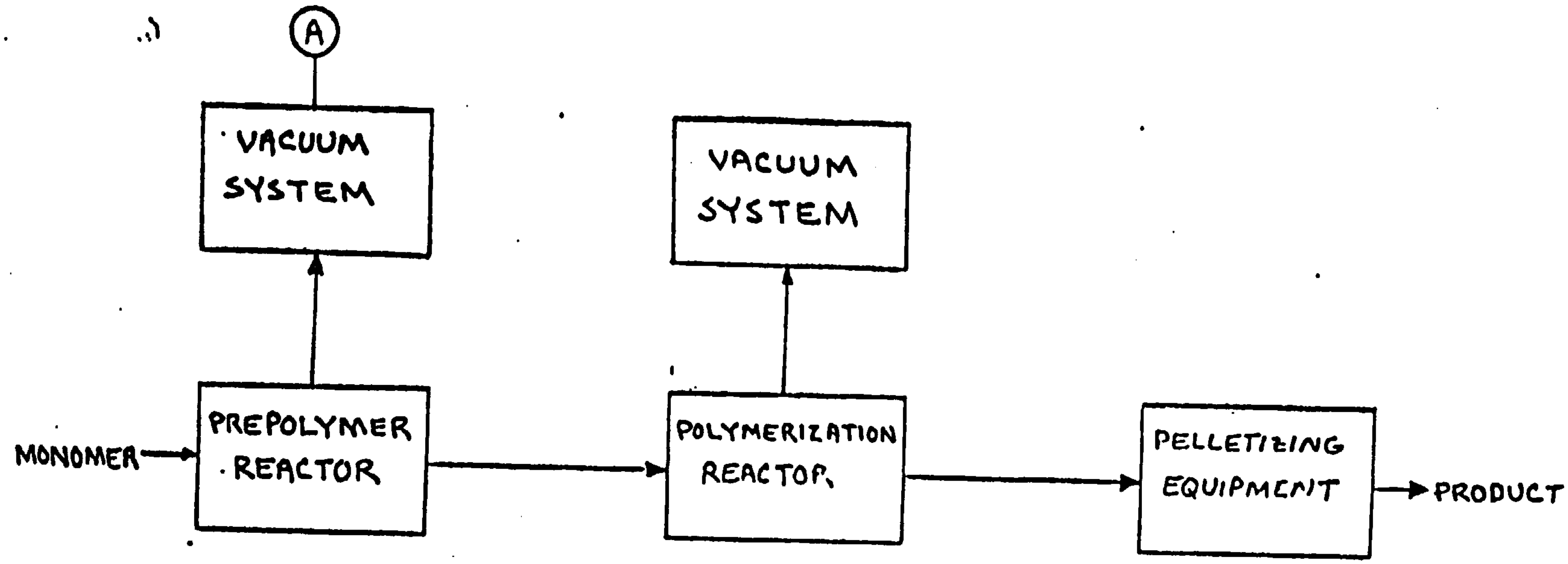
It was stated during the trip to TEC that future polyester plants in the Eastman Chemicals Division could be based on either the DMT process or the TPA process. However, a PET process using TPA is not now in production in the Eastman Chemicals Division.

ATTACHMENT A

OVERALL PROCESS BLOCK DIAGRAM



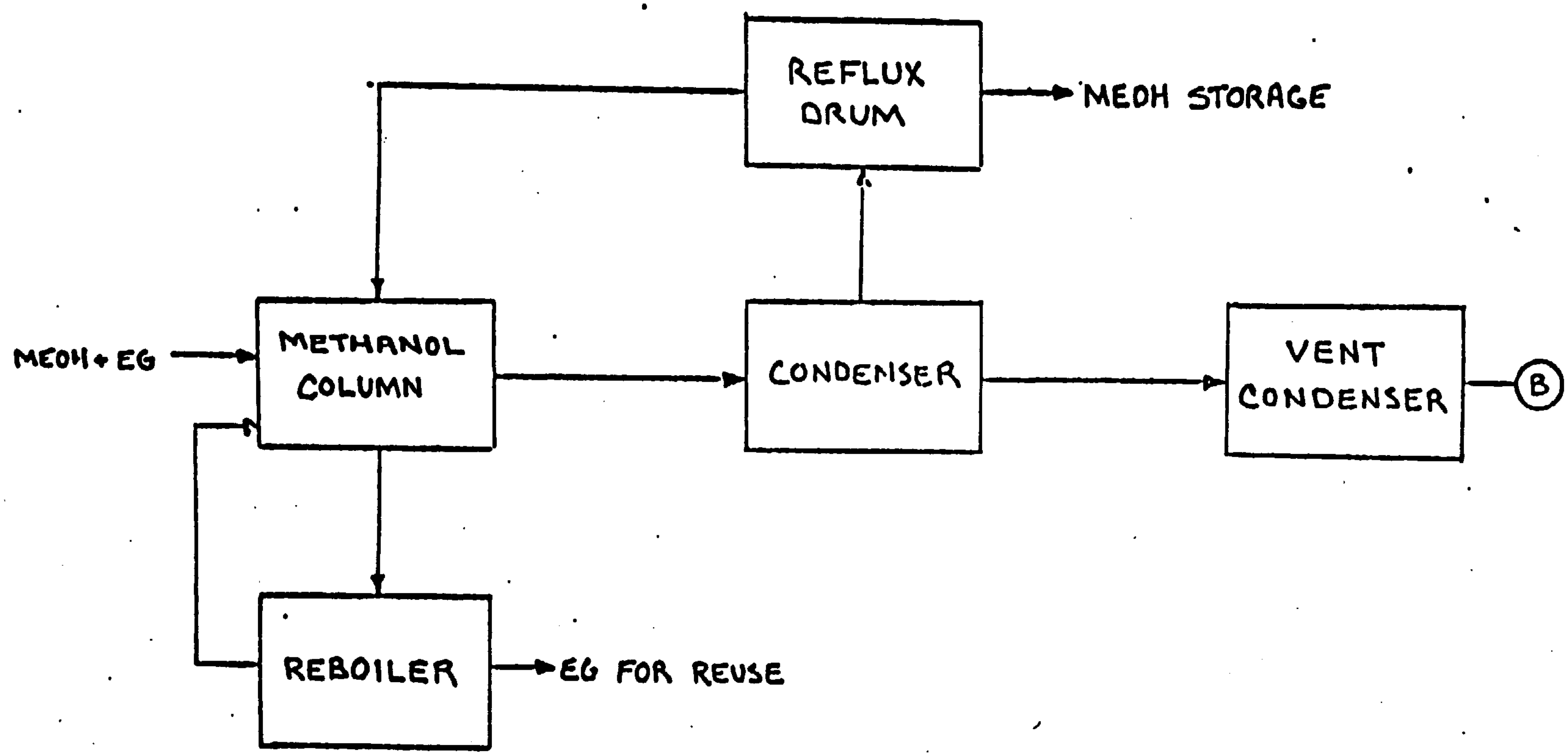
SOURCE: Tennessee Eastman Company



ATTACHMENT B

POLYMERIZATION REACTOR SECTION

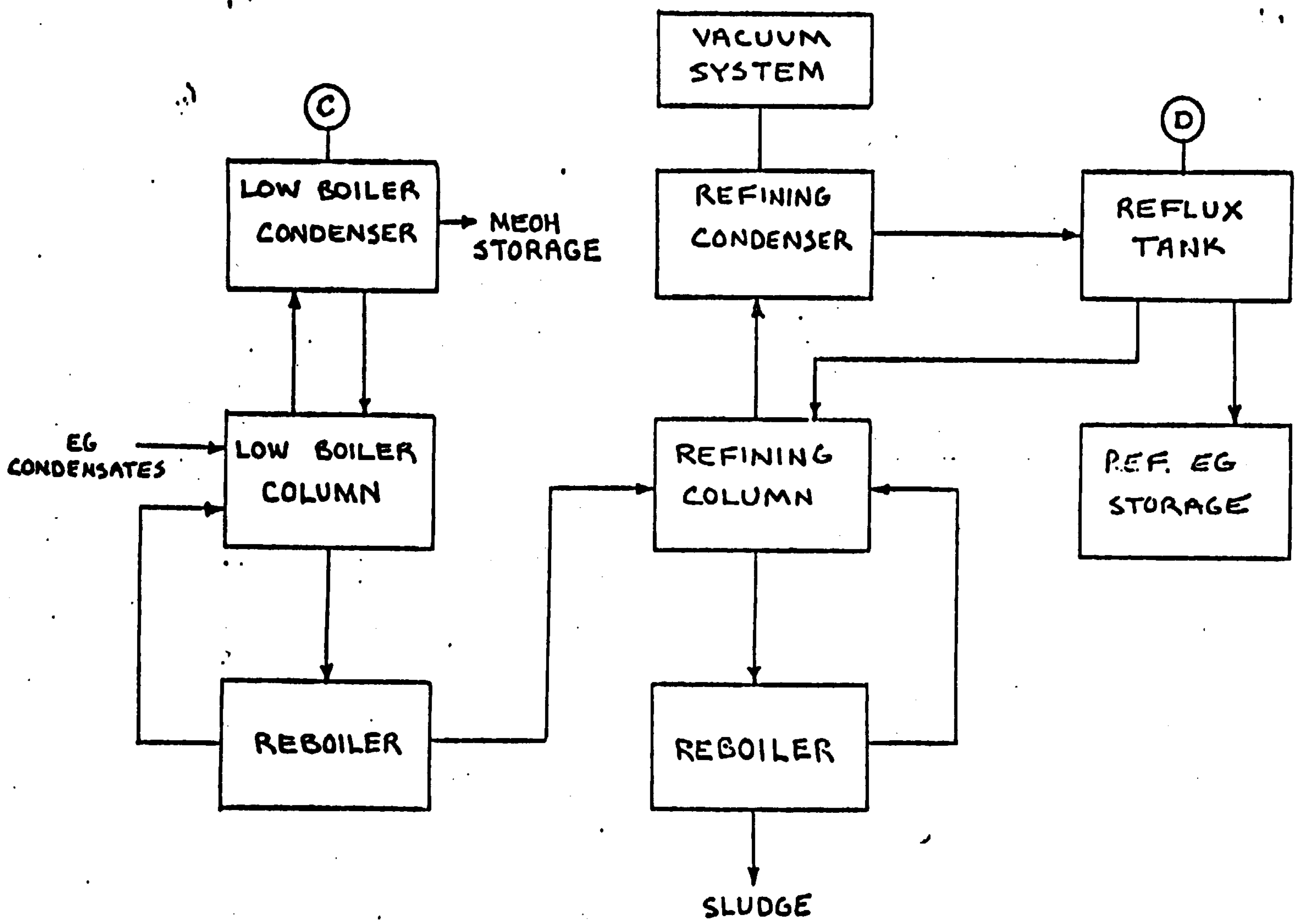
SOURCE: Tennessee Eastman Company



ATTACHMENT C

METHANOL RECOVERY

SOURCE: Tennessee Eastman Company



ATTACHMENT D

ETHYLENE GLYCOL RECOVERY