Commercial Scale PET Production Facility

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EASTMAN

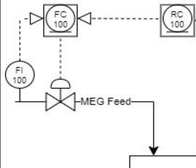
Objectives

- Design a plant capable of Producing 450,000 metric tons of polyethylene terephthalate (PET) per year starting from either dimethyl terephthalate (DMT) or terephthalic acid (TPA)
- Determine which starting reactant to use by evaluating environmental, economic, and other process considerations
- Provide a recommendation in favor of or against the building of the proposed plant

Motivation

- PET has multiple uses (synthetic fibers, food packaging, etc.)
- Bottle-grade PET was selected (IV = 0.78)
  - The global market is expected to continue growing through 2032 at an average of 9.5% annually

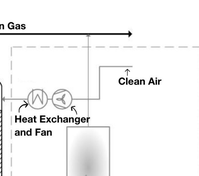
DMT vs TPA



TPA

- DMT produces methanol as a side product, TPA produces water
- $250/MT profit made using DMT, $540/MT profit made from using TPA
- Both can cause skin, eye, and respiratory irritation

→ TPA was selected



MEG

Safety & Environmental Analysis

Compound	Health Impacts
Terephthalic Acid	Low toxicity, skin, eye, and respiratory irritation
Polyethylene Terephthalate	Nonhazardous
Ethylene Glycol	Acute oral toxicity, skin, eye, and respiratory irritation; Hazardous Air Pollutant
Antimony Trioxide Catalyst	Carcinogenicity
Water	Nonhazardous
Acetaldehyde	Eye irritant, carcinogenic, acute aquatic hazard, respiratory toxicity; Hazardous Air Pollutant and Volatile Organic Compound

Focus Sections

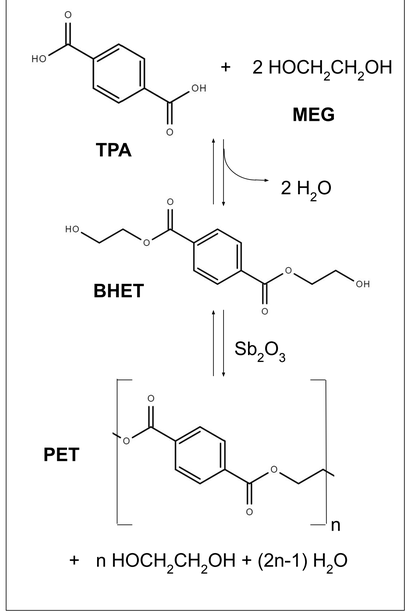
Process Controls

- Utilized a feedforward/ratio control system to regulate working volume

Environmental Design

- Implemented adsorption column to remove acetaldehyde using activated carbon

Chemistry



Process Description

M-101 Slurry Mixer

R-101 to 106 Esterification Reactors

R-107 to 109 Initial Polycondensation Reactors

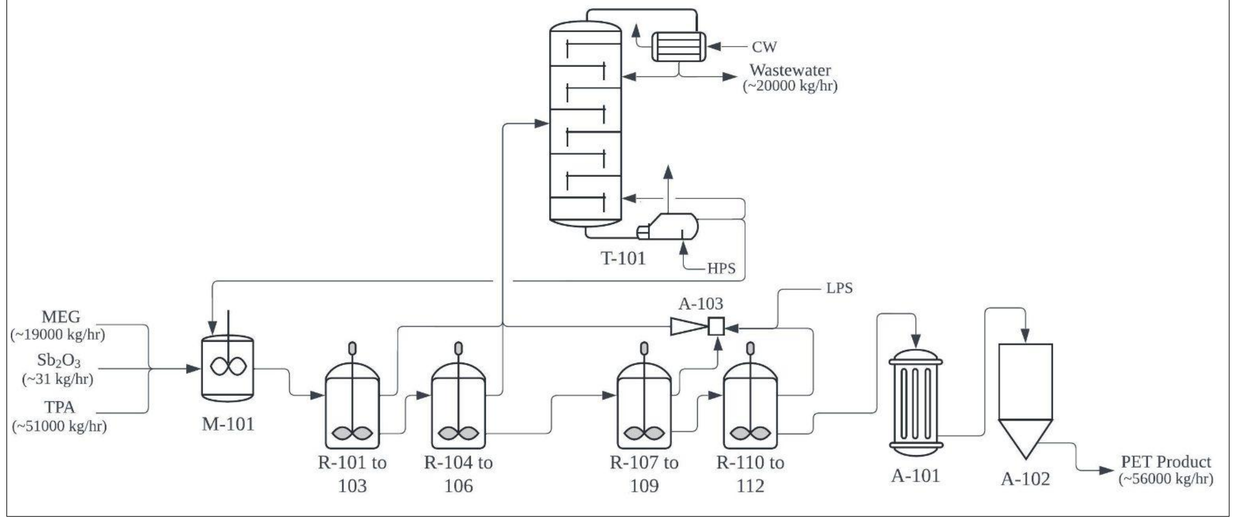
R-110 to 112 Finishing Polycondensation Reactors

A-101 Extruder, Cutter, Crystallizer

A-102 Rotary Dryer

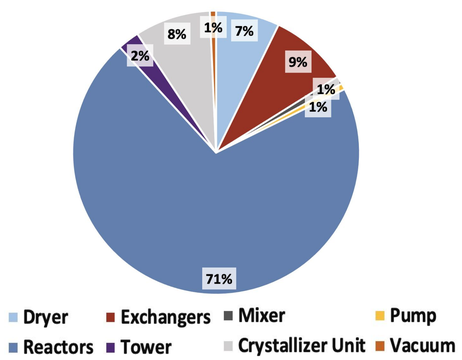
A-103 Steam Ejector Vacuum Unit

T-101 Tray Distillation Tower



Economic Analysis

Greenfield Cost Distribution By Equipment



Greenfield Cost: $228.2 million

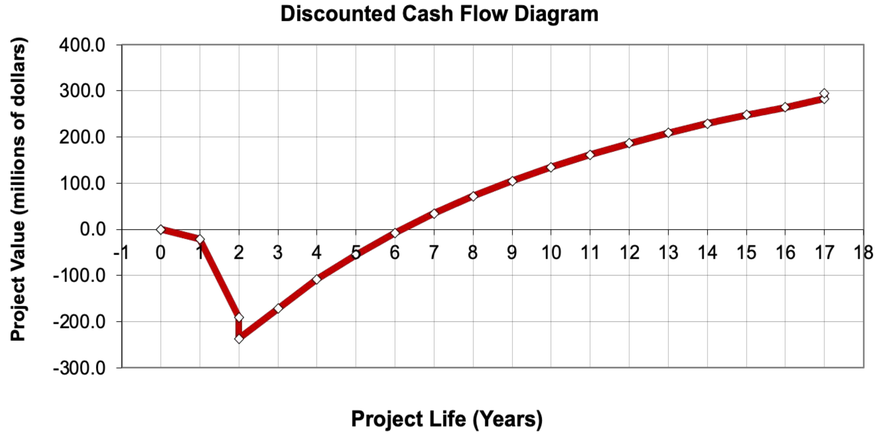
Discounted Profitability Criterion

NPV :	$294.4 million
DCFROR:	28.58%
Discounted Payback Period:	3.2 years

Non- Discounted Profitability Criterion

Cumulative Cash Position:	$998.1 million
RORO I:	29.16%
Payback Period:	2.6 years

Discounted Cash Flow Diagram



Stage	Specifications
Esterification (R-101 to R-106)	• Temperature Range : 250℃ - 260℃ • Pressure Range: 760 torr - 1965 torr • 15% excess MEG fed on a mass basis • 99 wt% conversion of TPA • ~190 minute residence time
Polycondensation (R-107 to R-112)	• Temperature Range: 280℃ - 290℃ • Pressure Range: 1 torr - 40 torr • Vacuum: Steam Jet Ejector • ~40 minute residence time
Crystallization (A-101)	• Temperature: 125.6℃ • 5 minute residence time
Distillation (T-101)	• Tops: ~99.7℃ and 99.5 wt% water • Bottoms: ~196.81℃ and 100 wt% MEG • 16 stages with 14 trays

Conclusions

- Since the DCFROR is 28.58% (> 15%) , Eastman Team 2 recommends moving forward with the build
- Moving forward, a recommendation to internally source raw materials will decrease sourcing costs

Acknowledgements

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References

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