NC STATE UNIVERSITY

EASTMAN

Design of a Commercial Scale PET Production Facility

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Motivation

Goal: Design a production facility capable of producing 450,000 metric tons of polyethylene terephthalate (PET) per year

Motivation

- Annual, global production of over 30 million tons of PET
- Large, global market including Asia, North America, and Europe

Background

PET End Uses:

- Food and Beverage Packaging
- Healthcare
- Fiber and Fabric Applications

The lack of an adequate recycle process, solidifies the PET market in the near future

Reactant Selection Matrix

	TPA	DMT
Cost	✓	✗
Safety	✓	✗
Environmental	✓	✗
Kinetics	✓	✗

Process Description

Esterification (260-270°C, 760-1520 torr):

- TPA and EG react to form low-weight oligomers

Polycondensation (270-290°C, 0.5-760 torr):

- Low-weight oligomers from esterification polymerize to form high-weight PET product

Vacuum System (EG seal fluid):

- Jets and LRVPs are used to generate low operating pressures of polycondensation reactions

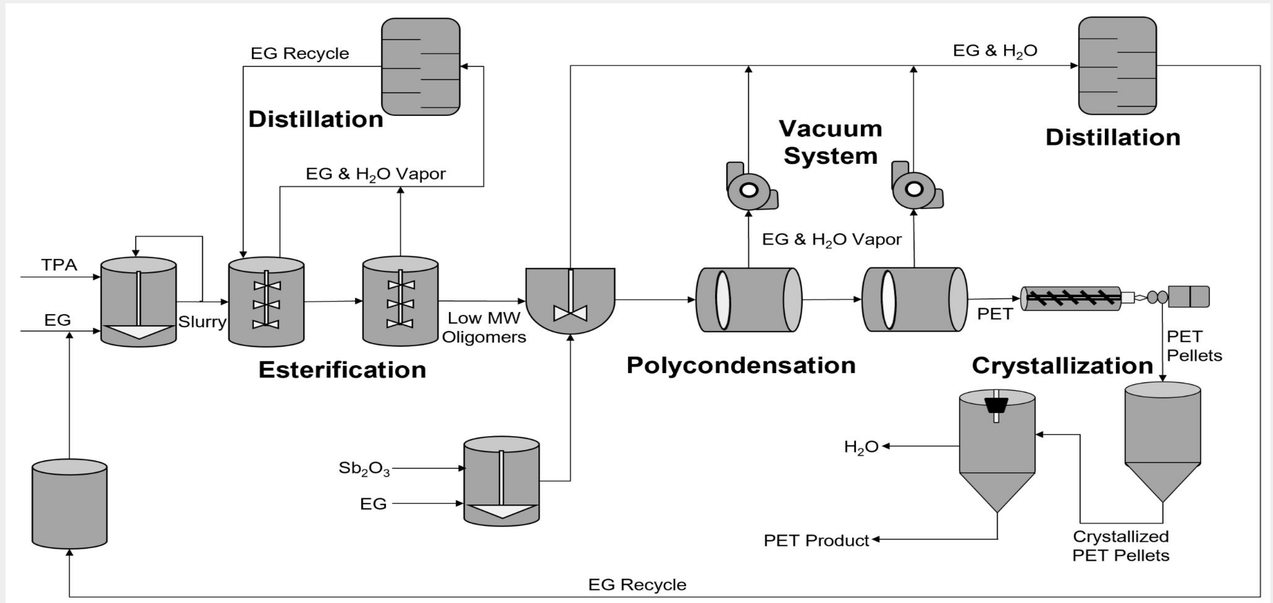
Distillation (trayed columns, 1 atm):

- Separation of EG and water vapors formed in reactors
- Purified EG is recycled back to the process

Crystallization (underwater pelletizer):

- Formation of crystallized pellets from amorphous PET
- Pellets used for end-use products

Process Flow Diagram



Safety Considerations

Antimony Trioxide:

- Prepare catalyst in batch to limit operator exposure

TPA Dust:

- Adequate ventilation and regular cleaning to reduce dust accumulation

Low-Pressure Vessels:

- Use of vacuum trapping, cold trapping, and/or vent traps to prevent vessel implosion

Water Treatment:

- Organic component removal in process water

Economics

Economic Investment for Plant Construction: $24,400,000

Revenue		$499,400,000/yr
Raw Materials	-	$464,000,000/yr
Utilities	-	$3,220,000/yr
Labor	-	$3,470,000/yr
Wastewater Treatment	-	$1,510,000/yr
Maintenance and Repairs	-	$4,390,000/yr
Net Annual Profit:		$22,400,000/yr

Recommendations

Key Economic Indicators:

- NPV: $150 million
- IRR: 92%

Next Steps: process should enter into more advanced design stages and be considered for construction

References

Love, Emma. “Study Finds 45 per Cent Fall in Purchases of Bottled Water on the Go.” *Resource Magazine*, 30 July 2020, resource.co/article/study-finds-45-cent-fall-purchases-bottled-water-go.