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## Motivation

- Polyethylene terephthalate (PET) is commonly used in food and beverage packaging, clothing, films, and medical devices.
- Advancements are also being made in PET recycling.
- 2023 PET market share of \$48 billion is expected to double by 2033.

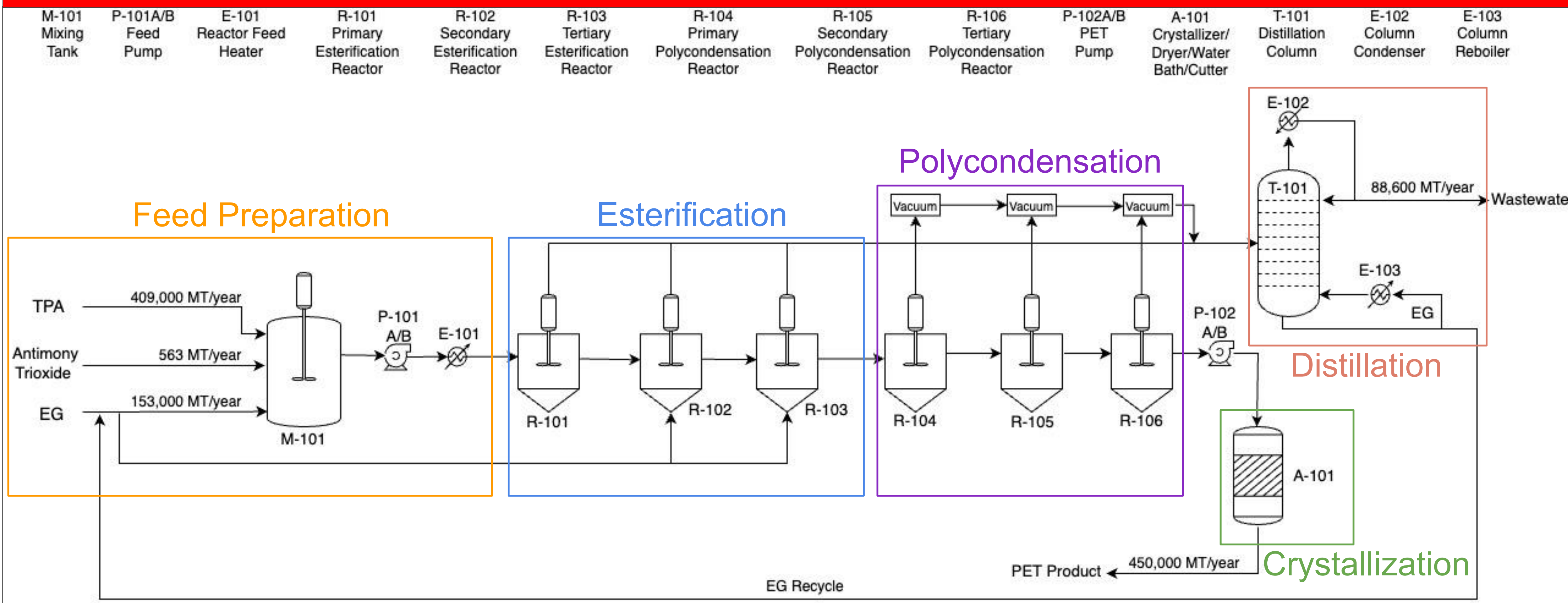
## Goals

- Design a manufacturing plant that produces 450,000 metric tons of PET/year.
- Determine primary reactant; develop process conditions and flow diagram; evaluate process safety and controls, environmental, and economic factors.
- Provide a recommendation for or against construction of the proposed plant.

## Determining Reactant

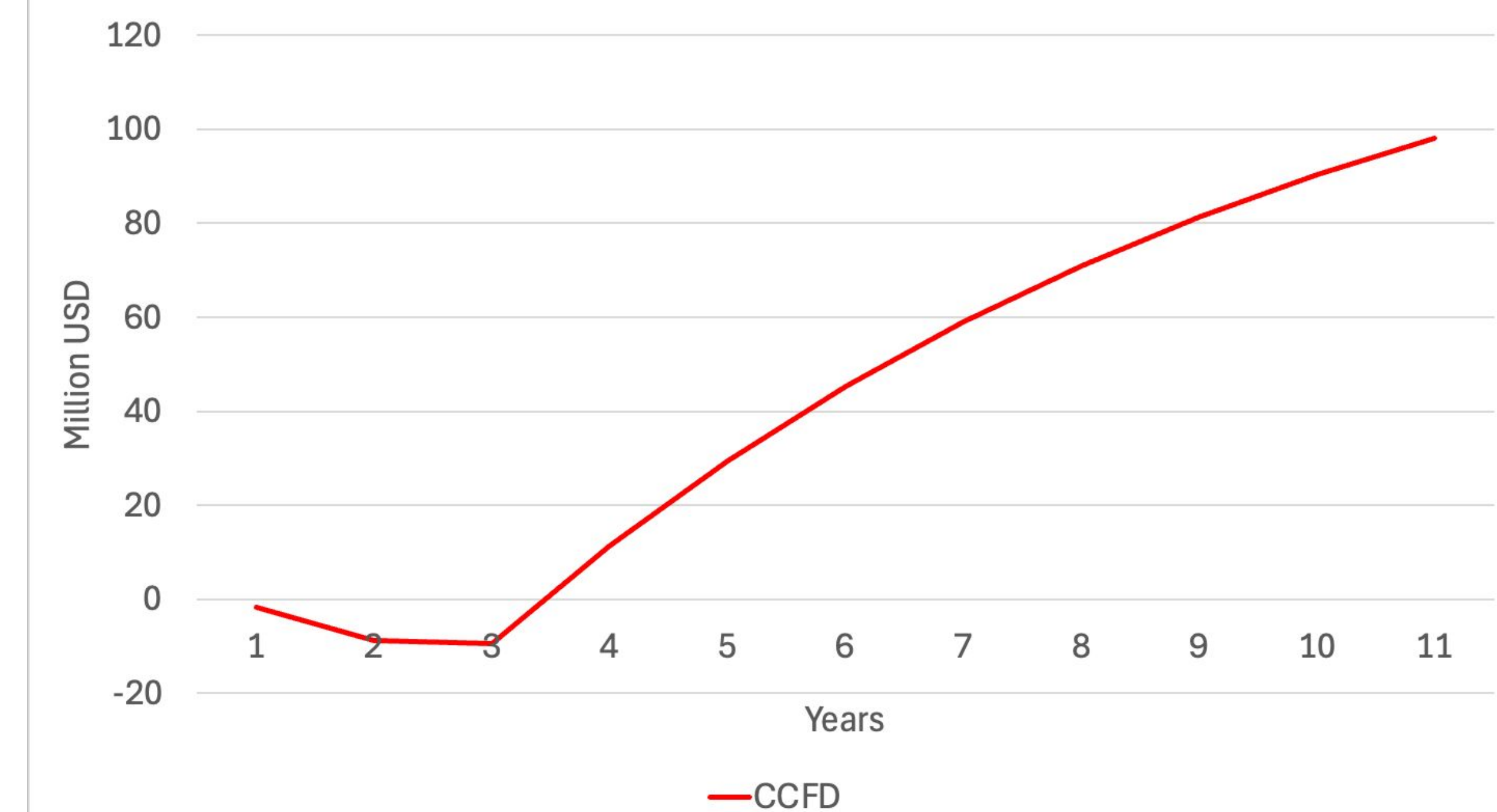
- Terephthalic acid (TPA) vs. dimethyl terephthalate (DMT)
- Compared economic, environmental, and process analyses for TPA and DMT.
- Using TPA → water = byproduct → profit ~94 USD/kmol of PET produced.
- Ultimately, **TPA was chosen** as the appropriate reactant for the process.

## Process Flow Diagram



## Economic Analysis

Cumulative Cash Flow Diagram (DCFROR: 0.15)



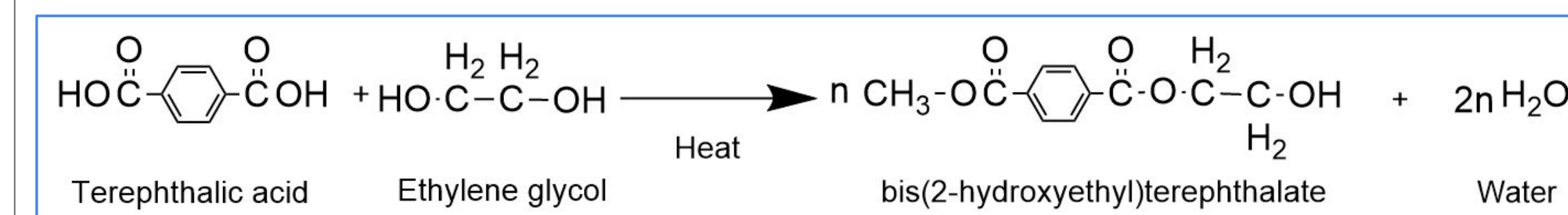
## Process Safety

### HAZOP Analysis around R-101

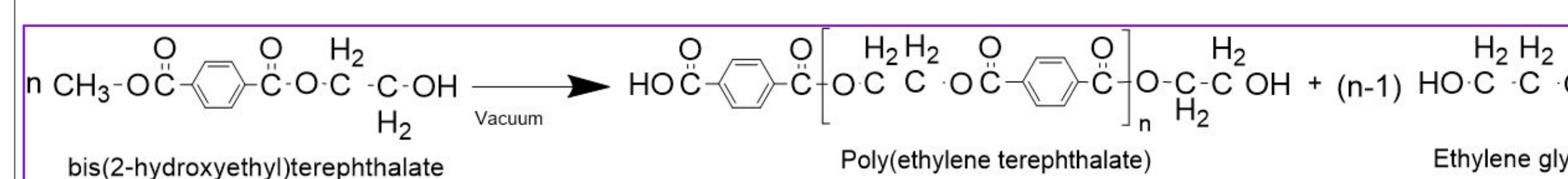
Guide Words		Key Findings
More	No	
Less	Incorrect	
Process Parameters		
Temperature	Pressure	
Flow	Agitation	
Composition	Residence Time	

## Process Chemistry

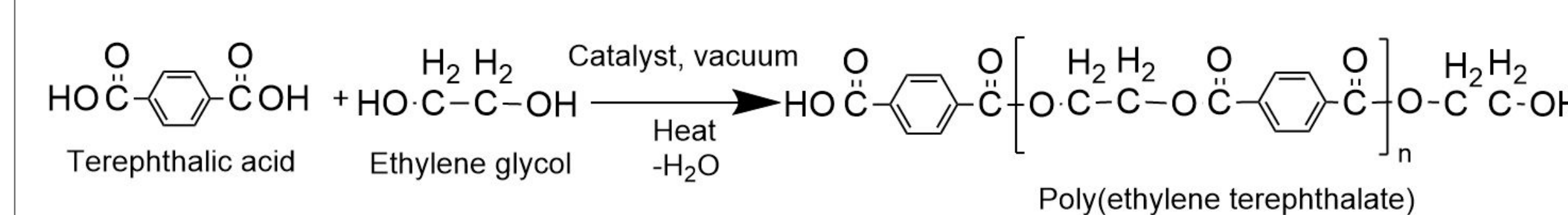
### 1. Esterification



### 2. Polycondensation

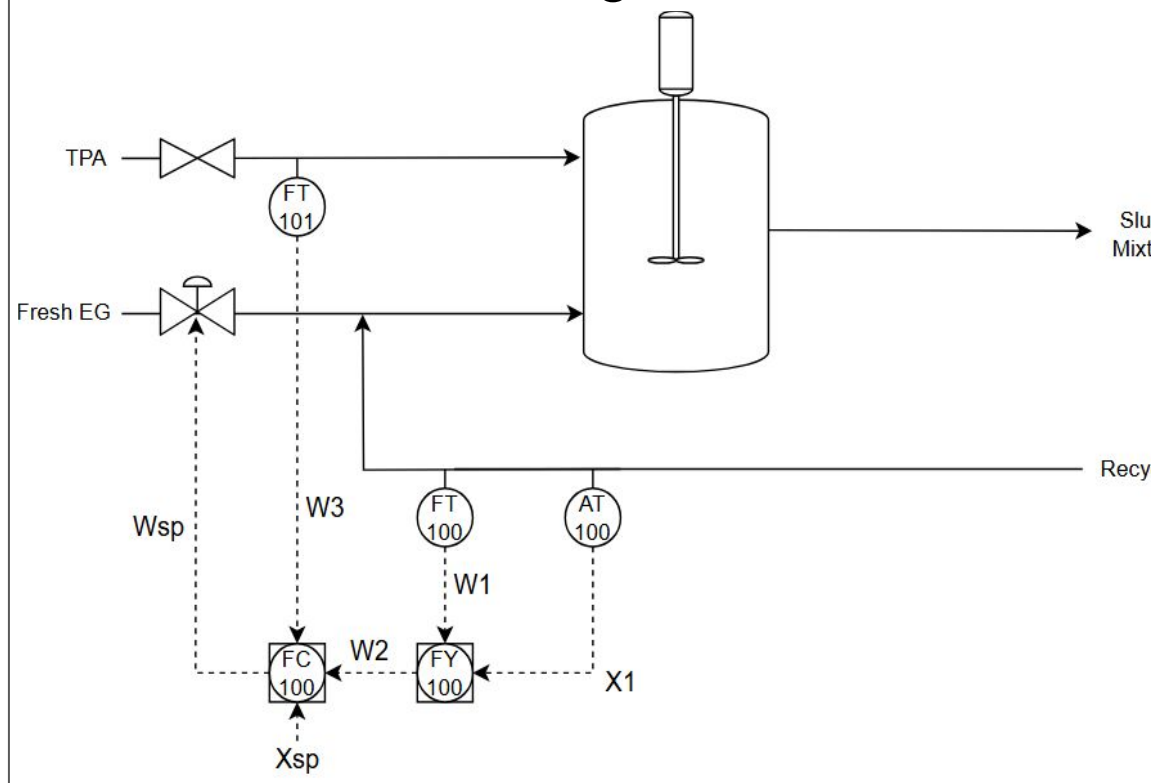


### Overall Reaction

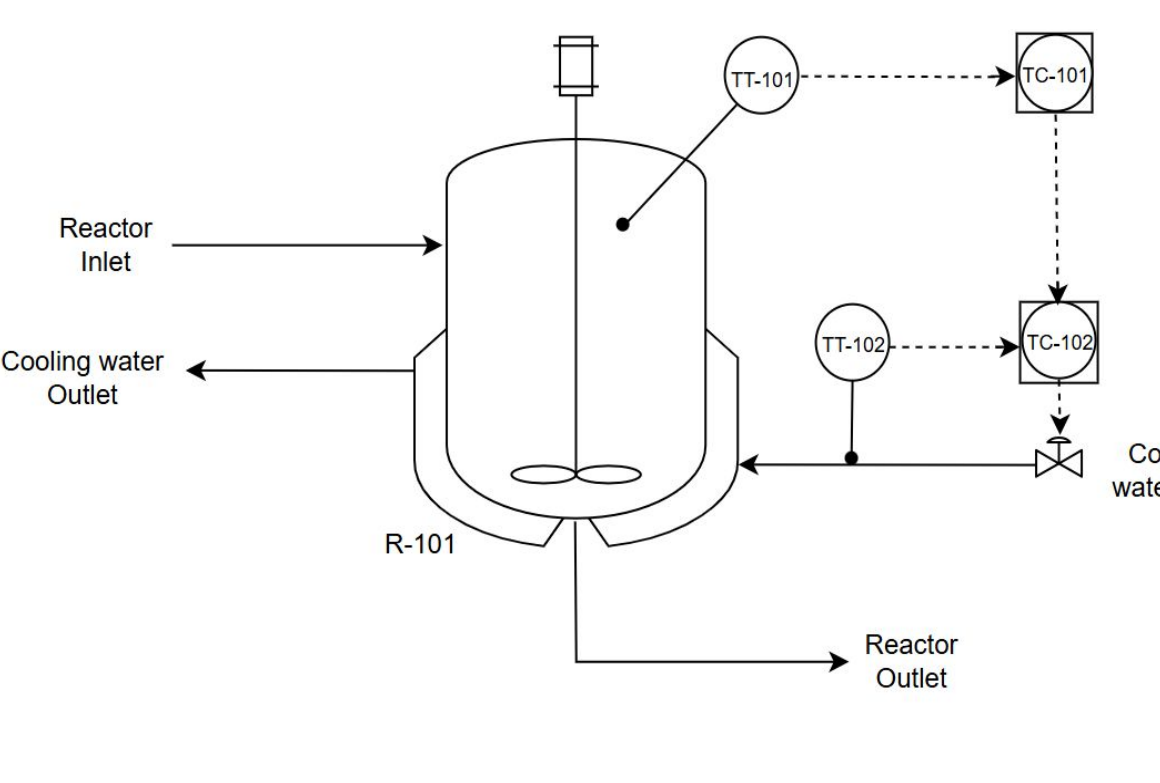


## Process Controls

### Feedforward Control Scheme for Controlling Output Flow Ratio From the Mixing Tank



### Cascade Scheme for Controlling Reactor Temperature for a Jacketed Stirred Tank Reactor



## Acknowledgements

We would like to thank our Eastman mentors **Alan Wessel, Gigi Gauthier, and Varun Atree** for guiding us through this project. We would also like to thank the **Department of Chemical Engineering**, specifically, **Dr. Bullard and Dr. Cooper**, for their unwavering support during our undergraduate education.

## Recommendation

The proposed greenfield facility is economically feasible and **should move forward to commercialization**. Further research should be conducted on additional necessary equipment and further market trends of raw materials.

## Sources

- [1] "Polyethylene Terephthalate [PET] Market Size & Growth, 2032." Polyethylene Terephthalate [PET] Market Size & Growth, 2032. Accessed October 7, 2024. <https://www.fortunebusinessinsights.com/industry-reports/polyethylene-terephthalate-pet-market-101743>.
- [2] Eastman Chemical Company. "Design of a Commercial Scale PET Production Facility - Scope Document," 2024.
- [3] Seborg, D. E. (2016). *Process Dynamics and control, 4th edition*. John Wiley & Sons, Incorporated.
- [4] Biswas, Tanmoy. "PET Polymer or Polyethylene Terephthalate Preparation Industrially by Dr. Tanmoy Biswas." YouTube, November 23, 2021. <https://youtu.be/2Hh-kFTzZaA>.

Description	Amount
Fixed Capital Investment (FCI)	\$7.4 million
Annual Cost of Manufacturing	\$644 million
Annual Revenue	\$684 million
Annual After Tax Cash Flow	\$32 million
Net Present Value (NPV)	\$10 million
Internal Rate of Return (IRR)	119%
Payback Period	3.5 years
Additional Expenses to meet 15% IRR	\$91 million

