

Waste Fry Oil Biodiesel

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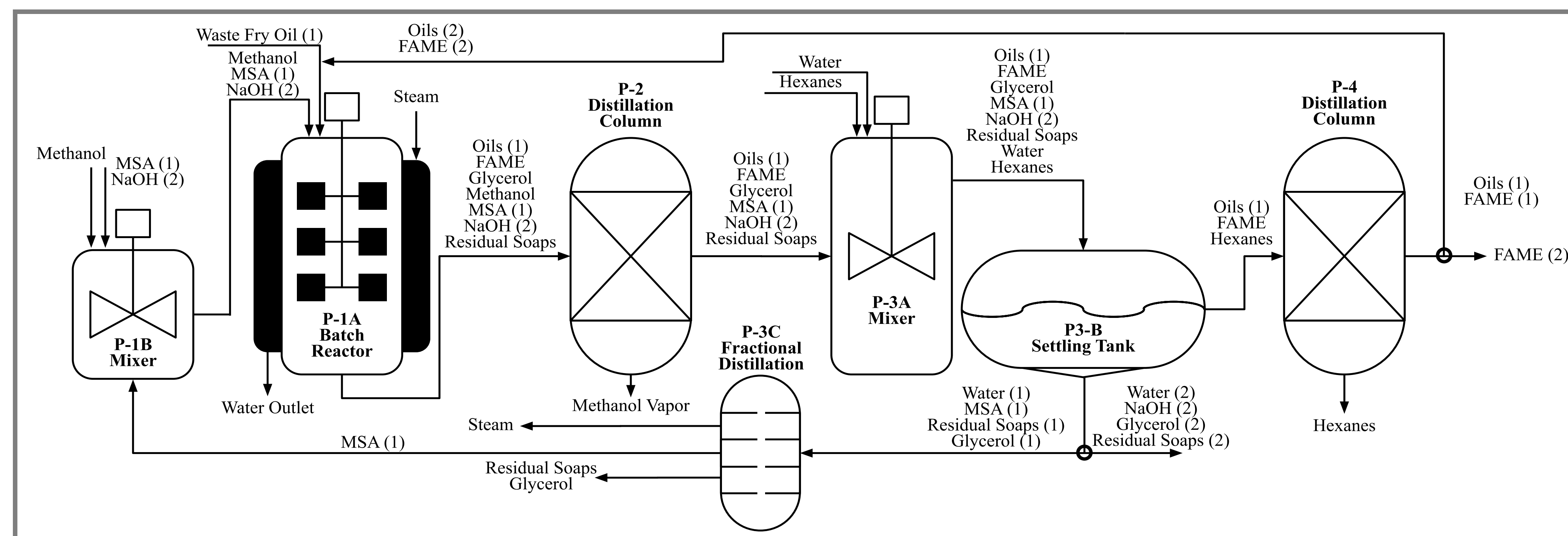
Objectives

- Design a market-ready plant to produce EPA compliant biodiesel (FAME) using waste fry oil (WFO).
- Incorporate a sustainable way to upcycle a waste product that effectively competes with petroleum-based fuels.

Process Considerations

Ethical	Social	Global
<ul style="list-style-type: none">Health and safetyMinimize carbon footprintWaste repurposing	<ul style="list-style-type: none">Geopolitical influencesEnvironmental impact awarenessGreen initiatives	<ul style="list-style-type: none">Trade commerceDistribution networksEconomic development

PROCESS FLOW DIAGRAM



Esterification (1), Transesterification (2)

Process: Batch Reactor
Alternative: Continuous Reactor

Methanol Distillation

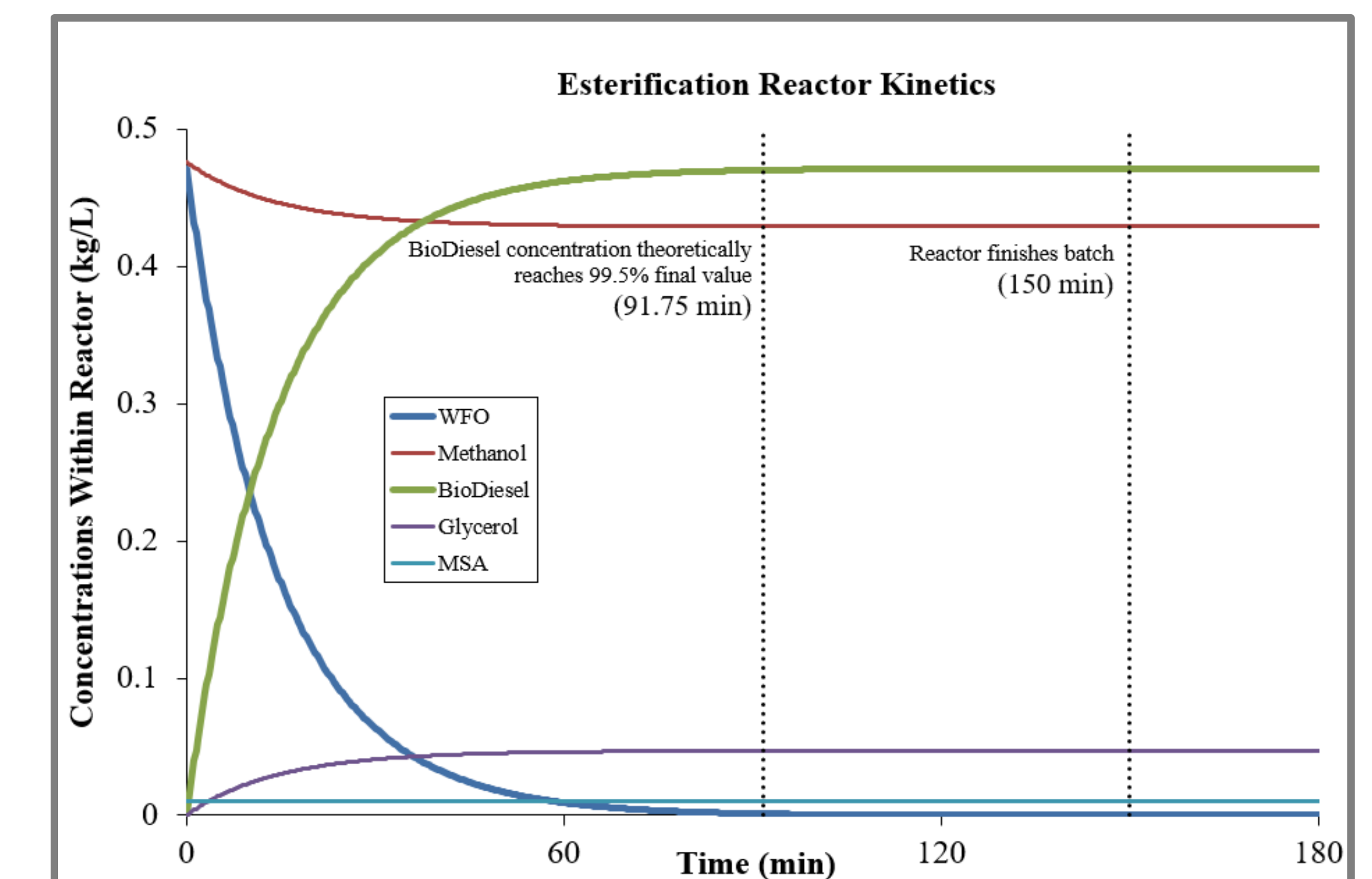
Process: Batch Distillation
Alternative: Flash

Physical Separation

Process: Mechanical Coalescence
Alternative: Membrane

Hexane Distillation

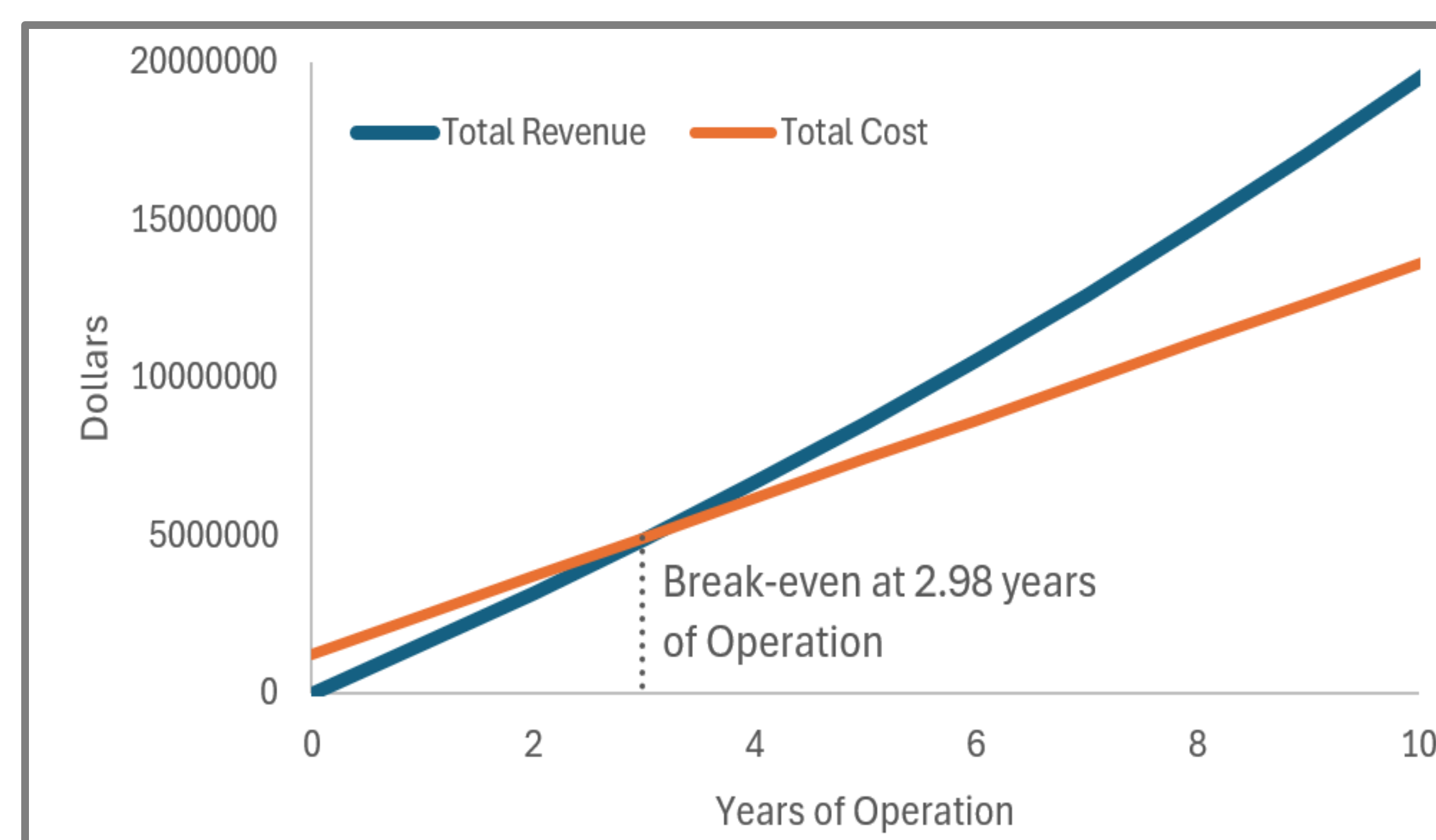
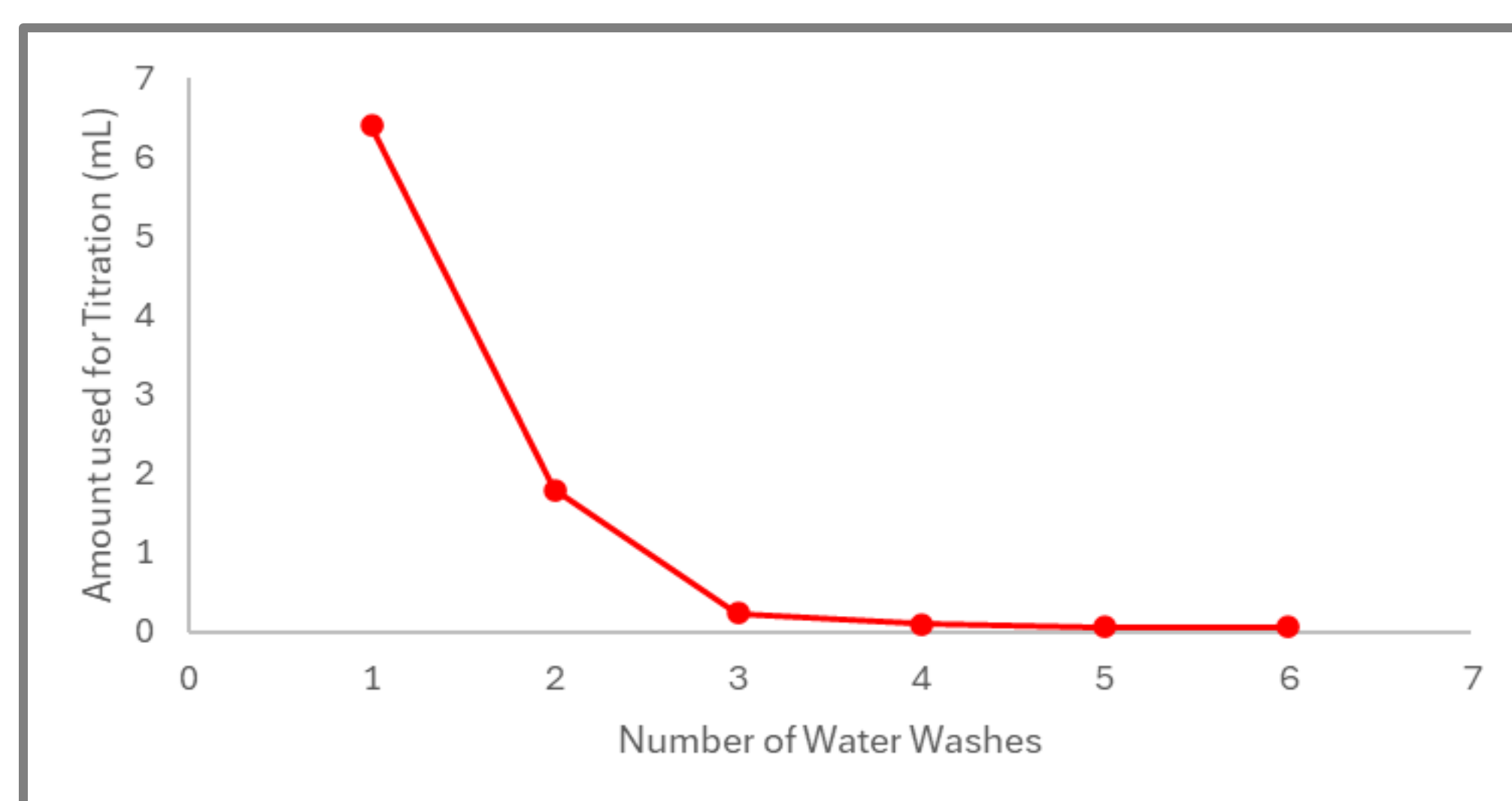
Process: Batch Distillation
Alternative: Flash



Analysis and Simulation

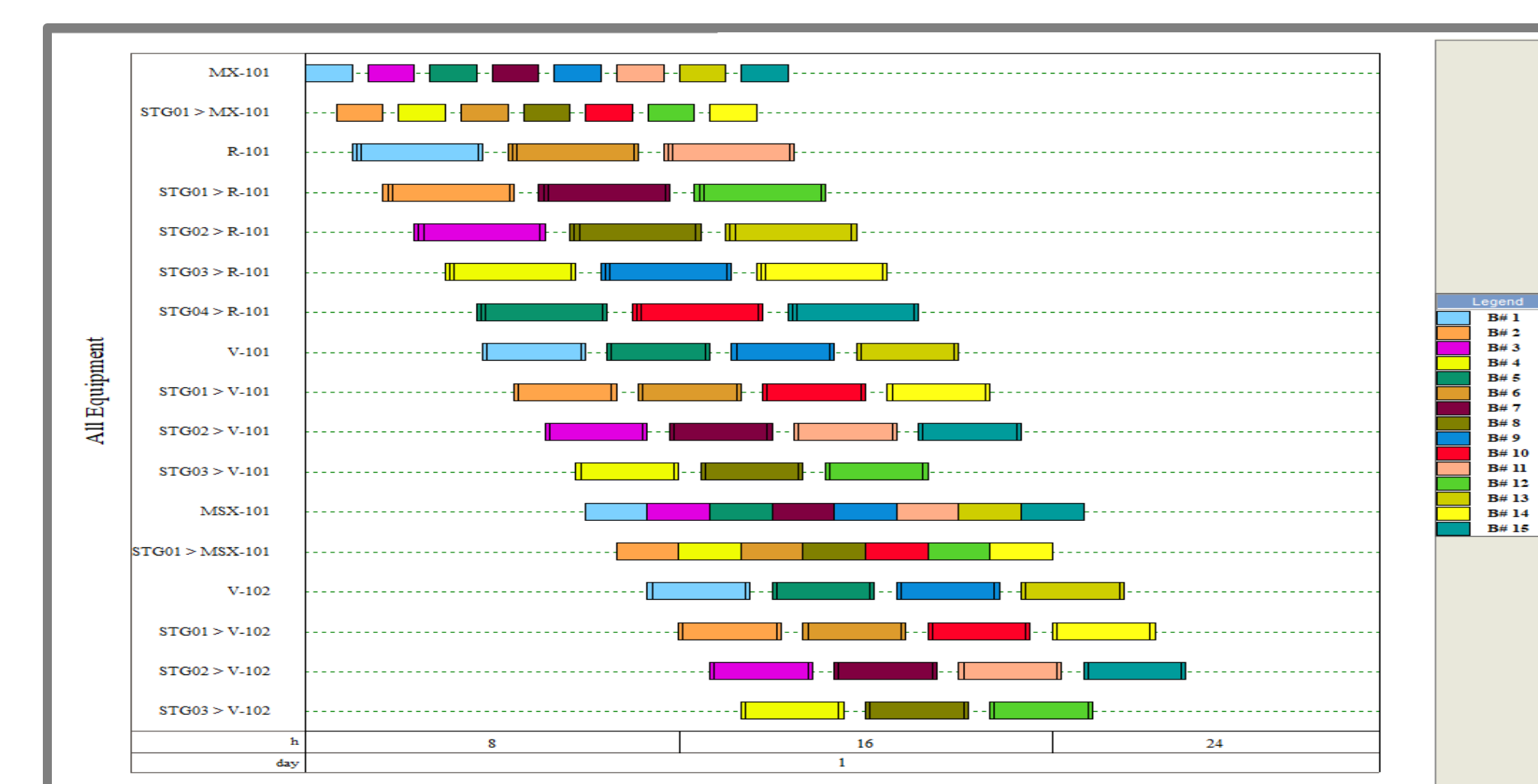
Simulated kinetics of esterification using SIMBAS:

- Consumption of waste fry oil decreases while the concentration of biodiesel increases
- Reaction achieves near-completion at 92 minutes, 38% faster than experimental estimates



Economic Analysis

- Waste fry oil basis of 950,000 lbs/year
- Recent price for B99 biodiesel is 5.48 \$/gal (DOE, 2022)
- Pricing of 5.48 \$/gal provides a NPW of \$2,690,000 over 10 years
- Sales price compared to total cost demonstrates that the plant breaks even at year 3

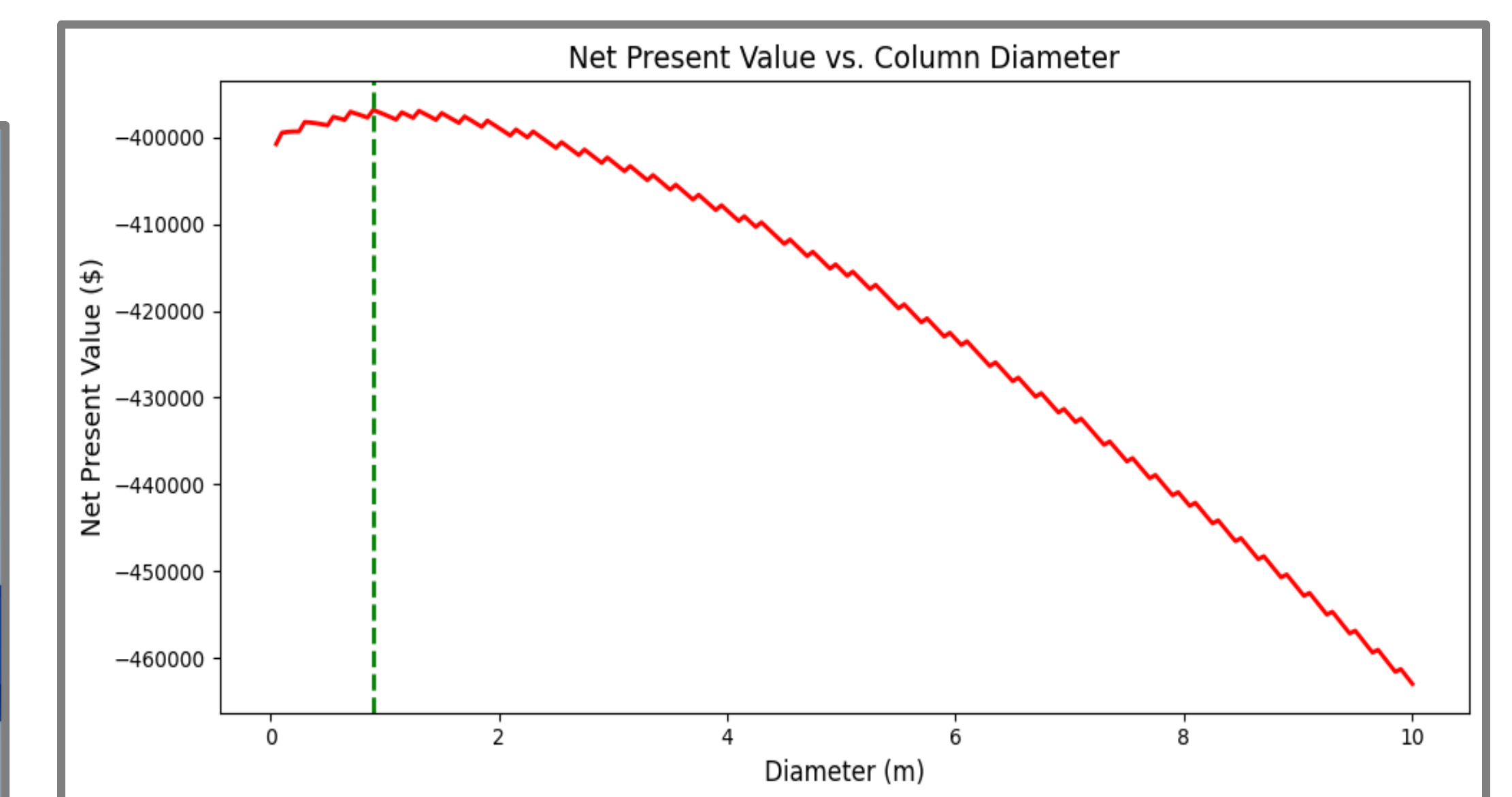


Plant Optimization

- Batch reactor was the limiting step (2.5 hours)
- Optimization converged to 8 reactors, 6 columns for both distillations and 2 settlers

Market Analysis

- Target Market: Commercial Vehicles
- Projections: 32.1 Billion global market 9.4% growth from 2023 to 2030 (Grand View Research)
- Competition: Chevron, FutureFuel, and Bunge



Optimization of the methanol distillation column found an optimal diameter of 0.90 meters to maximize net present value

Future Works

- Explore cost analysis of alternate oil sources and methods of MSA and NaOH recovery
- Explore alternatives such as flash distillation to increase the safety of the plant.
- Explore economics of continuous optimization versus batch

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Sources: American Oil Chemists' Society (AOCS), Department of Energy (DOE),

Grandview Research (n.d.). Biofuel market size, share & trends analysis report 2022-2030