P&G – Economics and CO_2 Emissions of Fatty Alcohols from CO_2

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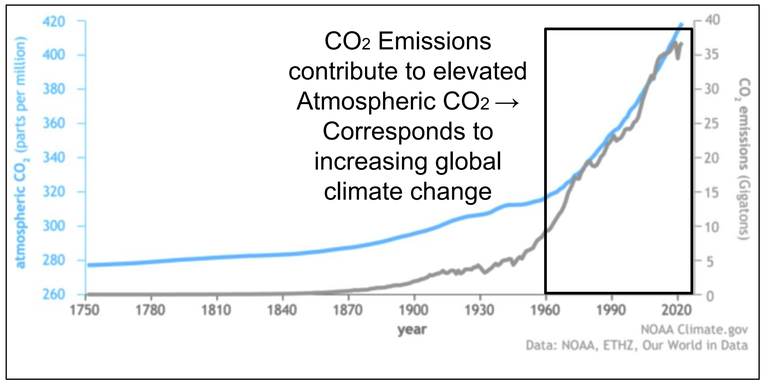
Motivation



⋆ **P&G's Goal:** lower greenhouse gas emissions and reach a net-zero greenhouse gas emission goal by 2040

Objective

⋆ Determine the feasibility of producing fatty alcohols through carbon capture by:

☆ Complete mass & atom balances for process design

☆ Determining the energy required for the process

☆ Demonstrate project costs are reasonable and

Project Overview

SOEC Electrolysis
Carbon Dioxide → Carbon Monoxide

$CO_2 \rightarrow CO + O_2$

Tandem Electrolysis
Carbon Monoxide → Ethylene

$2CO + 8H^+ + 8e^- \rightarrow C_2H_4 + 2H_2O$
$2CO + 4H^+ + 4e^- \rightarrow C_2H_3OOH$
$2H^+ + 2e^- \rightarrow H_2$
$2H_2O \rightarrow O_2 + 4e^- + 4H^+$

Oligomerization
Ethylene → a-Olefins

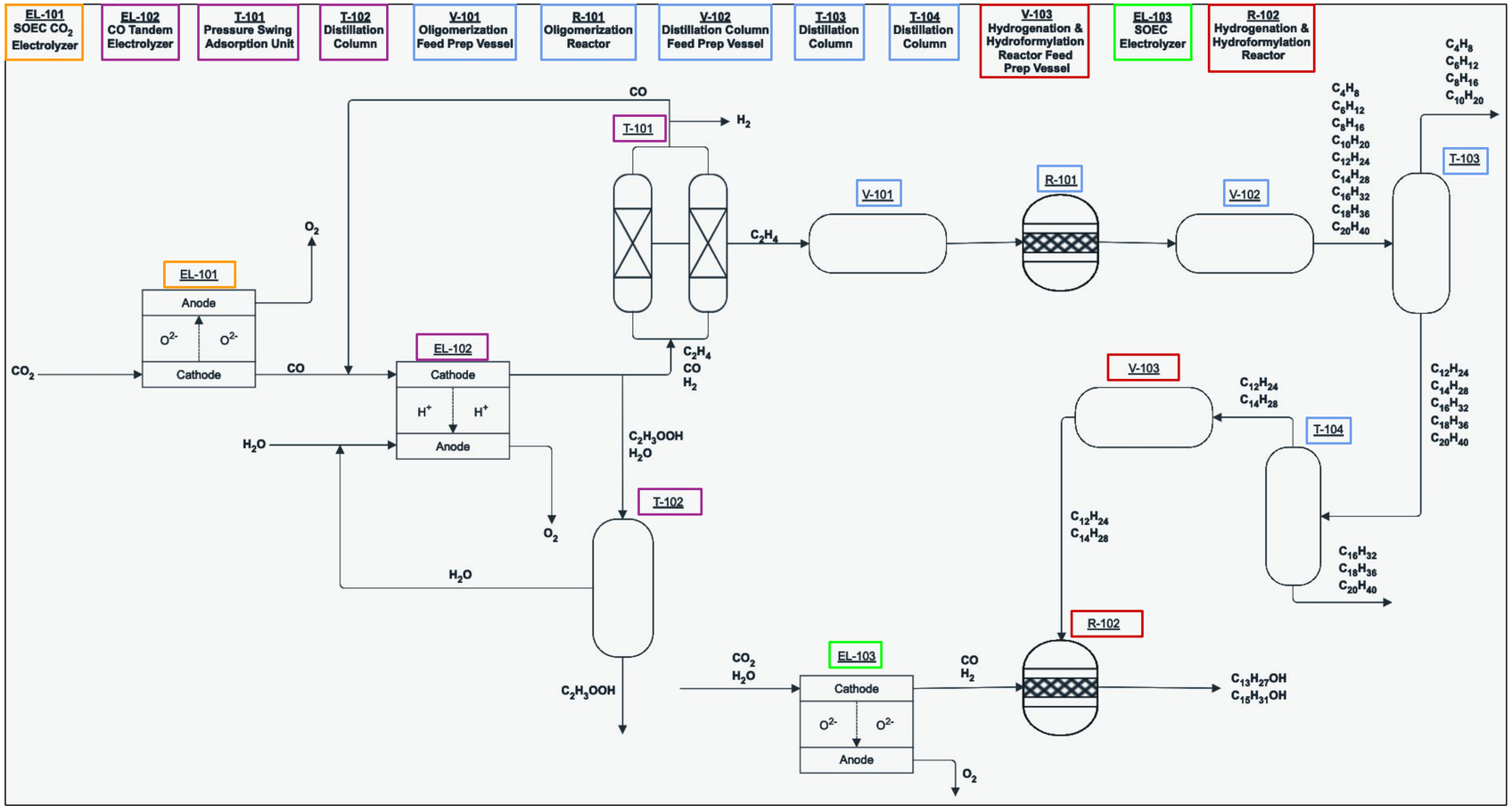
$nC_2H_4 \rightarrow C_{2n}H_{4n}$
n=2-10

SOEC Electrolysis
Carbon Dioxide + Water → Syngas

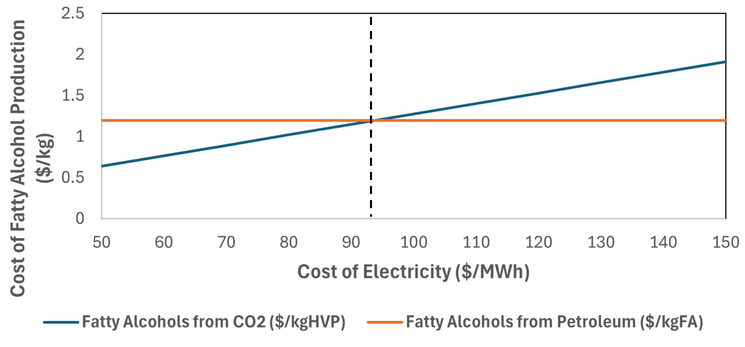
$CO_2 + 2e^- \rightarrow CO + O^{2-}$
$2H_2O + 4e^- \rightarrow 2H_2 + 2O^{2-}$
$3O^{2-} \rightarrow (3/2)O_2 + 6e^-$

Hydrogenation & Hydroformylation
a-Olefins + Syngas → Fatty Alcohols

$C_{12}H_{24} + CO + H_2 \rightarrow C_{13}H_{26}O$
$C_{13}H_{26}O + H_2 \rightarrow C_{13}H_{27}OH$



Cost & Carbon Analysis



Cost Sensitivity to Electricity Price

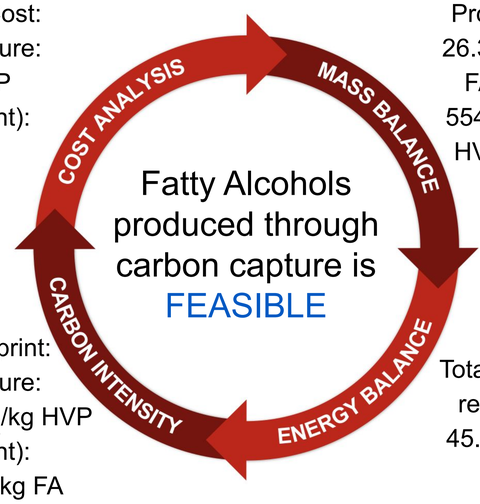
⋆ The production break-even point of this process is at $94/MWh. Below this value, our process is favorable.

Capital Cost: $355,768,446 to produce 6.4 kg HVP/s
Carbon Footprint: -1.52 kg CO_2/kg high value product

Conclusions

Production Cost:
Carbon Capture:
$1.30/kg HVP
Petro (Current):
$1.20/kg FA

Produces:
26.3 tonnes FA/year
554 tonnes HVP/year



Carbon Footprint:
Carbon Capture:
-1.52 kg CO_2/kg HVP
Petro (Current):
2.50 kg CO_2/kg FA

Total energy required:
45.8 MJ/kg HVP

Acknowledgements & Sources

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References→