P&G – Economics and GHG Emissions of Propylene from CO_2

Mikayla Atwood, Julie Casavant, Noah Hunter, Dylan Savant, Jacob Stana Mentors: Dimitris Collias, Eddie Sun

Motivation

- P&G net-zero greenhouse gas (GHG) emissions target for 2040
- High volume materials (polypropylene, superabsorbent polymers, etc.) must be produced using non-petroleum sources
- CO_2 → ethylene electrochemically which can then be used to produce PP and SAP

Objectives

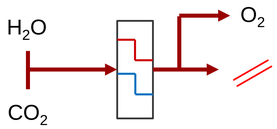
- Full process model needed for production (M&E Balance, Equip., etc.)
- Quantify production costs & GHG emissions of propylene from recaptured CO_2
- Compare proposed process to existing petroleum-based methods

Key Concepts

Propylene is produced primarily as a by-product of petroleum refining and to repurpose ethylene produced during hydrocarbon cracking. Production from recaptured CO_2 may follow four major steps:

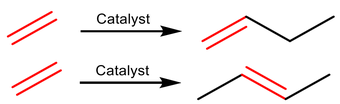
1. Electrolysis

CO_2 → Ethylene using electrochemical cells



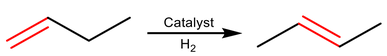
2. Dimerization

Ethylene → 1 & 2-Butene



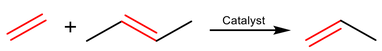
3. Isomerization

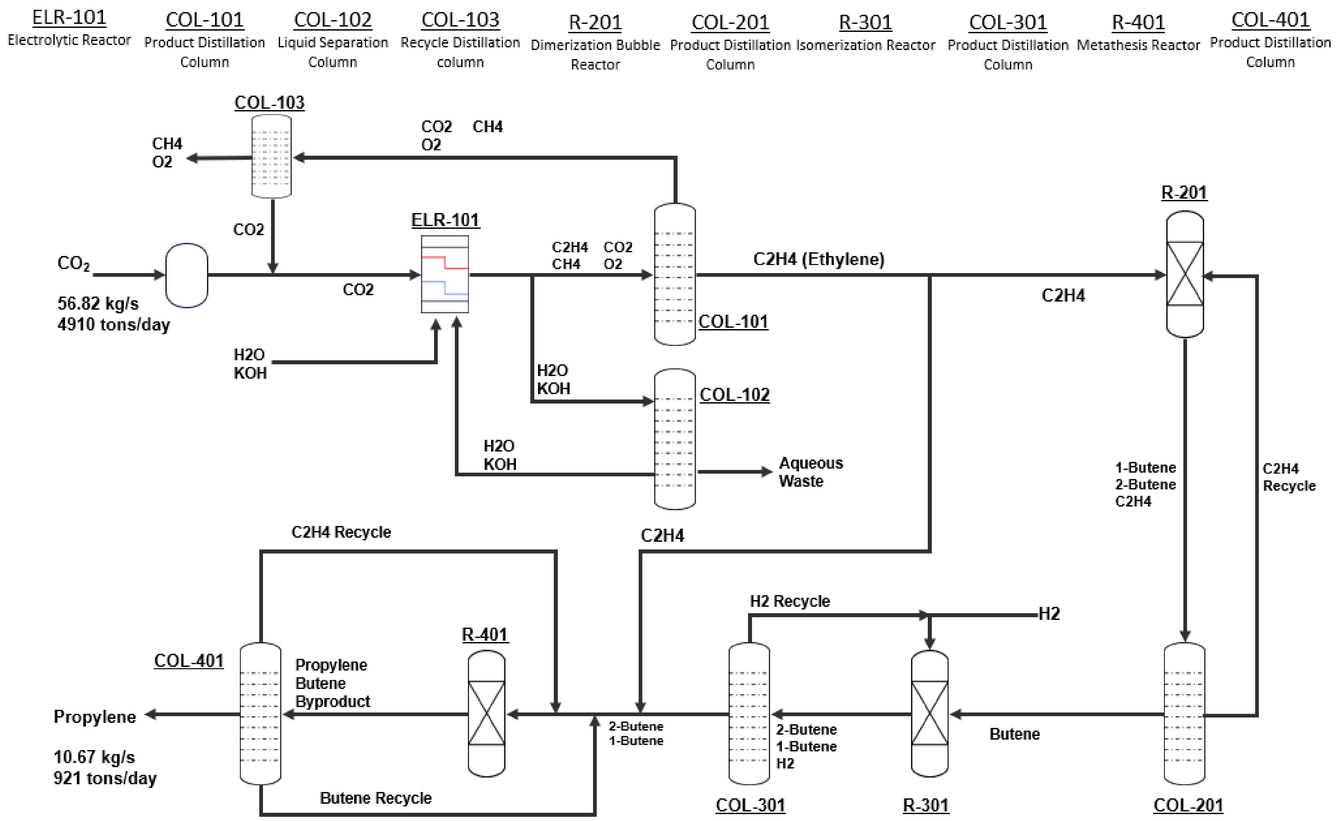
1-Butene → 2-Butene

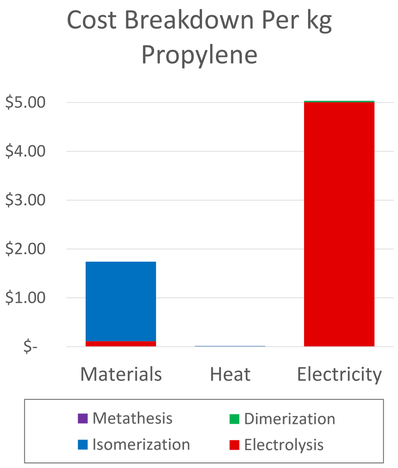


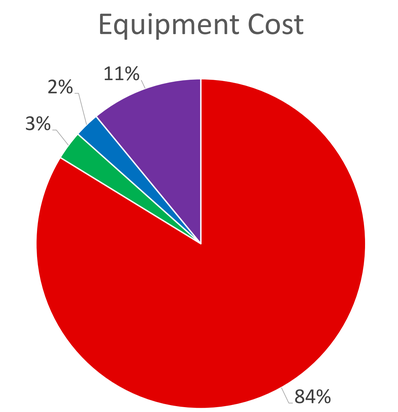
4. Metathesis

2-Butene + Ethylene → Propylene









TEA & LCA findings

Equipment Cost: $132 million
Total Greenfield Cost: $276 million

Net Annual Operating Costs:
- Labor: $2.4 million
- Maintenance: $3.8 million
- Loan Repayments: $26 million
- Materials & Energy: **$1.3 Billion**

$1.33 Billion/year

Comparison to Petroleum Production

Production Method	Recapture	Petroleum
CO_2 Impact (kg/kg C_3)	-5.3	+1.5
Cost ($/kg C_3)	$6.79	$0.99
Energy Consumption (MW/kg C_3)	115	30
$ to Sequester 1 ton CO_2	$1,090	-

Final Thoughts and Recommendations

- As it is now, we **cannot recommend** this process for commercialization
- The **cost and energy intensities are too large**, any plant built would operate at a loss
- Given sufficient technological **advancements in green energy** or **legislative incentives**, this process may become more viable over time

Acknowledgements & Sources

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