PROPIONIC ACID PRODUCTION FACILITY USING CARBONYLATION

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WHAT IS PROPIONIC ACID?

Propionic acid is a naturally occurring carboxylic acid with the molecular formula $C_3H_6O_2$. It can also be produced through chemical synthesis or bacterial fermentation. Propionic acid is an effective food preservative as it is highly effective at inhibiting the growth of mold with its inhibiting action being primarily fungistatic rather than fungicidal. The global market for propanoic acid was about 400 kilotons in 2022. It is sold for about $1.25/kg for industrial purposes.

Diverse range of uses:

- Food preservation
- Chemical intermediate in the production of polymers
- Flavoring agent in food
- The production of various pharmaceuticals

ACKNOWLEDGEMENTS

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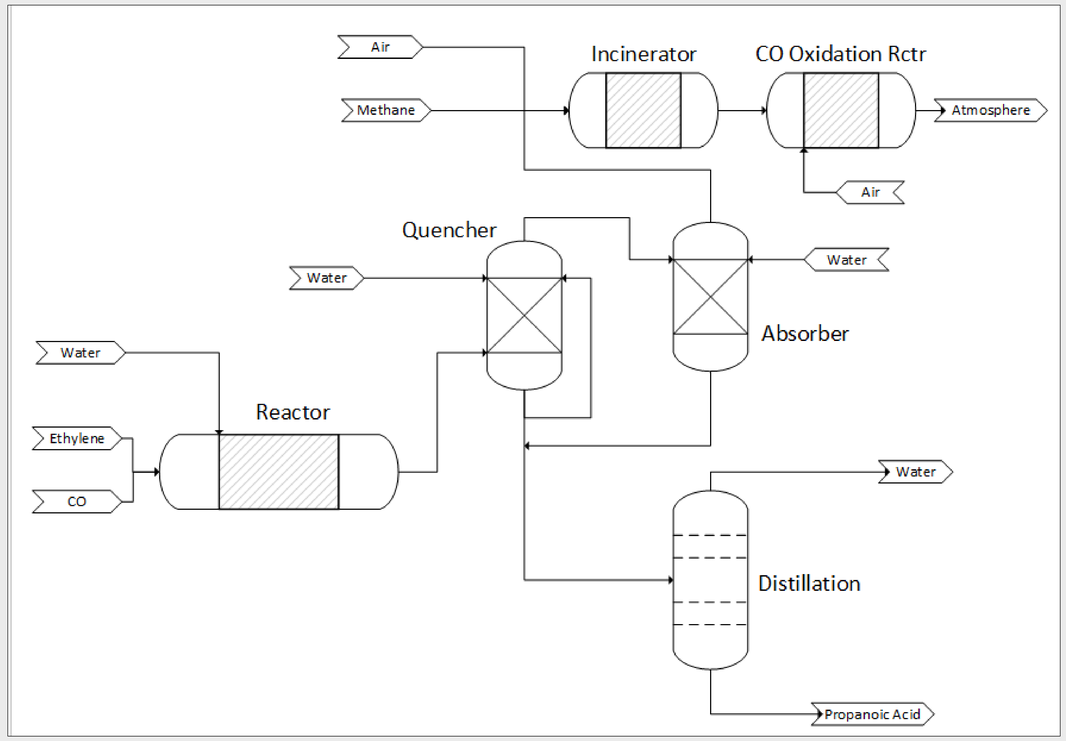


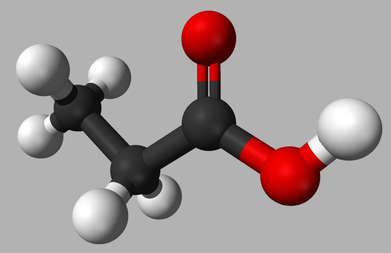
Objective: Design Process to Produce 50,000 tons of Food Grade Propionic Acid per year.

PROCESS

1. Ethylene, Carbon Monoxide, and Water are feed into the Plug Flow Reactor (operating at 40 bar and 350°C).
2. Gases products from the Reactor are then fed into the Quencher followed by the Absorber to recover propionic acid and propionaldehyde as a liquid.
3. A distillation column then further purify and isolate propionic acid. Water is sent to wastewater treatment.
4. The off-gas products are sent to the Incinerator to destroy the hydrocarbons. Then to a secondary reactor to oxidize the unreacted carbon monoxide.

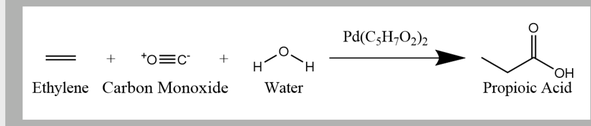
FUTURE WORK

- Economic analysis to determine breakeven cost. Breakeven cost should be around $1.25/kg to be competitive against other competitors.
- Detailed Safety Analysis to ensure the safety of operation due to high-operating pressure. Pressure relief valves and other regulating valves would be added.
- Look into the design of Wastewater Treatment to meet effluent guidelines and standards.



REACTION

- Ethylene Carbonylation



- 100% atom efficiency- no byproduct from reaction
- ~ 95% yield
- Possible side reactions:

$$CO + H_2O \rightarrow CO_2 + H_2$$
$$CH_2CH_2 + CO + H_2 \rightarrow CH_3CH_2CHO$$

- Operating conditions: 40 bar and 350 °C
- Exothermic: 2304 kW of heat generated
- Plug flow reactor (20 m length, 7 m diameter, and 20 cm thickness) with catalyst packed tubes

CATALYST

- Palladium acetylacetonate ($Pd(C_5H_7O_2)_2$)
- High melting point: 205-210°C
- Remains solid through the reactor conditions
- Does not require the installation of an additional catalyst recovery unit

TEAM CONTACT INFORMATION

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