TEAM M032

Pathways to Net-Zero Carbon in Ethylene and Propylene Production

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Introduction & Background

Ethylene production is energy-intensive and generates high CO_2 emissions. Conventional steam cracking relies on fossil fuels, limiting sustainability. This project introduces an electric furnace integrated with carbon capture and storage to reduce emissions.

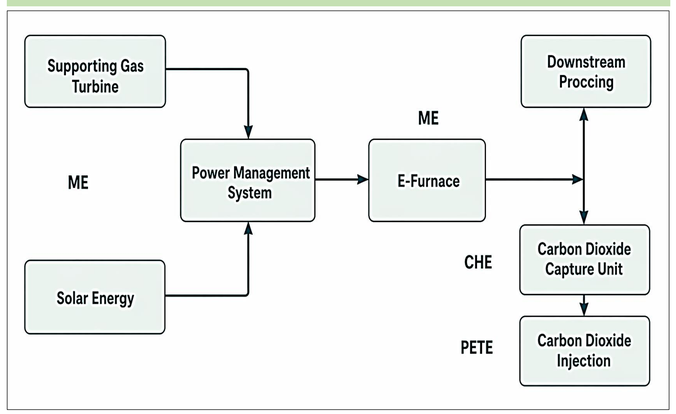
Problem Statement

High CO_2 emissions from steam cracking require a scalable low-carbon solution without compromising production performance.

Objective

Reduce CO_2 emissions by >50% using electric cracking, carbon capture, and geological storage while maintaining yield.

Multidisciplinary Block Diagram



Constraints

Absorber pressure drop ≤ 0.5 bar
Furnace withstands 1000 °C
Materials comply with ASME & ISO standards
Hybrid power: Solar >10% + Grid
Ethylene yield ≥ 50%
CO_2 storage depth ≥ 800 m
Injection pressure ≤ 80% fracture pressure

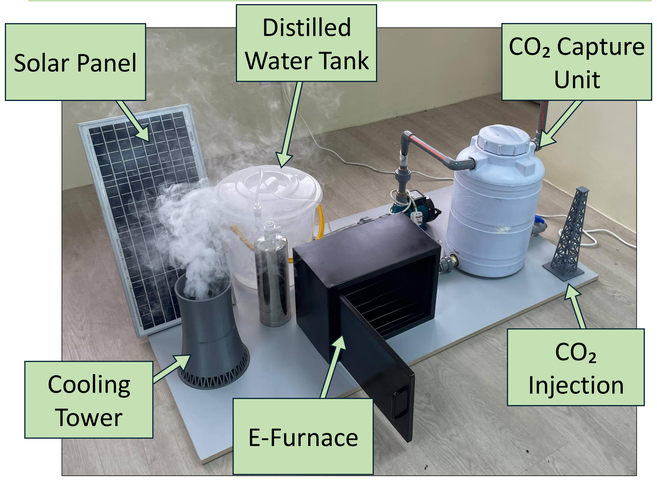
Specifications

Solar energy ≥ 20%
Long-term storage integrity (100 yrs)
Storage efficiency ≥ 30%
CO_2 reduction ≥ 50%
Scalable production (1–10 kT/y)
Yield ≥ 50%
Furnace efficiency ≥ 70%

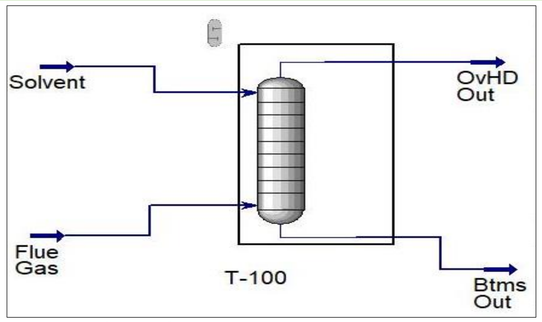
Integrated Specifications

Impurities ≤ 2%, Re > 10,000
Continuous operation ≥ 48 hr
CO_2 reduction ≥ 50%

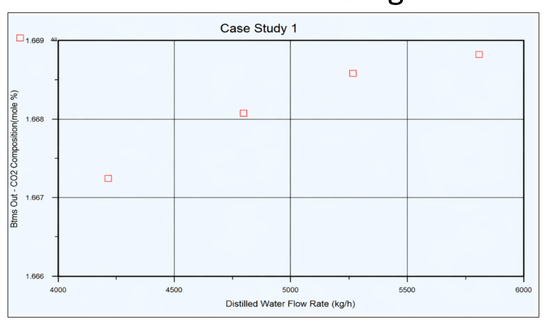
Prototype Design



Design Verification

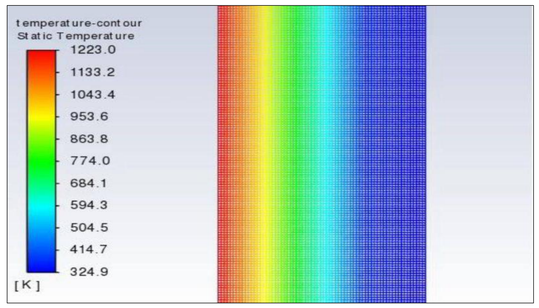


Absorber Process Diagram

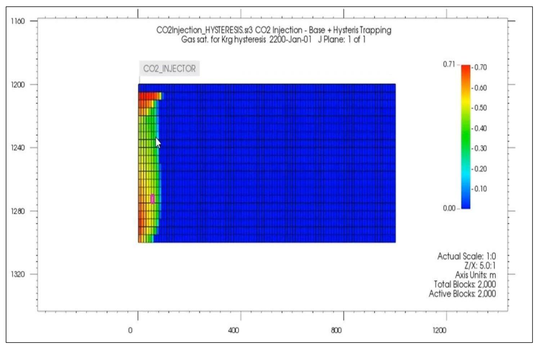


Performance Plot

Testing & Validation



Temperature Contour



CO_2 Saturation

Conclusion

- Low-carbon olefin system
- Electric renewable integration
- CO_2 capture system
- > 50% emissions reduction
- 82% capture efficiency
- > 50% ethylene yield
- Low pressure drop
- Scalable industrial design
- Integrated process efficiency