TEAM F010

Adsorption CO_2-to-Methanol System

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ME CHE 3 ISE

Introduction

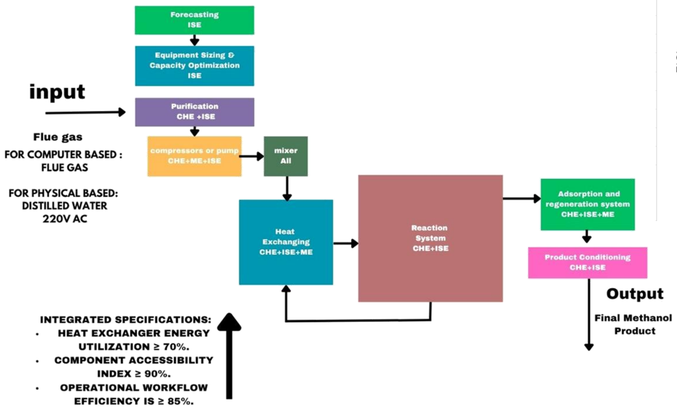
- Current CO2 to methanol prosses ignore thermodynamic equilibrium leading to low efficiency
- A novel system combining multi-tubular reactor with water adsorption
- Shifts the equilibrium to produce more methanol

Problem Statement

Industrial processes are major contributors to global CO_2 emissions:

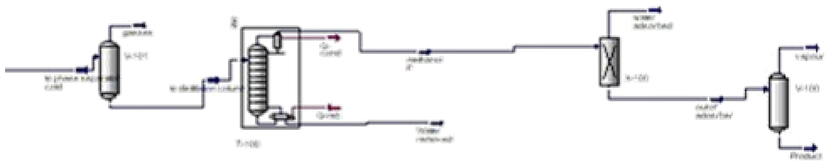
- Ethylene crackers release 1.8 tons CO_2/ ton ethylene.
- Current strategies rely on carbon capture and storage.

Deliverable

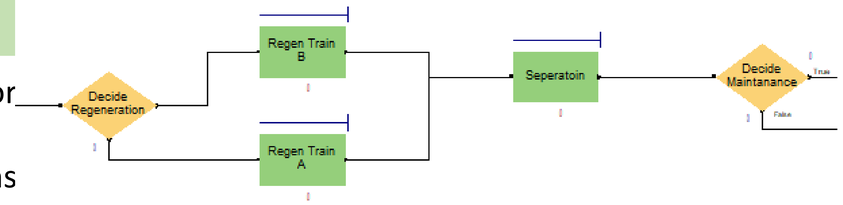


Prototype

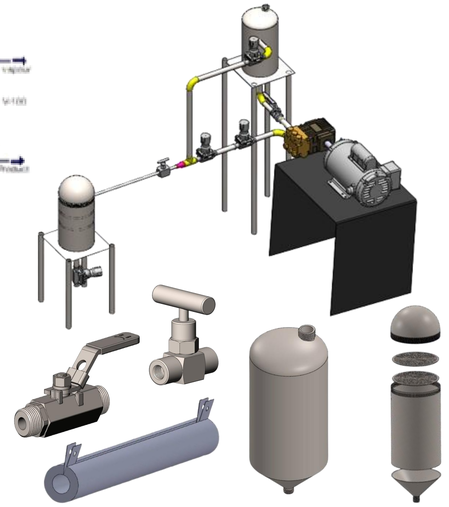
- Part of Aspen HYSYS Simulation for Separation system



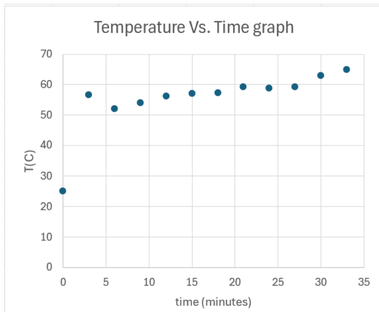
- Arena Simulation Model

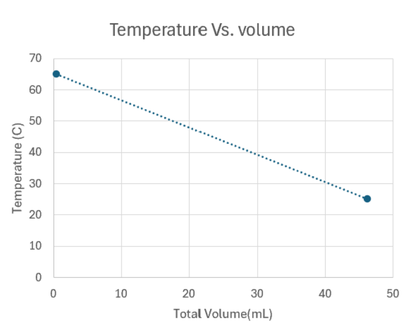


- CAD Simulation Model



Testing and Validation





Constraints and Specifications

Constraints:

- Methanol production ≥100% of forecasted demand
- O2 composition in the reactor feed < 0.01%
- Maximum allowable wall temperature ≤ 300 °C

Specifications:

- Forecasting model prediction accuracy ≥ 90%
- Methanol product quality 98%–99% in simulation
- Factor of safety ≥ 1.5

Achievements

Simulation	Methanol Purity	100% and loss 16%
	Single pass conversion	84%
	Safety factor achieved	100%
	System Reliability	96%
	OR model achieved	+8.7% above demand
	ARENA T Accuracy	96.9%
Physical Prototype	Reduction in water vol in the mixture	80%
	Operating temperature within allowable limits	100%

Conclusion

- The system achieved 99.99% methanol purity and 96% overall heat integration
- Methanol loss is 16%. We recommend modifying the separation conditions to reduce the loss
- Prototype