



Carbon Capture, Purification and Exporting from Olefins Flue Gas

TEAM12: Khalid Algouz (CHE) - Abdulrahman Alosaimi (CHE) - Zeyad Almubarak (EE) - Ahmed Alhussain (EE) - Amer Aljohani (ME) - Ayidh Alotaibi (ME)



Coach: Dr. Muhammad Siddiquee

Introduction

- Aligning with global emission reduction goals.
- Exporting 99.99% Purity of liquid/gas CO₂.
- Food, Methanol & Urea industries utilizes pure CO₂ for their production
- Saudi Arabia aims for Net Zero Emission by 2050.

Problem Statement

An interdisciplinary team of chemical, mechanical, and electrical engineers collaborates to design and implement an efficient Carbon Capture, Purification, and Exportation system for Olefins flue gas, integrating expertise in chemical processes, mechanical design, and advanced control strategies for sustainable emissions reduction.

Project Impact

Social	Environmental	Economical
•Creates new markets & Jobs	•Fight climate change •Protect atmosphere	•Less environmental taxes •Higher product value for customer

Final Target Specification

- Rotary Machine Efficiency**
The Efficiency of rotary machine should be above 70%
- Purge CO₂**
CCP plant purges 0 mol% of CO₂
- Product composition**
The purity of the product should be 99.99 mol%
- Power factor**
The power factor of the rotating equipment should be equal to 0.8
- Pressure sensors**
Pressure sensors withstanding up to 10 barg

Project Constraints

Mechanical

- Material Selection of Units and Piping
- Equipment Selection

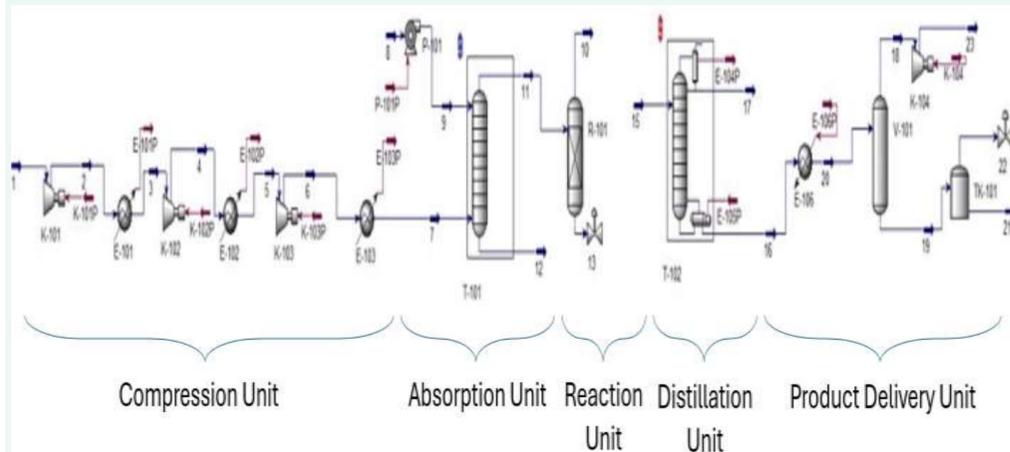
Electrical

- Copper Wires
- Power Supply (DC)

Chemical

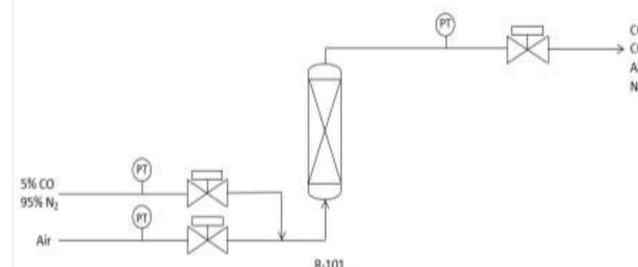
- Feed composition contains 0.09 mol% CO₂
- Fluid Package in Aspen HYSYS

Aspen HYSYS Simulation

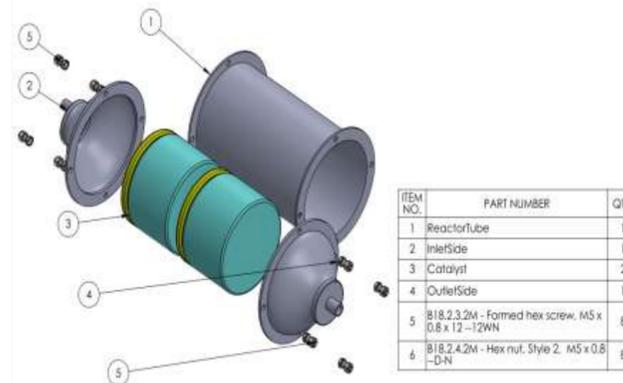


Prototype Design

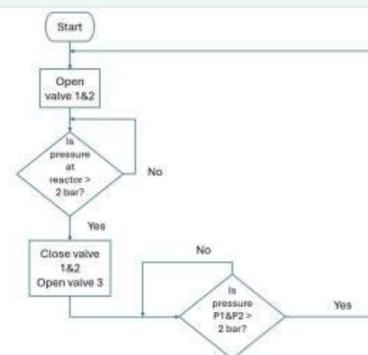
Schematic diagram



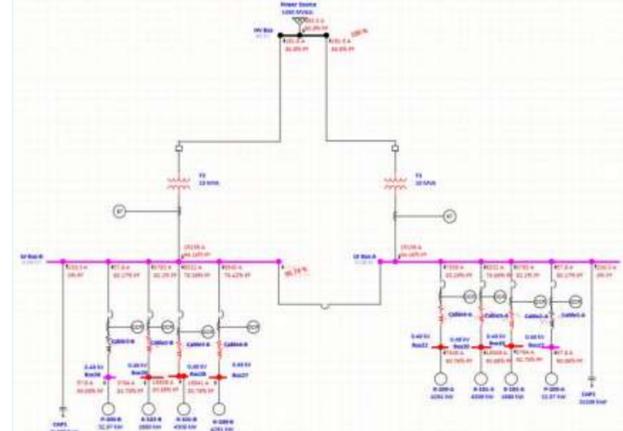
Exploded View of the Reactor



Control flow diagram

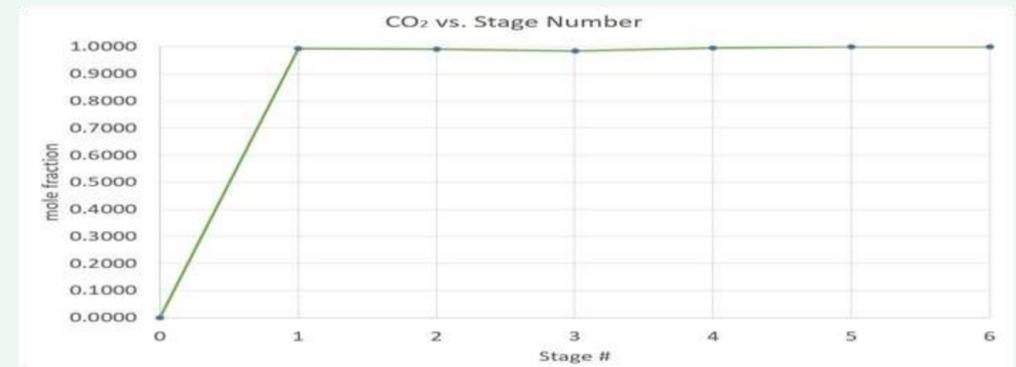


ETAP Load Flow Analysis



Testing / Validation

CO₂ Composition in the Distillation Unit



- Final unit of the CCP process reaching 99.99% purity of CO₂
- Total CO₂ received in the feed stream = Total amount leaving the process + Generation in the reaction area → 0% CO₂ Purged

Pump selection

Equations:

1-Formulas need to select the pumps:

$$N_s = 17200n_s$$

2-Formulas need to do cavitation analysis for the pump:

$$n_s = \frac{n \sqrt{Q}}{(gH)^{3/4}}$$

$$= \frac{fL \left(\frac{Q}{A_s}\right)^2}{2gD_s}$$

$$h_{Ls} = \frac{fL V_s^2}{2gD_s}$$

Given that:

$$Q = 0.0227 \text{ m}^3/\text{s}$$

$$H = 98 \text{ m}$$

$$n = 2000 \text{ rpm} = 33.33 \text{ rps}$$

$$D = 4 \text{ in} = 10 \text{ cm}$$

$$NPSHA = 36 \text{ m}$$

$$p_v = 2.33 \text{ KPa}$$

$$L = 30 \text{ m}$$

Substitute:

$$n_s = \frac{(33.33)\sqrt{0.0227}}{(9.81 \times 98)^{3/4}} = 0.03213$$

$$N_s = 17200 \times 0.03213 = 552.63$$

$$h_{Ls} = \frac{(0.021)(30) \left(\frac{0.0227}{\frac{\pi}{4} \times 0.1016^2}\right)^2}{2 \times 9.81 \times 0.1016} = 3.72 \text{ m}$$

$$\left| \frac{p_a - p_v}{\gamma} + h_1 - \sum h_{Ls} \right| = NPSHR$$

$$= \frac{101 - 2.33}{9.81} - 3.72 = 6.34 \text{ m}$$

∴ So, radial centrifugal pump will be chosen

Total Expenditure of Project

Items	Cost (SAR)
Air Compressor	179.7
Arduino Mega	115
Reactor	160
Valves	215
Pressure Sensors	474.6
Reactor Assembly	1050.5
CO Cylinder	2185
pipes	596.9
Total	5424

Conclusion

In conclusion, the interdisciplinary team of chemical, mechanical, and electrical engineers has collaboratively integrated expertise in chemical process simulation, mechanical design and material selection, and advanced control design and power simulation for an efficient Carbon Capture, Purification, and Exportation system for Olefins flue gas. Achieving a purity level of 99.99 mol% of CO₂, and zero purging amount of carbon demonstrate the effectiveness of the integrated approach, offering a sustainable solution for reducing emissions.