

Utilizing Circular Economy to Optimize Post CO2 Capture Unit



KFUPM Design Expo

Team 80

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Background

The rapid rise in CO2 emissions demands global scientific collaboration for mitigation. Saudi Arabia's Vision 2030 aims to significantly reduce CO2 emissions. PCC uses two columns to efficiently cycle solvent and capture CO2, integrating a circular economy approach to optimize energy use and reduce costs.

Problem Statement

This project aims to develop an innovative configuration for post-combustion CO2 capture units following the Circle Economy approach, focusing on increasing CO2 load in the solvent, reducing reboiler duty to lower energy consumption, operating costs, and capital cost.

Project Constraints

The project faces constraints due to diverse industry needs and limitations of the Aspen Hysys software. Challenges include varying Thermodynamic Package and Flue Gas Flowrate. Moreover, most of the typical design modeled on older versions of Aspen Hysys where the equilibrium model differs.

Target Specifications



Capturing 200,000 - 300,000 metric tons of CO2 yearly.



Capture 95% to 99% of CO2 in the flue gas.



Reduce energy consumption by 20% to 35%



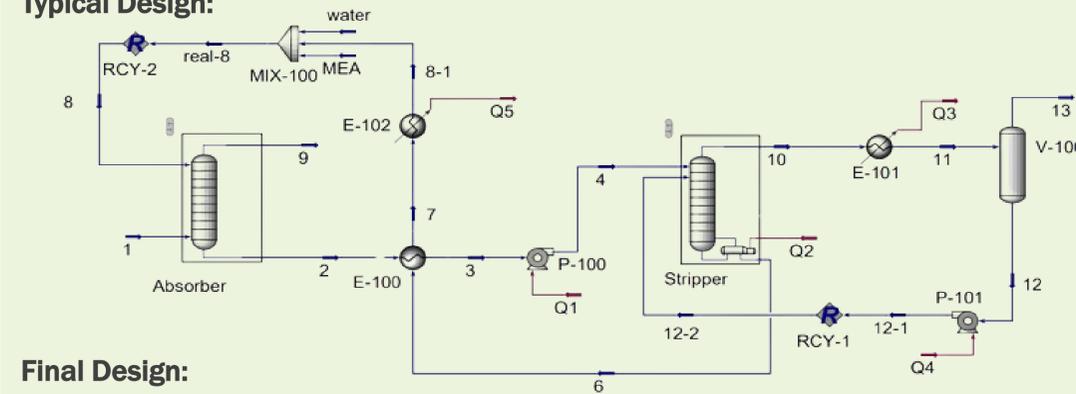
Reducing the overall cost of our plant by 15% to 25%

Project Impact

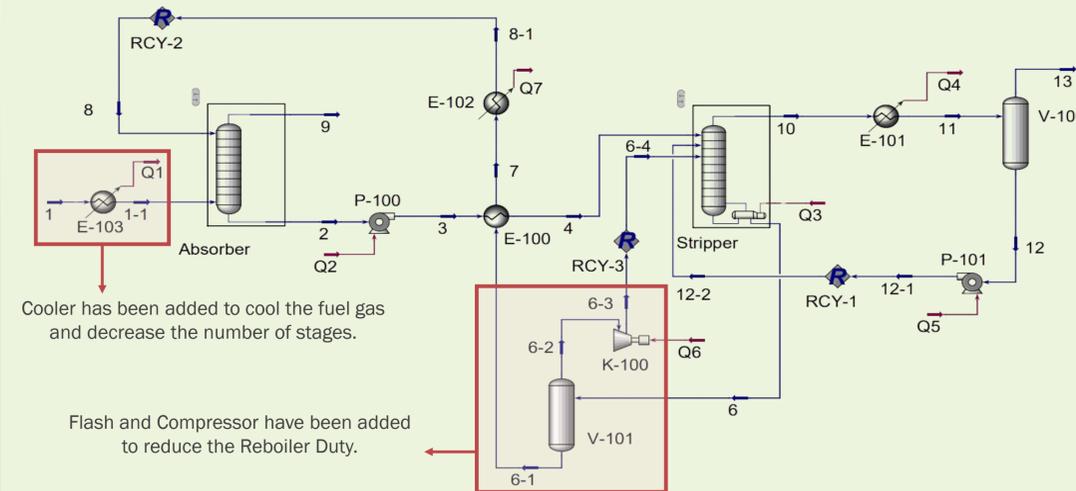
Amidst urgent climate challenges, our project develops an optimized PCC unit to address key environmental issues and offer economic and societal benefits, impacting local, regional, and global scales across multiple dimensions

Prototype Design

Typical Design:



Final Design:



Testing/Validation

Table 1. The met specification of our project

	Achieved Target	Desired Target	Status
% CO2 Capture Rate (mass bias)	98.49%	95-99%	Achieved
CO2 production Rate (tone/year)	128,950.00	200-300K	Not Achieved
Total Energy (KW)	37,516.74	Reduce it by 20%	Achieved
Capital Coat (SAR)	21,385,267.00	Reduce it by 20%	Achieved
Operating Cost (SAR/year)	27,969,899.00	Reduce it by 25%	Achieved

Overall, while there are areas where targets have not been met, such as CO2 production rate, the achievements in other areas like CO2 capture rate, total energy, capital cost, and operating cost suggest a strong foundation for the project. Addressing the shortfall in CO2 production rate may require further analysis and adjustments to processes to ensure alignment with targets and objectives.

Conclusion

Our project is seeking to enhance post-combustion CO2 capture efficiency by developing an innovative configuration based on circular economy principles. It aims to reduce energy consumption, and lower costs. Furthermore, the goal is to capture 200,000-300,000 metric tons of CO2 yearly with 95-99% efficiency, while also improving energy recovery and cutting plant costs. Moreover, this initiative addresses urgent climate concerns while offering economic and environmental benefits on local, regional, and global scales.

Result

