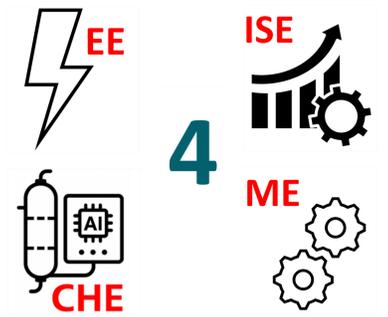


Direct Air Capture (DAC)

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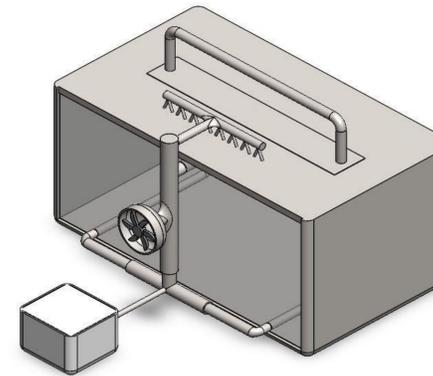
Introduction

Aligned with Saudi Vision 2030 on environmental sustainability and the Kingdom's ambition to achieve net-zero emissions by 2060, our Direct Air Capture (DAC) system offers a powerful tool for removing CO₂ directly from ambient air. By leveraging a modular architecture, the technology can be deployed in diverse settings, from urban centers to remote regions, and easily scaled to meet growing capture targets.

Constraints

- 1-System should comply Saudi environmental regulation.
- 2- Ensure energy efficiency.
- 3- Deliver CO₂ purity between 65%-85%.
- 4- Enable scalability for industry.
- 5- The total cost of DAC system should not exceed 8000 SAR.

Prototype Design



Conclusion

Over six trials, capture efficiency increased from 55 % to 67 % and residual CO₂ fell from 178 ppm to 133 ppm, highlighting significant performance gains. The DAC system's low-energy, modular design is ready for scalable negative-emissions deployment. Further energy optimization and larger-scale tests will drive down costs and support rapid expansion.

Problem Statement

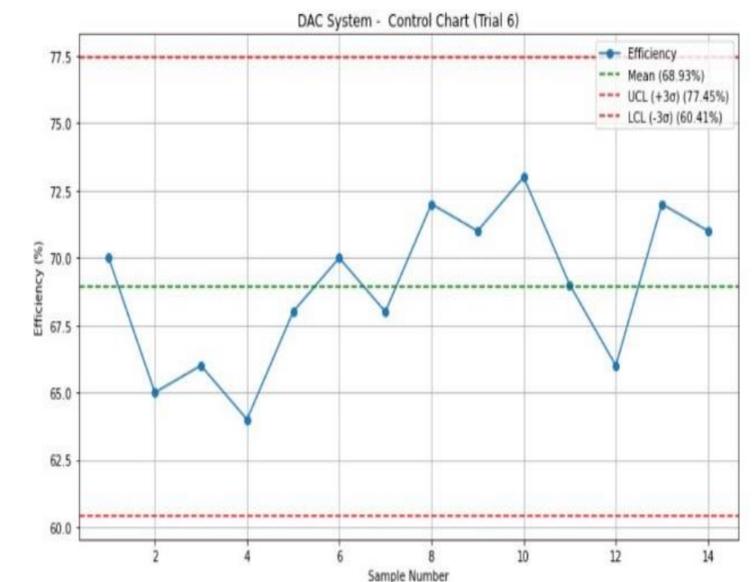
Under Saudi Vision 2030's goal of net-zero emissions by 2060, rising atmospheric CO₂ levels threaten both climate targets and economic stability. Existing capture methods remain energy-intensive and costly. There is an urgent need for a modular Direct Air Capture system that operates on minimal energy, employs regenerable sorbents, and can be deployed flexibly to achieve scalable negative emissions.

Specifications

- 1- Power consumption <50W.
- 2-System dimension:60cmx60cm x50cm.
- 3-Air flow rate 9.5CFM-22CFM.
- 4-Sensors Accuracy range Temp $\pm 0.5^{\circ}\text{C}$, CO₂ ± 50 ppm.
- 5-The DAC system must maintain a CO₂ capture rate of 70% \pm 10%.
- 6- Sorbent flows between 2.8ml/min-16.9ml/min.
- 7- Total operating time = 10 hours.
- 8- Microcontroller Supports I²C,3.3V/5V operation.

Validation and Verification

CO ₂ (PPM)	Efficiency
120	70%
140	65%
230	43%
136	66%
145	64%
130	68%
119	70%
130	68%
111	72%
115	71%
108	73%
123	69%
155	61%
113	72%
118	71%
133	67%



Trial 6 - Mean: 68.93% | Std Dev: 2.84% | UCL: 77.45% | LCL: 60.41%