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# SOLVENT SELECTION FOR EFFICIENT $CO_2$ CAPTURE

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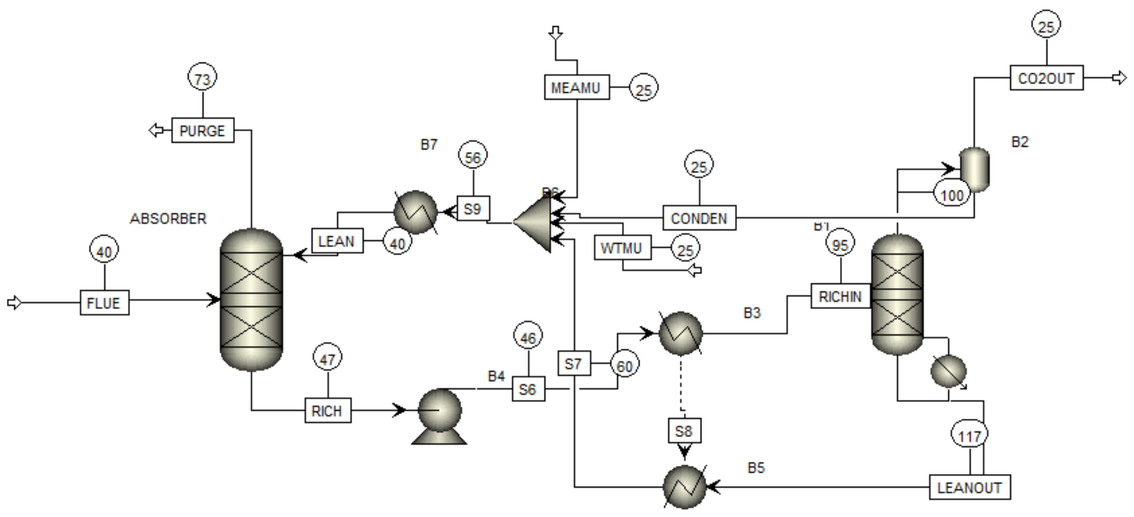
## INTRODUCTION & AIM

Carbon capture is essential for reducing industrial $CO_2$ emissions, particularly in the cement sector. This study evaluates several solvents for absorption-based $CO_2$ capture using Aspen Plus modeling, focusing on capture efficiency, purity, and regeneration energy. The analysis targets 90% capture and 95% purity using flue gas with 19.8% $CO_2$. Amine blends achieved 92% capture and 96% purity with 3.2 GJ/ton regeneration duty, outperforming conventional MEA systems. Ionic liquids and amino acid salts showed competitive performance but higher cost. Overall, hybrid amine solvents offer the best techno-economic feasibility for 2025–2030 applications.

## METHOD

- **Process simulation:** Aspen Plus
- **Inputs:** Flue gas (19.8% $CO_2$, 9.3% $O_2$, 63% $N_2$, 7.5% $H_2O$)
- **Targets:** ≥90% $CO_2$ capture, ≥95% purity
- **Analysis:** Sensitivity of solvent type, absorber temperature, lean solvent flowrate, and regeneration duty.
- **KPIs:** Capture efficiency, purity, reboiler duty, and CAPEX.
- **Solvent types:** Amine blends, Amino acid salts, Ionic liquids, MEA

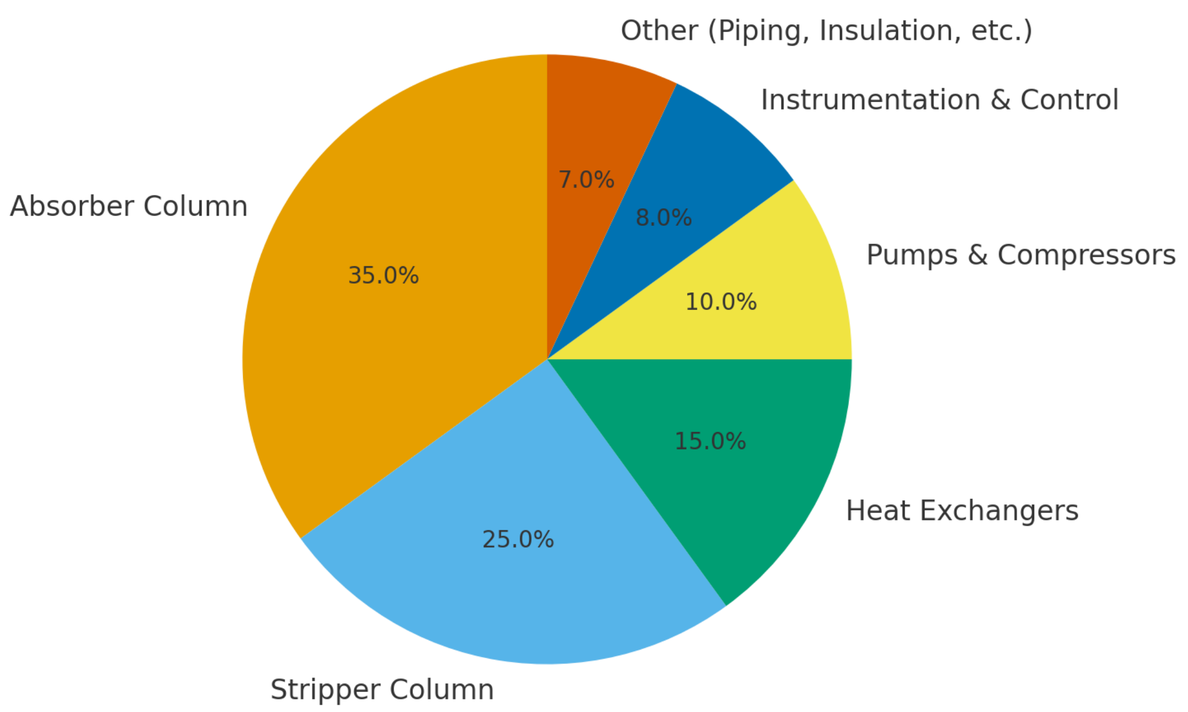
A process model was built for each solvent, and regeneration duty was optimized by varying temperature and lean solvent flowrate.




## RESULTS & DISCUSSION

| Parameter | MEA | Amine blends | Amino acid salts | Ionic liquids |
|---|---|---|---|---|
| **$CO_2$ Capture (%)** | 90 | 92 | 90 | 89 |
| **$CO_2$ Purity (%)** | 95 | 96 | 95 | 95 |
| **Regeneration Energy (GJ/ton $CO_2$)** | 4.0 | 3.2 | 3.4 | 2.8 |
| **CAPEX Impact** | Baseline | ↓15–20% | ↓15% | ↑ (High cost) |

Hybrid amine systems balance energy efficiency and cost better than pure MEA or IL systems.




## CONCLUSION

- Energy demand for hybrid amine systems reduced by ~20%.
- Ionic liquids show promise for long-term decarbonization.
- Amino acid salts are environmentally safer alternatives.
- Optimal regeneration duty: 3.0–3.2 GJ/ton $CO_2$.

## REFERENCES

Turakulov Z, Kamolov A, Eshbobaev J, Turakulov A, Norkobilov A, Boboyorov R. Modeling and Simulation of Chemical Absorption Methods for $CO_2$ Separation from Cement Plant Flue Gases. Engineering Proceedings. 2023; 56(1):142. https://doi.org/10.3390/ASEC2023-15352