Making Sense of Spectra: FTIR Spectroscopy for Tracking Solvent Health in Carbon Capture

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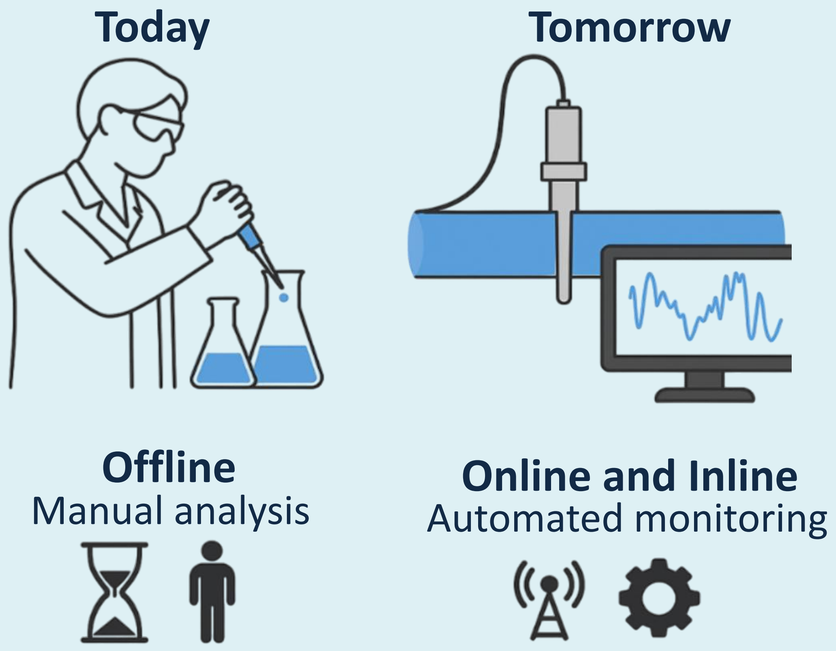
Why we care?



Amine-based carbon capture is a leading technology for reducing CO_2 emissions from industrial sources. **CESAR1**, a benchmark solvent blend of 2-amino-2-methyl-1-propanol (AMP), piperazine (PZ), and water, offers improved performance over traditional systems such as monoethanolamine (MEA), including higher capacity, lower regeneration energy, and reduced degradation [1].

However, maintaining stable performance requires frequent monitoring of solvent condition, which is typically done via **time-consuming offline methods** such as titration or gas-, ion- and liquid chromatography. Reliable **monitoring** of carbon capture solvents is essential for process stability, cost reduction, and long-term performance. **Real-time** insight into solvent health is a missing link in automation. This work explores how Fourier Transformed Infrared Spectroscopy (FT-IR) can help close that gap.

Methodology

1 Peak Identification

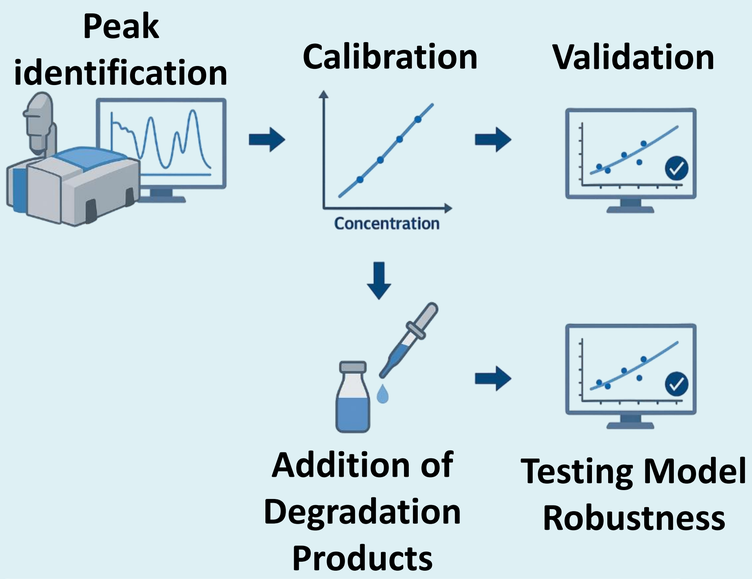
- Identified AMP and PZ peaks by single component analysis
- Identified CO_2 spectral region in CESAR1 loaded solvents

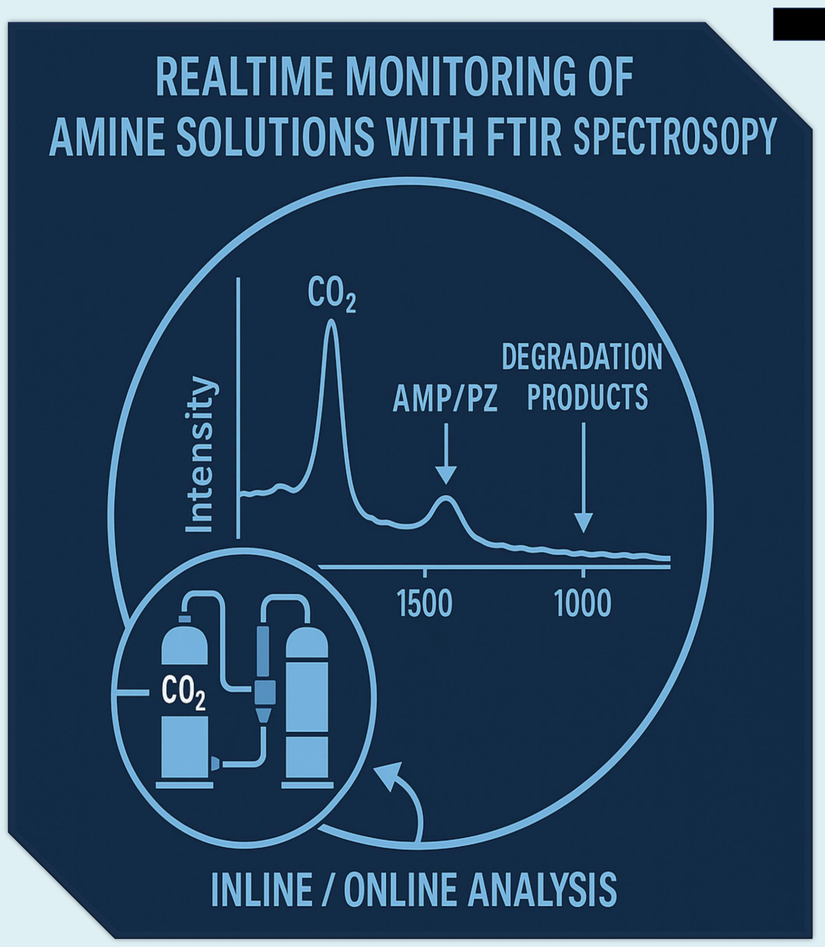
2 Model Calibration

- Built Partial Least Square (PLS) calibration model.

3 Model Validation

- Use test data to validate PLS model





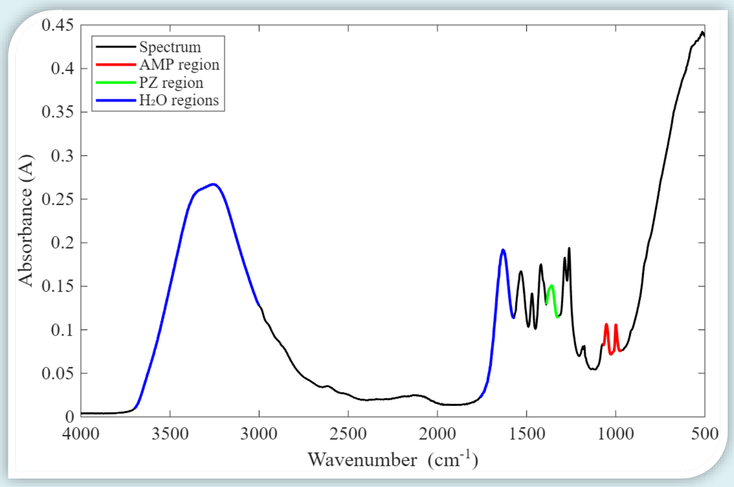
Zooming in on the spectra

Clear identification of **water** peaks

Characterized peak of **PZ** in the amine region

Characterized peak of **AMP** in the amine region

Peak lifting by presence of CO_2



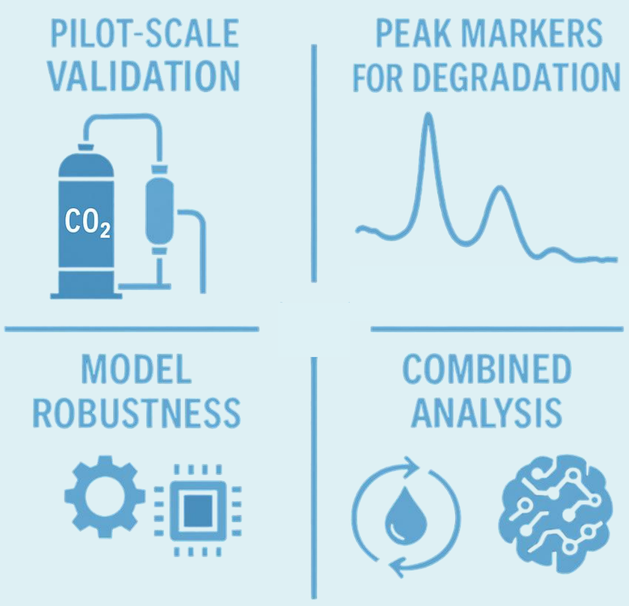
Results

Prediction performance of the **PLS model** shows **high accuracy** for all components, with minimal bias. This supports the use of FTIR spectroscopy for reliable quantification of **AMP, PZ, and CO_2** in amine-based capture systems.

Component	$R^2_{prediction}$	Prediction bias (wt. %)
AMP	0.999	-0.041
PZ	0.986	- 0.051
CO_2	0.978	0.26

Prediction R^2 values and prediction bias for AMP, PZ, and CO_2 based on FT-IR analysis using Partial Least Square (PLS) model.

Future work



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References

[1] "Final Report Summary - CESAR (CO2 Enhanced Separation and Recovery) | FP7," CORDIS | European Commission. Accessed: Dec. 18, 2024. [Online]. Available: https://cordis.europa.eu/project/id/213569/reporting