Development of Acoustic-Driven Packing Material, 3” Absorber with Stripper

for CO_2 Capture and Absorption Processes

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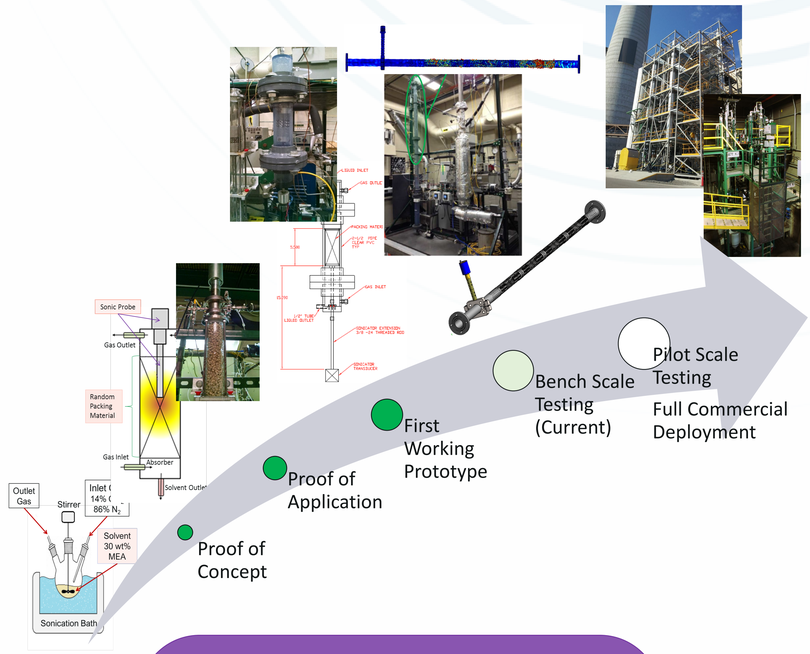
UK

Development

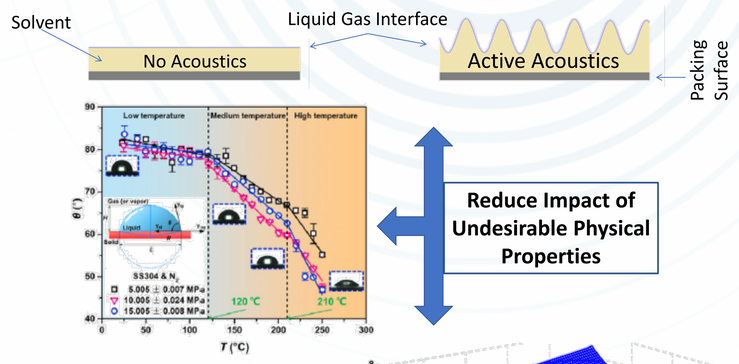


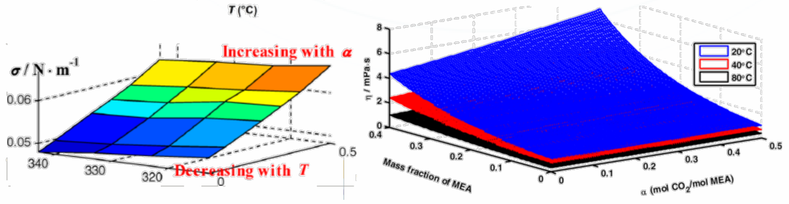
Introduction

A novel device is in development at UKy-CAER, acoustic-driven packing material, which uses acoustic streaming and micro turbulence to improve absorption rate in a counter current CO_2 absorption process. Transmitting high frequency acoustic energy, at resonance, into the packing material of an absorber column will cause that material to vibrate and become a transmitter of the incident acoustic energy. Solvent in contact with the vibrating packing material will oscillate at similar wave parameters to the source of acoustic energy.

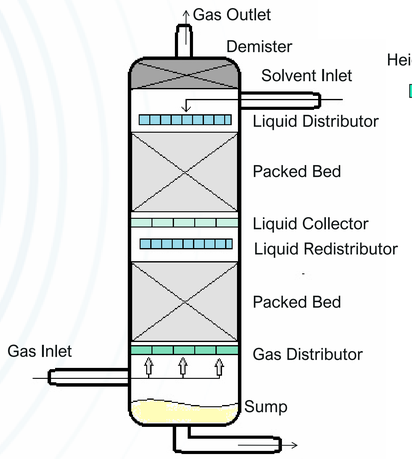
- Provide up to a 20% relative increase in solvent absorption rate with 30 wt% monoethanolamine.

Mechanism

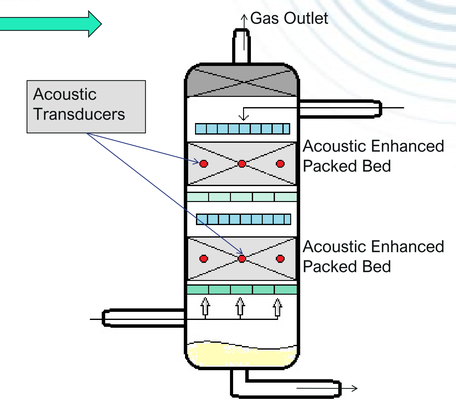




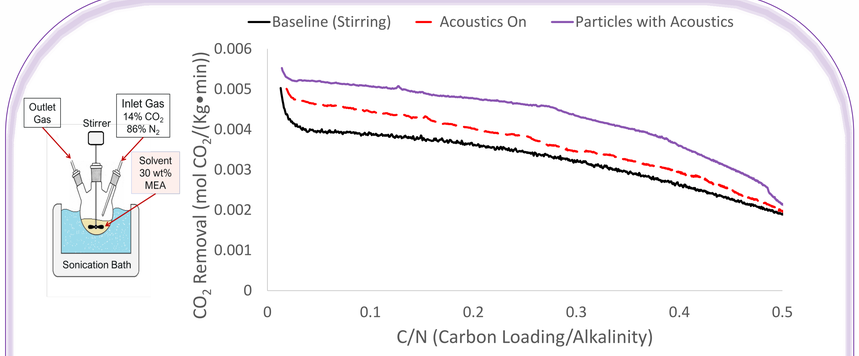
Goal



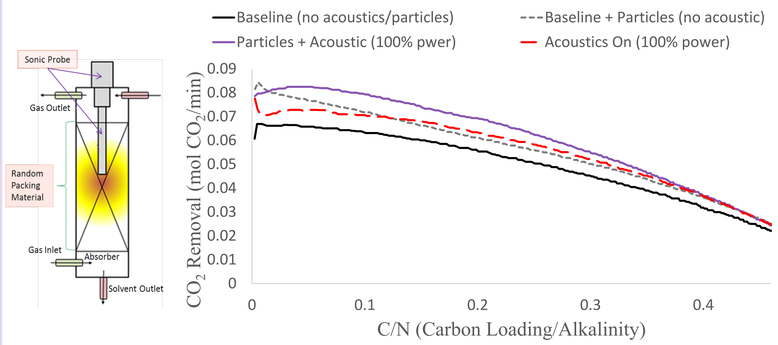
Height Reduction



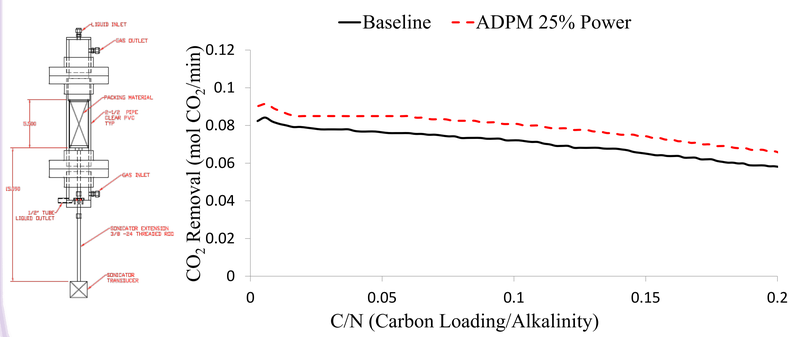
Past Results



- 30-40% absorption increase with acoustics and particle additive.
- 10% with just acoustics.



- 21-25% absorption increase with acoustics and particle additive.
- 11-15% increase with just acoustics

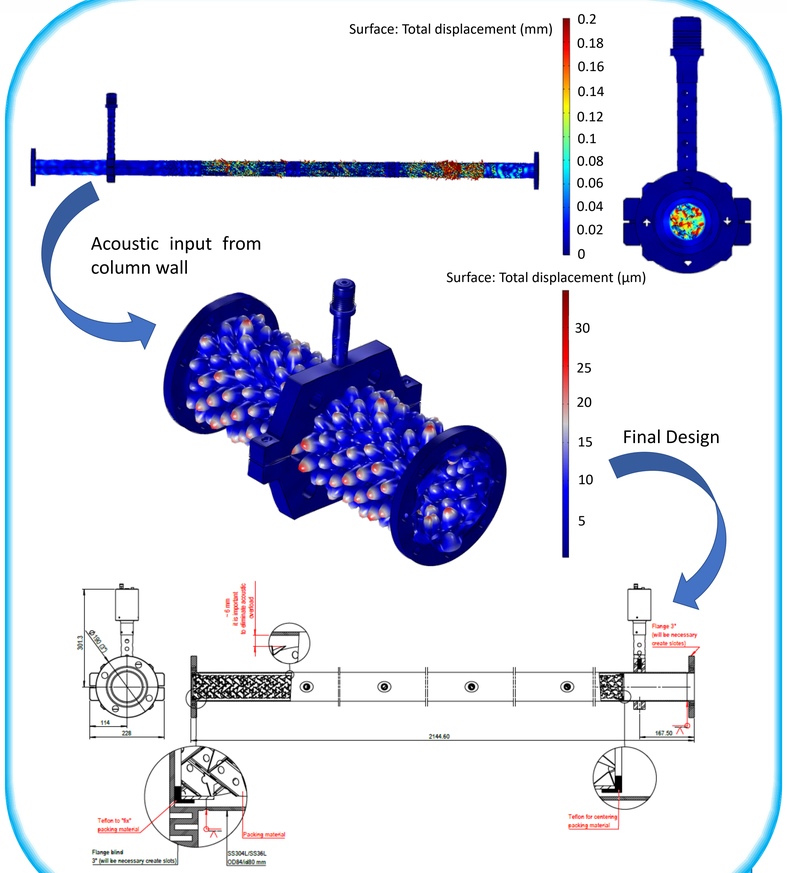


- Acoustic Driven Packing Material increased the rate of CO_2 absorption by approximately 15%.

What effects resonance frequency?

Load Shape Reflected Waves Reactive Load

Design



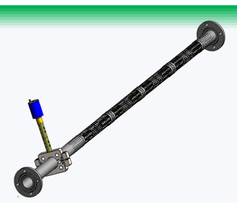
Considerations for Final Design

1. Thin and rigid metal material conducts sound very well.
2. Experimental flexibility necessitated the air coupling method instead of permanent fixtures.
3. Decoupling acoustic energy from the rest of the process.
4. Reactive loads.

Acknowledgements

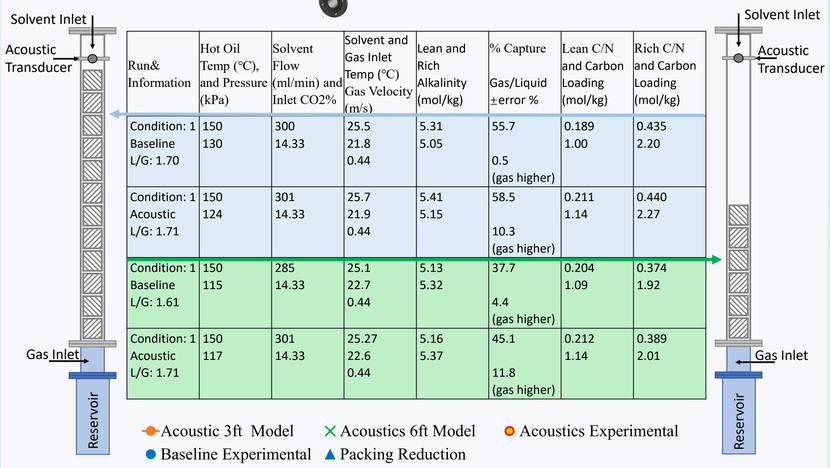
The authors acknowledge the Department of Energy (DOE), National Energy Technology Laboratory (NETL), PennState ant the Coalition for Fossil Energy Research (UCFER), and MPI Ultrasonics.

Initial Results

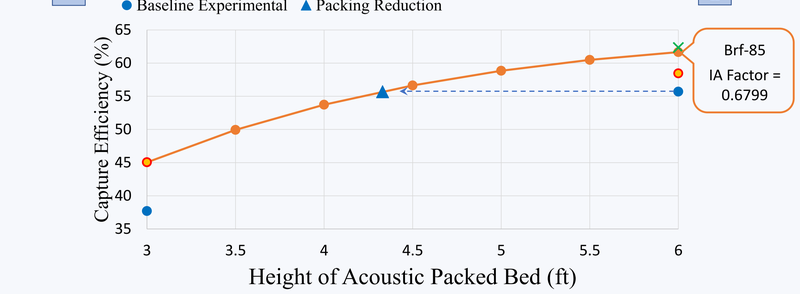


Full Column

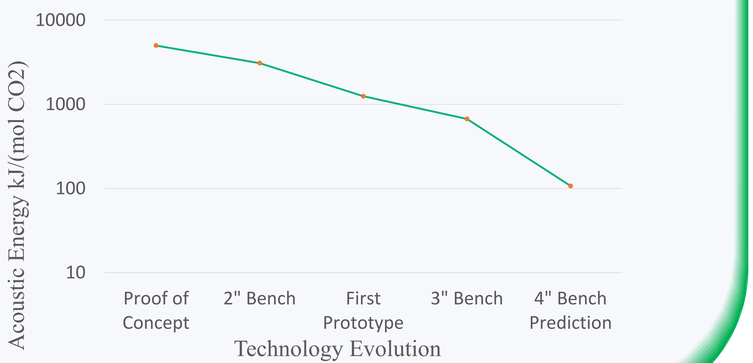
Half Column



Run& Information	Hot Oil Temp (°C), and Pressure (kPa)	Solvent Flow (ml/min) and Inlet CO2%	Solvent and Gas Inlet Temp (°C) Gas Velocity (m/s)	Lean and Rich Alkalinity (mol/kg)	% Capture Gas/Liquid ±error %	Lean C/N and Carbon Loading (mol/kg)	Rich C/N and Carbon Loading (mol/kg)
Condition: 1 Baseline L/G: 1.70	150 130	300 14.33	25.5 21.8 0.44	5.31 5.05	55.7 0.5 (gas higher)	0.189 1.00	0.435 2.20
Condition: 1 Acoustic L/G: 1.71	150 124	301 14.33	25.7 21.9 0.44	5.41 5.15	58.5 10.3 (gas higher)	0.211 1.14	0.440 2.27
Condition: 1 Baseline L/G: 1.61	150 115	285 14.33	25.1 22.7 0.44	5.13 5.32	37.7 4.4 (gas higher)	0.204 1.09	0.374 1.92
Condition: 1 Acoustic L/G: 1.71	150 117	301 14.33	25.27 22.6 0.44	5.16 5.37	45.1 11.8 (gas higher)	0.212 1.14	0.389 2.01



Capture Improvement with ADPM, 3’ column, condition 1: **19.63%**
→ **28%** reduction in column height



Market Opportunities

CO_2 Capture
General Acid Gas Scrubbing
Stripping
Distillation
General Separations
Defoaming