Enhancement of Carbon Capture Reactor Performance

University of Kentucky

Institute for Decarbonization and Energy Advancement

Primary Project Goal

The University of Kentucky (UK) is continuing to address the challenges persist in post-combustion carbon capture to reduce the cost of carbon dioxide (CO_2) capture via solvent development, improving absorber performance, and process and heat integration. There is still a need to improve solvent/packing wettability and increase CO_2 mass transfer in the absorber column with a liquid/gas ratio less than 1.2, and high gas velocity with low gas pressure drop across the absorption train. This challenge will be addressed through the development of new absorber reactor components and materials for UK's heat-integrated carbon capture technology. This includes using advanced polymeric packings that have enhanced compatibility with newly developed high viscosity non-aqueous and water-lean solvents.

Technical Goals

- Develop and test absorber reactor components that increase CO_2 mass transfer for high viscous solvents through increased turbulence on the gas-liquid interface and improved solvent wetting on the packing.
- Demonstrate the ability to efficiently capture CO_2 at 90–97% or greater and make significant progress toward a 40% reduction in cost of capture versus the reference natural gas combined cycle (NGCC) power plant with carbon capture at the same efficiency.
- Perform a techno-economic analysis (TEA) on the proposed technology to demonstrate decreased capital costs for NGCC capture plants at 95+% CO_2 capture efficiency.

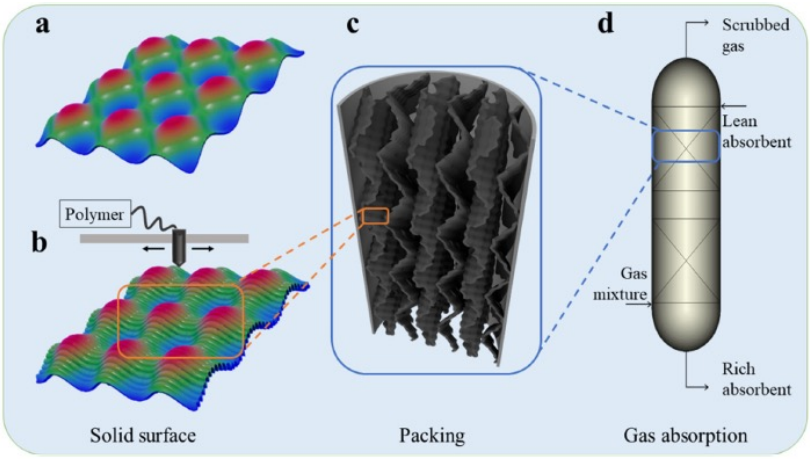
Technology Advantages

- Operating at 40°C eliminates the cost of the direct contact cooler (DCC), its cooling tower and balance of plant, which accounts for lowering the overall cost of carbon capture and storage (CCS) by 10%.
- Operating at 40°C results in nearly 35% reduction of solvent viscosity when compared to operating at 30°C.

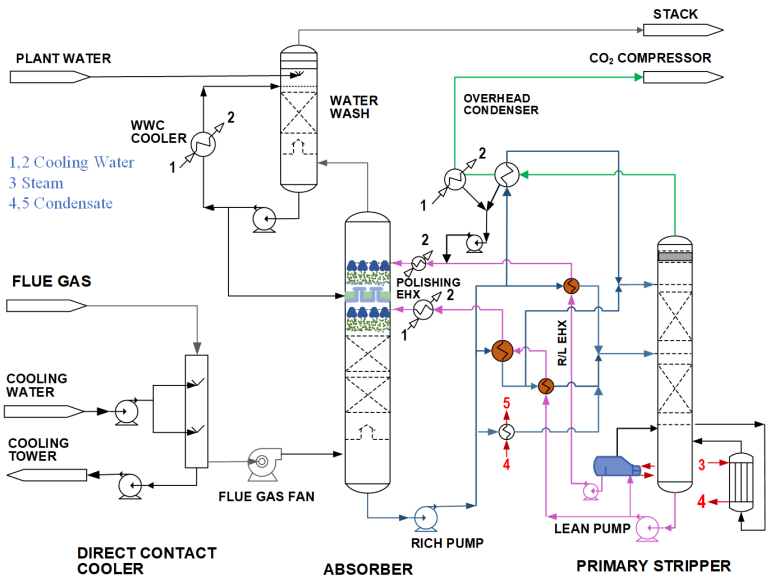
R&D Challenges

- Improving solvent properties for CO_2 uptake and release.
- Improving process and heat integration design to enhance CO_2 mass transfer in the absorber column.

Program area -	Point Source Carbon Capture
Ending Scale -	Bench-scale
Applications -	Post-combustion Industrial NGCC
Key Technology -	Solvents
Project Focus -	Absorber Packing Enhancement
Project Number -	FE0032217
NETL Project Manager -	Nicole Shamitko-Klingensmith
Principle Investigator -	Jesse Thompson - UK
Partners -	EPRI, PPL

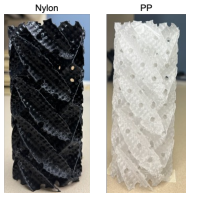


3D printed packing for CO_2 capture; (a) smooth steel packing surface, (b) 3D printed polymer packing surface with additional wavy sub-structure, (c) 3D-printed Nylon packing section, (d) CO_2 capture absorber column



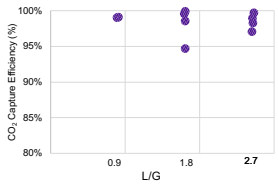
UK NGCC Process Design

POWER PLANT ECONOMICS AT 97% CARBON CAPTURE		
Economic Values	Units	Current R&D Value
Cost of Carbon Captured	$/tonne CO_2	60.4
Cost of Carbon Avoided	$/tonne CO_2	80.1
Capital Expenditures	$/MWhr	20.7
Operating Expenditures	$/MWhr	45.5
Cost of Electricity (levelized)	$/MWhr	66.1



Polymer 3D printed packings

Better wetting from Water-lean Solvent



Targeted +95% CO_2 capture at low L/G

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UK IDEA - https://idea.engr.uky.edu/

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