CO₂ Capture with Ionic Liquids Involving Phase Change

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Technology Summary

A new concept for CO₂ capture that uses phase change ionic liquids (PCILs) offers the potential to significantly reduce parasitic energy losses incurred from capturing CO₂ from flue gas. PCILs are solid ionic materials that have high CO₂ uptake (one mole of CO₂ for every mole of salt at post-combustion flue gas conditions) and form a liquid when they react with CO₂. This allows for a novel process that uses the heat of fusion to provide part of the heat needed to release CO₂ from the absorbent, reducing the total energy required.

This project will (1) develop and characterize PCILs; (2) evaluate energy savings in a new CO₂ capture process; and (3) demonstrate the technology at laboratory scale.

Goals:
- Develop ionic salts that undergo a phase change (from solid to liquid) when they react with CO₂; taking advantage of the enthalpy change when PCILs react, CO₂ to enable capture of 90% of the CO₂ from post-combustion flue gas with less than a 35% increase in the cost of electricity.

Discovery - solid ionic materials
- have high CO₂ uptake (close to one mole of CO₂ per mole of salt at post-combustion flue gas conditions) and
- form a liquid when they react with CO₂

Invention - use the heat of fusion (generated as the salt solidifies upon release of CO₂) as part of the heat needed to release the CO₂ from the absorbent in the solvent regeneration step

In a 500 MW (471 MW de-rated) coal plant:
- Aqueous amine scrubbing incurs parasitic energy losses of 28% (132 MW).
- Current ionic liquids could reduce this to 23% (110 MW).
- Proposed PCIL process could reduce energy losses to 14% (66 MW).

Key Milestones & Deliverables

Year 1
- Characterization of first set of PCILs (TRL 3)
- Identification of key process variables

Year 2
- Detailed process model based on theoretical and experimental results
- Go/NoGo based on predicted parasitic energy

Year 3
- TRL 4 demo of PCIL based CO₂ capture process

Approach

Progress to Date

- Synthesized five Gen1 PCILs
-Measured CO₂ uptake of two Gen1 PCILs and began measurements of other compounds
- Developed forcefields for Gen1 PCILs and initiated molecular simulations
- Initiated measurements of heats of reaction and construction of packed bed absorption column
- Initiated process modeling

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