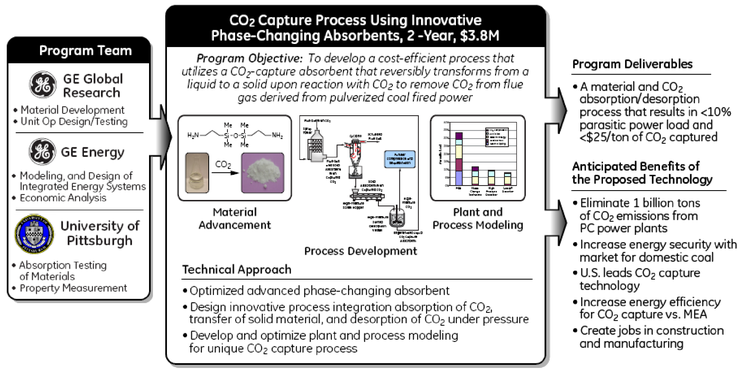
CO_2 Capture Process Using Phase-Changing Absorbents

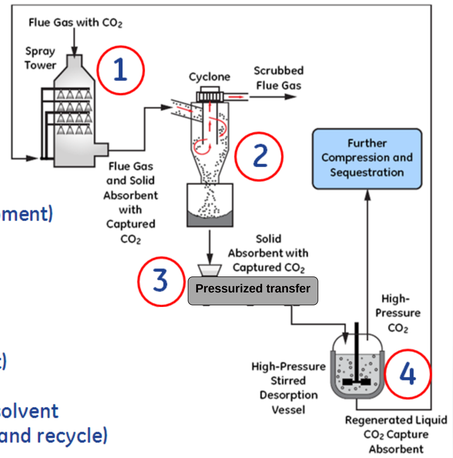
ARPA-E Project DE-AR0000084

Bob Perry, Sarah Genovese, Ben Wood, Tiffany Westendorf, Mike O'Brien, Matt Meketa, Tom Perry, Rachel Farnum, John McDermott, Irina Sultanova (GRC),
Ravi–Kumar Vipperla, Lisa Wichmann, Sam Draper (GEE), Bob Enick, Lei Hong, Deepak Tapriyal (U Pitt)

Program Strategy



Phase Change Concept



1 Make the solid (Solvent development)

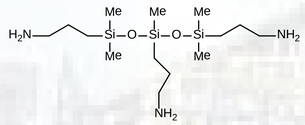
2 Collect the solid (Solid isolation)

3 Move the solid (Solids transport)

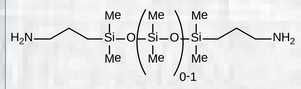
4 Regenerate the solvent (CO_2 desorption and recycle)

Absorbent Development

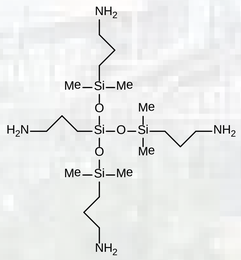
- Systematically vary chemistry and structure for optimal reactivity
- Representative materials found that:
  - are low viscosity liquids
  - produce solids on exposure to CO_2
  - have high CO_2 uptake
  - thermally reversible



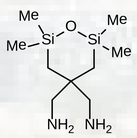
M'D'M'
17.8% CO_2 uptake



GAP-0/1
13.1-17.1% CO_2 uptake

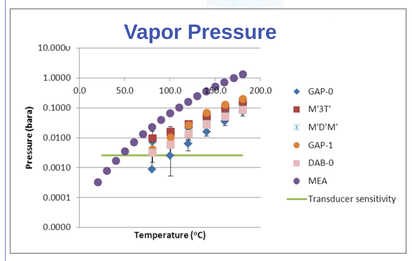


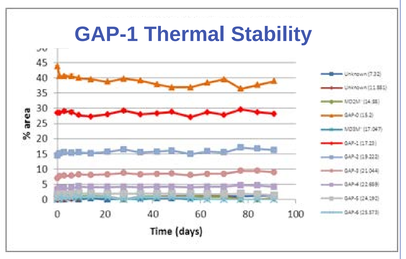
M'$_3$T"
18.8% CO_2 uptake



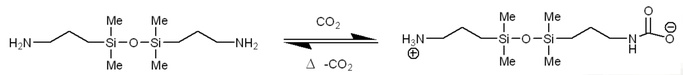
Cyclic
15.5% CO_2 uptake

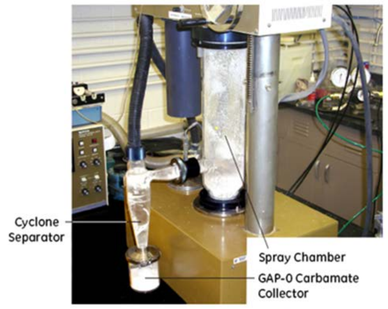
Absorbent Stability





Solid Formation and Isolation

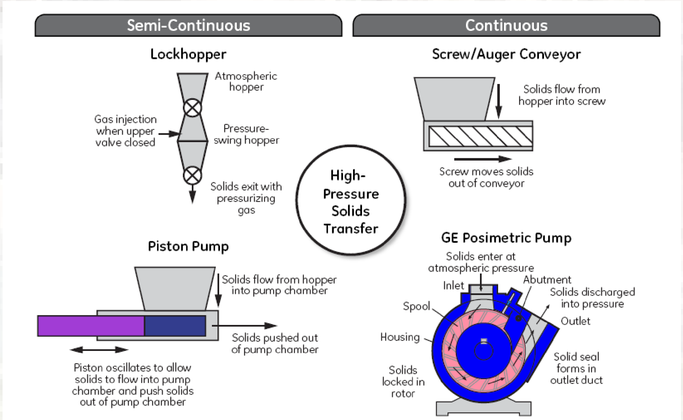




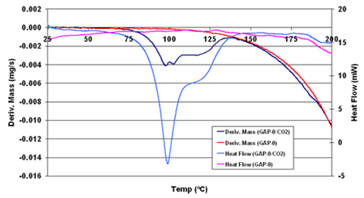
- Spray drier with co-current CO_2 flow
- Nearly instantaneous solid formation
- 50-100 g sample size
- Additional instrument procured

GAP-0 carbamate powder

Options for Solids Transfer

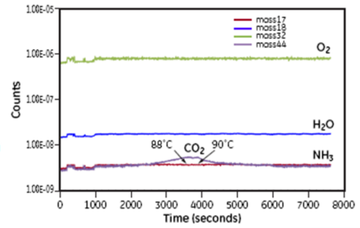


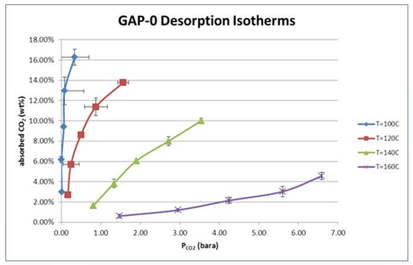
Desorption



- TGA shows 3 events
- Onset at ~70 °C
- Major loss 90-110 °C
- DSC indicates 2 events
- Looking at desorption kinetics

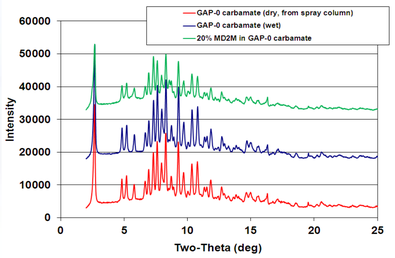
- TGA/MS confirms only CO_2 loss
- No decomposition products
- Examining DSC/TGA profiles to differentiate phase changes from decarboxylation process



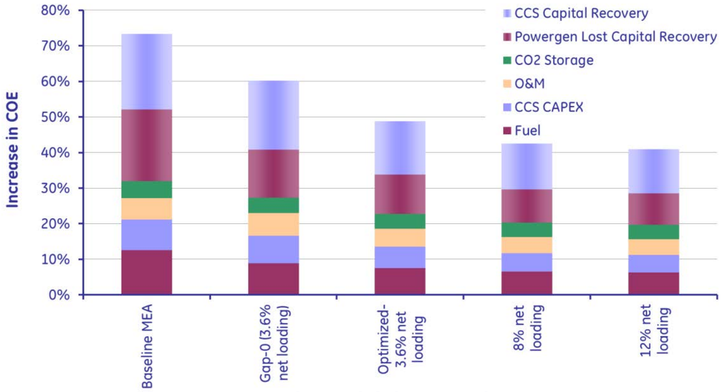


- Neat GAP-0 data
- >14% to <4%
- ~10% dynamic range

- GAP-0 carbamate is highly XL'n
- Water does not disrupt matrix
- Incompatible diluent does not affect XL structure



Preliminary COE Calculations



Substantial decrease in COE