An Advanced Sorbent for Direct Air Capture
DOE Contract No. DE-SC0020848

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DOE/NETL Direct Air Capture
Virtual Kick-off Meeting

February 24, 2021

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Project Summary

Project Objectives

• To develop an adsorption-based process to directly remove CO₂ from air
  • TDA’s process uses a unique chemically modified adsorbent that can effectively remove CO₂ at very low concentrations (i.e., 400 ppmv)
  • A mild temperature/concentration swing will be employed to regenerate the sorbent and recovery the CO₂ as a concentrated product
  • Unique gas-solid contactor is designed to minimize the pressure drop and the associated parasitic losses

Phase I Work Plan

• Optimize the sorbent structure through molecular modeling
• Develop techniques to make prepare pellets/ granules while preserving the desired adsorptive properties
• Demonstrate the stable operation through many cycles for DAC
• Design and optimize adsorption cycle sequence to achieve both high product (CO₂ capture) yield and high purity
• Techno-economic analysis to assess the merits of the DAC technology

Project Budget/Duration

• $250,000 – 9 months
A promising samples with high CO$_2$ uptake at low CO$_2$ partial pressure are further evaluated in a bench-scale flow reactor.
The Challenge - Sorbent Pelletization

- Material is pelletized using low energy compaction techniques
- Process optimization was carried out to achieve a material with high mechanical strength without giving up some of the desired material properties (e.g., surface area porosity)
- Currently exploring methods to apply the materials onto engineered structures

TDA’s disk agglomerator and pill press

Sample pellets
Evaluations at the Bench-scale

- Under a mild thermal swing of 30°C TDA’s sorbent achieved 3%wt. CO$_2$ uptake ($T_{\text{adsorption}} = 30^\circ\text{C}; T_{\text{regeneration}} = 60^\circ\text{C}$)
- Sample is stable under air flow at temperatures up to 80°C achieving a working capacity of 8.6% wt. CO$_2$ ($T_{\text{adsorption}} = 30^\circ\text{C}; T_{\text{regeneration}} = 80^\circ\text{C}$)
  - Above 80°C, the performance and stability decreases
- We carried out multiple cycles with adsorption at 30C and desorption at 80C and showed that the sorbent retained a stable capacity of $\sim$7.2% wt. CO$_2$ (1.6 mmol/g)
The specific energy required for CO$_2$ capture and compression to 2,200 psig as a function of CO$_2$ concentration was measured:

- DAC to all the way up to coal derived flue gas
- As the CO$_2$ concentration gets lower than 4% the energy needed to move the gas stream through the capture system far exceeds the energy needed for separation ($\Delta P$ fixed at 150 mbar)