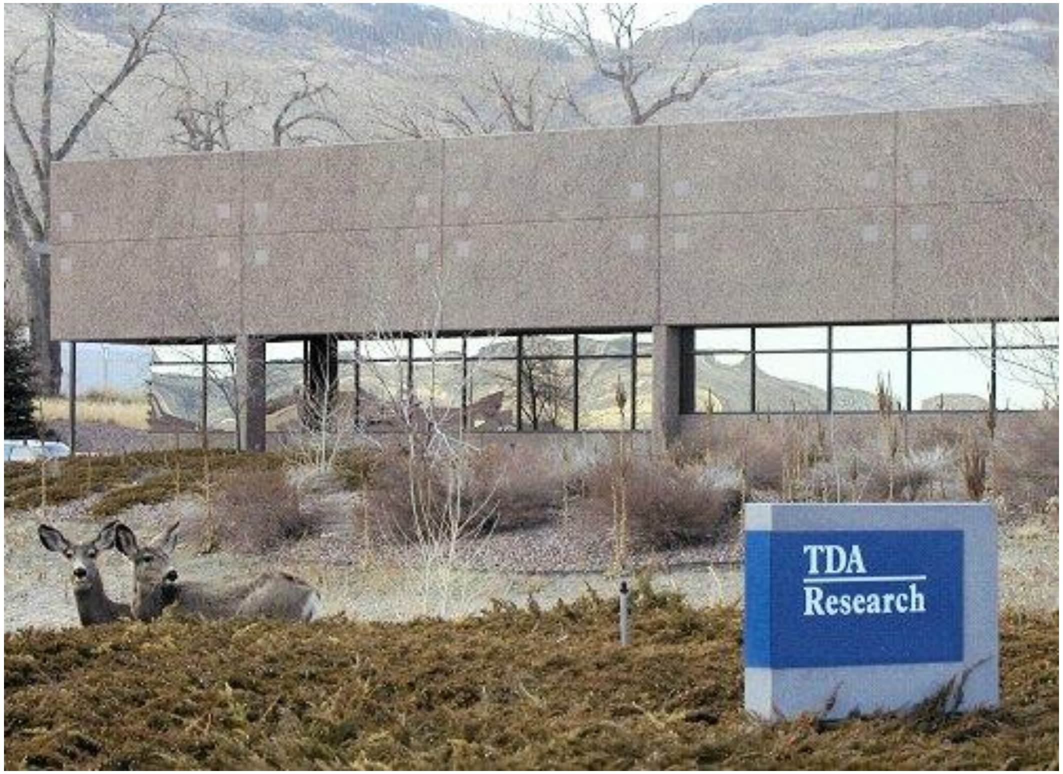
An Advanced Sorbent for Direct Air Capture
DOE Contract No. DE-SC0020848



Gokhan Alptekin, PhD
Ambal Jayaraman, PhD
Margarita Dubovik
Sarah DeVoss
Meredith Haanstad

TDA Research, Inc.
Wheat Ridge, CO

DOE/NETL Direct Air Capture
Virtual Kick-off Meeting

February 24, 2021

Project Summary

Project Objectives

- **To develop an adsorption-based process to directly remove CO_2 from air**
  - TDA's process uses a unique chemically modified adsorbent that can effectively remove CO_2 at very low concentrations (i.e., 400 ppmv)
  - A mild temperature/concentration swing will be employed to regenerate the sorbent and recovery the CO_2 as a concentrated product
  - Unique gas-solid contactor is designed to minimize the pressure drop and the associated parasitic losses

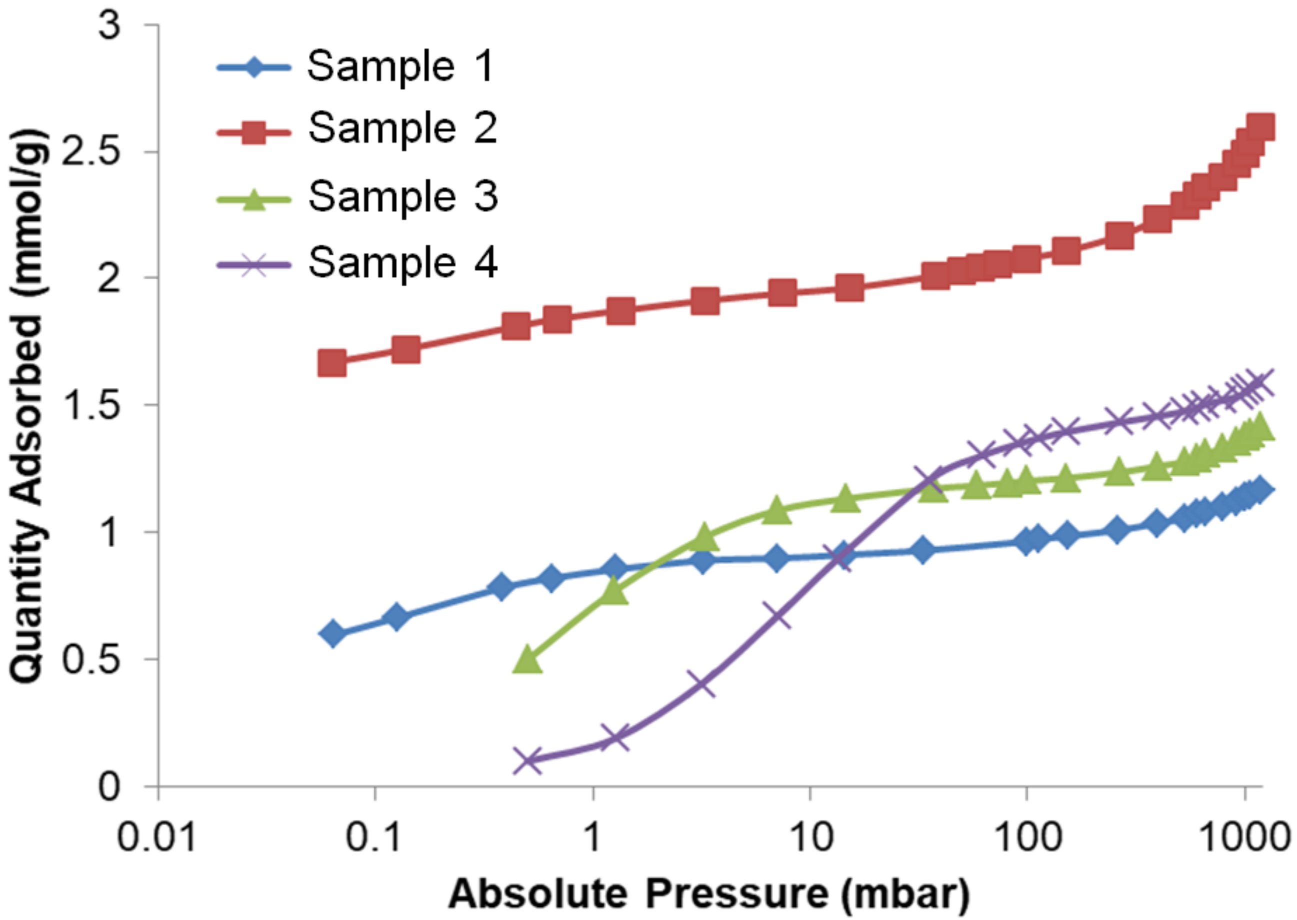
Phase I Work Plan

- **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 (CO_2 capture) yield and high purity**
- **Techno-economic analysis to assess the merits of the DAC technology**

Project Budget/Duration

- **$250,000 – 9 months**

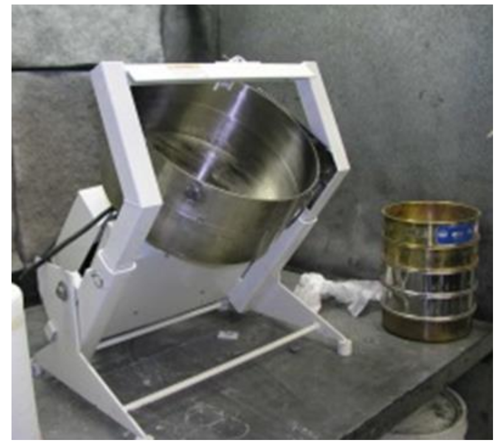
Rapid Screening by Isotherm Measurements



- **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

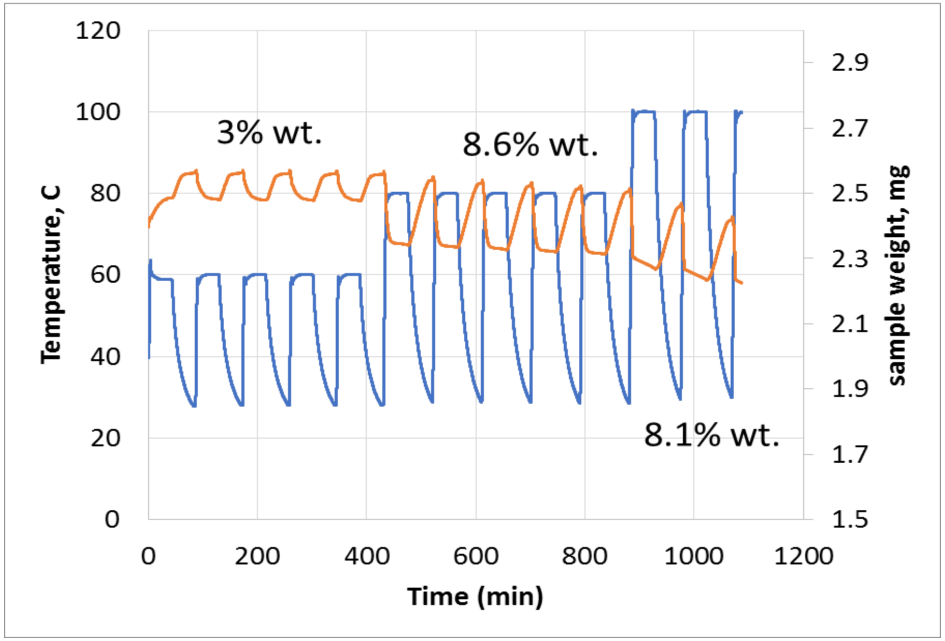
- **Material is pelletized using low energy compaction techniques**
- **Process optimization was carried out to achieve a material with high mechanical strength without giving up some of the desired material properties (e.g., surface area porosity)**
- **Currently exploring methods to apply the materials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

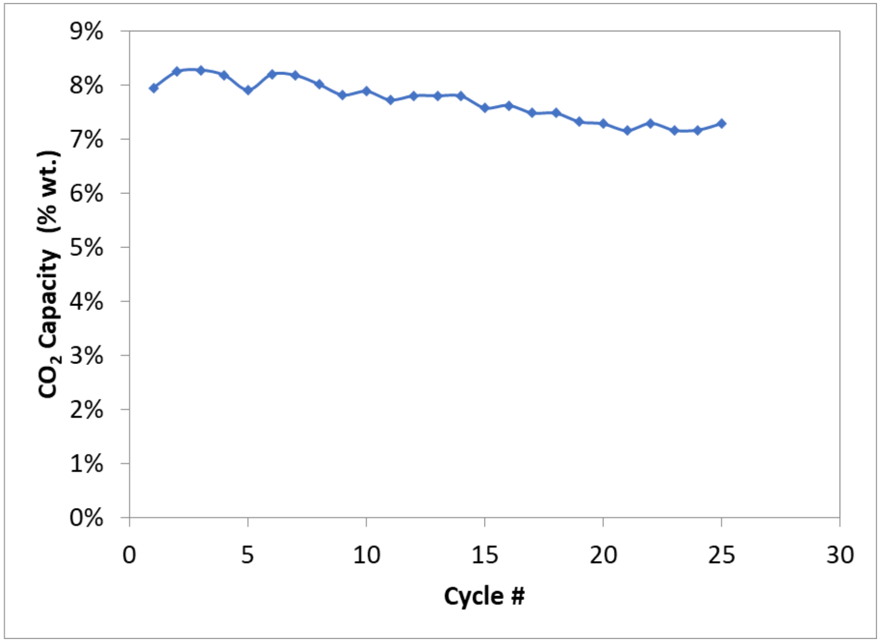



TDA's disk agglomerator and pill press


Sample pellets

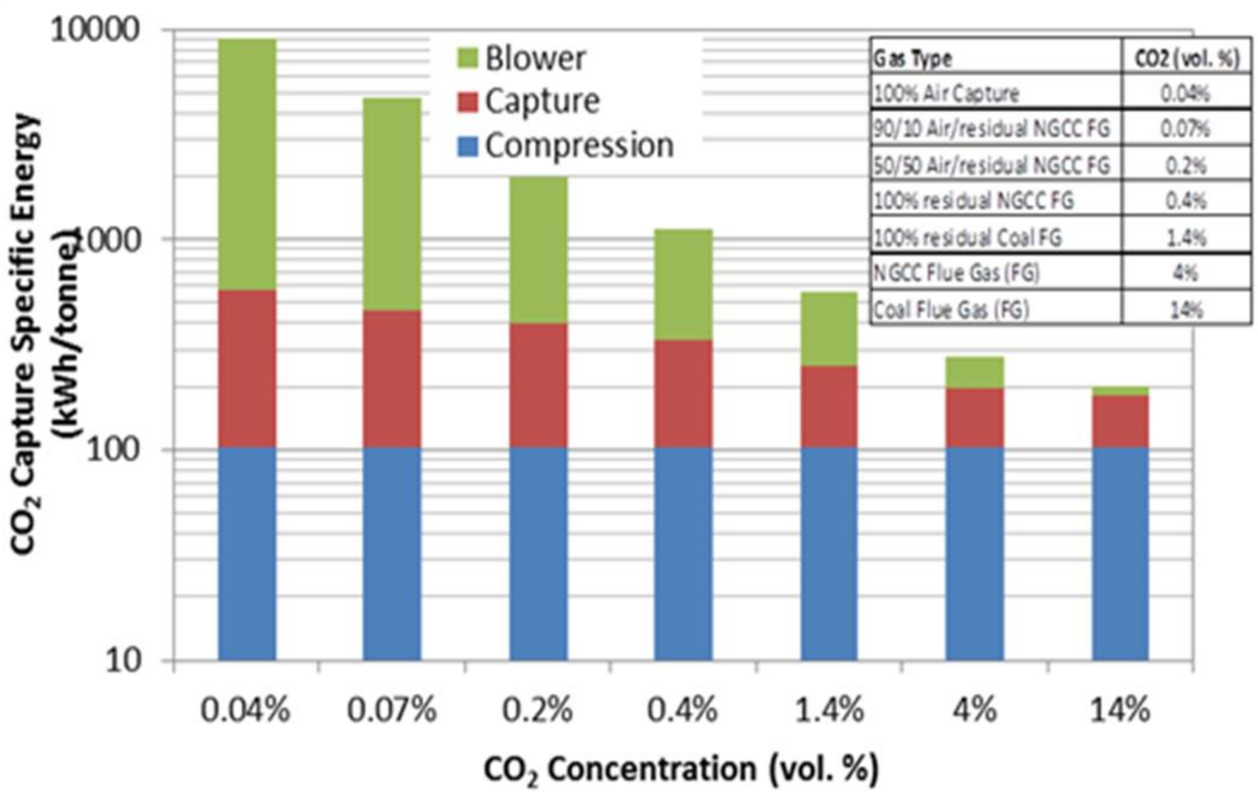
Evaluations at the Bench-scale





- **Under a mild thermal swing of 30°C TDA's sorbent achieved 3%wt. CO_2 uptake ($T_{adsorption}$ = 30°C; $T_{regeneration}$ = 60°C)**
- **Sample is stable under air flow at temperatures up to 80°C achieving a working capacity of 8.6% wt. CO_2 ($T_{adsorption}$ = 30°C; $T_{regeneration}$ = 80°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 ~7.2% wt. CO_2 (1.6 mmol/g)**

Engineering Analysis & System Design



- 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 (ΔP fixed at 150 mbar)

TDA