Transformational Sorbent Materials for a Substantial Reduction in the Energy Requirement for Direct Air Capture

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Direct Air Capture Kickoff Meeting

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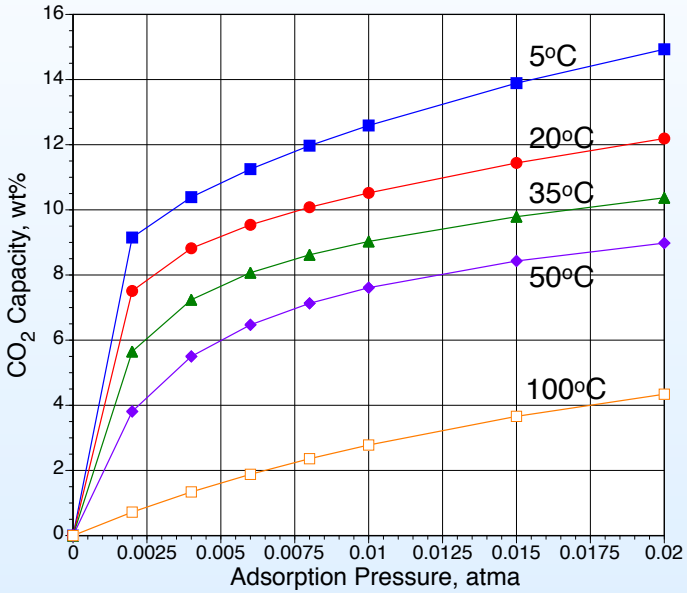
Project Overview

- Total DOE funding: $800,000; Cost Share: $200,000
- Project Dates: 10/01/2020 to 3/31/2022
- Project Partners: InnoSepra, DOE, Arizona State University, Missouri University of Science & Technology, Adroitech, Inc. and material suppliers
- Overall objective is to demonstrate that the proposed transformational materials have the potential to reduce the energy required for direct air capture compared to current state-of-the-art technologies by over 50%

Technology Background



- Base materials with high CO_2 capacity (>4-wt% at p_{CO2} = 0.04 kPa), low heats of adsorption (40-44 kJ/mol of CO_2) identified
- Chemical modification of base materials to improve capacity
- Low cost materials, easily scalable to quantities needed for commercial use, very stable (>5 year life)
- Challenges include fabrication of large quantities in structured forms

Technical Approach/Project Scope

Work Plan

- Literature review, procurement of base materials
- Optimization of base materials through lab experiments and simulations at DAC conditions (p_{CO2} = 0.04 kPa)
- Measurement of CO_2 sorption isotherms and kinetics
- Preparation, testing and characterization of selected materials in beaded and structured forms
- High level process design incorporating the best material

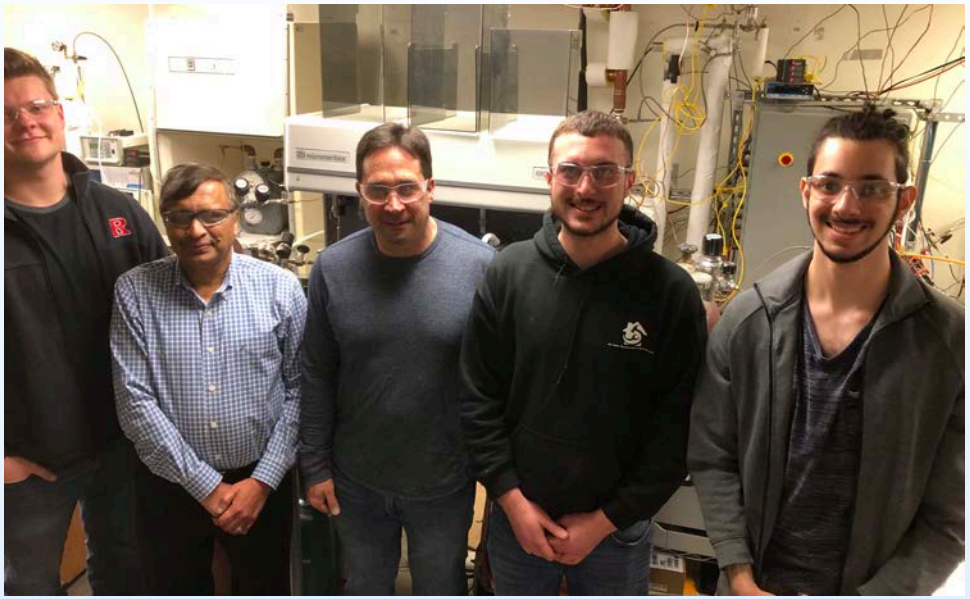
Key Milestones

- Sorbent down-selection based on capacity/energy – 6/30/21
- Preliminary technical design and analysis – 2/28/22

Project Success Criteria

- A CO_2 capacity >3.5-wt% at DAC conditions with potential for up to 50% reduction in energy requirement

Team and Facilities



- DOE Project Manager: Mr. Sai Gollakota
- Project partners include:
  - InnoSepra: Project management, testing, analysis, reporting
  - Adroitech: GCMC simulations, structured sorbents
  - Arizona State: Sorbent characterization
  - Missouri S&T: Structured sorbents
- Key equipment includes sorption microbalances and test units

Current Status of the Project

- Two key technologies identified through prior art search
  - Carbon Engineering uses an absorption system: reaction with NaOH, followed by regeneration with $Ca(OH)_2$ and reactivation of $CaCO_3$ to CaO, hydration of CaO to produce $Ca(OH)_2$
  - Global Thermostat and Climeworks use amine-impregnated sorbents with either indirect regeneration or direct steam regeneration
  - Both approaches need upwards of 8 GJ/ton of CO_2 in thermal energy, a significant amount of this energy is needed at >900^{o}C for the Carbon Engineering Process
  - Amine-based sorbent can degrade irreversibly, short sorbent life
- Obtained base materials for isotherm measurements and for chemical modifications
  - More than 4.5-wt% capacity at a p_{CO2} of 0.04 kPa

Opportunities for Collaboration

- The technology can be demonstrated quickly at scale through a synergistic combination of
  - Large scale production of CO_2 capture materials
  - Fabrication and testing of the capture equipment incorporating capture materials in structured form (>2,000 Nm^3/hr scale)
- InnoSepra would welcome opportunities to work with:
  - Companies involved in fabrication of structured sorbents
  - Research institutions involved in molecular simulations to predict sorption isotherms
  - Independent organizations involved in evaluating various technologies / materials for Direct Air Capture
  - Companies interested in scaling up sorbent manufacture
  - Investors / business partners

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