Demonstration of a Continuous Motion Direct Air Capture System

NETL DE-FE0031957

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Global Thermostat Operations

U.S. Department of Energy

National Energy Technology Laboratory

Direct Air Capture Kickoff Meeting

February 24-25, 2021

Program Overview

Federal: $2,499,996 Cost Share: $850,000 Total: $3,349,996

Budget Period 1: 1/1/2021 – 12/31/2021

Budget Period 2: 1/1/2022 – 12/31/2022

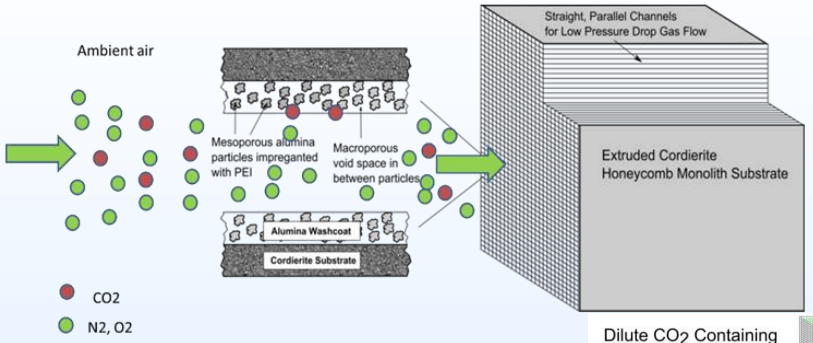
Budget Period 3: 1/1/2023 – 6/30/2023

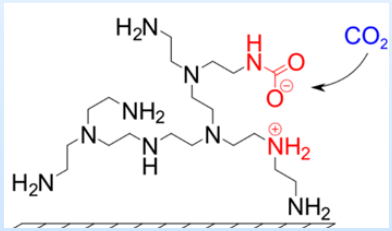
Project Participants:

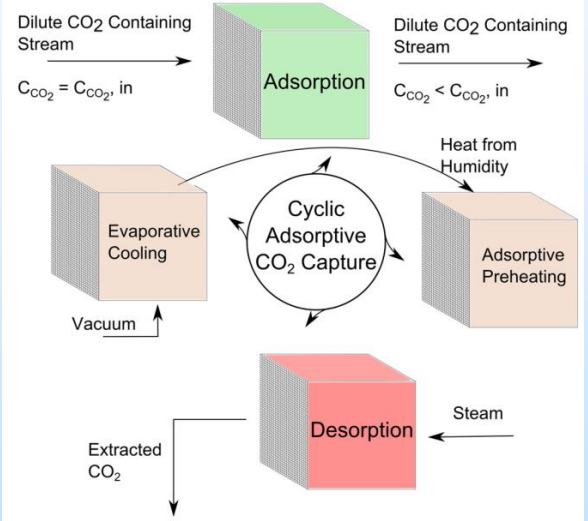
Global Thermostat
Georgia Institute of Technology
National Renewable Energy Laboratory
VADA
Zero Carbon Partners

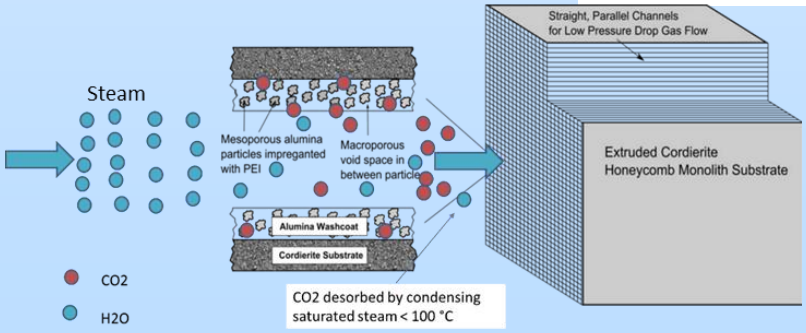
Primary Objectives: Design and construction of a field-test unit demonstrating a continuous-motion direct air capture process, reducing complexity, CAPEX, & OPEX while increasing reliability

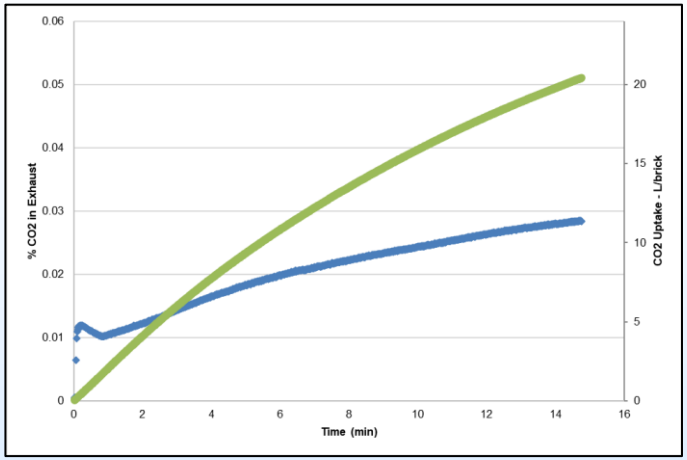
Global Thermostat DAC Platform

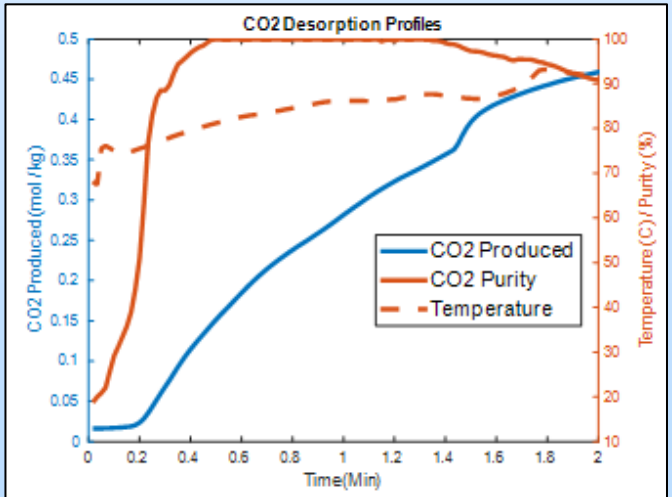










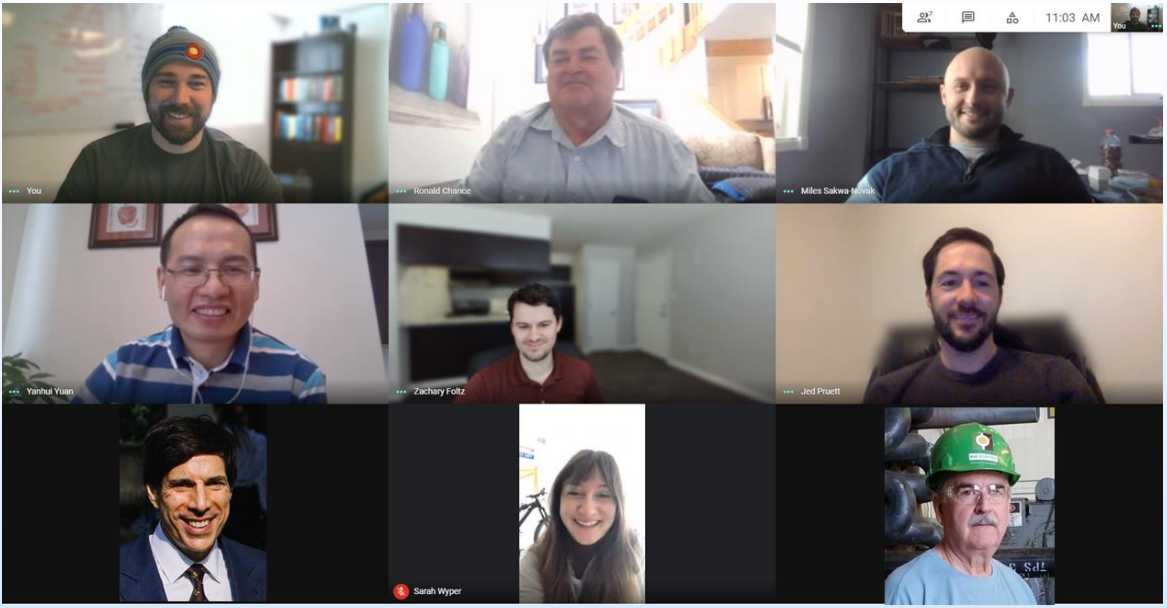


Technical Approach & Project Scope

- Benefits of applying multibed adsorption paradigm via continuous movement of active media through a regeneration zone
  1. Significant reduction in mechanical complexity, force requirement, while maintaining high capital utilization and rapid cycling
  2. Steady-state utility & energy flows: maximum instantaneous demand = average demand
  3. Enables direct heat integration capability – no intermediate storage necessary
- Requires careful consideration of movement, sealing methodologies to maximize adsorbent lifetime

- **Project Scope & High-Level Objectives**
  - BP1 (ends 4Q2021):
    - Prototype primary mechanical features and plant concepts of a continuous DAC (cDAC) process
    - Optimize primary process steps of a cDAC process to minimize cost & carbon footprint while protecting sorbent lifetime
    - Complete full field-test engineering design package
  - BP2 (ends 4Q2022):
    - Construct & commission cDAC field-test unit
    - Develop TEA, LCA, and sensitivity analyses for climate-relevant cDAC deployment
  - BP3 (ends 2Q2023):
    - Continuous operation of cDAC field-test unit & TEA/LCA revision from operating optimization

Project Team



Global Thermostat
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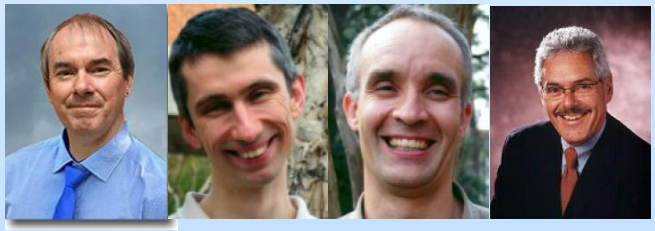
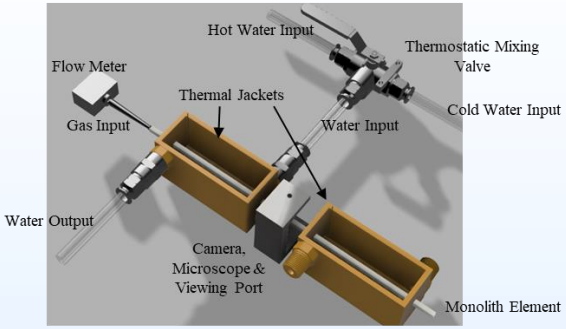
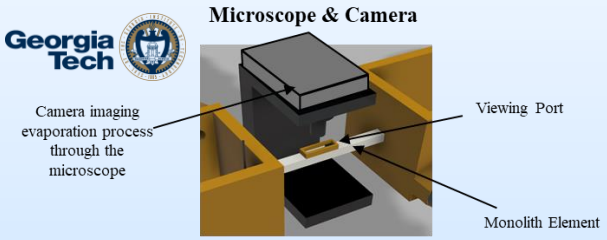


Georgia Institute of Technology
Matthew Realff (PI, ChBE)
Roman Grigoriev (Phys.)
Michael Schatz (Phys.)
Ari Glezer (MechE)

National Renewable Energy Laboratory
Eric Tan (PI)
Ryan Davis
Rob Brasington

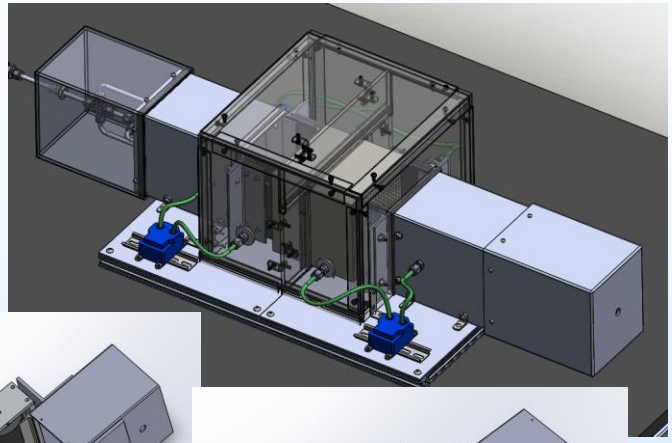
Initial Project Work

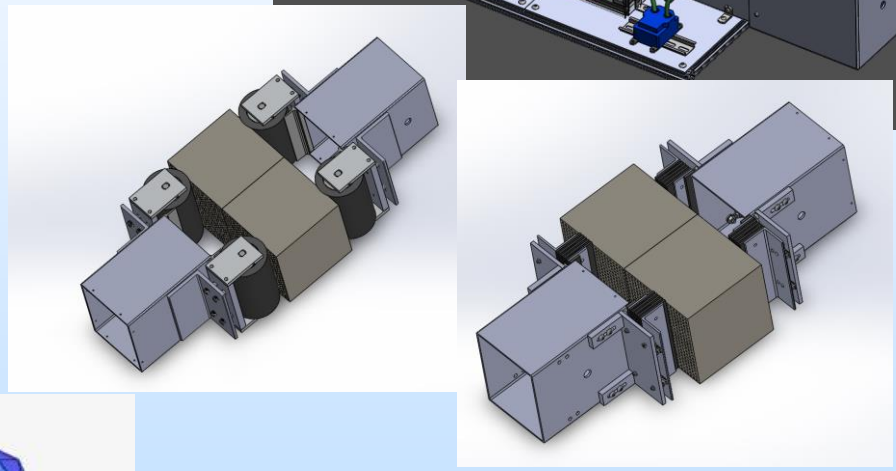


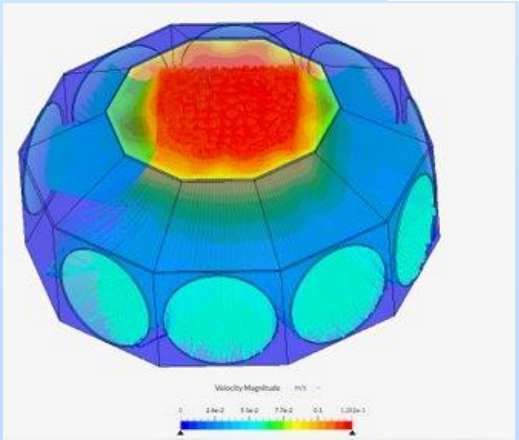


Monolith channel imaging device for purge/evaporation model validation (Schatz, Georgia Tech)

Zonal seal paradigm validation unit (Wyper, Pruett - Global)







Module airflow, scoping CFD (Wyper, Bouckenooghe - Global)

Opportunities for Collaboration

1. Fundamentals & Materials
   - Materials research lab dedicated to structure-property relationships of CO2 sorbents, transport and kinetic fundamentals, and sorbent lifetime assessment
2. Applied Materials Testing
   - Global DAC test units for measuring cyclic CO2 capacity, closing mass & energy balances, under real ambient conditions with full range of adsorption and desorption control at multiple scales
3. Downstream/Upstream Integration with DAC for Improved TEA/LCA
   - <100 °C heat energy enables opportunities for heat integration with downstream CO2 utilization (compression, bio/synthetic fuel production, etc.), or upstream energy generation
   - Intrinsic sorbent robustness enables mass integration opportunities upstream (e.g. flue gas) or downstream (e.g. algae headspace recycle – DE-EE0008520)