

Composite Solid Sorbent - Solvent Matrix for Capture of CO₂ from Mobile Systems

DE-SC0025105

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OptimaBiome

Project Overview

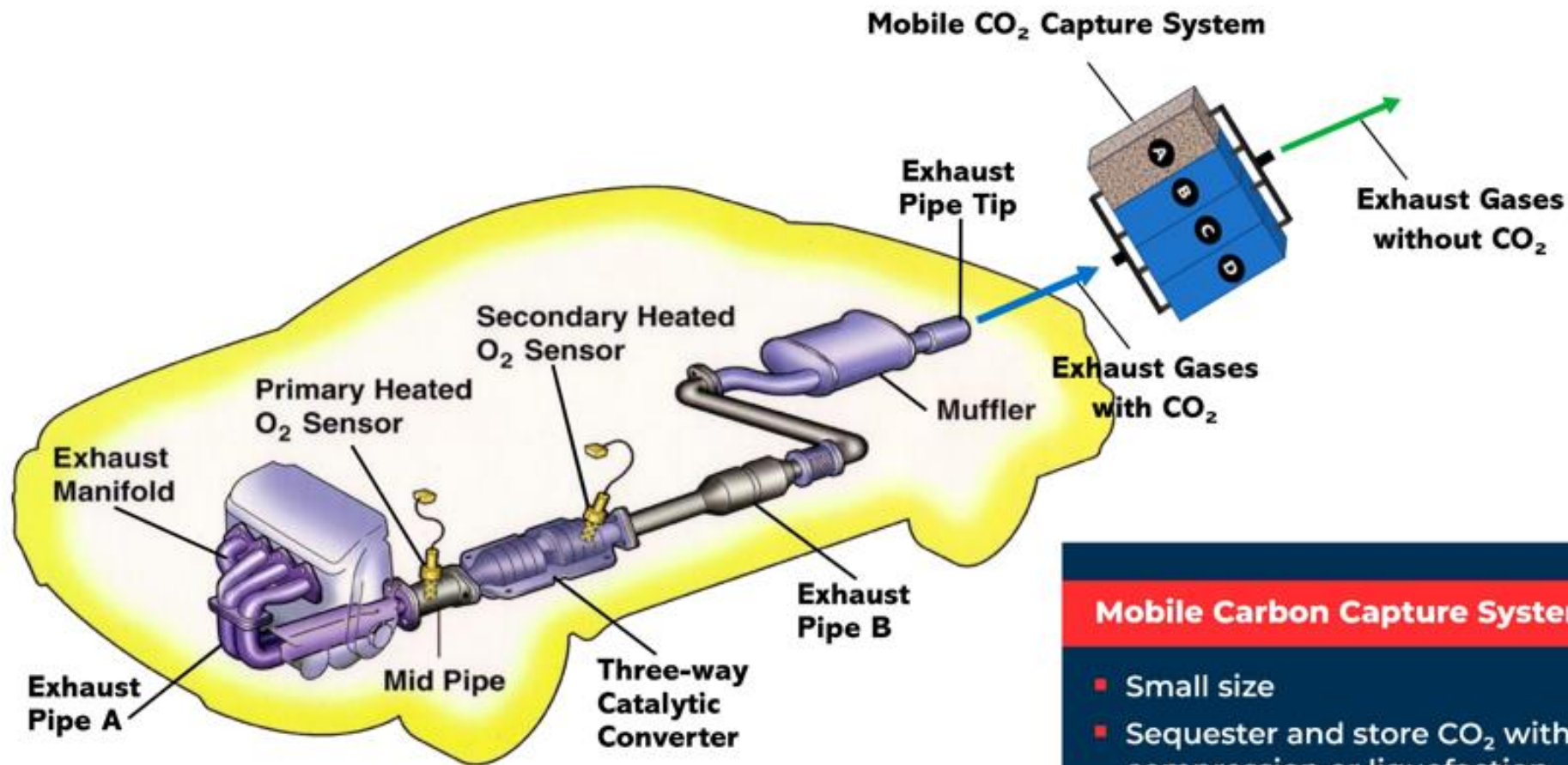
Objectives:

- Demonstrate feasibility of solid matrices to robustly sequester, store and transport CO₂ from cars, semis and heavy duty trucks, and long-range marine vessels
- Develop comprehensive technoeconomic analyses and LCA specifications for the proposed mobile CO₂ capture system(s).

Project details:

- Principal Investigator: Malcolm Fabiyi, PhD
- Duration: 9 months (7/22/2024 to 4/21/2025)
- Budget: \$248,978
- Program Manager: Nicole Shamitko-Klingensmith, Ph.D., PMP

Technology Background

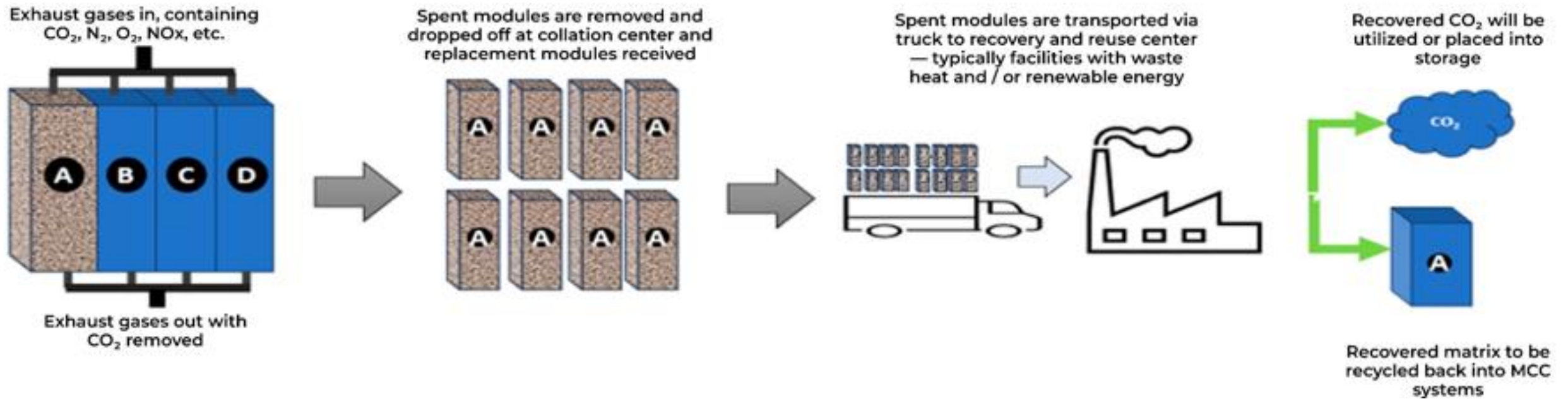


Picture of exhaust system from Alen Auto.

Mobile Carbon Capture System Features

- Small size
- Sequester and store CO₂ without compression or liquefaction
- Does not require online regeneration
- Modular, replaceable

Technology Risks & Challenges

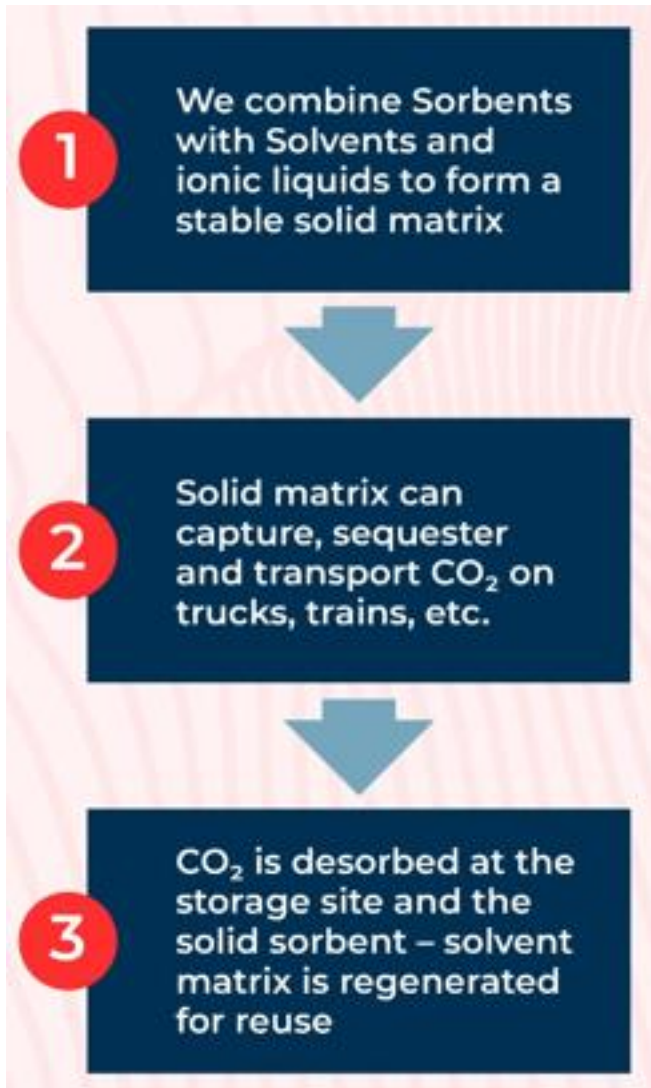


Simple, modular, compact, high-capacity systems

- CO₂ storage and transport capable
- Stable matrix, no degradation of materials or release of CO₂

- Rapid, effective desorption
- Recyclable, reusable matrix materials

Technical Approach



Sample composite matrix with Solvent + Sorbent



Tubes contains various solvent and matrix combinations with bound CO₂



Matrix with 50% w/w NaOH solvent. Resulting composite is safe to handle.

Objective	Tasks	Month
1	Determine suitable sorbents and solvents that can be utilized to make solid composite matrices that effectively sequester CO₂: Evaluate and characterize sorbent and solvent combinations with targeted attributes	M 1-3
2	Quantify CO₂ sequestration potential of the composite matrices: Determine sequestration potential for matrices across a range of key process variables	M 2-5
3	Determine optimal methods of CO₂ recovery and recycle and reuse of composite matrix materials: Evaluate methods for effective desorption of CO ₂ , Quantify recovery efficiency, & energy and material requirements	M 3-6
4	Demonstrate lab scale prototype using live ICE engine systems. Test select matrix options in lab scale mobile carbon capture system using live engine platforms	M 4-7
5	Develop process flow diagrams and undertake techno-economic analysis and Life Cycle Assessment. Develop process flow diagrams, technology gap analysis, techno-economic analysis (TEA) and Life Cycle Assessment (LCA)	M 5-9



Performance metric	Success value	Assessment tool
Stability of CO₂ sequestered within matrix	>90% stability of sequestered CO ₂ within matrix	% CO ₂ loss from saturated matrix
Size and weight of capture device	>0.6 tons CO ₂ per ton capture equipment	kg CO ₂ capture per m ³ of matrix
CO₂ capture efficiency of matrix	>2.0 mol CO ₂ removed per liter of matrix	mol CO ₂ per L matrix
CO₂ capture efficiency of recycled and reused material	>70% CO ₂ capture efficiency of recycled vs virgin material	% carbon removal of recycled matrix vs virgin matrix
CO₂ selectivity of matrix	>50% selectivity for CO ₂ vs other gases	% selective removal of CO ₂ vs other gases in mix
CO₂ recovery during de-sequestration	>90% recovery of sequestered CO ₂	% CO ₂ recovered vs sorbed CO ₂
Matrix component stability	>90% stability of matrix	None to minimal release of solvent from matrix composite
Specific energy for CO₂ capture	>1 kg CO ₂ /kWh for NG; >2 kg CO ₂ /kWh for diesel & gasoline engines	Energy and CO ₂ capture analysis
Net CO₂ removed per kg fuel used	Kg CO ₂ removed per gal fuel used	Overall efficiency of CO ₂ removal considering incremental fuel usage due to MCC system
% Energy used for CO₂ capture	<10% decrease in mpg after integration of MCC system	Mileage and fuel usage pre and post integration of MCC system
Carbon footprint of MCC	≤ 0 Net kg CO ₂ increment per kg CO ₂ sequestered and placed in storage using MCC	Comprehensive LCA – material and energy analysis

Community Benefits

- **Hiring Diverse Personnel:** 2 of 3 program hires identify as minorities
- **Mentorship program:** Formal program initiated to support project personnel with career growth & cleantech careers
- **Promote cleantech careers:** Seminars to Provide seminar session on cleantech solutions to student groups in educational institutions with diverse student bodies in the Maryland area
- **Internships:** Provide internship opportunities to diverse students with interest in | curiosity about cleantech research & development opportunities

Summary & Lessons Learned

- **Project Hiring:** Completed. Start probing ahead of time, Staffing agencies are your best friend
- **Testing:** Just getting underway
- **Commercialization:** Participating in DOE sponsored Phase Shift 1 initiative to support commercialization efforts



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