



Pilot Unit Testing at NCCC of Sorbent based CO₂ Capture Project # DE-FE0012870

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Project Overview

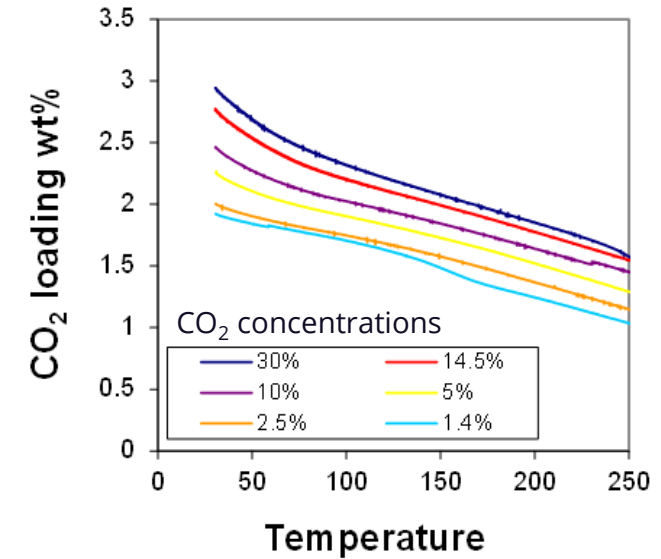
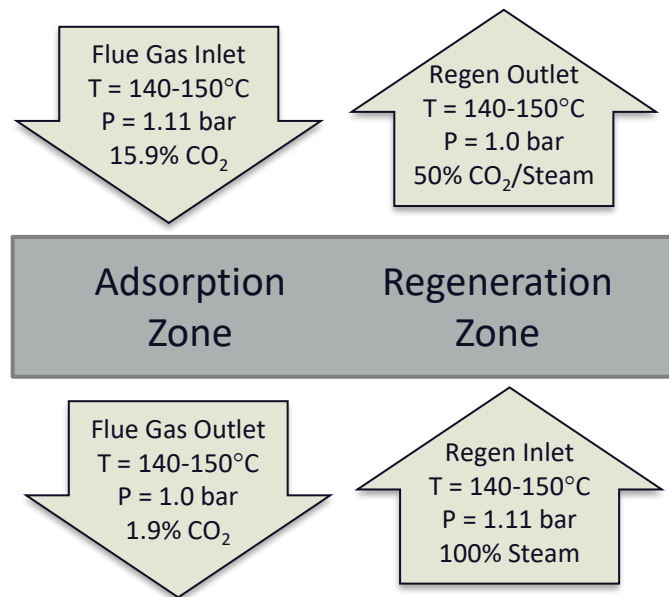
DOE Project DE-FE0012870
Funding - Total Project \$6,480,377
DOE \$5,204,509
Cost share \$1,275,860
Partners: ExxonMobil, UCI, & NCCC

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- **Budget Period 1: Optimization & Design**
 - **Budget Period 2: Construction & Installation**
 - Pilot Unit Construction
 - Sorbent Production Scale-up and Quality Assurance
 - Pilot Unit Installation
 - **Budget Period 3: Shakedown & Operation**

Sorbent Carbon Capture Technology

We have developed:

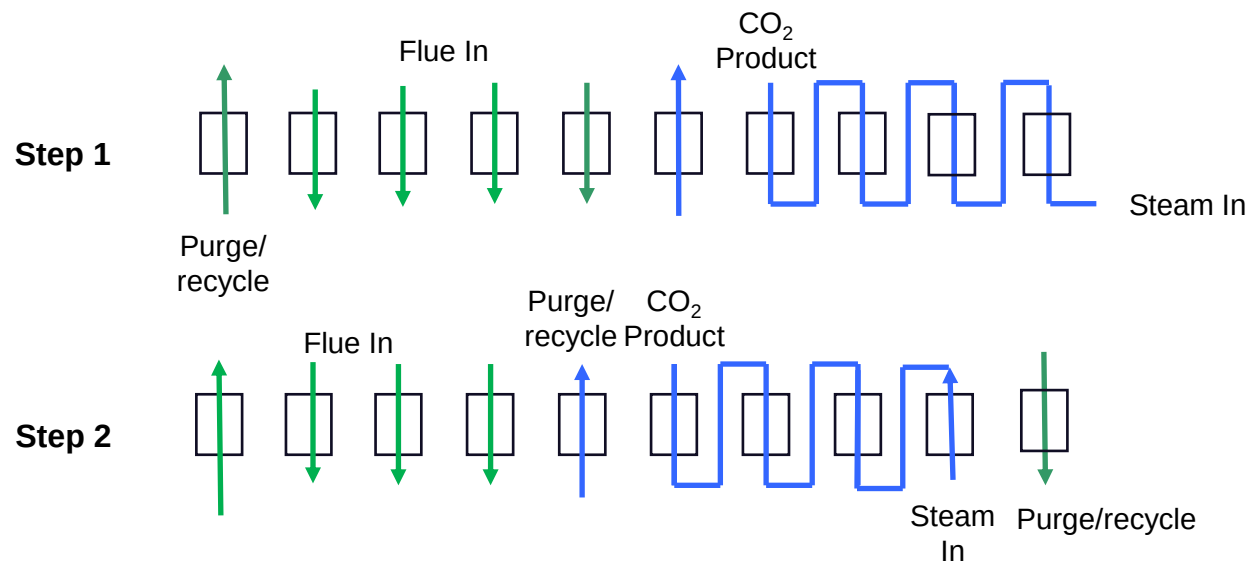
- A low-cost, alkalized alumina adsorbent
- A CO₂ capture process designed specifically for this sorbent
- A unique CO₂ capture process to run adsorption and regeneration at near isothermal conditions



Heat of adsorption ranges from 3 kcal/mole at higher CO₂ concentrations of 10-14%, to 10.3 kcal/mole at CO₂ concentrations of 1-5%.

Simulated Moving Bed Process

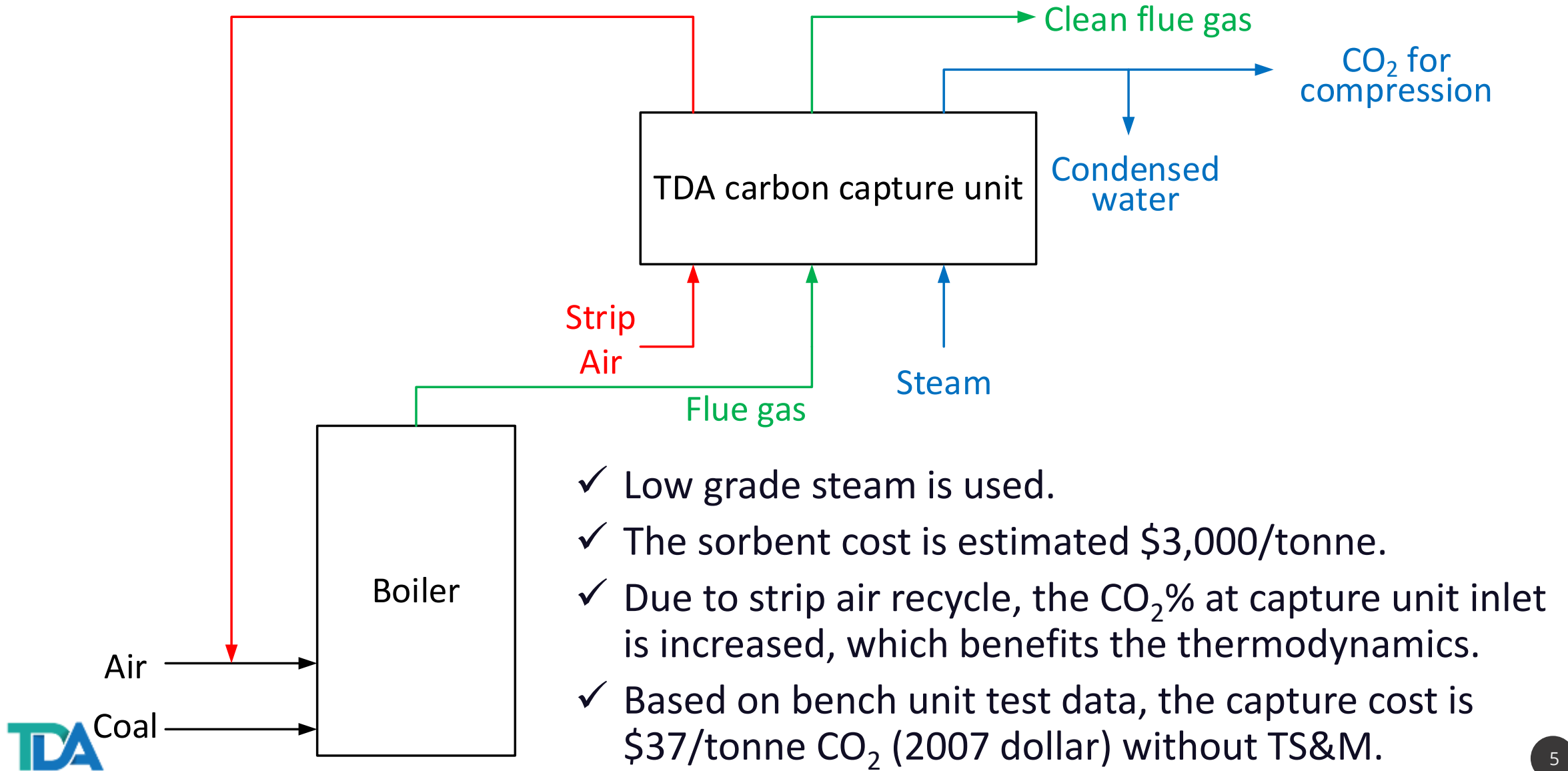
- Multiple Fixed Bed Contactor
 - Provides counter-flow contact between the solids and gases
- Beds cycle between adsorption and regeneration functions
- Gas flows in parallel through adsorption beds and in series across regeneration beds
- Multiple patents granted (US9539540B2, US9446343B2, US9504955B2, US9527029B2)



Advantages over moving bed

- Moving bed had expensive conveyors, although the beds would be smaller
- Multiple fixed bed design
 - ✓ Basic duct work
 - ✓ Low cost construction
 - ✓ Simple bed design
 - ✓ Eliminates parasitic power needed to move the sorbent
- Lower overall cost than moving beds

Process Overview



Schedule and Milestones

- Completed Milestones
 - Process Flow Pattern Optimization
 - System Design and Engineering
 - Pilot Unit Construction
 - Sorbent Production
 - Pilot Unit Installation and Shakedown
- Next Milestones
 - 1.5 Months of Parametric Testing (In Progress)
 - 2 Months of Steady State Testing
 - Update Techno Economics

Pilot Tests Overview

- Goals of NCCC testing
 - Demonstrate alkalized alumina sorbent technology under realistic conditions at the 0.5 MW_e (~10 tpd CO₂) scale on coal flue gas) to collect data necessary for scale up to next level plant.
 - Demonstrate sorbent technology on coal fuel gas and diluted flue gas to simulate NG flue gas
- Planned Testing
 - 1.5 month parametric testing and 2 months steady state testing



National Carbon Capture Center located at the E.C. Gaston power plant (Wilsonville, Alabama)

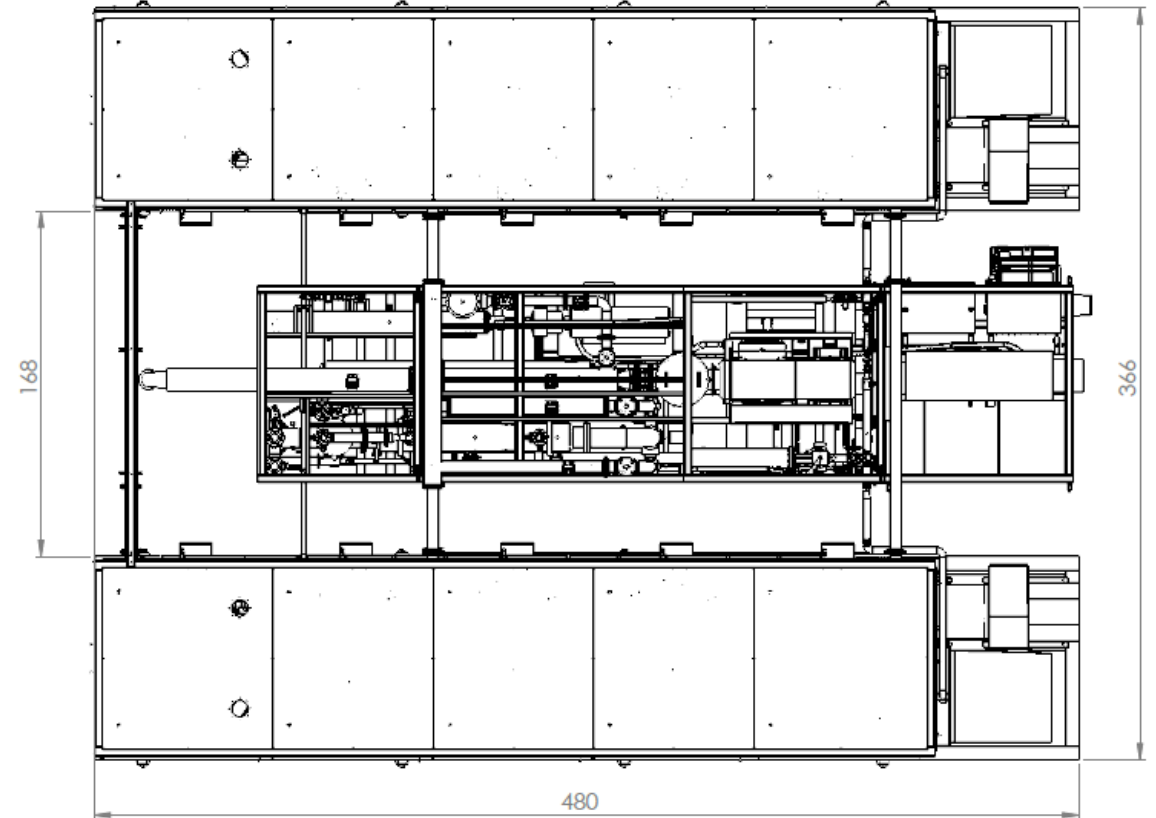
Pilot Unit System (0.5 MW Demonstration)

Two Sorbent Bed Trailers

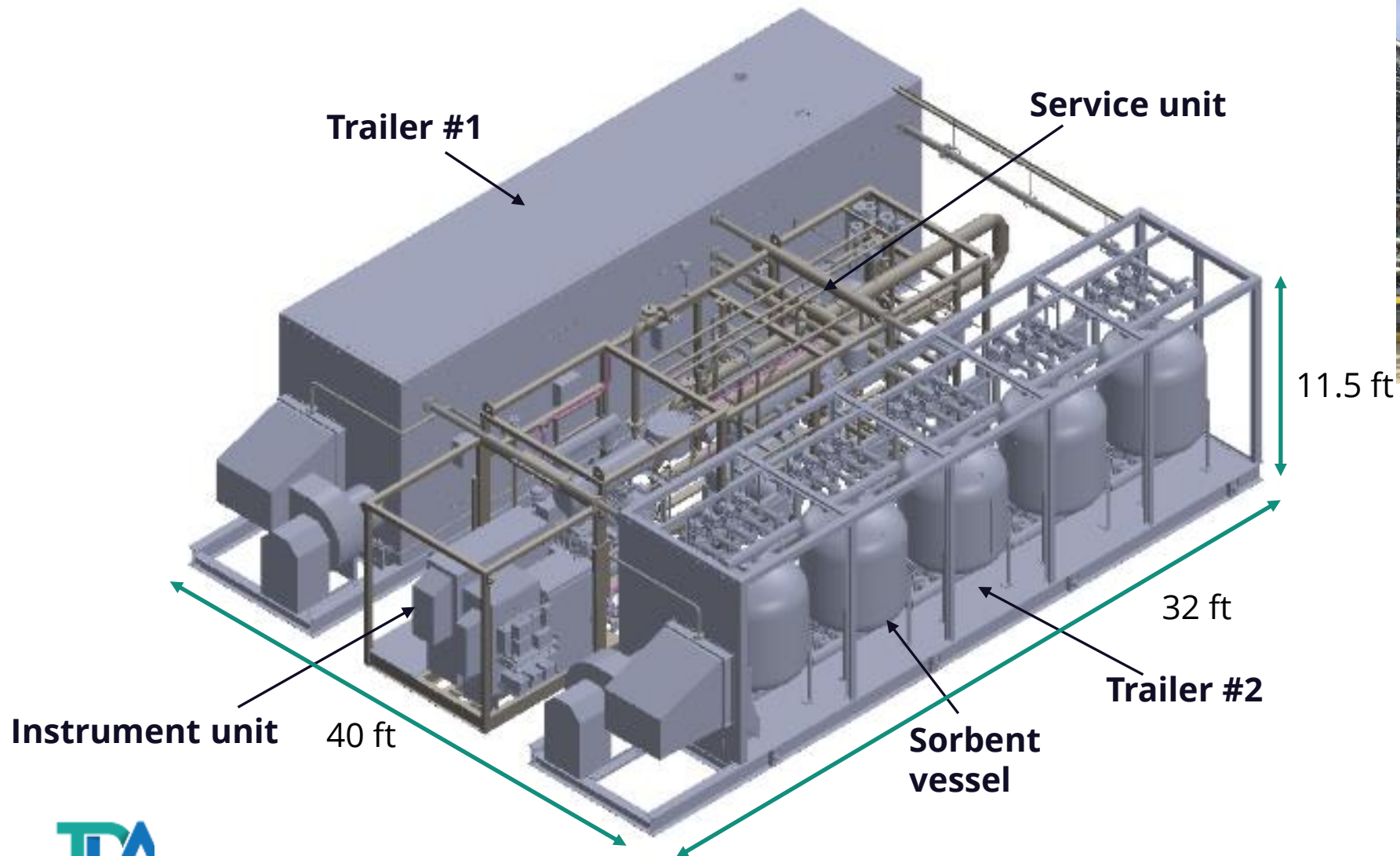
- Sorbent trailers house 10 sorbent beds (5 in each trailer) and manifold piping
- Each trailer is insulated and heated to provide an isothermal environment

Service Unit/Instrument Trailer

- Pressure, temperature and flow control for process gases
- Each process gas routed to both sorbent bed trailers
- Houses the control system and all electrical components for power allocation
- A full suite of on-board analyzers to evaluate system performance



Pilot Unit Skids



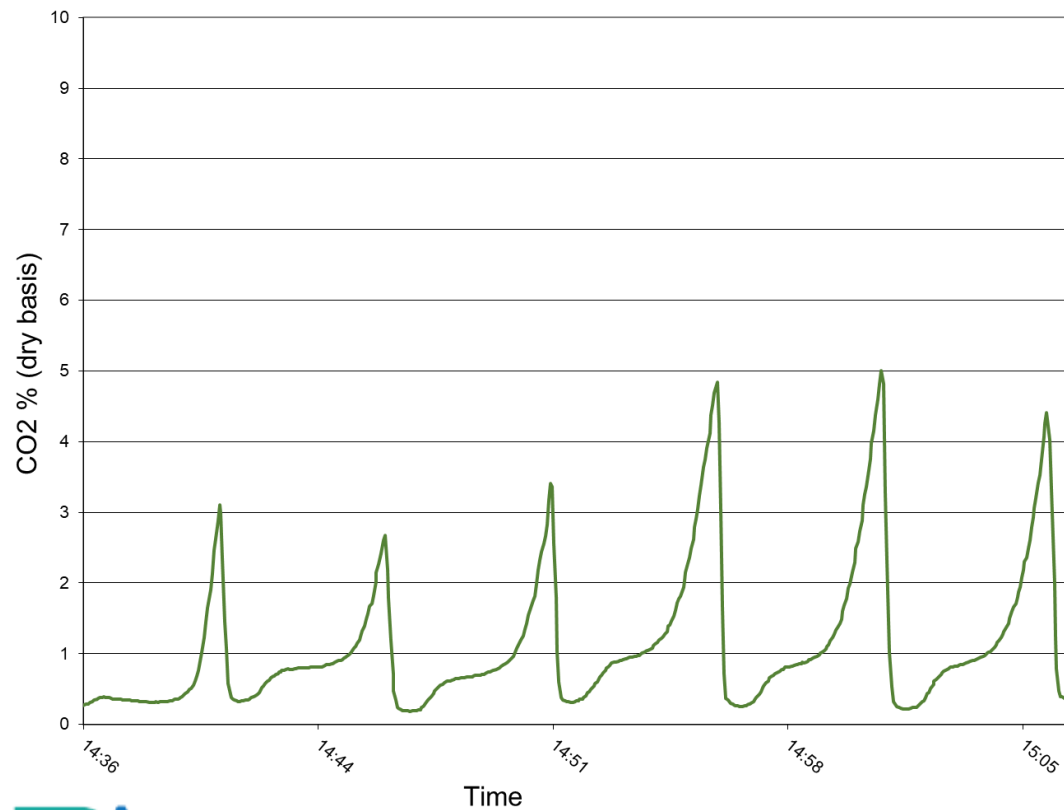
Current Pilot Tests Status & Plans

- New sorbent was loaded in June 2021.
- Testing started in mid July 2021.
- Next testing will include:
 - Complete parametric testing
 - Test the optimized flow pattern
 - Running with both coal and NG flue gases
 - Run 2 months of steady state testing

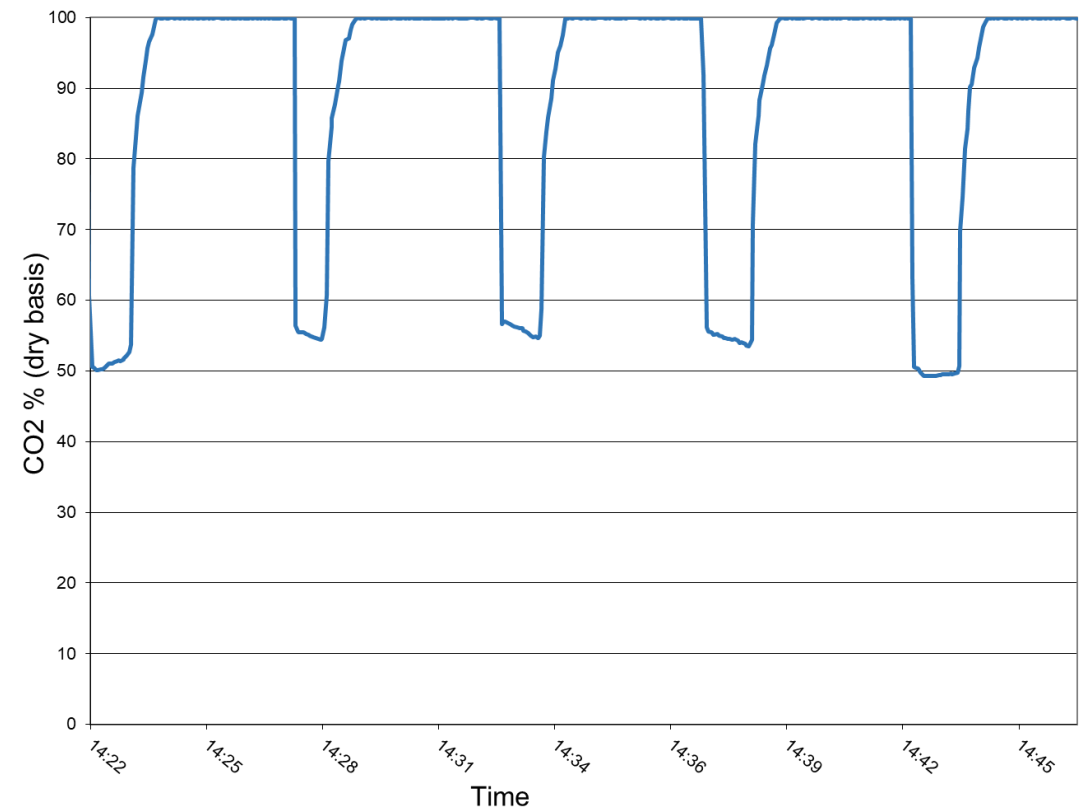
Performance

Steam Saver flow pattern (13.6% dry CO₂ in flue gas inlet)

CO₂% in the clean flue gas
90+% capture



CO₂% in the product outlet
99.9% purity



Split Steam Saver Flow Pattern

- Split steam saver is modified from the steam saver flow pattern to make full use of steam.
- Split steam saver improves the capture rate at the same steam consumption.

Date	Flow pattern	Capture, %
7/27/2021	Steam saver	87.7%
7/27/2021	Split steam saver	89.2%

Summary

- TDA's CO₂ capture system uses an alkalized alumina sorbent and a nearly isothermal process designed specifically for this sorbent.
- New sorbent was loaded in the pilot unit.
- Parametric tests were run on pilot unit at NCCC.
- 90+% capture and high purity CO₂ product (> 99%) was achieved.
- The split steam saver flow pattern improved the performance over the steam saver flow pattern.

Acknowledgement

- DOE: Andy O’Palko and Lynn Brickett
- ExxonMobil
- NCCC team
- UCI team

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