Pilot Unit Testing at NCCC of Sorbent based CO_2 Capture
Project # DE-FE0012870

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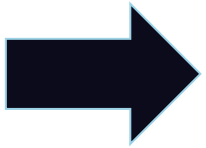
Project Overview

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

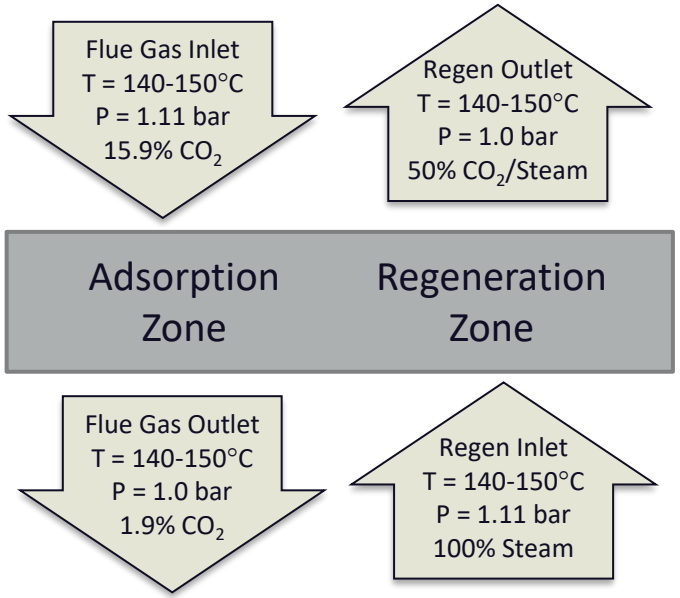
- **Budget Period 1: Optimization & Design**
- **Budget Period 2: Construction & Installation**
  - Pilot Unit Construction
  - Sorbent Production Scale-up and Quality Assurance
  - Pilot Unit Installation
- **Budget Period 3: Shakedown & Operation**

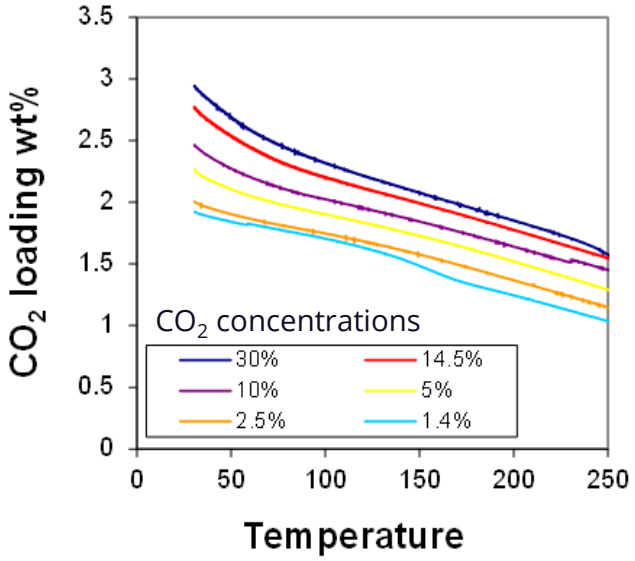


Sorbent Carbon Capture Technology

We have developed:

- A low-cost, alkalized alumina adsorbent
- A CO_2 capture process designed specifically for this sorbent
- A unique CO_2 capture process to run adsorption and regeneration at near isothermal conditions

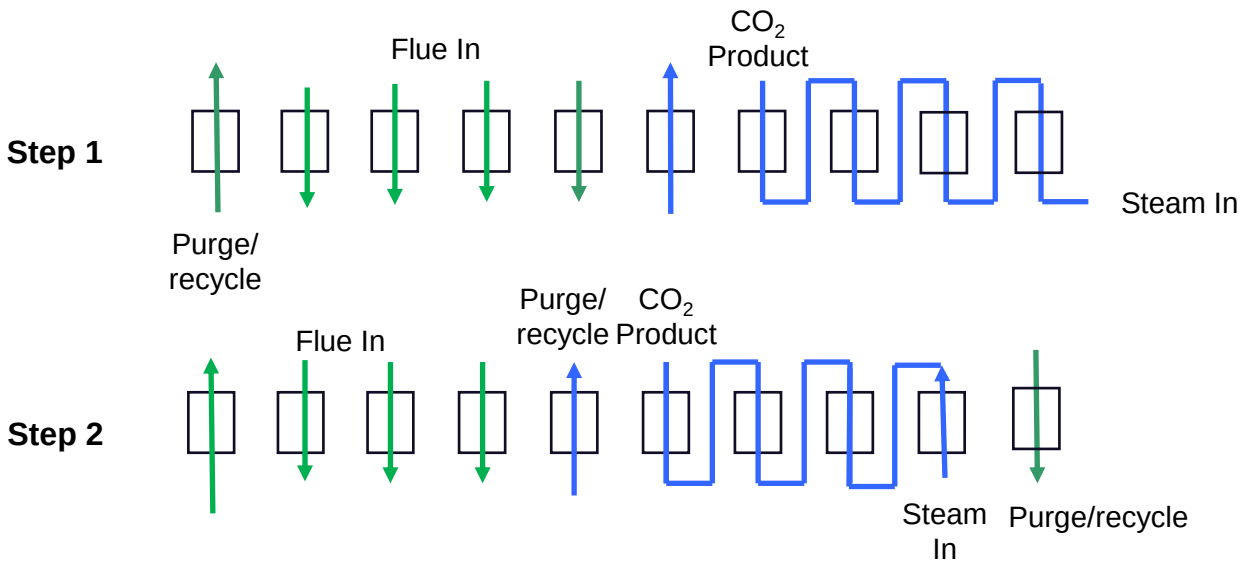




Heat of adsorption ranges from 3 kcal/mole at higher CO_2 concentrations of 10-14%, to 10.3 kcal/mole at CO_2 concentrations of 1-5%.

Simulated Moving Bed Process

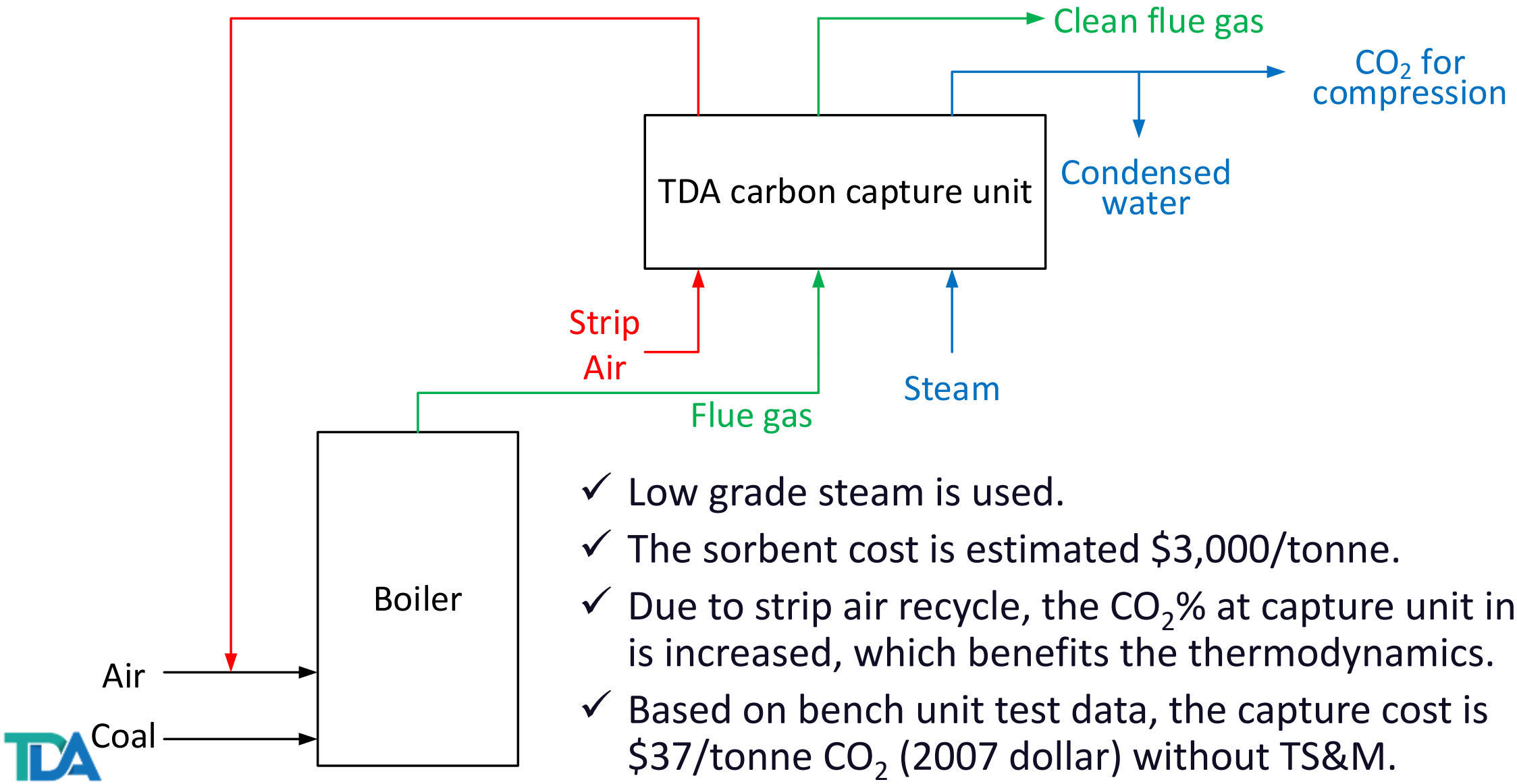
- Multiple Fixed Bed Contactor
  - Provides counter-flow contact between the solids and gases
- Beds cycle between adsorption and regeneration functions
- Gas flows in parallel through adsorption beds and in series across regeneration beds
- Multiple patents granted (US9539540B2, US9446343B2, US9504955B2,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



- ✓ Low grade steam is used.
- ✓ The sorbent cost is estimated $3,000/tonne.
- ✓ Due to strip air recycle, the CO_2% at capture unit inlet is increased, which benefits the thermodynamics.
- ✓ Based on bench unit test data, the capture cost is $37/tonne CO_2 (2007 dollar) without TS&M.

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 CO_2) 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)

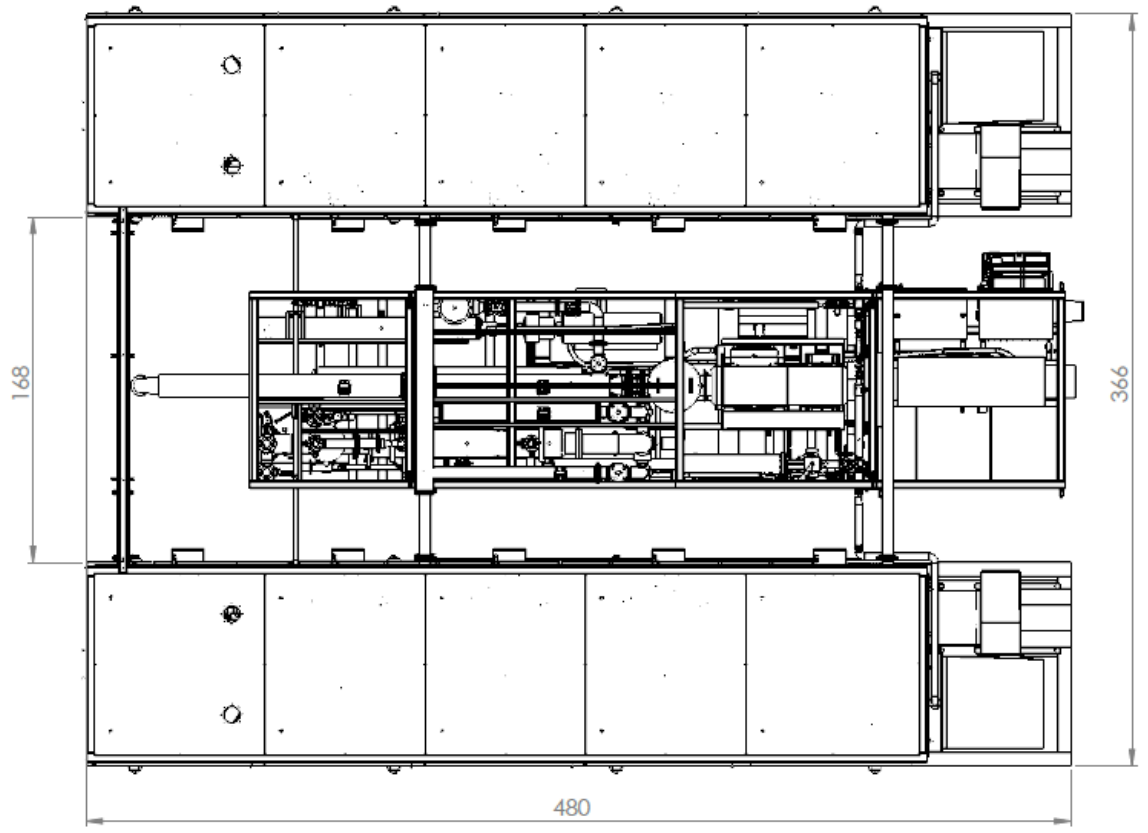
Pilot Unit System (0.5 MW Demonstration)

Two Sorbent Bed Trailers

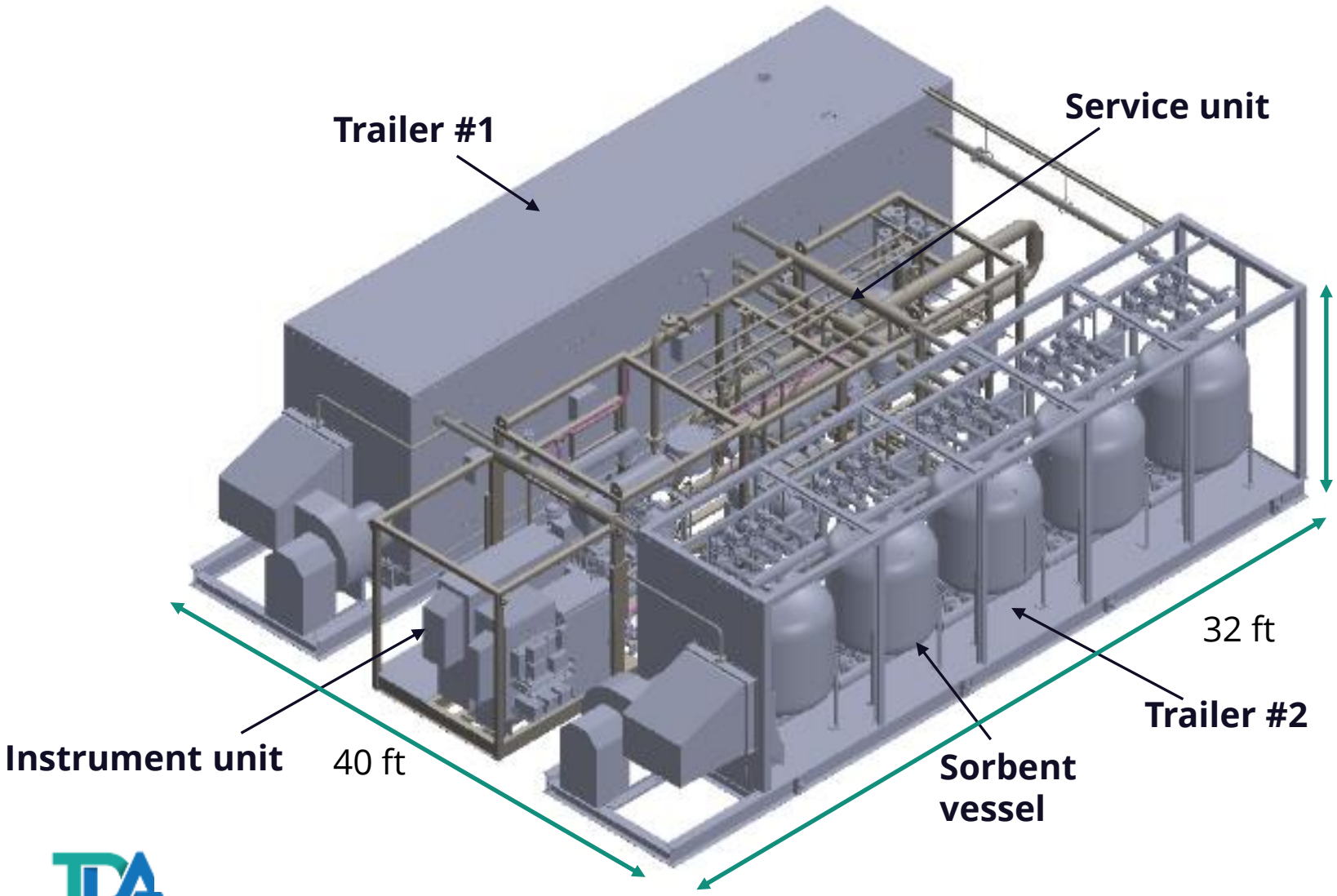
- Sorbent trailers house 10 sorbent beds (5 in each trailer) and manifold piping
- Each trailer is insulated and heated to provide an isothermal environment

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



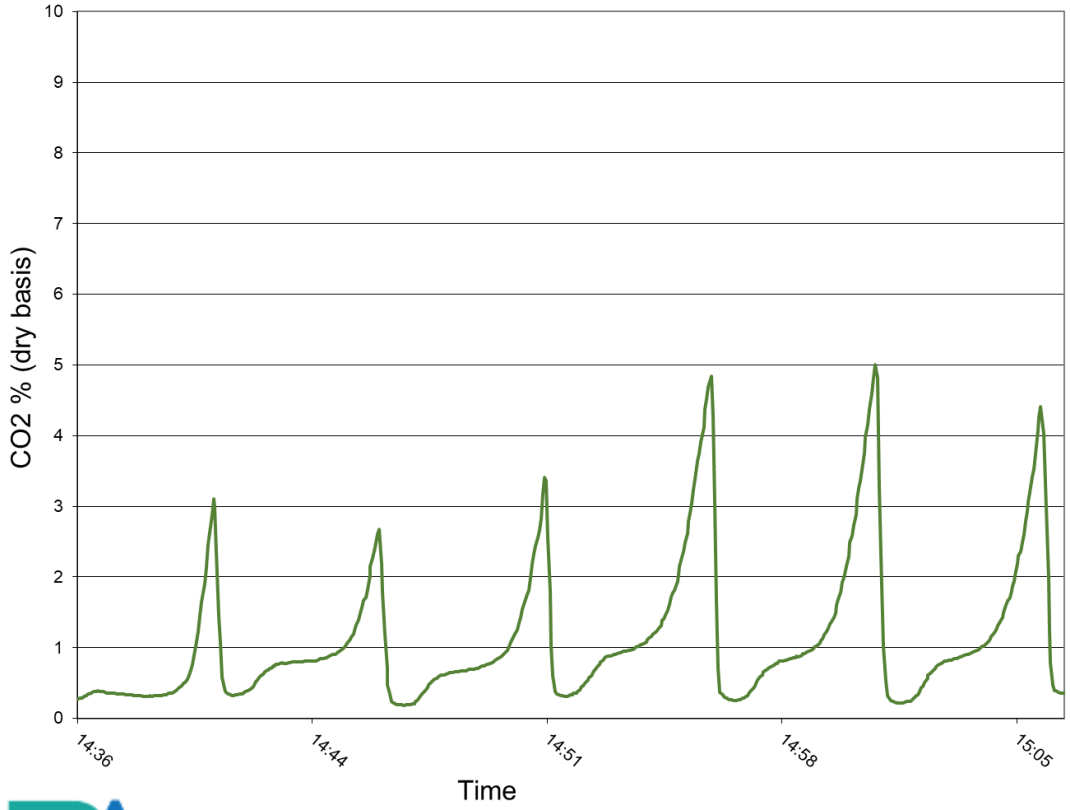
Current Pilot Tests Status & Plans

- 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

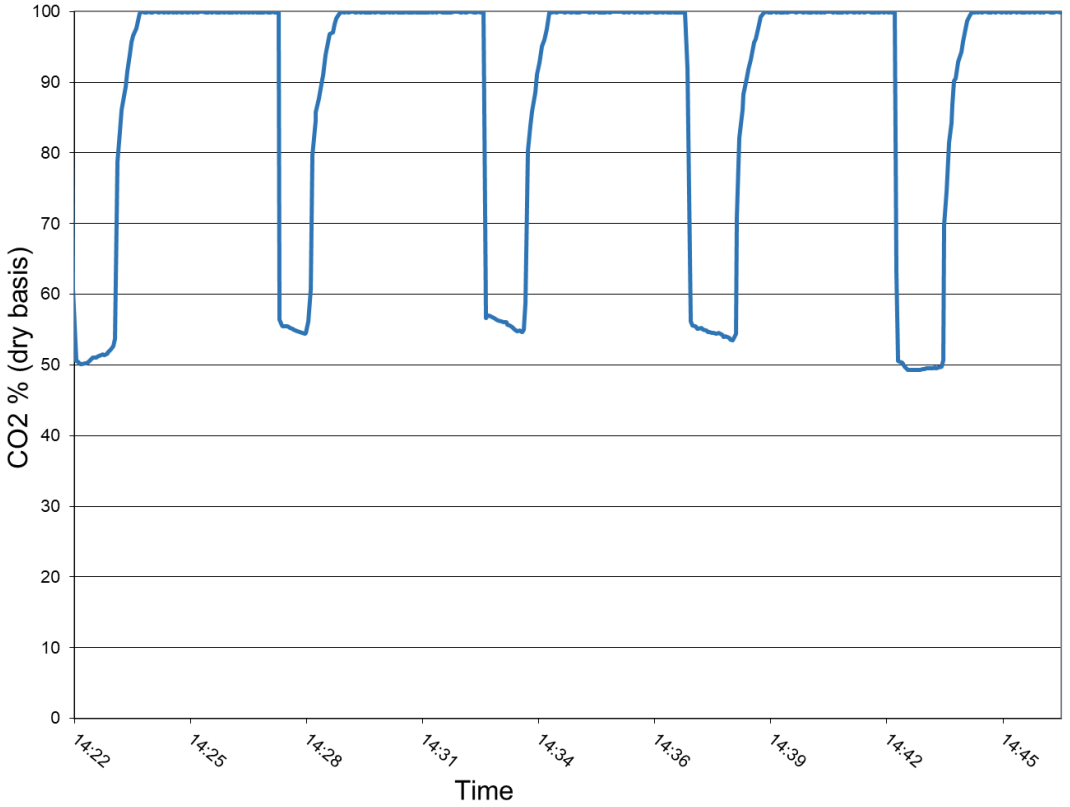
Performance

Steam Saver flow pattern (13.6% dry CO_2 in flue gas inlet)

CO_2% in the clean flue gas
90+% capture



CO_2% in the product outlet
99.9% purity



7/25/2021 data

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 CO_2 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 CO_2 product (> 99%) was achieved.
- The split steam saver flow pattern improved the performance over the steam saver flow pattern.

Acknowledgement

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