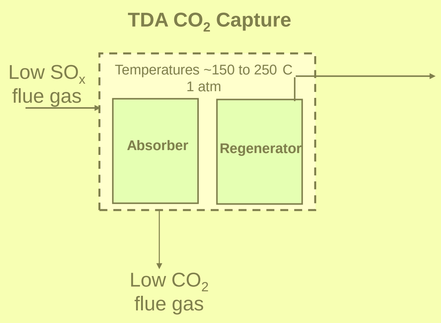
Low Cost Sorbent for Capturing CO_2 Emissions

Generated by Existing Coal-fired Power Plants

Post-Combustion CO_2 Capture: Technology Overview

- Low-cost regenerable sorbent-based process designed to capture CO_2 from existing pulverized coal plants
- TDA Research is developing:
  - Dry, solid alkalized alumina adsorbent material
  - Process design around that material.
- The adsorbent materials has low cost and a low heat of adsorption
- The process is located downstream of sulfur removal

System Picture



Research Objectives (Include this?)

- Demonstrate technical merit (Year 1)
  - Show effective performance of low cost sorbent
  - Use Aspen model to calculate system efficiency
- Characterize and Optimize Design (Year 2)
  - Measure sorbent cyclic lifetime and effect of contaminants
  - Optimize system design & refine economics calculations
- Demonstrate system on coal derived flue gas (Year 3)

Project Overview (Include this?)

- This work is a multi-year collaboration between with TDA Research, Inc, Babcock and Wilcox (B&W), Louisiana State Univerisity (LSU) and Western Research Institute (WRI).
- Team brings together research, simulation, and commercial experts to ensure success on both technical and commercial basis.
  - ➢TDA is leading development of sorbent and process design
  - ➢B&W is providing real world input and assessment of commercialization potenial
  - ➢LSU is developing Aspen system model of PC plant with TDA's CO_2 capture system
  - ➢WRI: will conduct an evaluation of the technology with on a real coal derived slip stream at their combustion test facility

Advantages of Approach

- Capturing dilute CO_2 and compressing it is energy intensive
- TDA calculated the theoretical energy assuming an isothermal compression
- Min. parasitic power loss of 13.46% TDA's Sorbent approach has estimated parasitic loss of 20.7%
- About half the power is for CO_2 compression and purification

Power Loss Associated with Energy Needed to	**Theo-retical**	**TDA System**
Concentrate CO_2 from 13.84% to 1 atm	3.05%	8.45%
Compress CO_2 to 150 atm	6.41%	8.25%
Transport and sequester*	4.0%	4.0%
Total	13.46%	20.7%

* Transport and sequester assumed 4%

Initial System Analysis (*Include this?)*

- Preliminary system and economic analyses performed to determine viability of the approach.
- Analysis predicts:
  - $18.76/ton CO_2 captured, $23.02/ton CO_2 avoided
  - 31.7% increase in energy services
- Performing analysis early in project establishes benchmarks for the sorbent and process
  - Sorbent performance requirements have been set
  - Process parameters defined.

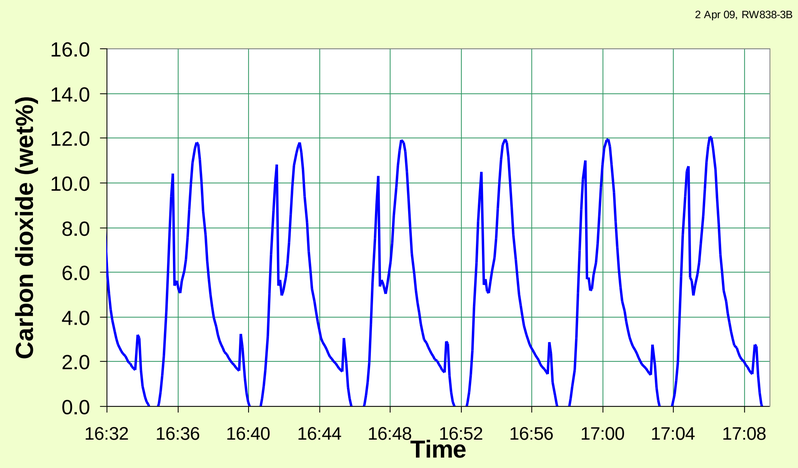
Sorbent Optimization

- Initial sorbents made from research/ laboratory supply grade materials.
- Goal of sorbent development work to move to low cost, bulk supplier raw materials.
- Sorbents are being screened for loading by thermogravimetric analysis (TGA), surface area (BET) and crush strength.
- Over 30 sorbent composition have been evaluated.
- New cheaper compositions have similar loadings.
- One sorbent has been evaluated further in fixed bed testing. Additional testing will begin soon on second sorbent candidate.

Sorbent Cycling data

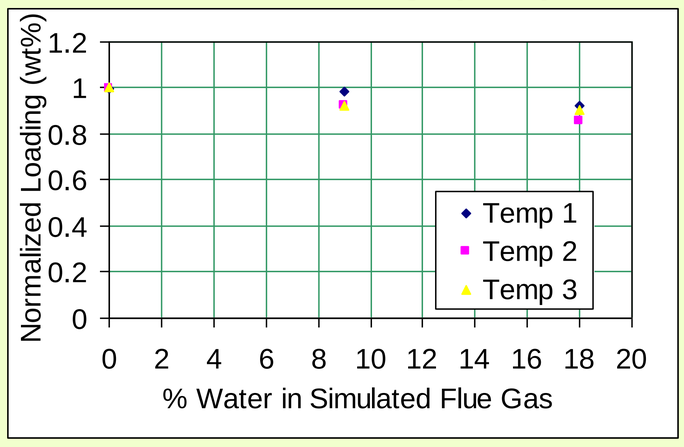
- Sorbents are being evaluated over a range of conditions including varying space velocities, temperatures, and cycle times.
- Flue gas is simulated by 13.8% CO_2, 9% water, 77.2% N_2.
- Over 500 cycles have been evaluated with good cyclic lifetime shown.
- CO_2 Loadings range from 0.3 to 0.7 wt%
- Sorbent cycling is rapid with fast absorption and desorption times.

Cycles 282 - 287, Dynamic Loading = 0.64 wt%



Effect of Moisture

- Moisture level in flue gas has minimal impact on adsorbent CO_2 loading
- Doubling the moisture level from 9% to 18% reduces loading by only ~8%.



Sorbent Testing apparatus

- 300 cc fixed bed reactor
- Automated equipment for continuous data logging, unattended operation
- Online analyzer for continuous CO_2 measurement

Summary

- TDA, in collaboration with B&W, LSU, and WRI is developing a sorbent-based CO_2 capture process for coal fired power plants
- Cost estimates for CO_2 capture using this process are favorable
- Technical progress to date has been promising.

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References

[1] NETL Conesville system