Flue Gas Mercury Removal Using Carbon-Polymer Composite Material

X. Sean Lu, Zach Xu, Steve Stark, Richard Gebert, W.L. Gore & Associates, Inc.

Tom Machalek, Carl Richardson, Jennifer Paradis, URS Corporation

Ramsay Chang, Electric Power Research Institute

Brandon Looney, Marcus Mathews, Southern Company

EUEC

January 31 – February 2, 2011, Phoenix, AZ

Outline

- Introduction
- Lab tests
- Field demonstrations
- Summary

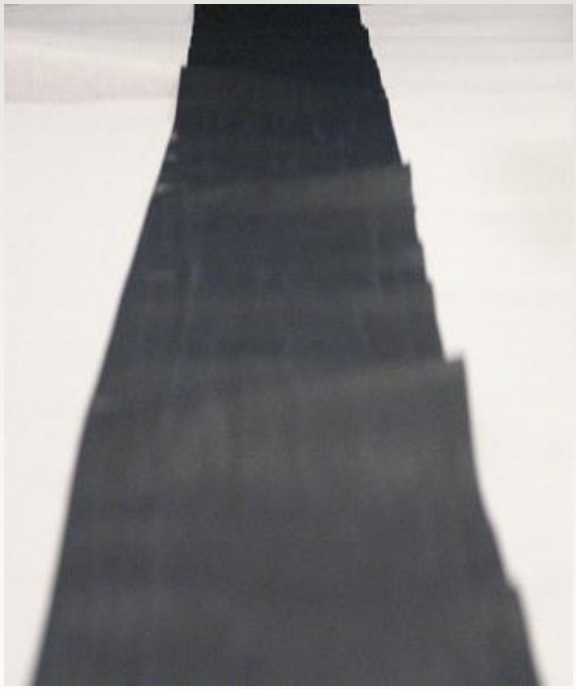
Introduction

- Activated carbon for flue gas Hg removal:
  - **Carbon injection**: low Hg capacity, fly ash contamination
  - **Stationary carbon bed**: saturation by SOx or other acid gases, frequent bed regenerations

- Gore's carbon-polymer composite (CPC) tape material:
  - Activated carbon (chemically treated) and fluoropolymer composite tapes
  - Applied in stationary bed configurations
  - Much less potential to be saturated by SOx or other acid gases, therefore, no frequent bed regenerations are required

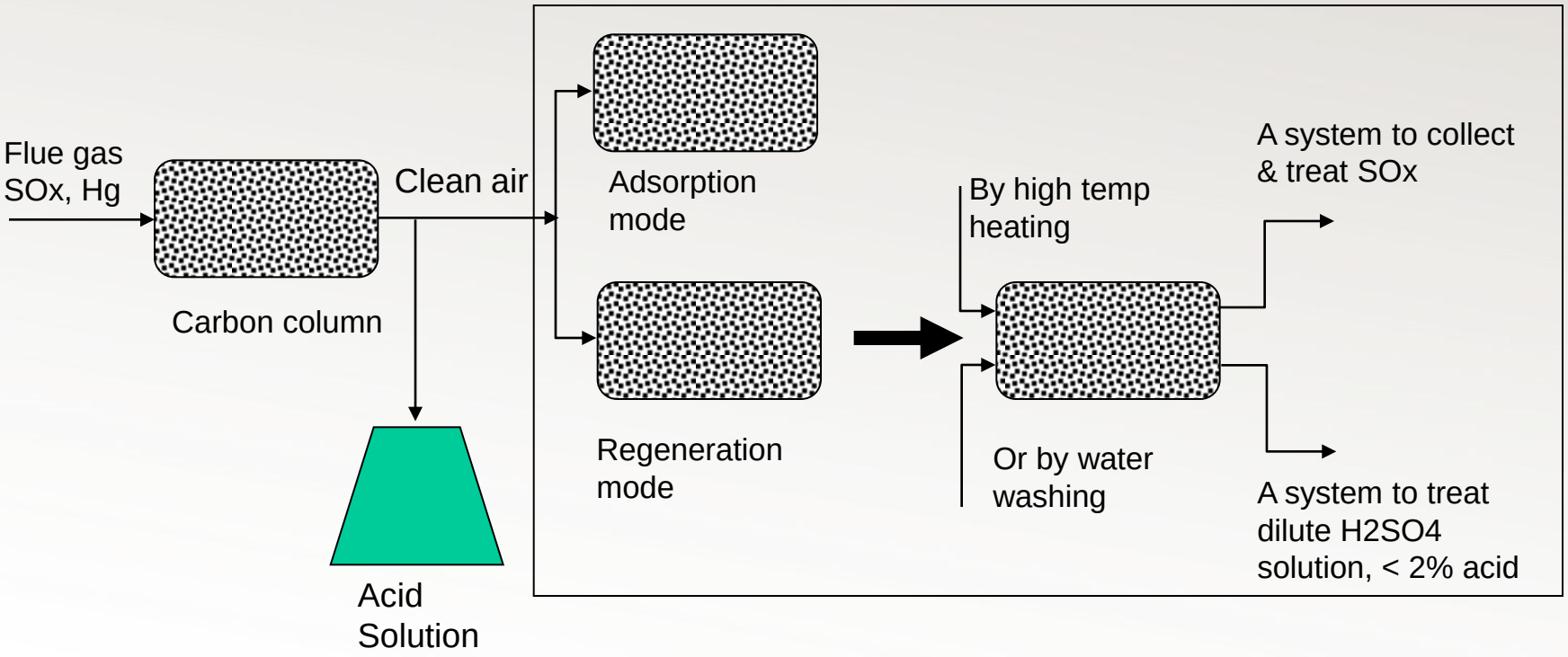
Introduction

- Gore's carbon-polymer composite (CPC) material (continued):
  - Flue gas conditions: low temperature (< 100^{o}C) and humid (> 50%RH)
  - SOx and other acid gases are converted into aqueous acid solutions and expelled to the CPC tape's outer surfaces, then collected
  - Hg can be fixed on the carbon surfaces with high capacity (> 1.0wt%) due to the low operating temperatures; therefore, long-term operation before sorbent saturation by **mercury**
  - CPC tapes can be made into modular forms with reasonably low pressure drop
  - US patent: 7,442,352 B2 (2008) by Lu & Wu



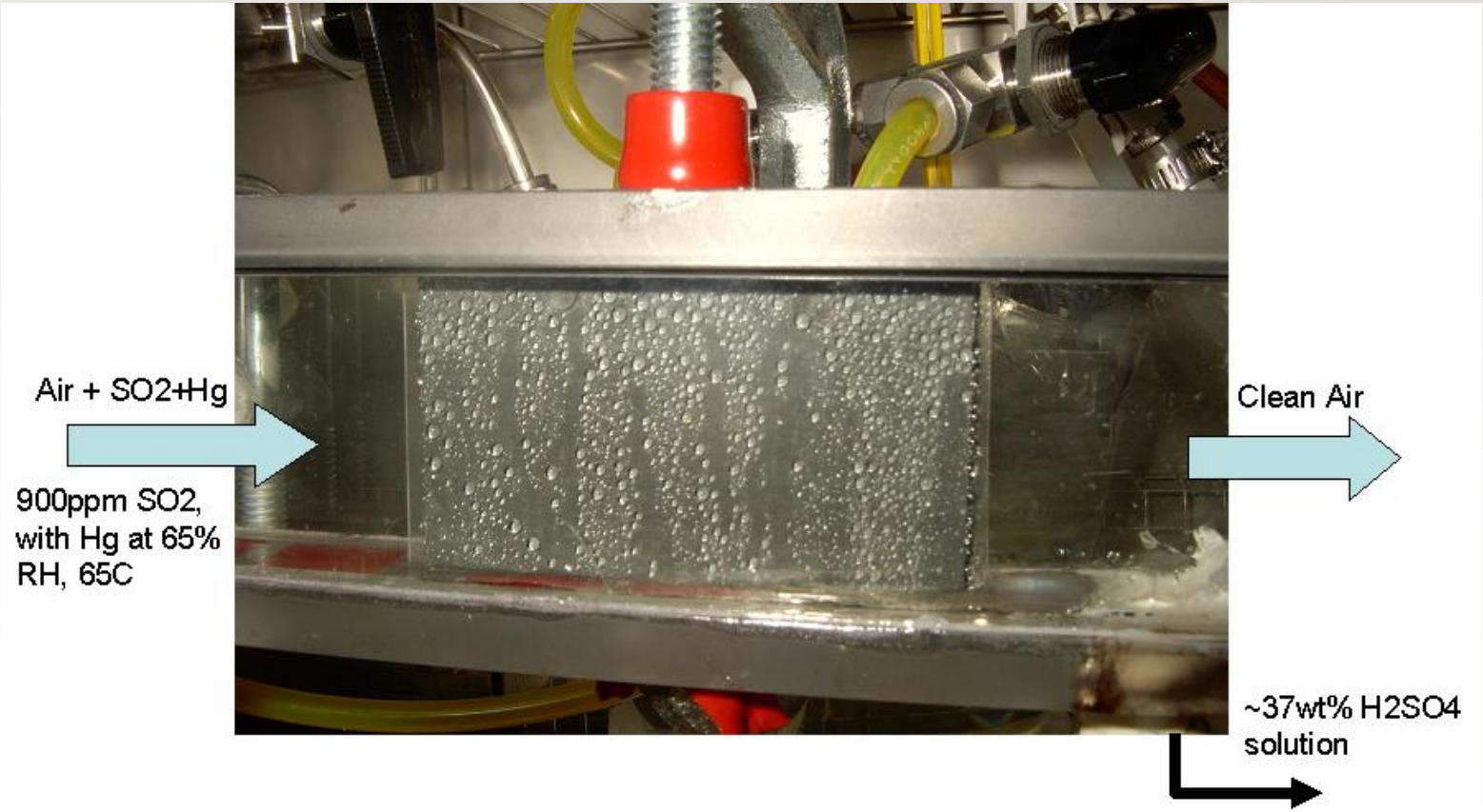
Introduction

Typical Stationary Carbon Bed Applications



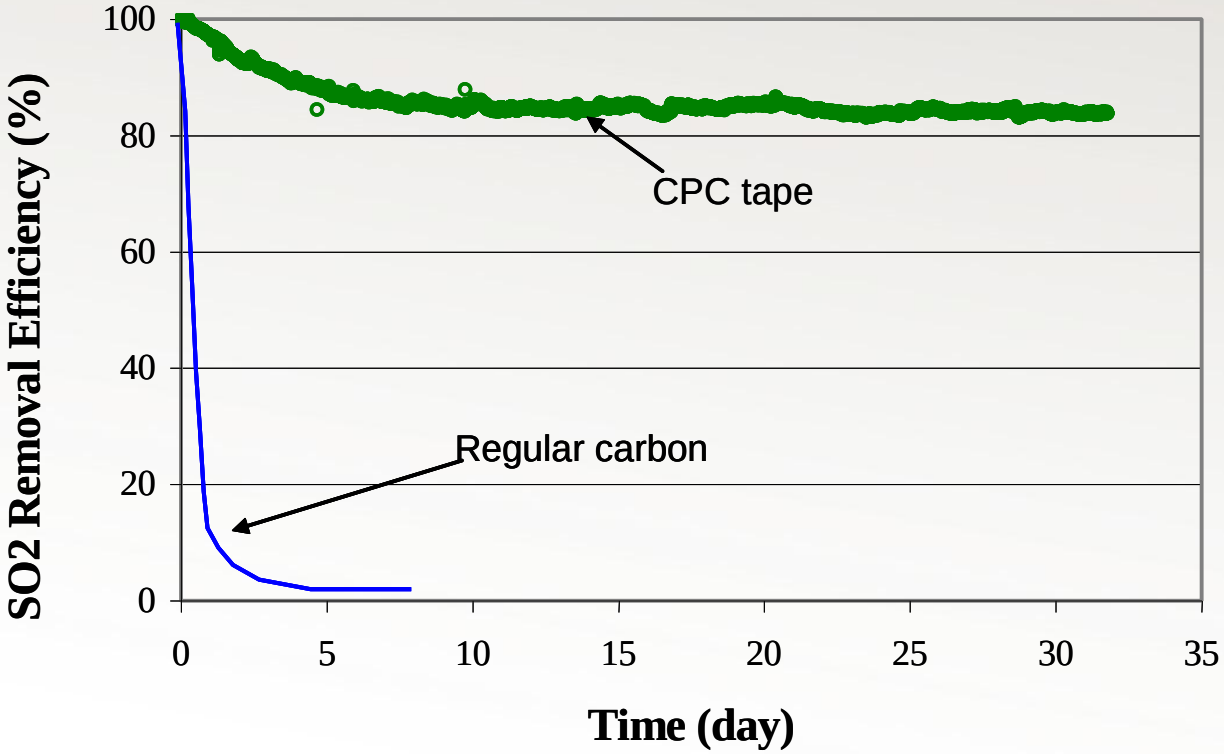
Lab Tests

- SOx and Hg removal - convert SOx into sulfuric acid solution



Lab Tests

- SOx and Hg removal - convert SOx into sulfuric acid solution (continued)

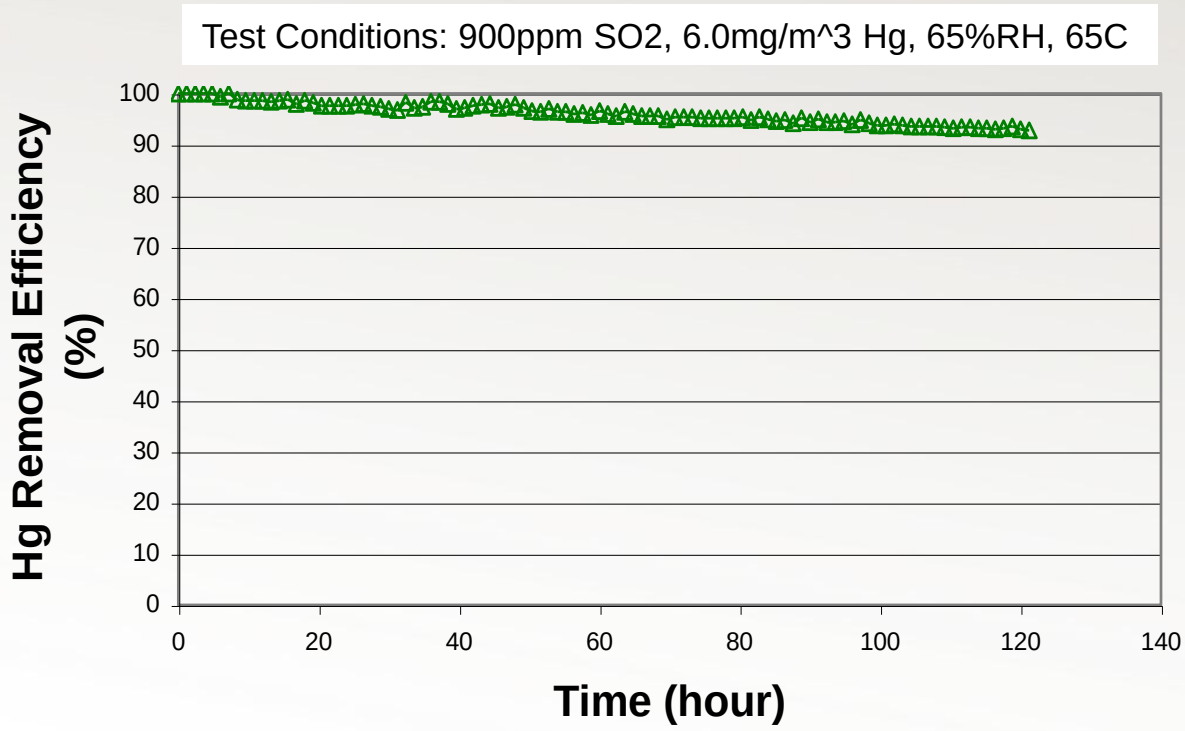


Test conditions:

- 900ppm SO2
- 6mg/m^3 Hg
- 4cmx7cm tape
- 300sccm flow
- 65C
- 65% RH

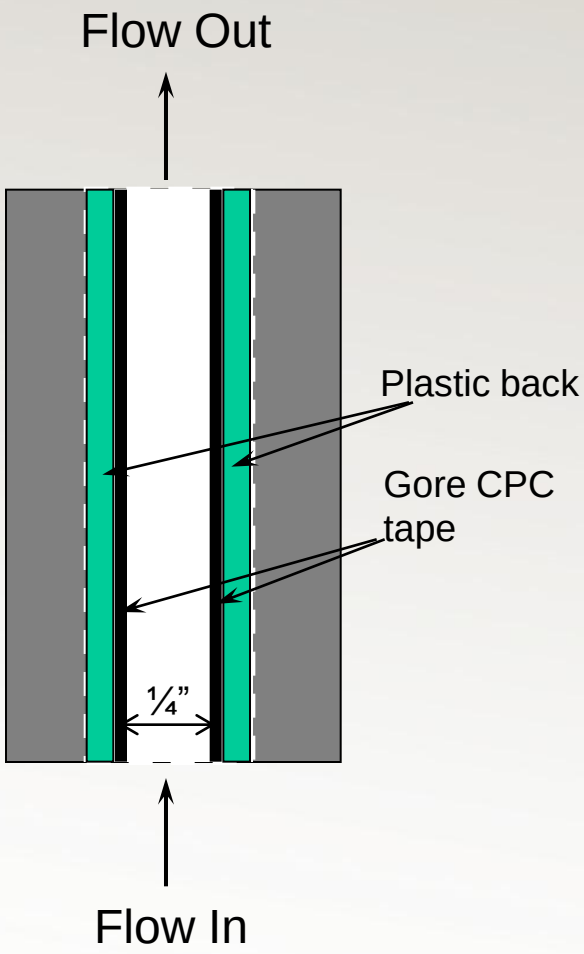
Lab Tests

- SOx and Hg removal (continued) – High mercury removal efficiency & capacity



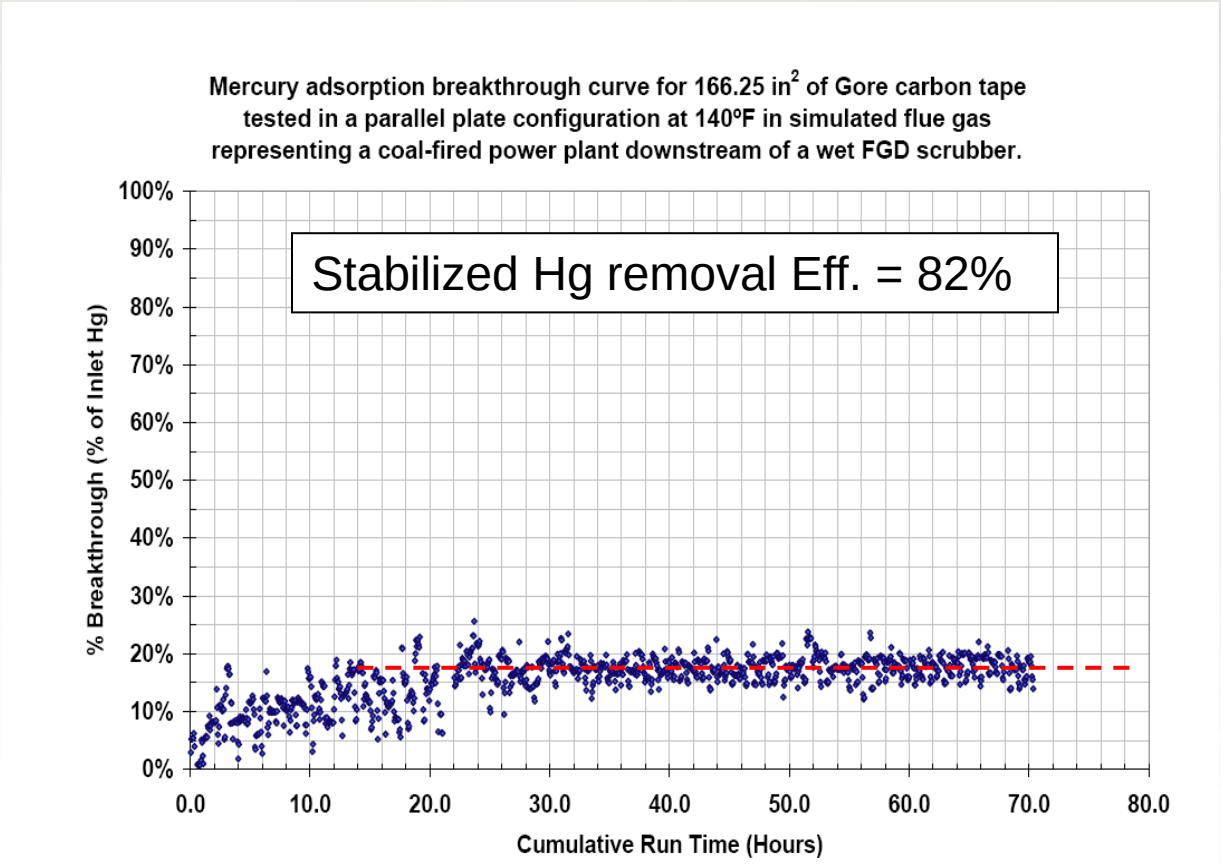
Lab Tests

- Mercury removal with parallel plate arrangement – by URS
  - Mercury: 20-50 μg/m^3
  - SO2: 50 ppmv
  - Temperature: 140F (60C)
  - RH: 50%
  - Gas flow: 0.8cfm
  - Total CPC tape: 3.8” x 23” (two strips)



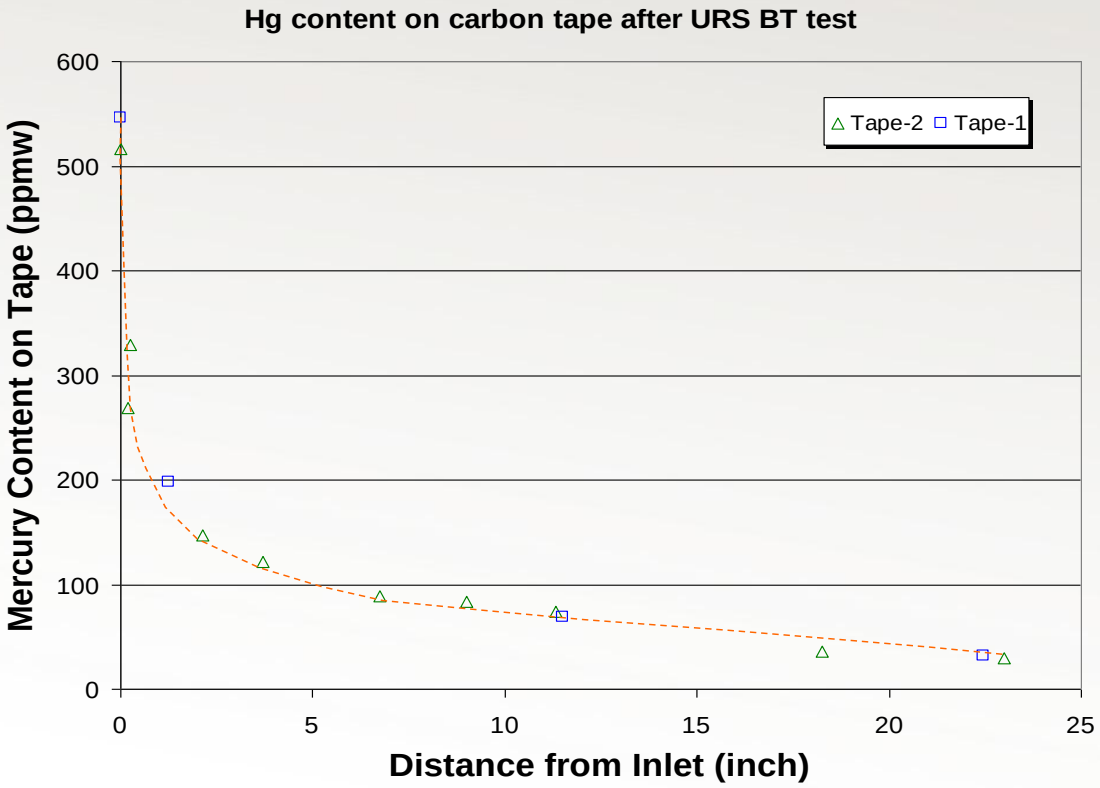
Lab Tests

- Mercury removal with parallel plate by URS (continued)
  - URS model simulations: Stabilized Hg removal efficiency = 80%



Lab Tests

- Mercury removal with parallel plate by URS (continued) - Distribution of Hg on CPC tape after URS testing

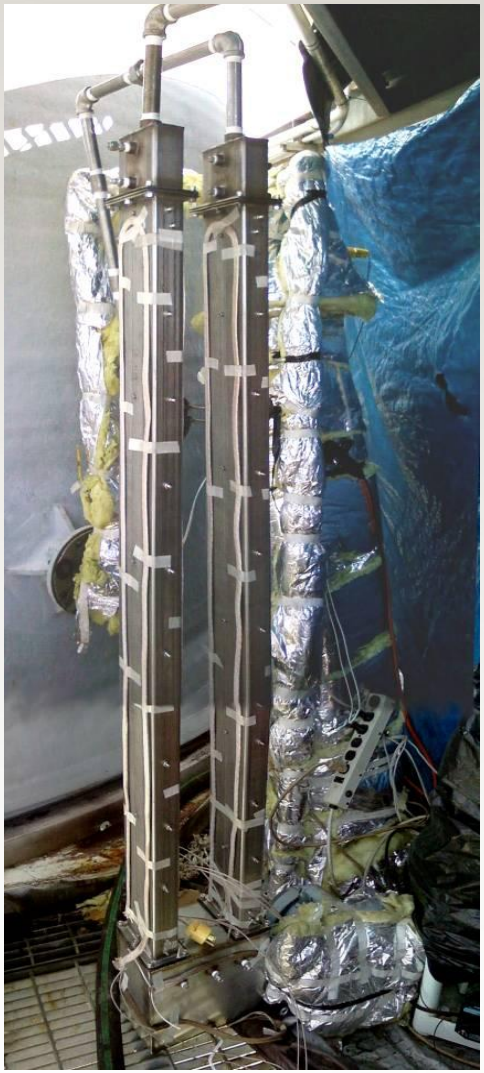


Small scale field demonstrations

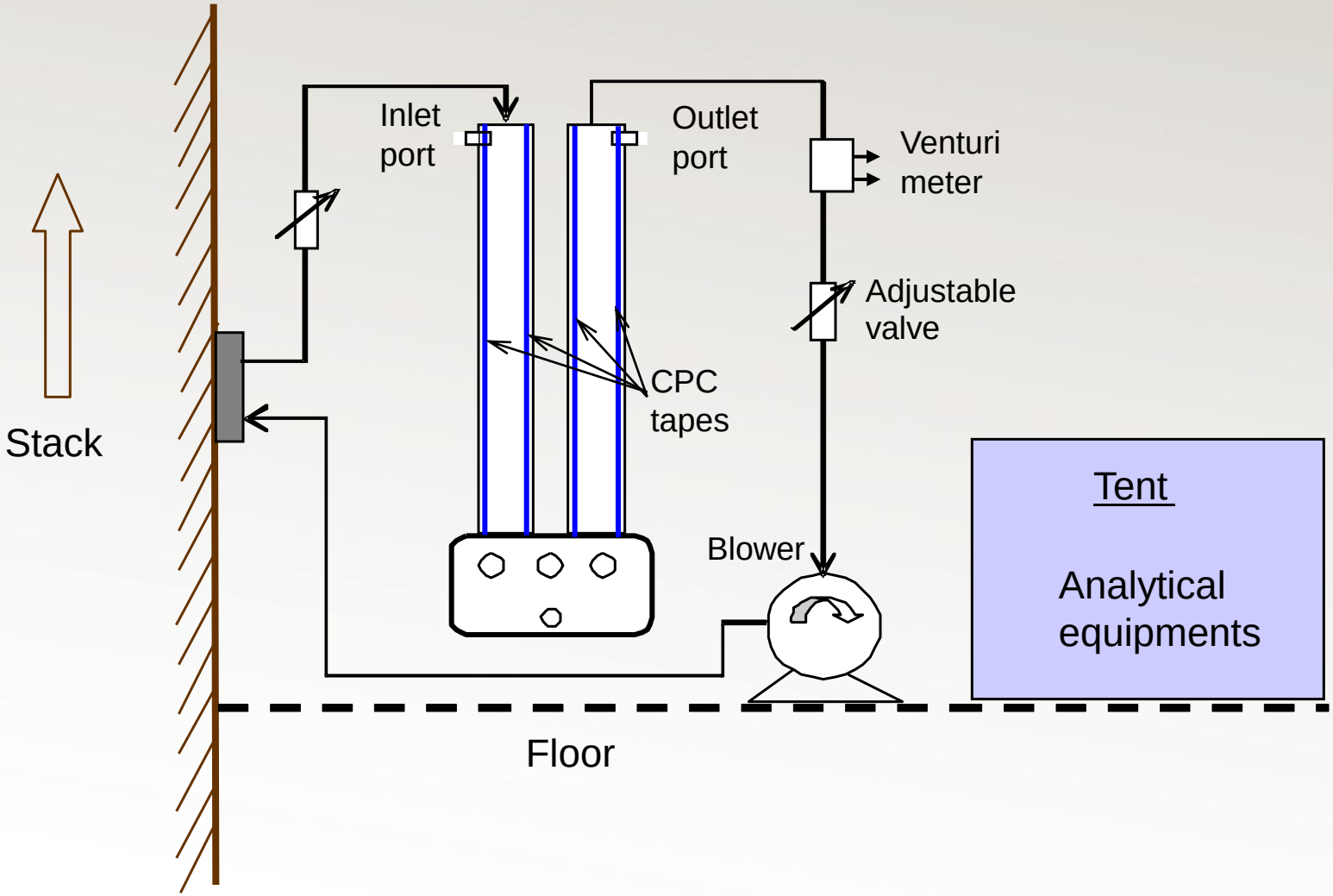
- Plant Yates Demonstration (I) – Parallel Plate (March – July 2010)
  - The demonstrations were jointly carried out by Gore, EPRI, URS, and Southern Company
  - Tests were done at Southern Company's Plant Yates power station
  - Slip stream flue gas was taken after limestone wet scrubber (from stack)
    - Temperature: ~123F (51C)
    - Humidity: 100%
    - Flow Rate: 5.0cftm (5ft/second linear velocity)
    - Carbon tape: 4-strips of 5in x 5ft
    - Testing date: March 26, April 21, May 20, July 13, and July 30, 2010

Plant Yates – Newnan, Georgia

Small scale field demonstrations (continued)

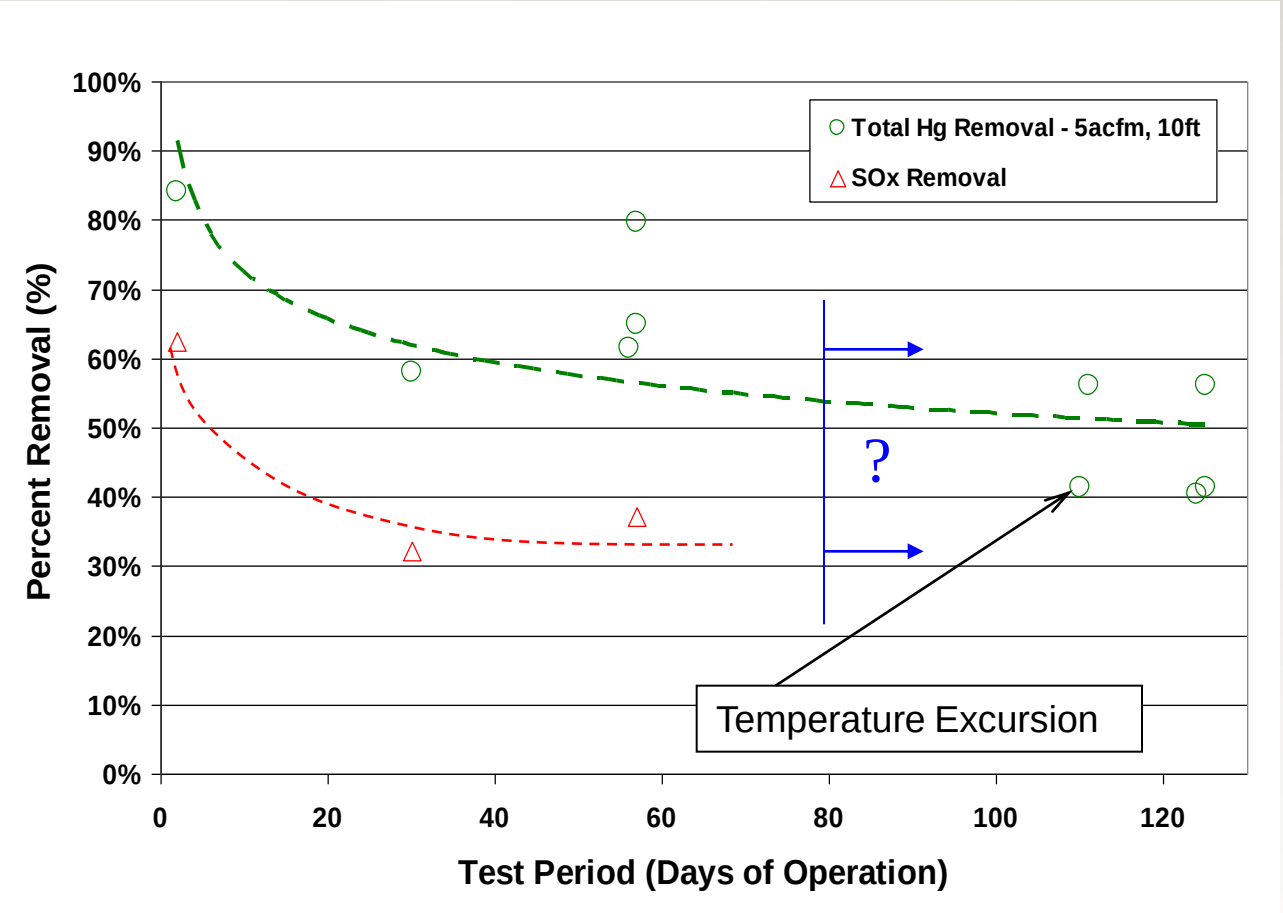


Small scale field demonstrations (continued)

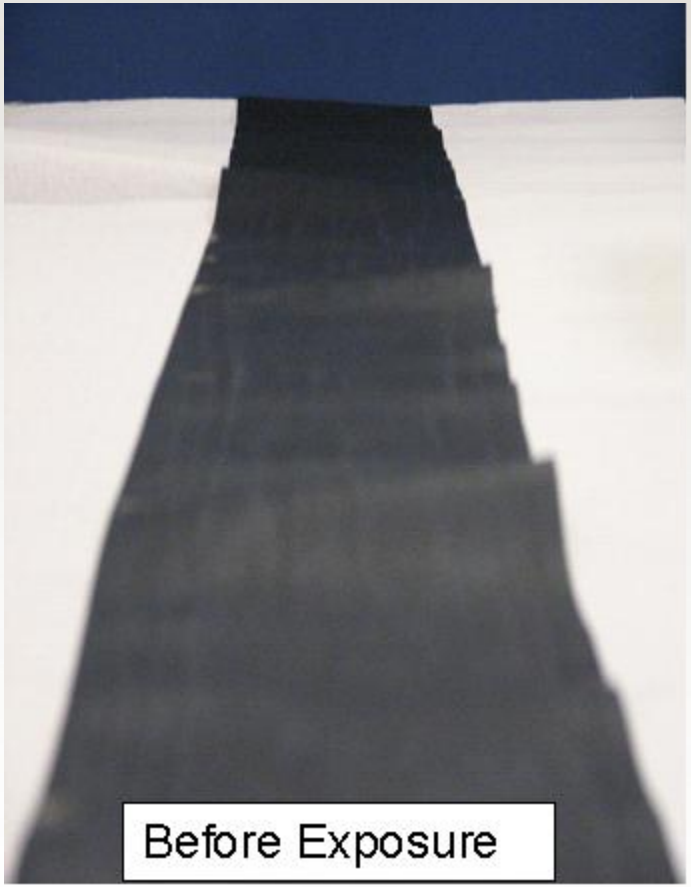


Small scale field demonstrations (continued)

Hg & SO2 Removal



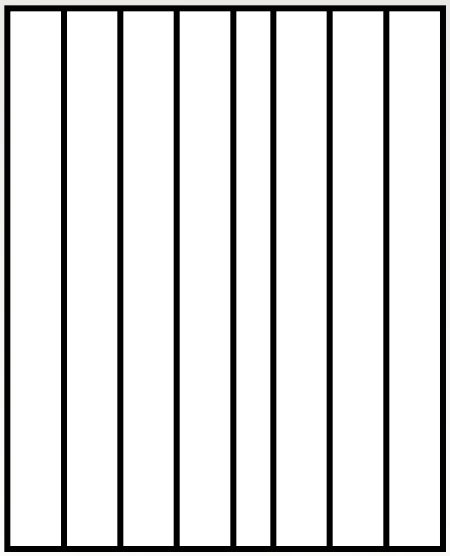
Small scale field demonstrations (continued)



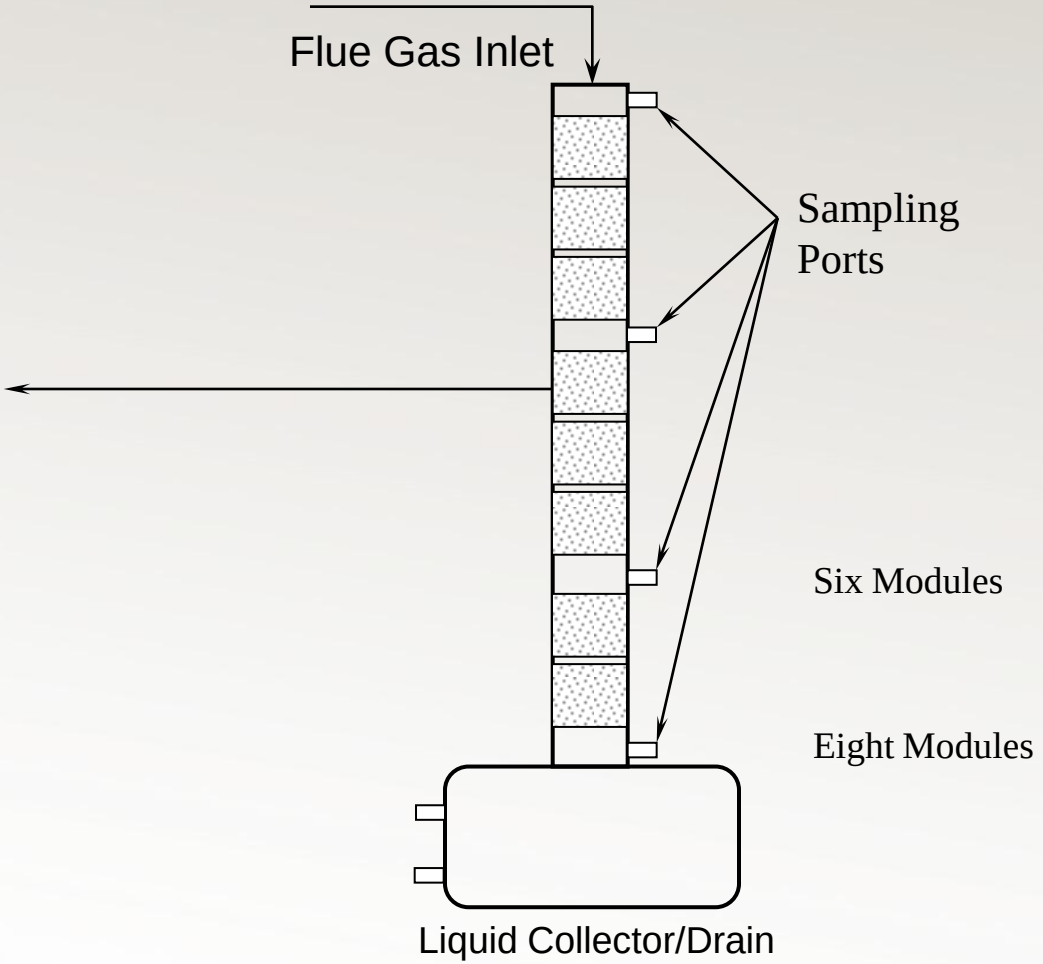
Small scale field demonstrations (continued)

- Plant Yates Demonstration (II) – Sorbent Module (Aug. - present)
  - The demonstrations were jointly carried out by Gore, EPRI, URS, and Sothern Company
  - Tests were done at Southern Company's Plant Yates power station
  - Slip stream flue gas was taken after limestone wet scrubber (from stack)
    - Temperature: ~123F (51C)
    - Humidity: 100%
    - Flow Rate: 13.0 and 24.7acfm (5 and 9.5ft/second linear velocities)
    - Carbon tape: 6" deep, 3.8" diameter cylindrical modules (8 modules)
    - Testing date: July 31, Aug. 30, Sept 16, Oct 26, Nov. 29

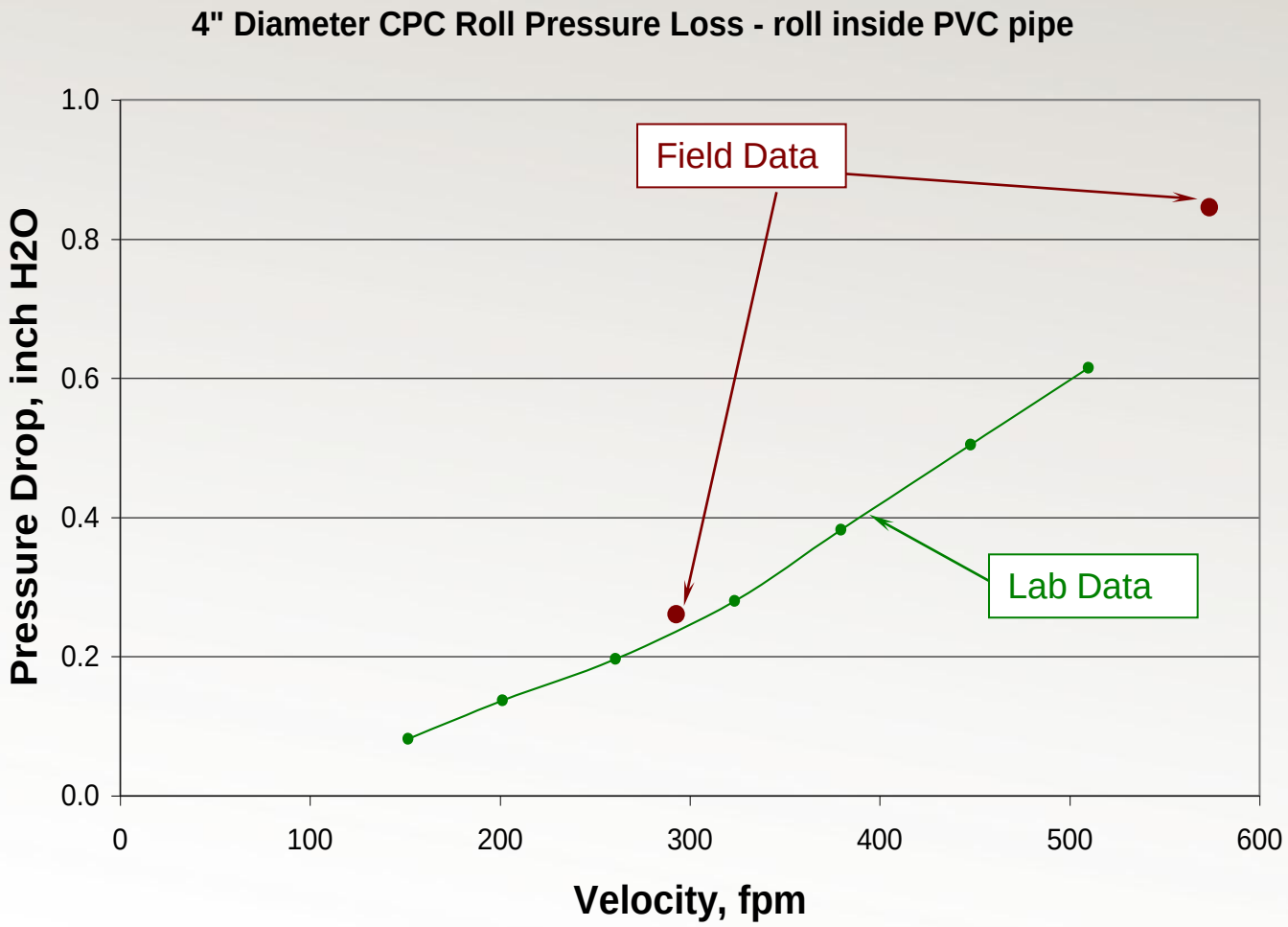
Small scale field demonstrations (continued)



CPC Tape module

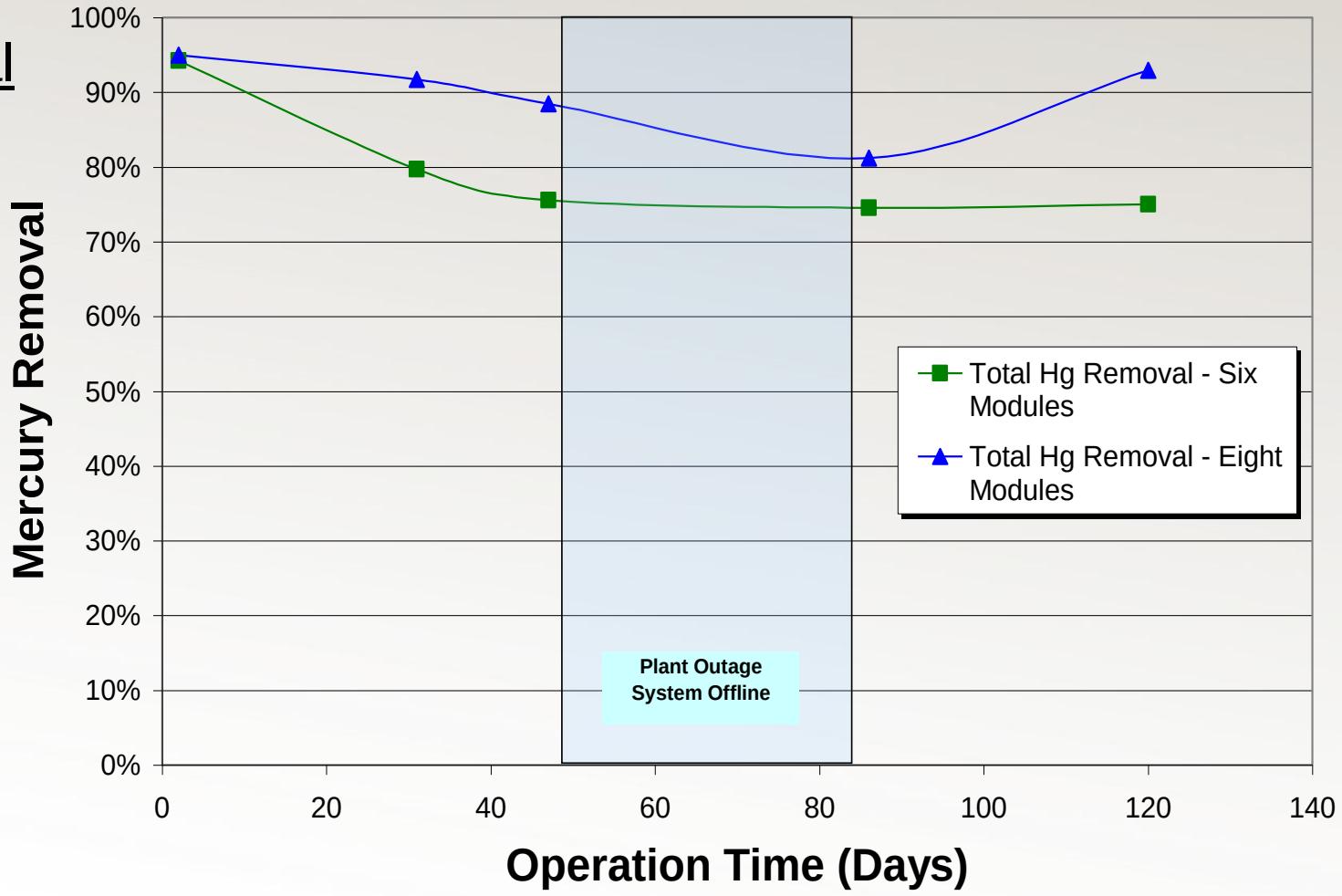


Small scale field demonstrations (continued)

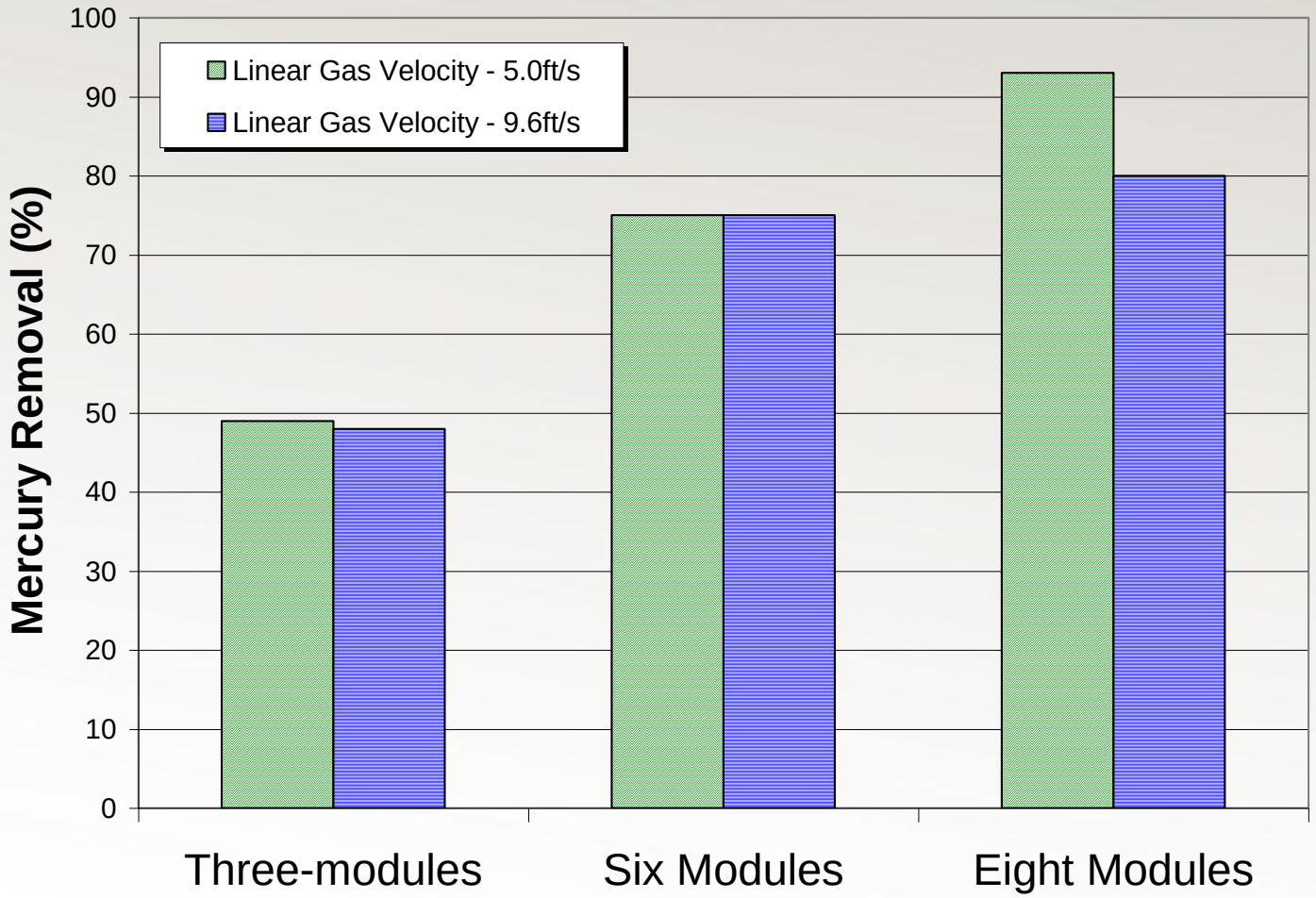


Small scale field demonstrations (continued)

Hg Removal

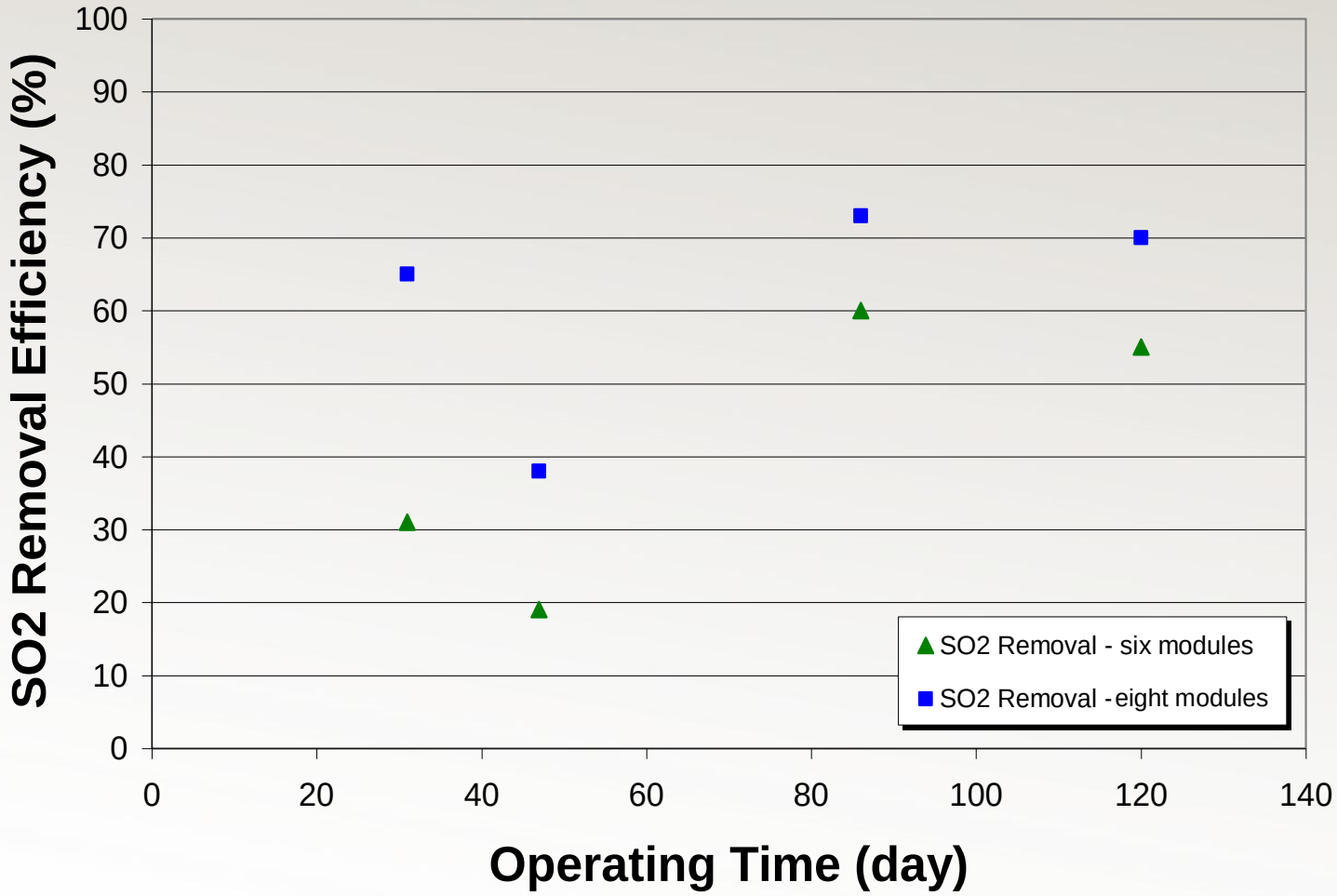


Small scale field demonstrations (continued)



Small scale field demonstrations (continued)

SO2 Removal



Summary

- A unique sorbent material, carbon polymer composite material (CPC), has been developed for flue gas mercury and other contaminates removal
- The CPC material is deployed in a stationary sorbent bed applications, and the sorbent bed does not require a frequent regeneration process
- Field demonstration tests have shown that the CPC bed is effective for Hg/SOx removal (in coal-fired power plant after a wet scrubber) for long-term (4-5 months without requiring frequent regeneration or maintenance processes)
- We will perform a preliminary engineering economic analysis is to assess the feasibility of retrofitting the CPC to the existing power plant and cost, and conduct a medium scale field demonstration this year, and a full-scale field demonstration afterward