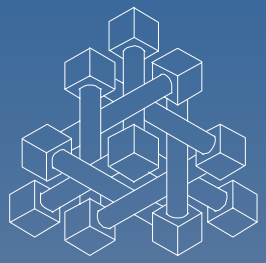


SOUTHERN RESEARCH

INSTITUTE

Mercury Control with Calcium-Based Sorbents and Oxidizing Agents

Thomas K. Gale

Acknowledgements

- Barbara Carney -- DOE Project Manager
- Babcock Power -- Na_2S_4 Technology

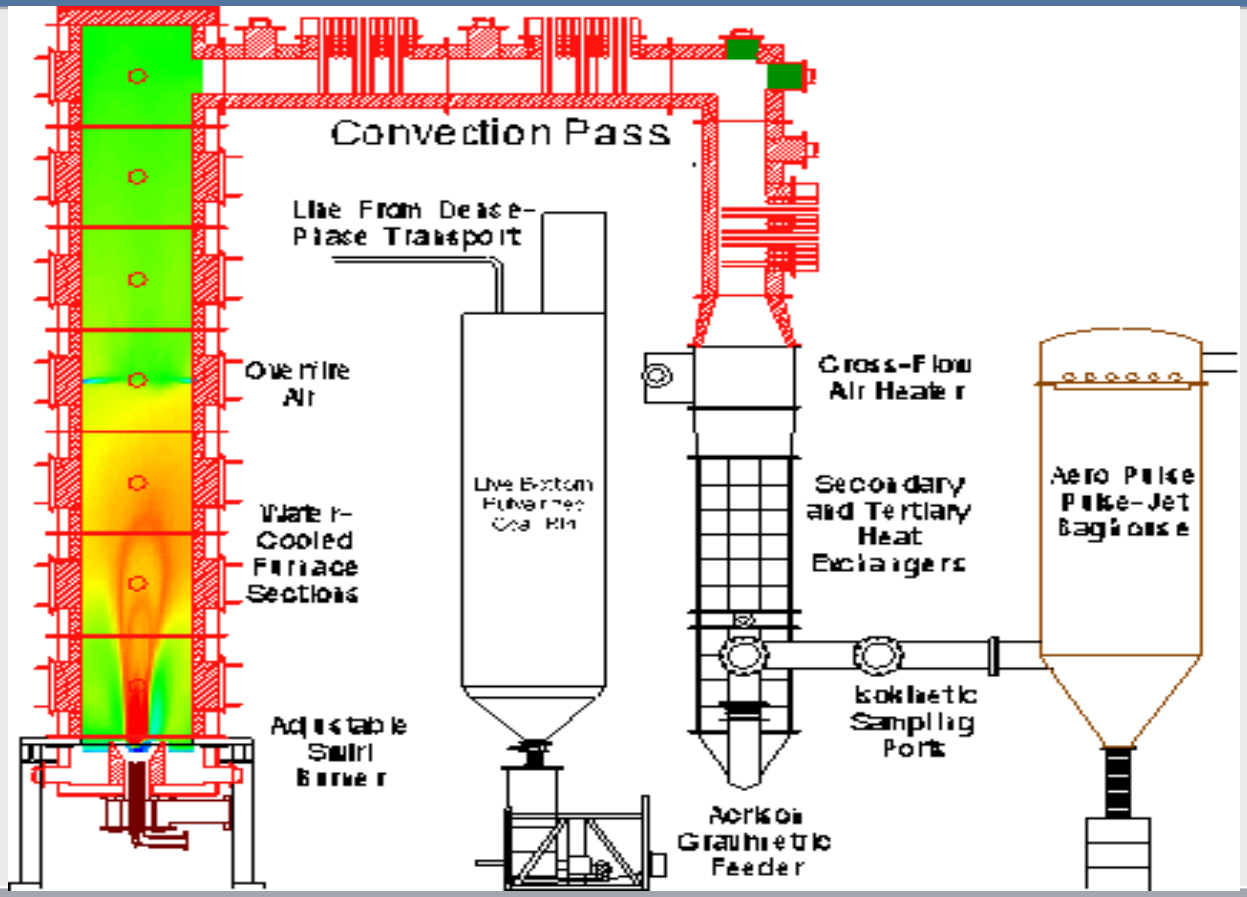
We would also like to thank EPA and EPRI for funding and allowing collaboration with a fundamental mercury speciation program, also being conducted at Southern Research Inst.

SOUTHERN RESEARCH
INSTITUTE

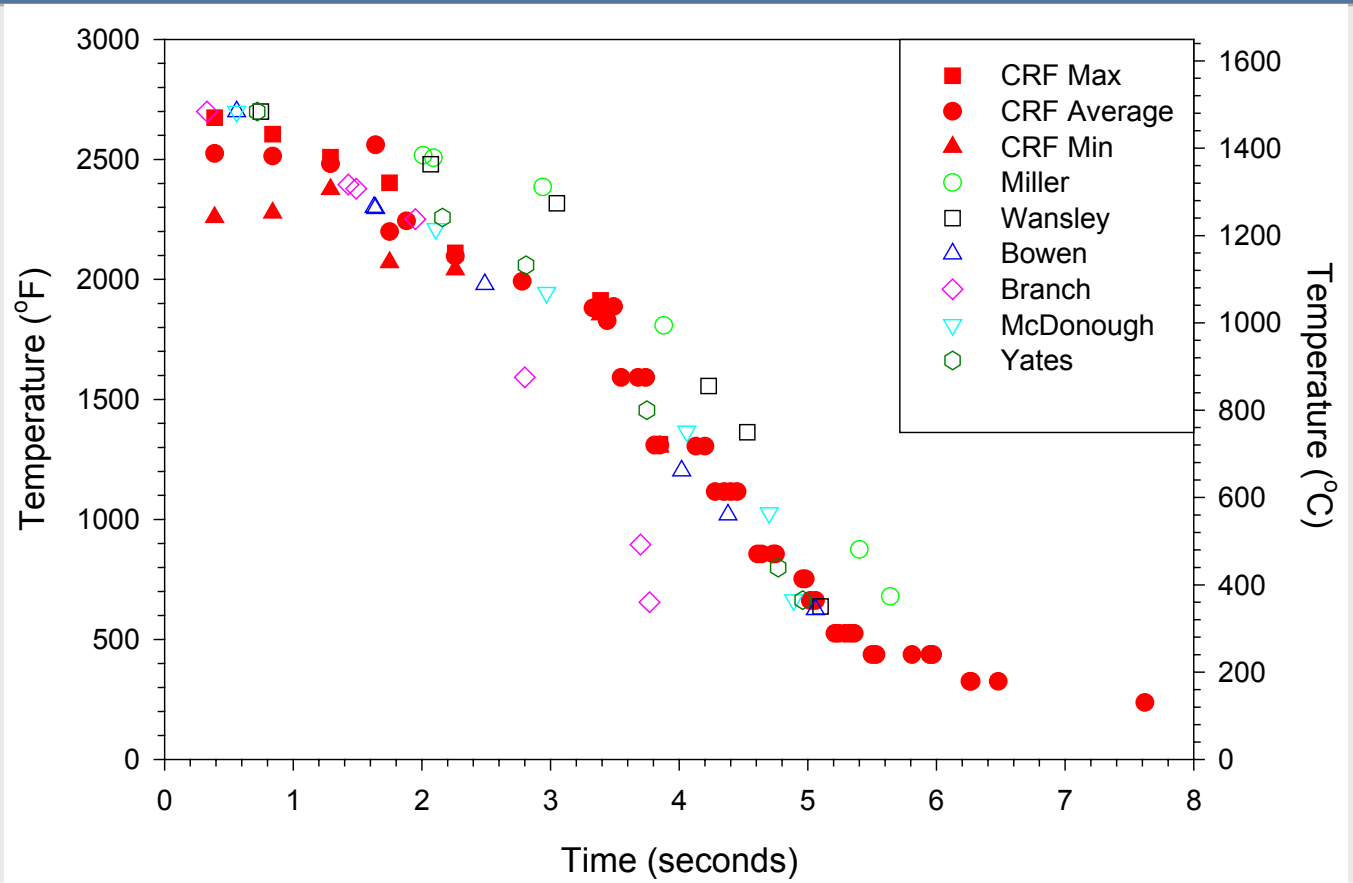
Outline

- Experimental
- Comparison of Hg-Oxidation and Hg-Capture -- PRB and Bituminous coals
  - Chlorine
  - General Flue Gas Components
  - Catalytic Material
- Na_2S_4 Injection
  - Effects of Chlorine, Temperature, Coal Type.

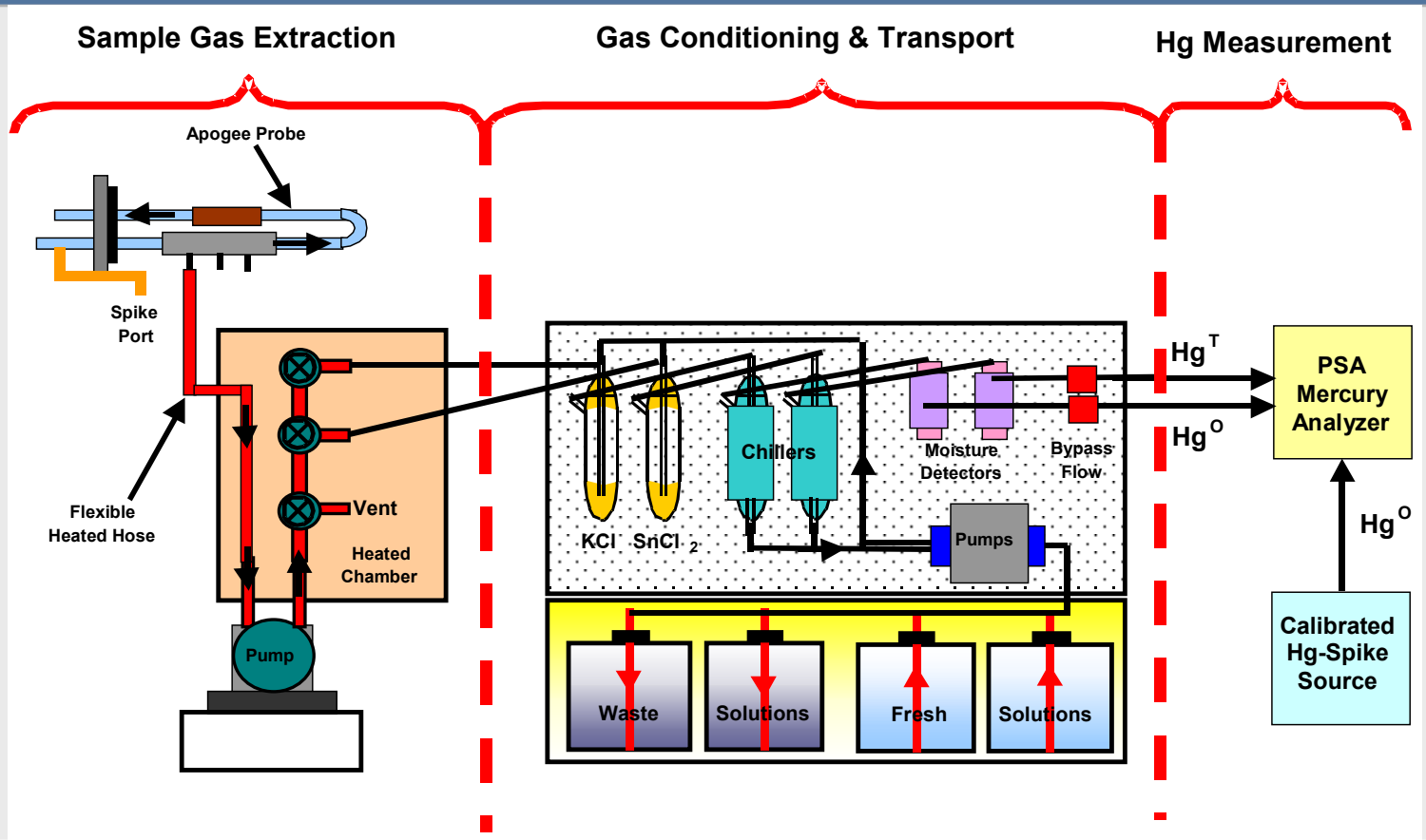
Combustion Research Facility



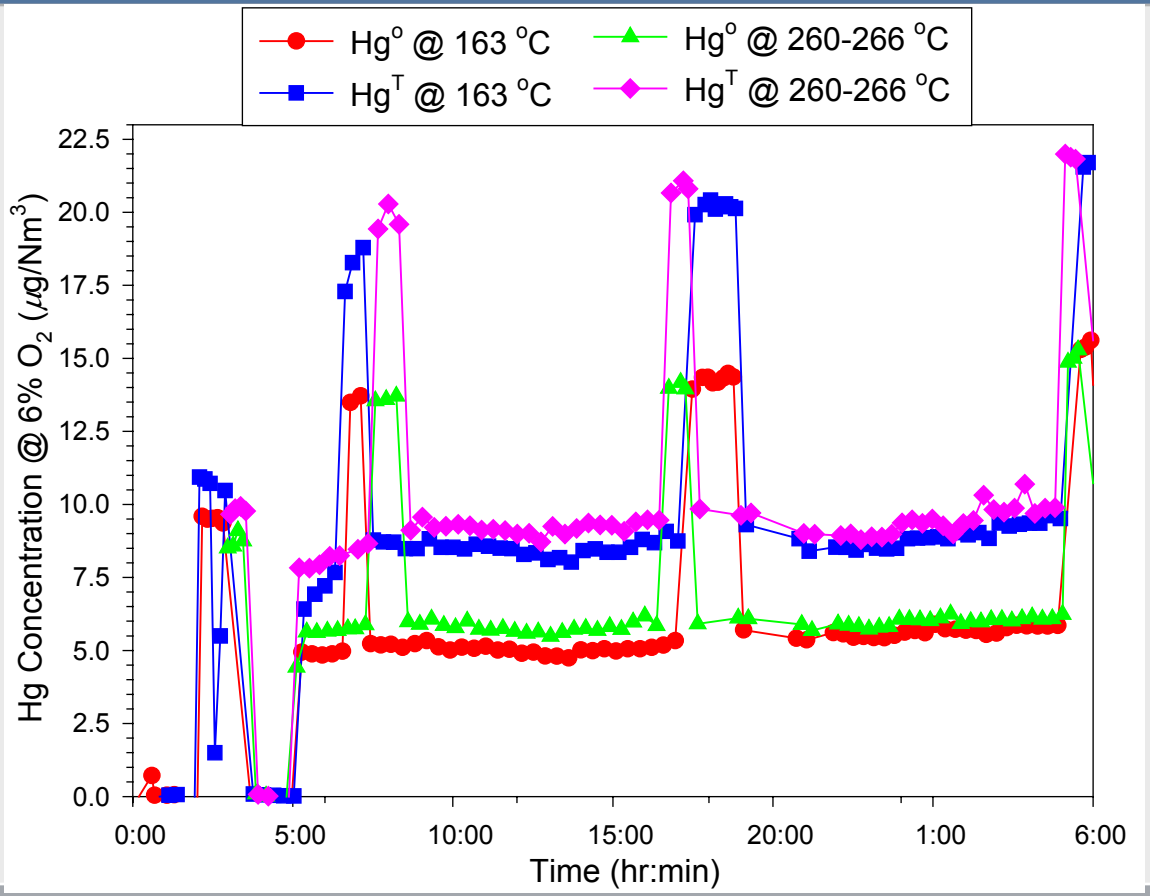
CRF $^{dT}/_{dt}$ Compared to Full-Scale



Mercury Monitoring System Including Spike and Recovery



Example of Data from Monitor Using Spike and Recovery

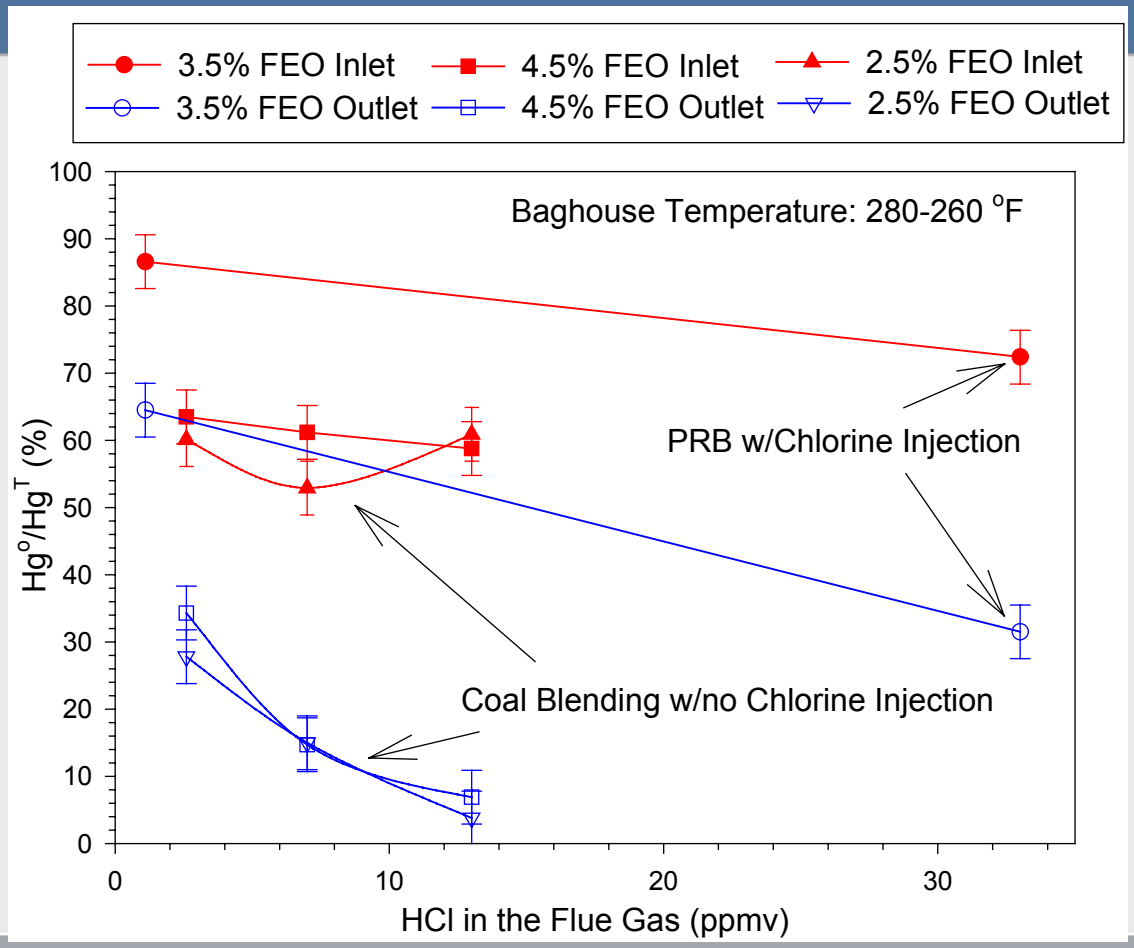


PRB/Bituminous Component Comparison Regarding Hg-Oxidation and Capture

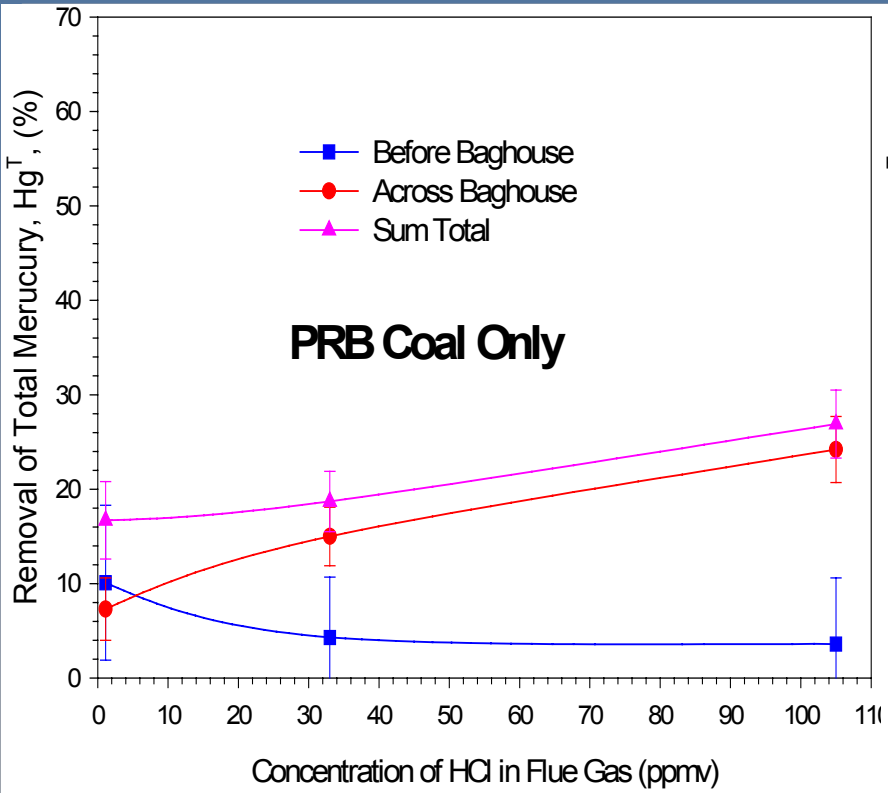
- PRB Coal *compared with* Bituminous Coal
- via coal blending

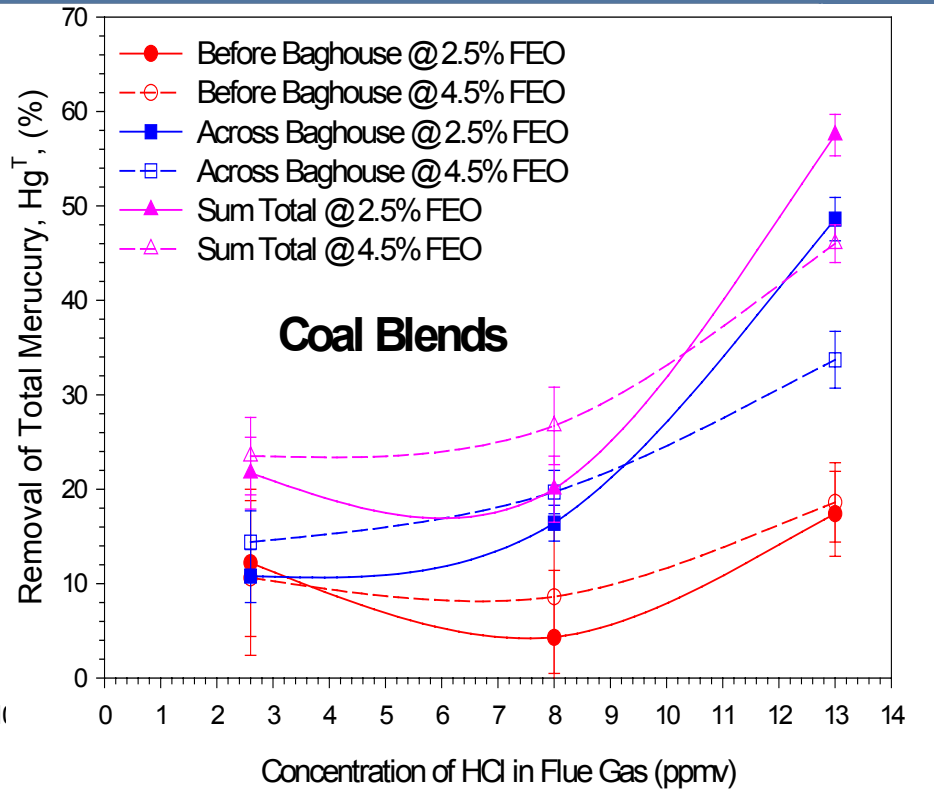
- Hg-Oxidation
- Hg-Capture

Effect of Flue-Gas Chlorine on Hg-Oxidation



Effect of Chlorine on Hg-Removal

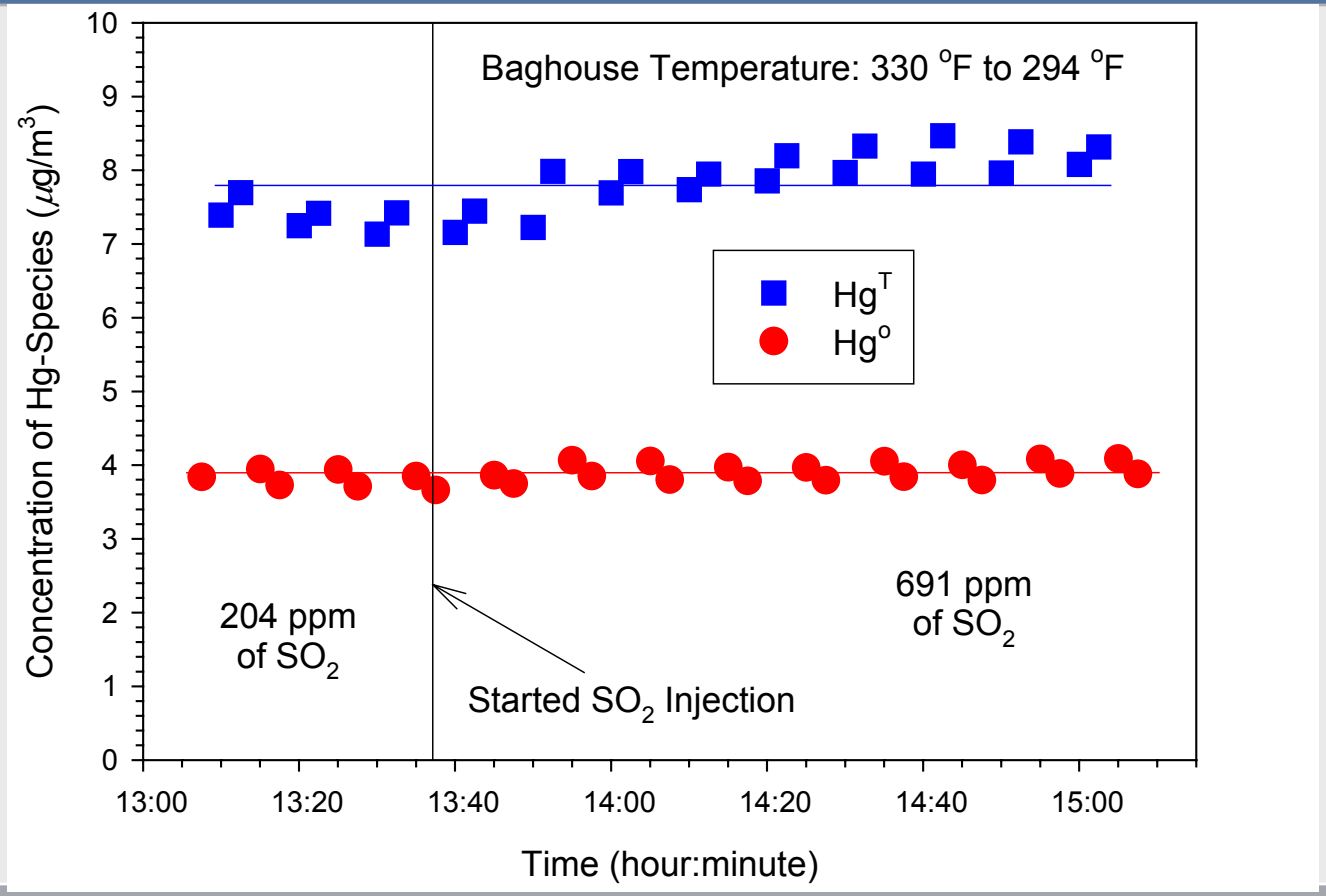




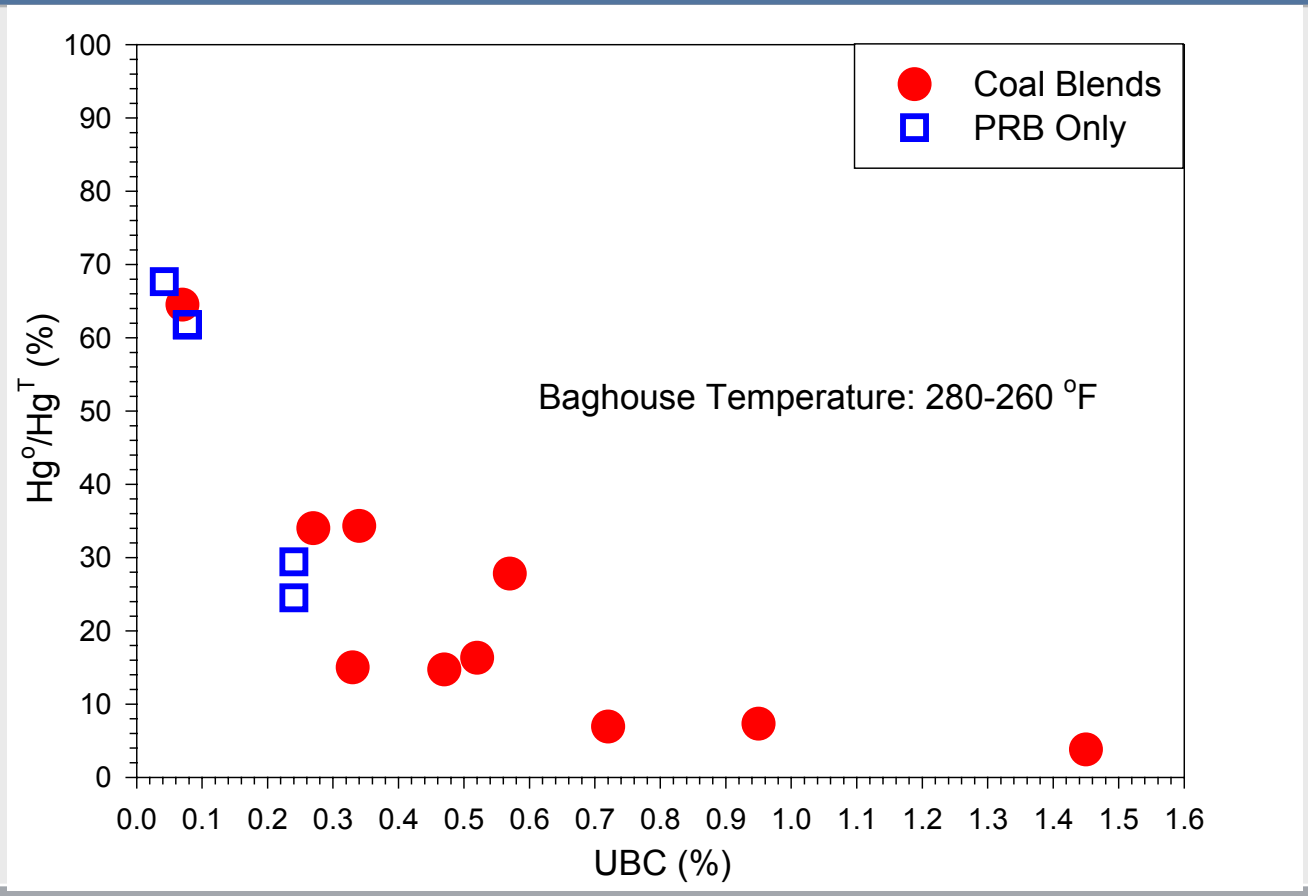
Isolated and Non-Correlated Parameters

- NO Correlation with CO_2, CO, O_2
- NO Correlation with NO_x or H_2O
- Through Isolation -- NOT SO_2
- What's Left? UBC and Coal Minerals

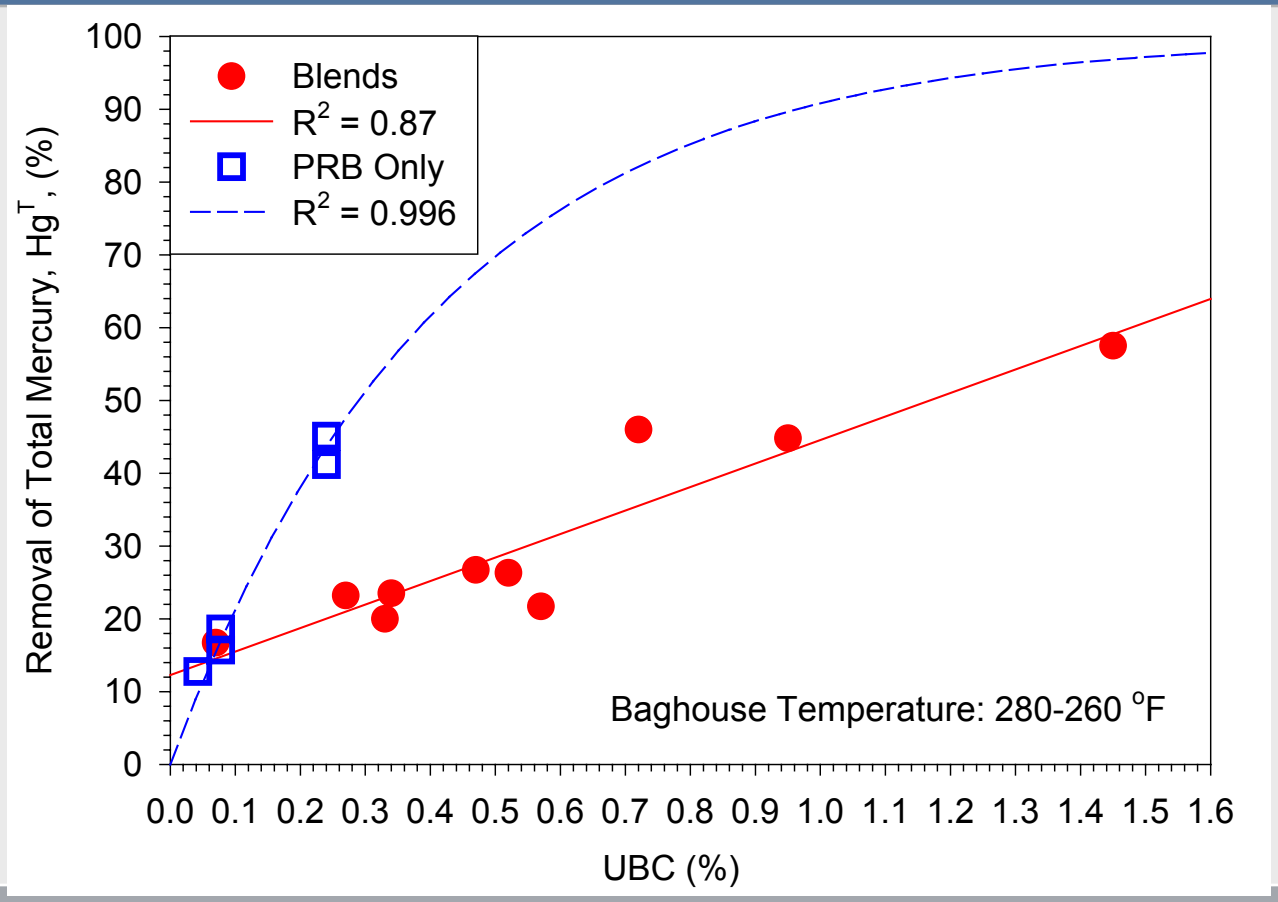
Effect of SO_2 on Hg-Speciation



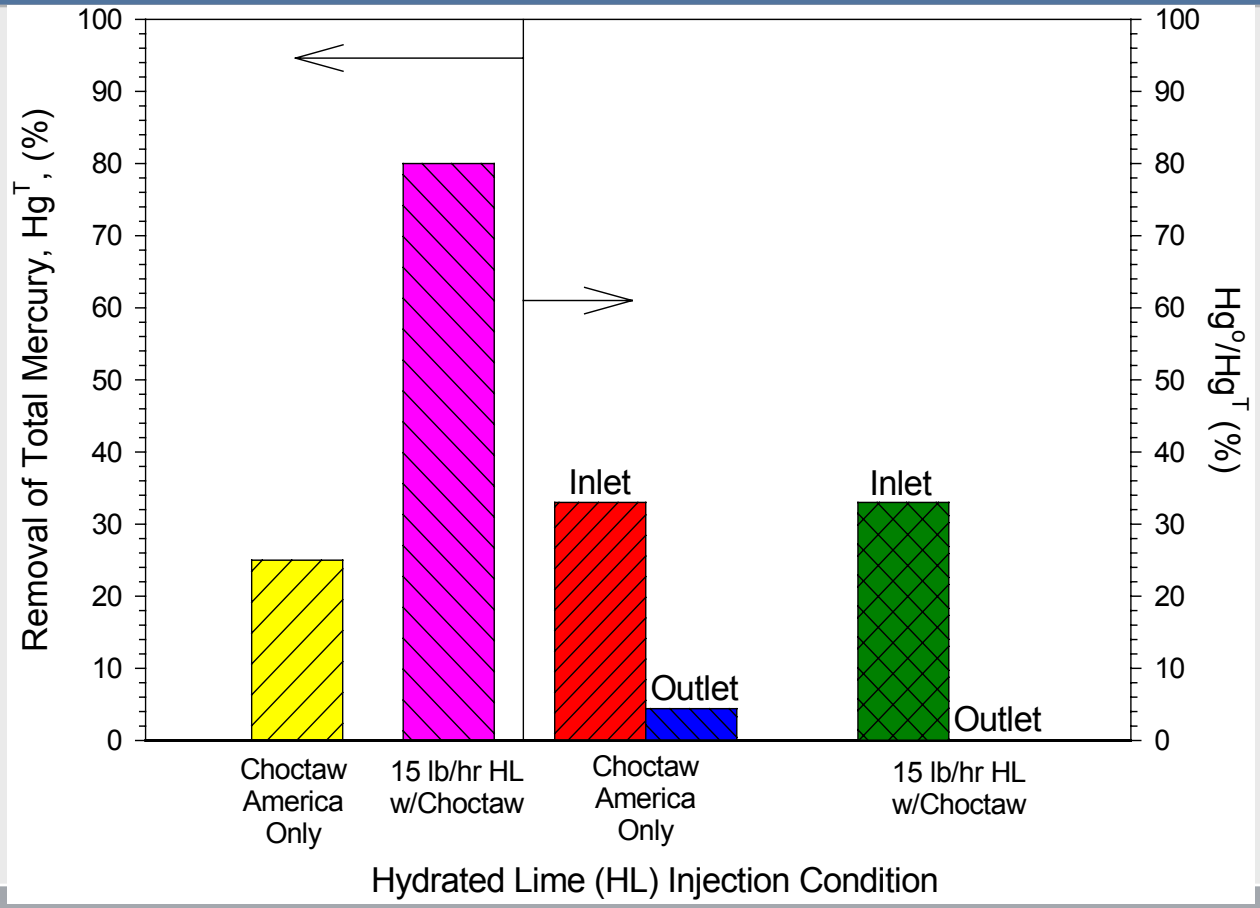
ANSWER: Unburned Carbon



UBC enhances $HgCl_2$/Ca Capture



Hydrated Lime w/Catalyst is Effective



Conclusions Regarding Hg-Oxidation

- FOR LOW UBC CONDITIONS
- Total chorine content, injected through the burner or inherent in the coal, tends to increase Hg-oxidation prior to and across the baghouse.
- The catalytic material in coal ash is a more important factor in determining Hg-oxidation than total chlorine content.
- The primary parameter responsible for enhancement of Hg-oxidation for blends of PRB and bituminous coal is the UBC in bituminous ash.

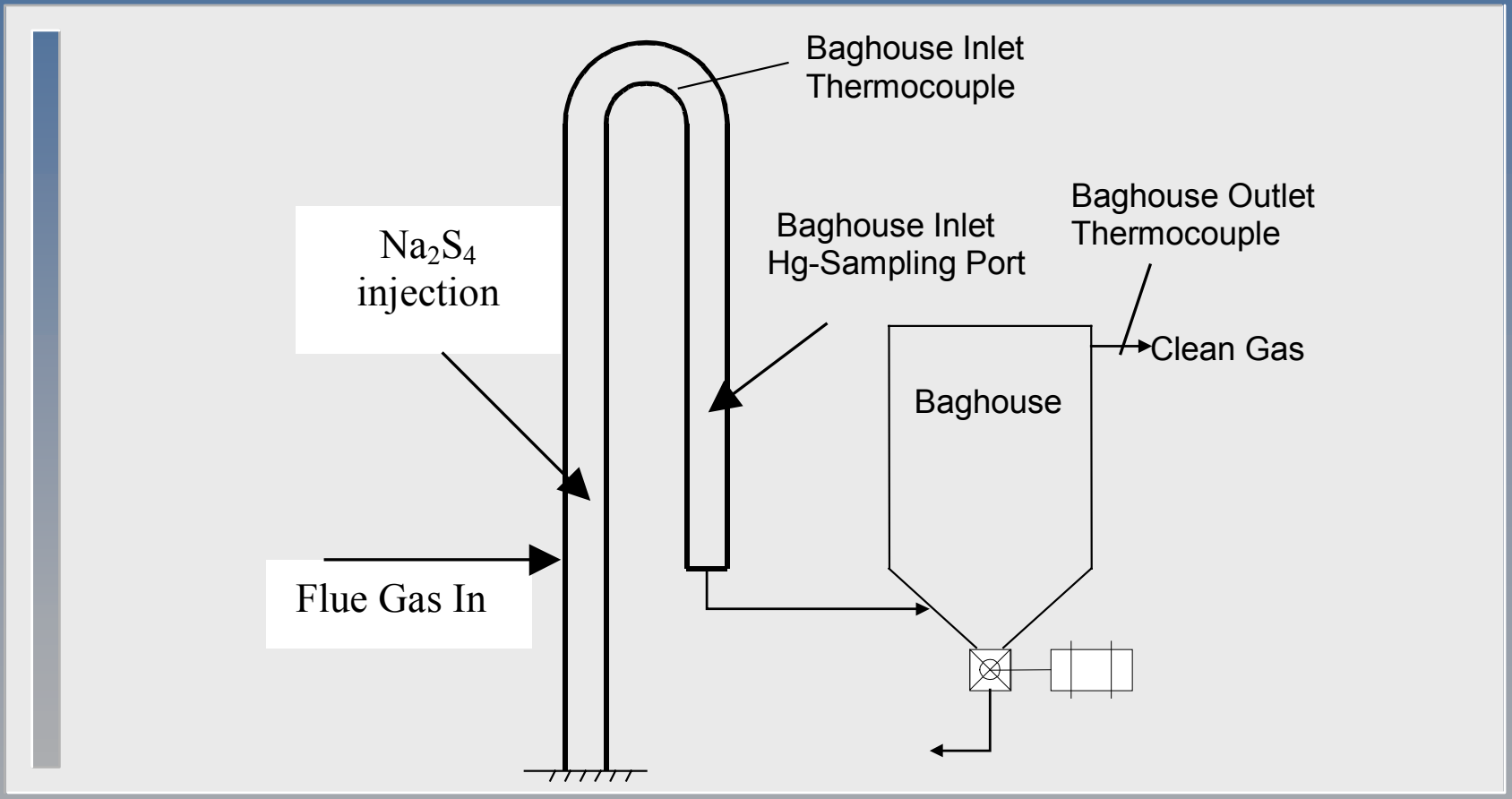
Conclusions Regarding Hg-Removal

- FOR LOW UBC CONDITIONS
- Total chorine content, injected through the burner or inherent in the coal, has little effect on total mercury removal.
- Hydrated lime and even high-calcium ashes such as PRB can be effective sorbents, if they are mixed with a catalyst.
- The primary parameter responsible for enhancement of Hg-capture for the blends of PRB and bituminous coal in this investigation was the UBC in bituminous ash.
- Most effective Hg-removal was observed for high-calcium and high UBC concentrations in the ash.

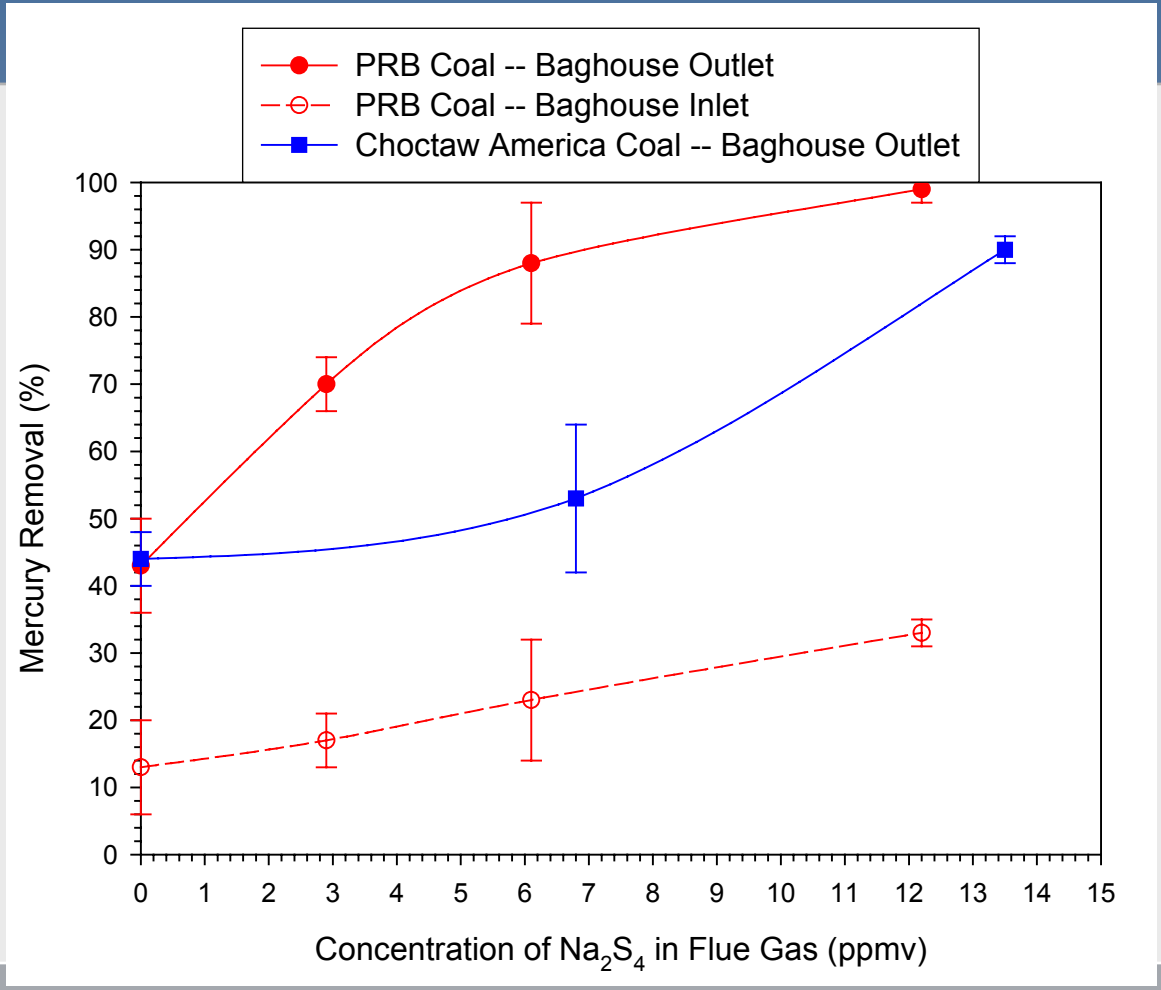
Na_2S_4-Injection

- Fine-spray injection of Sodium Tetrasulfide into flue gas before baghouse or ESP.
- Na_2S_4 decomposes into elemental S^o and ionic sulfur S^{-2}
- Hg^o is captured by S^o and $HgCl_2$ by S^{-2} to form HgS.
- HgS is the most stable and benign form of mercury in the environment.
- Results of injection ~2.0 seconds before baghouse.

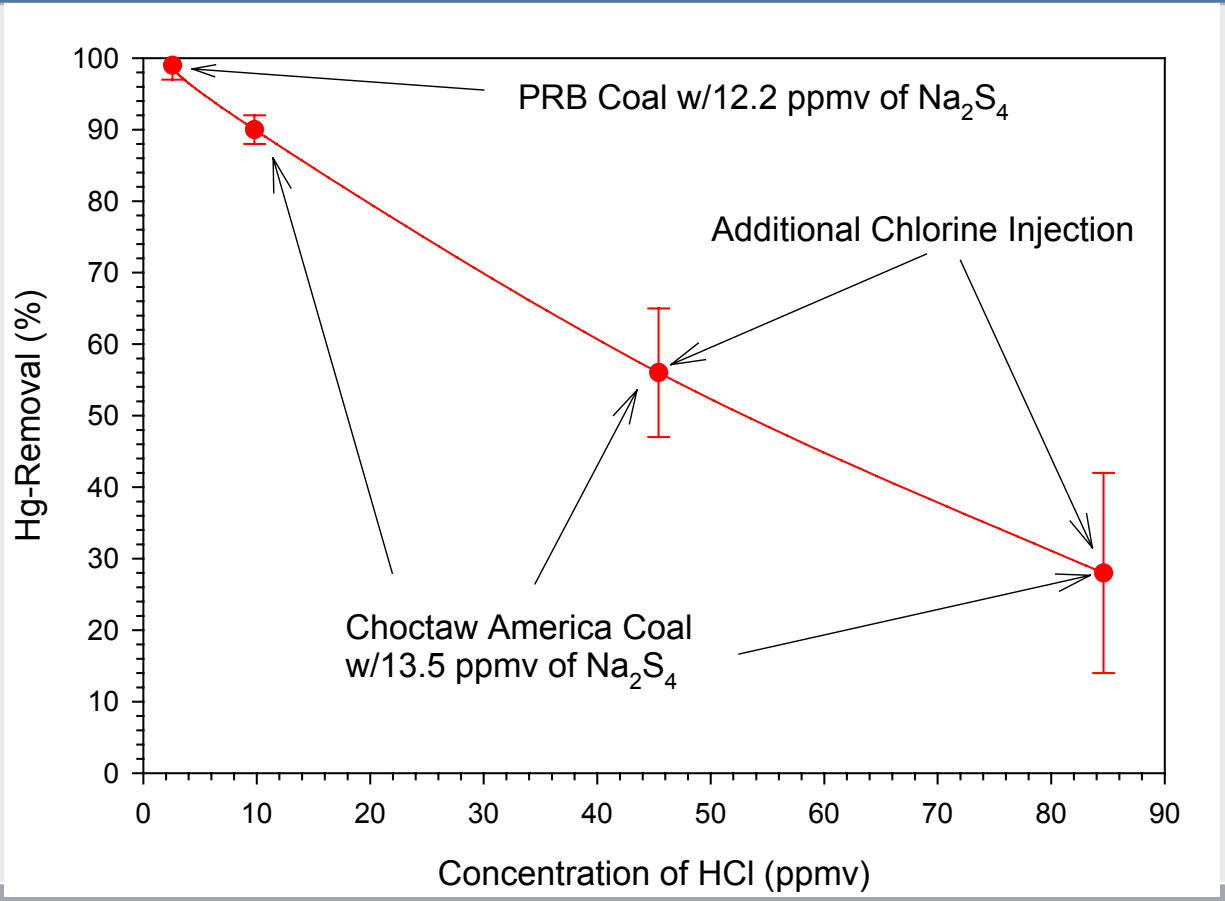
Na_2S_4-Injection Location



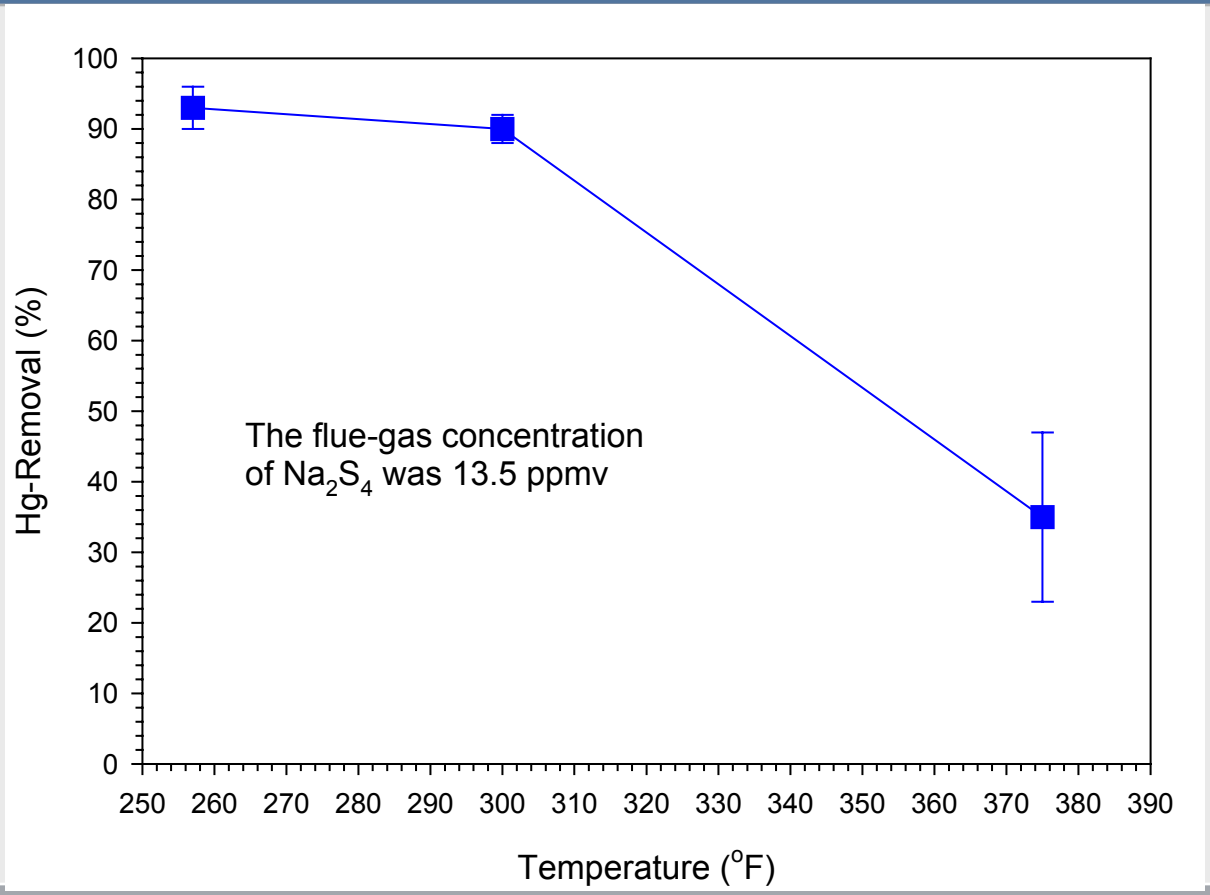
Gas-Phase Hg-Removal by Na_2S_4-Injection



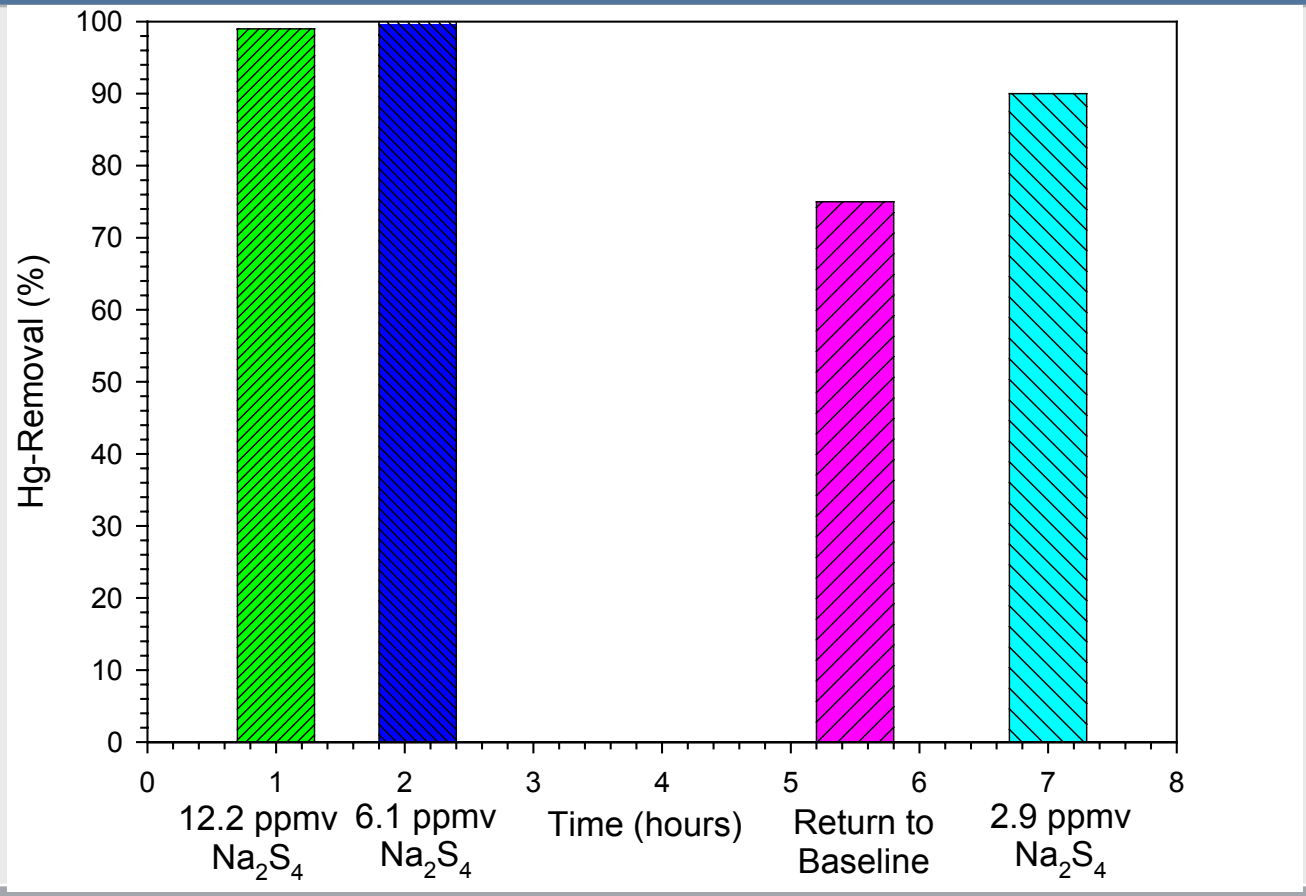
Effect of Chlorine



Temperature Effect on Na_2S_4-Injection



Residual Effect of Na_2S_4-Injection



Conclusions

- Sodium tetrasulfide injection (~10 ppmv Na_2S_4 in flue gas), approximately 2.0 seconds ahead of a baghouse, is sufficient to removal 100% +/- 2% of flue-gas *vapor-phase* mercury, while burning a relatively low chlorine coal.
- Injection temperatures above 350 °F are detrimental to the effectiveness of Na_2S_4-injection technology, while injection temperatures as low as 250 °F appear favorable.
- Chlorine in the flue gas reduced the effectiveness of Na_2S_4-injection for Hg-capture directly proportional to the concentration of chlorine in the flue gas. However, previous work has shown this technology to be successful for use in high-chlorine waste-incineration flue gas.
- Other than chlorine content, Na_2S_4-injection technology was unaffected by differences in coal type or flue-gas composition in this investigation.
- While Na_2S_4-injection technology may be effective in the disperse phase (i.e., ESP applications), Na_2S_4-injection in front of a baghouse benefits from a residual effect, probably associated with the baghouse filter cake. Hence, Na_2S_4-injection in front of a baghouse may only require intermittent injection, and thus operational costs may be lower.

Future Work

- Calcium-based sorbent development and optimization will continue, utilizing information obtained on catalytic enhancement of Hg-oxidation.
- An optimized sorbent will be tested to observe the ability of this designer sorbent to remove mercury in the disperse phase (ESP) and in a baghouse.
- Sorbents specifically designed to remove SO_2 in a semi-dry recirculating system will be examined for their effectiveness as a Multi-Pollutant Control Technology for removing both SO_2 and Hg from the flue gas.
- Sodium tetrasulfide injection will be tested for its ability to remove mercury across an ESP.
- Finally, field-testing options will be explored for promising technologies.