PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Environmental and Water Resources

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SORPTION MECHANISMS FOR MERCURY CAPTURE IN WARM POST-GASIFICATION GAS CLEAN-UP SYSTEMS

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Background

Power generation systems employing gasification technology must remove a variety of potential air pollutants, including mercury, from the synthetic gas steam prior to combustion. In general, efforts to remove mercury have focused on removal at lower temperatures (under 300 °F). The ability to remove mercury at warm-gas cleanup conditions (300 °F to 700 °F) or in the hot-gas cleanup range (above 1200 °F) would provide plant operators with greater flexibility to choose the treatment method best suited to conditions at their plant.

The University of Arizona is investigating the use of paper waste-derived sorbents (PWDS) for the removal of mercury and other trace metals at temperatures in and above the warm-gas cleanup range. PWDS consist of kaolinite with the addition of calcium hypochlorite. PWDS has been shown to capture mercury by chemisorption at temperatures higher than 400 °F, where more traditional forms of mercury removal, such as physic-sorption with activated carbon or similar compounds, cease to be effective. Additional tests are needed to determine the interaction mechanisms between the PWDS and mercury and to evaluate conditions for optimal removal.

Primary Project Goal

The primary goal of this project is to examine the use of PWDS for mercury removal at high temperatures.

Objectives

While examining PWDS, researchers will work toward the following objectives:

- Screen various PWDS sorbents via testing in a laboratory mercury reactor to identify sorbents with promising removal capabilities.
- Experimentally and computationally characterize spent sorbents
- Based on laboratory results, extrapolate mercury removal capabilities for gas compositions and operating conditions representative of commercial gasifiers

PARTNERS

University of Arizona
University of Utah

PERIOD OF PERFORMANCE

09/26/2004 to 09/30/2008

COST

Total Project Value
$558,594

DOE/Non-DOE Share
$493,140 / $65,454

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Accomplishments

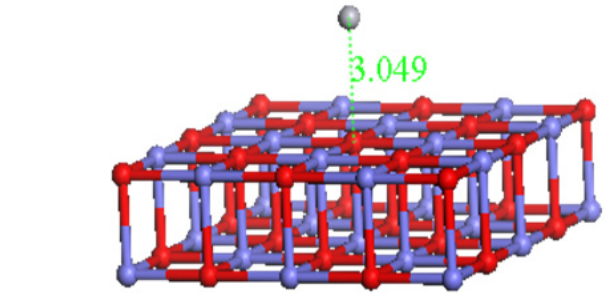
Accomplishments to date have included examination of the potential bonding mechanisms between mercury and solid substrates at high temperatures. A modeling program was used to examine mercury-surface interactions for calcium oxide (CaO), aluminum oxide ($Al2O_3$), and silicon dioxide (SiO_2), all of which are major components of PWDS materials. Modeling results indicated interactions with the SiO_2 surface are the strongest.

Benefits

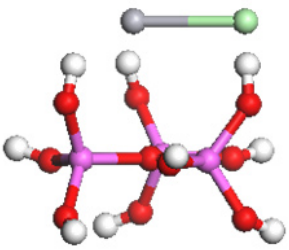
Current mercury removal technologies are ineffective at high temperatures. Research into the use of PWDS has the potential to provide a cost-effective technology for high-temperature mercury capture in gasification systems.

Planned Activities

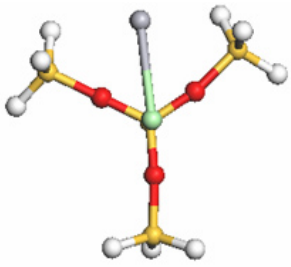
The next phase of this project involves experimental work exploring mercury capture. Sorbent screening will be conducted to determine the conditions under which various sorbents exhibit appreciable mercury capture. Reactor flow rates will be varied to determine optimal residence times, and experiments will be conducted at both high and low temperatures. Researchers will examine four sorbents: PWDS; an equivalent laboratory prepared mixture of kaolinite and lime powder; PWDS + calcium hypochlorite; and the equivalent laboratory prepared mixture of kaolinite and lime powder + calcium hypochlorite.



CaO 5x5x2 with optimized Hg-O surface bond interaction



HgCl adsorption on a T_3 $Al2O_3$ model cluster



HgCl adsorption on a model SiO_2 cluster

"CaO, $Al2O_3$, and SiO_2 are all constituents of PWDS that may contribute to mercury capture. These images show several of the possible interaction mechanisms."