PROJECT facts

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

Advanced Research

1/2006

BENCH SCALE KINETICS OF MERCURY REACTIONS IN FGD LIQUORS

Background

When research into the measurement and control of Hg emissions from coal-fired power plants began in earnest in the early 1990s, it was observed that oxidized mercury can be scrubbed at high efficiency in wet FGD systems, while elemental mercury cannot. In many cases, elemental mercury concentrations were observed to increase slightly across wet FGD systems, but this was typically regarded as within the variability of the measurement methods. However, later measurements have shown substantial re-emissions from some FGD systems.

Goals

- Develop a fundamental understanding of the aqueous chemistry of mercury (Hg) absorbed by wet flue gas desulfurization (FGD) scrubbing liquors.
- Determine the chemical reactions that oxidized mercury undergoes once absorbed, the byproducts of those reactions, and reaction kinetics; and
- Remove technology barriers so that Hg capture by wet FGD systems can be maximized.

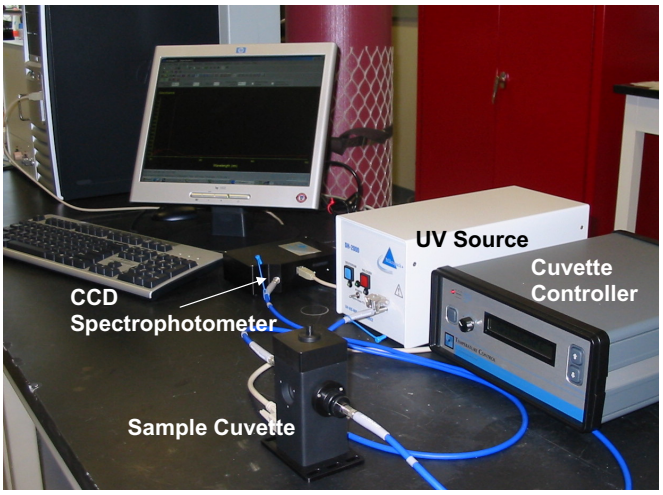

Photo of UV/Visible Light Spectrometer and Cell Holder Apparatus Used to Conduct Bench-top Measurements

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PROJECT DURATION

Start Date
10/1/04
End Date
3/31/06

COST

Total Project Value
$342,408

DOE/Non-DOE Share
$281,145 / $61,263

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Technical Approach

A series of bench-top, liquid-phase reactor tests are being conducted and mercury species concentrations measured by ultraviolet/visible light spectroscopy to determine reactant and byproduct concentrations over time. Other measurement methods, such as atomic absorption, are being used to measure concentrations of species that cannot be measured by UV/visible light spectroscopy.

These data will be used to develop an empirically-adjusted, theoretically-based kinetics model to predict mercury reactions in wet FGD systems. The model will be verified in tests conducted with a bench-scale wet FGD system, where both gas-phase and liquid-phase mercury concentrations will be measured to determine if the model accurately predicts the tendency for mercury re-emissions and the phase in which mercury is found in FGD by-products. The model will be run over a wide range of potential wet FGD design and operating conditions to determine conditions that maximize mercury capture, minimize mercury re-emissions, and/or ensure the mercury captured leaves the system in the by-product solids rather than in blow down liquor.

Benefits

- Will predict the chemical reactions of Hg species in FGD liquors;
- Will allow FGD systems to be optimized to maximize Hg capture and prevent or reduce Hg re-emissions, either through modification of FGD conditions or through the use of additives; and,
- Will avoid high liquid-phase Hg concentrations in FGD blow-down liquors.

Accomplishments

Reaction kinetics measurements have been conducted using several measurement techniques, including a UV/visible light spectrometer to track liquid-phase species concentrations and atomic absorption to measure elemental mercury release rates. Work has focused on the effects of chloride concentrations, pH, and ionic strength on re-emissions reaction mechanisms and kinetics. Effects of other species such as thiosulfate ion and iodide have also been investigated. The formation of a chloro-mercuric sulfite complex has been identified and the data collected are continually used to update an initial form of the kinetics model. Reactions involving the chloro-mercuric sulfite complex have been added to the model. The model will be used to design bench-scale experiments for testing on the wet FGD system.

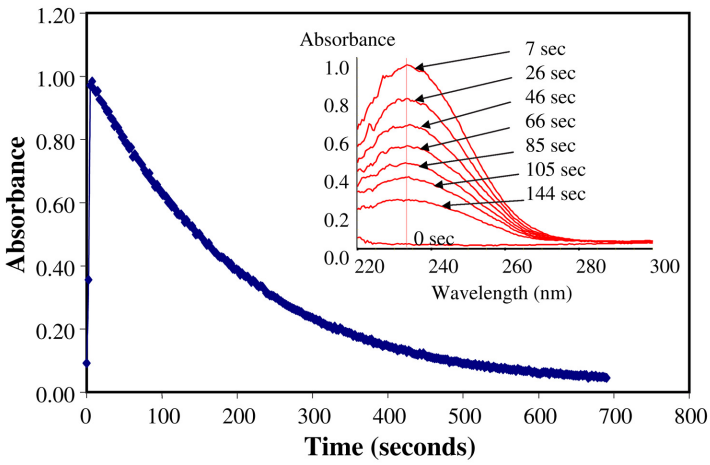

Figure 2. Experimental UV Absorbance and Spectra Data Showing the Formation and Decay of Mercury Disulfite, a Suspected Reactant in Mercury Re-emissions from Wet FGD Systems