PROJECT facts

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

Advanced Research

09/2005

DEVELOPMENT OF NEW OPTICAL SENSORS FOR MEASUREMENT OF MERCURY CONCENTRATIONS, SPECIATION, AND CHEMISTRY

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Project Description

The feasibility of developing accurate measurement systems for various forms of mercury is being investigated. The objective of the project is to develop a new class of optical sensors that can measure atomic mercury, total mercury, oxidized mercury, and particulate-bound mercury.

These new sensors will be assembled, tested, and optimized by researchers at Purdue University, and then tested in a well-controlled flow reactor, and in the exhaust stream of a coal combustor facility at Texas A&M University. The system, comprised of an atomic mercury sensor and a total mercury sensor for continuously monitoring emissions, will be assessed for use in coal fired power plants.

The development of an atomic mercury sensor is expected to advance current mercury detection techniques in three main areas: (1) increased sensitivity, (2) elimination of interference from broadband absorption from molecules such as SO_2, and (3) the potential to take real-time measurements directly in the exhaust stream without the need for extractive sampling, or complex chemical treatment of the extracted gas.

Researchers are investigating ways to measure the conversion of atomic mercury to oxidized forms, such as HgCl and $HgCl_2$. Laser-induced breakdown spectroscopy (LIBS) is being employed to obtain total mercury measurements, including mercury sorbed on particulates. Atomic mercury is being measured using high-resolution laser radiation at 253.7 nm produced by sum-frequency-mixing of beams from two diode lasers.

Techniques are also being employed to resolve interference, and improve resolution to measure elemental and oxidized forms of mercury in low part-per-billion (ppb) concentrations. For total mercury measurement using LIBS, new approaches will be researched to accurately measure mercury in the low ppb ranges in the presence of interfering species.

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PROJECT DURATION

October 2004 –
September 2007

PROJECT VALUE

$484,000

CUSTOMER SERVICE

1-800-553-7681

WEBSITE

www.netl.doe.gov

Accomplishments

In the first six months of project performance, a laboratory-scale atomic mercury sensor has been designed and constructed. Calibration studies are underway, along with appropriate software to acquire and transform the raw data. Work was also initiated on settings for operating the LIBS system for detecting total mercury.

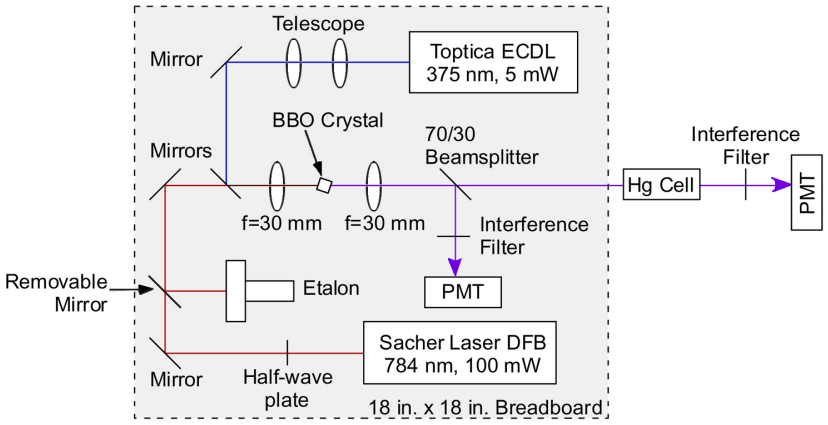

Figure 1. Diagram of the atomic mercury sensor.

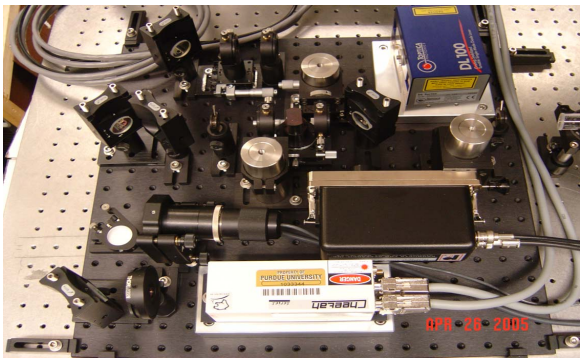

Figure 2. Photograph of the atomic mercury sensor.

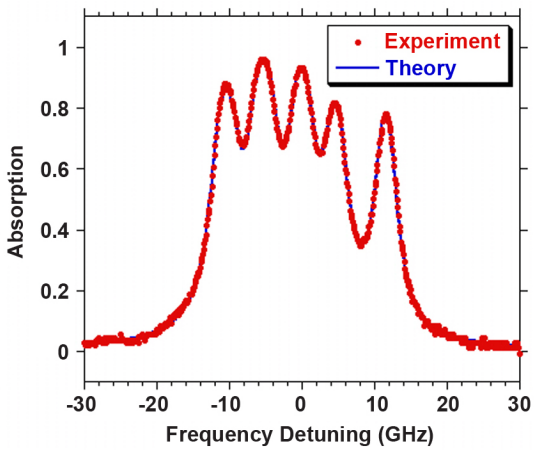

Figure 3. Normalized absorption of mercury (isotopes) derived from raw data.