PA.14 Mercury Measurements in Reduced Gas Atmospheres

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Abstract

The measurement of mercury emissions from coal-fired utility boilers has been the focus of numerous studies. Most of these studies investigate the effectiveness of various measurement techniques for total mercury and mercury species in oxidized flue gas matrices. However, very few studies have investigated the measurement of mercury or other air toxic substances in reduced gas matrices. Reduced gas matrices are typically encountered internal to integrated gasification-combined cycle (IGCC) and other advanced power systems that are likely to represent the next generation of electrical power plants.

The United States Department of Energy (DOE) has participated in the development and testing of advanced power system technologies through programs such as the Clean Coal Program and the Comprehensive Assessment of Air Toxics Emission Study. Under Phase III of DOE's Air Toxics study, Radian Corporation performed a comprehensive assessment of a coal gasification system for hazardous air pollutants (HAPs), including mercury. During the Air Toxics assessment, three different sampling techniques (EPA Method 29, charcoal adsorbent tubes, and direct gas analysis by atomic absorption spectrophotometry) were tested for measuring mercury and other vapor phase metals. The results indicated that EPA Method 29 was ineffective for accurately measuring mercury and many other vapor-phase metals in syngas. However, the on-site testing provided insights for the development of a mercury measurement method, with potential applications for other vapor-phase metals.

Radian International, LLC (formerly Radian Corporation) was subcontracted by EG&G Technical Services under DOE Release No. 825551 to continue the development of a measurement method for mercury in reduced gas matrices. A laboratory bench-scale test plan was implemented for testing various adsorbents and impinger solutions in a simulated syngas matrix. The collection efficiency for elemental and ionic forms of mercury and the effects of hydrogen sulfide, moisture, temperature, ammonia, and carbonyl sulfide were investigated. During the course of the study,

opportunities for testing the collection methods for speciating mercury forms were also investigated.

The adsorbents tested included two coconut-based charcoals, Hopcalite (a carbon adsorbent commonly used for Hg collection in ambient air), and a sulfur-impregnated coal-based charcoal. Numerous impinger solutions were also tested for various functions including the removal of H_2S, the reduction of mercury to its elemental form, and the collection of elemental and/or ionic forms of mercury with and without the presence of H_2S.

The results of the study have produced an impinger measurement method for total mercury in a reduced gas matrix, even in the presence of H_2S. Two charcoal adsorbents were also identified for use in an alternative measurement approach. One of the adsorbents also offers the potential for collecting and measuring other vapor-phase metals in addition to mercury.

In situ field testing of these measurement methods is anticipated in 1998 pending site identification and selection. The proposed gas streams for testing include internal process streams around a particulate control or sulfur removal device. Ideally, the selected process streams will offer contrasting conditions with respect to H_2S concentration, moisture, and temperature. Material balances around the control device are also proposed to assist in the demonstration of the method's effectiveness and to measure the fate of mercury across the targeted control device.

Such characterization is important not only from an emissions control or HAPs removal efficiency standpoint, but also from a material engineering perspective. Gas turbine and catalyst manufacturers are now attempting to establish fuel-gas quality criteria for use with their equipment to reduce the adverse effects of some gas phase components. If successful, a demonstrated measurement method for mercury and other vapor-phase metals in reduced gas matrices will enable plant operators and equipment vendors to reliably monitor the performance of control devices and the quality of their synthesis gas product.

The authors wish to recognize Dr. Peter Botros, DOE Project Manager, and Mr. Charles White of EG&G for their sponsorship and support of this study.