Research at NETL on Mercury Measurement and Control

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ABSTRACT

The in-house research effort on mercury studies at the National Energy Technology Laboratory is an integrated, multi-phase approach, including experimentation at both the laboratory-scale and the pilot-scale, as well as a numerical modeling effort to aid in interpretation of pilot-scale results. The lab-scale research objectives are to develop cost effective sorbents as well as a photochemical method for the removal of mercury from flue gas. A packed-bed reactor is used to screen sorbent alternatives to commercially available activated carbons. Several promising candidates have been identified, including the Thief carbons, metal oxides, metals, and sulfides. The best candidates are then tested in the 500-lb/hr pilot-scale combustion facility located on-site. A lab-scale photo-reactor has been employed to demonstrate the removal of mercury from flue gas using 254-nm radiation. The sensitized oxidation of mercury by flue gas constituents can interfere with UV-based continuous emissions monitors. Sensitized oxidation is also a potential removal method for mercury. High levels of mercury were removed from simulated flue gases, with capture as mercuric oxide, mercurous sulfate, and mercurous chloride. Larger removals were shown at temperatures below 300°F. The process, dubbed GP-254, will be tested on a slipstream of flue gas from the 500-lb/hr pilot-scale combustion facility.

The 500-lb/hr pulverized coal-fired combustion (PCFC) system at the National Energy Technology Laboratory (NETL) has been used to evaluate mercury sampling methods, as well as sorbent injection for mercury removal. The most recent testing has focussed on measurement of in-duct removals by injection of a commercial activated carbon (Darco FGD, manufactured by Norit Americas Incorporated). The coal fired during most of the testing was a low-sulfur, Eastern bituminous coal, but recent testing involved firing of a Powder River Basin sub-bituminous coal. Measurements were made upstream of the main baghouse on the 500-lb.hr unit and in a slipstream duct installed from the exit of the main baghouse to the inlet of the baghouse of a smaller pilot unit. Measurements were also made downstream of the main baghouse to determine removals across the baghouse and material balances. A number of devices for measurement of mercury in a flue gas with high solids loading were evaluated. The QSIS probe developed by Apogee Scientific proved to be the only device capable of measuring mercury in flue gas in the presence of an active mercury sorbent. Mercury flue gas concentrations were determined using EPA Method 101A, ASTM Method D6784-02 (Ontario-Hydro method), the Frontier Geosciences solid sorbent speciation method, and a P. S. Analytical semi-continuous emissions monitor. Results of the in-duct measurements were used for enhancements to a mathematical model of mercury sorption previously developed to predict baghouse mercury removals.