Field Experience Using an Automated, On-line Monitor to Measure Unburned Carbon in Utility Flyash

Edward C. Burgher, Thomas Hope
Rupprecht & Patashnick Co., Inc., 25 Corporate Circle, Albany, New York 12203
Email: eburgher@rpco.com; Tel: 518-452-0065; Fax: 518-452-0067

Summary

For the past two years, Rupprecht & Patashnick Co., Inc., Albany, New York (R&P) has conducted a project to modernize and upgrade our automated, on-line, carbon-in-flyash monitor. The new monitor, named the Series 4200 Combustion Efficiency Monitor (4200-CEM), incorporates recent advances in particle and gas measurement technologies and electronic devices to provide reliable, automated, highly accurate and precise measurement of unburned carbon in flyash samples at coal-fired power plants. On-line carbon-in-ash monitors increase the availability of combustion efficiency tracking data that can have dual benefit. First, plant operators can use the data to optimize plant performance, thereby lowering fuel costs and ash generation rates, improve heat rate performance and optimize mill operations. Secondly, lower carbon levels in the flyash can increase the availability of low carbon flyash for sale. This presentation describes the Series 4200's, its principal of operation and provides and overview of the advancements made to significantly improve the monitor's reliability and maintainability while also enhancing the quality of the percent carbon in flyash measurement. Lastly, the results of a study undertaken by R&P to evaluate the monitor's performance under actual plant operating conditions on a coal-fired utility boiler exhaust duct are summarized.

Principle of Operation

In general, the 4200-CEM measures the amount of unburned carbon in the flyash (CIA) sample using a inertial mass measurement / thermal oxidation technique. The sample analysis technique is similar to the loss-on-ignition test performed in a laboratory and directly measures the percent carbon in flyash (%CIA). However, by measuring the amount of carbon dioxide (CO2) produced by the oxidation of elemental or organic carbon present in the sample, the analysis is not influenced by variation in coal types. By integrating R&P's patented, highly accurate and precise inertial mass measurement technique (tapered element oscillating microbalance or TEOM®) with high resolution CO_2 measurements, the Series 4200 monitor can achieve a measurement resolution of $< \pm 0.5\%$ CIA with a minimum detection limit of about 1.0% CIA. Furthermore, the representativeness of the %CIA measurement has been improved by integrating a dual sampling system (optional) into the system configuration to allow time-shared monitoring of two sample points in a duct or single sample points in two different ducts that are closely located.

The sampling / analysis cycle is comprised of five main steps which are automatically controlled by the monitor's onboard computer:

- Sample collection.
- Total sample mass measurement.

- Sample oxidation and CO_2 measurement.
- Data processing, calculation and reporting of % CIA.
- Filter cleaning and repositioning to start new test.

The entire sample collection and analysis cycle is completed in approximately 12 - 15 minutes, therefore, the monitor can provide up to 5 readings per hour.

Through years of operating experience with the first generation, Series 4100 monitor, our customers consistently reported excellent measurement resolution, precision and accuracy. We also received comments about the time required to maintain the Series 4100 monitor and several reliability issues related to the original monitor's design. In re-engineering the monitor, our goal was to preserve the monitor's superior measurement performance characteristics while addressing reliability and maintainability concerns. These issues have been addressed in the new monitor with an overall objective to ensure that the monitor can be maintained with a single maintenance visit per week taking less than 15 minutes with preventive maintenance service every six months taking approximately 1 – 4 hours.

To study the performance of the new monitor and assessment the impact of improvements in system reliability under real-world conditions, R&P installed monitors in several locations. First, a monitor was installed at a utility station where eastern, bituminous coals are being used for fuel. The monitor was installed in the flue gas duct downstream of the heat exchanger. After a few months of startup/conditioning period, R&P tracked operating reliability, maintenance requirements and measurement performance over an additional three month period. During the tracking period, R&P found the monitor to meet our design goals for maintainability and reliability. Also, co-located samples taken during the tracking period for assessment of measurement performance. Again, the measurements indicate that the design goals were achieved.

For the second evaluation test, a monitor was installed at a large utility station in Germany. This test site was used to gain additional operating experience with the Series 4200 and more fully investigate measurement performance. This test is still in progress and we are finding similar results as at the first test site.

A detailed analysis of on-line operating statistics and measurement results will be presented at the conference.