Summary

Waste Coal Fines Reburn for NO_x and Mercury Emission Reduction

Stephen Johnson
Quinapoxet Solutions

This presentation will summarize progress on Cooperative Agreement DE-FC26-06NT42807, "Waste Coal Fines Reburn for Emission Reduction Technology Research." The project is being co-funded by the U.S. DOE/ NETL, Breen Energy Solutions and AES Beaver Valley. Breen Energy Solutions (BES) is the prime contractor.

Injection of coal-water slurries made with both waste coal and bituminous coal was tested for enhanced reduction of NO_x and Hg emissions at the AES Beaver Valley plant near Monaca, PA. Under this project, Breen Energy Solutions (BES) conducted field experiments on the these emission reduction technologies by mixing coal fines and/or pulverized coal, urea and water to form slurry, then injecting the slurry in the upper furnace region of a coal-fired boiler. The main focus of this project was use of waste coal fines as the carbon source; however, testing was also conducted using pulverized coal in conjunction with or instead of waste coal fines for conversion efficiency and economic comparisons.

The host site for this research and development project is Unit #2 at AES Beaver Valley cogeneration station. Unit #2 is a 35 MW Babcock & Wilcox (B&W) front-wall fired boiler that burns eastern bituminous coal. It has low NO_x burners, overfire air ports and a urea-based selective non-catalytic reduction (SNCR) system for NO_x control.

Coal slurry injection is expected to help reduce NO_x emissions in two ways:

1. Via fuel-lean reburning when just the slurry is injected above the combustion zone.
2. Via enhanced SNCR reductions when urea is incorporated into the slurry.

The focus of this presentation, however, will be on mercury control.

The mercury control process under research uses carbon/water slurry injection to produce reactive carbon in-situ in the upper furnace, promoting the oxidation of elemental mercury in flue gas from coal-fired power boilers. By controlling the water content of the slurry below the stoichiometric requirement for complete gasification, water activated carbon (WAC) can be generated in-situ in the upper furnace. As little as 1-2% coal/water slurry (heat input basis) can be injected and generate sufficient water activated carbon for mercury capture.

The carbon is activated by the surface reaction between carbon and water at high temperatures and locally oxygen-deficient conditions found in the upper furnace. These carbon surfaces are different from the carbon surfaces from coal fired through the main burners that experience the combustion process. Carbon surfaces that pass through the combustion zone are typically less active, because the high temperature combustion process tends to vitrify what little carbon that is not oxidized.

During July, August, and September 2007, BES designed, procured, installed, and tested the slurry injection system at Beaver Valley. Slurry production was performed by Penn State University using equipment that was moved from campus to the Beaver Valley site. Waste coal fines were procured and transported to the site in Super Sacks. In addition, bituminous coal was pulverized at Penn State and trucked to the site in 55-gallon drums.

This system was operated for three weeks during August and September 2007. NO_x emission data were obtained using the plant CEM system. Hg measurements were taken using speciated sorbent traps both downstream of the electrostatic precipitator and in the stack. Ohio Lumex Company was on site to provide rapid Hg analysis on the sorbent traps during the tests.

As of this writing, the field testing and sample analysis work is complete. Although data analysis is continuing, preliminary indications are:

- Coal Fines reburn alone reduced NO_x emissions by 0-10% with up to 4% reburn rate but with higher CO emissions. The higher CO limited our ability to try higher reburn rates for further NOx reduction.
- Coal Fines reburn with Urea (Carbon enhanced SNCR) decreased NO_x emissions by an additional 30% compared to Urea injection only.
- Coal Fines reburn did not change Hg capture across the ESP. The baseline Hg capture in the ESP was 40% with the high ESP temperatures of above 400 ºF.
- Coal Fines reburn with halogen salts added to the slurry increased the Hg capture in the ESP to 60%.