Project Status Report for: October 2000

Project Title: Ultra Low NOx Integrated System for Coal-Fired Power Plants

Project Number: 91890460 **Project Manager:** John Marion

Customer Name: U.S. DOE / Performance Projects **Project Leader:** Charles Maney

GOALS AND OBJECTIVES:

Develop low cost, retrofit NO_x control technologies to address current and anticipated, near term emissions control legislation for existing coal fired utility boilers. Specific goals include:

- Achieve < 0.15 lb/MMBtu NO_x for eastern bituminous coals
- Achieve < 0.10 lb/MMBtu NO_x for western sub-bituminous or lignitic coals
- Achieve economics at least 25% less than SCR-only technology
- Validate NOx control technology through large (15 MWt) pilot scale demonstration
- Evaluate the engineering feasibility and economics for representative plant cases
- Provide input to develop commercial guidelines for specified equipment
- Provide input to develop a commercialization plan for the resultant technologies

WORK PLANNED FROM PREVIOUS REPORT:

Task 2.1 – Test Fuels Characterization

- Complete the detailed characterization of the medium volatile test fuel.

Task 2.4 – Advanced Control System Design

- Complete installation and testing of coal flow meters
- Install and test advanced flame scanners

Task 3.1 – Test Planning & Facility Preparation

- Complete all facility preparation tasks, including coal pulverization, to permit combustion testing in the BSF to occur during the month of October.

Task 3.3 – Combustion Testing and Cleanup

- Complete the first combustion test period in the BSF.

ACCOMPLISHMENTS FOR REPORTING PERIOD:

Task 2.1 – Test Fuels Characterization

- *Complete the detailed characterization of the medium volatile test fuel.*

Three size cuts (200x400-mesh, X_{mean} ~ 60 μm; 270x400-mesh, X_{mean}~ 45 μm; and 100% -400-mesh, X_{mean} ~ 30 μm) were prepared from the medium volatile bituminous (mvb) test coal. Each size cut was then fed through ALSTOM Power's Drop Tube Furnace System-1 (DTFS-1) for pyrolysis testing and char generation. Subsequently, the chars were analyzed for volatile content to determine high temperature volatile yield, and oxidized in US PPL's Thermo-Gravimetric Analyzer (TGA) to determine relative char reactivity.

Figure 1 shows the 1,292 °F (700 °C) TGA plots for the 200x400 mesh medium volatile bituminous test coal char as compared to that of two similarly prepared hvAb coals. All the chars were generated in the DTFS-1 in a nitrogen (re. pyrolysis) atmosphere at 2650 °F (1,450 °C). As can be seen the medium volatile bituminous test coal char is, as expected, less reactive than those produced from either of the two hvAb reference coals, requiring approximately 50% more time to complete oxidation. This expected finding suggests that there would be significant increases in unburned carbon in the fly ash for the medium volatile bituminous test coal as compared to a typical hvAb coal under similar boiler operating conditions.

Figure 2 demonstrates that the oxidation trend for the medium volatile bituminous test coal char is also as expected with respect to DTFS-1 feedstock coal particle fineness. Here, the char from the 200x400-mesh coal was found to be less reactive than the char from the 270x400-mesh coal, which was then less reactive than the char from -400-mesh coal. At the high fineness, –400 mesh condition the char oxidation rate of the medium volatile bituminous test coal char approaches or exceeds that of both of the two reference hvAb coals. These results suggests that significant improvement in unburned carbon in the fly ash under staged combustion conditions can be achieved via improved coal particle fineness for the test coal as compared to operation at a standard commercial grind.

The high temperature volatile matter yields of the various coal size fractions for the mvb test coal were also measured, but there was an apparent discrepancy in the results (i.e., the high temperature VM yield from the -400-mesh coal was found to be lower than those from the other two coarser size cuts). This is thought to be due to an artifact of the experimental method (LOI) used to determine the proximate analyses of the devolatilization chars. Therefore, the proximate analyses of these chars will be redetermined using a more reliable (TGA) technique. These and other coal characterization test results will be presented in the next monthly report.

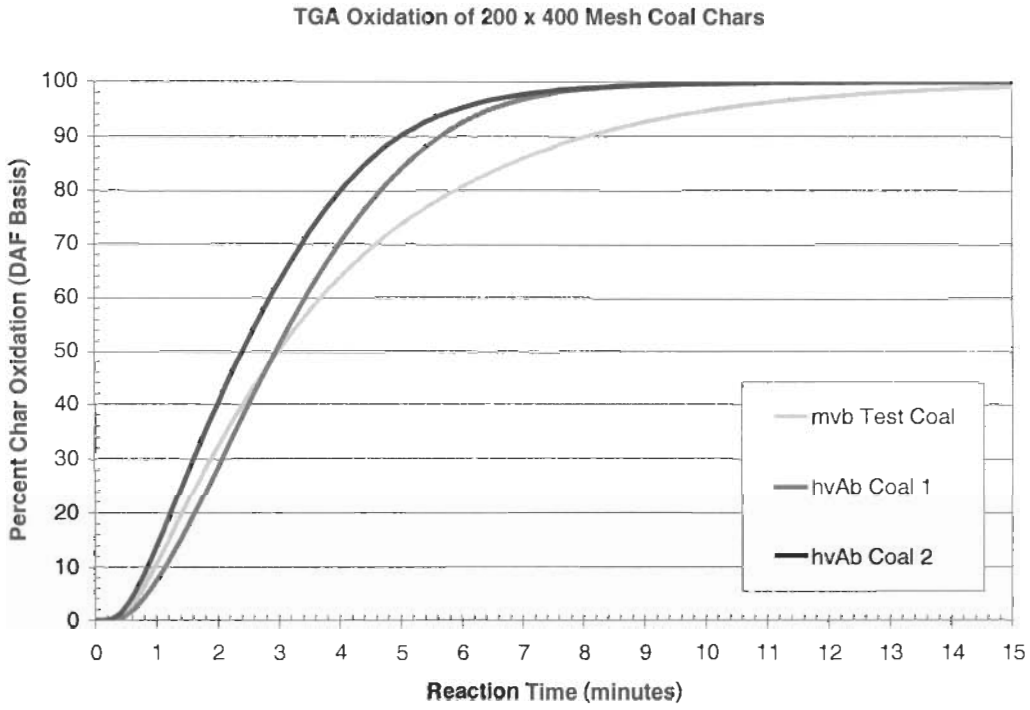

Figure 1 – TGA Char Oxidation v Coal Type

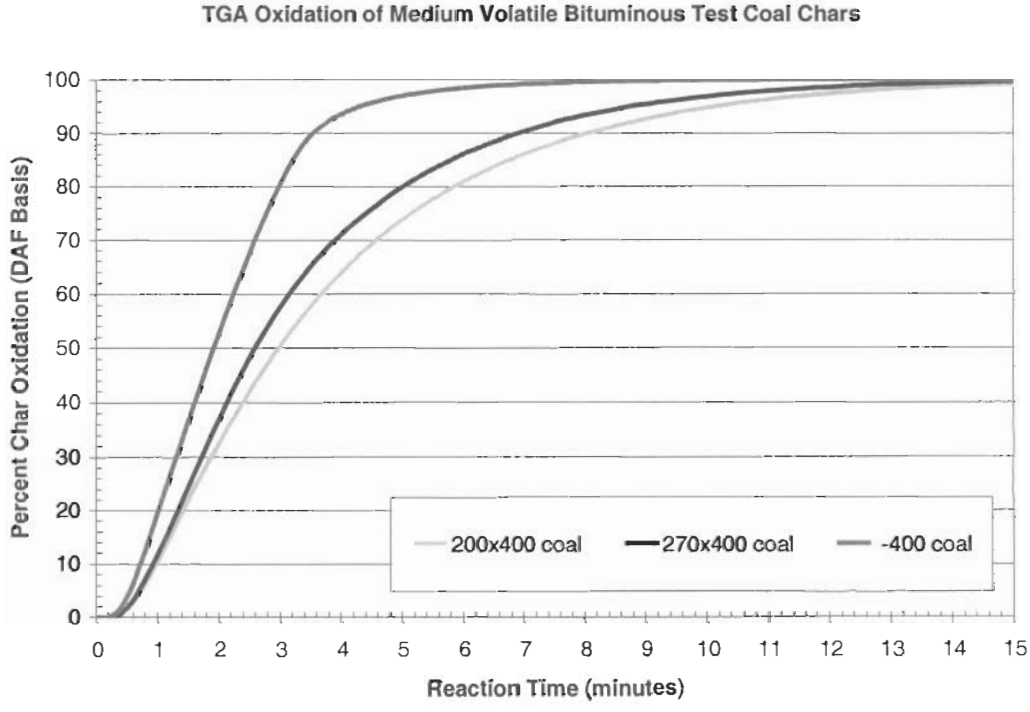

Figure 2 – TGA Char Oxidation v Particle Size – mvb Test Coal Chars

Task 2.4 – Advanced Control System Design

- *Complete installation of testing of coal flow meters.*

The coal flow sensors were installed and tested during the performance of the large pilot scale combustion testing. Engineers from the vendor (ABB Kent Taylor) were on site for 10 days to complete the electrical connections and commission the system. Preliminary performance results indicate that the individual coal pipe flow values qualitatively trended with known, forced variations in individual coal feed rate.

During the combustion testing, these devises along with and appropriate transport air and coal flow distributing means were used to affect a variation in the indicated coal flows and distribution to determine the resultant affect on NOx and unburned carbon in the fly ash emissions under staged combustion conditions. Preliminary results from the first test period suggest that it was possible to affect large variations in the coal flow distribution, including operation at conditions of high (+/-25% to 30% RMS) and low (<10% RMS deviation) coal flow distribution deviation from the mean. Results from the large pilot scale combustion testing of variation in the coal flow distribution on NOx and unburned carbon in the fly ash will be reported in an ensuing monthly report pending completion of the required post-test data analysis.

- *Install and test advanced flame scanners.*

Experimental, advanced flame scanners were installed in four locations in the BSF and used for data collection during the first week of combustion testing. Two were mounted in the right rear and left rear windboxes of the BSF, sighting the coal flame through the air compartments just below the top coal nozzle. The other two were mounted at the same elevation as the through the windbox scanners, but set-up to sight the coal flame from access ports located on the rear wall of the BSF (re. at 90 degrees from the coal jet). Results from the testing of these instruments as they relate to providing an indication of firing system performance will be reported pending completion of requisite post-test data analysis.

Task 3.1 – Test Planning & Facility Preparation

- *Complete all facility preparation tasks, including coal pulverization, to permit combustion testing in the BSF to occur during the month of October.*

All mechanical and electrical repairs were made to the BSF and the DCS system to allow execution of the first combustion test period during the month of October.

Task 3.3 – Combustion Testing and Cleanup

- *Complete the first combustion test period in the BSF.*

The first combustion test period in the BSF was executed 10-29-00 through 11-3-00, with follow-on mircofine coal grind testing occurring on November 13 & 14, 2000. Approximately 50 test conditions were run using the medium volatile bituminous test coal. During this work, the following variables were examined:

1. Transport Air & Fuel Flow Balancing
2. MBZ Stoichiometry
3. Sub-Compartmentalization
4. SOFA Velocity
5. SOFA Elevation
6. Transport Air to Fuel Ratio

7. Staged Residence Time
8. Boiler Load

as well as preliminary testing of SNCR reagent injection.

At each test condition, approximately 45 minutes of gaseous emissions data including O2, CO, CO2, SO2 and NOx was collected along with iso-kinetic and high volume fly ash samples. The furnace outlet temperature was also measured using a suction pyrometer for several test conditions. Data analysis is currently underway and a summary of the preliminary test results should be available for the November monthly report. Initial results from the testing indicate a baseline (re. unstaged / post-NSPS type) NOx emission level of approximately 0.75 lb/MMBtu with a test period best of approximately 0.17 lb/MMBtu achieved under staged conditions, representing a 77% reduction in NOx when firing the medium volatile bituminous test coal. A photo of ALSTOM Power's Boiler Simulation Facility (BSF) in operation during the first combustion test period is given in Figure 3.

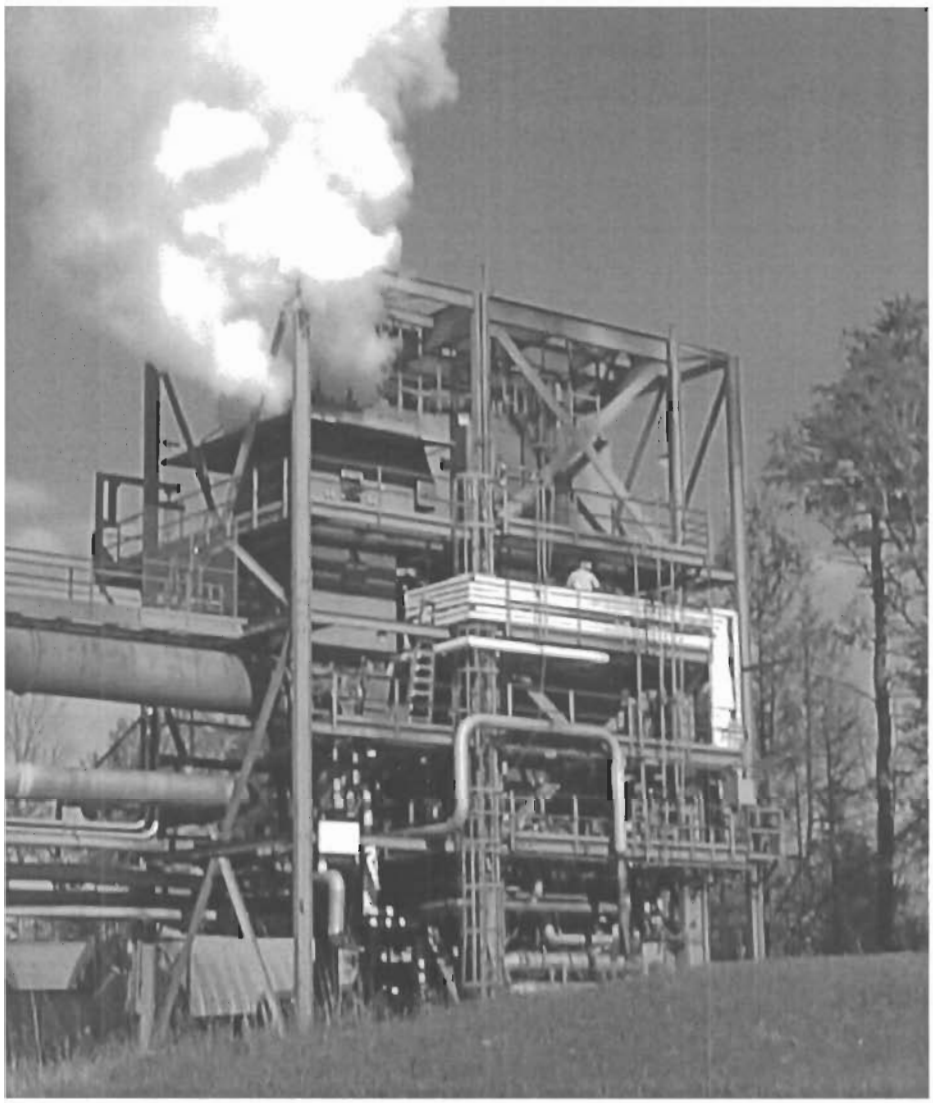

Figure 3 – ALSTOM Power's Boiler Simulation Facility (BSF) In-operation