Quarterly Technical Progress Report

Period of Performance: January 1–March 31, 2001
Title: Cofiring of Biomass at the University of North Dakota
Contract No. DE-FG26-00NT40807
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Summary:
Combustion testing of sunflower–coal blends on Boilers No. 3 and 5 at the University of North Dakota (UND) Steam Plant facility was completed. A total of four combustion tests were performed. In each boiler, a baseline combustion test was performed on subbituminous coal and a combustion test was performed on a sunflower–coal blend of approximately 25 wt% sunflower hulls. A cold-flow test was also performed on the boiler feed system. A summary review of the test results is included in this report, along with pictures. Additional analysis is currently being performed on the combustion test data.

We have completed Task 2, Fuel-Handling Issues, and are currently working on completing Tasks 3 and 5.

Accomplishments:

- Successfully mixed sunflower–coal blend in the UND Steam Plant facility's current feed system.
- Successfully combusted a 25% sunflower–75% coal (approximately) blend in Boilers No. 3 and 5.
- Identified potential dust problems with the feed system.
- Identified potential feed problems at the stokers and in the fireboxes.
- Obtained test data on the combustion tests.

Meetings:

Meetings were conducted with the UND Steam Plant facility personnel to review test protocols prior to the cold-feed test and the combustion test on Boiler No. 3. Another meeting

was conducted after the combustion test on Boiler No. 3 on March 29, 2001, to discuss the possibility of performing a second combustion test. The UND Steam Plant facility agreed to conduct a second combustion test on Boiler No. 5. This meant that the in-kind contributions from the Steam Plant facility could exceed the original commitment. The second combustion test was conducted to determine if problems with the first combustion test were correctly identified and resolved. We feel that they were. The UND Steam Plant facility deserves praise for its effort and commitment.

Project Organization and Functions:
NETL has awarded the Energy & Environmental Research Center (EERC) a contract to carry out a feasibility study for the University of North Dakota (UND). UND and the North Dakota Division of Community Services (DCS) are providing project cost share in the form of in-kind and cash, respectively. The EERC is working with UND students, professors, and the university facilities department to carry out project objectives. The NETL project officer is Sean I. Plasynski, and the NETL contracts specialist is Mary Beth Pearse.

Budget Report:

Total Project	$100,000	
DOE Funding	$ 80,000	UND In-Kind $10,000
DCS Funding	$ 10,000	
Funds Remaining as of 4/14/2001	$ 41,248	

Cost share is in place from the DCS ($10,000). UND has provided a budget to the EERC for its portion of in-kind services ($10,000).

Schedule:
The original project period was from June 15, 2000–June 14, 2001. A no-cost extension was approved by DOE to September 30, 2001. We will be requesting a no-cost extension from DCS to September 30, 2001. Analysis of the combustion test data is ongoing. Work is also being performed on the Task 5, Engineering Economic Analysis. Currently, this project appears to be about a month behind schedule since Task 1 was carried over into January.

Quick Review of Test Results–Cofiring Biomass at UND:

Goal:
Collect data on cofiring biomass at UND. Specifically test the minimum economical blend and the maximum possible biomass feed percentage.

Objectives:
- Combustion
  - Emissions – SO_x, NO_x, CO, opacity
  - Ash – clinkers, fouling, slagging, differential pressure
  - Performance – efficiency, data trend analysis, control issues, visual

- Fuel handling
  - Bin segregation – do we need a bin mixer?

- How well does fuel mix in the existing system?
- Equipment performance – general and specific capacities
- Stokers – Will we need air-assisted units?

Test on Boiler No. 5 (preliminary data remain to be analyzed):

- Steady steam – We produced steady steam at all load settings throughout the run.

- Firebox pressure – We maintained a steady negative pressure draft.

- Equipment damage – None. We did notice that the fuel burned hotter, and there was a thinner protective layer of ash on the grate. There were no backfires, no excessive pressures, no major hot spots, and no stoker malfunction. Fouling has not been assessed, although no increases in pressure drop in downstream systems were observed.

- Emissions – SO_x was lower, NO_x was slightly lower, opacity slightly increased from 10%–15%.

- Performance – May have operated at better efficiency, existing stokers performed well. No segregation of the feed was observed between the storage bunker and the stokers. Handling of the mixed fuel with the front-end loader was dusty.

- Combustion – No major clinkers or differences in the ash were observed.

Fuel-Handling Test:

- Bin segregation – We have determined that some segregation occurs in the bin, but not enough to warrant a bin-mixing system.

- Mixing – The fuel mixed very well in the feed augers.

- Equipment performance – By feeding fuel cold into Boiler No. 3, we confirmed that sunflower hulls would be distributed or consumed in the region closest to the stokers, while the coal is distributed towards the end of the grate. Slowing the grate will be required to maintain a deeper depth of ash on the grate. Higher velocities and a greater amount of overfire air injected above the stokers could improve the combustion performance of the sunflower hulls. The capacity of the auger feed system, when operated with the sunflower hull–coal mix, was tested at about 12 tons/hr. We calculated that coal delivery in this system is typically 16 tons/hr, which is approximately the feed rate necessary if all three boilers were operated at full capacity. Visual inspections of the capacity of the in-plant feed augers indicate that they may have a maximum capacity of approximately twice that tested, if the shallow pit auger system were modified to input more coal. The coal–sunflower hull mix will have a slightly higher heating value than coal alone. The shallow pit auger system handled the fuel without any equipment malfunctions. Some holes in the auger casings need patching, and better sealing of covers will be required to minimize dust.

- Stokers – Tests on Boiler No. 5 confirmed that the existing stokers performed well with a mix of 25%–30% sunflower hulls. Tests on Boiler 3 indicated the opposite. Hot testing on

Boiler No. 3 showed lack of control at high load due to uncontrolled sifting of fines into the boiler. Mixing of the sunflower–coal blend for the combustion test on Boiler No. 3 was done with a payloader as opposed to the existing feed system. Attrition of the coal to fines is a major consideration during mixing.

Test on Boiler No. 3 (preliminary data remain to be analyzed):

- Steady steam – We did well at ¼ and ½ load; however, we had difficulty controlling at full load. Sunflower hulls and coal fines were sucked into the boiler with stokers almost completely backed off.

- Firebox pressure – We maintained a steady negative pressure draft.

- Equipment damage – None. We did notice that the fuel burned hotter, and there was a thinner protective layer of ash on the grate. There were no backfires, no excessive pressures, no major hot spots, and no stoker malfunction. Fouling has not been assessed, although no increases in pressure drop of downstream equipment were observed.

- Emissions – SO_x was lower, NO_x was lower, opacity doubled.

- Performance – May have operated at better efficiency, existing stokers did not perform well, sieve analysis shows that we could have been feeding over 50% under ¼" at full load. Controlling the system was difficult primarily because of feed problems with excessive coal fines that may have been created during the mixing process. The mixing of the sunflower–coal blend for Boiler No. 3 was performed with a payloader. We felt that this may have contributed to the attrition of the coal to fines during mixing. Feed problems consisted of not being able to back off of boiler output by backing off with the stokers. Hulls and coal fines were being sucked into the boiler even at only a −0.5-in, water gauge draft. Feed material segregated between the discharge of the feed bin and the stoker in the inclined chute. Sunflower hulls would end up on top, coal on the bottom. We believe this caused difficulty for the stoker. Dust, generated in the feed system was a problem, causing dusty conditions for plant personnel, but it was a combination of coal and sunflower hull dust.

- Combustion – No major clinkers or differences in the ash were observed.

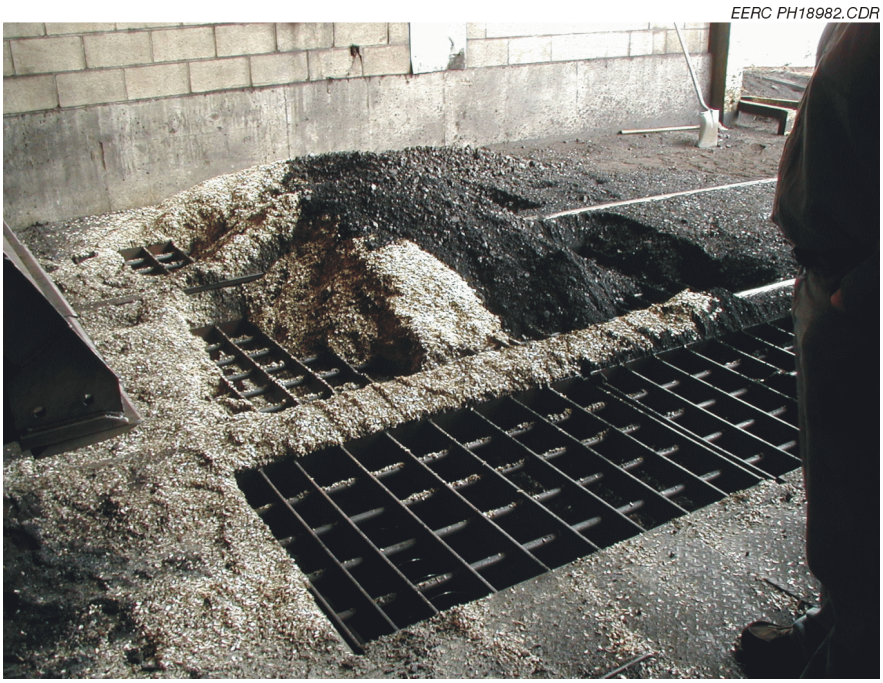

Figure 1. Blending of sunflower hulls and coal.

Figure 2. Result of blended fuel.

Figure 3. Mixing in auger system.

Figure 4. Cold test, Boiler No. 3 – Hulls at stoker end of grate, coal at opposite end.

Figure 5. Fuel feed at discharge of bunker on Boiler No. 5 prior to stokers.

Figure 6. Example of loading fuel into the system and potential dust issues.

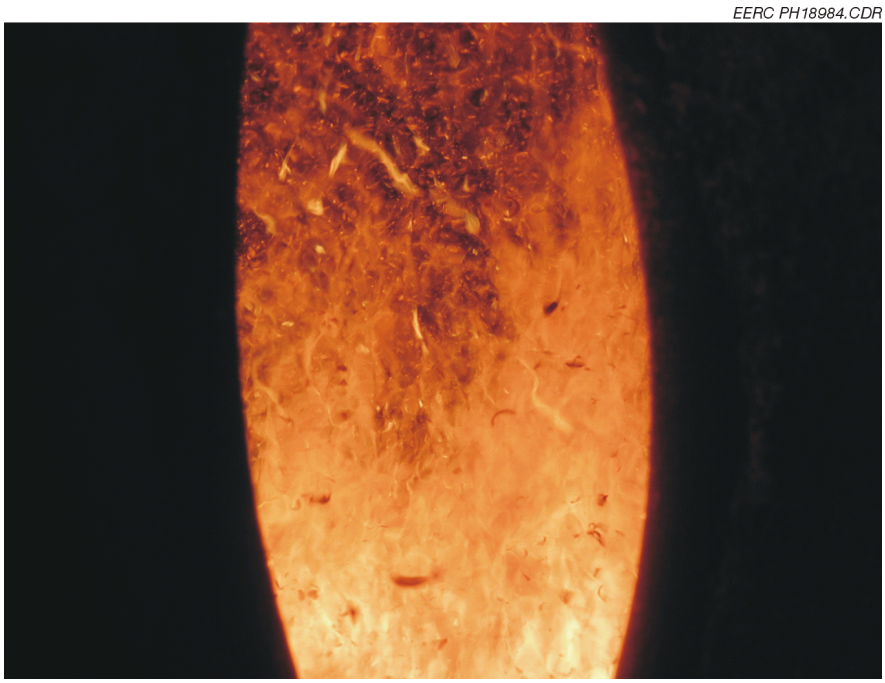

Figure 7. Midgrate inspection port on Boiler No. 5. Sunflower hulls burning in suspension.

Figure 8. Example of segregation issue at stoker inlet on Boiler No. 3.