TECHNICAL REPORT

December 1, 1991 through February 29, 1992

Project Title: Combustion Characterization of the Blend of
Plant Coal and Recovered Coal Fines

Principal Investigator: Shyam Singh, SS Energy
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Other Investigators: Dr. Alan Scaroni & Mr. Bruce Miller
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Project Monitor: Dr. Ken Ho, CRSC

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ABSTRACT

The overall objective of this proposed research program is to determine the combustion characteristics of the blend derived from mixing a plant coal and recovered and clean coal fines from the pond. During this study, one plant coal and three blend samples will be prepared and utilized. The blend samples will be of a mixture of 90% plant coal + 10% fines, 85% plant coal + 15% fines, 80% plant coal + 20% fines having particle size distribution of 70% passing through -200 mesh size. These samples' combustion behavior will be examined in two different furnaces at Penn State University, i.e., a down-fired furnace and a drop-tube furnace. The down-fired furnace will be used mainly to measure the emissions and ash deposition study, while the drop tube furnace will be used to determine burning profile, combustion efficiency, etc.

During this work period a slurry sample was collected from the effluent stream of the Randolph preparation plant of Peabody Coal Co. and shipped to MTU for recovery of coal using a packed column as proposed originally by Praxis. The procedure of collection of the sample and its thickening by decantation was jointly decided by Praxis and the plant personnel based on the plant operating conditions and access to the effluent stream for sampling. The processing of the sample to recover coal was also started at the MTU during this quarter and is nearing completion. A portion of the effluent slurry was used for the characterization work.

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This project is funded by the U. S. Department of Energy (PETC) and by the Illinois Department of Energy and Natural Resources as part of their cost-shared program.

EXECUTIVE SUMMARY

The overall objective of the research program is to determine the combustion behavior of plant coal and recovered coal fines blend (ignition temperature, flame stability, emissions and ash characteristics) in a laboratory scale furnace in which the time and temperature history of the burning particles are similar to the utility boiler furnace.

The details of the sample collection, recovery of coal from effluent sample, method for preparation of the coal blend for combustion characterization and testing were outlined.

The quantities of the sample considered necessary for the combustion testing indicated in the proposal were confirmed and are given below.

- 0% recovered coal 240 lb.
- 10% recovered coal 216 lb.
- 15% recovered coal 138 lb.
- 20% recovered coal 128 lb.
- 100% recovered coal 20 lb.

These quantities are essentially the same as written in the proposal with the exception of adding a 20 lb. sample of the 100% recovered coal for combustion characterization and combustion testing, if possible. Grind size for the blend was reviewed and finalized at 70% passing 200 mesh. The size reduction will be done in two stages, the first stage will consist of crushing the plant coal as stated in the proposal to minus 1/4" size. This will be blended with appropriate quantities of effluent recovered coal as indicated above, and then ground to 70% passing 200 mesh. Prior to shipping the samples to Penn State for testing, the various blends will be homogenized and packed in small bags of 40 lb. test samples for ease in handling. This will eliminate the need for double handling to prepare a representative sample during testing.

OBJECTIVE

The objective of the proposed research project is to determine the combustion behavior plant of coal and recovered coal fines blend (ignition temperature, flame stability, ash behavior and unburned fuel composition) in a laboratory scale furnace in which the residence time and temperature history of the burning particles are similar to the utility boiler furnace. To understand the combustion phenomenon, the blend compositions will be varied by adding different percentages of coal fines to the plant coal by maintaining 75% of the particles passing through -200 mesh size, but the weight percentage of coal fines will not exceed 20% in the total mixture. Praxis Engineers will guide the selection and appropriate composition of the fuel due to their experience and involvement in other similar projects. The overall combustion study will be done in the down-fired furnace and the drop tube furnace of the combustion laboratory at the Penn State University.

The objective of this study is to have three blends of plant coal mixed with recovered coal fines with approximately constant moisture content. The blends and the plant coal will be burned in the Penn State combustion laboratory furnaces at different firing rates to determine the ignition temperature, carbon burnout, ash behavior, SO_x , CO , NO_x , particulates, etc.

INTRODUCTION AND BACKGROUND

Use of recovered coal fines from a slurry effluent as a part of the blended fuel for utility will not be possible unless a systematic study is conducted to identify the variables that influence its economic advantage. The proposed research program is designed to understand the impact of the variables, i.e., the blend composition, moisture, etc. The proposed concept utilizes a mixture of certain percentage of recovered coal fines with the plant coal as a plant fines coal fuel. When this new fuel is prepared, the bulk properties of this fuel change and thus, the combustion characteristics change as well. It is not certain how this will affect the overall economics of the operation of a utility. Therefore, to systematically investigate this issue, a number of samples will be prepared and stored in a controlled manner to prevent contamination. These samples will then be analyzed using standard analytical tools. Simultaneously, a literature review of similar work done on other coal and blend will be conducted to establish the research methodology for the proposed program. In addition, drop tube furnaces will be used to determine the burning profile, and ignition temperature while down-fired will be used to measure the emissions and ash deposition.

EXPERIMENTAL PROCEDURE

As this is a multi-organizational effort, experimental procedures were set and jointly reviewed to achieve the goals of this project and conduct work in a systematic manner. The procedures were set for the following activities:

- Effluent sample collection
- Effluent sample processing for recovery of coal
- Preparation of plant coal and recovered coal blend for combustion testing.

TECHNICAL WORK COMPLETED

During this quarter, considerable progress was made on the project. A number of preparation plants in Illinois were contacted by Praxis for collecting the effluent sample. After some deliberations it was decided that the sample will be collected from the Randolph preparation plant of Peabody Coal Co. The procedure of collection and handling work was planned and completed in December 1991. The procedure of the sample thickening by decantation was finalized by Praxis in close cooperation with the preparation plant personnel. Small increments of the effluent sample were collected in 5-gallon buckets on a regular basis from the plant and the sample allowed to settle to increase its solids content so that sufficient solids could be obtained in the final sample. After allowing the sample to settle, it was decanted and the thickened slurry transferred to a 55-gallon drum. The thickening and decantation allowed the solids concentration to increase from approximately 5% to 30%. A total of four drums of thickened sample were collected. These drums were shipped to MTU for recovery of coal using a packed column as proposed originally by Praxis.

Upon receiving the sample at the MTU facility, it was homogenized and split into smaller sub-samples to allow ease of handling. One of the sub-samples was analyzed for particle size distribution ash and forms of sulfur, see Tables 1 and 2. A 4" diameter 10' tall experimental packed column was commissioned at the MTU especially for processing the sample of this project. The processing of the effluent will be undertaken in consideration with the plant requirements of the recovered coal. Processing of the slurry for recovering clean coal has been started and will be completed within the month of February 1992. The clean coal ash, total sulfur and pyritic sulfur will be analyzed in the recovered coal and reported along with the yield of clean coal.

Table 1
Particle Size Distribution

<u>Size (microns)</u>	<u>Cum. Wt. % Passing</u>
250	100
176	96.3
125	92.1
88	87.4
62	81.5
44	75.4
31	69.2
22	62.8
16	55.4
11	47.8
5.5	31.9

Table 2
Proximate Analysis

	<u>Drum-1</u>	<u>Drum-2</u>
Moisture	12.88%	13.58
Ash	10.24	10.89
Total Sulfur	3.12	2.80
Volatile Matter	36.18	
Fixed Carbon	40.72	
Total	100.0	

The recovered clean coal will be dewatered using a laboratory filter at the MTU and the dewatered clean coal will be homogenized prior to shipping to a commercial laboratory located in Somerset, Pennsylvania for preparing the various blends for combustion testing. The recovered coal sample will also be subjected to proximate and ultimate analysis along with the forms of sulfur.

In addition to the collection of the effluent sample, two drums of plant clean coal were also collected. This sample was shipped directly to the Geochemical Testing Laboratory in Somerset, PA where the preparation of the coal blends will be undertaken.

A review meeting was held on February 8 at the office of Praxis Engineers, Inc. to review the project progress to date and plan the work to be done during the remaining period of this quarter. The meeting was attended by Mr. Vas Choudhry of Praxis and Mr. Shyam Singh, Technical Director of SSEEII who travelled to Milpitas to attend this meeting. Following is a summary of the items discussed.

- The recovered clean coal will be dewatered using a pilot filter at the MTU laboratory facilities.
- The recovered coal sample will also be subjected to proximate and ultimate analysis along with the forms of sulfur as a part of characterization work. The ash and total sulfur analysis will be done at MTU whereas the analysis of sulfur forms will be done at a commercial laboratory (Geochemical Testing).
- The recovered coal is expected to contain 25% moisture and the plant coal has a total moisture in the range of 12%. The various blends of recovered coal and plant coal will have the following composition mix and moisture contents in the blend if no drying is undertaken:

Blend	Plant Coal	Recovered Coal	Total Weight	M%
0%	240 lb.	0 lb.	240 lb.	12.0
10%	216 lb.	24 lb.	240 lb.	13.3
15%	136 lb.	24 lb.	160 lb.	13.0
20%	128 lb.	32 lb.	160 lb.	14.6
100%	0 lb.	20 lb.	20 lb.	25.0
TOTAL	720 lb.	100 lb.	820 lb.	-

- The preparation of various blend samples will be undertaken at the Geochemical Testing Laboratories located in Somerset, Pennsylvania. These blends will be prepared using the following general procedure:
 - crush plant coal to nominal 1/4" size and homogenize
 - air dry this sample to a constant moisture level (say 8%)
 - split it into sub-samples of weights given above and weigh accurately
 - homogenize the recovered coal and weigh requisite amounts for preparing each of the preselected blends
 - mix the recovered coal with the corresponding plant coal sample and homogenize by mechanical means
 - pulverize each blend to 70% passing 200 mesh and 100% passing 48 mesh size
 - split each blend into four sub-samples for easy handling and pack in plastic bags
 - retain small samples from each blend for analysis of moisture, ash and sulfur
 - tag all the samples suitably and ship these bags to Penn State

CONCLUSIONS AND RECOMMENDATIONS

No specific conclusions and recommendations were made in this quarter, except prime contractor advised Praxis to make sure that the blend should have less than 15% moisture to alleviate obvious handling problems of the samples during combustion testing.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

PROJECT MANAGEMENT REPORT
December 1, 1991 through February 29, 1992

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COMMENTS

During this quarter, substantial progress has been made in carrying out the research work related to the pond slurry collection, cleaning the coal, etc. within the financial budget proposed. However, some further delays occurred in meeting the schedule due to a delay in contract execution, and thus, financial limitations. We firmly believe that the project will be on schedule in the third quarter without any further delay.

This project is funded by the U. S. Department of Energy (PETC) and by the Illinois Department of Energy and Natural Resources as part of their cost-shared program.

Projected and Estimated Expenditures by Quarter

Quarter*	Types of Cost	Direct Labor	Materials & Supplies	Travel	Major Equipment	Other Direct Costs	Indirect Cost	Total
Sept. 1, 1991 to Nov. 30, 1991	Projected	5,000.00	200.00	2,800.00		10,580.00	6,994.00	\$25,574.00
	Estimated	551.00	-	-	-	2,940.00	-	\$3,500.00
Sept. 1, 1991 to Feb. 29, 1992	Projected	14,000	700	3,800		15,580	11,994	\$46,074.00
	Estimated	7,943.52		142.90		19,089.00	6,668.16	\$33,843.64
Sept. 1, 1991 to May 31, 1992	Projected	29,000	1,200	5,800		18,080	26,994	\$81,074.00
	Estimated							
Sept. 1, 1991 to Aug. 31, 1992	Projected	41,731	1,200	6,800		19,580	30,154	\$99,465.00
	Estimated							

*Cumulative by quarter

COSTS BY QUARTER

Combustion Characterization of the Blend of Plant Coal
and Recovered Coal Fines

Schedule of Project Milestones

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Task 1			X			●						
Task 2				X			○					
Task 3						X	○					
Task 4									X			
Task 5									X			
Task 6a							■			X		X
Task 6b							■			X		X

- Task 1 Procurement and preparation of test samples
- Task 2 Characterization of recovered coal fines, plant coal and blend
- Task 3 Test facility calibration
- Task 4 Combustion characteristics of blends and plant coal
- Task 5 Data analysis and its interpretation
- Task 6a Technical Report preparation
- Task 6b Project Management Report preparation

END

**DATE
FILMED**

10 / 1 / 92