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POC-Scale Testing of Oil Agglomeration Techniques
and Equipment for Fine Coal Processing

U.S. Department of Energy
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TECHNICAL REPORT NO. 2
(October 1, 1995 - December 31, 1995)

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1.0 Introduction

This report covers the technical progress achieved from October 1, 1995 through to December 31, 1995, on the POC Scale Testing of Oil Agglomeration Techniques and Equipment for Fine Coal Processing, under PETC/DOE Contract No. DE-AC22-95PCPT 152.

The objective of this project is to develop and demonstrate a Proof-of-Concept (POC) scale oil agglomeration technology capable of increasing the recovery and improving the quality of fine coal streams. Two distinct agglomeration devices will be tested, namely, a conventional high shear mixer and a tubular (jet) processor.

To meet the overall objective an 11 task work plan has been designed. The work will range from batch and continuous bench-scale testing through the design, commissioning and field testing of POC-scale agglomeration equipment.

The project includes the following tasks:

- Task 1 - Project Planning and Management
- Task 2 - Host Site Selection and Plan Formulation
- Task 3 - Preliminary Engineering and Design of POC Equipment
- Task 4 - Coal Characterization and Laboratory (Batch) and Bench-Scale Testing
- Task 5 - Final Engineering and Design of POC Equipment
- Task 6 - Proof-of-Concept (POC) Equipment Procurement and Fabrication
- Task 7 - POC Equipment Inspection
- Task 8 - POC Equipment Installation, Shakedown and Operation
- Task 9 - Process Evaluation
- Task 10 - Dismantling of the System
- Task 11 - Final Report

2.0 Summary of Work Completed and in Progress

2.1 Host Site Selection (Subtask 2.1)

In the third week of October (week of October 16) ARC staff visited PBS Coal Inc. headquarters in Friedens, PA and Shade Creek coal preparation plant located in Central City, PA.

The plant was constructed and commissioned in 1964. The process flow diagram of the preparation plant was discussed with Mr. N. Weyant, PBS Coal Inc. Preparation Manager. The plant uses the following equipment: heavy media washers, cyclones, centrifuges, thickeners, filters, crushers, breakers, screens, dryers and washing tables. About seven years ago a flotation unit was added to the plant to handle classifying cyclone overflow. The annual production of the plant is 2,200,000 tons and the washed product size is in the range 50 mm x 0 (2.0" x 0).

Processing of the cyclone overflow (minus 150 μ m; 100 mesh) was identified as a major operational problem. The solutions to this problem were presented by ARC staff. Preparation and shipment of coal fines generated at the Shade Creek plant was also discussed.

It was agreed that bulk subsample of about 40 tons will be taken from the thickener and set aside. The subsample of about 20 kg will be sent right away to ARC for batch testing, while bulk sample will be shipped right after completion of preliminary batch testing.

2.2 Work Plan for Continuous Bench-Scale Testing (Subtask 2.4)

During the reporting period a test plant for continuous bench-scale testing was under development. The content of the plan includes the following description:

- materials and equipment
- testing procedure
- high-shear mixer testing
- tubular (jet) processor testing
- schedule
- quality assurance/quality control to be obeyed during testing

The bench-scale testing will be carried out with two samples of coal fines submitted by:

- PBS Coals Inc., Pennsylvania: fines generated at the Shade Creek Cleaning Plant
- Cape Breton Development Corporation, Nova Scotia: fines generated at the Victoria Junction Coal Preparation Plant.

The major objectives of bench scale testing are as follows:

- to establish the cleaning behaviour of the coal fines in a continuous operation
- to compare the performance of high-shear mixer and tubular (jet) processor
- to collect data that will be utilized in the design of the POC equipment and also in the development of basic scale-up factors
- to establish, verify and optimize process conditions for further POC-scale testing at the host site facility

The 250 kg/h continuous bench-scale unit to be used in this project is presented in Figure 1. The detailed description of unit, test procedures and sampling are included in the test plan.

The 0.25 tph bench continuous facility will be operated using both the conventional high-shear mixer and/or a tubular (jet) processor for the coal fines microagglomeration. Because the operation and performance of high-shear mixers for low oil concentration agglomeration process is reasonably well understood, the bench program will be focussed on the development of a similar knowledge/experience for the tubular (jet) processor.

2.3 Preliminary Engineering and Design of POC Equipment (Task 3)

During the reporting period the work on preliminary engineering and design of agglomeration equipment has started.

Overall objective of this task is to develop a preliminary conceptual design for a 3 t/h system for recovery and cleanup of coal fines from cyclone overflow stream of the Shade Creek preparation plant owned and operated by PBS Coals Inc.

Figure 1. Pilot Plant Flow Diagram for Continuous Bench Testing

INSTRUMENT LEGEND

FW106 - Flotation Conditioning Water
 FW107 - Flotation Conditioning Water
 FW108 - Flotation Conditioning Water
 FW109 - Flotation Conditioning Water
 FW110 - Flotation Conditioning Water
 FW116 - Grinding Mill Water
 FW117 - Coal Slurry Conditioning Water
 FW130 - Flotation Conditioning Water

FW132 - Flotation Conditioning Water
 FS201 - Coal Slurry Flow Meter
 FS502 - Flotation Tailings Flow Meter
 FS552 - Flotation Tailings Flow Meter
 FB151 - Bridging Liquid Flow Meter
 FR500 - Flotation Reagent Metering
 FR550 - Flotation Reagent Metering
 CF140 - Coal Weigh Belt

EQUIPMENT LEGEND

F500 - Flotation Cells
 F550 - Flotation Cells
 G170 - Rod Mill
 M220/230 - High Shear Mixers
 P100 - Water Distribution Pump
 P101 - Water Distribution Pump
 P151 - Bridging Liquid Pump

P200 - Coal Slurry Recirc. Pump
 P201 - Coal Slurry Feed Pump
 P700 - Clarified Water Pump
 SP174 - Grinding Mill Discharge Pump
 SP175 - Coal Slurry Transfer Pump
 SP500 - Flotation Froth Pump
 SP550 - Flotation Froth Pump
 SC170 - Coal Sizing Screen
 TK100 - Water Tank

TK700 - Tailings Thickener
 TK701 - Settling Tank
 V200 - Coal Slurry Tank
 VC600 - Vacuum Disc Filter

SAMPLE LEGEND

S-### denotes sample locations

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The specific objectives of the preliminary design are:

- determine the size of a high-shear agitator and jet processor for the 3 t/h system
- develop the 3 t/h system design with two processing options (high-shear agitator or jet processor)

Preliminary engineering and design of POC-scale equipment includes the following:

- a) design criteria
- b) conceptual flowsheet
- c) material balance
- d) high-shear mixer design
- e) jet processor design
- f) plant layout
- g) list of equipment instrumentation and control system

During the reporting periods, points a to d have been completed.

Figure 2 presents process block diagram of POC-scale system to be installed at Shade Creek coal preparation plant. Flow diagram and mass balance for the POC-scale system are shown in Figure 3. Detailed description will be presented in the design report.

2.4 Coal Characterization (Subtask 4.1)

The 20 kg coal fines sample from Shade Creek was received at the beginning of December 1996 and the work on Subtask 4.1 started. The project sample was subjected for the following analyses:

- particle size distribution
- proximate composition
- ultimate composition
- total sulfur and forms of sulfur
- calorific value
- washability

Figure 2. Process block diagram for fine coal recovery and cleanup system to be installed at Shade Creek coal preparation plant.

Figure 3. Flow diagram and mass balance for the 3 t/h system for fine coal recovery and cleanup to be installed at Shade Creek preparation plant.

Determination of coal fines size distribution revealed that about 20% of the fines were larger than cyclone size cut. The mass median diameter for the whole fines sample is 45 μm , while for the -150 μm fraction mass median diameter determined by laser granulometer is 26 μm . Following are the selected properties of project coal fines:

- ash - 11.1%
- volatile matter - 16.2%
- fixed carbon - 72.7%
- calorific value - 32.1 MJ/kg (13,800 Btu/lb)
- total sulfur content is 1.03% of which 0.48% is pyritic sulfur

Centrifugal float-sink testing at specific gravities in the range 1.3 to 2.0 showed that 89% of fines may be recovered in the 1.6 float product containing 7.1% ash. Preliminary Aglofloat experiments with project fines showed that:

- the Aglofloat process can perform very well with PBS coal fines and produce clean coal at high yields
- the clean coal yield always exceeds 90% which is equivalent to plus 95% combustible material recovery
- ash content is in the range 6.9-7.6, while total sulfur is in the range 0.75-0.90%

The above results are similar to that of float-sink testing at 1.6 specific gravity. More work on process optimization is scheduled for the next reporting period and will be presented in the next technical progress report.

3.0 Future Work

Future work to be performed and/or completed in the next reporting period is as follows:

- complete and submit draft preliminary design of POC-scale equipment for revision
- complete project coal fines characterization
- continue batch testing of project coal fines