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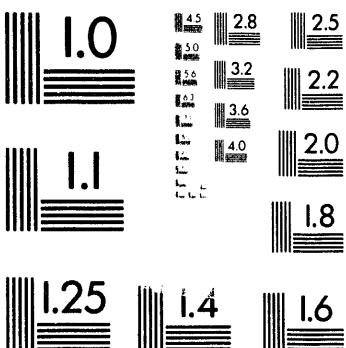
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COMBUSTION CHARACTERIZATION
OF BENEFICIATED COAL-BASED FUELS

QUARTERLY REPORT NO. 16 FOR THE PERIOD JANUARY TO MARCH 1993

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MASTER

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QUARTERLY REPORT

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INTRODUCTION

The Pittsburgh Energy Technology Center of the U.S. Department of Energy has contracted with Combustion Engineering, Inc. (CE) to perform a five-year project on "Combustion Characterization of Beneficiated Coal-Based Fuels." The beneficiated coals are produced by other contractors under the DOE Coal Preparation Program. Several contractor-developed advanced coal cleaning processes are run at pilot-scale cleaning facilities to produce 20-ton batches of fuels for shipment to CE's laboratory in Windsor, Connecticut. CE then processes the products into either a coal-water fuel (CWF) or a dry microfine pulverized coal (DMPC) form for combustion testing.

The objectives of this project include: 1) the development of an engineering data base which will provide detailed information on the properties of BCFs influencing combustion, ash deposition, ash erosion, particulate collection, and emissions; and 2) the application of this technical data base to predict the performance and economic impacts of firing the BCFs in various commercial boiler designs.

The technical approach used to develop the technical data includes: bench-scale fuel property, combustion, and ash deposition tests; pilot-scale combustion and ash effects tests; and full-scale combustion tests. Subcontractors to CE to perform parts of the test work are the Massachusetts Institute of Technology (MIT), Physical Science, Inc. Technology Company (PSIT) and the University of North Dakota Energy and Environmental Research Center (UNDEERC).

Twenty fuels will be characterized during the five-year base program: three feed coals, fifteen BCFs, and two conventionally cleaned coals for full-scale tests. Approximately nine BCFs will be in dry ultra fine coal (DUC) form, and six BCFs will be in coal-water fuel (CWF) form. Additional BCFs would be characterized during optional project supplements.

SUMMARY

During the first quarter of 1993, the following technical progress was made.

- Reported results of drop tube furnace data analyses to determine devolatilization kinetics.
- Reported the results from the re-analyzed pilot-scale ash deposits from the first nine feed coals and BCFs using a modified CCSEM technique.
- Prepared for upcoming tests of new BCFs being produced.

TASK 1 - FUEL PREPARATION

Beneficiated coals (BCs) and feed coals are acquired from other DOE projects and shipped to CE. These fuels are then processed into either a dry pulverized coal form by CE or a coal-water fuel (CWF) form using OXCE Fuel Company technology. The feed coals are fired as standard grind (70% minus 200 mesh) pulverized coal (PC), while the dry beneficiated fuels are generally dry microfine pulverized coal (DMPC).

Thirteen twenty-ton batches of test fuel have been produced under the DOE-PETC Coal Preparation program since 1987. These fuels include:

1. Illinois #6 feed coal
2. Pittsburgh #8 feed coal
3. Upper Freeport feed coal
4. Illinois #6 microbubble flotation product
5. Pittsburgh #8 microbubble flotation product
6. Upper Freeport microbubble flotation product
7. Illinois #6 spherical oil agglomeration product
8. Pittsburgh #8 spherical oil agglomeration product
9. Upper Freeport spherical oil a ;lomeration product
10. Fresh Upper Freeport feed coal
11. Upper Freeport microagglomerates
12. Illinois #5 microagglomerates
13. Pittsburgh #8 microagglomerates

The first nine fuels were tested in the pilot-scale facility between October 1989 and June, 1990. Bench-scale testing continued through this quarter. Since the first six fuels had been stored in sealed drums for approximately eighteen months, a fresh 20-ton sample of Upper Freeport parent coal was tested in the fourth quarter of 1991 to evaluate the effects of aging or "weathering". The next three BCs were produced during the second and third quarters of 1992.

TASK 2 - BENCH-SCALE TESTS

All test fuels are fully characterized using various standard and advanced analytical techniques. These tests evaluate the impacts of parent coal properties and beneficiation process on the resulting BCF's qualities.

A few selected fuels are tested in a laminar flow drop tube furnace to determine fly ash particle size and chemical composition. Results include mineral matter measurements and modeling of fly ash history and have been reported in previous quarterly reports and in the paper by Barta, et alia, 1991.

A swirl-stabilized, entrained flow reactor is used to characterize the surface compositions and the states of ash particles formed during combustion. Deposition rates on a target are determined, and the size and compositions of the deposits from different fuels are compared. Results were reported in the Quarterly Report for the period January to March, 1991.

The first ten coal and BCF samples received to date have been completely analyzed for: (1) complete chemical analyses; (2) flammability index measurements; (3) weak acid leaching; (4) TGA reactivities and BET surface areas of chars, and (5) combustion kinetics. All these data have been reduced and reported in the Quarterly Reports for July to September, 1990, January to March 1991, and October to December, 1991, as well as in papers by Nsakala, et alia, 1990 and 1991, and the draft Topical Report issued in June, 1991.

Work during this quarter focused on reporting the results of the CE Drop Tube Furnace System-1 (DTFS-1) devolatilization testing of the BCFs. The analyses of the samples collected during the tests were discussed in the last quarterly report. These results were also added to the Topical Summary Report.

TASK 3 - PILOT-SCALE TESTING

The pilot-scale studies were designed to provide key information for the technical and economic assessment of the BCFs for commercial applications. Comprehensive tests were conducted in the CE Fireside Performance Test Facility (FPTF) to evaluate the combustion, furnace slagging, convective pass fouling and fly ash erosion characteristics of the BCFs prepared in both dry (micro-fine) and wet (micro-fine coal-water fuel) forms. Studies were also carried out to evaluate the effect of BCF fly ashes on electrostatic precipitator (ESP) collection performance. Additionally, representative in-flame solids and ash deposit samples collected were analyzed in detail to enhance the understanding of mineral matter transformation and ash deposition and to relate these to fuel mineral distributions and combustion conditions. Also, complementary experiments were carried out in the MIT Combustion Research Facility (CRF) to provide more detailed information on the combustion and emission characteristics of selected BCFs. These experiments focused on application of the coal-water fuel form.

Nine test fuels were evaluated for combustion and performance testing from October, 1989, to June, 1990. These fuels included Illinois No.6, Upper Freeport, Pittsburgh No.8 microbubble flotation products (MFPs), spherical oil agglomeration products (SOAPs), and the MFP parent coals. Those pilot-scale results were reported in three previous quarterly reports: May to June, 1990, October to December, 1990, and January to March, 1991. Results are also included in the papers by Barta, et alia, 1991, and Chow, et alia, 1991, as well as the draft Topical Report issued in June, 1991.

Upper Freeport fresh parent coal was tested in the CE FPTF in October, 1991 for comparison to the previous Upper Freeport feed coal, which had aged for approximately eighteen months, stored in sealed drums. The results were reported in the 11th and 13th quarterly reports.

TASK 4 - SCALE-UP TESTS

The purpose of the scale-up tests is to verify that the results obtained from tests done at bench- and pilot-scales in Tasks 2 and 3 can be used to provide reasonable estimates of the performance effects when firing BCFs in commercial-scale boilers. Two beneficiated fuels would be fired in either a small utility boiler or a full-scale test furnace.

There were no activities scheduled in this task during this quarter.

TASK 5 - TECHNICAL-ECONOMIC EVALUATIONS

The results of bench-scale, pilot-scale, and scale-up tests (Tasks 2, 3, and 4) will be used to predict the performance of three commercial boilers. The boilers include: a 560MW coal-designed utility unit; a 600MW oil-designed utility unit; and an 80,000 lb/hr oil designed, shop assembled industrial unit. Eight of the base project BCFs will be used in models of each unit to calculate performance.

Boiler performance guidelines were reviewed to incorporate the BCF test results. The guidelines will also be updated to reflect current theories and correlations.

TASK 6 - TECHNICAL REPORTING

The Topical Report written in June, 1991 was further updated to include all data on the devolitilization kinetics. A paper was written for the Coal Utilization and Fuel Systems Conference.

WORK PLANNED FOR NEXT QUARTER

- Continue standard bench-scale tests on the new BCFs.
- Prepare for pilot-scale combustion tests and ash deposition tests.
- Procure more BCFs for testing.

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