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ADVANCED LIQUEFACTION USING COAL SWELLING
AND CATALYST DISPERSION TECHNIQUES

Report Number C-02
Quarterly Technical Progress Report
for
January - March 1992

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FWDC
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Pennsylvania State Univ.

Work Performed Under Contract No. DE-AC22-91PC91051

For

U. S. Department of Energy
Pittsburgh Energy Technology Center
Pittsburgh, Pennsylvania

By

Amoco Oil Company
Research & Development Department
Post Office Box 400
Naperville, IL 60566

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Prepared by
Amoco Oil Company (Amoco Corporation)
Naperville, Illinois

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EXECUTIVE SUMMARY

Research in this project centers upon developing a new approach to the direct liquefaction of coal to produce an all-distillate product slate at a sizable cost reduction over current technology. The approach integrates all aspects of the coal liquefaction process including coal selection, pretreatment, coal swelling with catalyst impregnation, coal liquefaction experimentation, product recovery with characterization, alternate bottoms processing, and a technical assessment including an economic evaluation. The project is being carried out under contract to the United States Department of Energy.

The Department of Energy has not yet authorized starting the experimental aspects of this and other similar projects; specifically, approval of the National Environmental Policy Act (NEPA) requirements. Previous work had centered upon the following: 1) preparing and obtaining approval of the Project Management Plan, Milestone Schedule/Manpower Plan, Cost Plan, and the Notice of Energy R&D Project, 2) negotiating contracts to be signed with subcontractors after the NEPA approvals, 3) obtaining bulk samples of feedstocks for the project, 4) up-dating the background literature, and 5) preparing and testing a computer program to perform material balance calculations for the continuous flow liquefaction unit.

There has been essentially no experimental activity during the current period due to the lack of having NEPA approval by DOE. A set of coal samples were sent to Hazen Research for beneficiation so that experimentation can get underway after DOE has approved the document.

PROGRAM OBJECTIVES

The objective of this project is to develop a new approach to the direct liquefaction of coal to generate an all-distillate product slate at a sizable cost reduction over current technology. The approach will integrate all aspects of the coal liquefaction process including coal selection, pretreatment, coal swelling with catalyst impregnation (and parallel runs with dispersed catalyst), coal liquefaction experimentation including solvent evaluation, product recovery with characterization, alternate bottoms processing, and a technical assessment including an economic evaluation. The three tasks of this program are:

1. Task 1: Laboratory-Scale Experimentation--The goals are to obtain samples of coals and Wilsonville-derived solvents and vacuum tower bottoms and to establish experimental procedures.
2. Task 2: Laboratory-Scale Operation--The goals are to:
(1) reduce the concentration of mineral matter and alkali metals in low rank coals. (2) swell and impregnate coals with dispersed catalysts, (3) characterize the resulting catalyst solids, (4) evaluate the effectiveness of the procedures using liquefaction runs, and (5) study solids separation and alternative bottoms handling, which includes observing pumping characteristics, deasphalting and coking.
3. Task 3: Technical Assessment--The goals are to analyze the data, develop descriptive models, and carry out an economic evaluation.

The research will be carried out in cooperation with the following subcontractors: Foster Wheeler Development Corporation, Auburn University, Pennsylvania State University, and Hazen Research Incorporated. Appropriate meetings and correspondence will be maintained to insure effective completion of the project.

PROGRAM MILESTONES

The first key milestone is to obtain the appropriate feed stocks for the experiments. The second milestone is preparing the beneficiated bulk samples of coal for subsequent experiments. The feedstocks have been obtained and the beneficiation of samples of Martin Lake lignite and Black Thunder subbituminous coal is currently be done by Hazen Research, Inc. After DOE approval of the NEPA requirement (defined as the start of the research program), the small-scale coal swelling and catalyst screening program will start. Sufficient data must be obtained from the latter program to establish conditions for bench-scale liquefaction experiments to start during the fourth quarter. The batch deasphalting and coking experiments will be completed by the end of the fifth quarter. Experimentation should be essentially complete by the end of the seventh quarter in order to complete the project within a two year period after approval of the NEPA requirement.

SUMMARY OF RESULTS AND ACTIVITY

Activity has been limited to carrying out non-experimental work covered under Subtasks 1.1 and 2.2.

Subtask 1.1: Laboratory Support

The following documentation has been completed as reported in the previous quarterly:

- 1) Project Management Plan,
- 2) Milestone Schedule/Manpower Plan,
- 3) Cost Plan,
- 4) Notice of Energy R&D Project.

Draft copies were submitted to the DOE project manager, Dr. Baird, and approval was received during a joint meeting of December 4.

Fresh, bulk samples of Black Thunder subbituminous coal and Martin Lake Texas lignite are on-hand. Analyses have been obtained from Commercial Testing Laboratories, Inc. These analyses are attached in the Appendix.

Sufficient quantities of coal-derived liquids (atmospheric tower bottoms and solvent) have been obtained from Wilsonville in order to complete this project. A bulk sample of Wilsonville atmospheric tower bottoms derived from the liquefaction of Black Thunder subbituminous coal has been sent to Foster Wheeler Development Corporation so that it will be available when the start of experimentation is authorized by DOE.

The literature concerning coal swelling and coal liquefaction using dispersed catalysts has been up-dated using Amoco's library computer search facilities.

Subtask 2.1: Laboratory Support

The material balance program for the continuous flow unit, AU-44, has been written for a moderate-sized PC in Lotus 123R22. This program has been tested using data generated under a previous DOE contract (DE-AC22-38PC88819). A print-out of the spreadsheet was included in the previous quarterly.

Drum quantities of Martin Lake (Texas) lignite and Black Thunder subbituminous coal have been sent to Hazen Research, Inc. for crushing, sizing (8x60 mesh and minus 60 mesh fines), aqueous SO₂-treatment, and heavy-media (sink/float) separation. It has been requested that conditions for the heavy-media separation be chosen that results in a high recovery (about 85%) of the float coal fractions.

CONCLUSIONS AND FUTURE WORK

After approval of the NEPA form by the Department of Energy, experimentation is ready to get underway. Feedstocks have been obtained and the beneficiation of the feed coal will be complete. It is anticipated that a new schedule of experimentation will have to be drafted.

ACKNOWLEDGMENTS

This work is being supported by the United States Department of Energy under Contract DE-AC22-91PC91051. Appreciation is particularly extended to Mr. C. Gutterman of Foster Wheeler Development Corporation, Dr. C. W. Curtis of Auburn University, and Dr. S. Chander of Pennsylvania State University for participating in contract negotiations and preparing to initiate work in this project.

APPENDIX I

ANALYSES OF SAMPLES OF THE MARTIN LAKE LIGNITE AND
BLACK THUNDER SUBBITUMINOUS COAL

COMMERCIAL TESTING & ENGINEERING CO.

GENERAL OFFICES: 1919 SOUTH HIGHLAND AVE., SUITE 210-B, LOMBARD, ILLINOIS 60148 • (708) 953-9300

Member of the SGS Group (Société Générale de Surveillance)

PLEASE ADDRESS ALL CORRESPONDENCE TO
15130 VAN DRUNEN RD., P.O. BOX 127
SOUTH HOLLAND, IL 60470
TELEPHONE: (708) 331-2900
FAX: (708) 333-3060

February 18, 1992

AMOCO RESEARCH CENTER
Warrenville Road & Mill St.
P.O. Box 3011
Naperville, IL 60566
ATTN: D.C. Cronauer
Mail Station H-4

Sample identification by
Amoco Research Center

Kind of sample
reported to us Coal

Sample No: 14007-117-C2
Sample ID: Raw Coal - Black Thunder

Sample taken at -----

Sample taken by Amoco Research Center

Date sampled February 10, 1992

Project No.: 70-6186-15
P.O. No. 099P25960

Date received February 13, 1992

Analysis Report No. 71-27775

Page 1 of 1

PROXIMATE ANALYSIS

	As Received	Dry Basis
% Moisture	25.81	xxxxx
% Ash	5.11	6.89
% Volatile	31.06	41.86
% Fixed Carbon	38.02	51.25
	100.00	100.00
Btu/lb	8808	11872
% Sulfur	0.30	0.41
MAF Btu		12751

ULTIMATE ANALYSIS

	As Received	Dry Basis
% Moisture	25.81	xxxxx
% Carbon	50.76	68.42
% Hydrogen	3.77	5.08
% Nitrogen	0.37	0.50
% Sulfur	0.30	0.41
% Ash	5.11	6.89
% Oxygen(diff)	13.88	18.70
	100.00	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Manager, South Holland Laboratory

OVER 40 BRANCH LABORATORIES STRATEGICALLY LOCATED IN PRINCIPAL COAL MINING AREAS, TIDEWATER AND GREAT LAKES PORTS, AND RIVER LOADING FACILITIES

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February 18, 1992

AMOCO RESEARCH CENTER
Warrenville Road & Mill St.
P.O. Box 3011
Naperville, IL 60566
ATTN: D.C. Cronauer
Mail Station H-4

Sample identification by
Amoco Research Center

Kind of sample
reported to us Coal

Sample No: 14007-116-C4
Sample ID: Raw Coal - Lignite

Sample taken at -----

Sample taken by Amoco Research Center

Date sampled February 10, 1992

Project No.: 70-6186-15

P.O. No. 099P25960

Date received February 13, 1992

Analysis Report No. 71-27774

Page 1 of 1

PROXIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	34.83	XXXXXX
% Ash	6.92	10.62
% Volatile	30.18	46.31
% Fixed Carbon	<u>28.07</u>	<u>43.07</u>
	100.00	100.00
Btu/lb	7367	11304
% Sulfur	1.30	1.99
MAF Btu		12647

ULTIMATE ANALYSIS

	<u>As Received</u>	<u>Dry Basis</u>
% Moisture	34.83	XXXXXX
% Carbon	42.13	64.64
% Hydrogen	3.15	4.84
% Nitrogen	0.80	1.23
% Sulfur	1.30	1.99
% Ash	6.92	10.62
% Oxygen(diff)	<u>10.87</u>	<u>16.68</u>
	100.00	100.00

Respectfully submitted,
COMMERCIAL TESTING & ENGINEERING CO.

Manager, South Holland Laboratory

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