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TECHNICAL PROGRESS REPORT

APPALACHIAN CLEAN COAL TECHNOLOGY CONSORTIUM

Cooperative Agreement No.: DE-FC22-94PC94152

Project Report for the period

July 1, 1995 - September 30, 1995

Performing Organizations:

Virginia Polytechnic Institute & State University
Blacksburg, VA

University of Kentucky
Lexington, KY

West Virginia University
Morgantown, WV

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INTRODUCTION

The Appalachian Clean Coal Technology Consortium (ACCTC) has been established to help U.S. Coal producers, particularly those in the Appalachian region, increase the production of lower-sulfur coal. The cooperative research conducted as part of the consortium activities will help utilities meet the emissions standards established by the 1990 Clean Air Act Amendments, enhance the competitiveness of U.S. coals in the world market, create jobs in economically-depressed coal producing regions, and reduce U.S. dependence on foreign energy supplies.

The consortium has three charter members, including Virginia Polytechnic Institute and State University, West Virginia University, and the University of Kentucky. The Consortium also includes industry affiliate members that form an Advisory Committee. Affiliate members currently include AMVEST Minerals; Arch Minerals Corp.; A.T. Massey Coal Co.; Carpco, Inc.; CONSOL Inc.; Cyprus Amax Coal Co.; Pittston Coal Management Co.; and Roberts & Schaefer Company.

OBJECTIVES

In keeping with the recommendations of the Advisory Committee, first-year R&D activities are focused on two areas of research: fine coal dewatering and modeling of spirals. The industry representatives to the Consortium identified fine coal dewatering as the most needed area of technology development. Dewatering studies will be conducted by Virginia Tech's Center for Coal and Minerals Processing. A spiral model will be developed by West Virginia University. The research to be performed by the University of Kentucky remains to be defined. Project management and administration will be provided by Virginia Tech, for the first year.

DISCUSSION

Virginia Tech: Innovative Approach To Fine Coal Dewatering

Introduction

There are no practical solutions to the problems associated with the dewatering fine coals at the moment. The mechanical dewatering technologies used today are inefficient while thermal drying is capital-intensive and costly to operate. Therefore, there is an impending need for innovative approaches to solving problems in fine coal dewatering.

In this project, two different approaches are taken. One approach involves displacing the water on the surface of coal by a hydrophobic substance that can be readily recovered and recycled. This novel concept, referred to as the Hydrophobic Dewatering (HD) process, is based on improved understanding of the surface chemistry of dewatering. The other approach is to use disposable dewatering substances in mechanical dewatering.

The objectives of the proposed work are i) to test the HD process on a variety of coals from the Appalachian coal fields, and ii) to identify suitable dewatering reagents that would enable mechanical dewatering to reduce the moisture to the levels satisfactory to electrical utilities and other coal users.

Results for the Current Quarter

Task A1 *Coal Sample Acquisition and Characterization*

Fine coal products (28 mesh x 0 and 100 mesh x 0) were collected from different coal preparation plants in the Appalachian region. The fine coal samples collected were characterized in terms of % solids, size distribution and ash content. The samples collected were used in the batch HD tests and the mechanical dewatering tests using various dewatering aids.

Task A2 <u>*Batch Dewatering Unit Design and Set-Up*</u>

In this quarter, the batch HD process unit was designed and constructed using butane as the hydrophobic substance. Since butane has a high vapor pressure, a high-pressure vessel made by Parr Instruments was used in the batch HD process unit. Shakedown tests of the batch unit were conducted using the flotation concentrates from Cyprus Amax Coal Company's Lady Dunn plant near Montgomery, West Virginia. There was a problem found in obtaining samples of the dewatered coal product for moisture analyses. Modifications to the sampling compartment of the batch unit were made and will be tested in the next quarter. There were no other problems observed with the batch HD process unit.

Task A3 <u>*Batch Dewatering Tests*</u>

After the shakedown tests, batch tests will be conducted on one coal sample collected in Task A1. Preliminary tests will be conducted to examine the effects of butane dosage, agitation speed, mixing time and phase separation time on the performance of the HD process. The resultant coal products will be analyzed for surface moisture, total moisture and ash content. A representative coal sample from one of the three states participating in the ACCTC program will be examined in the preliminary test program.

Task A5 <u>*Use of Disposable Dewatering Substances in Mechanical Dewatering*</u>

In this reporting period, laboratory scale vacuum filtration tests were conducted on different fine coal products collected in Task A1. Different reagents were screened in these filtration tests to identify suitable reagents for dewatering. However, only the results obtained with those reagents that were effective in reducing the moisture content are reported here.

In these dewatering tests, the dewatering aid was added to the slurry and the slurry was then agitated for one minute. The coal slurry was then subjected to vacuum filtration with drying times from one to ten minutes after liquid drainage. The dewatered coal samples were recovered from the filter and analyzed for moisture content.

Preliminary tests were conducted on 100 mesh x 0 Lower Kittaning run-of-mine coal samples that were dispersed in water. The slurry was subjected to vacuum filtration using a Buchner filter with a coarse glass frit (40-60μm). Some of the results for these different tests with and without using a dewatering aid are summarized in Table 1. In the absence of the dewatering aid, the moisture content of the Lower Kittaning coal was 27%. The moisture content was reduced significantly to as low as 3.9% with the use of the dewatering aid and longer drying time. The filtration rates were also increased four to five times higher when the dewatering aid was added.

TABLE 1. Dewatering test results obtained for Lower Kittaning coal.

	% Moisture		
	1 min Drying	5 min Drying	10 min Drying
without dewatering aid	29.0	28.0	27.1
with dewatering aid	13.1	8.8	3.9

Tests were also conducted on the actual fine clean coal products. The samples tested were filter feed (28 mesh x 0) and flotation product (100 mesh x 0) from a Pittsburgh No. 8 coal provided by CONSOL Inc. and column flotation product (100 mesh x 0) from Pittston Coal Management Company's Middle Fork plant in Southwest Virginia. In these tests, the sample was subjected to bottom-fed filter leaf test using a standard EIMCO filter leaf with a polypropylene filter media. The leaf was dipped into the slurry for 15 seconds (cake-formation time) and held at an upright position in air for one minute (drying time). After the drying period, the vacuum was stopped and the cake was discharged by lifting with a spatula. Some of the results obtained with these different coal samples with and without any dewatering aid are given in Table 2. In tests obtained without using any dewatering aids, the average moisture content of a Middle Fork column concentrate was 41.9%. Using a dewatering aid, the moisture content of this flotation column concentrate was reduced to 23.7%. The filtration rate obtained with the use of the dewatering aid was much higher as indicated by the thicker cake and larger volume of filtrate recovered. For the Pittsburgh No. 8 filter feed sample, the moisture content was reduced from 41.8% (without dewatering aid) to 23% when a dewatering aid was added. Similar results were obtained with the flotation concentrate from the Pittsburgh No. 8 seam.

TABLE 2. Dewatering test results obtained for actual fine clean coal products.

Coal Sample	% Moisture	
	Without Dewatering Aid	With Dewatering Aid
Middle Fork Column Concentrate[1]	41.9	23.7
Pittsburgh No. 8 Filter Feed[2]	41.8	23.0
Pittsburgh No. 8 Flotation Concentrate[3]	42.0	24.4

[1] Flotation column concentrate (15% solids, 100 mesh x 0) from refuse pond; [2] filter feed (30% solids, 100 mesh x 0); [3] flotation concentrate (20% solids, 100 mesh x 0).

West Virginia University: Spiral Modeling

Introduction

The most promising approach to improving spiral separation efficiency is through extensive computer modeling of fluid and solids flow in the various operating regions of the spiral. Previous efforts at accurate modeling have failed, primarily due to the use of incorrect physical models describing the flowing slurry stream.

Several key issues must be resolved to improve the performance of spirals. Since movement of particles into the separation zone of the spiral is the key to improving efficiency, the most important issue is control of fluid and particle flow. Critical questions to be answered include determining the optimum location for makeup water addition, how to control the position of the Roberts and Knoll lines, and how to control the movement of particles from the upper Grandy region into the lower Grandy region. In addition, the effects of spiral diameter, pitch and height on fluid/particle behavior need to be determined.

The objective of this project is to use computer modeling to develop better, more efficient spiral designs for coal cleaning. The fully-developed model will predict spiral performance based on variations in spiral profile, flow rate, and pitch. Specific goals are to: i) design spirals capable of making separations at a specific gravity of 1.5, and ii) broaden the size range at which spirals make effective separations.

Results for the Current Quarter

There are four major steps in modeling a physical problem. First, one gets a good physical model of what is happening. Second, the physical model is described mathematically. Third, a numerical method is selected that is best suited for solving the problem. Fourth, one selects the software in which to program the mathematics. During the past quarter, the physical model was completed and work is underway on completing the mathematics. The mathematical modeling task, however, has turned out to be significantly more difficult a problem than anticipated.

Originally, it was believed that one of the many forces operating on the particles in the spiral would be dominant. This would have permitted the modeling effort to concentrate on that force alone. The research has shown, however, that there are at least four forces of importance operating on the particles and all four forces must be considered.

It appears that a solution to the force problem has been found in the form of a mathematical transform. While discovery of this transform was unexpected, it makes a mathematical analysis possible. Through use this transform, one key variable that would have made an analysis most difficult, has been eliminated. The result of this discovery is that the mathematical modeling effort is now ahead schedule in spite of the increased difficulty.

In summary, physical modeling is now complete and seems to be exceptionally sound. The mathematical analysis is nearly finished. During the next quarter, options for numerical methods will be explored. Software options will also be investigated. The project is on schedule and gives every indication that it will produce a viable and commercially-successful model.