POC-SCALE TESTING OF AN ADVANCED FINE COAL DEWATERING EQUIPMENT/TECHNIQUE

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INTRODUCTION

Froth flotation technique is an effective and efficient process for recovering of ultra-fine (minus 74 μm) clean coal. Economical dewatering of an ultra-fine clean coal product to a 20 percent level moisture will be an important step in successful implementation of the advanced cleaning processes. This project is a step in the Department of Energy's program to show that ultra-clean coal could be effectively dewatered to 20 percent or lower moisture using either conventional or advanced dewatering techniques.

The cost-sharing program is for 36 months, which began October 1, 1994. The program includes laboratory, as well as pilot scale dewatering testing at a rate of 0.5 to 2 tons/hr of clean coal. The pilot scale studies were conducted at the Powell Mountain Coal Company's Mayflower Preparation Plant located at St. Charles, VA.

OBJECTIVES AND SCOPE OF THE PROJECT

The main objective of the proposed program is to evaluate a novel surface modification technique, which utilizes the synergistic effect of metal ions-surfactant combination, for dewatering of ultra-fine clean coal on a proof-of-concept scale of 0.5 to 2 tph. The novel surface modification technique developed at the UKCAER were evaluated using vacuum, centrifuge, and hyperbaric filtration equipment.

EXPERIMENTAL

POC-Scale testing of pressure and vacuum filtration of fine coal was conducted on the fine clean coal froth produced by the column flotation cells at the Powell Mountain Coal Company Mayflower Preparation Plant in St. Charles, Virginia. A stream of the clean coal froth product was diverted into a 500 gallon feed tank that was agitated to prevent settling. Filter feed was withdrawn from the feed tank for the dewatering tests.

The testing protocol used in this study was to set the operating parameters (rotation speed, feed rate, etc.) and operate the filter for 15 minutes prior to sampling. The sampling procedure was to obtain a one minute sample of the dewatered cake int a tared box. The filter cake sample was weighed, cake thickness was determined with a micrometer and a 1 kg portion was retained for moisture analysis. Moisture was determined by drying at 100°F to constant weight in accordance with ASTM procedures. Immediately after sampling the filter cake, one liter samples of feed slurry and filtrate were also collected. These samples were weighed, filtered and dried to determine solids content.

The pressure filter used in this study was an Andritz hyperbaric unit with a 1.4 meter (4.6 ft) diameter disc filter with 2 m^2 (22 ft^2) filter area. The filter was enclosed in a 2.5 m (8.2 ft) diameter pressure vessel. The vacuum filter used was a WesTech Engineering 0.9 m (3 ft) diameter, 0.6 m (2 ft) width drum with a filter area of 1.7 m^2 (18.8 ft^2). A decanter 18-in. diameter screen bowl centrifuge rotating at 1000 rpm speed was also used for the testing.

In all the tests, the baseline operating conditions for each equipment was determined. The results reported using various chemical additives were all obtained using the baseline dewatering conditions. When chemical additives were used, a test using the baseline operating parameters was conducted before and after each test series.

RESULTS AND DISCUSSION

The solids content of the clean coal slurries was about 15 percent and the average particle size for the high sulfur and low sulfur clean coal products was 25 μm and 32 μm, respectively.

Table I shows the baseline dewatering data obtained using the three different devices. Note, that the pressure filter provided the lowest moisture product containing 23.6 percent moisture. The solids capture for both pressure and vacuum filter were 99 percent, however, for the screen bowl centrifuge it was only 65 percent.

Table I. Baseline Dewatering Data

Filter Type	Pressure	Vacuum	Centrifuge
Filter Area (ft^2)	22	18.8	18-in. diam.
Baseline Conditions			
R.P.M.	1.5	1	1000
Pressure or vacuum	43.5 psi	15" Hg	---
C.F.A./Submergence	165°	30%	---
Cake Moisture (%)	23.6	27.8	30
Throughput (lb/ft^2/hr)	165	25	---
Throughput (tons/hr)	1.8	0.23	0.75
Air Consumption (scfm/t)	460	---	---
Solids Capture (%)	99	99	65

A comparison of the cake moisture obtained using the pressure, vacuum and centrifuge filter with respect to anionic flocculant (Allied Colloid Procol 156, MW 12 million) is shown in Figure 1. For the pressure filtration increasing flocculant dosage to 20 g/t shows increase in filter cake moisture from 22.5 to 26 percent. With he vacuum filter, increasing flocculant dosage to 20 g/t decreased filter cake moisture from 28 to 26 percent. For the centrifuge increasing flocculant dosage increased product moisture.

The effect of cationic flocculant (Allied Colloid Procol 371, MW 5 million) dosage on filter cake moisture is shown in Figure 2. For the pressure filter no change in moisture occurred up to 15 g/t dosage, however, moisture decreased from 23.5 to 21.0 percent when dosage increased to 20 g/t. For both vacuum and centrifuge filters increasing flocculant dosage increased filter cake moisture.

Using cationic surfactant (1-cetyl pyridinium chloride) pressure filtration lowered cake moisture form 22.4 to 19.0 percent as the dosage increased from 0 to 0.8 Kg/t, as shown in Figure 3. No change in filter cake moisture was observed with vacuum filter, however, with the centrifuge an increase in moisture content was observed with increasing surfactant dosage. Figure 4 shows the data obtained using anionic surfactant (sodium 2 ethylhexyl sulfate). No significant change in cake moisture occurred with pressure filtration. However, with vacuum filtration, cake moisture reduced from 29.5 to 24 percent as the surfactant dosage increased to 1.5 Kg/t. Increase in filter cake moisture was observed using the centrifuge filter with increase in surfactant dosage. Increasing nonionic surfactant (octyl phenoxy polyethoxy ethanol) dosage on filter cake moisture using the three devices is shown in Figure 5. For pressure filtration, cake moisture reduced from 21 to 15.9 percent as the dosage of surfactant increased from 0 to 1.5 Kg/t; while for vacuum filtration, the cake moisture lowered from 29.6 to 26 percent over the same dosage range. Again, a slight increase in moisture content was observed with centrifuge.

The results obtained using $CuCl_2$ are shown in Figure 6. Using pressure filtration, cake moisture was reduced from 23.2% to 20.7% with the addition of 250 mg/kg $CuCl_2$. Higher dosages did not provide any additional moisture reduction. Using vacuum filtration, cake moisture was reduced from 27% to 24.8% with a dosage of 500 mg/kg $CuCl_2$. In case of centrifuge the moisture increased with increasing $CuCl_2$ dosage.

The most promising dewatering results were obtained with the centrifuge using DOE/FETC `Granuflow' process. Figure 7 shows the product moisture and solids capture obtained as a function of `Orimulsion' dosage. Using 6 weight percent `Orimulsion' filter cake moisture reduced from 35.5 to 26 percent and solids capture increased from 64 to 95 percent.

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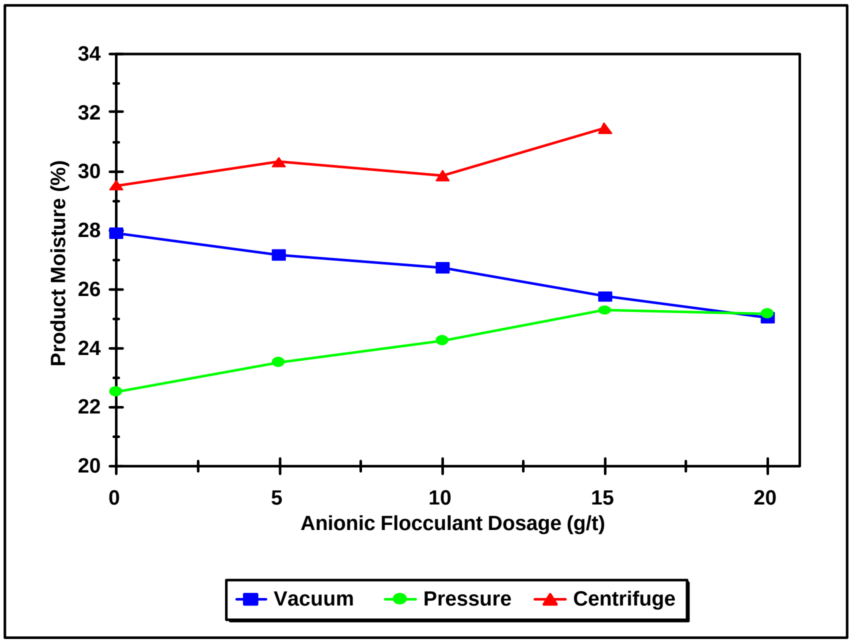


Figure 1. Effect of anionic flocculant dosage on filter cake moisture using various dewatering techniques

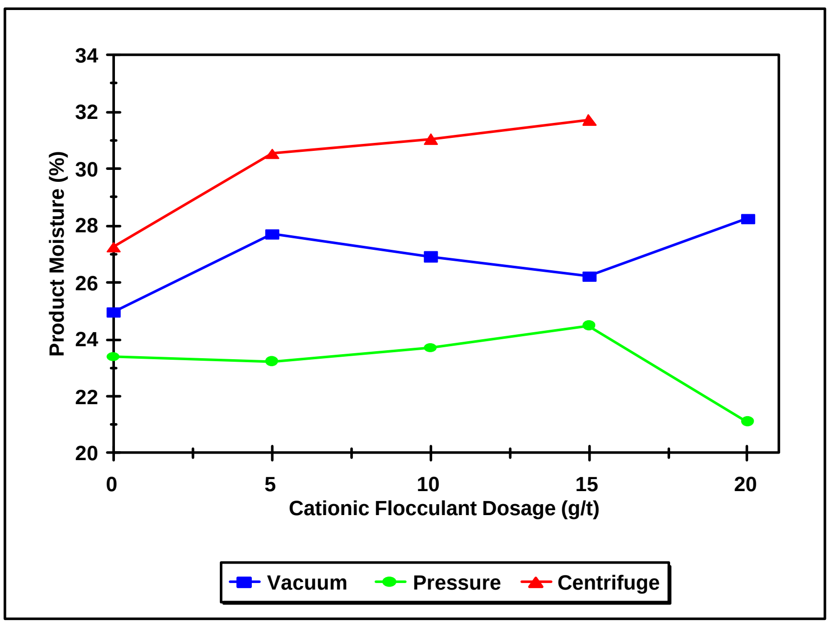


Figure 2. Effect of cationic flocculant dosage on filter cake moisture using three different dewatering

techniques

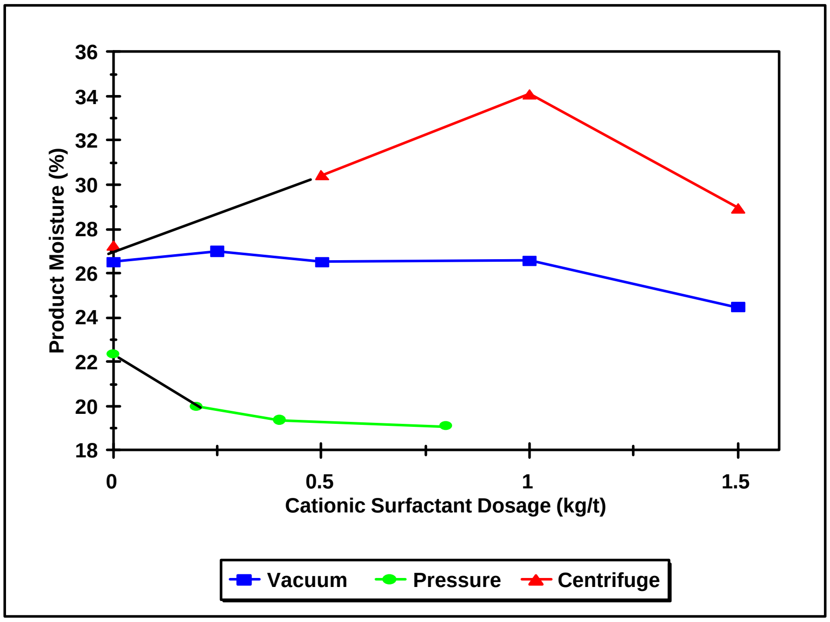
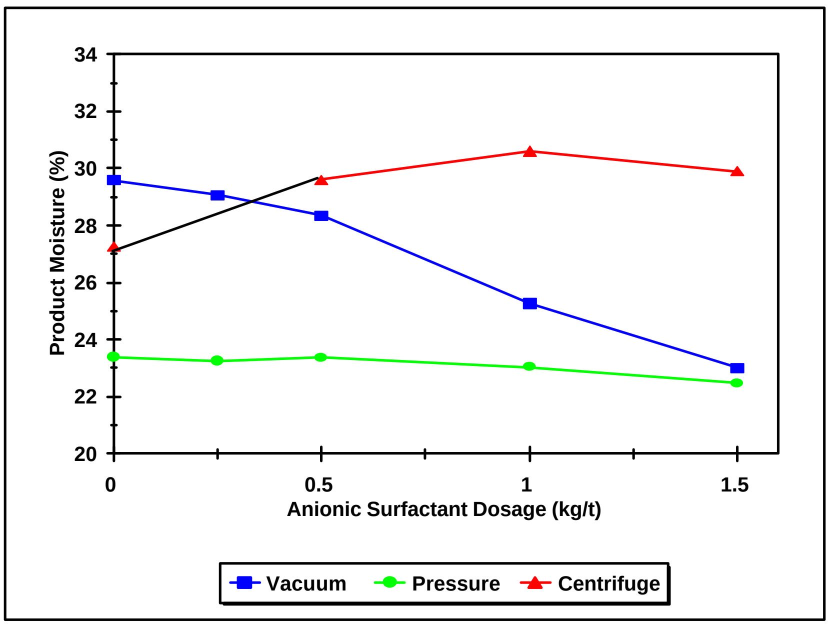
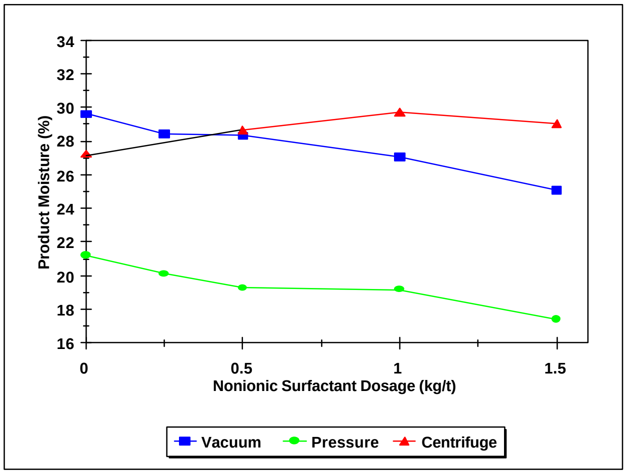


Figure 3. Effect of cationic surfactant dosage on filter cake moisture using different dewatering techniques





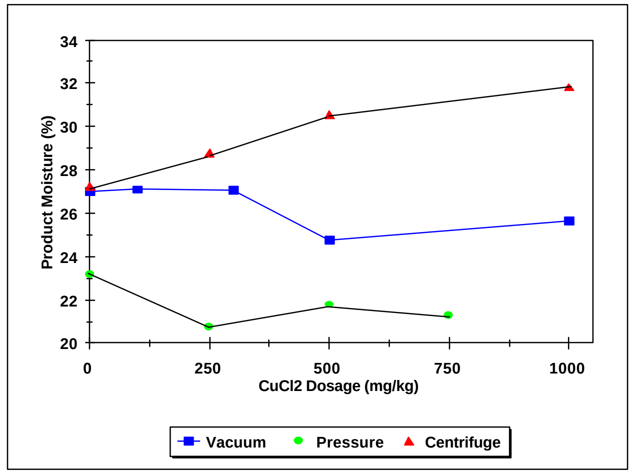


Figure 4. Effect of anionic surfactant dosage on filter cake moisture using various dewatering techniques

Figure 5. Effect of nonionic surfactant dosage on filter cake moisture using various dewatering techniques

Figure 6. Effect of copper chloride dosage on Filter cake moisture using various Dewatering techniques

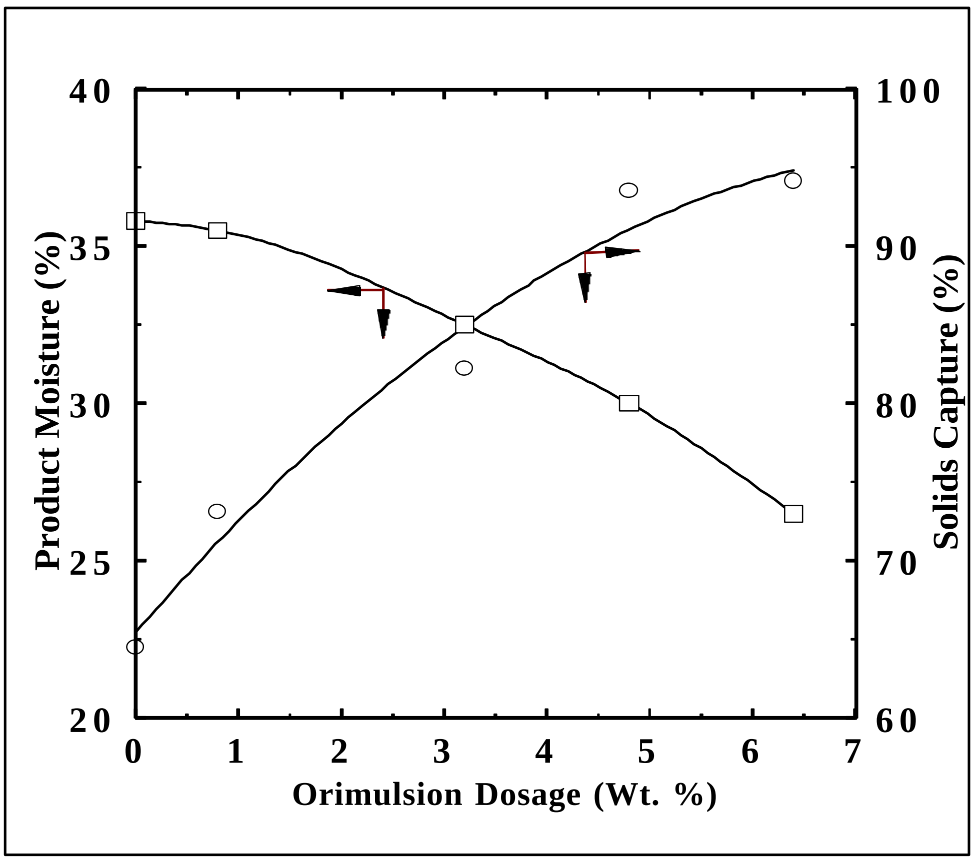


Figure 7. Screen bowl centrifuge data on column product using various orimulsion dosages