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Thickening Fine Coal Refuse Slurry for Rapid Dewatering and Enhanced Safety

By Bill M. Stewart, Ronald R. Backer, and Richard A. Busch

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot	min	minute
ft/s	foot per second	mL	milliliter
ft^3/st	cubic foot per short ton	mm	millimeter
gal	gallon	mol wt	molecular weight
gal/min	gallon per minute	pct	percent
h	hour	s	second
in	inch	sp gr	specific gravity
lb	pound	st	short ton
lb/st	pound per short ton	wt pct	weight percent

THICKENING FINE COAL REFUSE SLURRY FOR RAPID DEWATERING AND ENHANCED SAFETY

By Bill M. Stewart,[1] Ronald R. Backer,[2] and Richard A. Busch[3]

ABSTRACT

To decrease the potential for fine coal waste slurry impoundment failures, the Bureau of Mines investigated a new disposal technique. The fine coal waste slurry is rapidly thickened (i.e., dewatered) and deposited on a slightly sloping surface. To accomplish rapid dewatering, a chemical flocculation system using polymers was developed to treat the fine coal waste slurry stream. The fine solids formed flocs, settled from suspension, and rapidly released excess water.

During the last 5 days of the field test, slurry flowing at rates from 498 to 675 gal/min with a specific gravity range of 1.15 to 1.33 was successfully treated and dewatered. During this period, untreated slurry had an average moisture content of 227.4 pct (30.7 wt pct solids). The effectiveness of the dewatering system was determined by monitoring the moisture content of the deposited waste with respect to time. Sixty-five hours after ending the field test the average moisture content was 54.9 pct (64.5 wt pct solids); 68 days after the field test the average moisture content was 28.8 pct (78.0 wt pct solids).

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INTRODUCTION

As a continuation of work performed in 1981 by Backer and Busch,[4] the Bureau of Mines performed laboratory and field tests to evaluate the concept of using a single-polymer system to rapidly dewater coal refuse slurry. Two major differences were addressed in this research with respect to the 1981 study: (1) the flocculation system was automated, and (2) the system treated the entire slurry stream from preparation plant. Rapid dewatering of the slurry produces several disposal advantages: The slurry solidifies much faster, resulting in a more stable fill; the danger of high phreatic surfaces in the embankment of the impoundment is reduced; acid drainage potential is reduced; clarified water is immediately available for recirculation to the preparation plant; and more solid waste can be disposed in a given area.

To thicken the slurry and to accelerate dewatering, an automatic flocculation system was developed that injects a diluted polymer (at optimum dosage) into the coal waste stream immediately before discharge, with a resultant agglomeration of fine particles and a release of clarifed water upon discharge of the treated slurry into the impoundment. Automatic, optimum polymer dosage was achieved by installing instrumentation that (1) measured both flow rate and slurry density, (2) combined this information into a "mass-flow rate signal," and (3) used this signal to control a variable-speed injection pump that provided polymer at the precise rate required to flocculate the fine coal waste slurry. This automatic system both minimized personnel requirements and polymer costs.

Laboratory testing of the coal waste stream prior to the field test indicated that a single polymer could, at optimum dosage, achieve the desired material depositional characteristics. However, in conducting the field test, the planned single polymer injection, as determined by laboratory tests, did not provide effective treatment. Therefore, during the field test, a second polymer was added to complete the treatment process. The second polymer was added by "trickling" a small amount of this chemical into the slurry at the point of discharge. The primary polymer used in the field test was Nalco 8873,[5] a copolymer of acrylamide and sodium acrylate [10 to 12 million molecular weight (mol wt)], and the secondary polymer was Nalco 8856,[5] an organic polyamine (100,000 mol wt).

ACKNOWLEDGMENT

The authors wish to thank Jewell Smokeless Coal Corp., located near Vansant, VA, for permission to use its site; and for providing water and electricity; and for supplying personnel and equipment to prepare the site, to haul test equipment to and from the site, and to weld pipes and valves. Without their excellent cooperation this project would not have been possible.

LABORATORY TESTS

Several laboratory tests were performed before going to the field. Two hundred gallons of representative slurry sample were sent to the Bureau's Spokane Research Center for the laboratory tests. The samples were collected at the end of the slurry discharge line at the impoundment, over three consecutive days. No samples were collected during startup or shutdown of the preparation plant. The polymer (Nalco 8873) used in the laboratory tests was the same as that being used at the preparation plant for belt press treatment. This reduced the amount

[4]Backer, R. R., and R. A. Busch. Fine Coal Refuse Slurry Dewatering. BuMines RI 8581, 18 pp.

[5]Reference to specific products does not imply endorsement by the Bureau of Mines.

of preliminary laboratory work for polymer selection because the type of polymer best suited to the slurry had already been determined by the coal company. The solids in the slurry had a 2.24 sp gr, as determined by ASTM designation 854-58 (1972). The grain-size distribution of the solids in the slurry is shown in figure 1.

The first laboratory procedure was to ~~conduct settling~~ tests on 1,000-mL slurry samples. These tests were conducted to determine which dosage of polymer would be most effective in separating the solids from the water. Because these tests were conducted in graduated glass cylinders, the water could not drain and physically separate from the solids. It was, therefore, not possible to obtain an accurate measurement of freed water and moisture content of solids. These tests were, therefore, abandoned in favor of pour tests.

The pour tests were conducted on a 4- by 8-ft sheet of plywood with a 3.5° slope. Each pour consisted of 1,000 mL of slurry treated with various dosages of 0.5-pct polymer concentration. Forms were built on the plywood so that four pours could be made at the same time. Prior to collecting each 1,000-mL sample, the slurry density and solids content by weight percentage were determined. The amount of dilute polymer needed was calculated based on the weight of solids, and added to the slurry as it was being stirred with a propeller mixer. When the slurry started to flocculate (usually 10 to 20 s after adding the polymer), it was dumped into an 8-in-diam cylindrical tube placed in the forms on the plywood. The cylindrical tube was then lifted, allowing the flocculated slurry and water to flow freely. Figure 2 shows the flocculated slurry from one pour test.

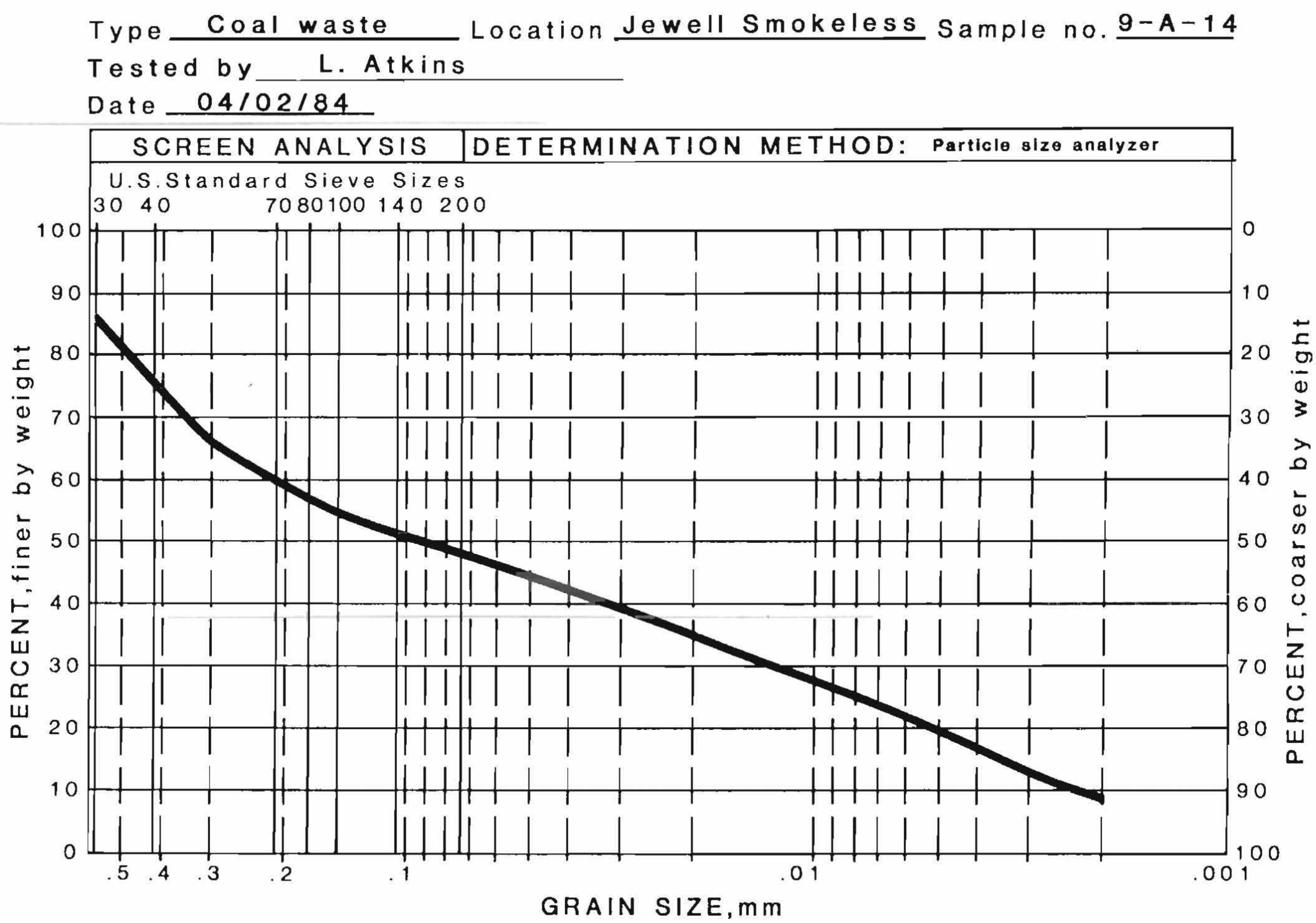

FIGURE 1.—Grain-size distribution of coal waste solids in slurry prior to treatment.

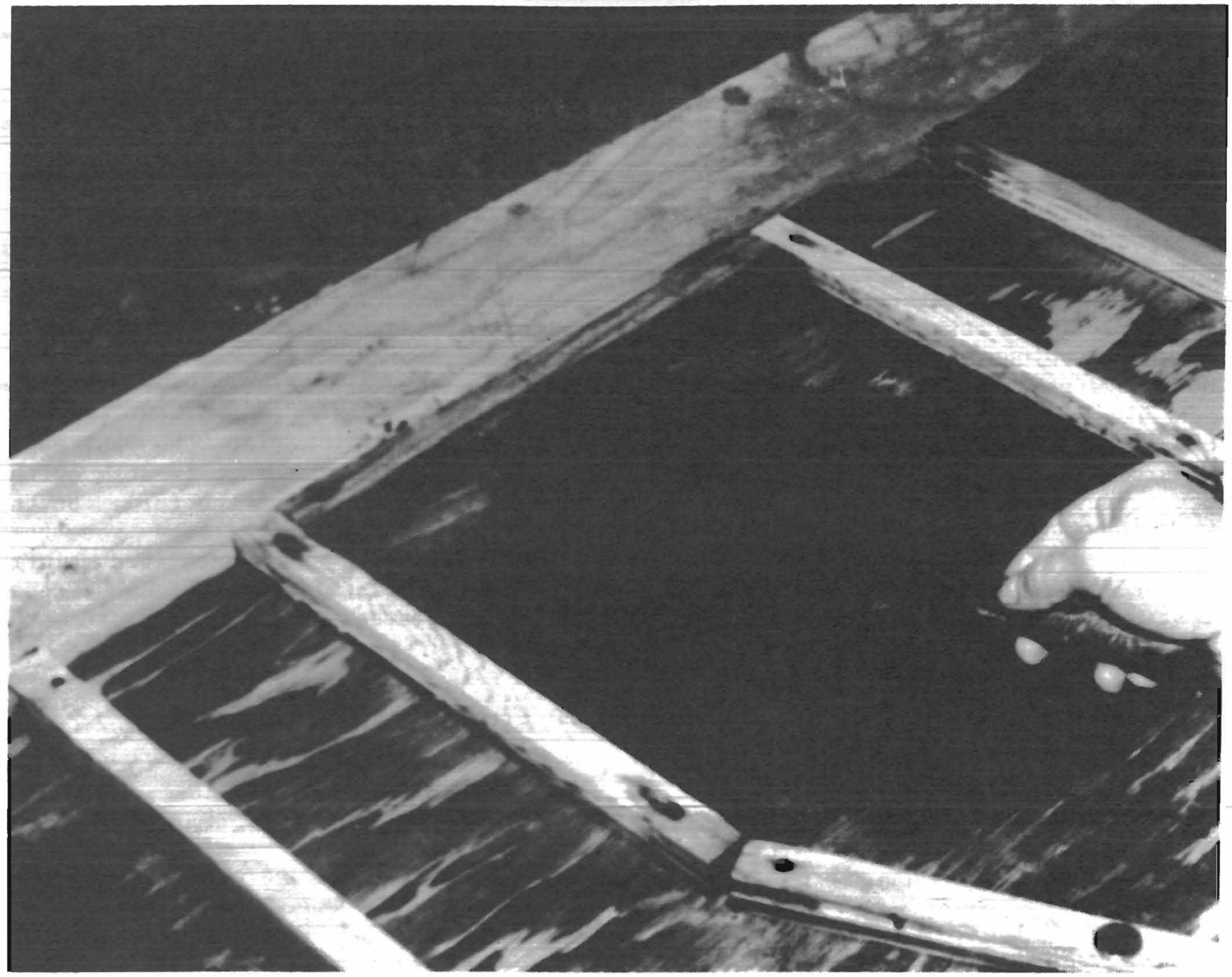

FIGURE 2.—Flocculated (thickened) slurry from a 1,000-mL laboratory pour test. Sample contained a dosage of 2.3 lb of neat polymer per short ton of solids.

Twenty-five pour tests were conducted, with polymer dosages ranging from 1.0 to 3.0 lb/st solids. Samples for moisture content were taken 1 h and 4 h after each pour to evaluate the release of water. The moisture content was determined according to ASTM D2216-71 and is defined as the weight of water divided by the weight of dry solids. Results are shown in table 1. Polymer dosages of 2.5 to 3.0 lb/st solids resulted in very small, sticky solid flocculi with polymer strings in the released water, indicating an overflocculated slurry. Lime additive did not aid the thickening process, nor did lowering the polymer concentration. The polymer thickened the slurry best at dosages of 1.5 to 2.0 lb/st solids.

The next step in the laboratory procedures was to increase the amount of slurry and measure the actual amount of water coming out of the slurry after flocculating. Seventeen tests were performed; these are referred to as "bucket" tests. For each test, about 25 lb of slurry was weighed out and poured into a cement mixer. The solid content in each slurry sample was determined by weight percentage. The amount of dilute polymer needed was calculated, based on the weight of solids, and added to the slurry during cement mixer rotation. As soon as the slurry began to flocculate, the

TABLE 1. - Pour tests with 1,000-mL slurry samples

Polymer type and dosage,[1] lb/st	Moisture content,[2] pct		Polymer conc in water, wt pct
	After 1 h	After 4 h	
MIXED DILUTE POLYMER AND SLURRY BY HAND			
American Cyanamid 1202:			
1.0	104.4	75.4	0.5
1.5	118.2	94.9	.5
2.0	138.7	100.8	.5
MIXED DILUTE POLYMER AND SLURRY WITH PROPELLER MIXER			
American Cyanamid 1202:			
1.0	NF	NF	0.5
1.5	149.1	116.7	.5
	225.0	177.4	.3
1.9	111.6	99.6	.5
2.0	125.5	107.2	.5
	116.7	105.4	.3
2.3	113.6	100.9	ND
3.0	183.2	163.3	.5
American Cyanamid 1204: 2.0	NF	NF	.5
Nalco 8873:			
1.0	186.8	ND	.5
1.5	156.2	125.2	.5
	121.7	101.6	.3
	116.7	102.4	.5
2.0	194.9	159.0	.5
	139.9	ND	.5
	138.9	119.9	.3
2.3	124.4	108.5	.5
2.5	207.3	161.3	.5
3.0	176.5	176.9	.5
ADDED 2 pct LIME BEFORE ADDING POLYMER (TEST REPEATED 3 TIMES)			
American Cyanamid 1202:			
2.0	NF	NF	0.5
3.0	136.8	111.5	.5

ND Not determined. NF No flocculation.
[1]Pounds of neat polymer per short ton of solids.
[2]Weight of water divided by weight of dry solids; expressed in percent.

sample was poured into a 5-gal bucket, modified with an internal vertical drain covered by filter cloth. After the material was allowed to drain for 18 to 21 h, the moisture content of each sample was determined. Results are shown in table 2. Again, slurry thickening was best at 1.5 to 2.0 lb/st dosage.

The third and final step in the laboratory test procedures had two objectives: (1) to see if the slurry would flocculate at expected field flow velocities, and (2) to develop an appropriate conditioning-discharge system. Two tests were conducted, using 50 gal of slurry for each test. To simulate field conditions, the slurry was pumped at 20 gal/min through a 1-in pipe. This produced a flow velocity equivalent to pumping at 700 gal/min through a 6-in pipe (expected field conditions). The previous tests indicated that a 10- to 20-s conditioning time was required after the polymer was added to the slurry. To obtain this conditioning time, 40 ft of 2-in pipe was attached to the 1-in pipe. This reduced the flow velocity to about 2 ft/s. By injecting the polymer at the beginning of the 2-in pipe section through a 1/2-in nipple, approximately 20

TABLE 2. - Bucket tests with 25-lb slurry samples

Dosage, lb/st	Moisture content,[1] pct	Flocculation comments
AMERICAN CYANAMID 1202 (0.5-pct CONCENTRATION)		
1.0..................	83.8	Did not.
1.1..................	60.9	Do.
1.5..................	134.3	Do.
	NM	Good.[2]
1.9..................	54.0	Very good.
2.0..................	71.0	Do.
	84.8	Fair on 2d try.
NALCO 8873 (0.5-pct CONCENTRATION)		
1.0..................	86.2	Good.
	81.4	Fair.
1.5..................	NM	Good.
	73.3	Very good.
	97.1	No comment.
	68.7	Excellent.
1.9..................	60.0	Very good.
2.0..................	64.0	Do.
	82.9	No comment.

NM Not measured.
[1]Moisture contents taken 18 to 21 h after treatment.
[2]Apparent minimum dosage for initiation of flocculation.

s of conditioning was obtained. The flocculated slurry was discharged from a 1-1/4-in hose into a 40-ft sloping trough. The laboratory setup for this test is shown in figure 3.

The results of the laboratory tests were very encouraging. The coal waste flocculated to a cottage cheese consistency with a dosage of 1.5 to 2.0 lb of polymer per short ton of solids, and clear water was liberated. The success of the two 50-gal laboratory tests greatly increased the confidence level for a successful full-scale field treatment.

EQUIPMENT

Reducing or minimizing waste disposal costs is a major goal for most coal mining operations. The equipment for the flocculation system was selected to minimize labor costs and to prevent polymer waste through overtreatment. The equipment consisted of (1) a 300-gal neat polymer tank (supplied by mine), (2) a 2,000-gal dilute polymer tank with high- and low-level control probes that provided automatic dilution of polymer, (3) a polymer dilution system consisting of a centrifugal water booster pump, a variable-speed polymer gear pump, and a static in-line mixer, (4) a variable-speed, positive displacement gear pump for dilute polymer injection, (5) a 2-in flowmeter to determine dilute polymer flow rate, (6) a 6-in flowmeter to determine the slurry flow rate, (7) a 6-in nuclear densimeter to determine the slurry specific gravity, and (8) a 4-pen recorder with a built-in math module to record the data and supply a mass flow rate signal to control the dosage injection system. Water was supplied from a 12,000-gal tank provided by the mine. The cost of equipment supplied by the Bureau is shown in table 3.

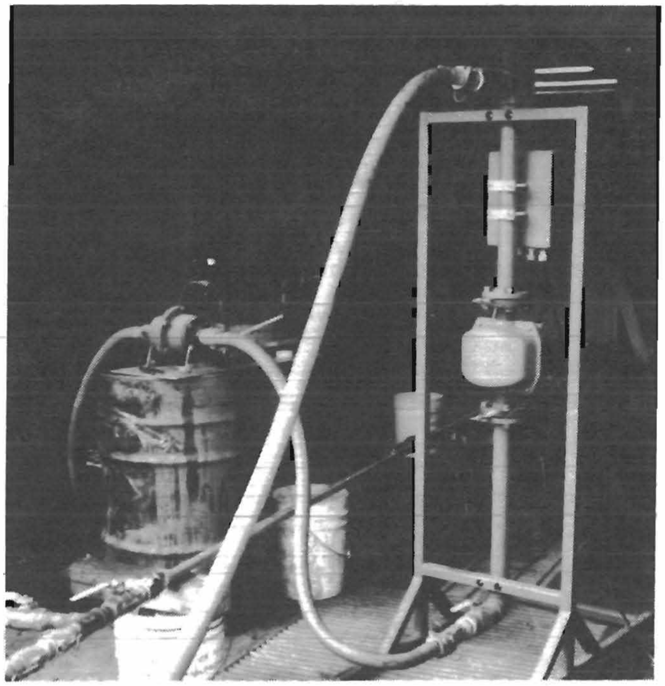

FIGURE 3.—Laboratory setup for 50-gal tests. These tests were conducted to see if the slurry would thicken at expected field flow velocities, and to develop an appropriate conditioning and discharge system.

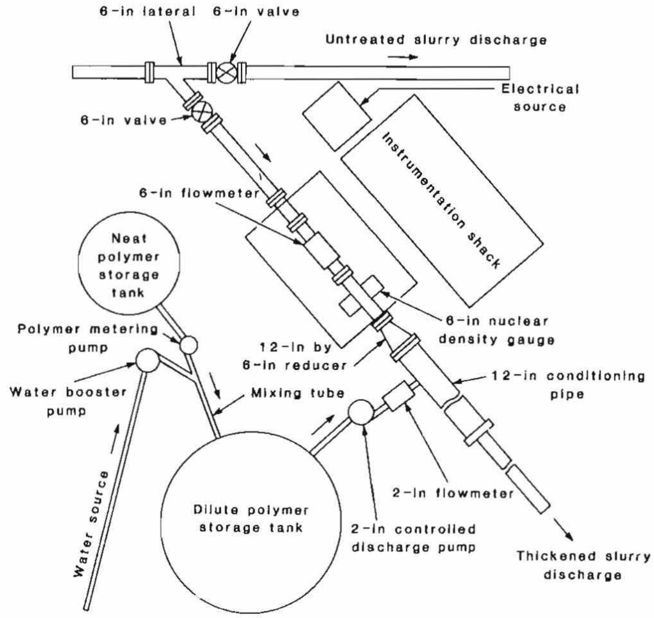

FIGURE 4.—Fine coal waste flocculation system (overhead view schematic).

A schematic of the equipment setup is seen in figure 4. The setup is a two-part system: One part is for automatically diluting the polymer, and the other part is for injecting the desired dosage of dilute polymer into the slurry. After calibrating the variable-speed neat polymer pump, the neat polymer was diluted with water and pumped to the 2,000-gal tank. When the dilute polymer reached the high-level probe in the tank, the neat polymer pump and the water booster pump automatically shut off. When the dilute polymer cleared the low-level probe, the neat polymer and water booster pumps automatically came on, refilling the dilute tank. The rate of fill was about 40 gal/min.

The second part of the system pumped the dilute polymer at the required dosage into the slurry. The dilute polymer was injected into the slurry at an average rate of 16.8 gal/min, providing a continuous slurry treatment. The dilute polymer flow rate was calculated based on the required dosage and the slurry steady state mass flow rate. The dilute polymer was pumped through a 2-in flowmeter, and the controller of the variable-speed dilute polymer pump was manually adjusted until the required pump rate was reached.

TABLE 3. - Equipment costs for the flocculation system

Item	Supplier	Approx. cost (1984)
Positive displacement pump; variable-speed motor.	Nalco......	$3,355
Polymer dilution system..........	Furrow.....	3,715
2,000-gal polymer tank...........	...do......	1,830
6-in nuclear densimeter..........	Ohmart.....	3,448
6-in flowmeter...................	Foxboro....	4,716
2-in flowmeter...................	...do......	3,530
4-pen recorder...................	Chessel....	6,260
Various pipes, reducers, etc.....	....	3,907
Total cost, equipment....................		30,761

When the controller of the dilute polymer pump was placed in the automatic mode, the mass flow rate signal would control the speed of the pump. The mass flow rate signal was calculated automatically by the math module in the recorder from signals provided by the 6-in magnetic flowmeter and nuclear densimeter. These two pieces of equipment continuously measured the flow rate and specific gravity of the slurry. By this method, as the mass flow rate of the slurry decreased or increased, the speed of the dilute polymer pump (amount of dilute polymer) decreased or increased accordingly. At no time would the system pump more than the required polymer dosage while in the automatic mode. The 4-pen recorder continuously plotted the dilute polymer flow rate, slurry flow rate, slurry specific gravity and mass flow rate.

The test equipment was wired, calibrated, and tested in the laboratory before going to the field. Water was used as the medium for calibration. The 6-in flowmeter and nuclear densimeter were mounted on a 6-ft section of slurry pipeline placed at a 45° angle from horizontal inside a utility trailer. This insured full pipe flow across the instrumentation. The electronic cabinets were also mounted inside the trailer, and the instruments were wired to a math module of the recorder. Next, the high- and low-level probes in the dilute polymer tank were wired to the controller of the polymer dilution system. The probes were tested to make sure the dilution system turned off when the tank was full and started up when the tank emptied.

The final step in laboratory testing and calibration of the system was to wire the dilute polymer pump to the math module of the recorder. When this was completed, two drums of dilute polymer were mixed and water was circulated at a known flow rate through the 6-in flowmeter and nuclear densimeter. The dilute polymer pump (in the automatic mode) then began to circulate the dilute polymer from one drum, through the 2-in flowmeter, and back to another drum. During this process, the 6-in flowmeter and dilute polymer pump were calibrated and the nuclear densimeter was zeroed. To simulate slurries of higher specific gravity than water, false signals were manually set in the electronics cabinet of the nuclear densimeter. This increased the mass flow rate which in turn automatically increased the dilute polymer pump speed. In this manner, the system was tested and calibrated at several different flow rates and slurry densities.

FIELD TESTS AND RESULTS

After the equipment was set up and field calibrated, slurry treatment began. During the initial testing (September 13-14, 1984), the slurry did not flocculate as expected. The slurry thickened, but not nearly as well as had been observed in the laboratory. The finest particles were not being flocculated. Several attempts were made to improve flocculation, including (1) manually adjusting the dilute polymer flow rate, (2) reducing the flow rate of slurry, (3) circulating the neat polymer prior to dilution, (4) increasing and decreasing the concentration of dilute polymer, (5) reducing downstream flow of treated slurry after discharge, and (6) moving the discharge pipe to flatter ground. None of these improved the thickening of the slurry. It was also noted that during manual adjustment of the dilute polymer flow rate, the slurry, with polymer dosages of 1.5 and 2.0 lb/st, contained polymer strings, indicating excess polymer in the slurry; at a dosage of about 1.0 lb/st, the slurry appeared thicker. This contradicted laboratory results.

In discussing the problem with the preparation plant manager, it was discovered that the mineralogy of the coal waste changes depending on the coal seams being mined. Thus, samples that had been tested in the laboratory were probably different from those encountered during the field test. A representative of the chemical supplier and the preparation plant manager suggested adding a small amount of neat cationic polymer (Nalco 8852) to the treated slurry at discharge. This vastly improved slurry flocculation yielding results similar to those observed in the laboratory (without cationic polymer). A 5-gal plastic jug was fitted with a valved copper tube to trickle the cationic polymer into the treated slurry at discharge. After observing the treated slurry, the amount of cationic polymer required was manually adjusted.

During the last 5 days of testing (September 17-21, 1984), a total of 967,258 gal slurry containing 1,501.7 st solids was treated with 1,786.9 lb anionic polymer and 566.8 lb cationic polymer. The valving system (fig. 4) was used to control or change the slurry flow rate. During this period, the flocculation system was tested successfully at flow rates between 498.8 and 675.4 gal/min and at specific gravities between 1.15 and 1.33. Prior to the last 5 days of testing, slurry flowing as low as 400.0 gal/min was thickened; however, at this flow rate, the nuclear densimeter tended to plug because of solids settlement. The field test operation data for the last 5 days of testing are shown in table 4. The cost of the anionic and cationic polymers were \$0.84/lb and \$0.56/lb, respectively. Total polymer costs for the last 5 days of testing were \$1,820.00, or \$1.21/st solids.

During the last 5 days of testing, the slurry mass flow rate was continuously recorded before treatment. This allowed an accurate average determination of solids content, by weight, in the untreated slurry. After treatment and discharge, samples of the consolidated material were collected from the test site at various times, locations, and depths. Five samples were collected at the surface on September 21, 1984, 18 h after ending treatment on September 20. One sample was taken at the surface 5 min after ending treatment on September 21. Five samples were also collected at the surface on September 24, 65 h after ending treatment on September 21.

The final sampling was made on November 29, 1984, 68 days after treatment ended on September 21. During the final sampling, a total of 10 samples were taken: The first three samples (at depths of 1, 2, and 3 ft) were taken 50 ft downstream from the point of discharge; the next four samples (at depths of 1, 2, 3, and 4 ft) were taken 75 ft from the point of discharge; the next two samples (at depths of 1 and 3 ft) were taken 100 ft from the point of discharge; and the last sample (at a depth of 1 ft) was taken 125 ft from the point of discharge. The final deposition 68 days after the last day of treatment is shown in figure 5. The results of all samples taken are shown in table 5. The fourth column in table 5 represents the total volume (V_T) required to hold slurry containing 1 st solids at the corresponding slurry moisture and solids contents shown in the second and third columns, respectively. The following formulas are used to calculate V_T:

$$W_w = \mu \times W_s\,;\ W_T = W_w + W_s\,;\ V_T = \frac{W_T}{G\gamma_w}$$

TABLE 4. - Field test operation data

Test date (1984)	Total test time, h	Coal waste slurry: Av feed rate, gal/min	Coal waste slurry: Slurry sp gr (av)	Coal waste slurry: Total daily flow, gal	Solids in slurry: Av mass flow rate, st solids/h	Solids in slurry: Total daily solids, st	Neat polymer used, Anionic: Weight, lb	Neat polymer used, Anionic: lb/st solids	Neat polymer used, Cationic: Weight, lb	Neat polymer used, Cationic: lb/st solids
9/17...	4.62	577.6	1.222	159,406	57.5	265.6	307.75	1.16	103.47	0.39
9/18...	4.95	606.3	1.202	180,071	48.3	239.1	298.88	1.25	95.64	.40
9/19...	6.73	594.6	1.218	240,218	53.18	357.9	422.32	1.18	139.58	.39
9/20...	4.42	574.2	1.247	152,163	58.83	260.0	306.80	1.18	114.40	.44
9/21...	6.47	606.7	1.233	235,400	58.60	379.1	451.13	1.19	113.73	.30
Total	27.19	NAp	NAp	967,258	NAp	1,501.7	1,786.88	NAp	566.82	NAp

NAp Not applicable.

FIGURE 5.—View of disposal area 68 days after last day of treatment. Slurry was solid enough to easily support the man's weight.

where W_w = weight of water in slurry (lb),

W_s = weight of solids in slurry (lb) = 2,000 lb,

W_T = total weight of slurry (lb),

μ = moisture content of slurry,

G = specific gravity of slurry,

and γ_w = unit weight of water = 62.4 lb/ft^3.

The data show that polymer treatment rapidly dewaters the slurry and significantly decreases the volume requirement for fine coal waste disposal.

TABLE 5. - Summary of field test results

Sampling date (1984) and time after or before treatment	Moisture content, wt pct	Solids content, wt pct	Total volume (V_T),[1] ft^3/st solids
Prior to treatment:			
9/17	204.9	32.8	80.1
9/18	274.5	26.7	98.4
9/19	233.3	30.0	87.6
9/20	204.9	32.8	80.1
9/21	219.5	31.3	83.9
Average, 5 days	227.4	30.7	86.0
18 h after treatment:			
9/21 (morning)	58.9	62.9	41.8
Do	54.9	64.6	40.7
Do	52.4	65.6	40.1
Do	54.7	64.6	40.7
Do	56.9	63.7	41.2
Average, 5 samples	55.6	64.3	40.9
5 min after treatment: 9/21 (afternoon)	122.0	45.0	58.4
65 h after treatment:			
9/24	57.5	63.5	41.4
Do	55.9	64.1	41.0
Do	54.0	64.9	40.5
Do	53.9	65.0	40.4
Do	53.4	65.2	40.3
Average, 5 samples	54.9	64.5	40.7
68 days after treatment:[2]			
11/29 (1 ft from surface)	22.4	81.7	32.2
Do	17.0	85.5	30.7
Do	38.8	72.0	36.5
Do	28.5	77.8	33.8
11/29 (2 ft from surface)	17.3	85.3	30.8
Do	20.7	82.9	31.7
11/29 (3 ft from surface)	31.6	76.0	34.6
Do	31.7	75.9	34.6
Do	45.2	68.9	38.1
11/29 (4 ft from surface)	34.5	74.3	35.4
Average, 10 samples	28.8	78.0	33.8

[1]See text for definition and calculation method for V_T.
[2]For these samples, "ft from surface" refers to depth at which samples were taken. All previous samples were taken at the surface.

CONCLUSIONS

The laboratory and field experiments indicate that the addition of polymer in the proper dosage has a dramatic and beneficial effect on the coal refuse slurry dewatering process. Polymer treatment could double the solids storage capacity of a waste impoundment. Some coal refuse slurries require pH adjustment up to pH 11 to achieve this effect.[6] As the treated slurry was discharged, an immediate separation of water and solids occurred. The flocculated solids readily settled, and relatively clear water was liberated. Untreated slurry takes much longer to settle, and decant water continues to have a muddy appearance.

It is necessary to add the polymer to the slurry in the pipeline so that 10 to 20 s of thorough mixing can take place prior to discharge. Usually, natural flow turbulence in the pipeline will achieve the mixing. Proper dilution of neat polymer is also important. In the field test, *extreme fluctuation* of slurry specific gravity was encountered. This is common with most fine coal waste streams from preparation plants. Automatic control of the polymer injection as a function of slurry mass flow rate optimizes polymer dosage and prevents overtreatment or undertreatment.

To aid water separation, deposition on a slightly sloping area is advised. A catchment area downstream would be used to intercept the water for recirculation to the preparation plant for coal cleaning and to the polymer system for dilution.

[6]Work cited in footnote 4.

Two laboratory events differed with field events: (1) The anionic polymer dosage requirement in the field was less than in the laboratory, and (2) a cationic coagulant was needed in the field but not in the laboratory. Approximately 6 months lapsed between the time the laboratory sample was collected and the time the field test was performed. Although mineralogical tests were not conducted, the differences between laboratory and field results are believed to be due to mineralogical changes of the fine coal refuse slurry during this time lapse. For this reason, laboratory investigations to determine polymer types, dosages, mixing requirements, etc., must be performed prior to large-scale field application, and polymer treatment may also have to be altered if the slurry properties change with time.

The equipment used to complete the field test was relatively inexpensive and capable of optimizing polymer dosage. The polymer requirements were similar to those required by a belt press or other mechanical dewatering systems. However, the continuous monitoring of the slurry density could result in a more efficient use of polymer, thus reducing the cost. All mines, especially those having a limited waste disposal area, could utilize polymer treatment to aid solid-water separation for the fine waste disposal. By recirculating freed water from the impoundment back to the preparation plant, a given waste disposal area could retain over twice as much solids, thus giving that much more service life.

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