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TECHNICAL REPORT
March 1, 1996, through May 31, 1996

Project Title: **PILOT SCALE SINGLE STAGE FINE COAL DEWATERING AND BRIQUETTING PROCESS**

DOE Cooperative Agreement Number: DE-FC22-92PC92521(Year 4)
ICCI Project Number: 95-1/1.1A-2P
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Project Manager: K. Ho, ICCI

ABSTRACT

The primary goal for this ICCI coal research project is to effectively liberate coal from finely disseminated minerals for Illinois Basin coal by using fine grinding and cleaning processes. However, because of the large surface area generated during the cleaning processes, it is difficult and uneconomic for conventional techniques to dewater the coal fines. In addition, these coal fine pose transportation, storage and handling problems at cleaning and utility facilities.

The objective of this research is to combine dewatering and briquetting processes into a single stage operation that will solve the problems mentioned above. To build on the promising results obtained from the previous studies, a pilot scale commercial briquetting machine was used to evaluate this technique.

The primary objective of the research in this reporting period is to determine the effectiveness of a single stage dewatering and briquetting technique using a commercial briquetting device. Two types of samples were prepared and the results of the -28 x 100 mesh samples are presented in this report. Modifications were made to the machine in an attempt to solve the back drainage problem. A total of six experiments were conducted and the results indicate that water resistance of coal briquettes increased as curing time increased. However, due to a deficiency of fine particles to bridge the gaps between the coarse particles, the wear resistance of the products declined. Also, at high roll speeds and compaction pressures, the coal briquettes produced tended to have higher moisture content and lower strength. On the other hand, at high feed rates, because of the screw extrusion effect, coal briquettes were produced with lower moisture content and higher strengths.

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EXECUTIVE SUMMARY

It is well known that mineral particles, including pyrite, are finely disseminated in the Illinois basin coal in the form of micron size particles. In order to separate mineral matter from coal particles efficiently, the mineral matter must be liberated from the coal matrix by the use of an ultrafine grinding operation followed by a wet physical coal cleaning process (column flotation). Due to the large surface area created by the fine grinding operation, these fine particles entrap a large amount of water after they are recovered from the column flotation process, and make the dewatering of the filter cake much more difficult than moderately ground particles. Moreover, this fine coal creates dust control problems during its transportation and results in storage and handling difficulty at coal-burning utility plants.

In order to overcome the above mentioned problems, efficient dewatering and briquetting of fine coal must be developed at the downstream end of the process, following the coal cleaning process. Continuing on the success of previous research, a commercial pilot scale briquetting machine was used to evaluate the potential of the single stage dewatering and briquetting technique. Two types of samples of Illinois Basin Coal (No. 6 Seam) were used during this reporting period. The 28 x 100 mesh coal has an initial moisture content of 25% while the 100 mesh x 0 coal has a moisture content of 30%. A total of 1,000 pounds of coal-binder mixture were prepared with 500 pounds for each particle size. Due to an electrical problem with the machine, only the 28 x 100 mesh coal samples were tested. The -100 mesh coal samples are currently being tested and test results will be presented in the next report.

The dewatering and briquetting processes were performed using a commercial scale single roll briquetting machine (Komarek Model B-220A). Each roll on the machine contains 24 pockets which produce briquettes that are 2.5 inches long, 1.5 inches wide and 1 inch thick. Several modifications on the machine were made to facilitate the dewatering and briquetting process. Modifications included a new design for the feed hopper drainage system and a new water collecting device. Both modifications helped to improve the primary stage dewatering and ensure the moisture content consistency of the feed material. Briquettes were produced under various roll speeds ranged from 2.8 to 6.3 rpm with compaction pressure settings ranging from 6,007 to 7,484 psi. A total of six experiments were performed using 28 x 100 mesh coal samples with a binder concentration of three percent.

Water absorption tests were carried out after 8, 16, 24 and 32 hours of curing time. The objective of this test was to evaluate the water resistance of the product. Briquettes were submerged in water for 24 hours after designated curing periods. The amount of water gained was used as a measurement for evaluating the water resistance of the briquettes. Results from this reporting period further substantiated the fact that curing time is needed for water to evaporate when bitumen emulsion is used as binding agent. The moisture content of briquettes decreased from 16% with no curing time to less than 5% after 32 hours of curing. Furthermore, after 24 hours of submersion of the briquettes in water with 32 hours of curing, the moisture content of the product was about 9%. Comparing this result to eight hours of curing time, the moisture content of briquettes after 32 hours of curing was about

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7% less than those cured for only eight hours.

Results also indicated that briquettes that were cured for longer times absorbed less water than those that had less curing time. Also, it was observed that the feed screw speed also plays an important role in the quality of the briquettes. At high feed speeds, the screw extrusion effect of the screw feeder squeezes out more water from the coal-binder mixture than at lower speeds. When considering the briquetting roll speed, due to the limited compaction time, the moisture content of briquettes increased as the roll speed increased. As expected, products that were formed at higher pressures tended to have lower moisture contents, even though the curing time may be longer, however the difference is insignificant.

The objective of the tumbling, drop and shatter tests were to assess the relative friability of the dewatered coal briquettes. Tests were conducted on samples that were cured for 0, 8, 16 and 24 hours. These technique provides a means of assessing the likelihood of briquettes to break into smaller pieces when subjected to repeated handling during transportation and storage at utility plants. Results indicate that as the curing time increased, the amount of weight loss (-6 mesh x 0) increased dramatically. With the exception of run No. 3, there was an average increase of 10% in weight loss for tumbling tests as the curing time increased from 8 hours to 32 hours. Also, briquettes that were formed at higher roll speeds and compaction pressures tended to have lower strength. For run No. 1, briquettes were made at a roll speed of 2.8 rpm with a compaction pressure of 6,722 psi while for run No. 2, the values were 3.8 rpm and 7,484 respectively. On average, briquettes from run No. 1 had 10% less in weight loss for tumbling tests and a 2 % difference in the drop shatter tests. The lack of fines in the sample is responsible for these trends. Fine particles provide better bonding by filling the gaps between the coarse coal particles and thus increase the overall strength of the briquette. However, at high feed rates, the lower moisture content of the feed material provides a more efficient packing during compaction stage; thus increasing the strength of the products.

A total of thirteen experiments are currently being conducted on -100 mesh x 0 coal samples. A statistical design software was employed to design the experimental matrix. On completion of these tests, the experimental results will be fed back into the software and optimal operating conditions will be determined.

OBJECTIVES

The objective of this research project is to combine fine coal dewatering and briquetting processes into a single stage operation which involves the utilization of a hydrophobic binder as the dewatering and briquetting agent, and a compaction device. A pilot scale commercial briquetting machine was used to determine the effectiveness of this single stage dewatering/briquetting technique.

INTRODUCTION AND BACKGROUND

Fine coal cleaning techniques, such as column flotation, can effectively liberate coal from finely disseminated minerals. However, products from these processes possess large surface areas in which conventional dewatering techniques cannot be effectively applied. Therefore, a new dewatering technique is needed in order to take full advantage of these fine coal cleaning techniques.

The development of a single stage fine coal dewatering and briquetting technique is the primary objective of this research. Previous research has proven the potential of fabricating briquettes that satisfy the fine coal handling, transportation, and storage requirements using both laboratory and pilot scale models. Research conducted in this reporting period is focused on the effectiveness of this technique using a commercial scale briquetting machine. Several modifications were made to the briquetting machine to facilitate water drainage and collection.

EXPERIMENTAL PROCEDURES

1. Sample Preparation:

a. Coal Sample:

Illinois Basin Coal (No. 6 Seam) of two different size ranges were used in this reporting period. The -28 x 100 mesh coal had an average moisture content of 25% while the -100 mesh x 0 coal fines had an average moisture content of 30%. The size distribution of the coal samples are shown in Figure 1.

b. Coal-Binder Mixture Preparation:

Orimulsion was the binding agent used for this dewatering and briquetting process. Orimulsion contains 65 to 70 percent of solid bitumen and 30 to 35 percent of water. When preparing the Orimulsion, three percents of bitumen (by weight of dry coal) was diluted with water for both 28 x 100 mesh and 100 mesh x 0 coal samples. A small scale muller mixer was used to mix the diluted Orimulsion with each coal sample for five minutes. The batch type muller mixer (see Figure 2) is capable of mixing 70 pounds of coal at a time. The final coal-binder mixtures had an average moisture content between 32 and 34 percent. A total of approximately 1000 pounds of coal-binder mixtures were prepared for testing. In this reporting period, about 450 pounds of the 28 x 100 mesh coal-binder mixture was consumed. This report is based on the experimental results of this batch while work is still in progress for the 100 mesh x 0 samples that were collected from Southern Illinois University, Carbondale. However, results from the -100 x 0 coal fines will be given in the next reporting period.

2. Briquetting Process:

The K. R. Komarek briquetting machine, Model B-220A, which was used in the last reporting period, was used again for all experiments. Modifications were made at the feed hopper to facilitate water drainage while a new sample collecting system was also installed. Detailed descriptions of each modification will be given in later sections of the report. The coal-binder mixture was fed into the roll press by a horizontal screw which runs at speeds ranging between 78 and 120 rpm. The sample was then compacted between the two rolls within the confine of the pockets. Each roll contains 24 pockets, is three inches wide and 12 inches in diameter. Each pocket produces a coal briquette that measures at 2.5 inches long, 1.5 inches wide and 1 inch thick. Briquettes were produced under various roll speeds (2.5 to 4.5 rpm) with the compaction pressures ranging from 6,000 to 7,000 psi. A total of six experiments were performed for this sample. Detailed experimental conditions are listed in Table 1.

3. Dewatering Mechanism:

During the briquetting process, the coal-binder mixture undergoes two stages of dewatering in the process. In the feeding process, the horizontal screw feeder pushes the coal-binder mixture into the roll press. Due to the feed screw extrusion effect, water is expelled from the mixture at the pre-densification zone, prior to the compaction stage. At the second stage of dewatering, the coal-binder mixture is compacted between two rolls that rotate against each other under high pressure. The remaining water in the feed material iss then squeezed out of the mixture as the briquette is formed.

4. Evaluation of Fine Coal Dewatering And Briquetting Efficiency:

a. Moisture Content Determination of Dewatered Coal Pellets:

Moisture content of the pellets is determined at several stages of the experiment. The initial weight of the pellet was measured immediately after they were fabricated. To determine the initial moisture of the pellets, they were placed in an oven at 110°C for at least 24 hours. The pellets were reweighed periodically until they reached a constant weight. The moisture content was then determined by the following equation:

$$\%Moisture = \frac{(Wi - Wd)}{Wi} * 100\%$$

where Wi is the initial weight of the pellets, and Wd is the dried weight of the pellets. Moisture content at different stages of the experiment follow a similar procedure to that described above.

b. Water Absorption And Curing Tests:

The water absorption test determines the effect of the binder on the water resistance of the coal briquettes with respect to different curing times. In the absorption test, briquettes were place under water for 24 hours after being exposed to atmosphere for a pre-determined curing period. For this reporting period, absorption tests were conducted at curing periods of 0, 8, 16, 24 and 32 hours, starting with an initial moisture of 17 %. The percentage weight gained after 24 hours under water was used to evaluate the water resistance of the coal pellets. For the curing test, coal pellets were weighted after being exposed to air for 8, 16, 24 and 32 hours. Samples were then dried in the oven and the moisture content of each pellet was determined.

c. Tumbling Test:

The tumbling test evaluates the abrasion resistance of the coal briquettes. The test procedure in this project was derived from the ASTM Standard Test D441-45 named "Tumbler Test for Coal." After predetermined curing times, ten briquettes were placed in a tumbler rotating at a speed of 60 rpm for 6 minutes. The briquettes were then re-weighed and the percentage of weight loss (- 6 mesh x 0) was calculated and used as an index to evaluate the abrasion resistance of the pellets.

d. Drop And Shatter Test:

The drop and shatter test also determines the strength and friability of the coal pellets. The test procedure in this project was derived from ASTM Standard Test D-440. After predetermined curing times, pellets were released from a height of 1 meter and allowed to fall and impact on a concrete floor. Broken pieces of the samples were recovered and the weight loss (- 6 mesh x 0) was determined.

RESULTS AND DISCUSSION

1. Effects of Curing Time on Moisture Content of Briquettes

A total of six sets of experiments were performed on the Illinois No. 6 coal (-28 +100 mesh). Coal briquettes weight between 40 to 60 g each with a specific gravity of 1.21 to 1.73. The initial moisture content of the product was on average, 16%. As shown in Table 2, after 8 hours of curing the moisture content decreased dramatically from 8.64% to 14.43%. As proven in earlier research, the moisture content continued to drop as the curing time increased. After 32 hours of curing, the briquettes had an average moisture content of 4.72%. It is believed that the hydrophobicity of the coal-binder mixture that caused the moisture to evaporate more easily, and thus dramatically reduce the briquettes' moisture content as curing time increased.

A similar trend was discovered in terms of water resistance tests. For samples that had been cured for eight hours, there was an average increase of 4.5% in moisture after they were submerging in water for 24 hours. However, after 32 hours of curing and 24 hours under water, the average moisture content was reduced to 8.89% with an increase of 4.15%. Therefore, it is obvious that the hydrophobicity of the mixture not only allows water to escape from the briquettes more easily, but also prevent water to reenter the briquettes.

2. Effects of Curing Time on the Strength of Briquettes

Tumbling, and drop and shatter tests were used to determine the strength, abrasion resistance and friability characteristics of coal briquettes. In the tumbling test, the amount of weight loss increased as the curing time increased. As shown in Table 2, the tumbling weight loss for coal briquettes after 32 hours of curing time were generally 10% higher than coal briquettes that had only been cured for 16 hours. In this short period of curing, the remaining amount of moisture within, acts as the bonds between coarse particles. However, as the water evaporates, the voids that were occupied by water become gaps between particles; thus reducing the strengths of the briquettes. As discussed in earlier report, the lack of fines bridging the gaps between coarser particles is believed to be the major cause of a high percentage of weight loss for all the experiments. Fine particles act as the filler of the gaps between coarser particles, and provide better bonding between particles, as with the tumbling test, the results of the drop and shatter test also illustrate the importance of fine particles within the briquettes. The average weight loss for briquettes in this test also increased as the curing time progressed. This effect was particularly noticeable for run No. 1 which rose from 4.2% weight loss after 8 hours of curing to 13.4% after 32 hours of curing. The absence of fine particles creates internal flaws or fractures as the water leaves the briquettes. Upon impact with a hard surface, these internal fractures propagate and shatter the pellets.

3. Effects of Feed Screw Speed on Briquette Characteristics

Four different feed screw speeds, 78, 90, 117 and 120 rpm were used to feed the coal-binder mixture into the briquetting machine. Results from the experiments suggest that the moisture content of the briquettes decreased as the feed screw speed increased. For run No. 2, the feed screw was operating at a speed of 78 rpm, and 90 rpm for run No. 3. After eight hours of curing, briquettes from run No. 2 had a moisture content of 14.4% while products from run No. 3 had a moisture content of 12.6%. This could be explained by the feed screw extrusion effect that serves as the first stage of the dewatering process. As the speed of the feed screw increases, more material is packed and exerts more pressure at the pre-densification zone. Therefore, more water is squeezed out of the feed due to increasing pressure; consequently, briquettes with lower moisture content are produced.

Besides moisture content, the feed screw speed also has an impact on the strength of the product. The abrasion resistance of the briquettes increased as the feed screw speed increased. After 32 hours of curing, samples from run No. 2 had 56.8% weight loss in the tumbling test and 10.8% weight loss in the drop and shatter test, while run No. 3 had 48.8% and 6.63% respectively. These test results indicate that the reduction of moisture in the feed material allows the coal-binder mixture to be packed more efficiently; thus provides a better bond between coal particles.

4. Effects of Roll Speed on Briquette Characteristics

There were four different roll speeds used in the experiments, namely 2.8, 3.8, 4.1 and 6.3 rpm. For coal briquettes made at various roll speeds, and the moisture content and saturation test moisture was gradually increased as the roll speed increased. These results are consistent with previous research findings. Briquettes were subjected to lower residence time inside the pocket due to the increasing speed of the roll, therefore less water was expelled from the mixtures. However, for longer curing times, the difference in moisture content was insignificant.

The roll speed also plays an important role in terms of briquette strength. For coal samples that had been cured for 32 hours, experimental results indicated that the amount of weight loss in both tumbling and drop and shatter test increased as the roll speed increased. The lesser compaction due to lower residence time in the pocket explains this trend.

5. Effects of Pressure on Briquette Characteristics

The applied pressure during the briquetting process ranged from 6,007 psi to 7,484 psi. Results indicate that the compaction pressure has tremendous impact on both the strength and moisture content of the products. Briquettes made at higher pressure tend to have lower moisture content, but also lower strength. After 8 hours of curing, briquettes made from run No. 3 (6,007 psi) had a moisture content of 12.6% while for run No. 4 (6,722 psi) a lower value of 8.6% resulted. This could be explained by the fact that more water was being squeezed out when subjected to higher pressure; thus reducing the moisture content of the product.

In terms of the strength of briquettes, the weight loss for run No. 3 was 48.8% by the tumbling test and 6.63% by the drop and shatter test. For briquettes that were made at higher pressure (run No. 4), the weight loss increased to 54.9% and 13.5% respectively. At higher compaction pressures, the internal flaws or shearing fracture tend to propagate; thus reducing the overall strength of the briquettes. Therefore, it is important to optimize the compaction pressure in order to produce briquettes that have low moisture content and high strength.

WORKS IN PROGRESS

1. Modifications of Komarek Model B220-A Briquetting Machine

During the last reporting period, several drainage problems were observed during the experiments. Because of the screw extrusion effect, water was squeezed out of the coal-binder mixture at the pre-densification zone. The expelled water drained back into the hopper and increased the initial moisture content of the subsequent feed. Modifications were made in this reporting period in an attempt to eliminate these problems. As shown in Figure 3, the solid plate bottom of the hopper was replaced by three layers of wire screens and a layer of coarse coal. The installation of the screens improved water drainage of the hopper; thus maintaining a consistent moisture content of the feed material. Due to the large amount of water being expelled from the hopper during past experiments, a new water collecting system was installed at the bottom of the feed hopper (Figure 4). This system consisted of two individual troughs that overlaid each other. The installation of the troughs is an attempt to collect the expelled water for analysis. The water analysis includes biochemical oxygen demand test (BOD), dissolved oxygen test (DO), heavy metal concentration determination and pH determination.

2. Experiments on - 100 Mesh x 0 Illinois Basin No. 6 Seam Samples

Thirteen experiments are currently in progress using -100 mesh x 0 coal samples. As mentioned in the earlier section, the coal-binder mixture for these samples have a binder concentration of 3% and initial moisture of 32%. A statistical design software was used to create a design matrix for statistical analysis. The matrix was based on the central composite design with no blocking involve. The experimental results will be reported in the next progress report.

3. Proposed Pilot Scale Circuit of Single Stage Dewatering/Briquetting

In order to simulate the overall coal cleaning process, a pilot scale circuit of the single stage dewatering and briquetting process is proposed. The circuit, shown in Figure 5, consists of a batch muller mixer, coal-binder hopper with a horizontal screw feeder, an inclined screw conveyor with gravity discharge and the Komarek Model B220-A briquetting machine. 70 pounds of coal with pre-determined amounts of Orimulsion will be mixed in the muller mixer and discharged into the hopper. The horizontal screw transfers the mixture to an inclined screw conveyor which discharges the feed material into the feed hopper of the briquetting machine. In addition, expelled water will be collected for water treatment analysis. This circuit will simulate a continuous process in a coal processing plant.

CONCLUSIONS

1. Two types of Illinois Basin No. 6 Seam samples were prepared in this reporting period. However, due to an electrical problem with the briquetting machine, only the results from the 28 x 100 mesh samples were reported.

2. Curing time has a significant impact on both moisture content and water resistance of the coal briquettes. As the curing time increases, the hydrophobic nature of the coal-binder mixture not just promote the evaporation of water, it also prevents the re-entry of moisture to the briquettes.

3. As discussed in the last report, the presence of fine particles to bridge the gap between coarser particles is important to the strength of the product. Due to the lack of fines in the -28 x 100 mesh coal, the briquettes exhibit a high percentage weight loss in both tumbling and drop and shatter test.

4. During the feeding process, the screw extrusion effect expels water from the feed material. As the speed of the feed screw increases, more materials are packed at the pre-densification zone. Consequently, higher pressure is exerted onto the feed and more water can be rejected, and thus products with a lower moisture content are produced.

5. Besides moisture content, the strength of the briquettes are also benefited from higher feed screw speed. The increasing amount of rejected water due to a higher feed screw speed reduces the gap between coarser particles and allows better bonding between the particles; thus improving the strength of briquettes.

6. The moisture content of briquettes is affected by the roll speed. As the roll speed increases the residence time of coal-binder inside the pocket is reduced and less amounts of water are squeezed out during briquetting. However, for longer curing times, the difference in moisture content is insignificant.

7. Roll speed also plays an important part in terms of the strengths and abrasion resistance of the product. A short compaction time during briquetting results in a decrease in strength

as the roll speed increases.

8. The moisture content of a briquette decreases as the compaction pressure is increased. This can be explained by the fact that more water is expelled when subjected to higher compaction pressures.

DISCLAIMER STATEMENTS

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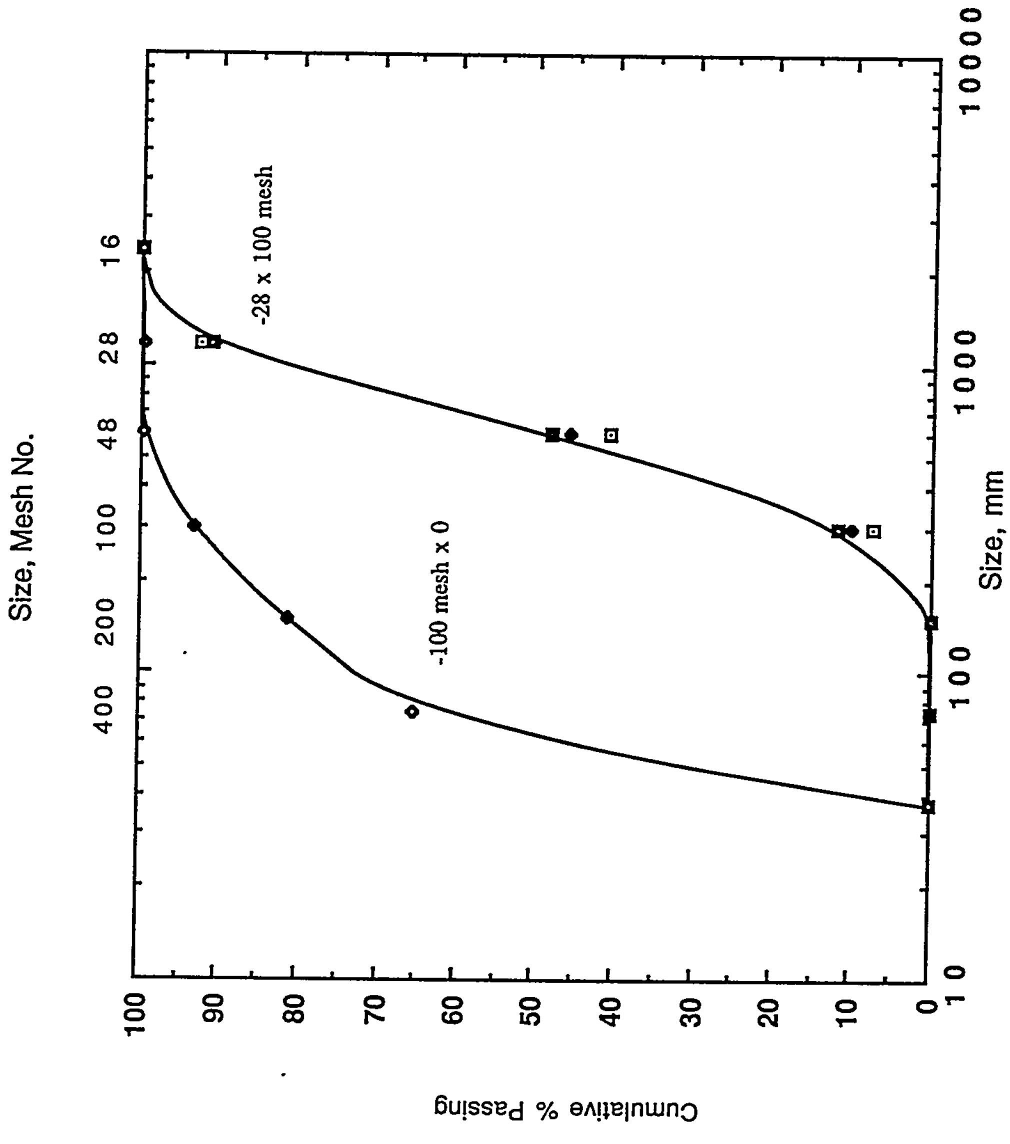

Figure 1. Size Distribution of Illinois No. 6 Seam Sample.

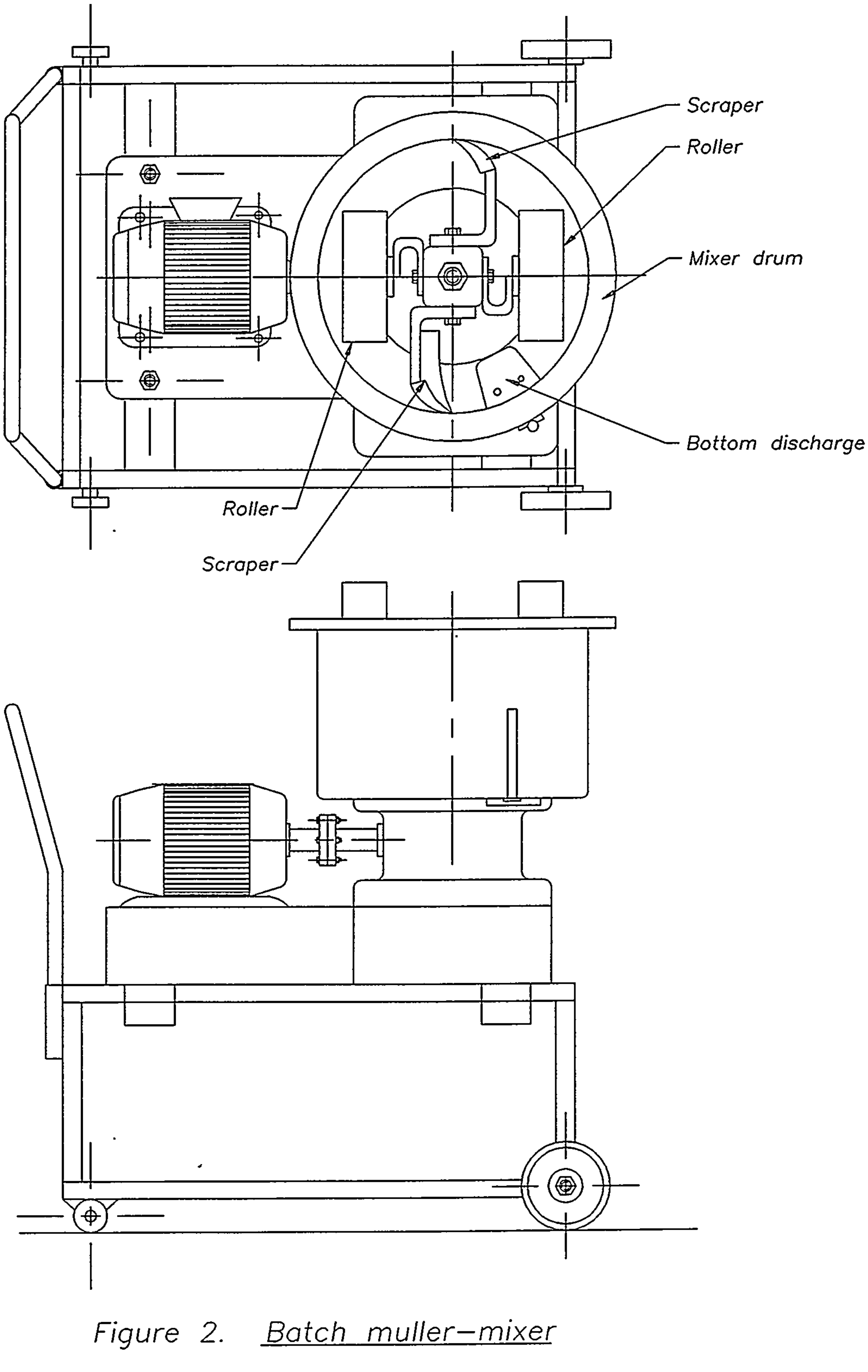

Figure 2. Batch muller–mixer

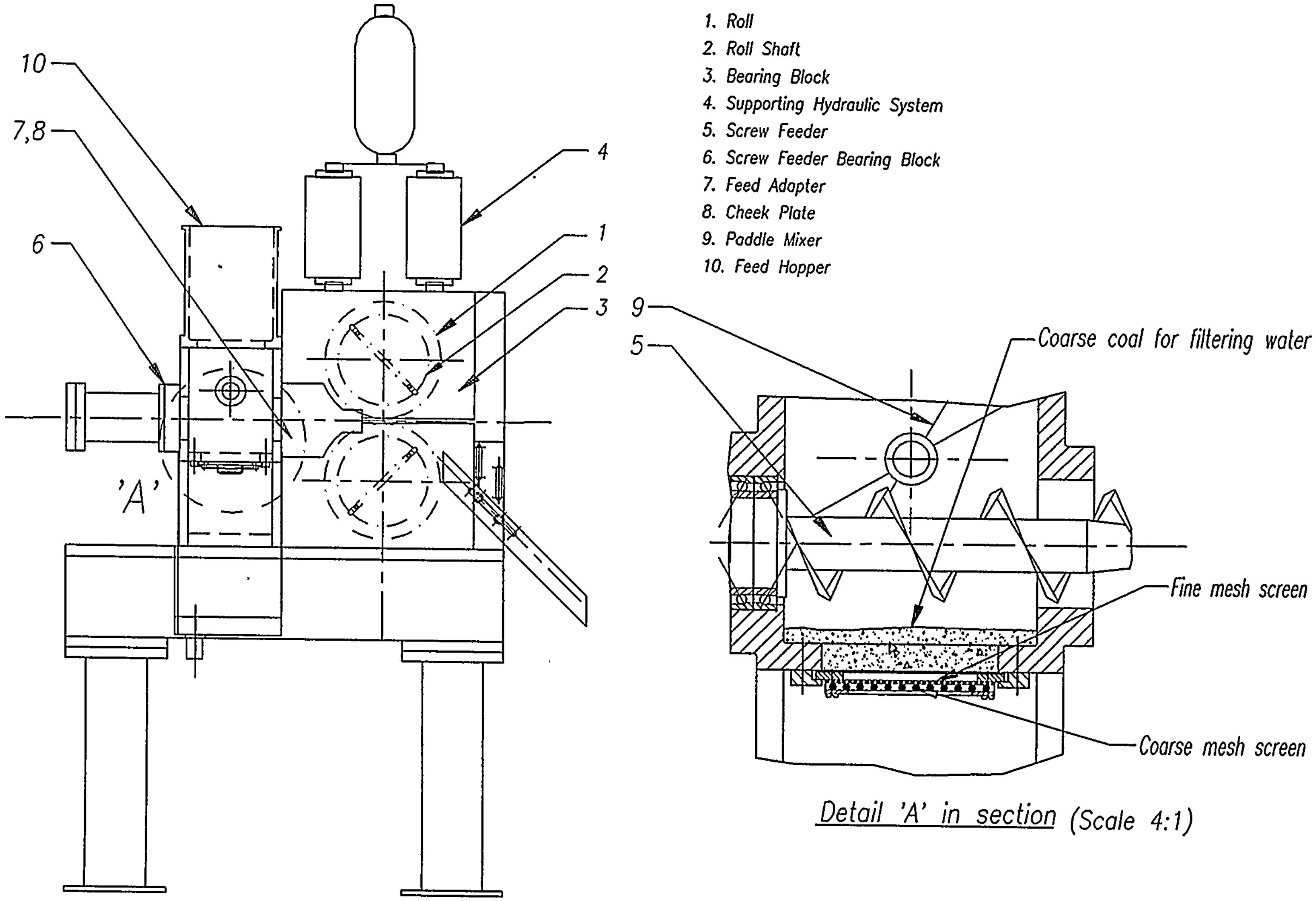

Figure 3. Modification of feed hopper

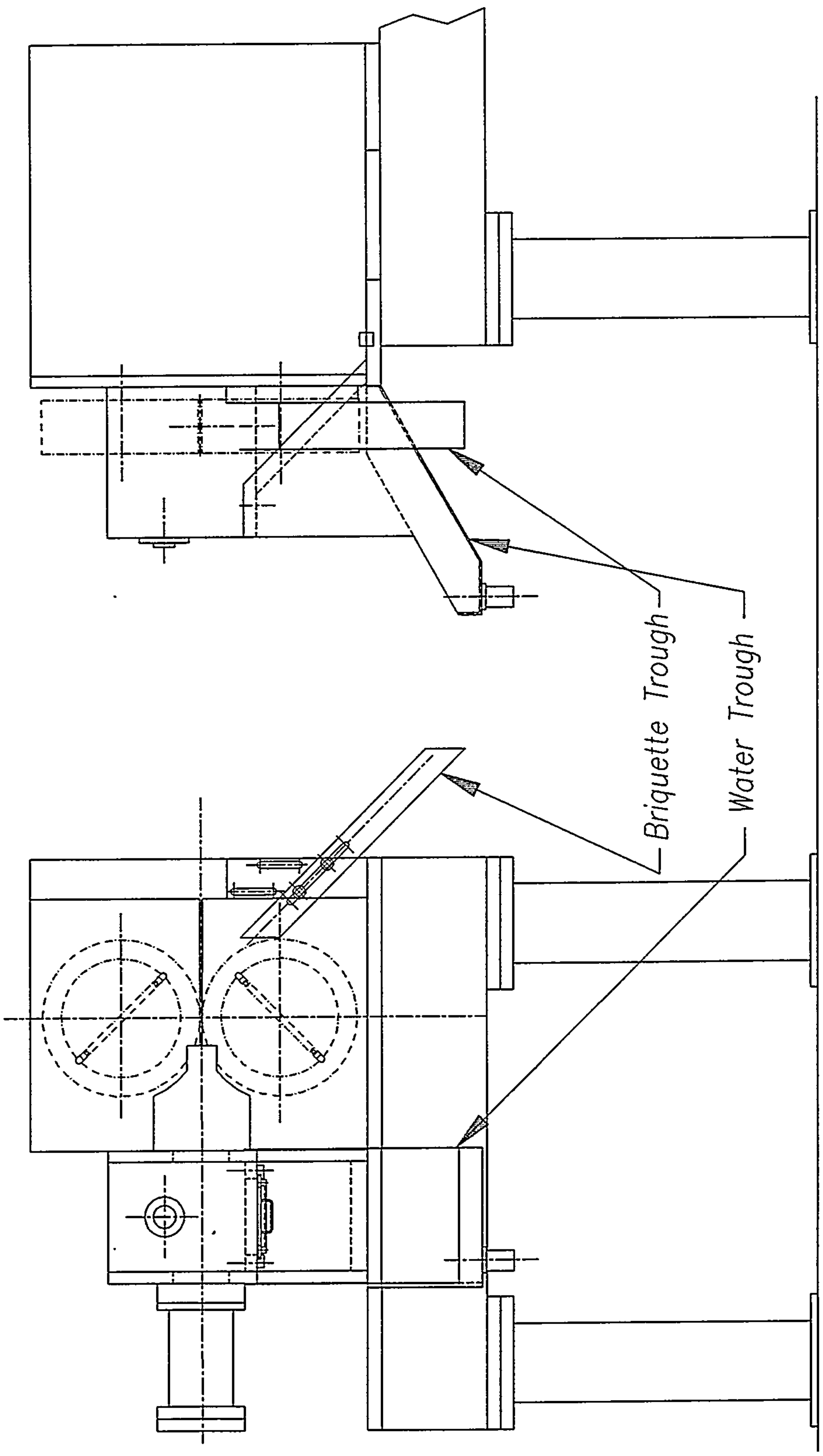

Figure 4. Newly installed water collecting system

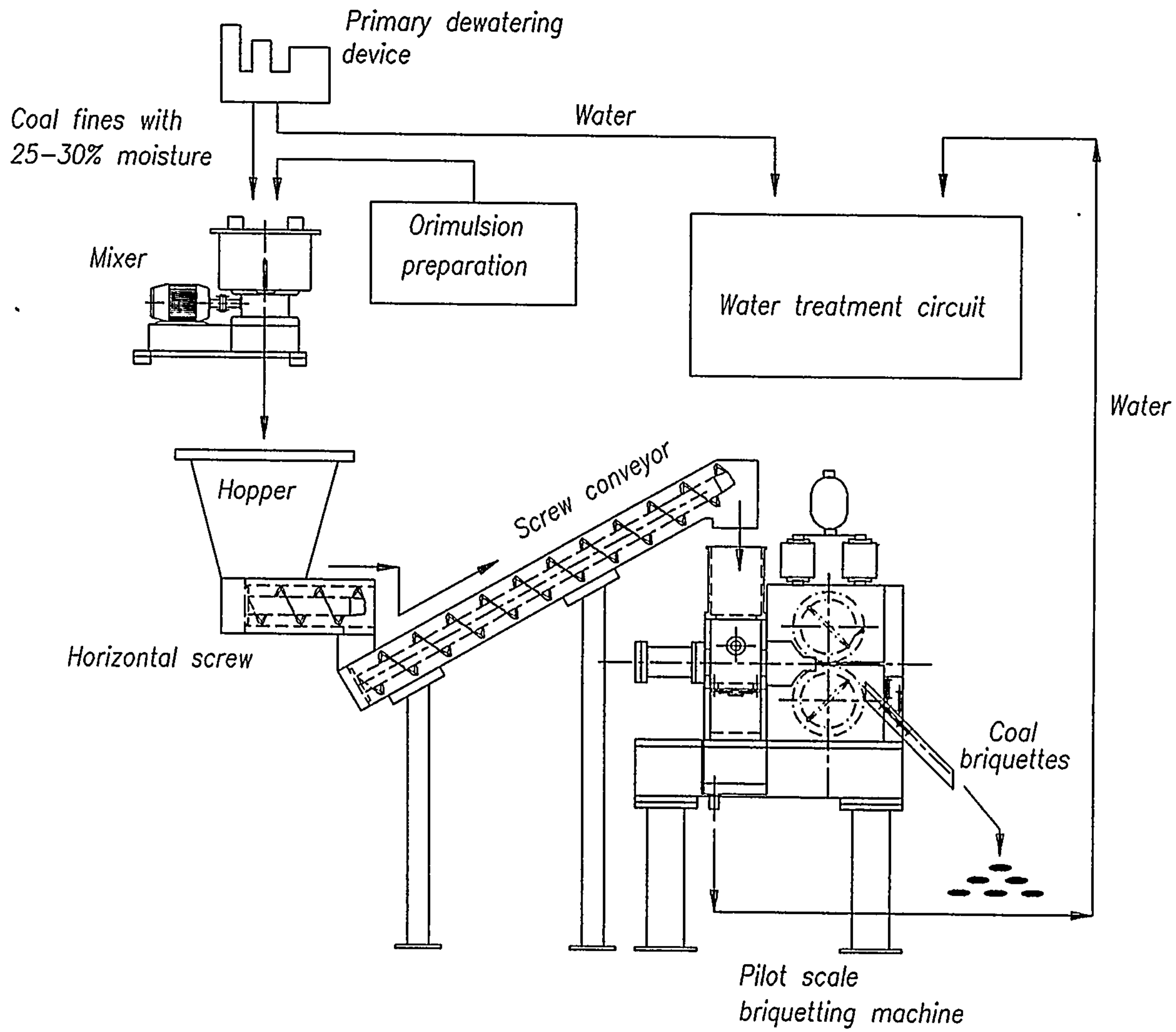

Figure 5. Proposed pilot scale circuit of single stage dewatering/briquetting process

Table 1. Test Conditions for Illinois No. 6 Coal Seam for Briquetting Experiments

Conditions: Komarek Model B220-A Briquetting Device
Illinois No. 6 Coal Seam
28 mesh x 100 mesh particle size

Run Number	Feed Moisture, %	Roll Speed, rev/min	Feed Screw Speed, rev/min	Briquette Form Pressure, psi	Briquette Net Prod. Rate, t/hr
1	32.80	2.8	78	6,722	0.157
2	34.30	3.8	78	7,484	0.218
3	33.04	3.8	90	6,007	0.341
4	34.27	3.8	90	6,722	0.218
5	33.14	4.1	120	6,007	0.240
6	34.14	6.3	117	6,722	0.358

Table 2. Summay of Briquetting Experiments for Illinois No. 6 Coal

Conditions: Komarek Model B220-A Briquetting Device
Illinois No. 6 Coal Seam
28 mesh x 100 mesh particle size

Run Number	Binder Concentration, %	Curing Period, hrs	Cured Moisture Content(1), %	Saturated Moisture Content(2), %	Wt. Loss 6-min.(3), %	Wt. Loss 1-m drop(4), %
1	3	8	12.52	17.07	N/A	6.53
1	3	16	8.30	13.36	34.55	4.78
1	3	24	7.18	12.49	45.51	7.15
1	3	32	4.71	8.95	47.38	8.89
2	3	8	14.43	20.29	N/A	11.09
2	3	16	9.10	15.13	43.56	2.06
2	3	24	8.48	15.09	49.54	7.15
2	3	32	5.65	9.82	56.81	10.84
3	3	8	12.59	16.82	N/A	2.48
3	3	16	9.01	14.06	46.01	1.66
3	3	24	6.76	11.21	46.39	4.95
3	3	32	4.70	8.75	48.78	6.63

(1) Cured Moisture Content, % : Moisture content after pre-determined curing period.
(2) Saturated Moisture Content, % : Moisture content after 24 hours of submerging in water.
(3) Wt. Loss 6-min, % : Weight loss after 6 minutes of tumbling test.
(4) Wt. Loss 1-m drop, % : Weight loss after drop and shatter test at height of 1 meter.

Table 2 Continued

Run Number	Binder Concentration, %	Curing Period, hrs	Cured Moisture Content[(1)], %	Saturated Moisture Content[(2)], %	Wt. Loss 6-min.[(3)], %	Wt. Loss 1-m drop[(4)], %
4	3	8	8.64	12.69	N/A	4.18
4	3	16	7.07	10.94	45.53	4.65
4	3	24	5.78	9.18	55.29	7.15
4	3	32	4.33	8.64	54.88	10.84
5	3	8	12.67	18.12	N/A	3.14
5	3	16	8.63	14.35	34.16	2.06
5	3	24	7.66	13.15	48.69	8.37
5	3	32	4.93	8.87	53.80	8.96
6	3	8	13.29	16.11	N/A	6.04
6	3	16	6.01	14.06	20.06	3.10
6	3	24	6.94	10.91	38.21	3.98
6	3	32	4.01	8..30	43.55	3.97

(1) Cured Moisture Content, % : Moisture content after pre-determined curing period.
(2) Saturated Moisture Content, % : Moisture content after 24 hours of submerging in water.
(3) Wt. Loss 6-min, % : Weight loss after 6 minutes of tumbling test.
(4) Wt. Loss 1-m drop, % : Weight loss after drop and shatter test at height of 1 meter.

PROJECT MANAGEMENT REPORT
March 1,1996, through May 31, 1996

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Principle Investigator:	J. W. Wilson, Department of Mining Engineering, University of Missouri-Rolla
Other Investigators:	R. Q. Honaker, SIUC-Mining: Y. Ding, UMR-Mining
Project Manager:	K. Ho, ICCI

COMMENTS

The pilot scale briquetting machine, Komarek B-220A, has been leased and tested at UMR. The experiments performed using this machine will be continued throughout the remainder of the project period. Several modifications to the briquetting machine, such as water drainage and collecting systems, have been completed.

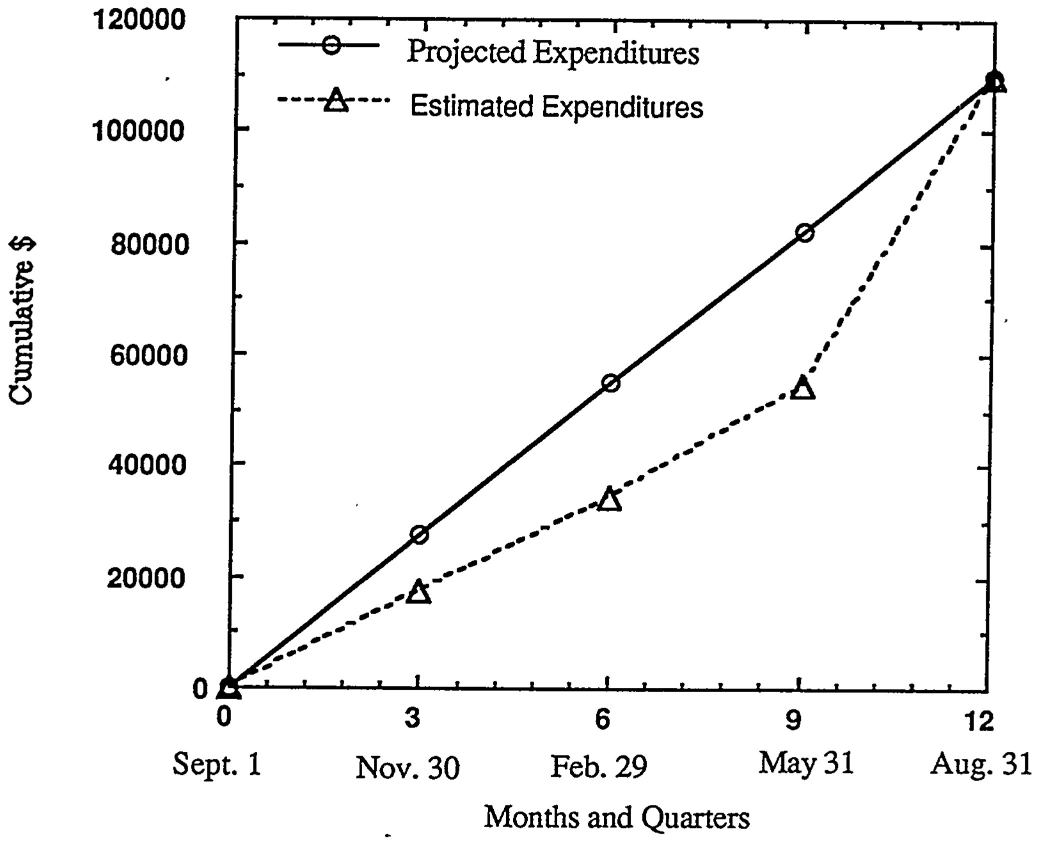
EXPENDITURES - EXHIBIT B

CUMULATIVE PROJECTED AND ESTIMATED EXPENDITURES BY QUARTER

Quarter*	Types of Cost	Direct Labor	Fringe Benefits	Materials & Supplies	Travel	Major Equip.	Other Direct Costs	Indirect Costs	Total
Sept. 1, 1995 to Nov. 30, 1995	Projected	$15,197.5	$2850.3	$272.5	$500	$ 3,500	$378.5	$4,799.7	$27,498.5
	Estimated	$11,173.0	$1,116.2	$100.00	$1,236.7	$ 0	$450.00	$3,519.0	$ 17,595.1
Sept. 1, 1995 to Feb. 28, 1996	Projected	$30,395.0	$5,700.5	$545.00	$1,000	$7,000	$757.00	$9,599.5	$54,997.0
	Estimated	$20,865.0	$2,803.0	$663.00	$2,284.4	$ 0	$757.00	$6,843.0	$34,215.0
Sept. 1, 1995 to May 31, 1996	Projected	$45,592.5	$8,550.8	$817.5	$1,500	$ 10,500	$1,135.5	$14,399	$82,495.5
	Estimated	$33,560.8	$4,858.7	$681.1	$2,597.5	$1,100.3	$1,135.5	$10,708.4	$54,642.3
Sept. 1, 1995 to Aug. 31, 1996	Projected	$60,790	$11,401	$1,090	$2,000	$14,000	$1,514.0	$19,199	$109,994.0
	Estimated	$60,790	$11,401	$1,090	$3,800	$12,000	$1,314.0	$19,599	$109,994.0

***Cumulative by Quarter**

COSTS BY QUARTERS
Pilot Scale Single Stage Fine Coal Dewatering and Briquetting Process

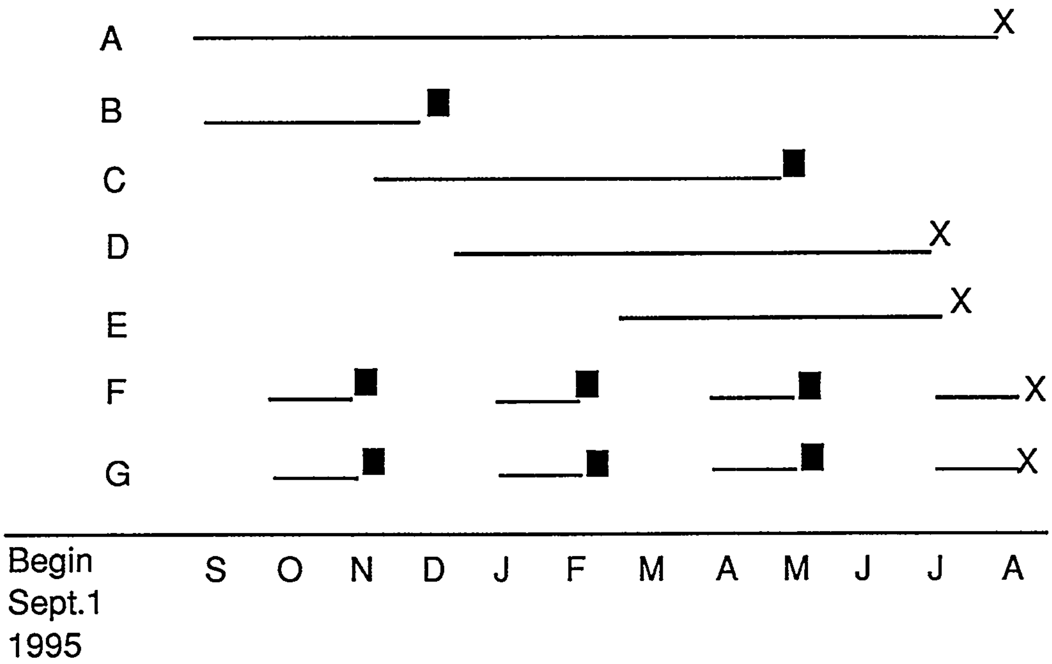


○ = Projected Expenditures ————

△ = Estimated Expenditures — — — —

Total Illinois Clean Coal Institute Award = $ 109,994

SCHEDULE OF PROJECT MILESTONES



Major milestones of the proposed project

A. Research assistant and technician employed.
B. Tests on commercially available pelletizing machines has been completed.
C. Modify the most appropriate commercially available pelletizing machine.
D. Evaluate the operating parameters of the selected commercial pelletizing machine.
E. Collaborate with industry to develop a customized commercial dewatering and pelletizing machine.
F. Technical report prepared and submitted.
G. Project management report prepared and submitted.

Comments:

The modifications to the pilot scale machine, such as water drainage and collecting systems, have been completed. A pilot scale muller mixer was acquired and used to prepare coal-binder mixtures. The -100 mesh x 0 coal mixtures will be tested extensively to optimize the overall dewatering and briquetting system.