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THE EFFECTS OF MINERALS ON COAL BENEFICIATION PROCESSES

Quarterly Report No. 11 for the Period July 1—September 19, 1980

By
Barry G. McMillan
Richard B. Muter
William C. Grady

December 15, 1980

Work Performed Under Contract No. AC22-77ET10559

West Virginia University
College of Mineral and Energy Resources
Morgantown, West Virginia

U. S. DEPARTMENT OF ENERGY

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Price: Printed Copy A04
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DOE/ET/10559-T1
Distribution Category UC-90i

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December 15, 1980

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY

Under Contract No. DE-AC22-77ET10559
(Formerly EF-77-S-01-2722)

ACKNOWLEDGMENTS

The authors would like to acknowledge the services and skills of Bureau personnel whose efforts are not otherwise documented in this report: Charles R. McFadden and Ronald Sheppard for some of the illustrations presented; Larry L. Nice and the analytical group at the Coal Research Bureau for extensive chemical testing; and Martha Fekete, Sheila Anderson and Sarah See for secretarial services.

OBJECTIVE AND SCOPE

The purpose of this research program is to examine the effect of coal cleaning and preparation on the distribution of mineral materials in coal and the influence of the mineral materials on the coal cleaning operation. The research program will involve the examination of, for coal mineral materials: (1) the natural occurrence and distribution of mineral materials in run-of-mine coal, (2) the changes in these characteristics during cleaning and preparation, (3) the specific effects of coal mineral materials on individual cleaning and preparation processes, and (4) improved methods for controlling their distribution.

In order to accomplish these objectives samples will be obtained from three commercial coal preparation plants which are: (1) handling coal from major (by volume) coal seams, (2) handling coal most likely to be used in future large scale coal conversion processes, and (3) using a range of different types of modern cleaning methods. At least one of these plants shall process a coal likely to be used as a feed to a D.O.E.-supported conversion process or similar to a type of coal likely to be used.

SUMMARY OF PROGRESS TO DATE

With the issuance of this report, all tasks and primary objectives of the contract have been addressed and completed, with the exception of the final report preparation, which is currently on-going. This study has attempted to examine that which complicates all phases of coal utilization, i.e. the contained minerals within the coal and the effect of coal cleaning on their distribution. Three nationally important and regionally different bituminous coals--the Pittsburgh seam, the Pocahontas No. 3 seam, and the Illinois No. 6 seam--have been studied during the course of the work, and a discussion of the final data acquisition, some of the findings, and data revisions are presented in this document.

Primary emphasis was on the mineral distributions and their concurrent actions. To study this, mineral washability diagrams, mineral separabilities and other data graphics were prepared to assist in interpreting the relationships.

As part of the finalization of data acquisition, a complete petrographic analysis of macerals and submacerals for the Illinois No. 6 coal was also performed. Methods and data presentation used are similar to that previously employed to allow comparisons of these three sets of coal samples. This area will be more easily accomplished in the final report.

DESCRIPTION OF TECHNICAL PROGRESS

This report describes Quarter eleven's efforts to update the washability characterization of the Illinois No. 6 preparation plant samples; to interpret mineral distributions in the Pittsburgh, Pocahontas No. 3, and Illinois No. 6 size-by-gravity fractions of the commercial preparation plants and laboratory-pilot scale cleaning tests; and the detailed petrographic examination of the Illinois No. 6 coal. A detailed explanation of this work follows.

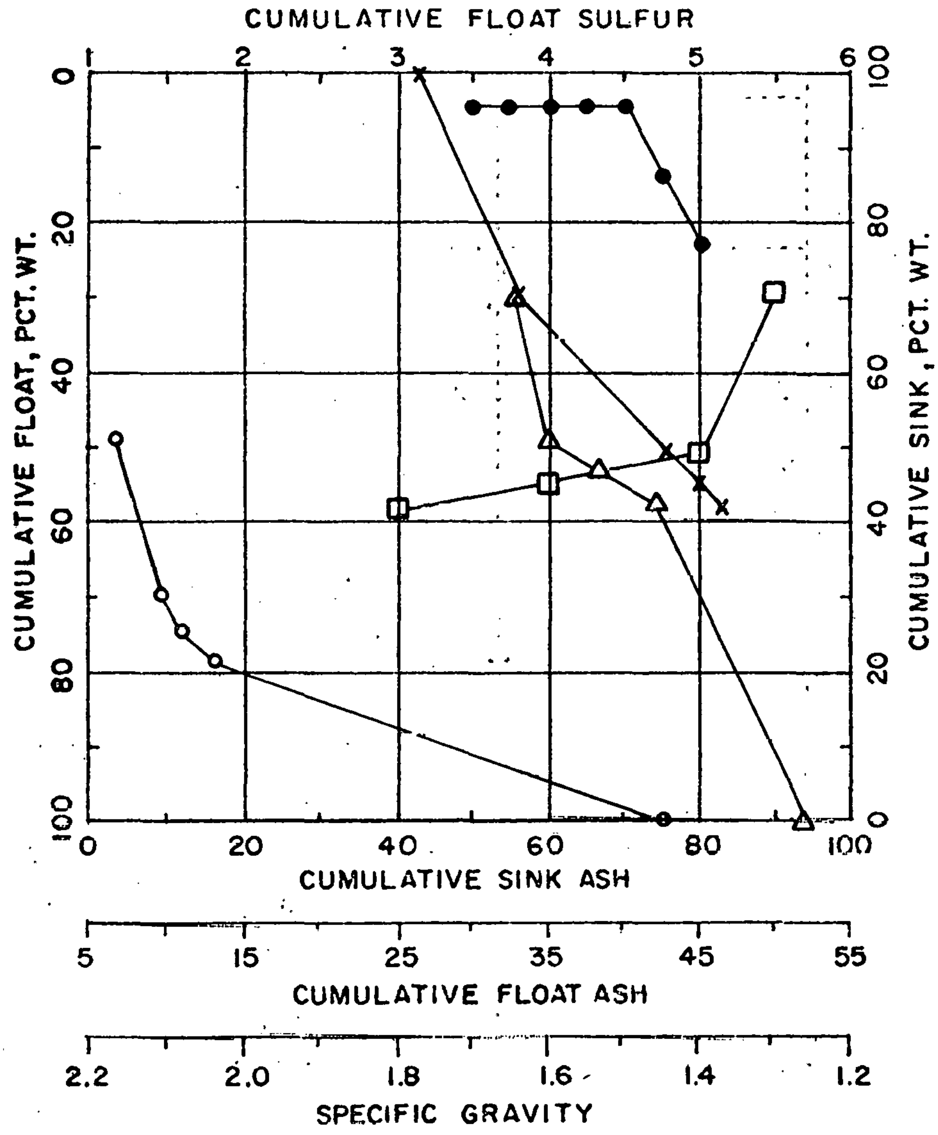
Physical Characterization of the Illinois No. 6 Coal

Figures 1-6 show the Calcomp plots of the washability data for the Illinois No. 6 coal. The washability graph data, Table 1, was previously reported in Table 7, Quarterly Report No. 7 (April 1 - June 30, 1979) and was reproduced to facilitate use of the graphs. The sulfur values have been changed (Column 11) in this table to correct an error found in the previous table.

Conventional plots of the type shown in Figures 1-6 (the 5 size fractions plus a composite washability) allow for interpolation between gravities. As with the data and plots previously reported on the Pocahontas No. 3 seam and the Pittsburgh seam, this information will enable data from the laboratory cleaning studies to be more fully evaluated.

In general, the data obtained from the in-house pilot-scale equipment are in good agreement with those obtained from the bench-scale washability studies. This information will be further compared in the final report.

SULFUR AND ASH WASHABILITY OF
THE ILLINOIS NO. 6 RAW COAL
+1-IN. FRACTION-7.73 WT. PCT. OF TOTAL SAMPLE



KEY

- ● =0.1 SPECIFIC GRAVITY DISTRIBUTION
- o CUMULATIVE FLOAT ASH
- x CUMULATIVE SINK ASH
- □ SPECIFIC GRAVITY
- △ CUMULATIVE FLOAT SULFUR

Figure 1

SULFUR AND ASH WASHABILITY OF THE ILLINOIS NO. 6 RAW COAL

1-IN. X 1/4 IN. FRACTION-24.50 WT. PCT. OF TOTAL SAMPLE

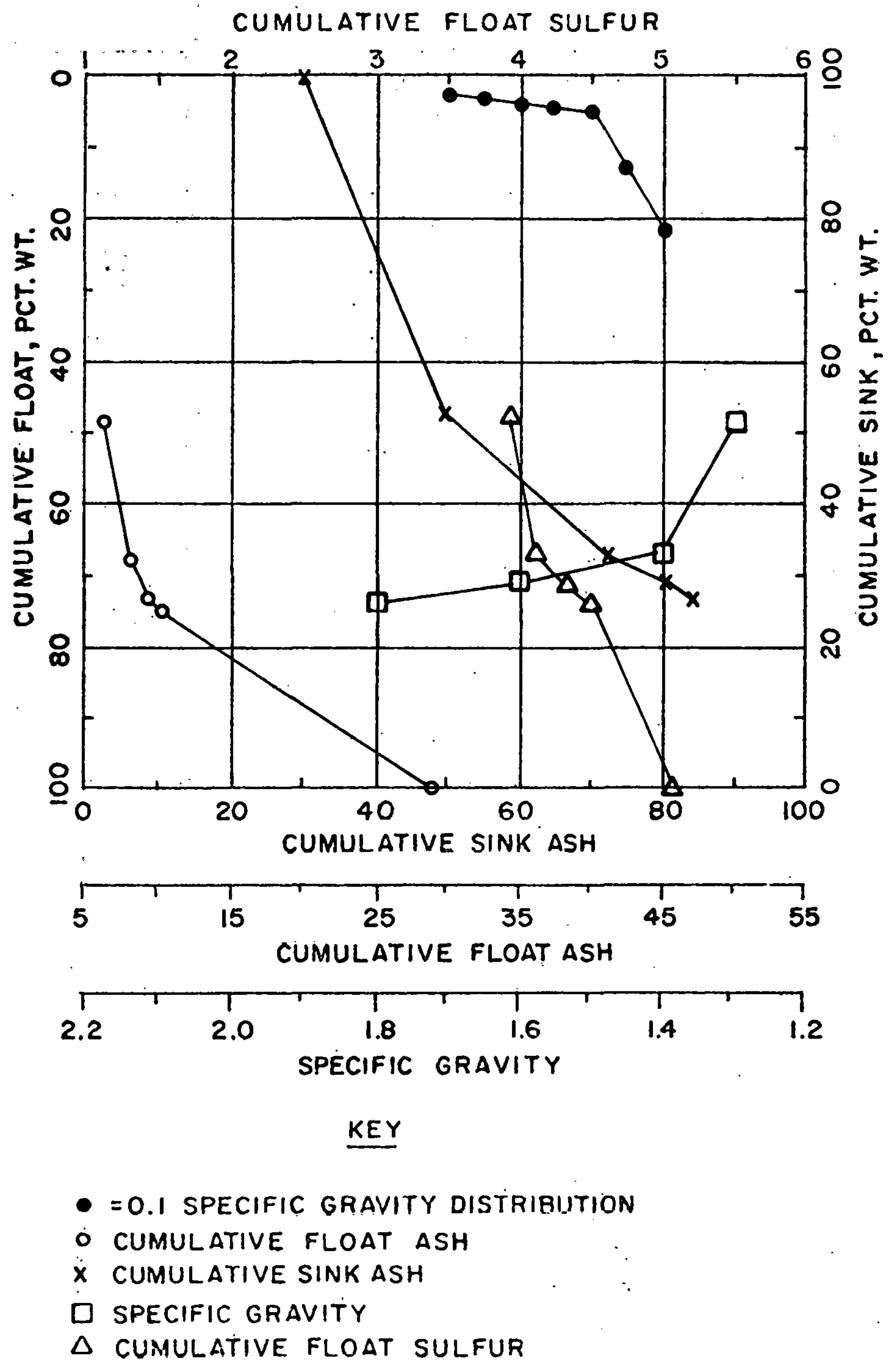
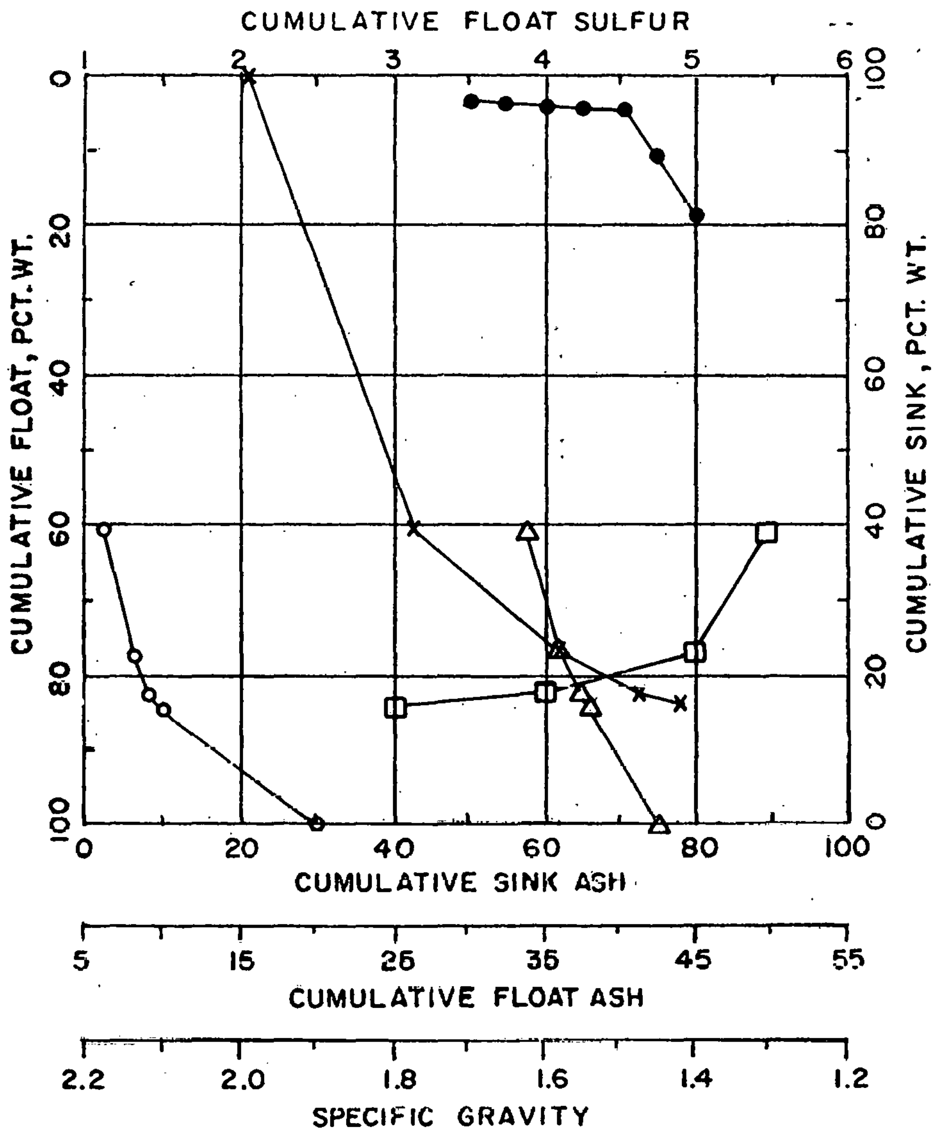


Figure 2

SULFUR AND ASH WASHABILITY OF THE ILLINOIS NO. 6 RAW COAL

1/4-IN. X 8 MESH FRACTION-25.52 WT. PCT. OF TOTAL SAMPLE

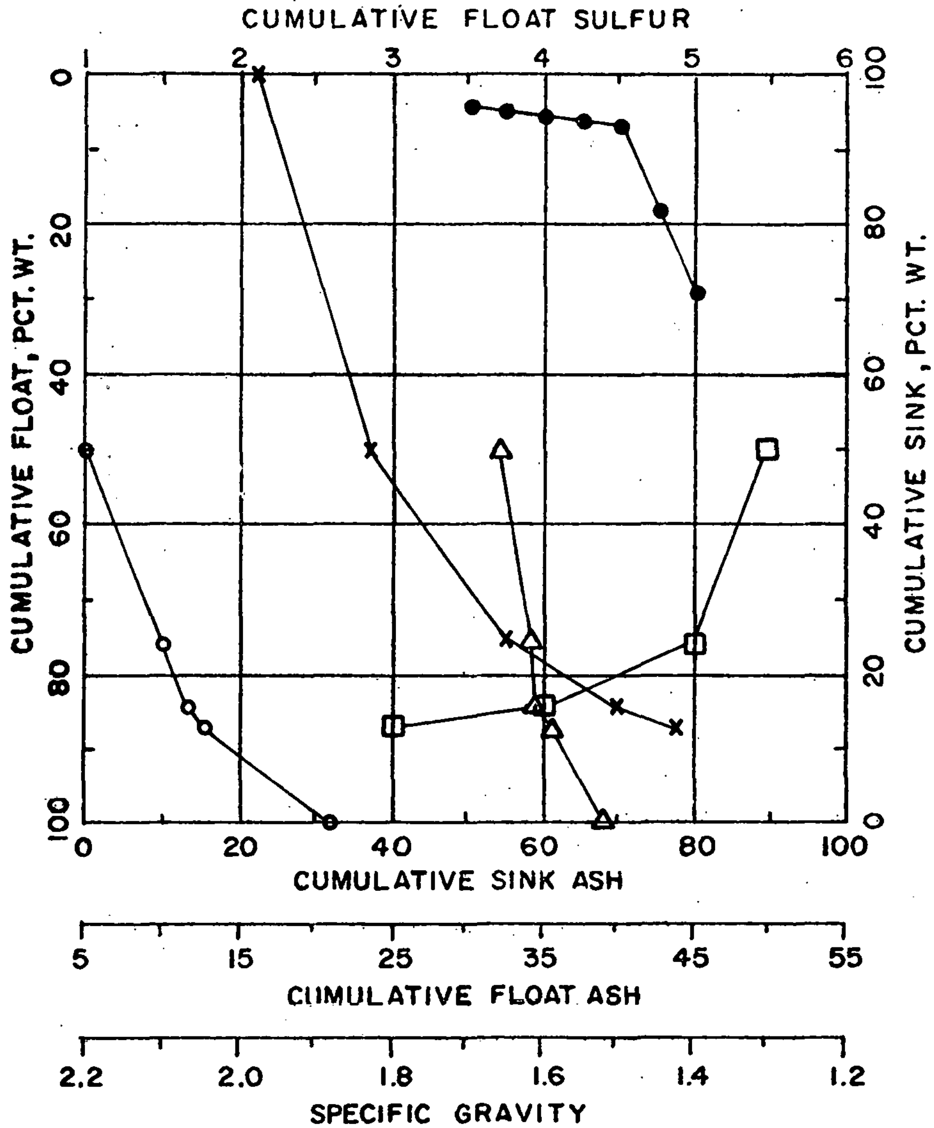


KEY

- ● =0.1 SPECIFIC GRAVITY DISTRIBUTION
- o CUMULATIVE FLOAT ASH
- X CUMULATIVE SINK ASH
- □ SPECIFIC GRAVITY
- Δ CUMULATIVE FLOAT SULFUR

Figure 3

SULFUR AND ASH WASHABILITY OF
THE ILLINOIS NO. 6 RAW COAL
8 MESH X 28 MESH FRACTION-22.86 WT. PCT. OF TOTAL SAMPLE



KEY

- ⊙ =0.1 SPECIFIC GRAVITY DISTRIBUTION
- o CUMULATIVE FLOAT ASH
- x CUMULATIVE SINK ASH
- □ SPECIFIC GRAVITY
- △ CUMULATIVE FLOAT SULFUR

Figure 4

SULFUR AND ASH WASHABILITY OF
THE ILLINOIS NO. 6 RAW COAL
28 MESH X 100 MESH FRACTION - 17.21 WT. PCT. OF TOTAL SAMPLE

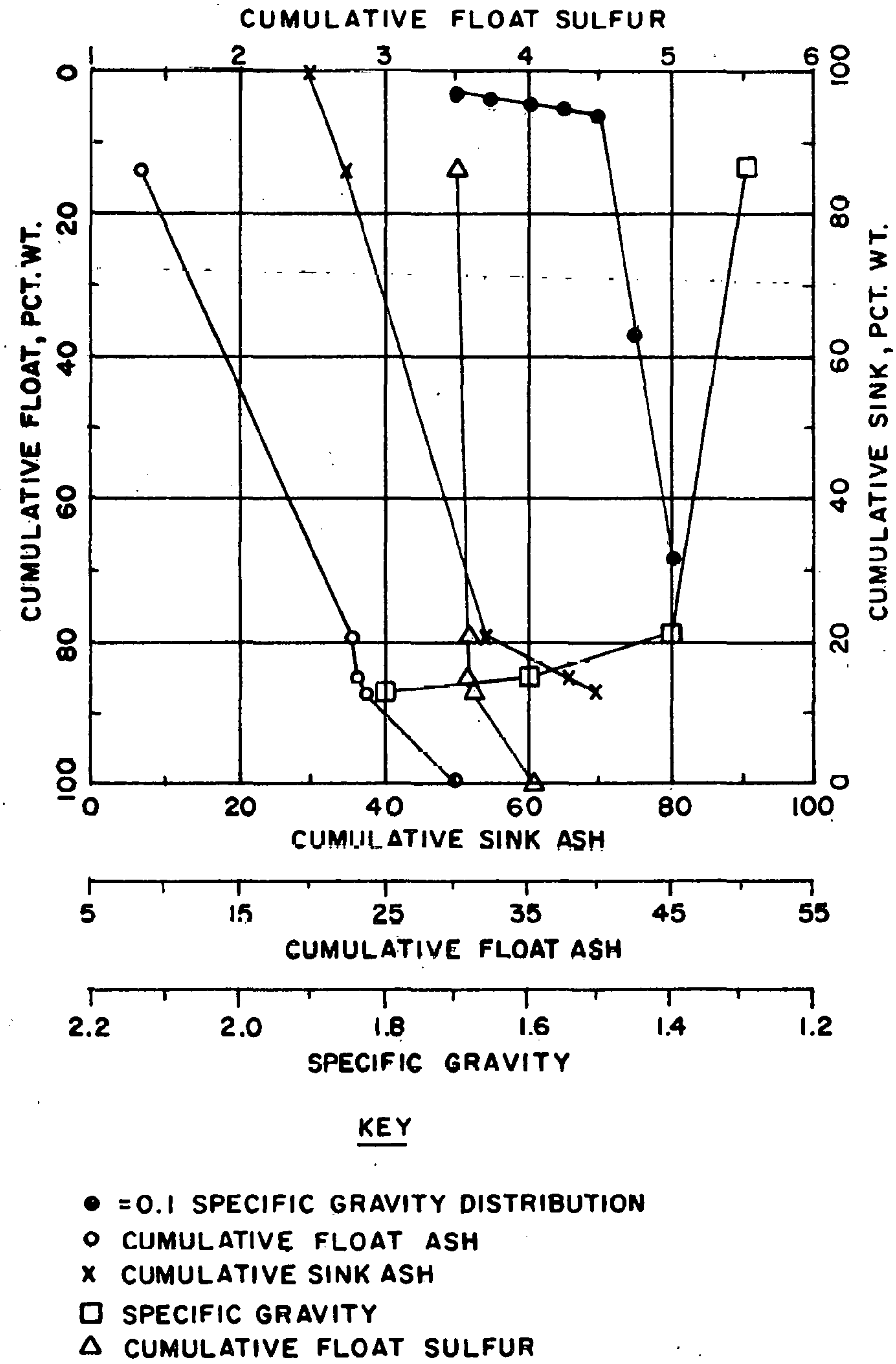
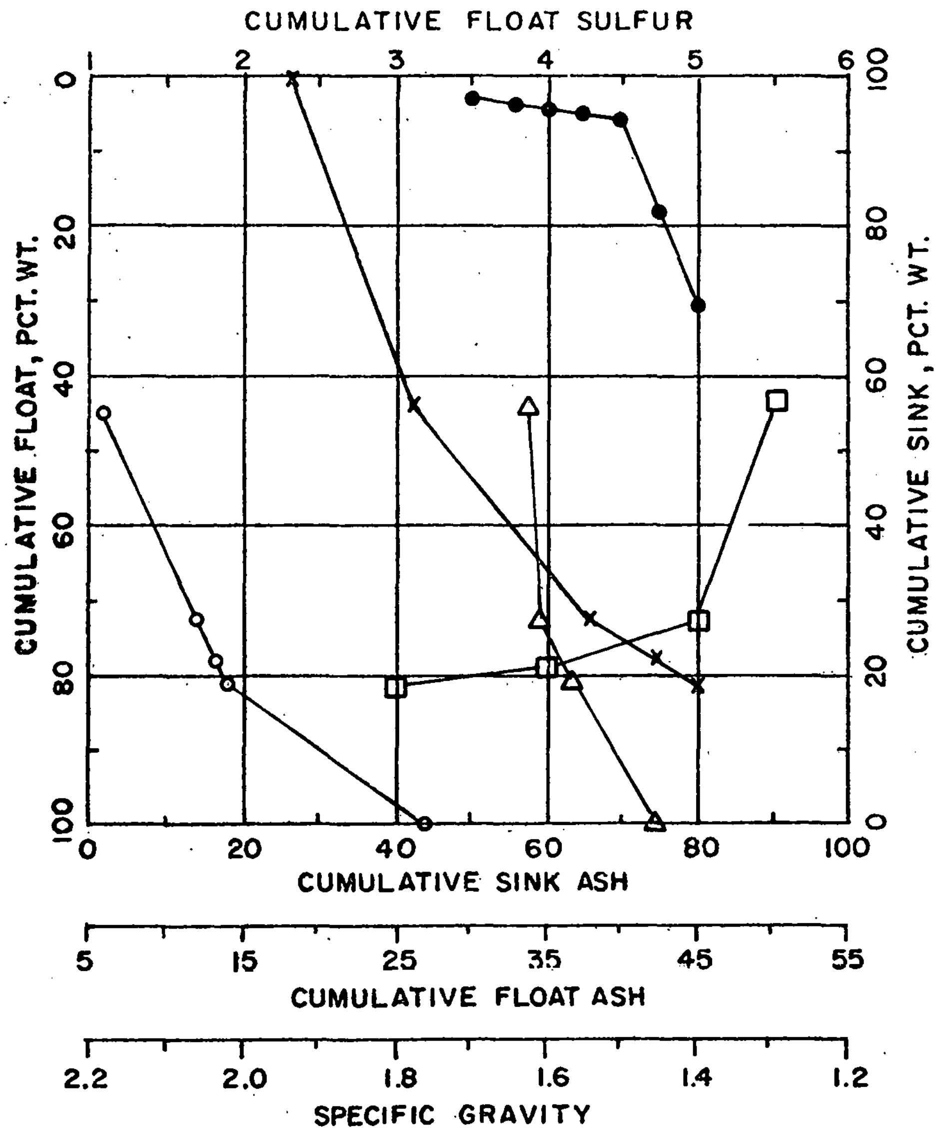


Figure 5

SULFUR AND ASH WASHABILITY OF THE ILLINOIS NO. 6 RAW COAL
COMPOSITE FRACTION-97.82 WT. PCT. OF TOTAL SAMPLE



KEY

- ● =0.1 SPECIFIC GRAVITY DISTRIBUTION
- o CUMULATIVE FLOAT ASH
- X CUMULATIVE SINK ASH
- □ SPECIFIC GRAVITY
- Δ CUMULATIVE FLOAT SULFUR

Figure 6

TABLE 1

FLOAT AND SINK DATA (+1" Head Sample).

Specific Gravity	Individual Fractions			Cumulative Float			Cumulative Sink			Cumulative Sulfur
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Wt. %	Ash %	Ash Prod.	Wt. %	Ash Prod.	Ash %	Wt. %	Ash Prod.	Ash %	
Float 1.3	29.1	6.4	186.24	29.10	186.24	6.40	100.00	4240.35	42.40	3.80
1.3 x 1.4	20.7	13.8	285.66	49.80	471.90	9.48	70.90	4054.11	57.18	4.01
1.4 x 1.6	4.0	22.5	90.00	53.80	561.90	10.44	50.20	3768.45	75.07	4.33
1.6 x 1.8	4.1	36.7	150.47	57.90	712.37	12.30	46.20	3678.45	79.62	4.69
Sink 1.8	42.1	83.8	3527.98	100.00	4240.35	42.40	42.10	3527.98	83.00	5.67

FLOAT AND SINK DATA (1" x 1/4" Head Sample)

Specific Gravity	Individual Fractions			Cumulative Float			Cumulative Sink			Cumulative Sulfur
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Wt. %	Ash %	Ash Prod.	Wt. %	Ash Prod.	Ash %	Wt. %	Ash Prod.	Ash %	
Float 1.3	48.3	6.0	289.80	48.30	289.80	6.00	100.00	2901.18	29.01	3.91
1.3 x 1.4	19.4	14.1	273.54	67.70	563.34	8.32	51.70	2611.38	50.51	4.11
1.4 x 1.6	4.8	23.2	111.36	72.50	674.70	9.31	32.30	2337.84	72.38	4.31
1.6 x 1.8	1.8	37.6	67.68	74.30	742.38	9.99	27.50	2226.48	80.96	4.39
Sink 1.8	25.7	84.0	2158.80	100.00	2901.18	29.01	25.70	2158.80	84.00	5.06

FLOAT AND SINK DATA (1/4" x 8 M)

Specific Gravity	Individual Fractions			Cumulative Float			Cumulative Sink			Cumulative Sulfur
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	Wt. %	Ash %	Ash Prod.	Wt. %	Ash Prod.	Ash %	Wt. %	Ash Prod.	Ash %	
Float 1.3	60.8	6.00	364.80	60.80	364.80	6.00	100.20	2032.70	20.29	3.90
1.3 x 1.4	17.0	16.80	285.60	77.80	650.40	8.36	39.40	1667.90	42.33	4.07
1.4 x 1.6	4.6	23.20	106.72	82.40	757.12	9.19	22.40	1382.30	61.71	4.20
1.6 x 1.8	2.3	27.60	63.48	84.70	820.60	9.69	17.80	1275.58	71.66	4.28
Sink 1.8	15.5	78.20	1212.10	100.00	2032.70	20.29	15.50	1212.10	78.20	4.72

TABLE 1 (Continued)

FLOAT AND SINK DATA (8 x 28 M)

Specific Gravity	Individual Fractions			Cumulative Float			Cumulative Sink			Cumulative Sulfur
(1)	(2) Wt. %	(3) Ash %	(4) Ash Prod.	(5) Wt. %	(6) Ash Prod.	(7) Ash %	(8) Wt. %	(9) Ash Prod.	(10) Ash %	(11)
Float 1.3	50.1	5.00	250.50	50.10	250.50	5.00	100.00	2107.19	21.07	3.67
1.3 x 1.4	25.0	19.50	487.50	75.10	738.00	9.83	49.90	1856.69	37.21	3.89
1.4 x 1.6	7.9	25.10	198.29	83.00	936.29	11.28	24.90	1369.19	54.99	3.94
1.6 x 1.8	3.5	36.00	126.00	86.50	1062.29	12.28	17.00	1170.90	68.88	4.02
Sink 1.8	13.5	77.40	1044.90	100.00	2107.19	21.07	13.50	1044.90	77.40	4.38

FLOAT AND SINK DATA (28 x 100 M)

Specific Gravity	Individual Fractions			Cumulative Float			Cumulative Sink			Cumulative Sulfur
(1)	(2) Wt. %	(3) Ash %	(4) Ash Prod.	(5) Wt. %	(6) Ash Prod.	(7) Ash %	(8) Wt. %	(9) Ash Prod.	(10) Ash %	(11)
Float 1.3	14.0	8.00	112.00	14.00	112.00	8.00	100.10	2990.73	29.88	3.49
1.3 x 1.4	64.8	26.60	1723.68	78.80	1835.68	23.30	86.10	2878.73	33.43	3.64
1.4 x 1.6	6.1	29.30	178.73	84.90	2014.41	23.73	21.30	1155.05	54.23	3.64
1.6 x 1.8	2.5	39.50	98.75	87.40	2113.16	24.18	15.20	976.32	64.32	3.65
Sink 1.8	12.7	69.10	877.57	100.10	2990.73	29.88	12.70	877.57	69.10	4.03

FLOAT AND SINK DATA (+100 M Composite Head Sample)

Specific Gravity	Individual Fractions			Cumulative Float			Cumulative Sink			Cumulative Sulfur
(1)	(2) Wt. %	(3) Ash %	(4) Ash Prod.	(5) Wt. %	(6) Ash Prod.	(7) Ash %	(8) Wt. %	(9) Ash Prod.	(10) Ash %	(11)
Float 1.3	44.4	5.87	260.63	44.4	260.63	5.87	100.00	2607.37	26.07	3.81
1.3 x 1.4	28.2	20.69	581.39	72.6	842.02	11.60	55.60	2346.74	42.21	3.95
1.4 x 1.6	5.6	24.94	139.66	78.2	981.68	12.55	27.40	1765.35	64.43	4.06
1.6 x 1.8	2.6	35.06	91.03	80.8	1072.71	13.27	21.80	1625.69	74.57	4.14
Sink 1.8	19.2	79.93	1534.66	100.0	2607.37	26.07	19.20	1534.66	79.93	4.68

Mineral Distributions - Pittsburgh Feed Coal

Mineral species abundances in the size and specific gravity fractions of the District 3 Pittsburgh feed coal were reported in Table 19 of Quarterly Report No. 9. To better use these mineral values in the interpretation of mineral paths through the commercial preparation plant and the pilot plant, the weight percent values were recalculated to weights of each mineral in each float-sink fraction based on the assumption that one short ton of feed coal had been processed. The distributions of the minerals in the size and the specific gravity fractions were examined, washability curves for the dominant minerals were constructed, and the relative effectiveness of sepcific gravity cleaning was evaluated based on each dominant mineral's size, morphology, and its relationship to coal particle size and specific gravity.

Table 2 presents the recalculated float-sink mineral data. Table 3 shows an example of the procedure used to calculate the data in Table 2. Because many of the recalculated mineral weights were less than one pound, all weights in Table 2 were reported to a tenth of a pound. This presentation, however, was in no way intended to infer a tenth of a pound accuracy for the values in Table 2. Experimental errors (resulting from float-sink testing, low temperature ashing, and X-ray powder diffraction) caused an estimated error of ± 8 pounds for illite, ± 5 pounds for kaolinite, quartz, and pyrite, and ± 1 pound for calcite.

Table 2 presents mineral weights in the float-sink fractions, and the composite mineral weights in each size range. Five important minerals in the Pittsburgh coal (illite, kaolinite, quartz, calcite, and pyrite) were further investigated to ascertain their washability characteristics. The most important characteristic was the mineral's washability curve, Figure 7, which displayed the cumulative weight of the mineral in the cleaned coal as the specific gravity of

TABLE 2

Mineral Weights in the Float-Sink Fractions of the Pittsburgh Coal

Size Fraction	Specific Gravity Fraction	COAL REPORTING lb[1]	MINERAL MATTER lb	ILLITE lb	KAOLINITE lb	QUARTZ lb	CALCITE lb	DOLOMITE lb	SIDERITE lb	PYRITE lb	FELDSPAR lb	MUSCOVITE lb	APATITE lb	BASSANITE lb
+1 inch	*1.30 Float*	252	19.7	4.1	4.5	3.2	0.4	0.6	---[2]	3.9	0.2	---	0.8	1.9
+1 inch	*1.40 Float*	54	7.3	1.4	1.1	1.2	0.1	0.2	---	2.0	0.1	---	0.1	0.0
+1 inch	*1.60 Float*	30	7.8	3.0	0.6	1.3	1.1	0.8	---	0.6	0.1	---	0.3	0.0
+1 inch	*1.80 Float*	4	1.6	0.8	0.1	0.4	0.1	0.7	---	0.2	0.0	---	0.1	0.0
+1 inch	*1.80 Sink*	50	41.2	14.4	4.1	8.2	3.7	1.2	---	7.4	0.4	---	0.8	0.0
+1 inch fractions combined		390	77.6	23.7	10.4	14.3	5.4	3.5	---	14.1	0.8	---	2.1	2.9
1 X ¼ inch	*1.30 Float*	424	30.5	8.2	8.8	5.2	0.6	0.6	---	5.2	0.3	---	0.3	1.2
1 X ¼ inch	*1.40 Float*	96	14.2	3.7	2.7	2.6	0.6	0.3	---	3.4	0.3	---	0.1	0.6
1 X ¼ inch	*1.60 Float*	24	6.9	1.8	0.8	1.3	0.1	0.2	---	1.9	0.1	---	0.1	0.6
1 X ¼ inch	*1.80 Float*	8	3.4	1.2	0.2	0.6	0.3	0.2	---	0.7	0.1	---	0.1	0.0
1 X ¼ inch	*1.80 Sink*	50	42.3	14.0	4.2	8.9	3.8	0.8	---	5.9	3.8	---	0.4	0.0
1 X ¼ inch fractions combined		602	97.3	28.9	16.7	18.6	5.4	2.1	---	17.1	4.6	---	1.0	2.4
¼ inch X 8 mesh	*1.30 Float*	348	24.7	6.4	6.9	4.0	1.0	0.7	---	4.4	0.2	---	0.2	0.7
¼ inch X 8 mesh	*1.40 Float*	34	8.1	2.1	2.3	1.3	0.3	0.2	---	1.5	0.1	---	0.1	0.2
¼ inch X 8 mesh	*1.60 Float*	10	2.8	0.7	0.3	0.5	0.2	0.1	---	0.9	0.1	---	0.0	0.0
¼ inch X 8 mesh	*1.80 Float*	4	6.2	1.6	0.4	1.1	0.7	0.2	---	1.7	0.1	---	0.1	0.2
¼ inch X 8 mesh	*1.80 Sink*	22	18.6	6.9	1.7	3.7	1.7	0.4	---	3.7	0.2	---	0.2	0.0
¼" X 8 mesh fractions combined		418	60.4	17.7	11.6	10.6	3.9	1.6	---	12.2	0.7	---	0.6	1.1

[1] *Mineral values are expressed as pounds of the mineral resulting from float-sink testing one short ton of feed coal.*

[2] *The symbol "---" indicates that the mineral was not present in the coal.*

TABLE 2
(continued)

Size Fraction	Specific Gravity Fraction	COAL REPORTING lb[1]	MINERAL MATTER lb	ILLITE lb	KAOLINITE lb	QUARTZ lb	CALCITE lb	DOLOMITE lb	SIDERITE lb	PYRITE lb	FELDSPAR lb	MUSCOVITE lb	APATITE lb	BASSANITE lb
8 X 28 mesh	*1.30 Float*	250	15.2	3.1	4.3	2.4	0.6	0.5	---[2]	3.7	0.2	---	0.2	0.5
8 X 28 mesh	*1.40 Float*	34	4.6	0.9	0.7	0.8	0.2	0.1	---	1.7	0.1	---	0.1	0.0
8 X 28 mesh	*1.60 Float*	12	2.9	0.5	0.3	0.5	0.2	0.1	---	1.3	0.1	---	0.1	0.0
8 X 28 mesh	*1.80 Float*	4	1.6	0.4	0.1	0.3	0.2	0.1	---	0.4	0.0	---	0.1	0.0
8 X 28 mesh	*1.80 Sink*	18	14.8	4.0	1.0	2.7	2.1	0.3	---	3.6	0.3	---	0.4	0.0
8 X 28 mesh fractions combined		318	39.1	8.9	6.4	6.7	3.3	1.1	---	10.7	0.7	---	0.9	0.5
28 X 100 mesh	*1.30 Float*	142	9.9	2.9	2.1	1.6	0.3	0.5	---	1.2	0.1	---	0.1	1.2
28 X 100 mesh	*1.40 Float*	20	2.3	0.6	0.6	0.4	0.1	0.1	---	0.3	0.0	---	0.0	0.0
28 X 100 mesh	*1.60 Float*	12	2.9	0.3	0.4	0.5	0.1	0.1	---	0.8	0.1	---	0.1	0.3
28 X 100 mesh	*1.80 Float*	4	1.4	0.1	0.1	0.2	0.2	0.1	---	0.3	0.0	---	0.0	0.4
28 X 100 mesh	*1.80 Sink*	12	10.2	3.4	0.6	1.4	2.6	0.4	---	1.6	0.1	---	0.1	0.0
28 X 100 mesh fractions comb.		190	26.7	7.3	3.8	4.1	3.7	1.2	---	4.2	0.3	---	0.3	1.9
-100 mesh feed coal fraction[3]		64	15.9	4.6	1.6	2.9	0.2	0.8	---	1.3	0.2	---	0.2	4.1
Cleaned coal head sample[4]		----	202.0	62.6	38.4	38.4	12.1	4.0	---	40.4	2.0	---	4.0	0.0
Feed coal head sample[4]		----	346.0	186.5	89.5	126.8	37.3	14.9	---	208.9	7.5	---	14.9	59.7
Refuse head sample[4]		----	1664.0	332.8	133.1	316.2	166.4	33.3	---	382.7	0.0	---	33.3	249.6

[1] *Mineral values are expressed as pounds of the mineral resulting from float-sink testing one short ton of feed coal.*

[2] *The symbol "---" indicates that the mineral was not present in the coal.*

[3] *Mineral values are expressed as pounds of the mineral resulting from screening one short ton of feed coal at 100 mesh.*

[4] *Minerals are expressed as pounds of the mineral in one short ton of the cleaned coal, feed coal, or refuse from the preparation plant.*

TABLE 3

Examples of calculations used to transform weight percent of the low temperature ash values to pounds of each mineral in each float-sink fraction with the assumption that one short ton of feed coal had been processed.

EXAMPLE: *+1 inch size fraction,*
1.30 float specific gravity fraction

ANALYTICAL RESULTS:
Yield = 12.6 wt.%
LTA = 7.8 wt.%
ILLITE = 21 wt.% (of the LTA)
KAOLINITE = 23 wt.% (of the LTA)
QUARTZ = 16 wt.% (of the LTA)
CALCITE = 2 wt.% (of the LTA)
PYRITE = 20 wt.% (of the LTA)

CALCULATIONS:

Coal Reporting = *one ton X yield/100*
= *2000 X 0.126*
= *252 pounds*

Mineral Matter = *Coal Reporting X LTA/100*
= *252 X 0.078*
= *19.7 pounds*

Illite = *Mineral Matter X ILLITE/100*
= *19.7 X 0.21*
= *4.1 pounds*

Kaolinite = *19.7 X 0.23 = 4.5 pounds*
Quartz = *19.7 X 0.16 = 3.2 pounds*
Calcite = *19.7 X 0.02 = 0.4 pounds*
Pyrite = *19.7 X 0.20 = 3.9 pounds*

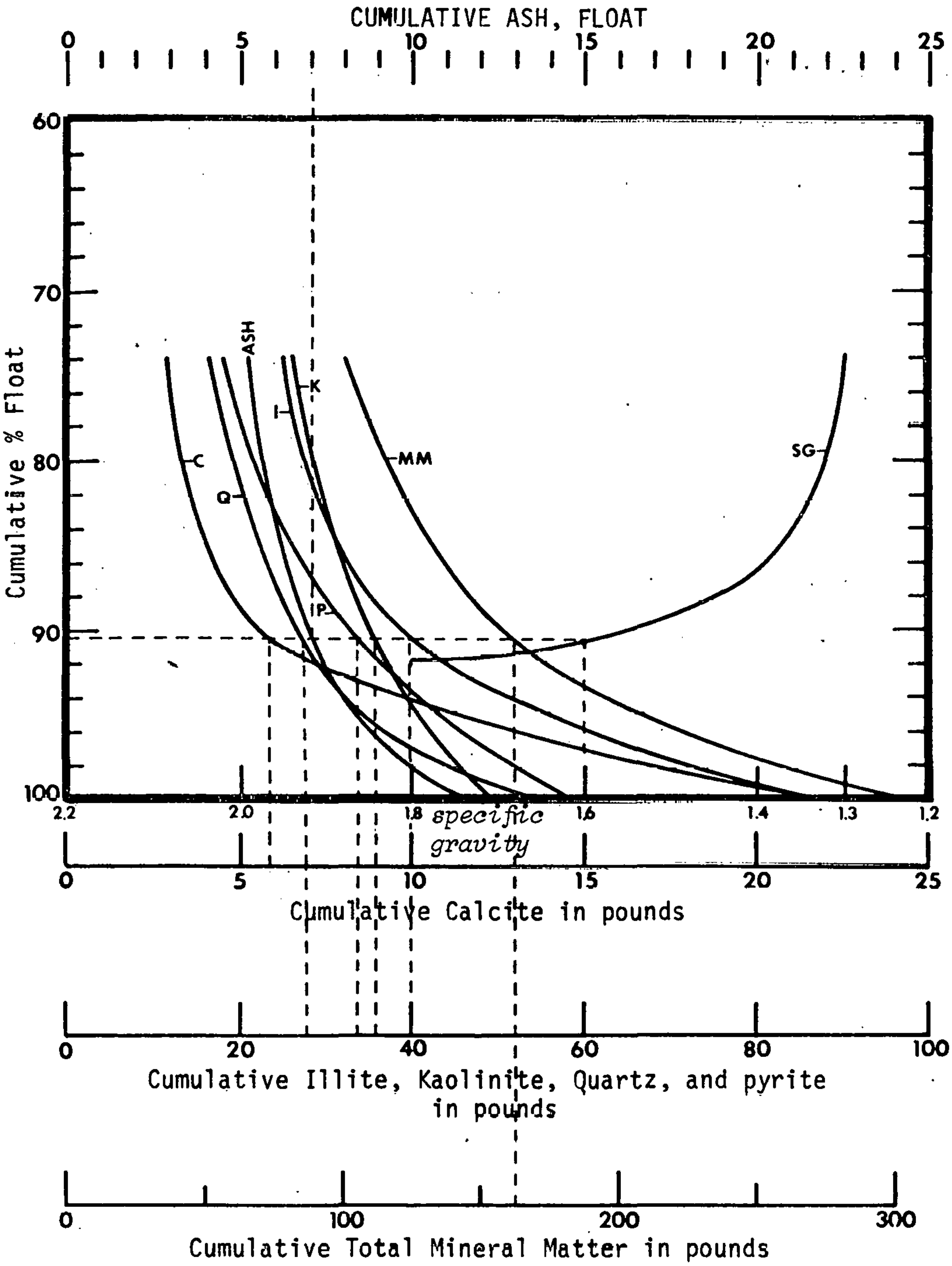


Figure 7

Washability curves for the minerals in the District 3 Pittsburgh coal (See the footnote on the next page for explanations of this diagram).

the cleaning medium increased. The weight of each mineral in the cleaned coal could be estimated once an ash or specific gravity value had been chosen as shown on the example in Figure 7. The shape of the washability curve reflected the effectiveness of coal cleaning by specific gravity for the removal of each mineral. For example, the slope of the calcite curve in Figure 7 was greatest below specific gravity 1.50, and lessened above 1.50 specific gravity. An increased specific gravity of the washing medium from 1.30 to 1.50 would have greatly increased the yield of the product, but would have had little effect on the amount of calcite in the cleaned coal. However, an increased specific gravity of the washing medium above 1.50 would have increased the calcite content without a significant increase in yield. Kaolinite, however, showed a differently shaped washability curve. Due to the steep slope of the kaolinite curve, any specific gravity increase would have only moderately increased the kaolinite content. Illite, quartz, pyrite, and the total mineral matter had intermediate shaped curves which showed a logarithmic increase in the mineral content of the cleaned coal with increased specific gravity of the cleaning medium.

Mineral washability curves allowed the estimation of mineral abundances in the cleaned coal and refuse depending on the specific gravity at which the feed coal was cleaned. Another objective of this study was to investigate the effects of coal sizing on the removal of the minerals by specific gravity

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Mineral values are expressed in cumulative pounds of the mineral in the cleaned coal with the assumption that one short ton of feed coal had been cleaned. For reference purposes, the cumulative float ash and specific gravity curves were plotted, and the yield values may be read on the cumulative % float scale on the left of the diagram. The dashed lines illustrate the working of the curves through example. In the example it was assumed that cleaned coal with an ash value of 7.0% was needed. Using that ash value the specific gravity at which the coal must be cleaned was read as 1.60, and the yield produced was 90.5%. Mineral weights in the cleaned coal produced at that specific gravity were: Total Mineral Matter = 160 pounds; Illite = 40 pounds; Kaolinite = 38 pounds; Quartz = 24 pounds; Calcite = 6 pounds; and Pyrite = 27 pounds.

methods. That investigation required a more detailed examination of the data presented in Table 2. Table 4 presents the data from Table 2 proportioned within each size range. The amount of each constituent which reported to the 1.30 float (1.30F) fraction was based on the total of the constituent in the size fraction. Middlings (1.30 x 1.80) and the 1.80 sink (1.80S) were also proportioned in the same manner so that the 1.30F, middlings, and 1.80S totaled to 100% for each constituent in each size range.

The mineral data in Table 4 were studied to determine how well each mineral was separated from the coal, and whether minerals could be segregated using the size and/or the specific gravity of their enclosing coal particles. Mineral separability was one such factor investigated. The separability of a mineral in a size fraction was defined as the "weight of the mineral in the 1.30 float fraction divided by the mineral's total weight in that size fraction $\frac{\text{wt. 130F}}{\text{wt. total}}$ minus the weight of the mineral in the 1.80 sink divided by the mineral's total weight in that size fraction $\frac{\text{wt. 1.80S}}{\text{wt. total}}$." Using this definition, $S_{mineral} = \frac{\text{wt. 1.30F - wt. 1.80S}}{\text{Total wt. of the mineral}} \times 100$, separability of each mineral, as presented in Table 4 was calculated as 1.30F minus 1.80S, and a high positive value indicated near-complete separation of the constituent into the 1.30 float fraction, and a high negative value indicated a near-complete separation into the 1.80 sink fraction. A separability value represented a single constituent in a single size range, and varied with size as shown in Figure 8. A separability of 0 represented a constituent which was intimately mixed with other constituents in such a manner that specific gravity fractionation would result in the constituent reporting equally to the 1.30 float and the 1.80 sink fractions. A constituent with a separability of +100 could occur as a single constituent particle, or combined with other constituents with +100 separability, and would report to the float fraction in any cleaning gravity from 1.30 to 1.80. A constituent with a -100 separability would report to the sink fraction at

TABLE 4

The constituents in the Pittsburgh coal from District 3 proportioned in a manner that the amount of the constituent in the 1.30 float, plus the amount in the 1.80 sink, plus the amount in the middlings (1.30 X 1.80) totalled to 100% in each size fraction. The absolute separability, |1.30F - 1.80S|, was greatest for constituents which were greatly liberated in the feed coal.

Size Fraction	*Specific Gravity/ Separability*	COAL	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	PYRITE
+1 inch	1.30F	65	25	17	43	22	7	28
	1.30 X 1.80	22	22	22	18	21	24	20
	1.80S	13	53	61	39	57	69	52
	Separability	+52	-28	-44	+4	-35	-62	-24
1 inch X ¼ inch	1.30F	70	31	28	53	28	11	30
	1.30 X 1.80	22	26	24	22	24	19	35
	1.80S	8	43	48	25	48	70	35
	Separability	+62	-12	-20	+28	-20	-59	-5
¼ inch X 8 mesh	1.30F	83	41	36	59	38	26	36
	1.30 X 1.80	12	28	25	26	27	30	34
	1.80S	5	31	39	15	35	44	30
	Separability	+78	+10	-3	+44	+3	-18	+6
8 mesh X 28 mesh	1.30F	79	39	35	67	36	18	35
	1.30 X 1.80	16	23	20	17	24	18	32
	1.80S	6	38	45	16	40	64	34
	Separability	+73	+1	-10	+51	-4	-46	+1
28 mesh X 100 mesh	1.30F	75	37	40	55	39	9	29
	1.30 X 1.80	19	25	14	29	27	12	33
	1.80S	6	38	47	16	34	79	38
	Separability	+69	-1	-7	+39	+5	-70	-9

any cleaning gravity from 1.30 to 1.80.

In Figure 8 mineral separabilities were plotted by coal size. The total mineral matter of the Pittsburgh coal, and the minerals illite, quartz, and pyrite were separated from the coal and reported to the 1.80 sink fractions only in the larger coal sizes. In finer coal sizes (-1/4 inch) these minerals reported nearly equally to the 1.30 float and the 1.80 sink fractions and to the middlings. The grouping of these minerals, and their distribution by size, are indicative of +1/4 inch rock fragments from partings, sulfur balls, and roof and floor rock mined with the feed coal. Kaolinite, especially in the finer coal sizes, reported predominantly to the 1.30 float fractions. This mineral distribution was indicative of the very small kaolinite occurrences which were intimately intermixed with the coal. Lower separabilities of the +1/4 inch kaolinite indicated that this mineral also occurred in partings, roof, or floor rocks. The very high separability of calcite in the finest coal size represented dissociated fracture-filling calcite which was less dissociated from the larger 1/4 inch x 28 mesh coal. The very great separability of calcite in the +1/4 inch size coal fractions was produced by coal-ball calcite which was also common in these samples of the Pittsburgh coal.

From Table 2 it appeared that the specific gravity of the cleaning medium had the greatest effect on the mineral distributions in the float-sink fractions of the Pittsburgh coal, but mineral size, morphology, and their interactions with the coal size were very important in determining the magnitude of the effect of specific gravity. Mineral occurrences such as fine fracture-filling calcite, coal-ball calcite, and partings containing illite, quartz, and kaolinite occurred as free particles in their respective size ranges, and were highly susceptible to specific gravity separation from the coal. Kaolinite was intimately associated with lighter, very clean coal, and therefore was segregated in the cleaned coal where it was separated from the

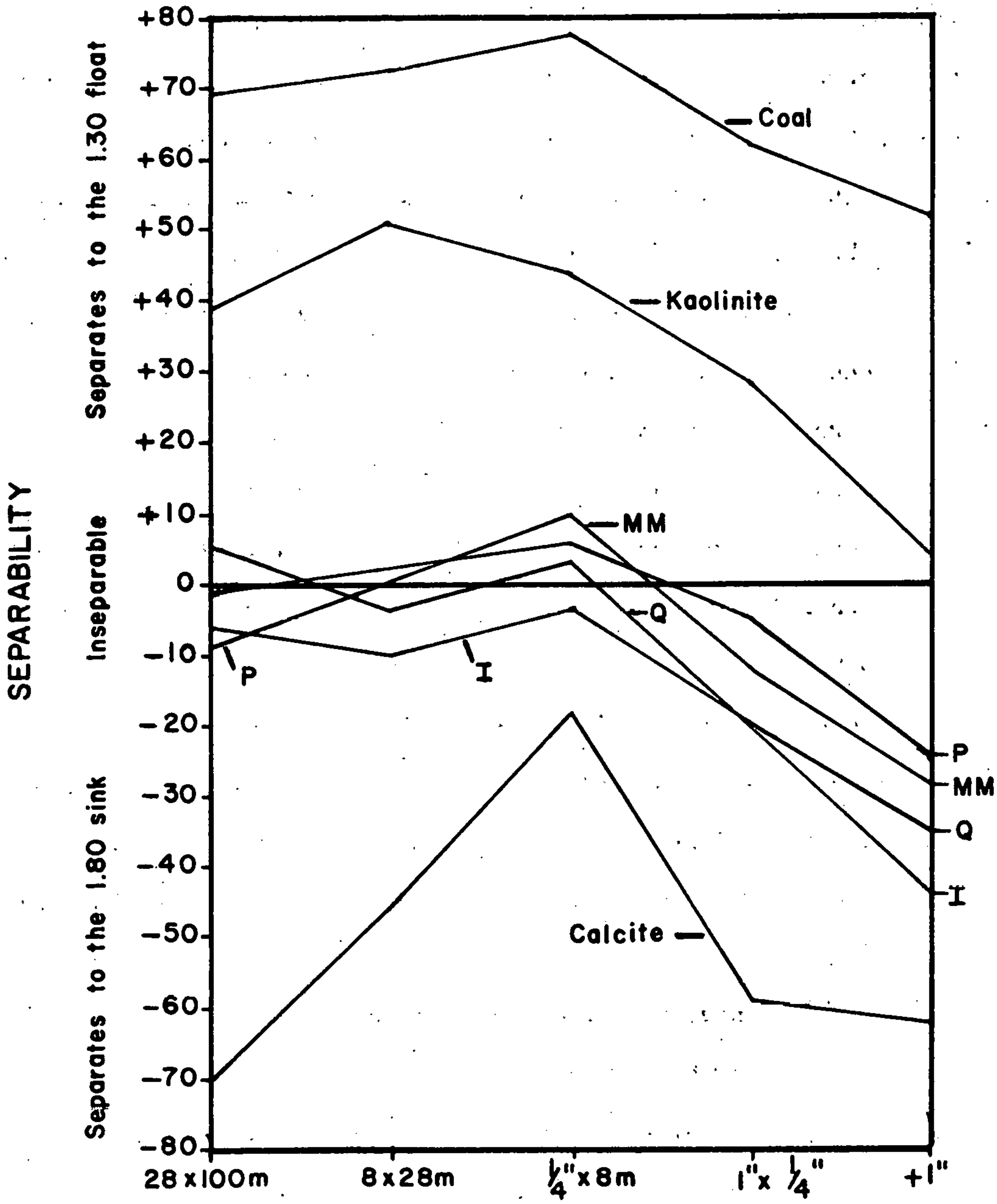

Figure 8. Size vs. Separability for the minerals in the Pittsburgh Coal.

I = illite, Q = quartz, MM = mineral matter, P = pyrite other minerals. Illite, quartz, and pyrite were finely disseminated in the -1/4 inch coal, and therefore reported nearly equally to the 1.30 float, middlings, and 1.80 sink fractions.

<u>Mineral Distributions - Pocahontas No. 3 Feed Coal</u>

Mineral species abundances in the size and specific gravity fractions of the District 7 Pocahontas No. 3 feed coal were reported in Table 20 of Quarterly Report No. 9. To better use these minerals values in the interpretation of mineral paths through the commercial preparation plant and the pilot plant, the weight-percent values were recalculated to weights of each mineral in each float-sink fraction as described in the mineral distribution section of this report for the Pittsburgh coal. The distributions of the minerals in the size and specific gravity fractions were examined, washability curves for the dominant minerals were constructed, and the relative effectiveness of specific gravity cleaning was evaluated based on each dominant mineral's size and morphology, and its relationship to coal particle size and specific gravity.

Table 5 presents the recalculated float-sink mineral data. The accuracies of these data (±10 pounds for illite, ±5 pounds for kaolinite and quartz, and ±1 pound for pyrite and calcite) are somewhat different than those of Table 2. Five important minerals in the Pocahontas No. 3 coal (illite, kaolinite, quartz, calcite, and pyrite) were further investigated to ascertain their washability characteristics. In Figure 9 the washability curves for these minerals are plotted with the cumulative float ash, yield, and the specific gravity curve. The shape of the washability curve indicated the effectiveness of coal cleaning by specific gravity on the removal of each mineral. In the case of this sample of the Pocahontas No. 3 coal, the mining process was cutting considerable floor and roof rock material which resulted in a preparation plant feed which consisted of very clean coal mixed with rock. The washability curves for illite, kaolinite,

TABLE 5

Mineral Weights in the Float-Sink Fractions of the Pocahontas No.3 Coal.

Size Fraction	Specific Gravity Fraction	COAL REPORTING lb[1]	MINERAL MATTER lb	ILLITE lb	KAOLINITE lb	QUARTZ lb	CALCITE lb	DOLOMITE lb	SIDERITE lb	PYRITE lb	FELDSPAR lb	MUSCOVITE lb	APATITE lb	BASSANITE lb
+1 inch	*1.30 Float*	44	1.6	0.1	0.6	0.2	0.1	---[2]	0.2	0.2	0.3	0.1	---	0.1
+1 inch	*1.40 Float*	30	2.0	0.5	0.7	0.3	0.1	---	0.1	0.1	0.2	0.1	---	0.0
+1 inch	*1.60 Float*	16	3.5	0.9	1.0	0.9	0.2	---	0.0	0.0	0.1	0.2	---	0.1
+1 inch	*1.80 Float*	16	6.2	0.9	0.6	1.7	0.0	---	0.0	0.0	0.1	0.1	---	0.0
+1 inch	*1.80 Sink*	200	167.4	56.9	35.2	58.6	3.3	---	1.7	0.0	3.3	8.4	---	1.7
+1 inch fractions combined		306	180.7	59.3	38.1	61.7	3.7	---	2.0	0.3	4.0	8.9	---	1.9
1 X ¼ inch	*1.30 Float*	76	2.4	0.1	0.9	0.2	0.1	---	0.4	0.2	0.4	0.1	---	0.0
1 X ¼ inch	*1.40 Float*	80	6.9	1.7	2.3	0.9	0.3	---	0.3	0.1	0.7	0.5	---	0.1
1 X ¼ inch	*1.60 Float*	30	7.1	1.9	1.8	2.1	0.4	---	0.0	0.1	0.1	0.4	---	0.1
1 X ¼ inch	*1.80 Float*	22	8.6	2.2	1.9	3.4	0.3	---	0.0	0.2	0.2	0.5	---	0.0
1 X ¼ inch	*1.80 Sink*	152	137.3	48.0	39.8	13.7	5.5	---	11.0	0.0	8.2	17.8	---	6.9
1 X ¼ inch fractions combined		360	162.3	53.9	46.7	20.3	6.6	---	11.7	0.6	9.6	19.3	---	7.1
¼ inch X 8 mesh	*1.30 Float*	280	9.0	0.7	3.9	0.9	0.3	---	0.9	0.0	1.3	0.7	---	1.0
¼ inch X 8 mesh	*1.40 Float*	114	10.5	2.4	3.6	1.9	0.2	---	0.4	0.3	0.9	0.6	---	0.1
¼ inch X 8 mesh	*1.60 Float*	32	6.4	1.5	1.7	1.5	0.3	---	0.3	0.1	0.3	0.4	---	0.2
¼ inch X 8 mesh	*1.80 Float*	14	5.1	1.5	1.2	1.4	0.4	---	0.0	0.1	0.1	0.3	---	0.2
¼ inch X 8 mesh	*1.80 Sink*	68	60.9	18.3	12.2	20.7	1.2	---	0.6	1.2	1.8	3.7	---	1.8
¼" X 8 mesh fractions combined		508	91.9	24.4	22.6	26.4	2.4	---	2.2	1.7	4.4	5.7	---	3.3

[1] *Mineral values are expressed as pounds of the mineral resulting from float-sink testing one short ton of the feed coal.*

[2] *The symbol "--" indicates that the mineral was not present in the coal.*

TABLE 5

(continued)

Size Fraction	Specific Gravity Fraction	COAL REPORTING lb[1]	MINERAL MATTER lb	ILLITE lb	KAOLINITE lb	QUARTZ lb	CALCITE lb	DOLOMITE lb	SIDERITE lb	PYRITE lb	FELDSPAR lb	MUSCOVITE lb	APATITE lb	BASSANITE lb
8 X 28 mesh	*1.30 Float*	528	14.8	2.7	6.7	1.5	0.4	---[2]	0.9	0.6	1.5	1.5	---	0.7
8 X 28 mesh	*1.40 Float*	96	12.5	3.2	3.6	3.2	0.4	---	0.2	0.2	0.7	0.9	---	0.0
8 X 28 mesh	*1.60 Float*	28	5.3	1.2	1.7	1.1	0.1	---	0.3	0.1	0.3	0.4	---	0.1
8 X 28 mesh	*1.80 Float*	8	2.8	0.7	0.7	0.8	0.1	---	0.2	0.1	0.1	0.1	---	0.1
8 X 28 mesh	*1.80 Sink*	42	35.1	0.9	0.6	0.9	0.1	---	0.0	0.0	0.1	0.1	---	0.1
8 X 28 mesh fractions combined		702	70.5	8.7	13.3	7.5	1.1	---	1.6	1.0	2.7	3.0	---	1.0
28 X 100 mesh	*1.30 Float*	100	2.7	0.8	1.1	0.3	0.1	---	0.1	0.2	0.2	0.2	---	0.0
28 X 100 mesh	*1.40 Float*	10	0.8	0.2	0.3	0.1	0.0	---	0.0	0.0	0.1	0.1	---	0.0
28 X 100 mesh	*1.60 Float*	4	0.6	0.2	0.2	0.1	0.0	---	0.0	0.0	0.0	0.0	---	0.0
28 X 100 mesh	*1.80 Float*	2	0.5	0.1	0.1	0.1	0.0	---	0.0	0.0	0.0	0.0	---	0.0
28 X 100 mesh	*1.80 Sink*	6	4.8	1.8	0.9	0.9	0.8	---	0.0	0.1	0.1	0.0	---	0.0
28 X 100 mesh fractions comb.		122	9.4	3.1	2.6	1.5	0.9	---	0.1	0.3	0.4	0.3	---	0.0
-100 mesh feed coal fraction[3]		10	1.8	0.7	0.4	0.3	0.2	---	0.0	0.0	0.1	0.1	---	0.0
Cleaned coal head sample[4]		----	160.0	64.0	35.2	41.6	3.2	---	1.6	0.0	3.2	6.4	---	3.2
Feed coal head sample[4]		----	752.0	240.6	210.6	157.9	45.1	---	15.0	15.0	30.0	30.0	---	0.0
Refuse head sample[4]		----	1676.0	519.6	352.0	569.8	33.5	---	16.8	0.0	33.5	134.1	---	33.5

[1] *Mineral values are expressed as pounds of the mineral resulting from float-sink testing one short ton of feed coal.*

[2] *The symbol "--" indicates that the mineral was not present in the coal.*

[3] *Mineral values are expressed as pounds of the mineral resulting from screening one short ton of feed coal at 100 mesh.*

[4] *Minerals are expressed as pounds of the mineral in one short ton of cleaned coal, feed coal, or refuse from the preparation plant.*

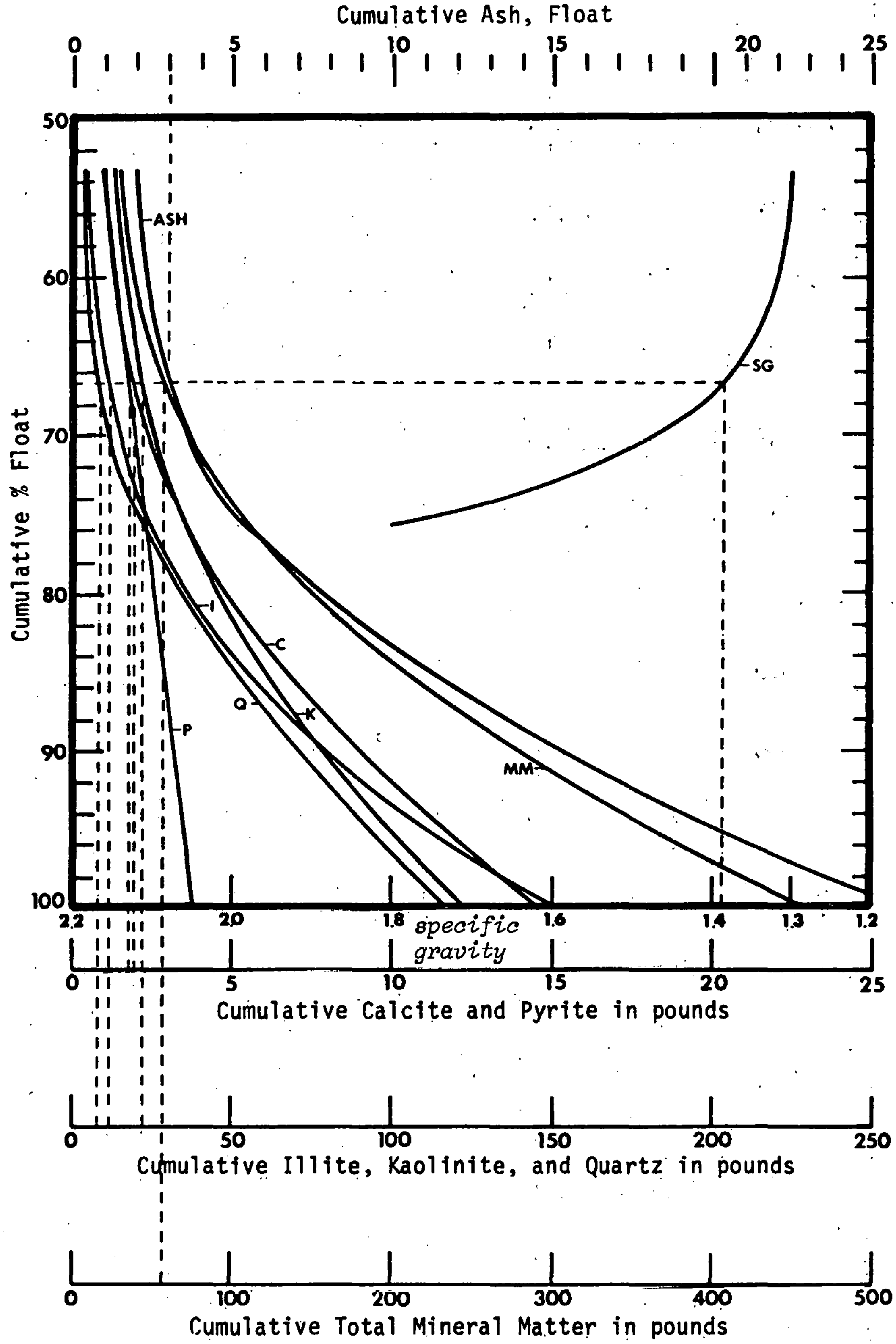

Figure 9

Washability curves for the minerals in the District 7 Pocahontas No.3 coal (See the footnote on the next page for explanations).

quartz, and calcite reflected the high rock content. The steepness of the curves show a dissociation of rock from coal in the float-sink fractionation of this coal. Because of the steepness of the curves, the mineral content of the cleaned coal would vary little over a range of cleaning medium specific gravities. The pyrite curve was steeper than the rest and indicated that the pyrite was fully disseminated in the coal, but absent in the rock.

Mineral washability curves allowed the estimation of mineral abundances in the cleaned coal and refuse depending upon the specific gravity at which the feed coal was cleaned as shown in the example in Figure 9. As with the Pittsburgh coal, the effects of coal sizing on the removal of minerals by specific gravity method was investigated. Table 6 presents the data from Table 5 proportioned within each size range in the same manner as Table 4 for the Pittsburgh coal. The mineral data in Table 6 were studied to determine how well each mineral was separated from the coal, and whether minerals could be segregated using the size and/or the specific gravity of their enclosing coal particles. In Figure 10 mineral separabilities from Table 6 were plotted by coal size. The figure shows that the behavior of the feed material (Pocahontas No. 3 coal and roof and floor rock) during float-sink fractionation was highly size-dependent. The finest feed material sizes reported to the 1.30 float fractions and the largest sizes reported to the 1.80 sink fractions.

Washability curves for the minerals in the Pocahontas No. 3 coal from District 7. Mineral values are expressed in cumulative pounds of the mineral in the cleaaed coal with the assumption that one short ton of feed coal had been cleaned. For reference purposes the cumulative float ash and specific gravity curves were plotted, and the yield values may be read on the cumulative % float scale on the left of the diagram. The dashed lines illustrate the working of the curves through example. In the example it was assumed that cleaned coal with an ash value of 3.0% was needed. Using that ash value the specific gravity at which the coal must be cleaned was 1.39, and the yield produced was 67%. Mineral weights in the cleaned coal produced at that specific gravity were: Total Mineral Matter = 60 pounds; Illite = 12 pounds; Kaolinite = 25 pounds; Quartz = 8 pounds; Calcite = 2 pounds; and Pyrite = 2 pounds.

TABLE 6

The constituents in the Pocahontas No.3 coal from District 7 proportioned in a manner that the amount of the constituent in the 1.30 float, plus the amount in the 1.80 sink, plus the amount in the middlings (1.30 X 1.80) totalled to 100% in each size fraction. The absolute separability, |1.30F - 1.80S|, was greatest for constituents which were greatly liberated in the coal, and therefore easily separated by specific gravity methods.

Size Fraction	*Specific Gravity/ Separability*	COAL	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	PYRITE
+1 inch	1.30F	14	1	0	2	0	3	67
	1.30 X 1.80	20	6	4	1	5	8	33
	1.80S	65	93	96	98	95	89	0
	Separability	-51	-92	-96	-96	-95	-86	+67
1 inch	1.30F	21	1	0	2	1	2	33
X	1.30 X 1.80	37	14	11	13	32	15	67
¼ inch	1.80S	42	85	89	85	68	83	0
	Separability	-21	-83	-89	-83	-67	-82	+33
¼ inch	1.30F	55	10	1	2	3	12	0
X	1.30 X 1.80	31	24	61	44	18	38	29
8 mesh	1.80S	13	66	38	54	78	50	71
	Separability	+42	-56	-36	-52	-75	-38	-71
8 mesh	1.30F	75	21	31	50	20	36	60
X	1.30 X 1.80	19	29	59	45	68	54	40
28 mesh	1.80S	6	50	10	5	12	9	0
	Separability	+69	-29	+21	+46	+8	+27	+60
28 mesh	1.30F	82	29	26	42	20	11	67
X	1.30 X 1.80	13	20	16	23	20	0	0
100 mesh	1.80S	5	51	58	35	60	89	33
	Separability	+77	-22	-32	+8	-40	-78	+33

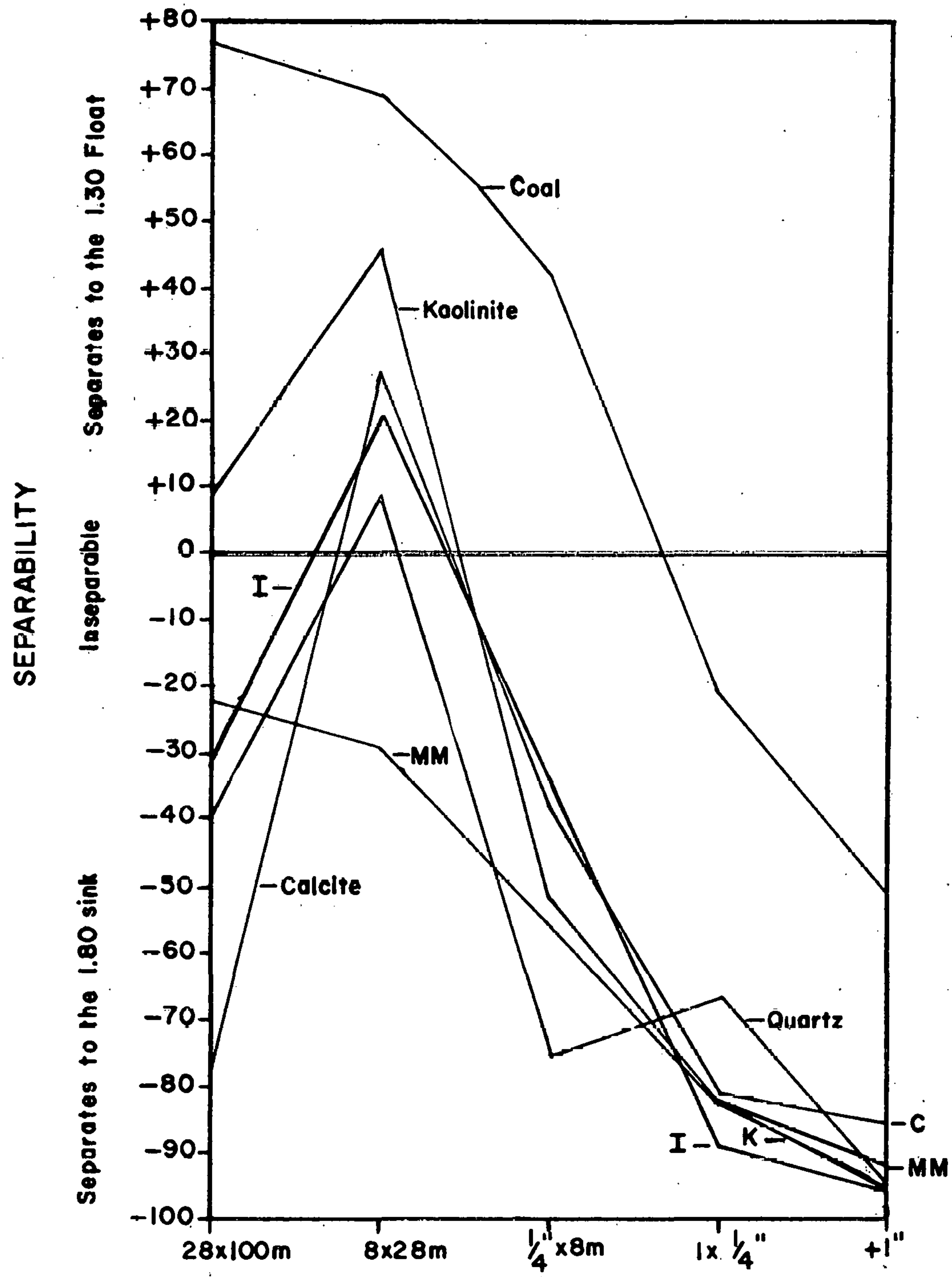

Figure 10. Size vs. Separability for the minerals in the Pocahontas No. 3 Coal.

I = illite, K = kaolinite, Q = quartz, C = calcite

Specific minerals behaved differently. Minerals in the larger (+8 mesh) feed material particles reported to the 1.80 sink fractions; however, minerals in the finest sizes also reported to the 1.80 sink. For all sizes of the Pocahontas No. 3 feed coal, except the 8 x 28 mesh size fraction, the minerals were highly separable, and specific gravity techniques of mineral segregation were highly effective.

Mineral Distributions - Illinois No. 6 Coal

Mineral species abundances in the size and specific gravity fractions of the District 10 Illinois No. 6 feed coal were reported in Table 21 of Quarterly Report No. 9. To better use these mineral values in the interpretation of mineral paths through the commercial preparation plant and the pilot plant, weight percent values were calculated to weights of each mineral in each float-sink fraction as described in the mineral distribution section of this report for the Pittsburgh coal. Distributions of the minerals in the size and specific gravity fractions were examined, washability curves for the dominant minerals were constructed, and the relative effectiveness of specific gravity was evaluated based on each dominant mineral's size and morphology, and its relationship to coal particle size and specific gravity.

Table 7 presents the recalculated float-sink mineral data. The accuracies of the data in Table 7 are ±10 pounds for illite, ±5 pounds for kaolinite and quartz, and ±1 pound for calcite and pyrite. Five important minerals in the Illinios No. 6 coal (illite, kaolinite, quartz, calcite, and pyrite) were further investigated to ascertain their washability characteristics. In Figure 11 the washability curves for these minerals are plotted and show the cumulative mineral content of the cleaned coal at specific gravitites between 1.30 and 1.80. The shape of the washability curves indicated the effectiveness of coal cleaning by specific gravity on the removal of each mineral. The shape and slope of the washability curves in Figure 11 are similar for all of the minerals. Below

TABLE 7

Mineral Weights in the Float-Sink Fractions of the Illinois No.6 Coal.

Size Fraction	Specific Gravity Fraction	COAL REPORTING	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	DOLOMITE	SIDERITE	PYRITE	FELDSPAR	MUSCOVITE	APATITE	BASSANITE
		lb[1]	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*	*lb*
+1 inch	*1.30 Float*	45	3.9	1.6	0.6	0.9	0.2	---[2]	---	0.7	---	---	---	---
+1 inch	*1.40 Float*	32	5.4	1.1	0.6	1.4	0.3	---	---	0.8	---	---	---	---
+1 inch	*1.60 Float*	6	1.7	0.1	0.2	0.4	0.1	---	---	0.6	---	---	---	---
+1 inch	*1.80 Float*	6	2.7	0.6	0.3	0.5	0.2	---	---	0.8	---	---	---	---
+1 inch	*1.80 Sink*	66	61.1	22.6	5.5	15.9	2.4	---	---	7.9	---	---	---	---
+1 inch fractions combined		155	74.8	26.0	7.2	19.1	3.2	---	---	10.3	---	---	---	---
1 X ¼ inch	*1.30 Float*	236	20.5	6.8	3.3	4.5	1.0	---	---	4.3	---	---	---	---
1 X ¼ inch	*1.40 Float*	95	16.4	6.4	2.1	3.9	0.8	---	---	3.1	---	---	---	---
1 X ¼ inch	*1.60 Float*	24	6.7	1.3	0.8	1.5	0.5	---	---	1.7	---	---	---	---
1 X ¼ inch	*1.80 Float*	9	4.0	1.0	0.4	0.8	0.3	---	---	1.2	---	---	---	---
1 X ¼ inch	*1.80 Sink*	126	116.6	43.1	10.5	29.1	4.7	---	---	17.5	---	---	---	---
1 X ¼ inch fractions combined		490	164.2	58.6	17.1	39.8	7.3	---	---	27.3	---	---	---	---
¼ inch X 8 mesh	*1.30 Float*	310	23.9	6.0	3.1	5.5	1.2	---	---	5.5	---	---	---	---
¼ inch X 8 mesh	*1.40 Float*	87	17.3	1.4	2.1	4.2	0.9	---	---	3.5	---	---	---	---
¼ inch X 8 mesh	*1.60 Float*	23	6.6	1.4	0.9	1.4	0.4	---	---	1.6	---	---	---	---
¼ inch X 8 mesh	*1.80 Float*	12	3.8	0.9	0.5	0.8	0.3	---	---	0.9	---	---	---	---
¼ inch X 8 mesh	*1.80 Sink*	79	69.1	33.2	6.9	16.6	4.8	---	---	11.0	---	---	---	---
¼" X 8 mesh fractions combined		511	120.7	42.9	13.5	28.5	7.6	---	---	22.5	---	---	---	---

[1] *Mineral values are expressed as pounds of the mineral resulting from float-sink testing one short ton of the feed coal.*

[2] *The symbol "--" indicates that the mineral was not present in the coal.*

TABLE 7

(continued)

Size Fraction	Specific Gravity Fraction	COAL REPORTING lb[1]	MINERAL MATTER lb	ILLITE lb	KAOLINITE lb	QUARTZ lb	CALCITE lb	DOLOMITE lb	SIDERITE lb	PYRITE lb	FELDSPAR lb	MUSCOVITE lb	APATITE lb	BASSANITE lb
8 X 28 mesh	*1.30 Float*	229	16.5	7.1	3.0	3.6	0.7	---[2]	---	3.5	---	---	---	---
8 X 28 mesh	*1.40 Float*	114	25.2	7.6	3.5	6.1	1.3	---	---	4.3	---	---	---	---
8 X 28 mesh	*1.60 Float*	36	10.2	3.4	1.4	2.4	0.9	---	---	1.4	---	---	---	---
8 X 28 mesh	*1.80 Float*	16	6.5	2.2	0.9	1.4	0.5	---	---	1.1	---	---	---	---
8 X 28 mesh	*1.80 Sink*	62	52.7	12.1	4.7	11.1	8.4	---	---	6.3	---	---	---	---
8 X 28 mesh fractions combined		457	111.1	32.4	13.5	24.6	11.8	---	---	16.6	---	---	---	---
28 X 100 mesh	*1.30 Float*	48	4.8	2.1	0.9	1.0	0.3	---	---	0.8	---	---	---	---
28 X 100 mesh	*1.40 Float*	223	65.6	26.9	9.8	14.4	6.6	---	---	7.2	---	---	---	---
28 X 100 mesh	*1.60 Float*	21	6.8	2.7	1.0	1.6	0.4	---	---	0.7	---	---	---	---
28 X 100 mesh	*1.80 Float*	9	3.7	1.5	0.6	0.9	0.3	---	---	0.4	---	---	---	---
28 X 100 mesh	*1.80 Sink*	44	34.0	10.2	3.4	6.5	7.1	---	---	3.7	---	---	---	---
28 X 100 mesh fractions comb.		345	114.9	43.7	15.7	24.4	14.7	---	---	12.8	---	---	---	---
-100 mesh feed coal fraction[3]		44	16.4	4.8	2.3	3.9	1.1	---	---	2.0	---	---	---	---
Cleaned coal head sample[4]		----	254.0	61.0	30.5	53.3	35.6	---	---	40.6	---	---	---	---
Feed coal head sample[4]		----	562.0	0.0	50.6	123.6	56.2	---	---	112.4	---	---	---	---
Refuse head sample[4]		----	1676.0	687.2	167.6	419.0	100.6	---	---	201.1	---	---	---	---
Black-water slurry fines[4]		----	1088.0	0.0	97.9	293.8	54.4	---	---	76.2	---	---	---	---

1 *Mineral values are expressed as pounds of the mineral resulting from float-sink testing one short ton of feed coal.*

2 *The symbol "--" indicates that the mineral was not present in the coal.*

3 *Mineral values are expressed in pounds resulting from screening one short ton of feed coal at 100 mesh.*

4 *Minerals are expressed as pounds of the mineral in one short ton of cleaned coal, feed coal, refuse, or black-water fines from the preparation plant.*

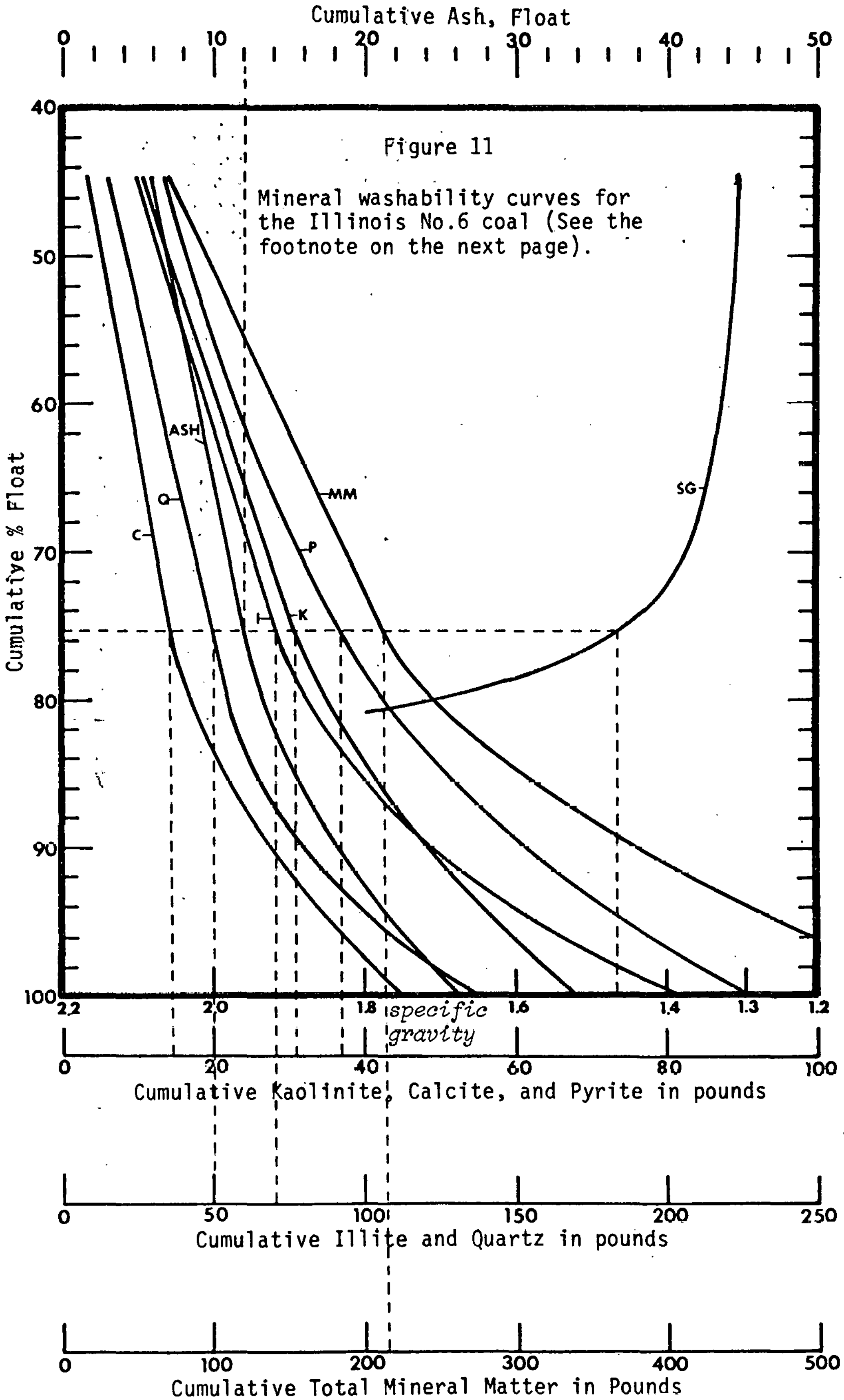

Figure 11

Mineral washability curves for the Illinois No.6 coal (See the footnote on the next page).

TABLE 8

The constituents in the Illinois No.6 coal from District 10 proportioned in a manner that the amount of the constituent in the 1.30 float, plus the amount in the 1.80 sink, plus the amount in the middlings (1.30 X 1.80) totalled to 100% in each size fraction. The absolute separability, |1.30F - 1.80S|, was greatest for constituents which were greatly liberated in the coal, and therefore easily separated by specific gravity methods.

Size Fraction	*Specific Gravity/ Separability*	COAL	MINERAL MATTER	ILLITE	KAOLINITE	QUARTZ	CALCITE	PYRITE
+1 inch	1.30F	29	5	6	8	5	6	6
	1.30 X 1.80	28	13	7	15	12	19	20
	1.80S	43	82	87	76	83	75	73
	Separability	-14	-76	-81	-68	-79	-69	-67
1 inch X ¼ inch	1.30FF	48	12	12	19	11	14	15
	1.30 X 1.80	26	16	15	19	16	22	22
	1.80S	26	71	74	61	73	64	63
	Separability	+22	-59	-62	-42	-62	-51	-47
¼ inch X 8 mesh	1.30FF	61	20	14	23	19	16	24
	1.30 X 1.80	24	23	9	26	22	21	27
	1.80S	15	57	77	51	58	63	49
	Separability	+45	-37	-63	-28	-39	-47	-24
8 mesh X 28 mesh	1.30F	50	15	22	22	15	6	21
	1.30 X 1.80	36	38	41	43	40	23	41
	1.80S	14	47	37	35	45	71	38
	Separability	+37	-33	-15	-13	-30	-65	-17
28 mesh X 100 mesh	1.30F	14	4	5	6	4	2	6
	1.30 X 1.80	73	66	72	73	69	50	65
	1.80S	13	30	23	22	27	48	29
	Separability	+1	-25	-19	-16	-23	-46	-23

specific gravity 1.50, the mineral curves are linear, and the specific gravity curve is very steep. A slight change in specific gravity of the washing medium at low gravities would produce a great change in yield of cleaned coal, but only a moderate change in mineral content. Above specific gravity 1.50, yield increased less, but the minerals did not increase greatly either.

Mineral washability curves allowed the estimation of mineral abundances in the cleaned coal and refuse depending upon the specific gravity at which the feed coal was cleaned as shown in the example in Figure 11. As with the Pittsburgh coal, the effects of coal sizing on the removal of minerals by specific gravity methods was investigated. Table 8 presents the data from Table 7 proportioned within each size range in the same manner as Table 4 for the Pittsburgh coal. The mineral data in Table 8 were studied to determine how well each mineral was separated from the coal, and whether minerals could be segregated using the size and/or the specific gravity of their enclosing coal particles. In Figure 12 mineral separabilities from Table 8 were plotted by coal size. The minerals of the Illinois No. 6 coal, except calcite, increase in separability with increased coal partize size. The feed material had greatest separability in the middle sizes (28 mesh x 1 inch). The finest feed material reported equally to the 1.30 float and the 1.80 sink, but as can be seen in Table 8 the majority of the material reported to the middlings. Most of the largest feed material

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Washability curves for the minerals in the Illinois No. 6 coal from District 10. Mineral values are expressed in cumulative pounds of the mineral in the cleaned coal with the assumption that one short ton of feed coal had been cleaned. For reference purposes the cumulative float ash and specific gravity curves were plotted, and the yield values may be read on the cumulative % float scale on the left of the diagram. The dashed lines illustrate the working of the curves through example. In the example, it was assumed that cleaned coal with an ash value of 12% was needed. Using that ash value, the specific gravity at which the coal must be cleaned was 1.47, and the yield product was 75%. Mineral weights in the cleaned coal produced at that specific gravity were: Total Mineral Matter = 215 pounds; Illite = 70 pounds; Kaolinite = 31 pounds; Quartz = 50 pounds; Calcite = 15 pounds; and Pyrite = 37 pounds.

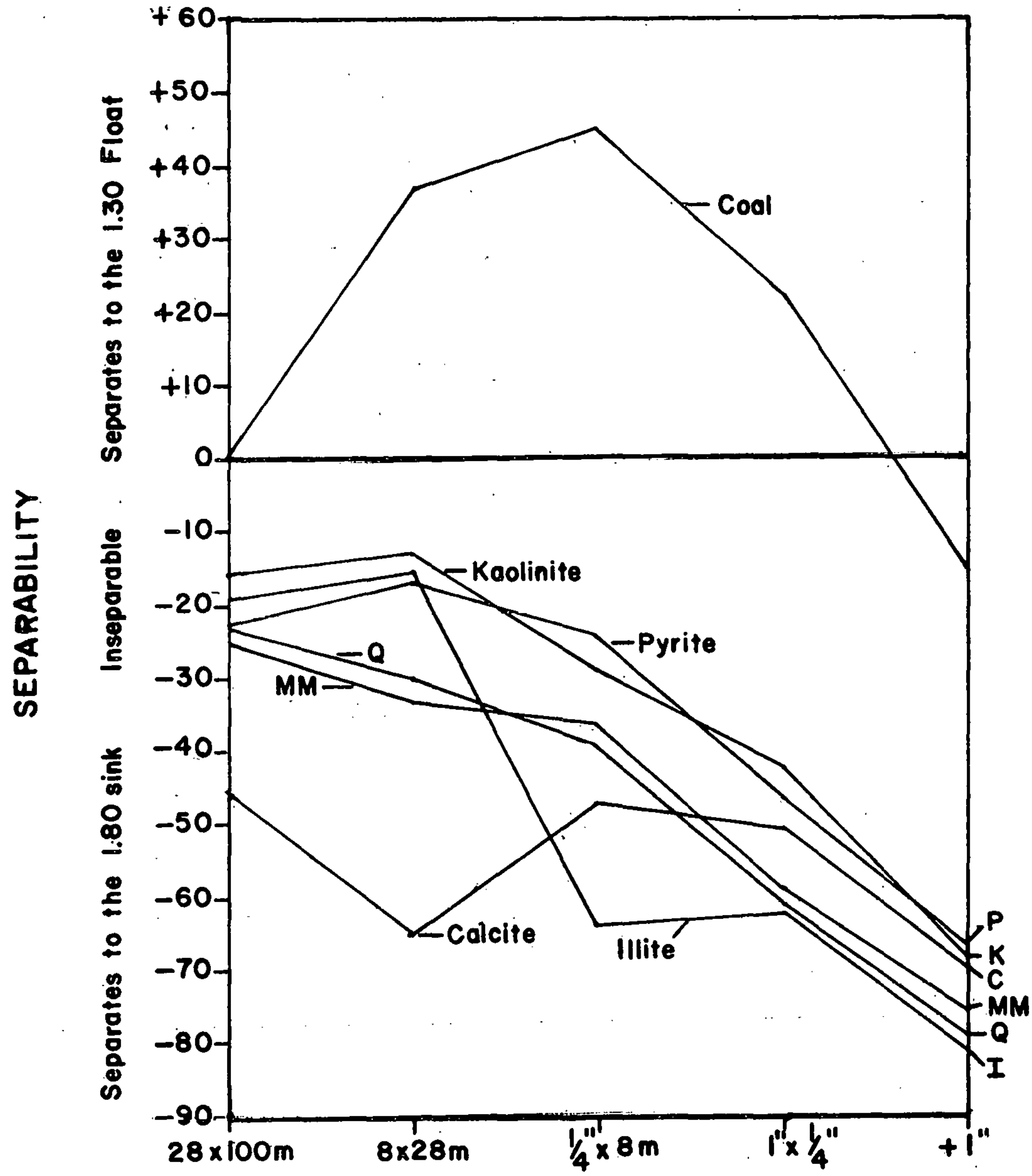

Figure 12. Size vs. Separability for the minerals in the Illinois No. 6 Coal.

I = illite, K = kaolinite, Q = quartz, C = calcite, P = pyrite reported to the 1.80 sink fraction. Calcite was dissociated from the other materials in the finest sizes. These findings explain what is commonly observed in most coal preparation plants, i.e. that large coal sizes are easily cleaned, while finer screened-coal fractions are often increasingly difficult to clean.

Mineral Distributions - General Observations

Ignoring differences in feed coal size, extraction methods, coal rank, and other factors about the coals studied, some general conclusions about coal mineral washabilities can be formed. The paths minerals followed in float-sink analysis and other specific gravity fractionation methods of coal cleaning were primarily determined by the mineral's specific gravity which was always greater than that of the coal. The separability of coal-mineral interrelationships were also very important and were size-dependent. For some mineral occurrences common in the three coals investigated, the separability could be anticipated. Rock-like mineral occurrences such as floor and roof rock material, partings, sulfur balls and coal-balls usually were dominant in the larger feed coal sizes, and reported to the 1.80 sink fractions. Minerals which reported with those occurrences included illite, quartz, pyrite, and calcite. Some illite and quartz was finely disseminated in the coal and was inseparable. Kaolinite occurred in the rock-like occurrences descirbed above, but kaolinite was generally disseminated in low mineral matter portions of the coal and reported with the cleaned coal of all sizes. Calcite occurrences, except coal-balls, were generally small and highly separable in the finest coal sizes, but less separable in the larger (+28 mesh) coal particle sizes. Most pyrite was finely disseminated in these coals, and rarely occurred as a separable mineral occurrence.

Mineral Washability Curve Applications

The applicability of the three sets of mineral washability curves derived in this report was tested by comparisons of mineral values predicted by the curve with actual mineral values measured in the cleaned coals from the commercial preparation plant, and the pilot plant scale Deister Table, "Baum" Jig, WEMCO HMS Drum Separator, and Heavy Media Cyclone. The ash values of the various product coals were used as keys for the curves from which yields, specific gravities of the cleaning media, total mineral matter, and weights of the individual minerals were estimated as presented in Tables 9, 10, and 11 for the Pittsburgh, Pocahontas No. 3, and the Illinois No. 6 coals, respectively. Mineral weights were proportioned on the assumption that one short ton of feed coal had been processed. One problem with applying the washability curves to the pilot plant tests was that the curves were based on the whole feed coal, and that the various pilot plant equipment used only specific size fractions of the whole coal. As discussed elsewhere in this report, the ease with which a mineral may be separated from the coal by specific gravity methods was sometimes highly size-dependent. Size-related effects will be discussed as each equipment type is discussed.

Commercial preparation plant product coal mineral abundances compared very well with the values derived from the mineral washability curves for all three coals. This showed that modified float-sink testing was useful in predicting the flow of specific minerals through a coal preparation plant. The use of this method to predict mineral paths through individual commercial sizing and cleaning equipment needs further investigation, but the pilot plant studies in this report provide an excellent beginning.

The mineralogic compositions of the Deister Table products compared very well with the washability curve values though only the finest 50-70% of the feed coal was cleaned on the table.

TABLE 9

Mineral weights in the products of the commercial preparation plant and the pilot plant scale coal cleaning equipment. Actual mineral weights are compared to weights predicted from the mineral washability curves of the Pittsburgh coal.

	Commercial Plant		*Deister Table 3/16" X 100M*		*"Baum" Jig 1" X 3/16"*		*WEMCO HMS Drum Separator 2" X 10M*		*Heavy Media Cyclone 10 X 100M*	
	actual	*curve*	*actual*	*curve*	*actual*	*curve*	*actual*	*curve*	*actual*	*curve*
YIELD	?	94%	85%	83%	71%	93%	89%	85%	94%	95%
S.G.	?	>1.80	?	1.35	?	>1.80	?	1.38	?	>1.80
ASH	8.0%	8.0%	5.9%	5.9%	7.7%	7.7%	6.2%	6.2%	8.4%	8.4%
M.M.	200#	195#	126#	120#	133#	185#	138#	135#	183#	210#
ILLITE	62#	51#	16#	29#	28#	46#	55#	31#	6#	58#
KAOLINITE	38#	38#	34#	30#	29#	38#	39#	31#	32#	41#
QUARTZ	38#	32#	21#	20#	25#	30#	23#	22#	26#	34#
CALCITE	12#	10#	13#	4#	12#	8#	10#	4#	9#	12#
PYRITE	40#	40#	30#	23#	28#	36#	0#	26#	36#	44#

 # = pounds of the mineral in the cleaned coal when one short ton of feed coal is cleaned.
M.M. = Mineral matter.
S.G. = Specific gravity of the washing medium.

TABLE 10

Mineral weights in the products of the commercial preparation plant and the pilot plant scale coal cleaning equipment. Actual mineral weights are compared to weights predicted from the mineral washability curves of the Pocahontas No.3 coal.

	Commercial Plant		*Deister Table 3/16" X 100M*		*"Baum" Jig 1" X 3/16"*		*WEMCO HMS Drum Separator 2" X 10M*		*Heavy Media Cyclone 10M X 100M*	
	actual	*curve*	*actual*	*curve*	*actual*	*curve*	*actual*	*curve*	*actual*	*curve*
YIELD	?	79%	86%	77%	48%	77%	45%	73%	92%	73%
S.G.	?	>1.80	?	1.60	?	>1.80	?	1.60	?	1.60
ASH	7.0%	7.0%	4.3%	4.3%	6.1%	6.1%	4.5%	4.5%	4.4%	4.4%
M.M.	160#	140#	82#	85#	67#	120#	47#	85#	92#	85#
ILLITE	64#	35#	24#	18#	20#	27#	12#	18#	26#	18#
KAOLINITE	35#	43#	30#	30#	24#	38#	17#	30#	37#	30#
QUARTZ	42#	30#	13#	15#	9#	25#	7#	15#	15#	15#
CALCITE	3#	4#	4#	3#	4#	4#	3#	3#	5#	3#
PYRITE	0#	2#	2#	2#	1#	2#	2#	2#	0#	2#

 # = pounds of the mineral in the cleaned coal when one short ton of feed coal is cleaned.
M.M. = Mineral Matter.
S.G. = Specific gravity of the washing medium.

TABLE 11

Mineral weights in the products of the commercial preparation plant and the pilot plant scale coal cleaning equipment. Actual mineral weights are compared to weights predicted from the mineral washability curves of the Illinois No.6 coal.

	Commercial Plant		Deister Table 3/16" X 100M		"Baum" Jig 1" X 3/16"		WEMCO HMS Drum Separator 2" X 10M		Heavy Media Cyclone 10M X 100M	
	actual	curve	actual	curve	actual	curve	actual	curve	actual	curve
YIELD	?	78%	87%	62%	63%	57%	95%	56%	93%	56%
S.G.	?	1.58	?	1.34	?	1.32	?	1.32	?	1.32
ASH	12.7%	12.7%	9.2%	9.2%	8.5%	8.5%	8.0%	8.0%	8.0%	8.0%
M.M.	254#	210#	210#	150#	143#	130#	207#	125#	199#	125#
ILLITE	61#	78#	46#	50#	4#	42#	37#	40#	6#	40#
KAOLINITE	31#	32#	31#	22#	19#	18#	31#	18#	26#	18#
QUARTZ	53#	52#	50#	35#	34#	30#	48#	28#	48#	28#
CALCITE	35#	16#	10#	10#	7#	8#	6#	7#	8#	7#
PYRITE	41#	40#	38#	25#	27#	21#	48#	20#	40#	20#

# = pounds of the mineral in the cleaned coal when one short ton of feed coal is cleaned.
M.M. = Mineral Matter.
S.G. = Specific gravity of the washing medium.

The mineralogic compositions and yield values of the "Baum" type jig did not compare well with the washability curve values. As described in Quarterly Report No. 9, test sample constraints never allowed the refuse bed to become thick enough to remove all of the clean coal fraction from the refuse, and as such, somewhat erratic mineral values were measured in the jig product coals.

All three product coals from the WEMCO HMS drum separator contained very erratic mineral abundances when compared to the mineral washability curves. No explanation for these mineral occurrences was determined.

The mineralogic compositions of the Heavy Media Cyclone products compared well with the washability curve values. Differences in illite contents were probably a result of the large XRPD errors inherent for that mineral.

Results of the pilot plant test runs indicate that the mineral washability curves best predict the behavior of the Deister Table and Heavy Media Cyclone in which fine coal sizes were cleaned. The commercial coal preparation plants were nearly ideally predicted by the mineral washability curves.

Petrographic Analysis - Illinois No. 6 Coal

Eighteen macerals and submacerals were identified in the District 10 Illinois No. 6 coal and are presented in Table 12. The nineteenth constituent is the total mineral matter content of the coals as determined petrographically. Abundances of individual mineral species in this coal were presented in Table 21 of Quarterly Report No. 9. Each data point presented in Table 12 has an expected error of ± 3 volume percent (ref. equations in Quarterly Report No. 3).

The range of maceral abundances was important in the interpretation of the petrography of these samples. Table 13 presents the minimum and maximum values measured for each maceral. Because the maceral values were non-normally distributed, the ranges of values were the only statistics available to describe the maceral frequency distributions. The distributions of the macerals in the size and float-sink fractions were very important in explaining the effects of macerals on coal preparation and the effects of coal preparation on the maceral distributions.

The distribution of macerals within the float-sink fractions was largely as expected, especially when the data were examined on a whole coal basis. Macerals of the vitrinite group observed in this coal included telinite and collinite. Vitrodetrinite from Table 6 of Quarterly Report No. 4 was not observed in these samples. Telinite was a rare maceral, and its cell lumens were filled with resinite or mineral matter (mainly illite), but lumens sometimes occurred empty. Collinite consisted of the two submacerals telocollinite and desmocollinite with the former most prevalent. Some vitrinite in these samples included oval bodies containing a minute (2 micron) granular material of vitrinite-to-exinite appearance. This type of vitrinite was referred to by the Illinois State Geological Survey by the informal descritive term "mottled vitrinite"[1], and for our purposes was point counted as telocollinite.

Referring to Table 12, the finest, the 28 x 100 mesh, size fraction contained the greatest proportion of vitrinite of the 6 size fractions. A size-related trend was noted in the 1.80 sink fractions in which vitrinite content increased substantially from 4% in the +1 inch fraction to 16% in the 28 x 100 mesh fraction. Within each size fraction the vitrinite content decreased with increased specific gravity, and was replaced mainly by the increased mineral matter content of the coal.

Five exinite macerals were observed in this coal, but they represented only a small protion of the whole coal. Sportinite was presented in the lower specific gravity fractions in the forms of microspore (maceral variety-microsporinite, and less than 200 microns in diameter) and megaspores (maceral variety-macrosporinite, and greater than 200 microns in diameter). Cutinite was also present in the lower specific gravity fractions in the

TABLE 12

PETROGRAPHIC ANALYSES OF ILLINOIS NO.6 COAL FLOAT-SINK FRACTIONS AND HEAD SAMPLES PRESENTED AS VOLUME PERCENT OF THE WHOLE COAL

	+1 inch					1 X ¼ inch					¼ inch X 8 mesh				
	1.30F	1.40F	1.60F	1.80F	1.80S	1.30F	1.40F	1.60F	1.80F	1.80S	1.30F	1.40F	1.60F	1.80F	1.80S
VITRINITE	89%	78%	62%	48%	4%	88%	80%	65%	40%	6%	93%	74%	62%	45%	8%
Telinite	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Collinite	89	77	62	48	4	88	80	65	40	6	93	73	62	45	8
telocollinite	88	76	61	48	4	86	75	61	35	5	91	72	59	42	8
desmocollinite	1	1	1	0	0	2	4	4	5	0	2	1	3	3	1
EXINITE	2%	3%	2%	3%	0%	3%	3%	3%	4%	0%	2%	3%	2%	3%	0%
Sporinite	1	2	1	1	0	2	1	1	0	0	0	1	1	0	0
Cutinite	1	0	1	0	0	1	1	1	0	0	1	1	0	0	0
Resinite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exsudatinite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liptodetrinite	1	1	1	2	0	1	1	1	3	0	1	1	1	2	0
INERTINITE	3%	7%	9%	9%	3%	4%	6%	10%	12%	2%	3%	8%	12%	14%	3%
Fusinite	1	4	4	5	2	1	1	4	5	1	0	2	5	8	2
pyrofusinite	1	3	3	4	1	0	0	2	4	1	0	1	2	6	2
degradofusinite	0	1	1	1	0	1	1	2	1	0	0	1	2	1	0
Semifusinite	1	1	2	2	1	1	2	4	5	1	1	4	3	3	1
pyrosemifusinite	1	1	0	1	1	1	1	2	2	0	1	2	2	1	0
degradosemifusinite	1	1	2	1	0	1	2	2	3	1	1	2	2	2	1
Macrinite	0	1	1	1	0	1	1	1	2	0	0	0	1	1	1
Micrinite	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inertodetrinite	1	1	2	1	0	1	1	1	1	0	1	1	3	3	0
MINERAL MATTER	5%	14%	27%	39%	93%	5%	11%	22%	45%	92%	3%	16%	24%	38%	88%

TABLE 12

(continued)

	8 X 28 mesh					28 X 100 mesh								
	1.30F	1.40F	1.60F	1.80F	1.80S	1.30F	1.40F	1.60F	1.80F	1.80S	-100 mesh fraction	Feed Coal Head	Cleaned Coal Head	Refuse Head
VITRINITE	91%	68%	62%	45%	10%	92%	72%	66%	48%	16%	63%	66%	84%	12%
Telinite	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Collinite	91	68	62	44	10	91	72	66	48	16	63	65	84	12
telocollinite	90	66	60	43	10	91	70	65	47	16	63	65	81	12
desmocollinite	1	2	1	1	0	0	1	1	0	0	0	0	2	0
EXINITE	3%	2%	3%	2%	0%	2%	3%	2%	1%	0%	1%	3%	2%	0%
Sporinite	1	1	1	0	0	1	1	1	0	0	0	3	1	0
Cutinite	1	1	1	0	0	0	1	1	0	0	1	0	0	0
Resinite	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Exsudatinite	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Liptodetrinite	1	1	1	1	0	0	0	1	1	0	1	1	1	0
INERTINITE	3%	11%	8%	15%	3%	4%	13%	12%	14%	7%	25%	6%	6%	3%
Fusinite	0	4	3	6	1	2	6	5	6	3	15	2	2	2
pyrofusinite	0	3	2	5	1	1	4	4	5	3	15	2	2	1
degradofusinite	0	2	1	1	0	1	2	1	1	1	0	0	1	1
Semifusinite	2	4	3	5	1	1	4	3	3	1	3	2	2	0
pyrosemifusinite	1	2	1	2	0	1	2	1	1	0	2	0	1	0
degradosemifusinite	1	2	2	3	0	0	2	2	2	1	1	2	1	0
Macrinite	0	0	0	1	0	1	1	1	1	0	0	0	1	1
Micrinite	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Inertodetrinite	1	2	2	3	1	1	2	3	5	3	7	1	1	1
MINERAL MATTER	3%	19%	27%	31%	87%	2%	13%	20%	37%	76%	11%	26%	8%	85%

TABLE 13

MACERALS PRESENT IN THE ILLINOIS NO.6 DISTRICT 10 COAL SAMPLES WITH THEIR MINIMUM AND MAXIMUM OBSERVED VALUES

GROUP MACERAL Maceral submaceral	Minimum	Maximum
VITRINITE	4% (60%)*	93% (96%)*
Telinite	0%	1%
Collinite	4%	93%
telocollinite	4%	91%
desmocollinite	0%	5%
EXINITE	0% (0%)*	4% (7%)
Sporinite	0%	3%
Cutinite		1%
Resinite	0%	0%
Exsudatinite	0%	0%
Liptodetrinite	0%	3%
INERTINITE	2% (2%)*	25% (39%)*
Fusinite	0%	15%
pyrofusinite	0%	15%
degradofusinite	0%	2%
Semifusinite	0%	5%
pyrosemifusinite	0%	2%
degradosemifusinite	0%	3%
Macrinite	0%	2%
Micrinite	0%	0%
Inertodetrinite	0%	7%
MINERAL MATTER	2%	93%

* Parentheses indicate values of the maceral group recalculated to a mineral-matter-free basis.

maceral varieties tenuicutinite (thin-walled) and crassicutinite (thick-walled). Resinite was commonly observed, but was not quantitatively important. Exsudatinite is an exinite maceral found in lower-ranked coals, and it was observed in this coal filling cavities, fractures, and desiccation cracks. This maceral too was quantitatively unimportant. Liptodeterinite represented fragmented exinite macerals in this coal, and was quantitatively most important in the 1.80 float fractions in which coal and mineral matter are most intimately mixed. The exinite group was evenly distributed through all of the specific gravity fractions except the 1.80 sink fractions in which all macerals were diluted to low abundances in the mineral-rich coal.

Important inertinite abundances occurred in this coal. Fusinite and semifusinite were the dominant inertinite macerals, and both increased in abundance from the 1.30 float fractions to the 1.80 float fractions. This was probably due to mineralizations within the cell lumens increasing the specific gravity of the fusinite and its enclosing coal particles. Macrinite was commonly observed, but micrinite was very rare in this coal. Inertodetrinite included fragmented inertinite macerals and was a prominent maceral in the 1.80 float fractions in which minerals and macerals are intimately intermixed. The inertinite group as a whole showed a general trend to increase in relative abundance in the finer coal sizes.

Mineral matter content increased as the specific gravity of the coal fraction increased. The 1.80 sink fractions always contained the greatest amount of mineral matter, but the mineral content of these fractions decreased in the finer coal sizes which indicated a greater mixing of minerals and macerals in the finer coal particles. In the Illinois No. 6 coal the larger coal particles which reported to the 1.80 sink fraction were nearly pure mineral matter, but the finer coal which reported to the same fraction contained significant vitrinite and inertinite maceral content. This was an opposite trend from what might have been exptected, but similar to trends observed in the Pittsburgh and Pocahontas No. 3 coals.

Petrographically determined mineral matter represented the actual mineral content of the coal as evidenced in Figure 13 where petrographic mineral matter was plotted versus the low temperature ash (LTA) content of the coals. A linear regression analysis of the points plotted on Figure 13 produced an R^2 value of +0.982, a very good correlation, and a slope of 1.07 for the regression line. The line slope of 1.07 indicates that the petrographic mineral analysis consistently determined lower mineral matter values than the low temperature ashing. Petrographic mineral matter values are compared to other mineral matter measurements (ash, LTA, and Parr mineral matter) in Table 14. Close agreement existed between LTA and Parr mineral matter in all samples. Volume percent petrographic mineral matter generally fell below the LTA or Parr mineral matter, especially in the lighter specific gravity fractions. The difference was possibly caused by the coal's inherent mineral matter which was finely dispersed in the coal and therefore unobservable with the optical microscope, but may also be due to differences caused by comparisons of volume percent with weight percent values. Calculations show that in low mineral matter coal fractions the volume percent mineral matter will always be less than the weight percent values. In the mineral-rich fractions (1.30 float and 1.30 sink) the inherent mineral matter would be diluted by the extraneous (optically observable) mineral matter and therefore less affect the petrographic mineral matter determinations. Calculations also show that differences caused by comparisons of volume percent with weight percent are minimal in high mineral matter and fractions.

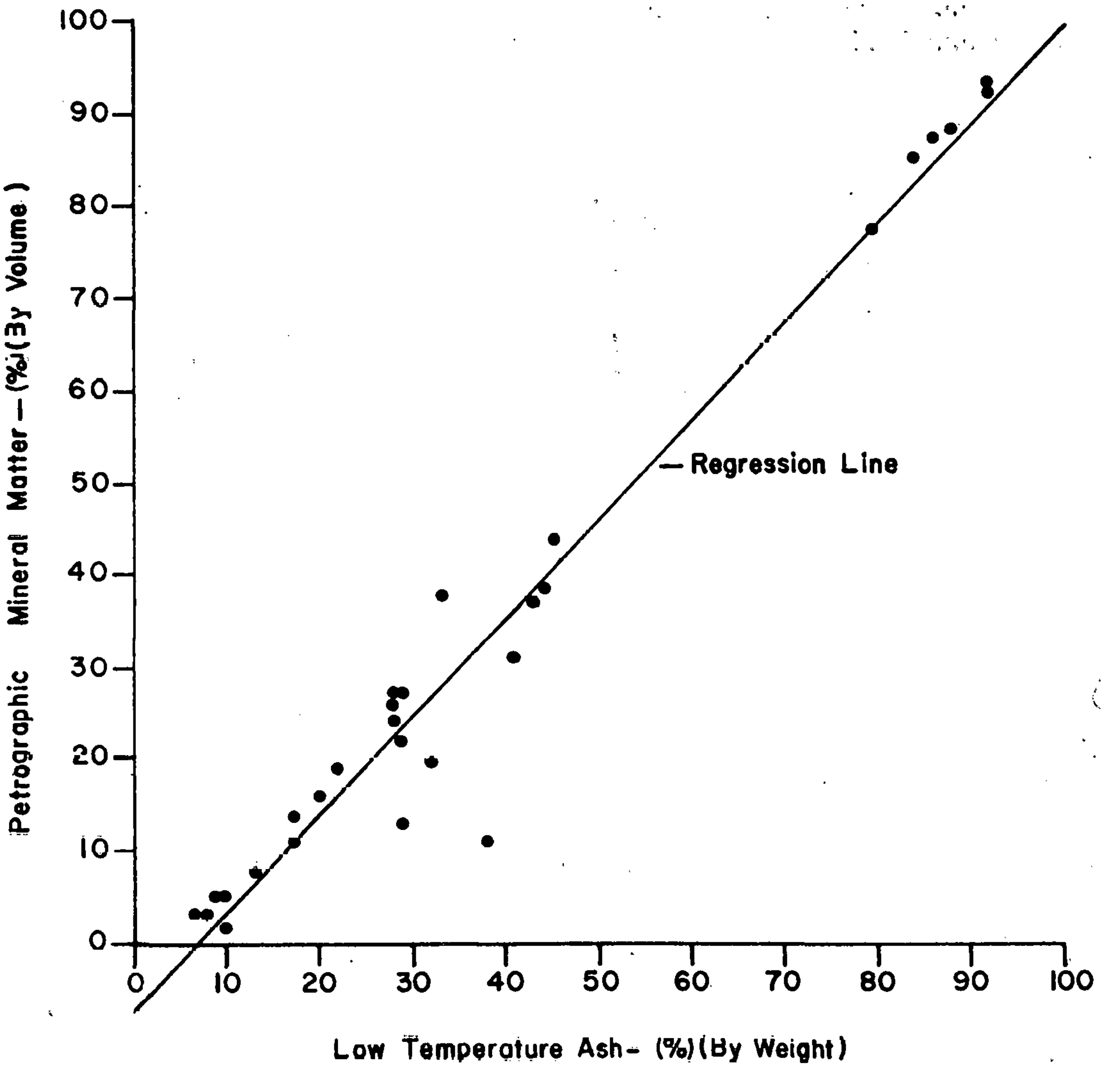

Figure 13

Relationship Between True Mineral Matter (LTA) And Petrographically Observed Mineral Matter In The Illinois No. 6 District 10 Preparation Plant Feed Coal

TABLE 14

A comparison of "true" mineral matter (LTA), ash values, Parr mineral matter values, and petrographic mineral matter (PMM) values in the District 10 Illinois No.6 coal float-sink fractions and head samples.

Size	*Specific Gravity*	ASH *(weight percent)*	LTA *(weight percent)*	PARR *(weight percent)*	PMM *(volume percent)*
+1 inch	1.30 float	6.4%	8.7%	9.0%	5%
+1 inch	1.40 float	13.8%	16.9%	17.3%	14%
+1 inch	1.60 float	22.5%	29.0%	28.9%	27%
+1 inch	1.80 float	36.7%	44.2%	44.8%	39%
+1 inch	1.80 sink	83.8%	92.5%	94.4%	93%
1X¼ inch	1.30 float	6.0%	8.7%	8.6%	5%
1X¼ inch	1.40 float	14.1%	17.3%	17.8%	11%
1X¼ inch	1.60 float	23.2%	28.6%	28.9%	22%
1X¼ inch	1.80 float	37.6%	44.7%	45.0%	44%
1X¼ inch	1.80 sink	84.0%	92.5%	94.6%	92%
¼X8 mesh	1.30 float	6.0%	7.7%	8.6%	3%
¼X8 mesh	1.40 float	16.8%	20.0%	20.7%	16%
¼X8 mesh	1.60 float	23.2%	28.4%	28.5%	24%
¼X8 mesh	1.80 float	27.6%	32.6%	33.7%	38%
¼X8 mesh	1.80 sink	78.2%	87.5%	88.4%	88%
8X28 mesh	1.30 float	5.0%	7.2%	7.4%	3%
8X28 mesh	1.40 float	19.5%	22.1%	23.5%	19%
8X28 mesh	1.60 float	25.1%	28.3%	29.6%	27%
8X28 mesh	1.80 float	36.0%	40.8%	42.1%	31%
8X28 mesh	1.80 sink	77.4%	85.5%	87.3%	87%
28X100 mesh	1.30 float	8.0%	9.9%	10.6%	2%
28X100 mesh	1.40 float	26.6%	29.4%	30.7%	13%
28X100 mesh	1.60 float	29.3%	32.5%	33.7%	20%
28X100 mesh	1.80 float	39.5%	43.0%	44.9%	37%
28X100 mesh	1.80 sink	69.1%	77.9%	78.3%	76%
-100 mesh screen fraction		34.2%	37.6%	39.1%	11%
Clean coal head		12.7%	15.7%	16.1%	8
Feed coal head		28.1%	32.9%	33.1%	26%
Refuse head		78.3%	83.8%	88.2%	85%

In summarizing the results of the petrographic analyses of the District 10 Illinois No. 6 coal it appeared that vitrinite content of the coal increased with decreased specific gravity and also decreased coal size. Exinite content changed little over the specific gravity and size ranges examined. Inertinite content of the fractions increased as specific gravity increased and size increased. Mineral matter content increased as specific gravity of the fraction increased and size increased. Liptodetrinite and inertodetrinite, both fragmental maceral remains, were greatest in the 1.80 float fractions where macerals and minerals are most intimately mixed.

REFERENCES

1. Personal communications, Richard D. Harvey, Illinois State Geological Survey.

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