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COKE CRUSHING CHARACTERISTICS

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ABSTRACT

Tests on coke from pilot and commercial ovens have indicated that the amount of coke fines produced when crushing to 3/4-inch top size for the chemical industry is dependent on the coke strength as determined by the American Society for Testing Materials tumbler test. A low tumbler stability index favors a minimum production of fines and a maximum yield of the larger 1/2" × 3/4" pieces. It is indicated also that a minimum production of fines is favored by a high tumbler hardness index.

Cokes meeting these requirements of low stability and high hardness have been made experimentally from Illinois bituminous B and C rank coals. By using these coals a minimum of fines has been produced during crushing.

INTRODUCTION

Coke that is to be used in the electric furnace reduction of ores, or in the conversion of limestone into calcium carbide, may have entirely different physical properties than are required for metallurgical coke. This "chemical coke" does not require the strength, or resistance to breakage, so necessary for blast furnace coke. The size of the chemical coke charged into electric reduction furnaces must be smaller than that of blast furnace coke. To obtain this small size the larger coke from coke ovens must be crushed, usually to a top size of about 3/4-inch. Very small sizes must be screened from the crushed coke, leaving an acceptable size of about 3/4" × 1/8".

Problems encountered in crushing chemical coke to the desired size range include excessive wear on crusher rolls, the production of coke dust, and a considerable percentage of minus 1/8-inch screenings. Dust that escapes into the atmosphere is a nuisance and that retained is a fire and health hazard. The screenings find a market, but at a lower return than the larger coke. Therefore, chemical coke producers strive to obtain a maximum yield of 3/4" × 1/8" size, or a similar size acceptable to the customer, and a minimum yield of the less valuable fines.

Coke fines can be kept at a minimum by choosing the proper coal, or coal blend, and by using a coke crusher designed to produce a minimum of screenings. A combination of the proper coal and a well designed crusher can increase the yield of sized coke by many percent.

Preliminary experimental work at the Illinois State Geological Survey had shown that cokes made from certain Illinois coals, and certain blends of Illinois and eastern coals, produced less fines, and less dust, than cokes made from all-eastern higher-rank coals. These tests had indicated that a relation existed between coke strength as measured by the American Society for Testing Materials tumbler stability index, and the amount of fines produced by crushing. Contrary to what might have been expected, strong cokes with high stability produced more fines on crushing than did the weaker cokes.

To check these findings over a wider range of cokes the Survey has systematically tested forty cokes made in the pilot oven over a five-month period. A crushing test was developed by which samples of all cokes were reduced to a size range similar to that required for chemical coke. Cokes from commercial coke plants, of both chemical and metallurgical quality, were tested also by the same procedure. In addition, the crushing results from our laboratory were checked against those from a commercial-type crusher designed to crush to the desired size range.

Acknowledgements

We wish to acknowledge the cooperation of Illinois and eastern coal producers who have furnished coals for these tests. We also wish to thank the Chemical Coke Company, Granite City Steel Company, Great Lakes Carbon Corporation, T. J. Gundlach Machine Company, New York Mining and Manufacturing Company, and Wisconsin Steel Company for furnishing cokes and crushing facilities.

PROCEDURE

Crushing properties of cokes were evaluated by using an adequate number of cokes with strengths ranging from very weak to very strong. These cokes were made in our pilot coke oven from coals and blends being tested primarily for other purposes. Coals included high-volatile coals from Illinois and eastern Appalachian mines, coked by themselves and in blends with medium- and low-volatile coals. Past experience has shown that pilot-oven cokes closely duplicate cokes made from the same coals in commercial plants.

Several commercial cokes from both beehive and slot-type ovens were tested in the same manner as the pilot-oven cokes.

Coke crushing tests were made on twenty-five pound samples. The 3" × 2" and 2" × 1" sizes were tested separately on all cokes from the pilot oven. Commercial cokes were tested on the 3" × 1" size. Duplicate tests were made on all samples where sufficient coke of the proper size was available. Duplicates are averaged in the tables and illustrations except in table 1.

Cokes were crushed in our laboratory jaw-crusher, the setting of which was not changed throughout the entire series of tests. The plus 3/4-inch coke produced ranged from 3 percent to less than one-half percent of the total. All crushed cokes were screened over 3/4", 1/2", 1/4", and 1/8" Tyler screens.

This crushing procedure was checked by comparison with results from a Gundlach two-stage adjustable coke crusher, set to give 3/4-inch top size. Three cokes were crushed in duplicate in each crusher and the results compared.

RESULTS

Duplicate Tests

Duplicate testing was continued throughout the entire series, although it soon became apparent that the results of such tests checked closely.

Table 1 shows crushing results on ten sets of duplicates representing five cokes; half are on the 3" × 2" size, and half on the 2" × 1" size. These test cokes were picked at random to cover the range of minus 1/8-inch screenings. The minus 1/8-inch screenings are shown to check within one percentage point in seven of the ten cases; the greatest variation between duplicates was 3.2 percentage points. Crushing results shown in subsequent tables are the average of duplicates except in the few cases where only one test was made.

Comparison of 3" × 2" and 2" × 1" Sizes

Experimental results indicate that there is very little difference between the crushing characteristics of 3" × 2" and 2" × 1" cokes. Minus 1/8-inch screenings produced by crushing both sizes checked within one percentage point for 24 of the 38 cokes tested, where both sizes were crushed. The maximum deviation in fines from the two sizes for any coke tested was 2.1 percentage points, and the average deviation for all cokes was 0.8 percentage point. The 3" × 2" size produced slightly more fines from 18 cokes, and the 2" × 1" produced more fines from an equal number. The production of fines was the same from both sizes of the remaining 2 cokes. Complete sizing results on all cokes crushed are given along with tumbler test data in table 7.

Coke Screenings vs. ASTM Tumbler Stability

Each coke produced in the pilot oven was sized and tested for strength by the ASTM tumbler procedure. The percentages of minus 1/8-inch screenings obtained from crushing tests were plotted against their respective tumbler stability indices, and a definite trend was found to exist between the percentage of minus 1/8-inch fines and tumbler stability.

Cokes in the tumbler stability range of from 10 to 30 produced from 12.2 to 17.6 percent of minus 1/8" screenings. These included most of the cokes made from 100 percent high-volatile coals. Stability and crushing results for all cokes in this range are given in table 2.

From 18.2 to 26.2 percent of minus 1/8-inch screenings were obtained at the stability range of from 45 to 60. Only 6 of the 44 crushing tests in this stability range produced less than 20 percent screenings. Stability and crushing results for these cokes are given in table 3.

Cokes in the intermediate stability range, between 30 and 45, produced from 14.6 to 21.7 percent minus 1/8-inch screenings. Of the 16 cokes tested in this group, 11 had less than 20 percent screenings. Although the results as plotted in figure 1 were quite scattered, they were nevertheless intermediate between the high and low ranges. Stability and sizing data are given in table 4.

Conversely to the trend in minus 1/8-inch screenings, the percentage of plus 1/2-inch size coke from the crusher was higher for cokes with tumbler stability indices under 30, lower for cokes with stabilities 45 to 60, and intermediate for cokes with intermediate stabilities. These values are listed also in tables 2, 3, and 4.

All values for minus 1/8-inch screenings over the entire range of tumbler stabilities are plotted in figure 1. Likewise, all values for plus 1/2-inch size coke from the crushing tests are plotted against tumbler stability in figure 2. Even though sizing results are scattered, very definite trends are shown for both screenings and the plus 1/2-inch sizes.

Although it is hard to assign values to the amount of dust produced when crushing small samples of coke, visual observations were made. It became apparent that certain cokes with low stability were less dusty during crushing than other harder cokes. This was observed also at one commercial plant where both Illinois and eastern coals were coked by themselves and compared.

It is not feasible to assess the wear on crusher rolls by laboratory tests. However, it is logical to believe that softer, less stable pieces of coke will cause less wear than harder, more stable pieces.

Correlations With ASTM Hardness Index

It was not possible from the data obtained to plot direct relation between crushing characteristics and the ASTM hardness index. Data did indicate, however, that scattering of the minus 1/8-inch screenings in figure 1 could be due in part to variations in coke hardness.

Line AB on figure 1 represents the trend in minus 1/8-inch screenings over the range of tumbler stability. Screening values within 2 percent of the trend line are bounded by lined CD and EF. There are 13 points plotted above line CD, indicating that these cokes produced a higher percentage of fines than the trend. These 13 cokes had a low average hardness index of 60.6. There are 10 points below line EF, indicating exceptionally low yields of fines. These cokes had a higher average hardness index of 65.8.

Considering all values plotted in figure 1, the average hardness index of all cokes plotted above the trend line AB is 61.5, and of all cokes plotted below this line is 65.2. It is indicated strongly, therefore, that coke hardness does influence the production of fines when crushing coke to as low as 3/4-inch top size and that a high hardness value is advantageous.

Commercial Oven Cokes

Coke crushing characteristics were checked also on 7 samples of chemical and metallurgical cokes produced in commercial plants in both beehive and slot-type ovens. Beehive ovens included both circular and rectangular types. Of these

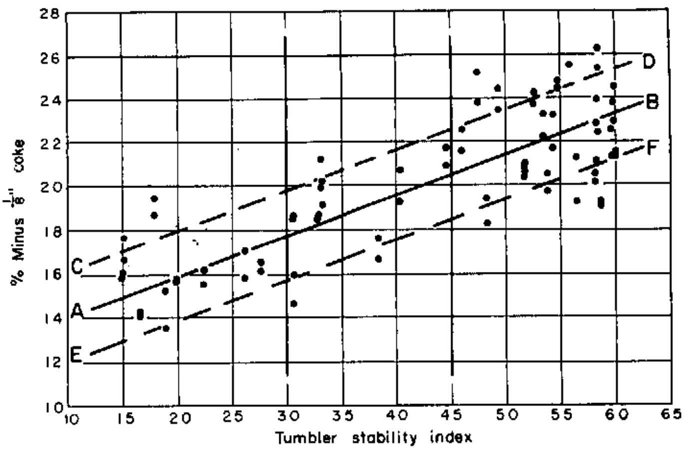

Figure 1 - Minus 1/8" coke screenings from crusher vs. tumbler stability index–pilot-oven cokes.

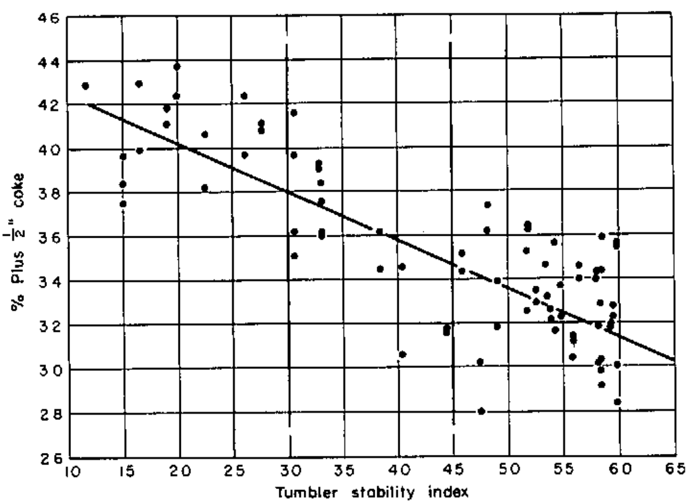

Figure 2 - Plus 1/2" coke from crusher vs. tumbler stability index–pilot-oven cokes.

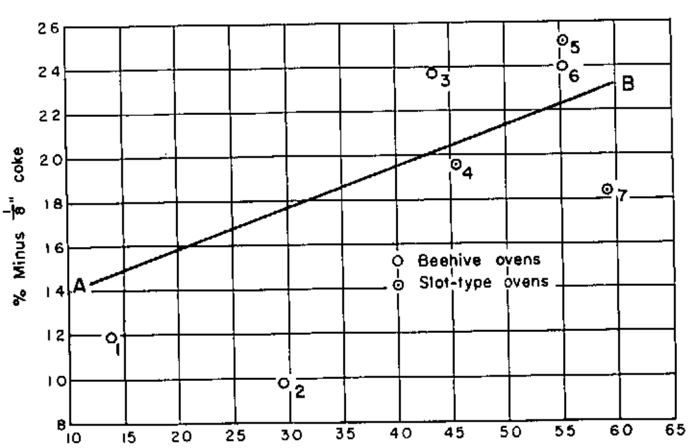

Figure 3 - Minus 1/8" coke screenings from crusher vs. tumbler stability index–commercial cokes. Line AB is same location as in figure 1.

seven cokes, six were made from all-eastern coals, and only one contained coal from Illinois. This is in contrast to pilot-oven cokes, a large percentage of which were made from Illinois coals or from blends containing them.

Tumbler stabilities of these 7 commercial cokes ranged from 13.8 to 59.1. When crushed by the procedure used with the pilot-oven cokes, the minus 1/8-inch screenings ranged from 9.8 to 25.1 percent. These results are given in table 5 and plotted in figure 3.

There is considerable spread in these crushing data, perhaps due in part to the different types of ovens in which the cokes were made. However, the relation between minus 1/8-inch screenings and coke stability remained essentially the same as with the pilot-oven cokes. Two cokes with stabilities under 30 produced less than 12 percent of minus 1/8-inch screenings, and the remaining 5 cokes, all with stabilities over 40, produced from 18 to 25 percent of the minus 1/8-inch size.

It appears that the hardness of these commercial cokes, like that of the pilot-oven cokes, had considerable influence on crushing characteristics. Note from figure 3 that cokes 3, 5, and 6 produced more minus 1/8-inch screenings than would be indicated from their stability indices alone. These three cokes had low hardness indices ranging from 54.3 to 61.7. Cokes 1, 2, and 7 produced exceptionally small amounts of screenings, well below what would be indicated by the trend line AB. These three cokes had high hardness indices ranging from 68.5 to 72.0. Coke 4, which is plotted almost on line AB, has an intermediate hardness index of 65.2. It is indicated strongly, therefore, that the hardness indices of these commercial cokes are related to the fines produced during crushing.

Comparison of Laboratory and Commercial Crushers

As a check on our crushing procedure, we have compared crushing results from our laboratory jaw-crusher with those from a Gundlach two-stage crusher of commercial size. This commercial crusher was set to produce a top coke size of about 3/4-inch, similar to the laboratory crusher. Three pilot-oven cokes were crushed as usual in the laboratory. Duplicate samples were then taken to the Gundlach plant and crushed by their personnel.

The size consists of the crushed cokes from the two crushers were remarkably similar considering the differences in crusher design. Minus 1/8-inch screenings from the two crushers, while not identical, varied only from 1.3 to 3.3 percentage points. Comparative sizes of these crushed cokes are listed in table 6.

SUMMARY AND CONCLUSIONS

Crushing tests have been made on cokes produced from a variety of coals and coal blends in pilot size and commercial slot-type ovens, and in circular and rectangular beehive ovens. These tests indicate that the amount of coke fines produced when crushing to 3/4-inch top size is influenced strongly by coke strength as measured by the ASTM tumbler test. A low tumbler stability index favors a minimum production of fines and a maximum yield of the larger 1/2" × 3/4" pieces. Crushing results appear to be influenced also by coke hardness, and it is strongly indicated that a high hardness index favors minimum fines from the crusher.

Cokes meeting these requirements of low stability and high hardness have been made experimentally from Illinois high-volatile bituminous B and C rank coals.

Other coals used commercially have been shown to produce cokes with similar characteristics. These cokes have been shown to produce a minimum percentage of fines when crushed to a size required by the chemical industry for utilization in electric furnaces.

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TABLE 1 - DUPLICATE CRUSHING TESTS

Run No.	Sizing of Crushed Coke (%) +3/4"	3/4"x1/2"	1/2"x1/4"	1/4"x1/8"	-1/8"
3" x 2" Coke					
826 E (1)	1.3	40.5	33.7	11.0	13.5
(2)	0.8	39.5	34.9	11.3	13.5
827 E (1)	0.9	33.6	35.7	12.8	17.0
(2)	0.9	33.6	34.0	13.2	18.3
830 E (1)	1.7	36.5	30.7	12.0	19.1
(2)	1.7	35.3	31.9	12.0	19.1
778 E (1)	0.9	31.3	30.9	12.0	24.9
(2)	0.9	31.5	30.2	12.9	24.5
809 E (1)	1.7	26.3	34.3	13.6	24.1
(2)	2.1	26.7	33.1	13.1	25.0
2" x 1" Coke					
826 E (1)	1.3	39.8	34.7	10.6	13.6
(2)	1.7	40.8	33.6	7.1	16.8
827 E (1)	0.8	37.3	34.3	11.9	15.7
(2)	0.8	33.9	35.7	12.0	17.6
830 E (1)	1.7	34.4	31.9	11.6	20.4
(2)	1.3	34.7	31.4	12.5	20.1
778 E (1)	1.3	31.9	30.6	12.1	24.1
(2)	1.3	32.4	30.6	11.3	24.4
809 E (1)	2.6	27.6	34.0	12.8	23.0
(2)	2.1	27.8	33.8	13.5	22.8

TABLE 2 - CRUSHING TEST RESULTS

Tumbler Stability - 10 to 30

Run No.	Tumbler Stability	Crushed Coke % Minus 1/8" 3" x 2"	% Minus 1/8" 2" x 1"	% Plus 1/2" 3" x 2"	% Plus 1/2" 2" x 1"
770 E	11.6	12.2		42.9	
779 E	27.6	16.1	16.5	41.1	40.8
784 E	19.9	15.6	15.7	42.4	43.7
787 E	22.4	15.5	16.2	38.2	40.6
788 E	15.1	16.6	17.6	39.7	39.0
789 E	15.0	15.9	15.8	38.4	37.5
802 E	26.1	15.8	17.0	39.7	42.4
810 E	16.6	14.0	14.2	39.9	43.0
826 E	18.9	13.5	15.2	41.1	41.8
Average values	19.2	15.0	16.0	40.4	41.1

TABLE 3 – CRUSHING TEST RESULTS
Tumbler Stability – 45 to 60

Run No.	Tumbler Stability	Crushed Coke			
		% Minus 1/8"		% Plus 1/2"	
		3" x 2"	2" x 1"	3" x 2"	2" x 1"
777 E	47.5	25.1	23.8	28.0	30.3
778 E	54.8	24.7	24.4	32.3	33.7
780 E	59.6	22.5	21.3	32.3	32.8
781 E	58.6	19.2	19.0	34.4	35.9
785 E	59.7	23.7	23.7	32.0	31.9
786 E	52.6	23.7	24.2	33.5	33.0
790 E	49.3	24.4	23.4	31.9	33.9
791 E	55.9	25.5	25.5	31.5	31.2
800 E	53.5	22.2	23.2	34.7	33.2
801 E	45.9	22.5	21.6	34.4	35.2
803 E	51.7	20.6	20.8	36.3	36.5
804 E	60.0	21.4	21.5	35.7	35.6
805 E	54.3	21.7	23.2	35.7	31.7
806 E	58.4	26.2	25.3	29.2	29.9
807 E	56.5	21.3	19.2	34.6	34.0
808 E	58.2	21.1	22.8	31.9	30.2
809 E	59.9	24.5	22.9	28.4	30.1
811 E	51.7	21.0	20.4	32.6	35.3
812 E	58.1	20.5	20.1	34.3	34.0
813 E	53.9	19.7	20.5	32.2	32.6
814 E	58.4	23.9	22.4	30.4	32.9
829 E	48.3	19.4	18.2	36.3	37.4
Average values	54.8	22.5	22.1	32.8	33.2

TABLE 4 – CRUSHING TEST RESULTS

Tumbler Stability – 30 to 45

Run No.	Tumbler Stability	Crushed Coke			
		% Minus 1/8"		% Plus 1/2"	
		3" x 2"	2" x 1"	3" x 2"	2" x 1"
776 E	32.8	18.5	18.6	39.1	39.3
782 E	30.6	14.6	15.9	41.6	39.7
783 E	33.1	19.9	21.2	36.0	38.4
827 E	38.4	17.6	16.6	34.5	36.2
830 E	33.3	19.1	20.2	37.6	36.1
831 E	44.5	21.7	20.9	31.8	31.6
832 E	30.6	18.5	18.6	35.1	36.2
833 E	40.4	20.7	19.2	30.6	34.6
Average values	35.5	18.8	18.9	35.8	36.5

TABLE 5 - CRUSHING TEST RESULTS ON COMMERCIAL PLANT COKES

Plant	Tumbler Test		Screen Analysis - Crushed Coke (%)				
	Stability	Hardness	+3/4"	3/4"x1/2"	1/2"x1/4"	1/4"x1/8"	-1/8"
1	13.8	68.5	0.8	46.1	32.1	9.1	11.9
2	29.4	72.0	1.8	45.1	33.0	10.3	9.8
3	43.3	54.3	1.7	34.8	29.6	10.2	23.7
4	45.5	65.2	1.7	33.9	32.9	11.9	19.6
5	55.3	57.3	2.1	30.0	29.8	13.0	25.1
6	55.2	61.7	2.7	37.4	26.5	9.4	24.0
7	59.1	70.7	2.3	34.7	33.2	11.4	18.4

TABLE 6 - COMPARATIVE COKE SIZING FROM LABORATORY AND COMMERCIAL CRUSHERS

	Type Crusher	Screen Analysis - Crushed Coke (%)				
		+3/4"	3/4"x1/2"	1/2"x1/4"	1/4"x1/8"	-1/8"
Coke 1	Laboratory	0.4	40.2	33.5	10.6	15.3
	Gundloch	3.2	37.9	30.3	10.0	18.6
Coke 2	Laboratory	2.0	32.5	28.5	11.8	25.2
	Gundloch	2.2	33.8	31.2	10.0	22.8
Coke 3	Laboratory	1.4	31.1	34.0	11.6	21.9
	Gundloch	1.9	32.9	33.5	11.1	20.6

TABLE 7 - COMPLETE TUMBLER AND COKE SIZING DATA

Run No.	Coal or Blend	Tumbler Test		Original Coke Size	Sizing of Crushed Coke (%)				
		Stability	Hardness		+3/4"	3/4"x1/2"	1/2"x1/4"	1/4"x1/8"	-1/8"
770 E	100% Ill. 2 A†	11.6	60.5	3 x 2	-	42.9	38.4	6.5	12.2
776 E	90% Ill. 6 A	32.8	67.0	3 x 2	0.4	38.7	35.0	7.4	18.5
	10% Hernshaw			2 x 1	0.4	38.9	31.4	10.7	18.6
777 E	80% Ill. 2 A	47.5	59.3	3 x 2	0.4	27.6	33.0	13.9	25.1
	20% Poca.			2 x 1	0.8	29.5	33.4	12.5	23.8
778 E	60% Ill. 2 A	54.8	64.8	3 x 2	0.9	31.4	30.6	12.4	24.7
	40% Poca.			2 x 1	1.3	32.4	30.6	11.3	24.4
779 E	100% Ill. 6 A	27.6	67.1	3 x 2	0.4	40.7	32.2	10.6	16.1
				2 x 1	0.6	40.2	33.0	9.7	16.5
780 E	55% Ill. 6 B	59.6	68.7	3 x 2	1.7	30.6	34.0	11.2	22.5
	20% Ill. 5 A			2 x 1	1.1	31.7	33.9	12.0	21.3
	25% Poca.								
781 E	60% Ill. 6 B	58.6	67.5	3 x 2	0.4	34.0	34.3	12.1	19.2
	20% Ill. 5 A			2 x 1	0.4	35.9	33.0	11.4	19.0
	20% Poca.								
782 E	100% Ill. 6 B	30.6	67.8	3 x 2	0.4	41.2	33.1	10.7	14.6
				2 x 1	0.4	39.3	33.9	10.5	15.9
783 E	100% Ill. 6 B-2	33.1	62.7	3 x 2	0.8	35.2	32.6	11.5	19.9
				2 x 1	1.1	37.3	29.7	10.7	21.2
784 E	100% Ill. 6 A-2	19.9	68.2	3 x 2	0.8	41.6	33.2	8.8	15.6
				2 x 1	0.6	43.1	30.7	9.9	15.7
785 E	50% Ill. 6 A-2	59.7	66.9	3 x 2	1.3	30.7	32.0	12.3	23.7
	50% Basin			2 x 1	0.6	31.3	32.6	11.8	23.7
786 E	100% Basin	52.6	61.4	3 x 2	1.0	32.5	30.8	12.0	23.7
				2 x 1	1.1	31.9	31.3	11.5	24.2
787 E	100% Ill. 6 A-3	22.4	65.6	3 x 2	0.4	37.8	34.5	11.8	15.5
				2 x 1	0.4	40.2	33.4	9.8	16.2

TABLE 7 – Continued

Run No.	Coal or Blend	Tumbler Test		Original	Sizing of Crushed Coke (%)				
		Stability	Hardness	Coke Size	+3/4"	3/4"x1/2"	1/2"x1/4"	1/4"x1/8"	-1/8"
788 E	100% Ill. 7 A	15.1	56.6	3 x 2	0.4	39.3	32.4	11.3	16.6
				2 x 1	0.4	38.6	32.8	10.6	17.6
789 E	100% Ill. 7 A-2	15.0	55.1	3 x 2	0.4	38.0	34.3	11.4	15.9
				2 x 1	0.6	36.9	34.8	11.9	15.8
790 E	80% Ill. 7	49.3	58.8	3 x 2	1.3	30.6	30.8	12.9	24.4
	20% Poca.			2 x 1	1.1	32.8	29.5	13.2	23.4
791 E	60% Ill. 7 A	55.9	63.5	3 x 2	1.7	29.8	30.3	12.7	25.5
	40% Poca.			2 x 1	1.5	29.7	31.1	12.2	25.5
800 E	60% Ill. 7 A	53.5	65.9	3 x 2	2.3	32.4	31.7	11.4	22.2
	40% Med.-Vol.			2 x 1	1.7	31.5	32.2	11.4	23.2
801 E	80% Ill. 7 A-3	45.9	58.5	3 x 2	2.1	32.3	31.3	11.8	22.5
	20% Med.-Vol.			2 x 1	2.3	32.9	32.5	10.9	21.6
802 E	100% Ill. D.&D.*	26.1	59.0	3 x 2	1.0	38.7	34.2	10.3	15.8
				2 x 1	1.2	41.2	30.7	9.9	17.0
803 E	80% Ill. D.&D.*	51.7	63.0	3 x 2	2.5	33.8	32.5	10.6	20.6
	20% Med.-Vol.			2 x 1	1.9	34.6	31.2	11.5	20.8
804 E	60% Ill. D.&D.*	60.0	66.8	3 x 2	2.7	33.0	31.5	11.4	21.4
	40% Med.-Vol.			2 x 1	2.8	32.8	31.7	11.2	21.5
805 E	80% Ill. D.&D.*	54.3	62.8	3 x 2	1.5	34.2	29.9	12.7	21.7
	20% Poca.			2 x 1	1.5	30.2	32.1	13.0	23.2
806 E	60% Ill. D.&D.*	58.4	65.2	3 x 2	1.3	27.9	31.7	12.9	26.2
	40% Poca.			2 x 1	1.5	28.4	32.1	12.7	25.3
807 E	75% Ill. 6 A-4	56.5	67.2	3 x 2	2.1	30.4	33.1	13.1	21.3
	25% Med.-Vol.			2 x 1	2.1	31.9	33.4	13.4	19.2
808 E	62½% Ill. 6 A-4	58.2	67.9	3 x 2	2.1	29.8	33.5	13.5	21.1
	37½% Med.-Vol.			2 x 1	1.5	28.7	34.0	13.0	22.8
809 E	50% Ill. 6 A-4	59.9	67.9	3 x 2	1.9	26.5	33.7	13.4	24.5
	50% Med.-Vol.			2 x 1	2.4	27.7	33.9	13.1	22.9
810 E	100% Ill. 6 C	16.6	64.4	3 x 2	0.8	39.1	34.6	11.5	14.0
				2 x 1	1.0	42.0	32.6	10.2	14.2
811 E	80% Ill. 6 C	51.7	64.1	3 x 2	1.3	31.3	33.9	12.5	21.0
	20% Med.-Vol.			2 x 1	1.3	34.0	33.0	11.3	20.4
812 E	60% Ill. 6 C	58.1	67.1	3 x 2	1.1	33.2	32.9	12.3	20.5
	40% Med.-Vol.			2 x 1	1.7	32.3	33.4	12.5	20.1
813 E	80% Ill. 6 C	53.9	63.5	3 x 2	0.6	31.6	33.1	15.0	19.7
	20% Poca.			2 x 1	1.1	31.5	33.3	13.6	20.5
814 E	60% Ill. 6 C	58.4	65.6	3 x 2	1.7	28.7	33.2	12.5	23.9
	40% Poca.			2 x 1	2.1	30.8	32.7	12.0	22.4
826 E	100% Ill. 6 A-4	18.9	66.4	3 x 2	1.1	40.0	34.3	11.1	13.5
				2 x 1	1.5	40.3	34.2	8.8	15.2
827 E	95% Ill. 6 A	38.4	67.5	3 x 2	0.9	33.6	34.9	13.2	17.6
	5% Med.-Vol.			2 x 1	0.8	35.6	35.0	12.0	16.6
828 E	95% Elkhorn	17.9	53.9	3 x 2	1.2	33.7	32.9	12.8	19.4
	5% Med.-Vol.			2 x 1	1.7	34.2	32.4	13.1	18.6
829 E	95% Hernshaw	48.3	64.0	3 x 2	2.6	33.7	32.1	12.2	19.4
	5% Poca.			2 x 1	3.0	34.4	33.1	11.3	18.2
830 E	95% E. Ky.-B	33.3	58.1	3 x 2	1.7	35.9	31.3	12.0	19.1
	5% Poca.			2 x 1	1.5	34.6	31.6	12.1	20.2
831 E	95% Va.-Taggart	44.5	64.8	3 x 2	0.8	31.0	34.1	12.4	21.7
	5% Med.-Vol.			2 x 1	1.3	30.3	34.3	13.2	20.9
832 E	100% E. Ky.-B	30.6	57.0	3 x 2	0.8	34.3	33.8	12.6	18.5
				2 x 1	1.5	34.7	32.9	12.3	18.6
833 E	90% E. Ky.-B	40.4	60.1	3 x 2	0.8	30.8	33.7	14.0	20.7
	10% Poca.			2 x 1	0.9	33.7	33.7	12.5	19.2

† Number following Ill. indicates coal seam. Information following seam is laboratory code that indicates mine and coal sizing or preparation.

* D. & D.-Abbreviation for Davis and Dekovan seams.

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14