Chilton Coal

Chilton coal (93) yielded 70.9 percent coke at 900° C., and the yields of other products on the basis of per ton of coal were: Gas, 10,600 cubic feet; tar, 13.0 gallons; light oil in gas, 3.24 gallons; and ammonium sulfate, 20.2 pounds. Variation in the yields caused by changing the carbonizing temperature were normal for high-volatile A coals; maximum yields of 23.7 gallons of tar and 24.0 pounds of ammonium sulfate were obtained at 600° and 700° C., respectively. Blending with 20 and 30 percent Pocahontas No. 3 coal increased the yield of coke 2.6-3.6 percent and lowered the yields of other products. Physical test indexes of the 900° C. coke were: 1-1/2-inch shatter, 78.7; 1-inch tumbler, 53.7; and 1/4-inch tumbler, 70.2. The shatter and 1-inch tumbler indexes were appreciably higher than the averages for 25 high-volatile A coals, although the 1/4-inch tumbler index was lower than the average. Blending with 20 percent Pocahontas No. 3 coal raised the shatter and tumbler indexes significantly; the blend containing 30 percent low-volatile coal yielded stronger coke than that containing 20 percent, except that the 1-1/2-inch shatter index was lower.

Lower Cedar Grove-Alma A Coal

The Lower Cedar Grove-Alma A beds are mined as one because they are close together in the Omar No. 5 mine. The carbonization sample (94) contained 62.0 percent fixed carbon on the dry, mineral-matter-free basis, and its heating value was 14,840 B.t.u.; it ranks, therefore, as a high-volatile A coal. At 900° C. it yielded 69.4 percent coke; and, per ton of coal, the yields of other products were: Gas, 10,450 cubic feet; tar, 12.3 gallons; light oil, 3.18 gallons; and ammonium sulfate, 21.4 pounds. The yield of coke was 0.6 percent higher and the yield of tar 1.6 gallons per ton lower than the average yields for 18 high-volatile A coals; other yields were about the same as the averages. Variations in the yields caused by changing the carbonizing temperature generally were normal. Blending with Pocahontas No. 3 coal raised the yield of coke 2.6-4.3 percent and lowered the yields of the other products, except ammonium sulfate. Strength-test indexes of the 900° C. coke and the averages for cokes from 25 high-volatile A coals were, respectively: 1-1/2-inch shatter, 66.3 and 70.4; 1-inch tumbler, 38.2 and 50.8; and 1/4-inch tumbler, 70.0 and 72.2. This comparison indicates that Lower Cedar Grove-Alma A coal cokes less strongly than the average coal of similar rank; however, high-volatile coals generally are carbonized as blends with coals of higher rank; consequently, their individual coking powers are of secondary importance. Blending with Pocahontas No. 3 coal strengthened the coke appreciably, especially when 30 percent of that low-volatile coal was used. The heating value of the 900° C. gas was 589 B.t.u. per cubic foot or 3,080 B.t.u. per pound of coal.

Upper Elkhorn Coal

Upper Elkhorn coal (322) contained less fixed carbon than the two West Virginia coals (59.2 percent on the dry, mineral-matter-free basis); consequently, it yielded less coke and more gas. The yields at 900° C. were 64.8 percent coke; and, per ton of coal, the yields were: gas, 10,850 cubic feet; tar, 12.9 gallons; light oil in gas, 3.48 gallons; and ammonium sulfate, 23.5 pounds. The 900° C. coke had low 1-1/2-inch shatter and 1-inch tumbler indexes (39.2 and 32.5, respectively), although the 1/4-inch tumbler index (74.3) was high. These indexes were satisfactorily high for the blends with Pocahontas No. 3 coal (322A and 322B). The ternary blend, containing 20 percent Pocahontas No. 3 coal, coked more strongly when 30 percent

Pittsburgh-bed coal (322C) was used. The heating values of the gas from 100 percent Elkhorn coal (610 B.t.u. per cubic foot and 3,310 B.t.u. per pound of coal) were high.

Palau No. 5 Coal

Palau No. 5 coal (328) was of medium-volatile rank and contained 13.2 percent ash on the as-carbonized basis, although it had been cleaned by the heavy-media process. It yielded 78.7 percent coke at 900° C., and the yields of other products per ton of coal were: Gas, 9,700 cubic feet; tar, 6.3 gallons; light oil in gas, 1.79 gallons; and ammonium sulfate, 19.2 pounds. The shatter and tumbler indexes of the coke were high, although some cokes of high ash content have low hardness factors or 1/4-inch tumbler indexes. The heating values of the gas were rather low as anticipated, because the ash content of the coal was high and the rank was medium-volatile.

Hill-Bed Coal, Cherokee County, Ala.

An investigation of Hill-bed[85] coal from Hickey No. 1 mine on Lookout Mountain, Cherokee County, Ala., showed it to be of medium-volatile rank, low in ash and sulfur, and strongly coking. The coking power of high-volatile Pittsburgh-bed coal was increased significantly by blending it with 20 percent Hill coal; this blend should be safe to carbonize in by-product ovens because it developed a maximum pressure of only 1.7 pounds per square inch in the vertical expansion-test oven. Hill coal oxidized more rapidly than Pittsburgh coal from the Warden mine and required less oxygen to effect a given decrease in coke strength.

Comparative Tests in BM-AGA and 500-Pound Slot Ovens

The recently constructed 500-pound electrically heated oven was put into operation and used to carbonize five blends of coal at flue temperatures rising from 1,650° F. at the start to 1,810° F. at the end. The following blends were carbonized: 80 percent Corona and 20 percent Pocahontas No. 3 (b316A); a commercial-blend coke in by-product ovens at Pittsburgh, Pa. (336); 65 percent Elkhorn slack and 35 percent Pocahontas (342A); and 40 percent Elkhorn slack, 25 percent Elkhorn egg, and 35 percent Pocahontas (342B). The latter two blends (342A and 342B) are carbonized in industrial by-product ovens at Indiana Harbor, Ind. These blends also were carbonized by the BM-AGA method at 800° and 900° C. for comparison of yields and quality of products obtained by the two methods, the results of which are shown in tables 14 and 15.

The yields of coke were similar for the two test methods, except for blend 342A, which was about 2 percent lower in the 500-pound slot oven. The yields of gas on the percentage basis were higher, and the tar and ammonium sulfate yields were lower for the slot oven. The 900° C. BM-AGA yields check the slot-oven yields more closely than the 800° C. yields.

[85] Davis, J. D., Reynolds, D. A., Ode, W. H., Brewer, R. E., Wolfson, D. E., and Birge, G. W., Carbonizing Properties of Hill-Bed Coal from Hickey No. 1 Mine on Lookout Mountain, Cherokee County, Ala.: Bureau of Mines Tech. Paper 703, 1947, 40 pp.

TABLE 14. - Yields of carbonization products, as-carbonized basis

Coal No.	Retort diameter, inches	Carbonizing temperature, °C.	Yields, percent by weight of coal 1/							Yields per ton of coal 1/				
			Coke	Gas	Tar	Light oil	Free ammonia	Liquor	Total	Gas, cubic feet	Tar, gallons	Light oil, gallons: In gas	Light oil, gallons: Tar to 170° C.	$(NH_4)_2SO_4$, pounds
a94A	18	800	73.0	13.3	6.2	0.66	0.188	6.3	99.6	8,700	13.6	1.93	1.02	26.5
a94A	18	900	72.4	13.9	5.9	.87	.158	6.3	99.5	9,950	12.3	2.46	.72	21.7
a94A	Slot	870-1,010	72.8	14.2	4.2	.66	.137	5.4	97.4	9,800	8.8	1.80	.49	21.0
b316A	18	800	69.9	13.9	6.6	.80	.170	8.2	99.6	8,650	13.9	2.28	.96	30.3
b316A	18	900	69.4	14.6	6.0	.98	.162	7.6	98.7	9,800	12.6	2.73	.81	30.1
b316A	Slot	870-1,010	70.5	15.2	4.4	.57	.116	7.8	98.6	9,950	9.0	1.56	.57	23.7
336	18	800	69.6	13.1	6.6	.71	.169	8.7	98.9	8,600	14.0	2.02	1.05	25.3
336	18	900	69.3	13.8	6.2	.97	.146	8.7	99.1	9,900	12.9	2.69	.71	22.0
336	Slot	870-1,010	69.6	13.1	5.4	.66	.130	8.5	97.4	8,930	11.1	1.79	.84	20.6
342A	18	800	74.0	13.7	4.3	.70	.178	5.9	98.8	9,250	9.5	1.93	.44	23.9
342A	18	900	73.4	14.6	4.1	.90	.148	7.3	100.4	10,400	8.4	2.46	.35	21.1
342A	Slot	870-1,010	71.5	16.6	3.5	.70	.095	7.7	100.1	10,650	7.2	1.92	.31	17.8
342B	18	800	72.2	13.6	4.4	.67	.186	7.9	99.0	9,100	9.3	1.88	.46	25.4
342B	18	900	71.7	14.4	4.0	.78	.146	7.1	98.1	10,350	8.2	2.14	.38	19.7
342B	Slot	870-1,010	72.5	14.2	3.5	.69	.129	7.2	98.2	9,650	7.2	1.90	.36	20.6

1/ Coke, tar, ammonia, and light oil are reported moisture-free; gas is reported as stripped of light oil and saturated with water vapor at 60° F. and under a pressure of 30 inches of mercury.

TABLE 15. - Physical properties of coke

Coal No.	Retort diameter, inches	Carbonizing temperature, °C.	True specific gravity	Apparent specific gravity	Cells, percent	Shatter test, cumulative percent upon- 2-inch screen	1-1/2-inch screen	1-inch screen	1/ 1/4-inch screen	Tumbler test, cumulative percent upon- 2-inch screen	1-1/2-inch screen	1-inch screen	1/2-inch screen	1/ 1/4-inch screen
a94A	18	800	1.87	0.86	54.0	85.5	92.8	96.4	98.4	11.5	31.4	44.5	50.3	50.9
a94A	18	900	1.94	.87	55.2	63.4	84.0	94.8	98.2	1.8	15.3	40.5	57.9	60.8
a94A	Slot	870-1,010	1.91	.86	55.0	80.2	90.3	95.5	98.2	5.3	21.4	42.2	55.5	57.4
b316A	18	800	1.91	.81	57.6	79.8	91.0	94.4	98.4	22.5	49.1	59.8	-	2/66.1
b316A	18	900	1.95	.81	58.5	66.8	85.7	93.9	97.7	.7	16.4	44.0	58.2	60.2
b316A	Slot	870-1,010	1.93	.84	56.5	80.3	90.8	95.8	98.4	6.1	23.9	44.1	53.7	55.3
336	18	800	1.90	.84	55.8	78.6	90.5	95.7	98.1	5.0	32.3	53.4	59.8	60.5
336	18	900	1.91	.86	55.0	50.5	81.7	94.7	98.3	.7	15.8	49.6	63.9	65.5
336	Slot	870-1,010	1.90	.87	54.2	67.5	88.2	95.4	98.3	2.5	21.7	50.9	60.6	61.9
342A	18	800	1.86	-	-	79.3	89.6	95.2	97.7	3.2	28.0	50.3	59.6	60.5
342A	18	900	1.91	.83	56.5	62.9	80.3	93.2	97.1	1.0	10.2	38.0	55.5	61.9
342A	Slot	870-1,010	1.92	.85	55.7	72.6	87.6	94.4	97.3	1.7	13.5	42.5	55.7	57.2
342B	18	800	1.87	.84	55.1	77.5	91.7	95.9	98.1	8.3	32.3	52.7	59.3	59.9
342B	18	900	1.90	.85	55.3	44.7	75.3	93.8	98.1	.0	9.0	44.9	65.2	67.5
342B	Slot	870-1,010	1.89	.84	55.6	68.9	86.2	94.7	98.0	1.2	15.7	45.8	59.1	60.6

1/ Actually 0.261-inch screen.
2/ 1/4-inch screen.

Note: Results determined by the American Society for Testing Materials methods.

The physical properties of the slot-oven cokes generally were intermediate between the 800° and 900° C. BM-AGA cokes. The 800° C. cokes were of larger size, and their 1-1/2-inch shatter and 1-inch tumbler indexes were higher; these differences generally were reversed for the 900° C. cokes, although a comparison of sizes shows that some of the slot-oven cokes were smaller than either BM-AGA coke. The average 1/4-inch tumbler index, hardness factor, for the five slot-oven cokes was 58.5, which is less than the averages for the 800° and 900° C. BM-AGA cokes (59.6 and 63.2, respectively), although this index was lowest for three 800° C. cokes. Table 9 shows no significant differences in the true or apparent specific gravities of cokes obtained by the two methods.

Swelling Properties of Coal During the Coking Process

The sole-heated oven was used in 60 tests, and the large vertical oven in 16 tests to determine the expanding properties of coals from 16 different beds and of 8 blends described in table 7. All large vertical-oven tests were made at a wall temperature equivalent to 2,300°-2,500° F. flue temperature. The expanding properties are given in table 16.

TABLE 16. - Expansion properties of coals

Coal No.	Test moisture, percent	Average test bulk density, lb. per cubic foot	Sole-heated oven expansion, percent: At 55.5 lb. per cubic foot 1/	Sole-heated oven expansion, percent: Dry solid coal	Large vertical oven, maximum pressure on movable wall, lb. per square inch 2/
93	1.9	53.39	-20.3	19.6	-
a93	1.9	53.22	3/-19.7	20.4	-
b93	1.8	53.54	3/-20.0	20.8	-
c93	1.8	53.21	3/-24.6	13.8	-
93A	1.9	53.34	- 7.9	40.2	-
93B	1.8	53.31	- 4.3	45.7	-
94	2.7	53.68	-11.3	37.1	-
a94	2.2	52.97	3/- 5.5	42.2	-
b94	1.9	53.73	3/- 8.4	37.4	-
c94	2.3	53.57	3/- 7.7	39.0	-
d94	2.2	53.51	3/- 7.7	39.9	-
e94	1.9	53.40	3/- 6.4	41.5	-
94A	2.6	53.28	- 4.0	49.0	-
94B	2.6	53.38	- .5	55.0	-
322	4.7	52.91	- 9.5	41.8	-
322A	3.9	52.72	- 6.3	45.7	-
322A	3.7	49.79	-	-	0.45
322B	3.7	53.31	- 3.5	50.8	-
322B	3.7	50.09	-	-	.45
322C	3.1	53.33	- 4.6	47.0	-
322C	3.1	50.49	-	-	.50
323	2.9	53.27	3/- 4.0	48.7	-
323	2.9	49.40	-	-	4.6
323	2.9	49.18	-	-	1.8

See footnotes at end of table on following page.

TABLE 16. - Expansion properties of coal (con.)

Coal No.	Test moisture, percent	Average test bulk density, lb. per cubic foot	Sole-heated oven expansion, percent: At 55.5 lb. per cubic foot1/	Sole-heated oven expansion, percent: Dry solid coal	Large vertical oven, maximum pressure on movable wall, lb. per square inch2/
323A	3.4	52.85	-20.4	24.0	-
323A	3.4	49.78	-	-	.9
323A	3.3	51.79	-	-	.5
324	3.6	53.24	3/-21.2	22.1	-
325	3.1	54.00	3/-23.6	20.3	-
326	3.6	53.73	3/- 7.8	45.0	-
326	3.0	53.55	3, 4/- 2.1	51.9	-
326	3.1	53.21	3, 5/+ .2	55.6	-
326	3.6	49.40	-	-	1.5
326	3.6	51.19	-	-	1.5
a326	2.7	53.22	3/+ 5.5	52.7	-
a326	2.7	49.66	-	-	3.8
327	2.9	52.95	3/-28.1	12.3	-
331	2.0	53.16	3/- 7.6	41.9	-
331	2.0	52.68	-	-	1.5
335	2.2	54.56	3/-13.5	33.0	-
335	2.4	53.39	3, 6/- 7.3	44.0	-
335	2.4	50.80	-	-	6/3.1
335	2.4	52.41	-	-	3.7
332	.6	53.58	+12.1	63.8	-
333	1.4	55.25	+ 5.8	61.2	-
334	.8	53.69	-12.1	33.4	-
b328	1.6	54.59	- 4.0	51.3	-
328A	1.9	54.07	3/- 3.6	51.2	-
328A	5.9	52.14	3/- 5.8	54.0	-
328A	6.3	53.60	3/- 7.5	51.8	-
328A	2.0	53.14	-	-	4.2
328A	5.9	48.66	-	-	1.7
328A	6.3	47.46	-	-	1.3

1/ End of test contraction for contracting coals; maximum expansion for expanding coals.
2/ Each large vertical-oven test reported individually.
3/ Single tests.
4/ Tested after 5 months' storage.
5/ Tested after 5 months' storage and size reduction.
6/ Tested after size reduction.

Two special samples of Chilton-bed coal (c93) and (b93) from different parts of the Lorado No. 5 mine, one sample (c93) from a prospect hole in the Chilton bed, and the BM-AGA sample (93) were tested to determine whether or not any variation in the expanding tendency existed in coal from various parts of the mine. The two special expansion samples from the mine agreed very closely with the BM-AGA sample, whereas the sample from the prospect hole contracted slightly more. The blends of Chilton-bed coal with Pocahontas No. 3 coal (93A and 93B) contracted to a smaller extent.

Alma A coal (bottom bench-b94) was found to have greater contraction than the Lower Cedar Grove (top bench-a94) or any of the combined special samples (c94, d94, and e94) from different data of the mine, but not greater than the BM-AGA combined sample (94). The 80:20 blend with Pocahontas No. 3 coal (94A) contracted 4.0 percent; the 70:30 blend (94B) was almost neutral, contracting only 0.5 percent.

A sample of Elkhorn No. 3 (322) from a prospect hole in Knott County, Ky., was tested in the sole-heated oven. The 80:20 and 70:30 blends of this coal with Pocahontas No. 3-bed coal (322A and 322B) and a 50:30:20 blend of Elkhorn No. 3-, Pittsburgh-, and Pocahontas No. 3-bed coals (322C) were tested in both the sole-heated and large vertical expansion ovens. The 100-percent coal and the blends contracted in the sole-heated oven; none of the blends exerted over 1.0 pounds per square inch pressure in the large, vertical oven.

In a search for new coals for gas-making purposes, the expanding properties of eight samples were determined. The coals ranged from 29.0 to 36.6 percent volatile matter (moisture-free basis). The expanding properties of these coals were desired because coals within this range of volatile matter may exert dangerous pressures on coke-oven walls during carbonization. Lower Freeport bed coal, Kramer mine (323), the resample of Lower and Upper Freeport bed coal, Kent Nos. 1 and 2 mines (a326), and Upper Freeport bed coal, Ernest mine (335), exerted over 2.0 pounds pressure per square inch in the large vertical oven, which would be unsafe for commercial use according to the arbitrary limit of 2.0 pounds per square inch as the maximum safe expansion pressure. The variation in the expanding tendency of the two samples of Upper Freeport-bed coal is not unusual for this coal. The reason for the increase in expansion pressure of the resample of Kent No. 1 and 2 (a326) is not known, but the necessity for a constant check on the expansion of Freeport coals used in industry is indicated by this difference in two samples from the same mine.

During the fiscal year 1945, sole-heated-oven tests were made for Rochester Gas & Electric Co. on two of the coals tested this year; Pittsburgh bed, Banning No. 1 mine (342), and Lower and Upper Freeport bed, Kent Nos. 1 and 2 mines (326). The expansion results are: Banning No. 1 (1945), 23.1 percent contraction and (1948), 21.2 percent contraction; Kent Nos. 1 and 2 (1945), 3.0 percent maximum expansion and 2.0 percent contraction at end of test, (1948) original sample (326), 7.8 percent contraction at end of test, and resample (a326), 5.5 percent maximum expansion and 0.5 percent contraction at end of test. Sole-heated-oven tests were made on the resample of Kent Nos. 1 and 2 (a326) after 5 months' storage in closed steel drums, and the contraction decreased from 7.8 to 2.1 percent; and, after crushing of the stored coal to a finer size, it expanded 0.2 percent.

A byproduct plant which operates a gas-fired Bethlehem tester at a constant flue temperature of 2,350° F. submitted three samples of coal (332, 333, and 334) for comparison of its Bethlehem tester with the Bureau of Mines sole-heated oven. The byproduct plant air-dries its sample at 105° C. overnight and obtains a test bulk density of 55.0 pounds per cubic foot. The closest agreement between the two experimental ovens was obtained when the Bureau of Mines expansion results were calculated to 55.5 pounds per cubic foot of dry coal. Results obtained by the byproduct plant and the Bureau of Mines were, respectively: Coal 332, 13.2 and 12.8 percent expansion; 333, 7.5 and 7.3 percent expansion; and 334, 13.2 and 12.1 percent contraction, or differences of 0.4, 0.2, and 1.1 percent. These differences are only of the order of differences between duplicate tests. The expansion results given in table 16 for these coals are reported on the basis of 55.5 pounds per cubic foot of coal, with moisture content as tested.

One sample of 2- by 1/4-inch coal (b328) from the Palau No. 5 mine, Coahuila, Mexico, was tested in the sole-heated oven for comparison with a blend (328A) consisting of 45.9 percent 2- by 1/4-inch coal (328) and 54.1 percent 1/4- by 0-inch coal (a328). The blend contracted 3.6 percent, and the special expansion sample for comparison contracted 4.0 percent. The 1/4- by 0-inch coal contained 2 percent less ash than the 2- by 1/4-inch sample.

The bulk density in the first large vertical oven test on Palau No. 5 mine coal was high, and the pressure exceeded the limit of the oven, making it necessary to allow lateral expansion of the charge. In later sole-heated and large vertical-oven tests at lower bulk densities obtained by the addition of moisture, wall pressures in the vertical oven were reduced greatly. The coke yield, apparent specific gravity, and percentage of coke remaining on a 4-inch screen for the Palau-coal blend (328A) were lowered by the addition of moisture to the coal, but the coke-strength indexes were all very high. The coke from coal 328A had a real specific gravity of 1.98.

Four sole-heated oven tests of Mary Lee coal in a finer size than used in the original tests showed that the contraction decreased with decreasing particle size.

One sole-heated-oven charge (Pittsburgh-bed coal) was removed after 3 hours' coking to study the plastic layer. The average thickness of the coked layer was 1-1/2 inches. The thickness of the plastic layer ranged from 1/4- to 1/2-inch.

The accumulated data[86] obtained with a small vertical-expansion oven were reported. The oven is a small replica of the large vertical-slot oven, the charge being only 17 pounds as compared with 350 pounds for the large oven and its thickness being 5 inches instead of 10. The small oven gave high, erratic results, mainly because of the thickness of charge. It was concluded that it would be difficult to predict from results obtained in an oven of this size, the pressures a sample would develop in a large oven, or to state definitely that a borderline coal would be safe or dangerous for industrial use.

Plasticity of Coals

Plastic properties of 26 of the bituminous coals and 16 of the bituminous coal blends described in table 7 were determined during the fiscal year. Two or more tests on the same sample were usually made by the Gieseler-plastometer and by the Davis-plastometer methods. A total of 189 tests - 96 by the Gieseler method and 93 by the Davis method - were made. Twenty of the coals tested were high-volatile A, two were medium-volatile, and four were low-volatile bituminous coals. Eleven blends were in the high-volatile A group and five blends were in the medium-volatile group.

Unless modified by unusual chemical composition or by oxidation, the plastic properties of coals vary with rank. In general, the characteristic temperatures - at which fusion, maximum fluidity, and resolidification occur - are increased, the degree of fluidity (Gieseler method) is decreased, and the maximum resistance (Davis method) is increased with change of rank of coal from high-volatile A, through medium-volatile, to low-volatile.

86/ Naugle, B. W., Davis, J. D., McCartney, J. T., and Wilson, J. E., Measurement of Coking Pressure in a Small Laboratory Oven: Bureau of Mines Rept. of Investigations 4285, 1948, 15 pp.

The maximum fluidity of a blend depends on its constituent coals and their relative proportions, and may be intermediate or higher than the maximum fluidities of the individual coals. Limits for plastic characteristics of coals and blends chosen according to classification by rank will be arbitrary because of some overlapping.

The plastic properties of each of the 26 coals and of the 16 coal blends tested are here summarized:

Coal name, number, and rank	Plastic properties
Chilton (93) high-volatile A.	Typical of coals of this rank.
Blend of (93) and 20 percent Pocahontas No. 3 (75) low-volatile.	Characteristic temperatures raised increased maximum resistance, increased maximum fluidity.
Blend of (93) and 30 percent Pocahontas No. 3 (75) low-volatile.	Characteristic temperatures raised, increased maximum resistance, decreased maximum fluidity.
Lower Cedar Grove-Alma A (94) high-volatile A, and resample (a94).	Similar to coal (93) except for lower maximum fluidity and lower maximum resistance.
Blend of (94) with 20 and 30 percent Pocahontas No. 3 (75) low-volatile.	Increased characteristic temperature over (94), sharply decreased maximum fluidity, markedly increased maximum resistance.
Corona (b316) high-volatile A; lower in rank than (94).	Typical of coal of this rank; resistance ended at lower temperature than (94).
Blend of (b316) with 20 percent of Pocahontas No. 3 (75) low-volatile.	Slightly higher characteristic temperatures than (b316), appreciable fluidity, and higher maximum resistance.
Pocahontas No. 3 (317) low-volatile.	Typical of coal of low-volatile rank.
Blend of (317) with 80 percent Pittsburgh (28) high-volatile.	Markedly decreased characteristic temperatures as compared to (317), sharply increased maximum fluidity, markedly decreased maximum resistance.
Upper Elkhorn No. 3 (322) high-volatile A; (low in this rank).	Typical behavior with low maximum fluidity and low maximum resistance.
Resample of (322) cleaned at 1.50 specific gravity, 60-mesh size.	Closely checked (322).
Blend of (322) with 20 percent (322A) and with 30 percent (322B) Pocahontas No. 3 (75) low-volatile.	Characteristic temporarily not appreciably effected by maximum fluidity lowered and maximum resistance increased, especially with 30 percent blend.

Coal name, number, and rank	Plastic properties
Blend of (322) 50 percent, (75) 20 percent and Pittsburgh (28) high-volatile A 30 percent.	Maximum fluidity increased of (322) maximum resistance higher than for (322) and for (322A) and lower than (322B).
Lower Freeport (323) high-volatile A.	High maximum fluidity and maximum resistance and strong free swelling (Gieseler method).
Blend of 40 percent of (323), 30 percent each of (324) and (325); blend (323A).	Lower maximum fluidity and higher maximum resistance than (323).
Pittsburgh bed (324) high-volatile A and Pittsburgh bed (325) high-volatile A.	Generally typical of coals of this rank but (324) came more fluid and gave slightly higher maximum resistance than the strong free-swelling coal (325).
Lower Upper and Freeport coal (326) high-volatile A and resample (a326) from new area, high-volatile A.	Strong free swelling properties; (326) showed lower maximum fluidity, and slightly lower maximum resistance than (a326).
Resamples of (326), No. 326-S-2 and 326-S-3, after storage 6 months.	Characteristic temperatures and maximum fluidity increase; maximum resistance decreased; (326-S-3) strongly free-swelling.
Thick Freeport (327) high-volatile A.	Plastic properties typical of coal of this rank.
Blend (328A) of two screened fractions of Coahuila, Mexico, high-volatile A.	Appreciable fluidity and high maximum resistance for coal of this rank.
Upper Freeport (331) high-volatile A.	Typical plastic properties except for strong free swelling.
Sewell (332) low-volatile (lower in rank than Pocahontas No. 6).	Much higher fluidity and lower maximum resistance than Pocahontas No. 6.
Pocahontas No. 6 (333) low-volatile.	Typical plastic properties for its rank.
Pittsburgh (334) high-volatile A.	Very high fluidity and low maximum resistance.
Upper Freeport (335) and (335-S-2) medium-volatile.	Very high fluidity and appreciable maximum resistance.
Blend used in byproduct ovens at Pittsburgh, Pa. (336).	Good fusion, high maximum fluidity, and appreciable maximum resistance.
Lower Thacker (338) high-volatile A.	Similar to plastic properties of (334).
Pocahontas coal (341) low-volatile.	Typical plastic properties of this rank coal.