properties of coal-ash slag, (b) the behavior of ash and slag deposits on heat-absorbing surfaces, and (c) means for applying the data available on ash and slag to practical problems of interest to operators and designers.

Measurement of Heat Absorption in the Primary Furnace of a Central Station Boiler

The absorption of heat in the furnace of a large boiler is determined by many factors as yet imperfectly understood. To provide a basis for the rational and economical design of boilers, and to permit the most economic use of available coals, the Special Research Committee on Furnace Performance Factors of the American Society of Mechanical Engineers has initiated a program of investigation of representative boilers, to determine the effect of surface to volume ratio, method of firing, load, excess air, and cleanliness of furnace walls, on heat absorption in boiler furnaces.

The Bureau of Mines, cooperating with this committee in this investigation, has applied improved methods of measuring temperature and composition of furnace gases, to the determination of heat absorption in boiler furnaces. The study of one unit has been completed[83] and work is in progress on a second unit.

CARBONIZATION AND GASIFICATION

Small-Scale Laboratory Carbonization Tests

As part of the survey of the gas- and coke-making properties of American coals, small-scale laboratory carbonization tests are made of various coals to evaluate their metallurgical coke-making properties. These tests include the United States Steel Corp. high-temperature distillation test, Fischer low-temperature carbonization assay, and the Bureau of Mines agglutinating-value test. During the year three high volatile A bituminous coals from the following sources were examined by these methods: Lower Banner bed, No. 56 mine, Dante, Russell County, Va.; Chilton bed, Lorado No. 5 mine, Larado County, W. Va.; and Lower Cedar Grove and Alma A beds, Omar No. 5 mine, Omar, Logan County, W. Va. Generally the yields of carbonization products were similar for the coals.

The results of small-scale carbonization tests[84] of washed coal from the Hill bed, Cherokee County, Ala., showed that this coal yields less gas and more tar in the Fischer assay than in the BM-AGA tests at 500° and 600° C. because the volatile products escape from the Fischer retort with less cracking. The yield of coke in the assay is intermediate between BM-AGA yields at 500° and 600° C. The yields from the United States Steel Corp. high-temperature distillation test approximate those from the BM-AGA test at 900° C.

Agglutinating-value tests were made of 103 drill-core samples of coal submitted in connection with investigations to determine minable reserves of coking coals in the Castleman Basin field in western Maryland and the Coal Creek district in Gunnison

83/ Reid, W. T., Cohen, P., and Corey, R. C., An Investigation of the Variation in Heat Absorption in a Pulverized-Coal-Fired, Water-Cooled Steam-Boiler Furnace. Part II. Furnace Heat Absorption Efficiency, as Shown by the Temperature, Composition, and Flow of Gases Leaving the Furnace: Trans. A.S.M.E., vol. 70, No. 5, July 1948, pp. 569-585.

84/ 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.

County, Colo. Agglutinating values of the Castleman Basin coals ranged from 3.3 to 11.7 kilograms; these values show that most of these coals are medium to strongly coking. The Coal Creek coals of Colorado has agglutinating values ranging from 3.8 to 6.5 kilograms, which indicates that the coals examined having coking properties generally superior to those of the Lower Sunnyside coals of Utah, a standard western coal for making metallurgical coke.

Low-temperature tar yields by the Fischer laboratory assay were determined on five face samples of high-volatile C bituminous coal from Sweetwater County, Wyo., in connection with preparation of process estimates by the Bureau of Mines Synthetic Oil Plant for large-scale hydrogenation studies. The yields of tar ranged from 25 to 28 gallons per ton of coal, which are considered normal for coals of their rank.

The yields of low-temperature carbonization products were determined by the Fischer assay on a sample of wash 3- by 1/2-inch nut coal from the Corona bed, Corona No. 20 mine, Walker County, Ala., as a part of a study of complete gasification of this coal. The yields of low-temperature carbonization products on an as-received coal basis were as follows: Coke, 72.1 percent; tar, 35 gallons per ton; light oil, 2.5 gallons per ton; and gas, 1,940 cubic feet per ton.

Fischer low-temperature carbonization assays were made of 18 samples of Upper Cretaceous coals from northern Alaska to determine their value as a potential source of liquid fuel. The samples were collected in the summer of 1947 by the Federal Geological Survey in connection with the Navy Department's petroleum investigations in Naval Petroleum Reserve No. 4. The range of yields of carbonization products on an air-dried coal basis was as follows: Carbonized residue, 63 to 86 percent; tar, 5.8 to 33.8 gallons per ton; light oil, 0.50 to 2.30 gallons per ton; and gas, 1,210 to 3,570 cubic feet per ton. One coal formed a nonswollen coke that was very weak and friable. The carbonized residues from seven coals showed evidence of very slight fusion. The other 11 samples were noncoking in the Fischer assay, the carbonized residues being loose powders.

Survey of Carbonizing Properties of American Coals

Two coals were tested during the year for complete BM-AGA yields and quality of products obtained at low, medium, and high temperatures. Both were West Virginia high-volatile A coals - No. 93 represented the Chilton bed, Lorado No. 5 mine, Lorado, Logan County, W. Va.; and No. 94 represented the Lower Cedar Grove-Alma A beds, Omar No. 5 mine, Omar, Logan County, W. Va. Two other coals - No. 322 representing the Upper Elkhorm bed, prospect hole No. 1, Knott County, Ky., and No. 328 the Palau No. 5 mine, State of Coahuila, Mexico - were tested by the BM-AGA method at high temperature. The source and analyses of the coals carbonized are given in tables 7 and 8. The yields and quality of the products from the BM-AGA tests are given in tables 9 to 13, inclusive. Expansion and plasticity data obtained on these coals are described in other sections of this report.

TABLE 7. - Description of coals and blends tested

Coal No.	Description
93	Chilton bed, Lorado No. 5 mine, Logan County, W. Va.
a93-b93	Expansion samples from various parts of Lorado No. 5 mine.
c93	Expansion sample from prospect hole, Chilton bed.
93A	80 percent Chilton (93) and 20 percent Pocahontas No. 3 (75).
93B	70 percent Chilton (93) and 30 percent Pocahontas No. 3 (75).
94	Lower Cedar Grove-Alma A beds, Omar No. 5 mine, Logan County, W. Va.
a94	Expansion sample, Lower Cedar Grove bed.
b94	Expansion sample, Alma A bed.
c94-d94-e94	Expansion samples from various parts of Omar No. 5 mine.
94A	80 percent Lower Cedar Grove-Alma A (94) and 20 percent Pocahontas No. 3 (75).
94B	70 percent Lower Cedar Grove-Alma A (94) and 30 percent Pocahontas No. 3 (75).
b316	Corona bed, Corona mine, Walker County, Ala.
b316A	80 percent Corona (b316) and 20 percent Pocahontas No. 3 (75).
317	Pocahontas No. 3 bed.
317A	20 percent Pocahontas No. 3 (317) and 80 percent Pittsburgh (28).
322	Upper Elkhorn No. 3 bed, prospect opening No. 1, Knott County, Ky.
a322	Resample of Upper Elkhorn No. 3 (322), cleaned at 1.50 specific gravity, and tested in 60-mesh size.
322A	80 percent Upper Elkhorn No. 3 (322) and 20 percent Pocahontas No. 3 (75).
322B	70 percent Upper Elkhorn No. 3 (322) and 30 percent Pocahontas No. 3 (75).
322C	50 percent Upper Elkhorn No. 3 (322), 30 percent Pittsburgh (28), and 20 percent Pocahontas No. 3 (75).
323	Lower Freeport bed, Kramer mine, Jefferson County, Pa.
323A	40 percent Lower Freeport (323), 30 percent Pittsburgh (324), and 30 percent Pittsburgh (325).
324	Pittsburgh bed, Banning No. 1 mine, Fayette County, Pa.
325	Pittsburgh bed, Hutchinson mine, Westmoreland County, Pa.
326	Lower and Upper Freeport beds, Kent Nos. 1 and 2 mines, Indiana County, Pa.
a326	Resample of Lower and Upper Freeport beds (326) from new areas.
326-S-2	Resample of Lower and Upper Freeport beds (326) after storage for 6 months.
326-S-3	Resample of Lower and Upper Freeport beds (326) after storage for 6 months, crushed through hammer mill.
327	Thick Freeport bed, Renton No. 3 mine, Allegheny County, Pa.
b328	Carbonifera Unida Palau, Palau No. 5 mine, Palau, Coahuila, Mexico. Cleaned by heavy-media process. Expansion sample 2- by 1/4-inch.
328A	Carbonifera Unida Palau, Palau No. 5 mine, Palau, Coahuila, Mexico. 45.9 percent of 2- by 1/4-inch and 54.1 percent of 1/4- by 0-inch.
331	Upper Freeport bed, Watson mine, Indiana County, Pa.
332	Sewell (or Davey) bed, Twin Branch mine.
333	Pocahontas No. 6 bed, Black Eagle mine.
334	Pittsburgh bed, Vesta mine, Washington County, Pa.
335	Upper Freeport bed, Ernest mine, Indiana County, Pa.
335-S-2	Upper Freeport (335) crushed to finer size in hammer mill.
336	Blend used in by-product ovens at Pittsburgh, Pa.
338	Lower Thacker bed.

TABLE 7. - Description of coals and blends tested (con.)

Coal No.	Description
341	Pocahontas bed coal blended at by-product plant, Indiana Harbor, Ind.
342	Upper Elkhorn No. 3 bed, Wheelwright mine, Floyd County, Ky., slack coal.
342A	65 percent Upper Elkhorn No. 3 (342) and 35 percent Pocahontas (341).
342B	40 percent Upper Elkhorn No. 3 (342), 35 percent Pocahontas (341), and 25 percent Upper Elkhorn No. 3 (343).
343	Upper Elkhorn No. 3 bed, Wheelwright mine, Floyd County, Ky., egg coal.
344	Corban: Mixture of various high-volatile Kentucky and West Virginia coals carbonized commercially at Indiana Harbor, Ind.
344A	65 percent Corban (344) and 35 percent Pocahontas (341).
344B	50 percent Corban (344), 35 percent Pocahontas (341), and 15 percent Upper Elkhorn No. 3 (343).
75	Pocahontas No. 3 bed, Kimball, McDowell County, W. Va. (Low-volatile blending coal.)
28	Pittsburgh bed, Warden mine, Allegheny County, Pa. (High-volatile blending coal.)

TABLE 8. - Analyses of coals, as-received basis[1/]

Coal No.	Dry, mineral-matter-free, fixed carbon, percent	Proximate, percent				Ultimate, percent					Air drying loss, percent	Heating value, B.t.u. per pound	Softening temperature of ash, °F.
		Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur			
93	62.6	1.8	35.2	57.9	5.1	5.3	80.6	1.4	6.9	0.7	0.6	14,330	2,630
a93	63.9	1.9	33.9	58.9	5.3	5.2	80.8	1.4	6.5	.8	.9	14,300	2,650
b93	63.9	1.8	33.7	58.3	6.2	5.2	80.0	1.4	6.4	.8	.7	14,190	2,660
c93	63.7	1.8	33.8	58.1	6.3	5.3	79.8	1.5	6.4	.7	.8	14,190	2,840
93A	67.8	1.9	30.2	62.3	5.6	5.2	81.1	1.4	6.0	.7	.9	14,360	2,540
93B	69.5	1.9	28.6	63.8	5.7	5.0	80.9	1.3	6.4	.7	1.0	14,320	2,550
94	62.0	3.0	34.7	55.3	7.0	5.2	77.3	1.4	8.5	.6	1.5	13,690	2,680
a94	61.4	2.2	36.4	57.0	4.4	5.4	79.6	1.8	8.1	.7	.8	14,170	2,620
b94	60.7	1.9	37.1	56.5	4.5	5.4	79.8	1.8	7.8	.7	.7	14,210	2,470
c94	61.5	2.3	36.0	56.6	5.1	5.4	79.2	1.5	8.1	.7	1.1	14,010	2,430
d94	61.3	2.2	36.1	56.2	5.5	5.4	78.9	1.5	8.1	.6	.9	14,010	2,520
e94	61.6	1.9	36.4	57.7	4.0	5.4	80.5	1.5	7.9	.7	.7	14,230	2,540
94A	66.1	2.8	31.1	59.2	6.9	5.1	78.1	1.4	7.9	.6	1.4	13,720	2,520
94B	69.0	2.7	28.5	61.6	7.2	5.0	78.3	1.3	7.5	.7	1.5	13,780	2,450
b316	56.1	3.1	38.7	47.9	10.3	5.4	70.7	1.6	9.4	2.6	1.6	12,850	2,280
b316A	62.6	2.5	33.7	54.3	9.5	5.1	73.7	1.6	7.7	2.4	1.3	13,260	2,250
317	80.3	4.1	18.1	70.8	7.0	4.5	80.0	1.2	6.5	.8	3.3	13,890	2,440
317A	65.6	1.9	32.1	60.0	6.0	5.2	78.8	1.3	7.9	.8	.8	14,060	2,620
322	59.2	4.7	37.5	53.6	4.2	5.6	75.8	1.5	12.0	.9	1.5	13,530	2,220
322A	63.0	3.9	34.2	57.2	4.7	5.4	77.2	1.4	10.4	.9	1.2	13,650	2,280
322B	65.8	3.7	31.7	59.8	4.8	5.3	77.2	1.4	10.4	.9	1.4	13,740	2,310
322C	64.3	3.1	33.2	58.7	5.0	5.3	78.0	1.5	9.3	.9	.9	13,830	2,470
323	68.4	2.9	28.8	60.5	7.8	5.1	77.2	1.3	7.4	1.2	1.8	13,670	2,670
323A	64.9	3.4	31.7	56.8	8.1	5.2	76.1	1.4	8.1	1.1	2.1	13,550	2,620

See footnote at end of table on following page.

TABLE 8. - Analyses of coals, as-received basis[1/] (con.)

Coal No.	Dry, mineral-matter-free, fixed carbon, percent	Proximate, percent				Ultimate, percent					Air drying loss, percent	Heating value, B.t.u. per pound	Softening temperature of ash, °F.
		Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur			
324	62.3	3.6	34.0	54.7	7.7	5.4	75.6	1.6	8.6	1.1	2.5	13,490	2,680
325	61.9	3.1	34.0	53.6	9.3	5.2	74.0	1.4	8.9	1.2	1.8	13,320	2,610
326	67.7	3.6	29.0	58.7	8.7	5.2	76.4	1.3	7.2	1.2	2.6	13,550	2,600
a326	67.7	2.7	29.6	60.2	7.5	5.2	78.2	1.4	6.5	1.2	1.9	13,880	2,570
326-S-2	68.7	3.0	28.4	60.2	8.4	5.1	76.6	1.3	7.4	1.2	2.2	13,650	-
326-S-3	69.2	3.1	28.0	60.7	8.2	5.1	76.7	1.4	7.4	1.2	2.3	13,680	2,570
327	60.2	2.9	35.6	52.2	9.3	5.2	74.8	1.4	7.5	1.8	1.6	13,370	2,310
b328	75.7	1.6	21.5	62.1	14.8	4.6	73.3	1.2	5.2	.9	1.0	12,960	-
328A	75.2	1.8	22.1	62.9	13.2	4.7	75.0	1.3	4.9	.9	1.1	13,200	2,910
331	67.4	2.0	29.7	59.4	8.9	5.1	77.1	1.5	6.1	1.3	1.1	13,730	2,470
332	78.8	.6	20.6	74.8	4.0	4.7	85.9	1.5	3.1	.8	.2	14,980	2,570
333	81.5	1.4	17.5	73.5	7.6	4.4	82.0	1.3	4.0	.7	.9	14,220	2,870
334	61.6	.8	35.4	55.3	8.5	5.1	76.5	1.5	7.0	1.4	-	13,720	2,490
335	69.1	2.2	28.3	60.8	8.7	5.0	77.2	1.4	5.4	2.3	1.6	13,760	2,220
335-S-2	68.8	2.4	28.4	60.1	9.1	5.0	76.4	1.4	5.5	2.6	2.0	13,660	-
336	64.3	4.7	32.0	56.0	7.3	5.3	75.1	1.5	9.5	1.3	3.6	13,440	2,600
338	64.0	2.4	34.4	60.6	2.6	5.4	81.4	1.5	8.4	.7	.7	14,520	-
341	81.5	1.7	17.4	73.1	7.8	4.4	81.8	1.2	4.0	.8	.9	14,160	2,550
342	62.1	3.0	34.4	54.9	7.7	5.3	75.0	1.4	9.7	.9	.5	13,350	2,340
342A	68.1	2.5	29.3	60.8	7.4	5.0	77.6	1.4	7.8	.8	.8	13,690	2,470
342B	68.9	2.5	28.9	62.5	6.1	5.1	78.8	1.4	7.8	.8	.8	13,880	2,390
343	60.7	2.6	37.2	56.9	3.3	5.6	79.7	1.6	9.0	.8	.5	14,180	2,210
344	62.8	2.7	33.5	54.8	9.0	5.2	74.4	1.3	9.1	1.0	.7	13,280	2,570
344A	69.2	3.5	27.8	60.3	8.4	5.0	76.2	1.3	8.2	.9	1.5	13,340	2,550
344B	68.6	3.5	28.5	60.6	7.4	5.1	77.0	1.3	8.4	.8	1.8	13,550	2,550
75	82.2	3.2	16.6	72.7	7.5	4.4	80.8	1.1	5.5	.7	2.7	13,990	2,400
28	61.7	1.6	36.0	56.9	5.5	5.4	79.1	1.5	7.7	.8	.5	14,130	2,830

1/ Analyses made under supervision of H. M. Cooper, chemist, Bureau of Mines, Pittsburgh, Pa.

TABLE 9. - Yields of carbonization products in BM-AGA tests, 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
93	13	600	74.2	9.0	10.3	0.71	0.078	4.7	99.0	4,400	23.7	2.22	1.47	6.1
93	13	700	71.8	12.5	8.6	.94	.218	5.8	99.9	7,100	18.6	2.74	1.03	24.0
93	13	800	70.5	14.2	7.6	1.02	.213	4.8	98.3	9,200	15.6	2.86	.61	23.6
93	18	900	70.9	15.1	6.4	1.18	.192	4.8	98.6	10,600	13.0	3.24	.44	20.2
93A	18	900	73.5	14.0	5.3	1.03	.192	4.9	98.9	10,400	10.9	2.81	.39	20.8
93B	18	900	74.5	13.4	5.1	.93	.181	4.8	98.9	10,200	10.5	2.57	.40	20.1
93	18	1,000	71.8	15.4	5.8	1.20	.172	4.5	98.9	11,600	11.5	3.29	.29	17.4
94	13	600	72.6	9.0	9.9	.50	.077	7.2	99.3	4,150	22.7	3/1.46	1.50	13.0
94	13	700	70.3	12.2	8.5	.91	.163	7.3	99.4	6,700	18.6	2.73	1.06	22.2
94	13	800	69.0	13.7	7.8	1.02	.175	6.7	98.4	8,600	16.5	2.93	1.11	23.3
94	18	900	69.4	15.5	6.0	1.16	.151	6.6	98.8	10,450	12.3	3.18	.66	21.4
94A	18	900	72.0	13.9	5.3	.95	.142	6.7	99.0	9,950	11.3	2.64	.62	21.3
94B	18	900	73.7	13.4	5.1	.92	.146	6.2	99.5	9,950	10.7	2.57	.59	20.4
94	18	1,000	69.2	15.8	5.5	1.16	.131	6.2	98.0	11,300	11.0	3.18	.36	17.0
322	18	900	64.8	17.4	6.3	1.26	.172	9.0	98.9	10,850	12.9	3.48	.55	23.5
322A	18	900	68.5	15.3	5.0	1.15	.173	8.4	98.5	10,600	10.4	3.17	.40	24.7
322B	18	900	70.6	15.0	4.3	.89	.180	7.8	98.8	10,500	8.9	2.46	.35	23.8
322C	18	900	70.4	14.8	5.1	1.06	.201	7.4	99.0	10,200	10.5	2.92	.39	25.3
328	18	800	78.9	11.8	3.4	.60	.202	4.4	99.3	8,500	7.1	1.69	.36	20.5
328	18	900	78.7	12.1	3.1	.65	.181	4.3	99.0	9,700	6.3	1.79	.20	19.2
Average[2]	18	900	68.8	-	-	-	-	-	-	10,710	13.9	3.20	.74	21.0

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. under a pressure of 30 inches of mercury.

2/ Average for 24 high-volatile A coals.

3/ The yield is low because the residual light oil in gas was not determined.

TABLE 10. - Screen analysis of coke

Coal No.	Retort diameter, inches	Carbonizing temperature, °C.	Screen sizes, cumulative percent upon-				
			4-inch	3-inch	2-inch	1-1/2-inch	1-inch
a94A	18	800	82.7	94.0	97.3	98.5	99.2
a94A	18	900	54.0	79.5	93.2	97.2	98.6
a94A	slot	870-1,010	66.6	85.1	94.7	96.7	97.8
b316A	18	800	82.8	93.2	97.2	98.4	98.9
b316A	18	900	42.5	72.7	91.4	96.0	97.9
b316A	slot	870-1,010	51.4	83.2	94.7	96.8	97.9
336	18	800	74.8	89.0	96.5	98.5	99.6
336	18	900	33.1	63.6	87.1	95.1	98.1
336	slot	870-1,010	29.0	69.9	92.6	96.2	97.8
342A	18	800	77.7	91.8	95.5	97.6	98.6
342A	18	900	48.9	73.6	88.4	93.7	96.6
342A	slot	870-1,010	45.8	73.8	87.7	91.0	93.0
342B	18	800	74.1	91.2	96.7	97.4	98.3
342B	18	900	49.9	76.9	92.2	96.3	98.6
342B	slot	870-1,010	41.8	73.7	91.1	93.6	95.1

TABLE 11. - 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-				Tumbler test, cumulative percent upon-			
						2-inch screen	1-1/2-inch screen	1-inch screen	1/4-inch screen	2-inch screen	1-1/2-inch screen	1-inch screen	1/4-inch screen
93	13	600	1.57	0.78	50.3	65.3	81.1	90.9	96.9	4.6	24.6	51.3	66.0
93	13	700	1.74	.85	51.1	68.5	79.2	91.0	97.2	5.9	24.1	49.8	67.7
93	13	800	1.84	.89	51.6	59.8	83.1	93.6	98.2	8.4	32.3	58.1	71.8
93	18	900	1.88	.87	53.7	46.3	78.7	93.4	98.3	2.1	18.2	53.7	70.2
93A	18	900	1.91	.90	52.9	52.6	80.9	93.3	98.4	3.7	28.6	58.7	73.1
93B	18	900	1.90	.91	52.1	46.0	73.9	94.3	98.5	3.1	23.3	59.6	76.0
93	18	1,000	1.90	.88	53.7	15.3	50.1	85.2	98.0	.0	7.5	44.9	71.6
94	13	600	1.58	.72	54.4	50.9	61.4	82.7	95.5	.6	8.8	28.4	57.3
94	13	700	1.75	.78	55.4	58.6	66.8	80.3	95.7	1.0	5.8	24.0	61.9
94	13	800	1.79	.81	54.7	53.9	72.2	85.3	97.0	.0	9.7	32.4	66.0
94	18	900	1.90	.84	55.8	42.8	66.3	84.1	97.0	.5	9.9	38.2	70.0
94A	18	900	1.90	.83	56.3	50.4	74.5	88.3	97.4	2.6	20.5	46.9	70.0
94B	18	900	1.89	.86	54.5	58.0	80.8	92.2	98.3	6.4	28.1	55.0	73.1
94	18	1,000	1.89	.84	55.6	16.1	43.2	79.1	97.0	.0	3.5	34.3	74.4
322	18	900	1.88	.76	59.6	13.8	39.2	72.6	97.5	.0	1.7	32.5	74.3
322A	18	900	1.90	.81	57.4	37.3	68.4	89.6	98.4	.9	18.4	55.0	74.4
322B	18	900	1.90	.82	56.8	39.4	72.0	89.8	98.1	1.9	23.9	56.6	75.3
322C	18	900	1.89	.84	55.6	53.3	73.8	92.0	98.1	1.8	27.9	57.5	74.7
328	18	800	1.92	.94	51.0	79.6	93.3	97.1	98.8	30.0	61.8	70.7	73.7
328	18	900	1.96	.93	52.6	49.0	84.5	95.8	98.6	10.7	46.3	70.8	76.7
Average[1]	18	900	-	-	-	-	70.4	-	-	-	-	50.8	72.2

1/ Average for 25 high-volatile A coals.

Note: Results determined by the BM-AGA survey methods.

TABLE 12. - Physical and chemical properties of gas

Coal No.	Retort diameter, inches	Carbonizing temperature, °C.	Specific gravity	Gross heating value[1]/ B.t.u. per cubic foot Determined	Gross heating value[1]/ B.t.u. per cubic foot Calculated	B.t.u. per pound of coal	H_2S, grains per 100 cubic feet	Composition, dry, percent by volume CO_2	Illuminants	O_2	H_2	CO	CH_4	C_2H_6	N_2
93	13	600	0.547	795	757	1,750	450	3.6	2.7	0.4	31.6	5.3	49.0	6.4	1.0
93	13	700	.467	702	675	2,490	370	3.0	4.4	.4	43.6	5.6	37.4	4.5	1.1
93	13	800	.418	641	628	2,850	290	1.9	5.6	.4	50.3	5.9	32.8	2.1	1.0
93	18	900	.378	602	593	3,190	260	1.7	4.3	.4	53.2	6.1	33.4	.3	.6
93A	18	900	.357	587	577	3,050	240	1.5	3.8	.4	55.0	5.5	32.8	.0	1.0
93B	18	900	.349	581	568	2,960	230	1.5	3.6	.4	56.9	5.0	31.0	.4	1.2
93	18	1,000	.352	571	561	3,310	250	1.5	3.9	.4	56.5	6.3	30.2	.0	1.2
94	13	600	.578	824	787	1,710	520	4.8	4.0	.4	28.0	5.8	48.0	8.0	1.0
94	13	700	.480	705	684	2,360	380	3.3	4.5	.4	41.8	6.1	37.7	5.1	1.1
94	13	800	.424	647	623	2,780	300	2.3	5.3	.5	49.5	6.6	33.1	2.0	.7
94	18	900	.394	589	582	3,080	240	2.1	4.5	.3	52.6	7.0	31.7	.4	1.4
94A	18	900	.373	579	569	2,880	220	2.0	4.3	.4	55.3	5.8	30.6	.3	1.3
94B	18	900	.357	574	567	2,860	200	1.7	4.1	.4	56.7	5.7	29.3	.8	1.3
94	18	1,000	.370	562	562	3,180	230	1.9	4.4	.4	54.5	8.0	29.7	.0	1.1
322	18	900	.425	610	569	3,310	330	2.7	4.4	.4	50.7	9.7	30.7	.2	1.2
322A	18	900	.382	599	561	3,170	310	2.3	4.0	.4	53.6	8.2	30.4	.0	1.1
322B	18	900	.379	579	553	3,040	280	2.2	3.7	.4	55.3	7.6	29.7	.0	1.1
322C	18	900	.386	597	560	3,040	320	2.0	3.9	.4	55.3	6.6	30.5	.0	1.3
328	18	800	.370	627	614	2,660	250	1.1	3.6	.4	52.9	4.0	35.3	1.5	1.2
328	18	900	.330	585	582	2,840	230	.9	3.6	.4	57.3	3.9	32.8	.3	.8
Average[2]/	18	900	.386	603	594	3,220	320	2.0	4.9	.4	52.6	6.6	31.2	1.1	1.3

1/ Stripped of light oil and saturated with water vapor at 60° F. and under a pressure equivalent to 30 inches of mercury.

2/ Average for 39 high-volatile A coals.

TABLE 13. - Analysis of tar distillate and light oil

Coal No.	Retort diameter, inches	Carbonizing temperature, °C.	Distillate, percent by volume of dry tar			Neutral tar oil, percent by volume			Refined light oil from gas, percent by volume				Olefins in crude light oil from gas, percent by volume
			Acids	Bases	Neutral oils	Olefins	Aromatics	Paraffins and naphthenes	Benzene	Toluene	Paraffins	Solvent naphtha	
93	13	600	13.3	1.7	36.9	9.0	54.9	36.1	12.4	12.4	49.8	25.4	34.1
93	13	700	12.8	1.8	30.2	9.0	74.6	16.4	26.3	29.5	20.2	24.0	26.4
93	13	800	6.9	1.9	25.4	9.4	87.9	2.7	45.8	32.7	6.2	15.3	14.4
93	18	900	3.0	1.6	20.3	10.8	87.6	1.6	72.9	19.2	3.5	4.4	9.1
93A	18	900	2.8	1.4	18.9	10.6	88.0	1.4	73.4	19.2	4.2	3.2	9.3
93B	18	900	4.6	1.5	23.7	8.9	86.3	4.8	63.7	21.1	6.3	8.9	11.3
93	18	1,000	2.4	1.6	17.8	13.2	85.3	1.5	80.0	16.0	1.5	2.5	7.7
94	13	600	18.4	1.1	38.2	8.0	57.1	34.9	16.1	11.5	50.8	21.6	33.3
94	13	700	17.6	1.4	33.9	10.5	75.9	13.6	21.3	21.4	32.9	24.4	26.9
94	13	800	12.5	2.0	33.6	10.8	78.5	10.7	38.4	26.9	17.0	17.7	20.7
94	18	900	4.2	1.9	25.0	12.0	83.2	4.8	73.9	16.6	4.7	4.8	10.6
94A	18	900	9.9	2.3	32.5	11.0	86.8	2.2	63.0	20.8	7.9	8.4	13.3
94B	18	900	8.2	2.0	29.8	9.5	86.0	4.5	62.6	20.8	7.9	8.8	13.8
94	18	1,000	3.1	.7	18.0	11.6	87.2	1.2	79.7	15.0	2.4	2.9	7.8
322	18	900	7.1	2.2	26.1	10.0	89.1	.9	71.4	20.8	3.8	4.0	10.2
322A	18	900	5.7	2.4	26.0	10.0	89.3	.7	68.6	22.9	4.4	4.1	10.4
322B	18	900	5.6	2.8	24.2	10.0	89.3	.7	67.0	23.5	3.4	6.1	11.2
322C	18	900	7.6	2.6	26.4	11.5	87.2	1.3	65.0	23.4	4.8	6.8	12.0
328	18	800	4.5	1.4	30.2	8.8	81.5	9.7	41.4	31.7	9.2	17.7	17.1
328	18	900	2.2	1.1	24.0	9.6	87.3	3.1	61.5	24.6	3.9	10.0	12.2