

UNITED STATES  
DEPARTMENT OF THE INTERIOR  
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BUREAU OF MINES  
R. R. SAYERS, DIRECTOR

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REPORT OF INVESTIGATIONS

COMPARATIVE YIELDS OF LIGHT OIL, TAR, AND CONSTITUENTS  
FROM CARBONIZATION TESTS AT 800°, 900°, AND 1,000° C.



BY

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FROM CARBONIZATION TESTS AT 800°, 900°, AND 1,000° C.<sup>1/</sup>

By C. R. Holmes<sup>2/</sup>, J. E. Wilson<sup>3/</sup>, and J. D. Davis<sup>4/</sup>

The Bureau of Mines-American Gas Association (BM-AGA) method<sup>5/</sup> has been used in surveying the carbonizing properties of American coals and, to date, in testing coals from 43 beds. The results in this report apply only to tests in the 18-inch retort at 800°, 900°, and 1,000° C. on coals from 32 beds. Table 1 gives the proximate and ultimate analyses of these coals and the name and location of mines. Coals from Pennsylvania, Virginia, West Virginia, Kentucky, Indiana, and Washington are considered. Seven of the coals are of low-volatile, four of medium-volatile, and twenty-one of high-volatile bituminous rank. One of the high-volatile coals (No. 45) is of high-volatile C rank, whereas all the others are of high-volatile A rank.

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<sup>1/</sup> The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 3695."

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<sup>5/</sup> Fieldner, A. C., and Davis, J. D., Gas-, Coke-, and Byproduct-Making Properties of American Coals and Their Determinations: Bureau of Mines Mon. 5, 1934, 164 pp.



TABLE 1. - Origin and analyses of coals, as carbonized  
(arranged in order of decreasing rank)

Coal No	State	County	Bed	Mine	Dry, mineral-matter-free fixed carbon, percent	Analyses, percent								
						Proximate			Ultimate					
						Moisture	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur
				<u>Low-volatile</u>										
57	W. Va.	Raleigh	Pocahontas No. 4	No. 4	83.3	1.4	16.0	75.6	7.0	4.3	82.6	1.3	3.7	1.1
48	Pa.	Cambria	Lower Kittanning	No. 72 (washed)	83.0	2.9	16.1	75.3	5.7	4.6	82.8	1.4	4.7	.8
47	Do.	Do.	Do.	No. 72 (unwashed)	82.9	1.7	16.3	75.3	6.7	4.4	82.5	1.4	3.7	1.3
50	Do.	Do.	Upper Kittanning	No. 73 (unwashed)	82.1	1.8	16.9	72.0	9.3	4.5	79.1	1.2	3.6	2.3
56	W. Va.	Wyoming	Pocahontas No. 3	Buckeye No. 3	81.7	1.6	17.4	74.5	6.5	4.4	83.7	1.2	3.6	.6
51	Pa.	Cambria	Upper Kittanning	No. 73 (washed)	81.5	2.2	17.3	72.0	8.5	4.5	80.2	1.4	4.2	1.2
41	W. Va.	Raleigh	Beckley	Winding Gulf No. 1	81.3	2.3	17.9	76.0	3.8	4.6	85.3	1.4	4.5	.4
				<u>Medium-volatile</u>										
55	W. Va.	Wyoming	Sewell	Wyoming	77.5	1.6	21.8	73.7	2.9	4.9	85.8	1.4	4.3	0.7
64	Do.	Tucker	Bakerstown	No. 23	77.1	2.2	21.6	70.5	5.7	4.8	82.1	1.6	4.8	1.0
58	Va.	Buchanan	Lower Banner	Keen Mountain	76.9	2.5	21.4	67.8	8.3	4.7	79.5	1.2	4.8	1.5
60	Pa.	Indiana	Lower Freeport	--	73.4	2.0	24.9	66.7	6.4	5.1	81.2	1.3	5.3	.7
				<u>High-volatile</u>										
65	Wash.	Pierce	No. 2	Bartoy	68.4	2.2	28.1	58.3	11.4	5.2	74.0	2.3	6.5	0.6
59	W. Va.	Monongalia	Upper Freeport	--	67.7	2.8	29.3	59.6	8.3	5.2	77.0	1.4	7.4	.7
42	Va.	Dickenson	Upper Banner	No. 9	66.6	1.6	31.8	62.3	4.3	5.3	82.8	1.4	5.4	.8
31	Do.	Buchanan	Clintwood	Buchanan Nos. 1 & 2	66.4	1.9	31.5	61.0	5.6	5.3	80.4	1.8	6.0	.9

Note: See footnote page 3.



TABLE 1. - Origin and analyses of coals, as carbonized (Cont'd)  
(arranged in order of decreasing rank)

Coal No.	State	County	Bed	Mine	Dry, mineral-matter-free fixed carbon, percent	Analyses, percent									
						Proximate				Ultimate					
						Moisture	Volatiles	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Oxygen	Sulfur	

1/ High-volatile C. Classification based on heating value.



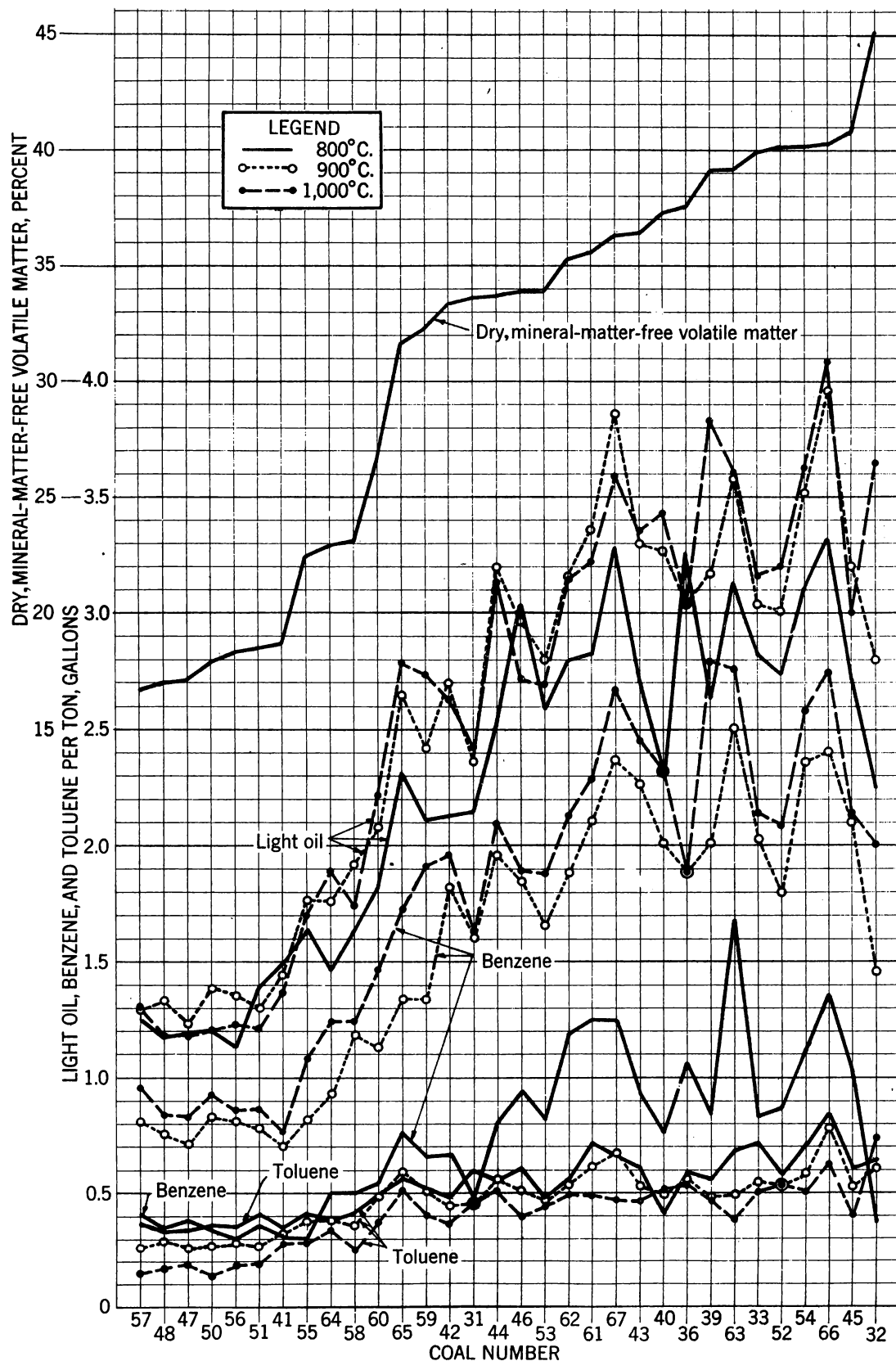


Figure 1.- Comparative yields of light oil, benzene, and toluene at 800°, 900°, and 1,000° C.



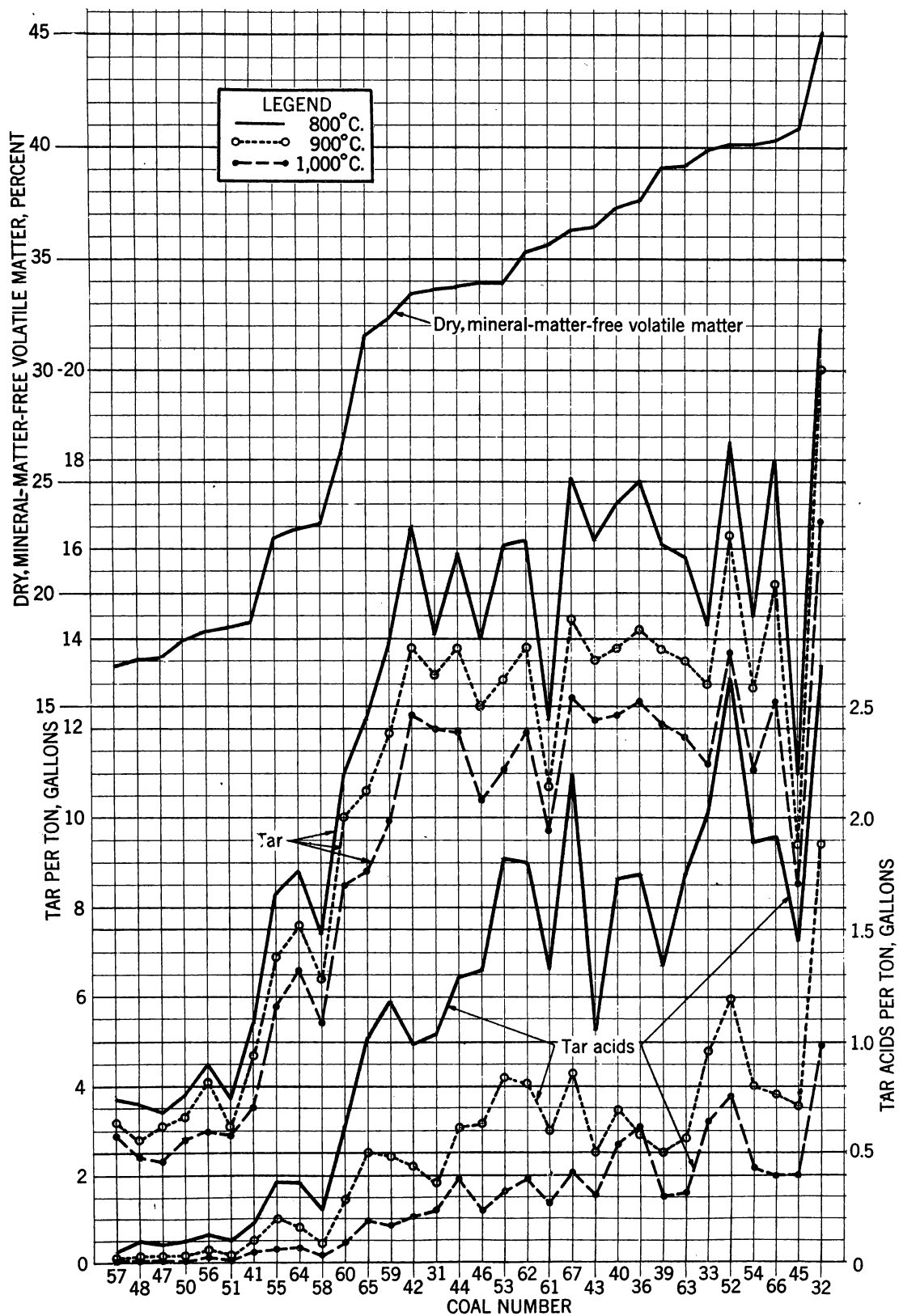


Figure 2.- Comparative yields of tar and tar acids at 800°, 900°, and 1,000° C.



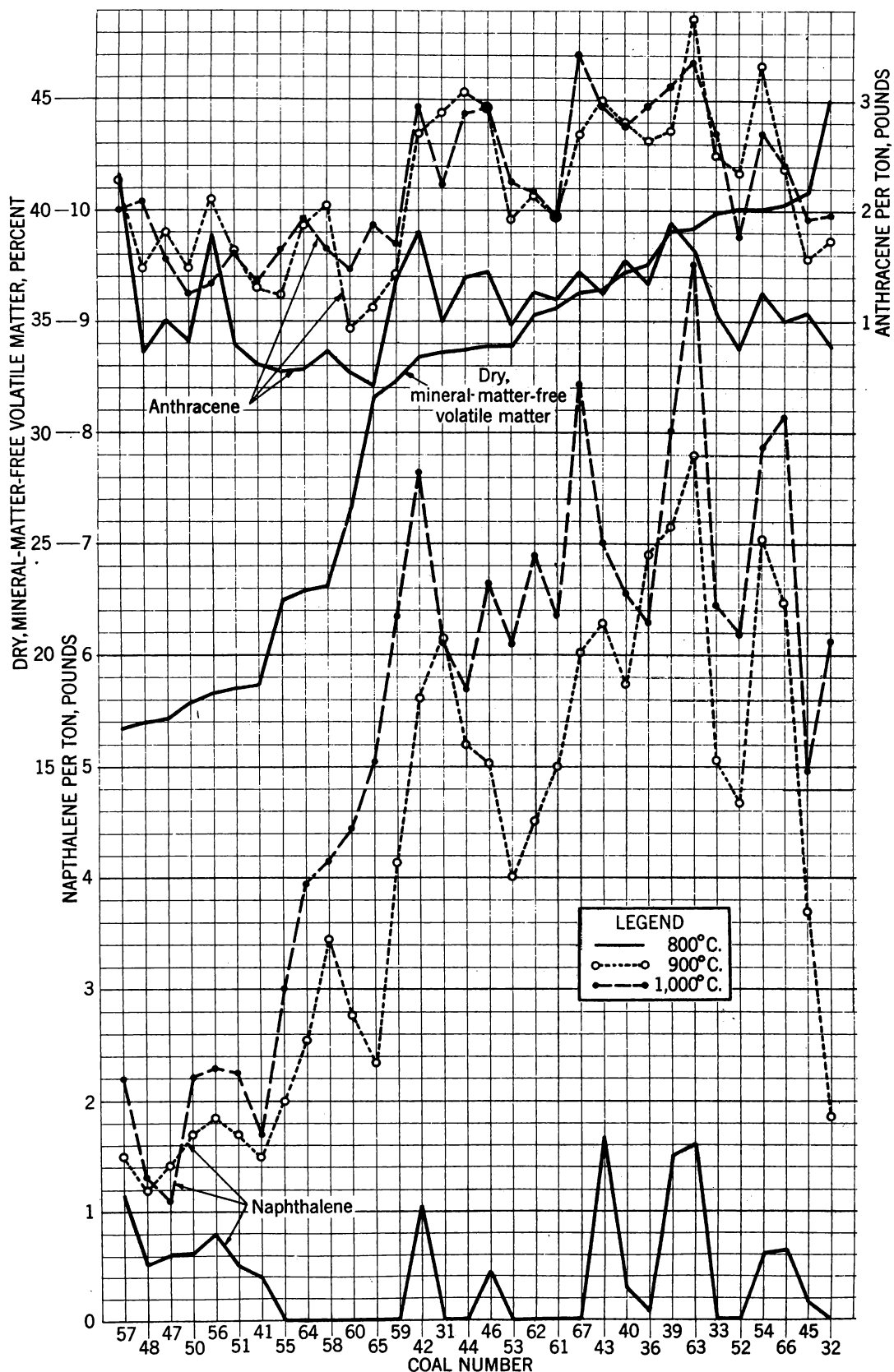


Figure 3.- Comparative yields of naphthalene and anthracene at 800°, 900°, and 1,000° C.



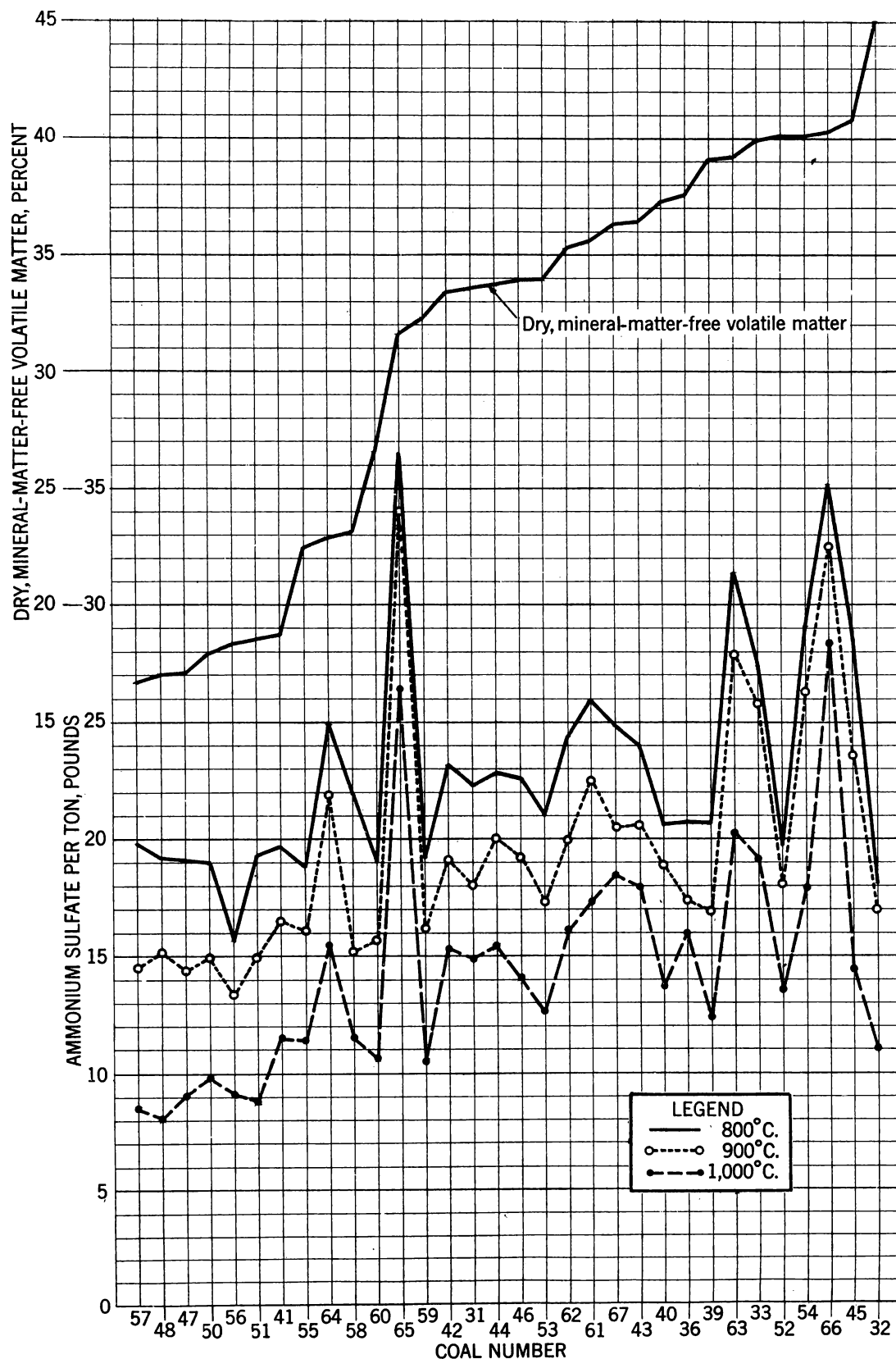


Figure 4.- Comparative yields of ammonium sulfate at 800°, 900°, and 1,000° C.



It is the purpose of this paper to show the effect of variation of carbonizing temperature on yields of certain products now very important in prosecution of the war. Increasing the carbonizing temperature in the considered range causes some further devolatilization of coal and more extensive cracking of these volatile products in passing through the hot coke to the top of the charge and through the free space<sup>6/</sup> above the charge. Thermal decomposition of certain products results in formation of others. Thus, with increasing temperature, higher yields of benzene are obtained, whereas yields of toluene decrease. The tar is cracked, yielding more gas, light oil, etc., and, of course, less tar.

All yields are given in gallons per ton or pounds per ton. The total crude light oil stripped from the gas is given but does not include the light oil that condenses with the tar; the benzene and toluene yields from the light oil from the gas are shown. The total yield of tar is included, with its constituents - tar acids, naphthalene, and anthracene. As would be expected, the yields of liquid products from the low-volatile coals are lower than for the lower-rank bituminous coking coals; the variation in yields with carbonizing temperature, however, shows the same general trend except for total light oil, which is low for the 1,000° C. carbonizing temperature. The volume of vapor and gas obtained from the low-volatile coals is relatively small; they have a longer time of exposure in the retort and free space than those from the other coals, and therefore they are cracked more severely.

In table 2 the coals are arranged in low-, medium-, and high-volatile groups, showing the yields of light oils with their benzene and toluene constituents; tars, with their tar-acid, naphthalene, and anthracene constituents; and finally, ammonium sulfate. Results are given for 800°, 900°, and 1,000° C. carbonizing temperatures, and averages at these temperatures are included for each of the three ranges of rank.

Figure 1 shows the yields of light oil, benzene, and toluene; figure 2, the yields of tar and tar acids; figure 3, the yields of naphthalene and anthracene; and figure 4, the yields of ammonium sulfate. All coals are arranged in order of decreasing rank. The dry, mineral-matter-free volatile-matter values for each coal are plotted on the curves.

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<sup>6/</sup> Davis, J. D., and Auvil, Stuart, High-Temperature Carbonization of Coal: Ind. Eng. Chem., vol. 27, 1935, pp. 459-461.



TABLE 2. - Effect of increasing carbonizing temperature upon the yields of certain byproducts (18-inch BM-AGA retort)

Coal No.	Carbon-izing temper-ature, ° C.	Gallons per ton					Pounds per ton			
		Light oil	Benzene	Toluene	Tar	acids	Naptha-lene	Anthra-cene	(NH <sub>4</sub> ) <sub>2</sub> -SO <sub>4</sub>	
			Low-volatile coals							
57	800	1.26	0.41	0.37	3.7	0.05	1.16	2.33	19.8	
	900	1.29	.81	.26	3.2	.02	1.52	2.28	14.5	
	1,000	1.30	.96	.15	2.9	.01	2.19	2.01	8.5	
48	800	1.17	.35	.33	3.6	.10	.53	.73	19.2	
	900	1.33	.76	.29	2.8	.03	1.19	1.48	15.2	
	1,000	1.18	.84	.17	2.4	.01	1.32	2.07	8.1	
47	800	1.19	.38	.34	3.4	.08	.62	1.01	19.1	
	900	1.23	.71	.26	3.1	.03	1.43	1.79	14.4	
	1,000	1.18	.83	.19	2.3	.01	1.09	1.56	9.1	
50	800	1.20	.34	.36	3.8	.10	.61	.81	19.0	
	900	1.39	.83	.27	3.3	.03	1.70	1.48	14.9	
	1,000	1.21	.93	.14	2.8	.01	2.22	1.25	9.8	
56	800	1.13	.30	.35	4.5	.13	.78	1.78	15.7	
	900	1.36	.81	.28	4.1	.06	1.84	2.10	13.4	
	1,000	1.23	.86	.18	3.0	.03	2.32	1.34	9.1	
51	800	1.39	.36	.41	3.7	.10	.51	.79	19.3	
	900	1.30	.78	.27	3.1	.03	1.73	1.63	14.9	
	1,000	1.21	.87	.19	2.9	.01	2.24	1.61	8.8	
41	800	1.49	.31	.35	5.4	.18	.40	.61	19.7	
	900	1.45	.70	.32	4.7	.10	1.51	1.31	16.5	
	1,000	1.37	.77	.28	3.5	.05	1.72	1.36	11.5	
Average low-vol.	800	1.26	.35	.36	4.0	.11	.66	1.15	18.8	
	900	1.34	.77	.28	3.5	.04	1.56	1.72	14.8	
	1,000	1.24	.87	.19	2.8	.02	1.87	1.60	9.3	

TABLE 2. - Effect of increasing carbonizing temperature upon the (Cont'd)  
yields of certain byproducts (18-inch BM-AGA retort)

Coal No.	Carbon-izing temperature, ° C.	Gallons per ton					Pounds per ton		
		Light oil	Benzene	Toluene	Tar	Tar acids	Naphthalene	Anthracene	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>
<u>Medium-volatile coals</u>									
55	800	1.64	0.30	0.41	8.3	0.37	0.00	0.54	18.8
	900	1.77	.82	.38	6.9	.20	2.01	1.24	16.1
	1,000	1.70	1.08	.28	5.8	.06	3.02	1.64	11.4
64	800	1.46	.50	.38	8.8	.37	.00	.57	24.9
	900	1.76	.93	.38	7.6	.16	2.55	1.86	21.9
	1,000	1.89	1.24	.34	6.6	.07	3.95	1.92	15.5
58	800	1.64	.50	.41	7.4	.24	.00	.74	21.9
	900	1.92	1.18	.36	6.4	.08	3.46	2.05	15.2
	1,000	1.74	1.24	.25	5.4	.03	4.17	1.66	11.5
60	800	1.82	.54	.49	11.0	.62	.00	.54	19.0
	900	2.08	1.13	.48	10.0	.29	2.77	.93	15.7
	1,000	2.22	1.47	.37	8.5	.09	4.44	1.47	10.6
Average medium-vol.	800	1.64	.46	.42	8.9	.40	.00	.60	21.2
	900	1.88	1.02	.40	7.7	.18	2.70	1.52	17.2
	1,000	1.89	1.26	.31	6.6	.06	3.90	1.67	12.3
<u>High-volatile coals</u>									
65	800	2.32	0.76	0.57	12.2	1.02	0.00	0.42	36.5
	900	2.65	1.34	.59	10.6	.50	2.35	1.13	34.0
	1,000	2.79	1.73	.52	8.8	.19	5.05	1.87	26.4
59	800	2.11	.66	.52	13.9	1.18	.00	1.38	19.2
	900	2.42	1.34	.51	11.9	.48	4.14	1.43	16.2
	1,000	2.74	1.91	.40	9.9	.17	6.35	1.70	10.5
42	800	2.13	.67	.48	16.5	.99	1.07	1.81	23.2
	900	2.70	1.82	.44	13.8	.44	5.62	2.71	19.1
	1,000	2.63	1.96	.37	12.3	.21	7.64	2.94	15.3

TABLE 2. - Effect of increasing carbonizing temperature upon the (Cont'd)  
yields of certain byproducts (18-inch BM-AGA retort)

Coal No.	Carbon- izing temper- ature, ° C.	Gallons per ton					Pounds per ton		
		Light oil	Benzene	Toluene	Tar	Tar acids	Naphtha- lene	Anthra- cene	(NH <sub>4</sub> ) <sub>2</sub> - SO <sub>4</sub>
High-volatile coals									
31	800	2.15	0.48	0.60	14.1	1.03	0.00	0.99	22.3
	900	2.37	1.61	.46	13.2	.37	6.14	2.88	18.0
	1,000	2.42	1.63	.46	12.0	.24	6.11	2.23	14.9
44	800	2.53	.81	.56	15.9	1.29	.00	1.39	22.8
	900	3.20	1.96	.56	13.8	.61	5.20	3.07	20.0
	1,000	3.14	2.10	.51	11.9	.38	5.71	2.88	15.4
46	800	3.04	.94	.61	14.0	1.32	.45	1.45	22.6
	900	2.97	1.85	.51	12.5	.63	5.03	2.94	19.2
	1,000	2.71	1.89	.40	10.4	.24	6.64	2.94	14.1
53	800	2.59	.82	.47	16.1	1.82	.00	.96	21.0
	900	2.80	1.56	.46	13.1	.84	4.01	1.92	17.3
	1,000	2.69	1.88	.43	11.1	.33	6.09	2.26	12.7
62	800	2.80	1.19	.56	16.2	1.80	.00	1.26	24.4
	900	3.16	1.89	.53	13.8	.81	4.52	2.14	19.9
	1,000	3.15	2.13	.49	11.9	.38	6.90	2.17	16.2
61	800	2.83	1.25	.72	12.2	1.33	.00	1.20	25.9
	900	3.36	2.11	.62	10.7	.60	4.99	1.97	22.5
	1,000	3.22	2.29	.48	9.7	.27	6.37	1.97	17.3
67	800	3.28	1.25	.66	17.6	2.20	.00	1.44	24.8
	900	3.86	2.37	.67	14.4	.86	6.02	2.69	20.5
	1,000	3.59	2.67	.47	12.7	.41	8.43	3.42	18.5
43	800	2.70	.93	.61	16.2	1.05	1.67	1.25	24.0
	900	3.30	2.27	.53	13.5	.50	6.30	2.99	20.6
	1,000	3.35	2.45	.47	12.2	.31	7.00	2.95	18.0

TABLE 2. - Effect of increasing carbonizing temperature upon the (Cont'd)  
yields of certain byproducts (18-inch BM-AGA retort)

Coal No.	Carbon-izing temperature, ° C.	Gallons per ton					Pounds per ton		
		Light oil	Benzene	Toluene	Tar	acids	Naphtha-lene	Anthra-cene	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>
			High-volatile coals						
40	800	2.30	0.76	0.41	17.0	1.73	0.29	1.55	20.6
	900	3.27	2.01	.49	13.8	.69	5.74	2.80	18.9
	1,000	3.43	2.32	.51	12.3	.54	6.54	2.78	13.7
36	800	3.26	1.06	.59	17.5	1.75	.08	1.33	20.7
	900	3.04	1.88	.56	14.2	.58	6.90	2.63	17.4
	1,000	3.04	1.88	.54	12.6	.62	6.31	2.96	16.0
39	800	2.63	.84	.56	16.1	1.34	1.51	1.89	20.7
	900	3.17	2.01	.48	13.8	.50	7.19	2.73	16.9
	1,000	3.83	2.80	.47	12.1	.30	8.02	3.14	12.4
63	800	3.13	1.68	.68	15.8	1.75	1.61	1.64	31.4
	900	3.58	2.51	.49	13.5	.57	7.79	3.73	27.9
	1,000	3.61	2.76	.38	11.8	.32	9.52	3.35	20.3
33	800	2.82	.83	.72	14.3	2.02	.00	1.07	27.4
	900	3.04	2.03	.55	13.0	.96	5.06	2.49	25.8
	1,000	3.16	2.14	.51	11.2	.64	6.45	2.70	19.2
52	800	2.74	.87	.58	18.4	2.63	.00	.75	19.7
	900	3.01	1.80	.54	16.3	1.19	4.68	2.34	18.1
	1,000	3.20	2.09	.54	13.7	.75	6.19	1.77	13.6
54	800	3.11	1.12	.72	14.5	1.89	.61	1.26	29.1
	900	3.52	2.36	.58	12.9	.80	7.04	3.31	26.3
	1,000	3.63	2.59	.51	11.1	.43	7.83	2.70	17.9
66	800	3.32	1.36	.85	18.0	1.91	.65	1.00	35.2
	900	3.96	2.41	.78	15.2	.76	6.48	2.38	32.5
	1,000	4.09	2.75	.63	12.6	.40	8.16	2.41	28.4

TABLE 2. - Effect of increasing carbonizing temperature upon the yields of certain byproducts (18-inch BM-AGA retort) (Cont'd)

Coal No.	Carbon-izing temper-ature, ° C.	Gallons per ton					Pounds per ton			
		Light oil	Benzene	Toluene	Tar	acids	Naphtha-lene	Anthra-cene	(NH <sub>4</sub> ) <sub>2</sub> -SO <sub>4</sub>	
45 <sup>1/</sup>			<u>High-volatile coals</u>							
	800	2.72	1.03	0.61	11.0	1.45	0.17	1.08	28.8	
	900	3.20	2.10	.53	9.4	.71	3.70	1.57	23.6	
	1,000	3.00	2.14	.40	8.5	.40	4.97	1.92	14.4	
32	800	2.25	.37	.64	20.9	2.68	.00	.77	18.1	
	900	2.80	1.46	.61	20.0	1.88	1.86	1.74	17.0	
	1,000	3.65	2.01	.75	16.6	.98	6.13	1.97	11.0	
Average high-vol.	800	2.70	.94	.61	15.6	1.63	.39	1.23	24.7	
	900	3.11	1.94	.55	13.5	.73	5.27	2.46	21.5	
	1,000	3.19	2.20	.49	11.7	.41	6.78	2.53	16.5	

<sup>1/</sup> High-volatile C.Light Oil

The yields of light oil increase with decreasing rank of the coal. For both the low- and medium-volatile coals more light oil tends to be produced at 900° than at 1,000° C.; however, on an average the medium-volatile coals produce slightly more at 1,000° C. Invariably less light oil is produced by these coals at 800° C. than at the higher temperatures.

The greatest effect of increase in carbonizing temperature upon the yields of light oil is obtained on the lowest-rank high-volatile A coals; coal 32 (Pittsburgh bed), which is the lowest in rank of the high-volatile A coals studied, showed an increase in yield of light oil of 2.25 to 2.80 to 3.65 gallons per ton for the 800°, 900°, and 1,000° C. carbonizing temperatures, respectively. Coal 39 (Upper Cedar Grove bed), which is also low in the high-volatile A group, gave 1.20 gallons more light oil at 1,000° C. than at 800° C. Coals 36 and 46 gave higher yields of light oils at 800° than at higher temperatures, but the benzene fraction was lower for the 800° C. tests.

### Benezene

The highest yields of benzene are obtained at 900° and 1,000° C. At these temperatures there is generally a twofold increase over the 800° yields. The high-volatile coals on an average produced over twice as much benzene as low-volatile coals at all temperatures. Increasing the carbonizing temperature of coal 39 from 800° to 1,000° C. increased the yields of benzene nearly 2 gallons per ton - the largest increase in benzene over this temperature range for any coal tested.

### Toluene

The yields of toluene decrease with increasing carbonizing temperature. Of course, the highest yields are obtained from high-volatile coals, but there is not a very great variation with change in rank. In the high-volatile range, the highest yield of toluene at 1,000° was 0.75 gallon from coal 32, whereas the lowest was 0.37 gallon from coal 42. Usually the best yields of toluene are obtained at 800° C., as the averages indicate, but figure 1 shows that there are some exceptions; for several coals, equally good or slightly better yields are obtained at 900° C. Coal 40 gives the best yield at 1,000° C.

### Tar

Figure 2 shows that the yields of tar increase fairly regularly and rapidly as volatile matter increases over the low- and medium-volatile ranges of rank. There is considerable variation for the individual coals in the high-volatile range, but a general trend toward increase with increase of volatile up to coal 45 (which is of high-volatile C rank) is evident. The yields decrease with increasing carbonizing temperature. The average high-volatile coals yield nearly four times as much tar as low-volatile coals.

### Tar Acids

The yields of tar acids are considerably higher at 800° than at 900° or 1,000° C., and with decreasing rank this trend becomes more pronounced (fig. 2). At 800° C. the medium-volatile coals on an average yield nearly four times as much tar acids as the low-volatile coals; this same increase is noted when the high-volatile coals are compared with the medium-volatile coals. Several of the high-volatile coals were outstanding in this respect. For example, coal 67, Taggart bed, yields 0.41 gallon of tar acids at 1,000°, 0.86 gallon at 900°, and 2.20 gallons at 800° C. The same figures for coal 52 were 0.75, 1.19, and 2.63 gallons respectively.

### Naphthalene

The medium-volatile coals studied yield no naphthalene (fig. 3) at a carbonizing temperature of 800° C., and at this temperature about half the high-volatile coals likewise yielded no naphthalene. It is evident that the 800° carbonizing temperature will yield little or no naphthalene regardless of rank of coal. However, where the temperature is increased to 900°, the yields increase abruptly; at 1,000° C. the yields increase still more, but not nearly as great a change is noted as from 800° to 900° C. At the higher carbonizing temperature the yields generally increase with decreasing rank. However, this trend is not perfectly regular. For example, at 900° coal 65, from Pierce County, Wash., with a dry, mineral-matter-free fixed-carbon content of 68.4 percent, yields 2.35 pounds of naphthalene per ton, whereas coal 32 (Pittsburgh bed), from Washington County, Pa., at the other end of the range of rank of coals studied in this paper, with a dry, mineral-matter-free fixed carbon content of 54.9 percent, yielded only 1.86 pounds per ton.

### Anthracene

The average low-volatile coals yield more anthracene at 800° and 900° C. than the medium-volatile coals. At 1,000° C., there is little variation on an average between the low- and medium-volatile coals. Figure 3 shows that the yields are very irregular when plotted according to decreasing rank of the coals. When the 900° yields of anthracene are compared with those at 1,000° C., it will be noted that there is small difference. Some coals give slightly higher yields at 900°, whereas others yield more at 1,000° C. However, for all temperatures the anthracene yields seem to reach a peak with coals of about 39 percent dry, mineral-matter-free volatile-matter content and then taper off considerably.

### Ammonium sulfate

The yields of ammonium sulfate (fig. 4), appear to increase fairly regularly with decreasing rank of the coals. Ammonia is decomposed<sup>7/</sup> by the hot steel of the retorts; consequently, with rising carbonizing temperature, more of the ammonia is decomposed and the yield declines. The yield of ammonium sulfate at 800° C. approaches that obtained in commercial practice. However, as shown in figure 4, a very irregular curve

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<sup>7/</sup> Fieldner, A. C., Davis, J. D., Thiessen, R., Selvig, W. A., Reynolds, D. A., Jung, F. W., and Sprunk, G. C., Carbonizing Properties and Petrographic Composition of Clintwood-bed Coal from Buchanan Mines Nos. 1 and 2, Buchanan County, Va.: Bureau of Mines Tech. Paper 570, 1936, p. 15.

is obtained when the coals are plotted according to decreasing rank. Coal 65, for example, yielded 36.5 pounds of ammonium sulfate per ton at 800°, whereas coal 59, with a decrease of only 0.7 percent of dry, mineral-matter-free fixed carbon, yielded only 19.2 pounds per ton. At 900° and 1,000° C., these figures were 34.0 and 26.4 pounds per ton compared with 16.2 and 10.5 pounds per ton, respectively. Coals 65 and 66 yielded a high percentage of ammonium sulfate, but these coals have a high nitrogen content - 2.3 and 2.1 percent, respectively.

It is evident that the best yields of ammonium sulfate can be obtained from high-volatile coals carbonized at 800° C. It is indicated that when the carbonizing temperature of these coals is increased to 1,000° C., the yield of this product will decline about 33 percent.

### Summary and Conclusions

A survey of the yields of various byproducts obtained upon carbonization of coal samples from 32 beds at 800°, 900° and 1,000° C. in the BM-AGA 18-inch retort included coals of low-, medium-, and high-volatile rank. The origin and analyses are given, as well as the yields of light oil, benzene, toluene, tar, and tar acids, in gallons per ton of coal carbonized; yields of naphthalene, anthracene, and ammonium sulfate are given in pounds per ton. These yields are shown graphically; the effects of increasing carbonizing temperature and decreasing rank are presented.

It is indicated that, in general, increasing carbonizing temperature increases the yields of light oil, benzene, naphthalene, and anthracene; at the same time the yields of toluene, tar, tar acids, and ammonium sulfate decline. The effect of decreasing the rank is to increase, on an average, the yields of light oil, benzene, toluene, tar, tar acids, and ammonium sulfate. The naphthalene and anthracene yields usually show no particular trend with decreasing rank, except when considered at the different carbonizing temperatures. Naphthalene increases with decreasing rank at 900° and 1,000° C., but at 800° C. the highest yield is obtained from the low-volatile coals. At 1,000° C. anthracene increases with decreasing rank, whereas at 800° and 900° C. the medium-volatile coals yield the least.



