Expansion tests were made on coals 291 to 300, inclusive, 308, 309, 312, and 313, and all contracted at 55.5 pounds per cubic foot. Sample Nos. 298, 299, and 300 were tested also after being dried. Comparison of the results obtained on air-dried and as-received coal indicate that the lower-moisture coal expanded more. If the expansion of both samples at 55.5 pounds per cubic foot are calculated on the weight of dry coal per cubic foot, the expansion of both dried and undried samples is about the same. The differences are of the order of the deviation between duplicate tests.

Pocahontas No. 3-bed coal (317) expanded 4.9 percent at 55.5 pounds per cubic foot, which is low for that coal. Other expansion results previously determined in the sole-heated oven for Pocahontas No. 3 bed coals are: Buckeye No. 3 mine, Wyoming County, W. Va. (No. 56), 17.8 percent, and Carswell mine, McDowell County, W. Va. (No. 75), 24.4 percent. The 80:20 blend of Pocahontas No. 3 (No. 317) and Pittsburgh (m28) coals contracted 5.6 percent.

Plasticity of Coals

Plastic properties of 30 fresh coals, 15 oxidized coals, and 5 coal blends described in table 22 were determined during the fiscal year. Excepting coals 314, 315, and 316, all samples were tested by the Gieseler plastometer method. The nine coals oxidized at 99.3° C., the eight Canadian coals, and the four South American coals were not tested by the Davis plastometer method. Two or more tests on the same sample were usually made by the method used. A total of 193 tests - 117 by the Gieseler method and 76 by the Davis method - were made.

TABLE 22. - Description of coals and blends tested

Coal No.	Description
88A	80 percent No. 5 Block Bed, No. 5 mine, Raleigh County, W. Va., and 20 percent Pocahontas No. 3 bed, McDowell County, W. Va. (coal c75).
88B	70 percent No. 5 Block bed, No. 5 mine, Raleigh County, W. Va., and 30 percent Pocahontas No. 3 bed, McDowell County, W. Va. (coal c75).
91	Lower Banner bed, No. 56 mine, Russell County, Va.
c91	Lower Banner bed, first right, 400 feet off 4th main.
d91	Lower Banner bed, No. 6 room, 239 feet off 1st left, moist coal face.
d75	Pocahontas No. 3 bed, McDowell County, W. Va.
91A	80 percent coal 91 and 20 percent coal d75.
91B	70 percent coal 91 and 30 percent coal d75.
92	Upper Banner bed, No. 9 mine, Dickenson County, Va.
92A	3.2 percent Lower Banner bed (coal b91, resample 91), 36.8 percent Lower Banner bed (coal a91, resample 91), and 60 percent coal 92.
m28	Pittsburgh bed, Warden mine, Allegheny County, Pa. (washed).
291	Thick Freeport bed, Indianola mine, Allegheny County, Pa.
292	Thick Freeport bed, Russellton mine, Allegheny County, Pa.
293	Pittsburgh bed, Crescent mine, Washington County, Pa.

TABLE 22. - Description of coals and blends tested (Cont'd.)

Coal No.	Description
294	Pittsburgh bed, Clyde mine, Washington County, Pa.
295	Elkhorn bed, Republic Kentucky mine, Pike County, Ky.
308	Mary Lee bed, Sayreton No. 2 mine, Jefferson County, Ala.
309	Mary Lee bed, Sayreton Nos. 1 and 2 mines, Jefferson County, Ala.
312	America bed, Virginia mine, Jefferson County, Ala.
313	Mary Lee bed, Sayre mine, Jefferson County, Ala.
314	"B" or Lower Kittanning bed, Pennsylvania No. 46 mine, Winburne, Pa.
315	Fairview bed, Sutt Creek mine, St. Clair County, Ala.
316	Corona bed, Corona No. 20 mine, Warrior Field, Ala.
	Oxidized Samples
	Stored on open trays at room temperature for days indicated:
h28-5a-ox	Pittsburgh bed, Warden mine, Allegheny County, Pa. (washed), 1,303 days.
78-6a-ox	McAlester bed, Bernardi mine, Pittsburg County, Okla., 1,291 days.
81-4a-ox	Powellton bed, Coal Mountain mine, Wyoming County, W. Va., 1,136 days.
82-4a-ox	Eagle bed, Carbon Fuel Co. mine, Kanawha County, W. Va., 1,211 days.
86-2a-ox	Elkhorn No. 3 bed, Wheelwright mine, Floyd County, Ky., 788 days.
156-7a-ox	Raton bed, Brilliant mine, Colfax County, N. Mex., 1,364 days.
	Oxidized at 99.3° C. for days indicated:
m28-1-ox	Pittsburgh bed, Warden mine, Allegheny County, Pa., 3.2 days, small unit.
m28-1-ox	Pittsburgh bed, Warden mine, Allegheny County, Pa., 3.0 days.
m28-2-ox	Pittsburgh bed, Warden mine, Allegheny County, Pa., 6.0 days.
91-1-ox	Lower Banner bed, No. 56 mine, Russell County, Va., 3.9 days.
91-2-ox	Lower Banner bed, No. 56 mine, Russell County, Va., 11.2 days.
91-3-ox	Lower Banner bed, No. 56 mine, Russell County, Va., 19.2 days.
92-1-ox	Upper Banner bed, No. 9 mine, Dickenson County, Va., 3.3 days.
311-1-ox	No. 9 bed, Santa Maria mine, Naricual Coal Basin, Venezuela, 3.2 days.
b310-1-ox	Sample 3, asfaltita from Argentina, S. A., 3.3 days (not a true coal)
	Canadian Coals
28081	Phalen bed, No. 1B mine, Nova Scotia.
28082	Phalen bed, No. 4 mine, Nova Scotia.
28083	Phalen bed, No. 16 mine, Nova Scotia.
28084	Harbour bed, No. 12 mine, Nova Scotia.
28085	Harbour bed, No. 26 mine, Nova Scotia.
28086	Harbour bed, Princess mine, Nova Scotia.
28087	Emery bed, No. 11 mine, Nova Scotia.
28088	Gardiner bed, No. 25 mine, Nova Scotia.
	South American Coals
310	Run-of-mine asfaltita from Argentina (not a true coal).
a310	Sample No. 2, asfaltita from Argentina (not a true coal).
b310	Sample No. 3, asfaltita from Argentina (not a true coal).
311	No. 9 bed, Santa Maria mine, Naricual coal basin, Venezuela.

The 80:20 and 70:30 blends of high-volatile A coal 88 and low-volatile coal d75 showed plastic properties typical of blends of these compositions. Raising the proportion of the low-volatile coal from 20 percent to 30 increased the characteristic temperatures observed by the two test methods, decreased the maximum fluidity (Gieseler method), and increased the maximum resistance (Davis method). The three samples from Lower Banner bed, coals 91, c91, and d91, taken from different points in the mine, showed differences in plastic properties. Coal c91 was most fluid and coal 91 least fluid; it also showed the highest maximum resistance. Characteristic temperatures agreed well for the three coals, except for the end of resistance, for coal 91 which was appreciably higher. Pocahontas No. 3-bed coal (d75) showed plastic properties typical of other samples of this low-volatile coal tested earlier; a high maximum resistance of 83.4 pound-inches was developed in the Davis plastometer test. Blends of this coal with 80 and 70 percents of high-volatile coal 91 gave plastic properties typical of the proportions used, the 80:20 blend being most fluid. Coal 92 is high-volatile A bituminous in rank; its dry, mineral-matter-free fixed carbon content is 67.4 percent compared with 62.1 percent for coal 91. It swelled strongly in the Gieseler plastometer test, and its maximum fluidity was only half that of coal 91. The blend containing both coals (sample 92A) gave plastic properties which indicate that blending improves coking properties. Coal m28 is a resample of the Warden mine and is used as a standard high-volatile A blending coal in the BM-AGA Survey of American Coals. Its plastic properties are typical of a coal of this rank and agree well with other samples from this mine tested earlier. The plastic properties of the two high-volatile A Thick Freeport-bed coals 291 and 292 are much alike; both coals showed a maximum fluidity of 12,000 dial divisions per minute, strong swelling in the Gieseler test, and low maximum resistance in the Davis test. In comparison, the two Pittsburgh-bed coals 293 and 294 of about the same dry, mineral-matter-free fixed-carbon content were less fluid; coal 294 was more fluid than coal 293. Elkhorn-bed coal 295 is a higher-ranking high-volatile A coal than the Thick Freeport-and Pittsburgh-bed coals. The higher rank is reflected in its plastic properties; its maximum fluidity is lower, and its characteristic temperatures and maximum resistance values are higher than of the lower-ranking coals. The three Mary Lee-bed coals - 308, 309, and 313 - are high-ranking high-volatile A coals and showed plastic properties characteristic of this rank. All showed strong swelling in the Gieseler test; coal 313 was the most fluid. The American-bed coal is medium-volatile in rank and showed only moderate swelling, lower fluidity, and higher characteristic temperatures and maximum resistance than the other Alabama coals. These differences would be expected from the relative ranks of the coals from the two different beds. Coals 314, 315, and 316 are high-volatile A bituminous, decreasing in rank in the order named. They were tested only in the Davis plastometer and showed decreasing characteristic temperatures and decreasing maximum resistance in this same order.

The six high-volatile A coals that were stored on open trays at room temperature for the number of days indicated before testing their plastic properties are difficult to compare directly because the rate of loss of carbonizing properties with oxidation differs for individual coals. At the times indicated, coal 82-4a-ox showed strong swelling and the highest maximum fluidity in the Gieseler test and the highest maximum resistance in the Davis test of the six coals. Coal h28-5a-ox showed moderate swelling and the other four coals little or no swelling in the Gieseler tests. Considering the days of storage and data obtained in another investigation, the plastic properties obtained on the six coals were characteristic of those to be expected.

The nine coal samples that were oxidized at 99.3° C. for the number of days indicated before testing in the Gieseler plastometer all showed that oxidation had affected their plastic properties. Reduction in swelling and increase in maximum fluidity, with mild oxidation of the Warden mine coal, suggest that its carbonizing properties would be improved; this prediction is verified from data obtained on other samples of this coal. The maximum fluidity of Lower Banner, Upper Banner, and No. 9-bed coals was reduced by oxidation, whereas that of the asfaltita sample (not a true coal) increased. The unusually large increase, from 3,670 to 17,500 dial divisions per minute, after oxidation for 3.3 days may be partly explained by the fact that the coke residue left after the test had a very unusual cell structure and oxidation has caused the asphaltic material to undergo a marked change.

The eight Canadian coals from Nova Scotia were received for test from the Canadian Bureau of Mines. These high-volatile A bituminous coals all showed strong swelling in the Gieseler plastometer tests. The maximum fluidity values ranged from a low of 1,450 dial divisions per minute for the Gardiner-bed coal to a high of 10,000 dial divisions per minute for the Harbour-bed, No. 12 mine, coal. Characteristic temperatures and fluidity values for all eight coals indicate that, so far as plastic properties are concerned, all coals would make good coke.

Tests of the plastic properties of the three asfaltita samples showed that samples 2 and 3 were much more fluid than the run-of-mine sample. Samples 2 and 3 have dry, mineral-matter-free fixed carbon contents of 54.2 and 53.6 percent, respectively, compared with 68.4 percent for the run-of-mine sample. The latter fused very weakly, giving a fluidity of only 1.1 dial divisions per minute compared with 5,000 and 3,670 dial divisions per minute for samples 2 and 3, respectively. Coal 311 from Venezuela contained 54.8 percent of dry, mineral-matter-free fixed carbon and had a heating value of 14,060 B.t.u. per pound on the moist, mineral-matter-free basis. This low-ranking high-volatile A bituminous coal showed a maximum fluidity of only 2.2 dial divisions per minute, which is characteristic of many coals of this low rank when they have a high oxygen content.

Oxidizing Properties of Various Bituminous Coals

The characteristic rate of oxidation of coal is defined as the percentage of oxygen by weight of the coal after the coal has consumed 1 percent of oxygen by weight; the numerical value may be expressed either on the basis of dry, mineral-matter-free coal or on the basis of dry coal. To determine this rate, the coal is subjected to oxidation at constant temperature (99.3° C.) in a specially designed apparatus and under defined test conditions that give data from which the relation between amount of oxygen consumed and time of oxidation may be calculated. Two different sizes of apparatus, specially designed and built for controlling the oxidation of the coal at 99.3° C., are employed: (1) A 450-pound-capacity, steam-jacketed, rotary-drum unit and (2) a similar unit of 50-pound capacity. Both units use a controlled supply of air after the coal charge has been dried in situ using nitrogen.

Table 23 summarizes the results obtained on 13 coals tested during the year. The coals are listed in the approximate order of decreasing rank within each of the two size ranges of coal tested. Coal 296 contained 11.3 percent ash on the dry basis, which accounts for its extremely low characteristic rate of oxidation, as compared with rates for the other 4 Alabama coals. One might expect that coal 300 would show a characteristic rate of oxidation between those for coals 299 and 298. The relative freshness of the 3 samples was unknown; freshness of preparation of sample before testing is an important factor in the rate of oxidation. Coal DSC-2, as received, was a grab sample from the top bench and contained 9.2 percent ash and 2.4 percent sulfur. Its lower rate of oxidation, as compared with rates for coals 292 and 291, which meet the specifications for gas and coking coals and are representative of their respective mines, would be expected. Duplicate tests on coals DSC-2 and 292 were made to determine the reproducibility of tests in the small drum unit; more work needs to be done to establish this reproducibility with certainty.

Because of the growing industrial practice in recent years of using finer size coal in coke-oven charges, 0- to 1/8-inch, stage-crushed charges were used in tests of the last five samples listed in the table. The results obtained were as expected for coals 92, 91, m28, and 311. Close reproducibility of results was obtained on coal m28 by the large and small test units. As the name implies, sample b310 contained asphaltic material and is not a true coal. It contained only 53.6 percent dry, mineral-matter-free fixed carbon but had a heating value of 16,630 B.t.u. per pound on the moist, mineral-matter-free basis. Its unusual composition in respect to material contributing to a high treating value accounts for its relatively low rate of oxidation, as compared with the other four coals tested in the same size range.

The last 2 columns of the table show the relative rates of oxidation of the 13 coals compared to the Pittsburgh bed, Warden mine, coal taken as unity. The first 8 coals are compared for the 0- to 1/4-inch, stage-crushed size range; the last 5 samples for the 0- to 1/8-inch, stage-crushed size range.

TABLE 23. - Oxidizing properties of various bituminous coals

Coal 296 - Mary Lee bed, Sayreton No. 1 mine, Jefferson County, Ala., run-of-mine coal on which float-and-sink was made, high-ash, crushed to approximately 68 percent through 1/8-inch.

Coal 297 - Mary Lee bed, Sayreton No. 2 mine, Jefferson County, Ala., washed coal crushed to approximately 68 percent through 1/8-inch.

Coal 299 - Mary Lee bed, Sayreton coarse coal, 30 percent through 1/8-inch, crushed to approximately 75 percent through 1/8-inch.

Coal 298 - Mary Lee bed, Sayreton fine coal, 60 percent through 1/8-inch, crushed to approximately 75 percent through 1/8-inch.

Coal 300 - Mary Lee bed, Sayreton average coal, 45 percent through 1/8-inch, crushed to approximately 75 percent through 1/8-inch.

Coal DSC-2 - Pittsburgh bed, Shannopin mine, Green County, Pa.

Coal 292 - Thick Freeport bed, Russellton mine, Allegheny County, Pa.

Coal 291 - Thick Freeport bed, Indianola mine, Allegheny County, Pa.

Coal 92 - Upper Banner bed, No. 9 mine, 0- to 1-1/4-inch raw nut and slack from tipple, Dickenson County, Va.

Coal 91 - Lower Banner bed, No. 56 mine, Russell County, Va.

Coal m28 - Pittsburgh bed, Warden mine, Allegheny County, Pa., washed coal.

Coal b310 - Asfaltita, sample No. 3, Argentina, S. A. (not a true coal).

Coal No.	Stage-crushed coal, size range tested	Drum unit used	Characteristic oxidation rate; absolute values		Oxidation rate relative to Warden mine coal[1]	
			Dry, m.m.-free coal	Dry coal	Dry, m.m.-free	Dry
296	0- to 1/4-inch	Small	0.062	0.054	0.47	0.43
297	do.	do.	.101	.089	.76	.70
299	do.	do.	.109	.097	.82	.76
298	do.	do.	.126	.110	.95	.75
300	do.	do.	.167	.148	1.26	1.17
DSC-2	do.	do.	.140	.126	1.05	.99
Do.	do.	do.	.219	.196	1.65	1.54
292	do.	do.	.209	.188	1.57	1.48
Do.	do.	do.	.275	.247	2.07	1.63
291	do.	do.	.301	.275	2.26	1.38
92	0- to 1/8-inch	do.	.121	.110	.69	.67
91	do.	Large	.157	.146	.89	.88
m28	do.	do.	.176	.165	1.00	1.00
Do.	do.	Small	.186	.174	1.05	1.05
311	do.	do.	.300	.293	1.70	1.78
b310	do.	do.	.149	.143	.85	.87

[1] Absolute values for 0- to 1/4-inch size Pittsburgh-bed, Warden mine coal are 0.133 on the dry, mineral-matter-free basis and 0.127 on the dry basis; corresponding values for 0- to 1/8-inch size are 0.176 and 0.165.

Low-Temperature Coke by Krupp-Lurgi Process

Although only one low-temperature carbonization plant has been operated commercially in the United States on bituminous coal, the problem of low-temperature carbonization and the utilization of the products continue to intrigue research workers and coal-producing companies. As a member of the Solid Fuels Mission to Germany, one of the Bureau of Mines' staff visited two German commercial-size plants of Krupp-Lurgi design and published his observations.[50] Carbonization is conducted in rectangular cells 10 feet 6 inches long, and 6 feet 11 inches high, with an average width of 3-1/2 inches. To facilitate removal of the product, the cells are 3 inches wide at the top and 4 inches at the bottom. Gases are recirculated to heat the charge. These gases enter the oven at about 620° C. and have a velocity so that the exit gases are not more than 50° cooler than the entering gases. The time for a complete cycle in the Krupp-Lurgi plant averages between 5 hours 20 minutes and 6 hours. The ovens were equipped for byproduct recovery. The low-temperature coke was used in locomotives as a gas generator fuel in stationary Diesel plants, for the production of synthesis gas for synthetic liquid fuels. The 3/4-inch to 1-1/2-inch size made an excellent fuel for ordinary household stoves. The author concluded his report with:

> It should be kept in mind, when considering the economic practicability of the low-temperature carbonization process, that it produces a better domestic fuel than high-volatile bituminous coal, and that this better fuel costs more per B.t.u. than the raw material from which it was made. This increase in cost per B.t.u. depends on the size of the plant, the local conditions, and the quality of the coal. All these factors can vary through a considerable range.

Carbonization of Elkhorn No. 3-Bed Coal

An investigation of Elkhorn No. 3-bed[51] coal from Wheelwright mine, Floyd County, Ky., showed this coal to be of high-volatile A rank, low in ash and sulfur, and suitable for gas making. Its coke was fissured excessively, but stronger coke was obtained from blends containing 20 and 30 percent Pocahontas No. 3 coal. The carbonization sample contracted 7.4 percent at a charge density of 51.92 pounds per cubic foot; expansion tests indicated that blends containing as much as 30 percent Pocahontas No. 3 coal may be carbonized without damage to byproduct ovens. The characteristic oxidation rate of Elkhorn No. 3 coal was about twice that of Pittsburgh-bed coal.

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[50] Schmidt, L. D., Low-Temperature Coke by the Krupp-Lurgi Process: Bureau of Mines Inf. Circ. 7395, 1947, 18 pp.

[51] See footnote 47, page 61.

Carbonizing Properties of Western Coals

In an investigation of the properties of western coals,[52] 106 coals from 7 Western States were subjected to carbonization or related tests. These coals were classified by States as follows: California, 2; Colorado, 24; New Mexico, 12; Texas, 2; Utah, 39; Washington, 5; and Wyoming, 23. They ranged in rank from subbituminous C through high-volatile A bituminous, although a major proportion were bituminous coals. The high-volatile A coals generally contained more volatile matter and oxygen than eastern coals of similar rank; consequently, their coking properties were inferior. The correlation of agglutinating value with coking propensity was more satisfactory for these western coals than for Appalachian coals. Many samples did not fuse in Gieseler and Davis plastometer tests at the normal heating rate of 3° C. per minute. Generally, the yields of gas were high and those of coke low.

Two California coals that outcrop in the Eel River district were of subbituminous rank and gave low yields of noncoherent char and high yields of gas at 950° C. The composition of Colorado coals varied greatly. Twenty-two ranked as high-volatile bituminous, but 12 of these were low in that classification and coked weakly. Frederick coal from the Trinidad district was the only Colorado coal fusing in plastometer tests, and it had the highest agglutinating value (8.5 kilograms) of any western coal tested. It yielded well-fused coke that was stronger than the average coke from eastern high-volatile A coals. Oliver and Hawks Nest mine coals from Gunnison County coke less strongly than Lower Sunnyside coal from the Columbia mine in Carbon County. Thirteen core-drill samples from the Paonia district, Gunnison County, yielded either noncoherent char or friable coke.[53] Eight New Mexico coals were of high-volatile A rank, and four were high-volatile C coals. Three Raton-bed coals from Colfax County that had agglutinating and plastic properties characteristic of high-volatile coking coals, yielded abradable coke. Two Gallup district coals were noncoking. Miller Gulch- and Lamb-mine coals from Santa Fe County coked as strongly as Lower Sunnyside (Utah) coal, and Jones mine coal from the same county coked even more strongly. One sample from Socorro County coked weakly. Two high-volatile coals from Texas were almost nonagglutinating and noncoking. Thirty-six, or all but 2, Utah coals were of bituminous rank. Upper and Lower Sunnyside-bed coals from the Horse Canyon and Sunnyside mines yielded coke similar to that from Columbia mine coal, the coking properties of which are well-known. Columbia mine coal was carbonized at bulk densities of 50.9, 52.6, 56.1, and 59.3 pounds per cubic foot, neither the yields of products nor the coke strength being affected significantly by the variation in density. Blending Sunnyside mine coal with 10 percent low-temperature char strengthened the coke slightly. Bear Canyon and Blind Canyon coals from Emery County coked weakly and yielded large volumes of gas. Six core-drill samples from Sanpete County coked less strongly than Lower Sunnyside coal. No. 6- and Roslyn No. 5-bed coals from Kittitas County, Wash., were strongly agglutinating and yielded well-fused coke that were rather abradable because they contained appreciable proportions

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[52] See footnote 47, page 61.
[53] See footnote 14, page 22.

of ash. The 23 samples from Wyoming included bituminous and subbituminous coals, most of which were noncoking. BM-AGA tests were made only on Lincoln County coals; 2 samples represented the Gomer mine and 5 were core-drilled. The cokes from the drilled samples had satisfactory shatter indexes but were more abradable than coke from Lower Sunnyside (Utah) coal.

Carbonization of Velva Lignite and Monarch Coal

Velva lignite from Ward County, N. Dak., and Monarch coal from Sheridan County, Wyo.,[54] were carbonized by the BM-AGA method at 500°, 600°, 700°, 800°, and 900° C. Generally, the yields of char, tar, and light oil were low, and the yields of gas and liquor were high. Predrying caused the lignite to devolatilize more completely when carbonized at temperatures above 500° C. Both samples yielded noncoherent char, with size degradation occurring largely below 500° C. The gases had the high specific gravity and low heating values characteristic of gas from low-rank coals.

Improvement of Methods for Testing Physical Properties of Coke

Existing methods for testing coke are inadequate. Coke producers have great difficulty in selecting the better of two coals for coking purposes if they are similar, and coke consumers are in a similar position because methods for closely measuring the physical properties of coke are not in existence.

Investigations are underway at the Southern Experiment Station, Tuscaloosa, Ala., to determine the size of coke sample necessary to obtain physical test data of any desired or specified precision and to improve the precision and utility of tests measuring the resistance of coke to breakage by shattering or impact forces. A mechanized shatter machine, the impact drum, has been developed and preliminary testing is almost complete. Preliminary studies indicate that the mechanized shatter will be more precise than the hand-operated apparatus. They also indicate that mechanization of the apparatus will make practical the development of a testing procedure which will allow the prediction of the amount of breakage a coke will suffer under any given set of handling shocks.

Large-Scale Coking Investigations

A model coke oven, having a capacity of 800 pounds of coal per charge, and the necessary auxiliary equipment are in process of installation at the Southern Experiment Station at Tuscaloosa, Ala. The oven chamber is of full width (17 inches), so that it can be used to study the effect of scale factors in smaller carbonizing apparatus. After the model oven has been subjected to correlation tests with full-scale byproducts ovens, it will be used for investigations of the effect of carbonizing conditions on the quality of coke and for studies of the coking properties of coals available to southern coke producers.

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[54] Reynolds, D. A., Davis, J. D., Ode, W. H., Wolfson, D. E., and Birge, G. W., Carbonizing Properties of Velva Lignite from Ward County, N. Dak., and Monarch Coal from Sheridan County, Wyo.: Bureau of Mines Tech. Paper 695, 1946, 41 pp.

Fuel Industry of Japan - Low-Temperature Carbonization

Between March and September 1946 a field survey was made of the commercial low-temperature carbonization processes used in Japan before and during the war. The results of this investigation were presented at the spring meeting of the American Society of Mechanical Engineers, in Tulsa, Okla., March 2-5, 1947, and were recently abstracted.[55]

Although water power was an important source of energy in Japan before the war, a considerable part of the 66,000,000 metric tons of coal mined annually was used for generating steam for power and process industries. A large amount also was used for manufacturing metallurgical coke; and although most of the low-volatile bituminous coal required for blending was at one time imported from north China and Manchuria, Japanese engineers ultimately developed two low-temperature carbonization processes for making a semicoke that suited their blending requirements satisfactorily.

Some of the low-temperature carbonization plants were operated primarily as a source of liquid fuel. Although Japan had a few Bergius and Fischer-Tropsch plants in operation, they were not very successful; but the low-temperature carbonization processes were satisfactory from the start and produced seven times as much liquid fuel as was produced by the synthetic liquid-fuel plants that were in operation. The plants that operated most sucesssfully were of German design and consisted of both Lurgi and continuous vertical Koppers units.

The chemical utilization of coal in Japan was primarily for the production of ammonia, and the gasification methods used for producing the necessary synthesis gas were developed largely along conventional lines. The principal source of gas was the Otto-design water-gas set, although Winkler and Fiag gas generators also were used to some extent.

Small-scale low-temperature carbonization plants were used to recover coal tar from high-ash waste coals; it was used directly as a lubricant for mine-car wheels and the pulleys of cable-haulage equipment. Needless to say, its lubricating value was very low, which made it useless for highly loaded bearings.

Very little coal was used in Japan as a domestic fuel, coking and heating being done with small braziers in which semicoke or briquets of semicoke and lime were burned.

During the war, when gasoline was not obtainable for civilian use, the Japanese used a number of portable gas producers for their vehicles. Again, semicoke was the main source of fuel, since charcoal was very scarce; and although the ash frequently was as high as 30 percent, necessitating frequent cleaning of the fuel bed, the vehicles gave staisfactory performance.

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[55] Reid, W. T., The Fuel Industry of Japan: Combustion, vol. 18, No. 11, April 1947, pp. 41-42.