coals, particularly low-cost coals of very large reserve volume and to develop supercoal cleaning methods to treat these coals.

Ash is so deleterious in coal used in the hydrogenation process for producing synthetic liquid fuel that the coal employed for this purpose must be cleaned to an ash content lower than the limit usually considered economical. In making the separation between coal and impurity in the finer sizes, such as 14-mesh, the flotation process offers the most promise. Accordingly, flotation tests were made on 14-mesh coal from the Pittsburgh bed in the Bureau's Experimental mine at Bruceton. Kerosine was superior to all other reagents tried. With a single recleaning of the froth, the ash was reduced from 7.3 to 3.3 percent; the yield of clean coal at this ash content amounted to 58.5 percent. Float-and-sink tests indicate that about 50 percent of the coal is available at 2.0 percent ash, but none of the flotation reagents tried was selective enough to give a product of this quality.

Fourteen midwestern and western coals were sampled and tested by a newly developed technique of very close gravity float-and-sink testing. These tests showed that nearly all the coals examined contain fractions amounting to as much as 50 percent of the total raw material of an ash content as low as 2.5 percent. This fact was established by separating the samples at very low specific gravities - substantially below the range of current coal-washing practice - so as to separate the pieces of very pure coal from the pieces slightly higher in ash. Thus, if separations could be made at such precise gravities, any of the corresponding products indicated could be obtained. Results of detailed float-and-sink studies on the possibilities of producing an exceptionally low-ash product from Pittsburgh bed, Bruceton mine, bituminous coal were published.49/ Figure 13, taken from this publication, represents graphically a typical coal specific-gravity consist. Each horizontal black band represents a certain portion of the sample differing from the adjacent band by 0.01 specific gravity. The first column at the right shows the yield by cumulative weight and the second column the cumulative ash content of the washed coal that would be obtained by cutting the raw coal in the washery along the specific gravity line indicated by the specific gravity indicated at the left side of the chart.

Removal of Extraneous Material from Coal

A pilot-plant unit, based on a new Bureau of Mines process for cleaning and dewatering the fine sizes of coal found around coal-preparation plants, was installed by the cooperating company in Alabama. The results so far obtained are satisfactory with respect to ash reduction, to recovery, and to dewatering of coal; capacity is still somewhat in doubt. To obtain required data as to the capacities of 2-cell and 4-cell combinations, the company plans to install another unit.

The feasibility of using concentrating tables for recovering coke breeze from old beehive coke dumps has been demonstrated, under Bureau of Mines supervision, at one plant.

49/ Fraser, T., Crentz, W. L., Cooper, H. M., Abernethy, R. F., and Barrett, O. T., Low-Gravity Float-and-Sink Separations of Bituminous Coal Samples: Bureau of Mines Rept. of Investigations 3812, 1945, 11 pp.

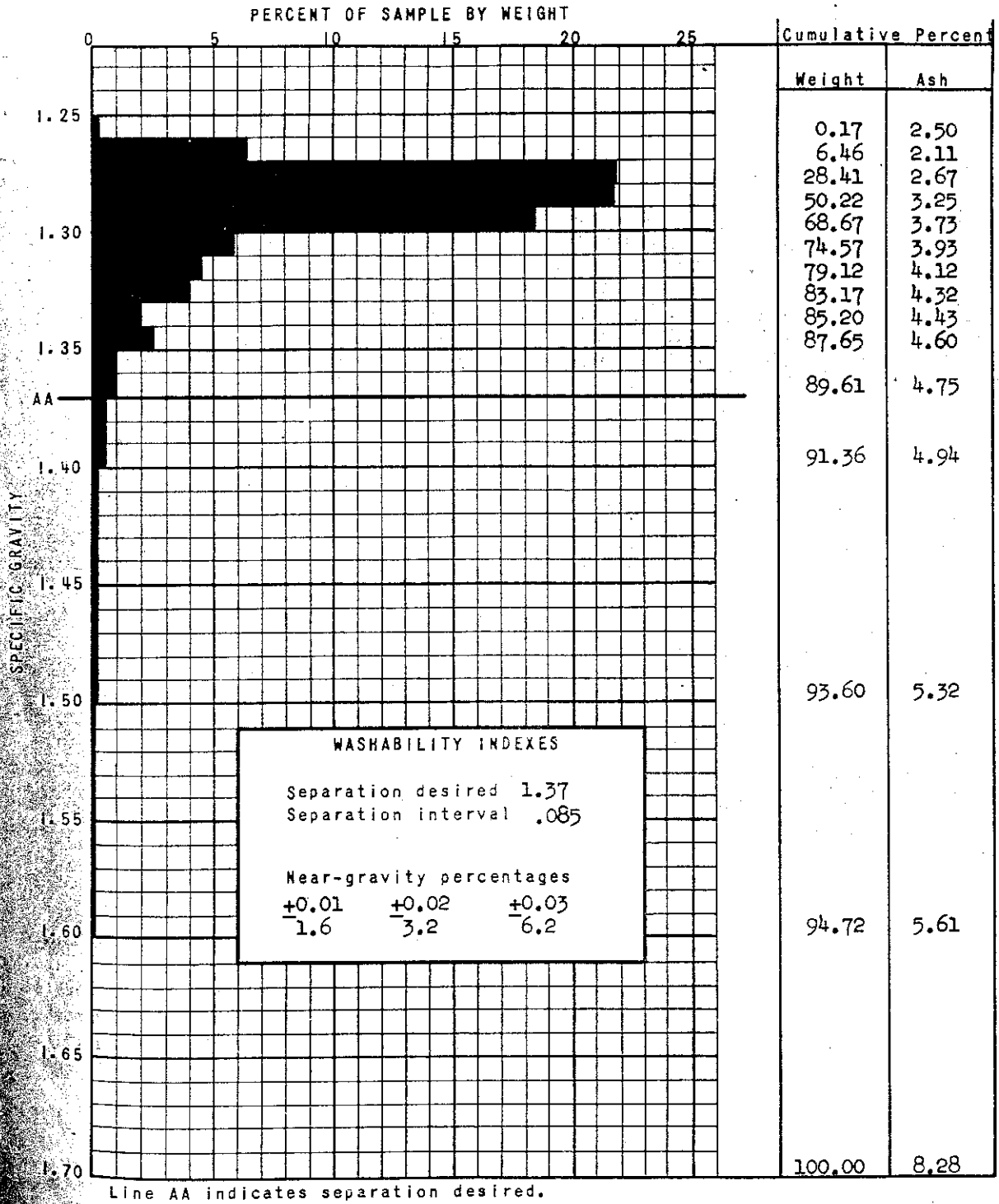

Figure 13. - Chart of typical coal specific-gravity consist.

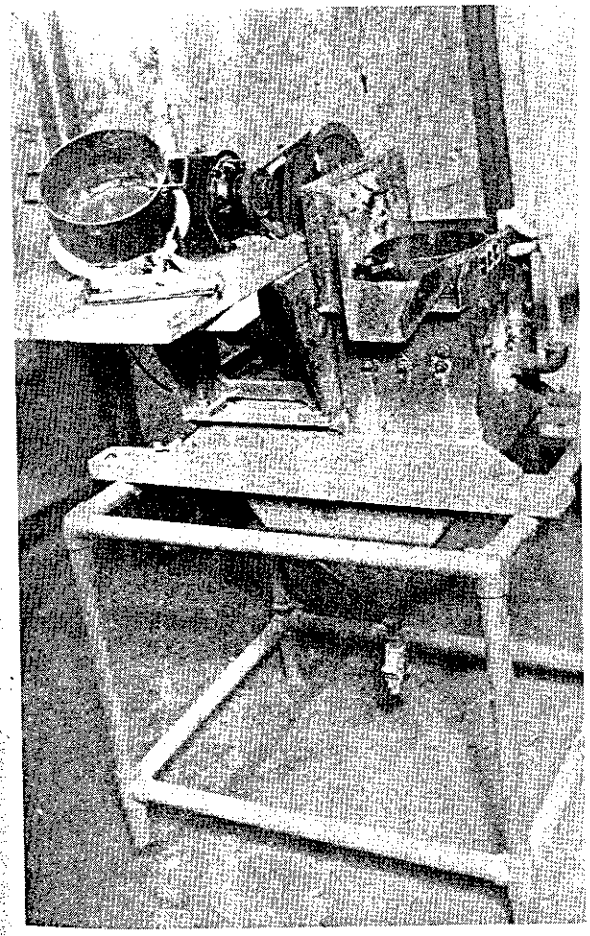

Figure 14. - Laboratory batch jig for concentration of sized charge and classification of unsized charge.

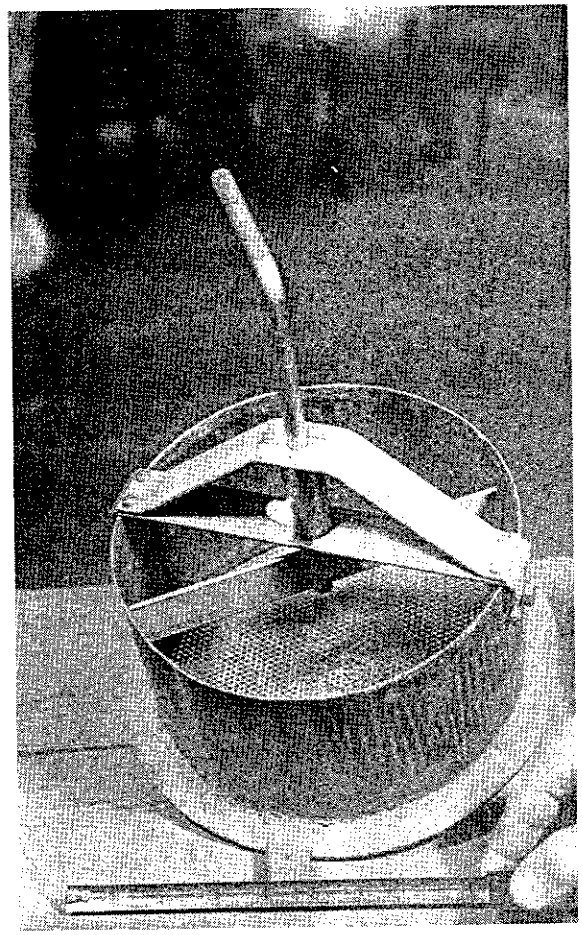

Figure 15. - Basket and skimmer used with laboratory batch jig.

Those engaged in washing coal on tables have long realized the need of a nonchoking hydraulic classifier. As a result of Bureau of Mines research, this nonchoking feature was provided by a "periodic pincer" which insures a constant and controlled flow of particles through an oversize orifice.[50] With some modifications in design, the classifier and pincer are being used in the laboratory to treat 3 tons of coal per hour. It is planned to use two small tables in the unit to demonstrate the advantages of classification for tabling.

Precision Jigging of Coal

All gravity-concentration processes, even including the new heavy-media processes, are influenced to some degree by particle size and shape. Although specific gravity is usually considered the predominating influence in these separations, size and shape under some circumstances may completely counteract the effect of specific gravity. Laboratory float-and-sink separations fail to appraise the size and shape effects. For this reason, in interpreting float-and-sink data, it is necessary to allow for the effect of such factors as particle size and shape and a general plant efficiency factor. The precision jig furnishes experimental data to facilitate this practical interpretation of basic washability data. A laboratory batch jig of unusual precision was developed to supplement washability data obtained by standard float-and-sink tests.[51]

Figure 14 shows the jig and figure 15 the basket and skimmer. In using the jig a removable basket 9 inches in diameter and 7 inches in depth is amply large for coal not coarser than 0.5-inch diameter. The use of about 6 pounds of steel punchings to form a layer about 0.5 inch deep provides uniform distribution of water throughout the bed. Before the coal is added to the basket, the punchings are jigged for several minutes with a long stroke and with much water for leveling and orientation. The jigging of a sized feed has been found to be equally effective for predominately pulsion or predominately suction action. To reduce hutching suction should be avoided, and to prevent the overflowing of fine, light particles (28- to 35-mesh) the pulsion should not be excessive. In a test with fine material, it was quite easy to achieve a balance between plunger stroke and hydraulic water, so that the bed opens on the pulsion stroke but does not overflow the basket. A pretreatment with a wetting reagent is required for fine coal. Upon removal of the basket, as many strata as may be desired can be skimmed off.

Table 7 contains data from float-and-sink and batch-jig testing of 14- to 20-mesh and 3/8-inch to 3-mesh raw coal. For each size, the weight, percent is obtained by the float-and-sink fractionation. The determined ash contents of the float-and-sink fractions are recorded and the ash contents of

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50/ Coe, C. D., and Coghill, W. H., Periodic Pincer to Control flow of Wet Ore Pulp through an Orifice: Bureau of Mines Rept. of Investigations 3750, 1944, 6 pp.

51/ Coe, C. D., and Coghill, W. H., Precision Jigging as a Substitute for Laboratory Sink-Float: Bureau of Mines Rept. of Investigations 3769, 1944, 7 pp.

the jig fractions of corresponding weight percent were calculated from the batch-jig comulative curves. The float-and-sink data for the 14- to 20-mesh size show that 54.1 percent of the sample is coal with an average ash content of 5.8 percent. By this jig, the ash content of the corresponding fraction was 7.9 percent. These data illustrate the application of the test jig in estimating probable commercial jig performance by reference to the fundamental specific-gravity characteristic of the coal.

TABLE 7. - Comparison of precision batch jigging with float-and-sink fractionation of raw coal

14- to 20-mesh

Specific gravity	Weight percent	Ash in specific-gravity fractions	Batch-jig ash, percent
Float 1.30	54.1	5.8	7.9
1.30 -1.38	24.5	14.5	10.8
1.38 -1.50	10.1	23.0	22.0
1.50 -1.70	3.8	36.2	37.1
Sink -1.70	7.5	75.9	72.7
	100.0	16.1	16.1

3/8-inch to 3-mesh

Specific gravity	Weight percent	Ash in specific-gravity fractions	Batch-jig ash, percent
Float 1.30	21.1	6.9	8.4
1.30 -1.38	50.8	11.8	11.8
1.38 -1.50	11.2	20.0	24.9
1.50 -1.70	4.6	32.7	39.4
Sink -1.70	12.3	77.3	69.4
	100.0	20.7	20.8

Characteristics of Coal-Cleaning Processes

The performance characteristics of coal-cleaning processes must be considered in selecting equipment for a particular application; with coals that are difficult to clean, performance is of primary importance. A recent report[52/] provides a detailed comparison of the performance of three commonly used units treating the same coal - a pneumatic jig known as the air-flow cleaner, a pneumatic table, and a Baum-type jig. The pneumatic jig and pneumatic table effected ash reductions of 1.6 and 2.0 percent, respectively, at efficiencies of 92.5 and 95.9 percent; in comparison, the Baum-type jig reduced the ash content by 6.5 percent and operated at an efficiency of 97.1 percent. In all three cleaning units, the sharpness of the separation effected between clean coal and impurity decreased with decrease in particle size. With both pneumatic units the modifying effect of particle size was so marked that no cleaning was accomplished in the material finer than

52/ Yancey, H. F., and Geer, M. R., Coal-cleaning Performance - Comparison of Pneumatic Jig, Pneumatic Table, and Baum-type Jig: Am. Inst. Min. and Met. Eng., Tech. Pub. 1888, 1945, 16 pp.

28-mesh. With the Baum-type jig, however, the efficiency of the separation between coal and refuse was influenced much less by particle size and a substantial reduction in ash content was effected in the sizes finer than 20-mesh.

Chemistry of Coal Cleaning

The relation of chemistry to the cleaning of coal was described in a chapter of a recent book published under the auspices of the National Research Council.[23] Coal cleaning touches the field of chemistry principally in flotation, the flocculation of slurry, dustproofing, the extraction of ash-forming impurities by treatment with acids, and heavy-media processes. These aspects of coal cleaning are critically reviewed. Also included in the chapter is a discussion of the impurities occurring in coal that are removable by cleaning, and the effect of their removal on utilization.

Preparation Tests of Toledo, Wash., Lignite

One of the few coal deposits in Washington that offers promise of being amenable to strip mining is a bed of lignite occurring near Toledo in Lewis County. Exploration by private companies indicated that the lignite averages about 40 feet in thickness and that the cover averages some 43 feet. Added interest attaches to this property because it is within 20 miles by highway of a high-grade clay deposit at Castle Rock. Since improving the quality of the coal appeared to be the critical factor upon which development of the property depends, the Bureau of Mines undertook coal-preparation tests to determine the quality of coal that could be produced and the treatment needed to prepare it for the market.[24] This investigation showed that coal obtainable from the deposit near Toledo, Wash., would contain not less than 33 percent moisture and 12 to 17 percent ash on the bed-moisture basis or 19 to 25 percent on the moisture-free basis, depending upon the size of coal and method of preparation. The heating value on the bed-moisture basis would be 6,000 to 6,500 B.t.u. per pound. If mined cheaply by stripping, the coal could be used as a low-cost fuel in a suitably designed boiler plant near the property; owing to its low calorific value, however, it probably could not be shipped in competition with high-grade coals to more distant points of consumption.

Miscellaneous Washability Examinations

Washability examinations and in some instances washing tests were made on coals from Alaska, Montana, Oregon, and Washington. Some of these coals were from new mines that are being developed; others were from mines at which cleaning plants will be required to provide coal of better quality for the

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23/ Yancey, H. F., and Geer, M. R., The Cleaning of Coal: Nat. Research Council (H. H. Lowry, ed.), Chemistry of Coal Utilization, New York, vol. 1, 1945, pp. 572-599.

24/ Yancey, H. F., and Geer, M. R., Preparation Tests of Lignite from a Deposit near Toledo, Lewis County, Wash.: Bureau of Mines Rept. of Investigations 3795, 1945, 14 pp.

postwar market. Recent washability data for Alabama coals are being used by mining companies in designing preparation plants at two mines recently put into production.

Reclaiming of Beehive Coke

Small coke that was discarded by the beehive industry for many decades because it was not acceptable to industrial consumers at the time of production was removed during the war from old coke dumps and reclaimed by screening, hand picking, and occasionally washing operations. Coke from western Pennsylvania dumps alone furnished about 250,000 tons of badly needed solid fuel during the year. The major part of this reclaiming was done by small operators; because it was of temporary nature, no facilities were installed to determine the quality of output. At the request of the Solid Fuels Administration for War, Bureau engineers visited and sampled the product at almost all such plants at least once during the year. Operators were kept informed on all developments for expediting production or improving the quality of this emergency fuel. Results of all analyses of the product were furnished the Solid Fuels Administration so that the consuming public was protected against unscrupulous operators. The best operators produced coke of an ash content ranging from 14 to 25 percent, whereas poor operators sold some reclaimed coal having an ash content as high or higher than 35 percent.

STORAGE OF COAL

Action of Coal in Storage

Activities on the storage of coal included laboratory investigations of the relative tendency of 28 coals to heat spontaneously and interpretations and correlations of the data obtained with observed field experiences in the storage of these and similar coals. Most of these coals were tested at the request of the War Department. Representative bituminous and subbituminous coals from 8 States in this country and from the Lota and Schwager mining areas in Chile, South America, were tested. The coals included: 2 medium-volatile bituminous coals - 1 from Alabama and 1 from West Virginia; 7 high-volatile A bituminous coals - 1 from Alabama, 1 from Colorado, 1 from West Virginia, and 4 from Chile; 9 high-volatile B bituminous coals - 2 from Colorado, 2 from Illinois, 1 from Indiana, 3 from Kentucky, and 1 from Missouri; 8 high-volatile C bituminous coals - 1 from Colorado, 1 from Illinois, 2 from Indiana, 3 from Missouri, and 1 from Ohio; and 2 subbituminous A coals, 1 from Oregon and 1 from Wyoming. Although considerable variation in heating tendency was observed for individual coals within the several ranges of rank, averages for the several ranks proved the general rule that the tendency of coal to heat spontaneously in storage varies inversely with its rank. Moreover, check tests on individual coals made under comparable conditions by another method in which the rate of consumption of oxygen is determined at 212° F. in air gave close agreement with results obtained by this direct adiabatic calorimeter test. For the several ranges in rank, the averages of comparative self-heating rates at 212° F. in the adiabatic calorimeter tests, based on a value of 1 for a typical, high-volatile A bituminous, Pittsburgh bed, coal, were: Medium-volatile 0.80; high volatile A, 2.9; high-volatile

B, 6.7; high-volatile C, 10.8; and subbituminous A, 7.2. The last value is low because these 2 subbituminous A coals had already oxidized appreciably when received for test; earlier work on two other subbituminous A coals gave a value of 14.1

A paper describing the adiabatic calorimeter test method for determining the spontaneous heating tendency of coal and summarizing the results obtained on 39 bituminous and 6 subbituminous coals and 1 lignite was published.25/ Results on several of the coals tested during the present fiscal year were included. It was found that the spontaneous-heating tendencies of coals depend on: (1) The nature or rank of the coal, the heating increasing with decreasing rank; (2) the temperature at which the coal is stored, the rate of reaction increasing very rapidly with rise in temperature; (3) the past history of the coal, the reaction rate decreasing rapidly with increased time of storage and quantity of oxygen consumed; (4) the availability of oxygen, the rate of oxidation being proportional to the oxygen concentration in contact with the coal raised to the 0.66 power; (5) the particle size and effective surface area, the rate of oxidation being proportional to the cube root of the surface area; and (6) the moisture and ash content of the coal, which tend to reduce relative spontaneous tendencies because of the latent heat of vaporization and high specific heat of water and the inert diluting effect of the ash.

Consulting Service to Government Establishments

Upon request, consulting service on various coal-storage problems was given to several Government establishments and industries. Consulting service was given to the War Department on a fire in a coal pile in Missouri; on the heating tendencies and storage of Bevier, Mo., coal; on methods of storage of Coos Bay, Oreg., coal; and on storage of coal and temperature measurement in coal piles at Fort Belvoir, Va. A study was made for the War Department of various proposed formulas for determining the amount of coal in storage piles of three specific shapes; a simplified scheme was developed for making such estimates. Another study at Camp Carson, Colo., for the War Department provided new information on storing lump subbituminous coal. Consulting service was given to the Navy Department on determining the amount of coal in storage, and on methods of storing coal at the Washington Navy Yard. The Bureau of Mines furnished material and assisted the Navy Department in preparing a bulletin on coal handling and storage for distribution to the various land plants of the Navy. A series of questions and answers covering home storage of subbituminous coal was prepared at the request of the Division of Solid Fuels Administration for War for use in a campaign to induce householders to store such coal during the summer, thus supplying domestic needs and alleviating production and distribution loads in the later months. Consulting services were given to the Department of Justice on the storage of subbituminous coal at Englewood, Colo.; to the Public Buildings Administration on sprays for coal-storage piles; and to the Hanna Coal Co. of Ohio on the difficulties of coal storage at many different locations.

25/ Elder, J. L., Schmidt, L. D., Steiner, W. A., and Davis, J. D., Relative Spontaneous Heating Tendencies of Coals: Bureau of Mines Tech. Paper 681, 1945, 24 pp.

Effect of Oxidation on Physical and Chemical Properties of Coal

A comprehensive article discussing the significant changes in the physical and chemical properties of coal that occur upon exposure to air at atmospheric temperatures was published.[56] Changes observed in storage piles, studies of the rate of the oxidation reaction under controlled conditions, characteristic rates of oxidation of various coals, the mechanism of the oxidation reaction and the influence of the physical structure of coal, methods of measuring relative tendencies toward spontaneous ignition, the effect of oxidation on the properties of coal, and the relative storability of various coals were discussed. Various factors, such as temperature, oxygen concentration, and particle size and composition of the coal, that affect the storage properties of coal, its combustion characteristics, and the yields and quality of its carbonization products, were considered in detail.

UTILIZATION OF COAL

Combustion

Fuel-Engineering Service

Fuel-engineering service to Government establishments with respect to the selection and use of fuels and fuel-burning equipment was continued. Special surveys of various problems were made at requests of the Navy Department, the War Department, the National Housing Agency, the Veterans Administration, the Department of Agriculture, the Department of Justice, and a number of Government heating plants in the Washington, (D.C.), area. Studies and analyses of the corrosive deposits on boiler tubes and the economizer at the Washington Navy Yard power plant showed them to be high in sulfates resulting from sulfur dioxide and sulfur trioxide in the products of combustion. Similar boilers and fuel-burning equipment using the same coal did not experience such deposits. Special collecting tubes that could be kept at various temperatures were used in numerous places throughout the path of the products of combustion. It was found that the accumulation of deposits depends on the type of fuel-burning equipment, the amount of sulfur in and the type of coal, the temperatures of the gases and the tubes, and apparently the amount of fly ash. At the request of the Navy Department, studies were made of two boilers at an industrial plant at Hopewell, Va., and at a public utility plant in Washington, D. C. Products of combustion were analyzed for sulfur trioxide content; the A.S.T.M. code method for making such tests was found to be unsatisfactory. Changes in stoker operation gave some relief; special equipment to affect combustion is being installed in one boiler. Troublesome boiler-tube deposits which forced operators to take each boiler off the line every 2 to 4 weeks at the Naval Aviation Supply Depot at Philadelphia, Pa., were analyzed, as well as the ash from three anthracite coals then used; slagging was prevented by eliminating use of two of the coals. The proper type of coal and the amount of coal required for a proposed Navy project in Vermont

56/ Schmidt, L. D., Changes in Coal During Storage: Nat. Research Council (H. H. Lowry, ed.), Chemistry of Coal Utilization, New York, Vol. 1, 1945, pp. 627-676.

were determined. Studies were begun to determine the fuel efficiency at each plant under the command of the Army Regional Headquarters, Ninth Service Command, at Salt Lake City, Utah. At requests of the National Housing Agency, specifications were studied and recommendations made covering refractory plastics and fire brick for furnaces at Greenbelt, Md.; a talk on coal conservation and boiler-plant maintenance was given before a conference of superintendents of projects at New York City. At requests of the Veterans Administration, over-all operating costs using different fuels were determined for plants at Grand Junction, Colo., Wilmington, Del., Kansas City, Mo., Peckskill, N. Y., Salisbury, N. C., Pittsburgh, Pa., and Providence, R. I. Decisions as to coal size were made for plants at Lyons, N. J., and Lakeside, Fla., and type of fuel and equipment for its use were determined for a project at Fargo, N. Dak. A series of three talks on fuel efficiency and boiler-plant operation was given before a group of boiler-plant engineers from Veterans Administration plants in the general vicinity of Chicago, Ill. At requests of the Department of Agriculture, a survey was made at Beltsville, Md., of the Central Office heating plant to determine needed changes in furnace design and proper coal for use, and an investigation was conducted of the overloading of a motor driving an induced-draft fan at the boiler plant of the Horticultural Station. Furnace changes needed for burning slabs at the Mill Point, W. Va., project were studied at the request of the Department of Justice. The amount of added condenser water needed and the piping required to bring this water from the Anacostia River were determined and recommendations made on proposed new equipment at the Capitol Power Plant. Specifications for stokers, prepared by the Purchasing Division of the Department of Interior, for Klingle Mansion, Washington, D. C., were studied and changes and recommendations were made. Specifications were reviewed, changes made, and resulting bids analyzed for boiler feed-water requirements at Howard University. Work was continued on the contract change order of new power-plant equipment for St. Elizabeths Hospital. An acceptance test run on a new deaerator showed unsatisfactory and unacceptable performance; changes were made, and a test run showed a satisfactory outcome. A new condenser pump had to be replaced because of unsatisfactory performance. A proposed lay-out for new boilers, including type, size, and type of fuel-burning equipment, was determined for the Bureau of Mines Station at Bruceton, Pa. Specifications for boilers and stokers were studied and changes recommended; bids on boilers and stokers were analyzed and recommendations made as to acceptance. A cooperative study by the Air Preheater Corporation, New York City, and the Bureau of Mines has been planned at a public utility plant in Indianapolis, Ind. Tests will be made on different kinds of construction materials to determine corrosion and deposit effects; weights and thicknesses of various types of test plates to be used in the study have already been determined by laboratory investigations.

Boiler Feed-Water Conditioning

Analyses and resulting recommendations were made on 18,185 samples of water during the fiscal year as follows: 16,610 samples from the War Department, 610 from the Veterans Administration; 345 from the Office of Indian Affairs; 214 from the Department of Justice; 186 from District plants; 67 from the Post Office Department; 54 from the United States Public Health Service; 49 from the National Housing Agency; 24 from the Navy Department; 22

from the Department of Agriculture; 2 from the War Relocation Authority; and 2 from the Bureau of Mines. Reports were made on analyses of 11 boiler compounds, 30 boiler scales and sludges, and 10 oil contaminations. One hundred and eighty-three special Bureau of Mines field water test kits, 13,511 bottles of chemical reagents, and 13,939 test-kit replacement items were distributed, mostly to Army posts. At the request of the Maritime Commission, a study was made of boiler feed-water pump corrosion difficulties on ships; special tests were made on the stability of cyclohexylamine at high pressure and temperatures. At the request of the War Department, a study was made of boiler-water treatment and recommendations made as to choice and amount of chemicals to be used in locomotives operated by the Army. At the request of the Procurement Division, a study was made of a proposed method for analyzing polyphosphates, and a different method was developed for use. At requests of the Veterans Administration, a new test procedure was developed for analyzing chloride content, and boiler feed-water conditioning was discussed before a group of engineers from Veterans' plants in the Chicago area. A study was made of the accuracy of the yellow spot diameter method of testing for phosphate and the effect of bleaching of tannin on the phosphate test; a report on this work was made at a meeting of War Department boiler-water engineers at Atlanta, Ga. At the request of the District Government, a study was made of foaming difficulties caused by a boiler-water compound used for sealing cracks in cast-iron boilers; experiments with and analyses of the compound resulted in eliminating its further use. A new test kit was developed for determining sodium sulfate in boiler water and an instruction booklet completed; directions were prepared for field testing of tannin. A boiler inspection was made by request at the Jefferson Junior High School, Washington, D. C. Consulting service on various other problems of boiler feed-water conditioning was given to 30 Government agencies. To help boiler operators who have not studied chemistry to understand the essentials of boiler feed-water conditioning, questions and answers on this subject have been published.57/ This publication is a reprint of part of a 132-page booklet of the same title and by the same author, published as Bureau of Mines Question and Answer Handbook 3 in 1936.

A paper describing the use of cyclohexylamine for preventing corrosion in steam-heating systems, discussed in last year's report, was republished and abstracted in several publications.58/

Boiler Feed-Water Research

The heavy investment of more than $300,000,000 in steam-heating systems at Army camps alone and rapid deterioration of a part of the piping under

57/ Barkley, J. F., Questions and Answers on Boiler Feed-Water Conditioning: Coal-Heat, vol. 46, October 1944, pp. 50, 53-54; vol. 47, January 1945, pp. 35, 38-39; February 1945, pp. 40-41, 56; March 1945, pp. 50-51, 57.

58/ Berk, A. A., Observations on the Use of Cyclohexylamine in Steam Heating Systems: Proc. Nat. District Heating Assoc., vol. 35, 1944, pp. 172-189; discussion, pp. 189-193. Abs. Steam Eng., vol. 14, December 1944, pp. 78-80; Power, vol. 89, March 1945, pp. 71-73, 146, 148; Power Plant Eng., vol. 49, May 1945, pp. 130, 132.

corrosive conditions have emphasized the need of developing more effective methods of treating boiler water for use in such systems. Cyclohexylamine, although useful in correcting corrosive conditions, has several limitations. Preliminary observations in the laboratory and in an operating steam system showed that the amine volatilized from the boiler water and neutralized the carbon dioxide acidity in the condensate steam, but because of high volatility excessive quantities of the amine were lost at vents. Moreover, the neutralized carbon dioxide, instead of being lost at the feed-water-heater vent, was recirculated with the amine in the condensate returned as boiler feed water. Economical treatment requires not only maximum recirculation of the amine but also minimum recirculation of the carbon dioxide. It appeared probable that an amine of more desirable properties would provide a more economical treatment. On the other hand, the use of cyclohexylamine offers distinct advantages as a local injection into single pieces of equipment, such as large hot-water generators, in which carbon dioxide tends to concentrate dangerously with respect to corrosion. A comprehensive study of amine treatments is now in progress. The behavior of compounds of widely different volatilities and alkalinities is being studied in thousands of samples of condensate steam taken from a typical heating system. Testers were placed in the piping to detect whether any of the compounds used have special merit in preventing corrosion. It is expected that this study will define the properties and characteristics of the most economical amine treatment for any particular steam-heating system.

Embrittlement cracking in boiler seams has been caused by concentrated potassium hydroxide. It is entirely feasible to operate high-pressure boilers with water which contains no free potassium hydroxide, but which is alkaline by virtue of its content of potassium phosphate and silicate. Correlation of the results of hundred of embrittlement detector tests, made according to the tentative method of the American Society for Testing Materials,[29] with boiler water analyses showed that the nitrate treatment of preventing embrittlement cracking has been entirely successful. Quebracho extract has also proved satisfactory in many instances. Tests in high-pressure boilers have shown that use of phosphates in a preferred method of treatment and has been adopted by many power plants. In some instances, it has been possible to correlate the results of embrittlement detector tests with actual failures in stationary power plants.

Fly-Ash Separator for Use in Homes

Improvements in design of a simple, practicable, gravitational-type fly-ash separator, recently developed for use in homes, were suggested.[60]

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[29] American Society for Testing Materials, Tentative Method of Field Test for Tendency of Boiler Water to Cause Embrittlement Cracking of Steel, A.S.T.M. Designation D 807-44T: A.S.T.M. Standards, 1944, pt. III, Nonmetallic Materials, pp. 2099-2105.

[60] Barkley, J. F., Discussion of "The Fly-Ash Problem with Domestic Stokers and the Use of Settling Chambers and Firebox Baffles," by T. S. Spicer, R. G. Bowman, and C. C. Wright: Trans. Am. Inst. Min. and Met. Eng., Coal Div., vol. 157, 1944, pp. 244-245.