ILLUSTRATIONS (Cont'd.)

INTRODUCTION

This, the 11th annual report of research and technologic work conducted by the Bureau of Mines on coal and coal products, is issued following the closing of the Bureau's war work on fuels and contains references to most of the published articles containing results of war investigations. The few remaining papers will be discussed in next year's report. The trend in coal research in the Bureau of Mines was discussed in Mechanization.4/ This publication, covering the period from the close of armed conflict to resumption of normal coal-research activities, includes a section never previously presented. There is included for the first time a discussion of the Bureau's activities in the Liquid Fuels and Lubricants and the Solid Fuels Subcommittees of the Technical Industrial Intelligence Committee. This report does not replace the more comprehensive ones prepared

4/ Fieldner, Arno C., Coal Research for 1946: Mechanization, February 1946, pp. 105-109.

by individual authors and listed as footnote references in this publication. Its purpose is to bring to the reader a résumé of the work for the fiscal year ended June 30, 1946. The material presented herein is based largely upon publications, but the results of some research and testing, which would not otherwise be published in the near future, are presented in detail.

SUMMARY

The Bureau of Mines continued its studies and services for increasing the economy and efficiency in governmental, industrial, and domestic fuel-using operations. Analytical-testing programs were designed to develop substitutes to overcome the depletion of high-grade coal resources, and process development went forward to utilize advantageously the great lignite deposits of the Northwest.

Services to Federal agencies included the sampling and analysis of coal and tests of fuels and boiler-room equipment. Analyses of boiler water and recommendations on fuel purchasing and boiler-water treatment were made. The coal-analysis laboratory examined a total of 15,601 samples. Of these, 5,910 were samples of coal-mine dusts taken as part of the safety program for the reduction of dust explosions, 4,674 were samples of coal taken in connection with Government purchase and tipple and breaker inspections, and 5,017 were samples of coal and related materials examined for research and related groups. Types of fuel and fuel-burning equipment were determined for 37 new hospitals for the Veterans Administration. Consulting service on smoke-abatement work was given to a number of cities.

Five engineers of the Bureau of Mines were detailed to the Foreign Economic Administration to serve under the Technical Industrial Intelligence Committee to obtain the latest hitherto unavailable information on European practice in the mining, preparation, and utilization of coal. Another was detailed to obtain information in Japan on low-temperature carbonization of coal.

With the close of the war, the National Fuel Efficiency Program was terminated. Cooperation of 16,000 industrial organizations had been obtained, and the estimated savings had reached the rate of 5,000,000 tons of coal amounting to some $30,000,000 per year.

The construction of a new-type scraper-shaker-gangway loading machine is virtually complete, and tentative arrangements have been made to test this equipment and special shearing machines in mining thin, steeply pitching beds of anthracite. A study of utilization of light earth-moving equipment in bituminous-coal strip mining was completed. The development of a coal planer uncovered in Europe has been arranged. Five million tons of lignite minable at low cost by strip-mining methods were proven in a deposit in Washington. Exploration for coking coal, critically needed for long-term, economically competitive operation of the western steel industry, was continued in Colorado. Preliminary results of coking tests indicated coal equal to the best previously known western coking coal. Exploration was also conducted in Alabama for coking coal and in Maryland for highly desirable semi-smokeless coal of coking quality and in Alaska for coal necessary for regional

use. More than 1,800 feet of drill cores from coal beds at seven exploration projects were studied in detail, and nearly 1,000 feet of coal from drilling received petrologic examination, chemical analysis, and other tests.

Studies were made of coal seams in 11 States to determine their adaptability to the production of a very low-ash washed coal for the production of synthetic liquid fuels by the hydrogenation process. It was shown that some strip coal in the State of Washington, otherwise never mined, could be made marketable by washing. A study of the preparation characteristics of the thinner coal seams in the State of Maryland was undertaken, aimed at the development of these resources as the more important beds become depleted. A similar project has been initiated in Alabama as a part of a general drilling and exploration program. Assistance has been given Alaska and several South American countries to enable them to utilize their coal resources better through preparatory treatment. Improved preparation practice, combined with the use of the ash-removal stoker, has broadened the markets for high-ash coals with high-fusion-point ash.

Four years of study, involving the use of 30,000 tons of coal, proved that subbituminous coal could be stored without danger of spontaneous heating and little loss in heating value by using simple methods to prevent air circulation within the storage pile. Advice on storage facilities and the storing of particular coals was given to the many Federal fuel-consuming facilities upon request. Investigation was begun of a new process, developed in Holland, for cleaning fine coal. Recoverable montan wax (hitherto imported) has been found in lignite from Malvern, Ark., and Ione, Calif.

An investigation designed to minimize or prevent corrosion of boiler tubes has led to a procedure for evaluating various protective tube coatings. To obtain more efficient boiler design, studies have been made of the heat absorption in large central-station boiler furnaces. In connection therewith, the examination of the properties of coal-ash slag was continued. Slag properties are of interest in the utilization of Rhode Island anthracite in a slagging-gas producer designed to make rock wool as well as gas. To evaluate fuels from new processes and packaged fuels from various sources, using various binders, a test procedure has been developed.

To offset the depletion of the best known coking coals under war and reconstruction demands, the survey of carbonization properties was continued. Examinations included the expanding, plastic, and oxidation properties, particularly as related to the adaption of various coals in the making of metallurgical coke. Laboratory tests indicated that Beckley-bed coal from West Virginia might be suitable for blending with high-volatile coal in coking mixtures. Coking and byproduct tests were made on three coals from Colorado and four from West Virginia, as well as several South American coals for the State Department.

Studies on the utilization of lignite showed that gas suitable for the reduction of iron ore or gas suitable for the synthesis of liquid fuels could be made in externally heated alloy retorts.

Investigations on synthetic liquid fuels are carried out under Public Law 290 (78th Cong.) to develop processes for making gasoline and oil from coal, oil shale, and other substances and apply them on a demonstration-plant scale. This legislation was passed, funds were provided, and the work was started as the demand for oil products rose to unprecedented heights during the war and discoveries of oil in new fields in this country fell to about one-third of the annual requirements. The great war demand for oil no longer exists, but, contrary to expectations, the country's normal demand is now at about the same level as the peak reached during the war, and results from exploration are no better. These conditions indicate that the need for the synthetic-fuel work is greater now than it was at the time the legislation was passed and that it will steadily become more important as the country's industrial activity increases.

Two processes are being studied on the research and development scale for production of oil and gasoline from coal. This work is in Pittsburgh, Pa., the nearby town of Bruceton, and Morganton, W. Va. Equipment now in operation provides for the production and testing of catalysts, preparation of coal, gases, and other raw materials for the processes, and the operation of two complete units of equipment for the continuous synthesis of oil and gasoline from coal. Other synthesis units, producing up to about a barrel of oil a day, are being completed and will be in operation as soon as laboratory space is available in new buildings that are being erected and will be available this fall.

Significant progress has been made in one of the processes, both in preparation of the catalysts and in removal of the heat of reaction, which has been one of the bottlenecks in the design and construction of large units of commercial equipment. It is estimated that by this process these improvements can cut production costs in half. Similar possibilities for cutting costs are in sight for the second process for making oil from coal.

A demonstration plant to produce 200 barrels of oil a day by the hydrogenation of coal is being designed for erection at Louisiana, Mo., on the site of the Government-owned synthetic-ammonia plant located there. It is expected this plant will incorporate the major features of design worked out in the development program.

Tests of new permissible explosives, permissible samples collected in the field, and new types of industrial explosives seeking to utilize surplus military stores were made. Two new explosives were added to the permissible list, which now includes 180.

An extensive investigation on the hazards of toxic gases from sheathed explosives established the limitations of such explosives and the conditions under which they may be employed. Industrial cooperative studies were made on the performance and hazards of liquid-oxygen explosives, which will be of material aid to field operators.

Significant advances have been made in the accurate determination of hazards of static electricity produced by friction or successive contact

and separation of unlike surfaces, in the manufacture, storage, and use of explosives and inflammable substances. The precise measurement of the electrostatic charge acquired by personnel and equipment during typical operations enabled setting up safety standards.

Study of the ignition of firedamp by explosives revealed that the geometry of the explosive and the position of the detonator relative to the charge play an important role in the ignition process.

Special inquiries from industry and other Government agencies brought about investigations of the use of hydrogen peroxide as an oxidizing agent in explosives, in the evaluation of hazards in specific industrial operations, and in devising methods of measuring rates of detonation with a high degree of precision.

Further tests in the experimental coal mine connected with the safe use of larger explosive charges have confirmed the desirability of continuing the 3-pound explosive-charge limit for coal mining in lieu of the previous 1-1/2-pound limit.

Knowledge of the mechanism of ignition of explosive gas mixtures by electric sparks has been advanced by the accurate determination of minimum spark energies for ignition.

Fundamental studies of flame have developed principles governing the performance of gas burners that will aid in the scientific designing of burners, including jet burners of all types.

For the first time, research has made it possible to state conditions for eliminating explosions in medium-pressure acetylene generators by adding prescribed amounts of hydrocarbons such as natural gas, propane, or butane to acetylene as it is produced in the generator. Solid and gaseous products of unusual interest were found to result from explosion of such mixtures. Other investigations of combustible materials involved determination of minimum ignition temperatures, limits of inflammability, prevention of gasoline and naphthalene explosions and the use of helium or Freon in explosion prevention.

Over 60 samples of industrial dusts and powders for special purposes submitted by industry, some of which had already caused explosions and fires, were studied for their hazardousness, and recommendations for preventing such explosions were formulated.

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ORIGIN, COMPOSITION, AND PROPERTIES OF COALS

Inspection, Sampling, and Analysis

A shortage of coal existed throughout the year, and, in general, Government agencies had difficulty in obtaining enough coal to meet requirements. The Office of Indian Affairs, the Department of Justice, and, to a limited extent, the War Department purchased coal on a guaranteed-analysis basis. The rest was purchased on a flat-price basis and in some instances was obtained through directives by the Solid Fuels Administration for War. Consulting service, including in some instances the analysis of bids and recommendations of awards and recommendations on coal specifications, was given the War Department, Navy Department, Department of Justice, Post Office Department, Procurement Division, Treasury Department, and Department of the Interior. Coal purchases by Federal Agencies during the fiscal year were originally estimated at 10,000,000 tons, the War Department being the largest purchaser and the Navy Department the second largest. Many War Department posts were closed during the year, resulting in a decrease in the tonnage actually purchased.

Analyses were furnished all purchasing agencies for use in evaluating coal bids and for use when substitute coals were offered. In connection with contracts for furnishing this coal, 4,672 reports on proximate or ultimate analysis and heating value of coal and 1,893 reports on fusing temperature of ash were issued to Federal Agencies. These reports provided analyses for price adjustment where applicable and for other action as provided by the contracts, such as cancellation of contracts, refusal of further shipments, and rejections of coal.

Coal sampling at Army posts, begun in September 1943 upon request of the War Department, was continued, and particular attention was given to instructing Army personnel in proper methods of sampling. In all, 1,442 visits were made to Army posts and 1,343 samples were collected. Upon the request of the War Department, coal loaded for export was inspected and sampled at the posts of Pensacola, Fla., Mobile, Ala., and Charleston, S. C., and, to determine suitability of coal for export, inspections were made at 18 mines in Alabama.

Sampling at Pennsylvania anthracite breakers, begun in November 1943 upon the request of the Solid Fuels Administration for War, was continued, and 144 samples were collected at 40 breakers. As a result of this work, a number of breakers were shut down, others installed new cleaning equipment, and in general the quality of anthracite shipped was improved. Upon the request of the Office of Price Administration, 69 samples of Pennsylvania anthracite were collected at railroad weigh scales for the purpose of providing data upon which to base price adjustments for substandard coal.

Visits were made to 29 agencies of the Indian Service for the purpose of checking sampling methods and instructing Indian Service personnel in proper sampling methods. Samples of coal were collected for special purposes in various States. The coals included 38 face samples and 11 five hundred-pound samples at 11 mines in Alabama to determine suitability of the coals for use in a Lurgi pressure-type gas generator; 7 samples ranging from 250 to 1,000 pounds for hydrogenation tests; and 5 samples for microscopic examination at 6 mines in Illinois; two 1,000-pound samples for hydrogenation tests and two for microscopic examination at 2 mines in Missouri; 65 samples at 60 mines in Utah, 30 samples at 22 mines in Wyoming, and 1 sample at 1 mine in Idaho for preliminary carbonization tests at the Golden station; 1 sample at a mine in Illinois and 1 at a mine in Colorado for tests on prolonged air-drying loss; 2 samples at 2 mines of Pennsylvania semianthracite for microscopic examination; and the following samples for analysis for the general use of Federal Agencies in determining awards of contracts and for information for public use: 62 tipple samples at 21 mines in West Virginia, 1 tipple sample at 1 mine in Pennsylvania, 6 tipple samples at 2 mines in Ohio, 54 tipple samples at 16 mines in Illinois, 1 tipple sample at 1 mine in Colorado, 15 tipple samples at 3 mines in Montana, 81 tipples at 29 mines and 4 face samples at 4 mines in Wyoming, 149 tipples at 56 mines and 38 face samples at 10 mines in Utah, and 3 tipple samples at 1 mine in Idaho.

Analyses of Alaska Coals

A compilation[5] of analyses of Alaska coal was published and is another in the series of technical papers describing coals of individual producing States. The geology of the coal fields, production, distribution, uses, and the relationship of mine samples to commercial shipments were discussed. Descriptions of mine and delivered samples included chemical analyses, calorific values, classification by rank, agglomerating indices, and fusibility of ash temperatures. Descriptions were given of the location, thickness of bed, nature of floor and roof, and partings of a number of operating mines. A map of Alaska showing principal areas known to contain coal was included.

Data on Coals in District No. 9, Western Kentucky

A data book[6] giving information on coal produced in western Kentucky (Producing District No. 9) was published and is another in the series heretofore prepared by the Office of the Bituminous Coal Consumers' Counsel in collaboration with the Bureau of Mines. The book contained descriptive tables of direct rail-connected and ramp-loading mines, with seam names, mine index numbers, and originating railroad or river, maps showing their locations, and tables giving specimen analyses (with usual ranges) by seams and counties.

The number of samples analyzed in connection with Government fuel purchases declined slightly owing to reduction in force of several samplers after the termination of hostilities. Samples analyzed for the War and Navy Departments accounted for 74 percent of the Federal samples. Research of the Bureau on exploration, preparation, and utilization of coal and coal products required analysis of 5,017 samples. These samples came from 16 States, Alaska, Chile, China, Ireland, Italy, and Peru.

Assistance was given to Federal coal-mine inspectors by analyses of 5,910 samples of coal mine-dust collected on the ribs, roofs, and floors of 904 coal mines in 18 States. These analyses were used in determining whether corrective recommendations were necessary at specific mines and in formulating the recommendations where necessary.

In addition to analytical services given to the several sections of the Bureau of Mines and other Federal Agencies in analyzing 15,601 samples requiring 164,533 determinations, portions of samples recently analyzed were sent to 14 coal laboratories or schools for the purpose of checking equipment and for student use.

5/ Fieldner, A. C., Gates, George O., Bell, C. H., Anderson, R. L., Snyder, N. H., Cooper, H. M., Abernethy, R. F., Tarpley, E. C., and Swingle, R. J., Analyses of Alaska Coals: Bureau of Mines Tech. Paper 682, 1946, 114 pp.

6/ Fieldner, A. C., Sweeny, Harry P., Rice, W. E., and Moran, H. E., Typical Analyses of Bituminous Coals Produced in District 9: Bureau of Mines Data Book, vol. 6, 1945, 32 pp.