## Mineral Wool from Rhode Island Anthracite

In cooperation with the Rhode Island State College, a study was made of the suitability of Rhode Island anthracite for the direct production of mineral wool. Characterized by an ash content usually over 30 percent and with low-reactivity because of its high content of graphite, this material has been considered unsuited for use as fuel. These properties, however, are desirable for the manufacture of mineral wool, and this application is considered to be most promising in developing a market for this material. Experimentation will be conducted in a slagging gas producer having an inside diameter of 21 inches, thus approaching in size the smaller cupolas already used for manufacturing mineral wool. The investigation will include as objectives not only the production of a commercial quality of mineral wool, including a study of the local materials available as fluxes, but also the generation of useful producer gas as a byproduct.

## Use of Barley-Size Anthracite in Gas Producers

To permit the substitution of Barley- for Rice-size anthracite in gas producers, experiments made with the use of a fuel-bed agitator showed that Barley-size anthracite could be gasified at approximately one-half the normal rate attainable with Rice-size anthracite when no agitator was used.[82] Higher rates were not obtainable, mainly because the center of the fuel bed was weak. A method of feeding the producer fuel so as to permit a deeper center is expected to remedy the troubles due to thickness, shape, and heating conditions of the fuel bed.

## Carbon Monoxide Generator

For use in a proposed small-scale Fischer Tropsch experimental plant, a carbon monoxide generator was developed utilizing pitch coke or petroleum coke as fuel and having an oxygen blast. The raw gas leaving the generator contains approximately 97 percent carbon monoxide, 1.6 percent nitrogen, 1 percent hydrogen, and 0.5 percent carbon dioxide and oxygen. Most of the ash in the fuel is volatilized and present in the gas as a "smoke," necessitating electrical precipitation methods for cleaning. Although the experimental unit had a capacity of 25,000 cubic feet per day of cargon monoxide, extension of the same principle to larger units having greater capacity seems warranted.

# LIQUEFACTION

## Literature Reviews and Abstracts

Comprehensive reviews of technical publications and patents which appeared before 1941 on synthetic liquid fuels processes were published as chapters of a new two-volume book entitled "Chemistry of Coal Utilization."

[82] See footnote 66.

One of these chapters[83] summarizes the industrial development of the hydrogenation of coal and tar, and gives a critical discussion of the important physical chemical factors involved in the liquefaction of coal by hydrogenation. Results of industrial operations and of laboratory investigations on the influence of rank and of type of coal, pretreatment of coal, nature of solvent or vehicle, importance of vehicle, agitation, and catalyst, effects of temperature, pressure, and contact time, characteristics of oils produced in liquid-phase hydrogenation, hydrogenation of coal tar, and the design and materials for construction of coal- and tar-hydrogenation equipment were comprehensively reviewed.

A second chapter[84] deals with the synthesis of hydrocarbons from water gas. Industrial developments, methods of production of synthesis gas and of hydrogen, mechanisms of the reactions, factors involved that affect the composition and yield, properties of Fischer-Tropsch products, and the economics of coal and carbon monoxide hydrogenation were thoroughly reviewed.

Another chapter[85] discusses the methanol synthesis from water gas. Processes of manufacture, determination of the methanol equilibrium, methanol-process patents, production and purification of hydrogen and of carbon monoxide, apparatus for methanol synthesis, methods of purification of methanol, and catalysts used in its synthesis were comprehensively examined.

A critical review of the fundamental chemistry of destructive hydrogenation of coal, coal tar, and oil, and of the synthesis of hydrocarbons from water gas was published.[86]

A bibliography of Bureau of Mines investigations on the production of liquid fuels from oil shale, coal, lignite, and natural gas was compiled.[87] In addition to the publications issued by the Government in printed or mimeographed form, references are included to articles written by Bureau of Mines staff members for the technical press and to cooperative reports of work done jointly with States, colleges, and industries. The bibliography lists a total of 231 publications and 5 patents.

A systematic abstracting service was organized for reviewing current literature on synthetic liquid fuels and related subjects. These abstracts

83/ Storch, H. H., Hydrogenation of Coal and Tar: Nat. Research Council (H. H. Lowry, ed.), Chemistry of Coal Utilization, New York, vol. 2, pp. 1750-1796.

84/ Storch, H. H., Synthesis of Hydrocarbons from Water Gas: Nat. Research Council (H. H. Lowry, ed.), Chemistry of Coal Utilization, New York, vol. 2, 1945, pp. 1797-1845.

85/ Hirst, H. H., Methanol Synthesis from Water Gas: Nat. Research Council (H. H. Lowry, ed.), Chemistry of Coal Utilization, New York, vol. 2, 1945, pp. 1846-1868.

86/ Storch, H. H., Catalysis in Synthetic Liquid-Fuel Processes: Ind. Eng. Chem., vol. 37, 1945, pp. 340-351.

87/ Fieldner, A. C., and Fisher, P. L., Bibliography of Bureau of Mines Investigations on the Production of Liquid Fuels from Oil Shale, Coal, Lignite, and Natural Gas: Inf. Circ. 7304, 1945, 18 pp.

cover a wide range of pure and applied science and are of value not only to the Synthetic Liquid Fuels Office, but also to the Coal, Explosives, and Petroleum and Natural Gas Divisions of the Fuels and Explosives Branch. Exhaustive patent surveys on synthetic liquid fuel processes are in progress and will be completed and ready for publication during the next year.

## Inspection of Synthetic Liquid Fuel Plants in Germany

Five members of the staff of the Office of Synthetic Liquid Fuels were sent to Germany where they spent 2 to 3 months in inspecting synthetic liquid fuel plants, examining documents containing technical information, and interrogating key personnel connected with the plants. Reports on these activities will be made through the Petroleum Administration for War. All of the commercial-size plants were 1938 models. Some interesting and potentially important laboratory and pilot-plant research data were found.

## Reaction Mechanisms in Hydrogenation of Coal

The products obtained by the hydrogenation of coal are, in part, assumed to be present in the original coal structure and to be formed by the depolymerization of the coal. An interesting possibility is that some of the condensed aromatic nuclei obtained during the hydrogenation of coal result from less highly cyclic structures by the thermal or catalytic intramolecular loss of hydrogen. Such transformations might occur by the loss of hydrogen from two suitably situated methyl groups or from a methyl group and an aromatic nucleus. It was found[88] that when 2,2'-dimethylbiphenyl is repeatedly passed over a palladium-charcoal catalyst at 450° C. it is converted to 4-methylfluorene (a three-ring aromatic). A similar reaction starting with methylbiphenyl gave fluorene[89] and with dinaphthyl gave perylene. Cyclodehydrogenation of mesityl was unsuccessful, which indicates that the pyrene nucleus may be present in the original coal. Byproducts of this research work consisted in the synthesis of about 10 new organic compounds needed as intermediates and in a new design of a useful dropping funnel.[90]

Many data on various research problems concerned with the hydrogenation of coal were collected during the year. These data are in a preliminary "progress-report" stage; and upon the accumulation of more data and critical reviews thereof, publications on these research programs will be made.

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87/ Orchin, M. and Woolfolk, E. O., Aromatic Cyclodehydrogenation. I. 4-Methylfluorene from 2,2'-Dimethylbiphenyl: Jour. Am. Chem. Soc., vol. 67, 1945, pp. 122-124.

88/ Orchin, M., Aromatic Cyclodehydrogenation. II. A New Synthesis of Fluorene: Jour. Am. Chem. Soc., vol. 67, 1945, p. 499.

89/ Orchin, M., Modified Dropping Funnel: Ind. Eng. Chem., anal. ed., vol. 17, 1945, p. 99.