Science News-Letter

The Weekly Summary of Current Science

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ENGINEERING—CHEMISTRY—FUELS

Coal Promises to Provide Gasoline and Oil of Future

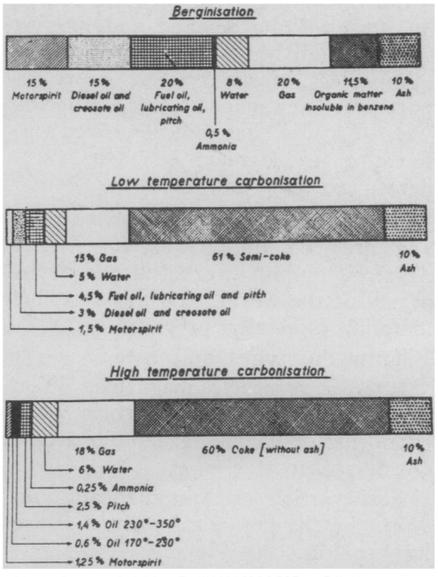
The International Conference on Bituminous Coal held at Pittsburgh, November 15 to 18, under the auspices of the Carnegie Institute of Technology, attracted over 1600 people interested in various aspects of coal production and utilization and there were delegates from twenty countries. The leaders in coal research of Europe and this country contributed to the program. Dr. Edwin E. Slosson reports in the following articles the highlights of the meeting.

How Bergius Liquefies Coal

Gasoline, the most valuable of motor fuels, may be made directly from lignite, the cheapest of coals by a direct and economical process. The inventor of this process for synthetic petroleum, Dr. Friedrich Bergius of Heidelberg, Germany, gave details of the manufacture on a commercial scale of light and heavy fuel oils, lubricating oil, benzene and phenol compounds and ammonia from waste coal dust or low-grade coal.

That the process has passed beyond the experimental stage and is thought likely to become an important factor in the world-wide struggle for new sources of motor fuel is proved by the fact that it has been taken up by strong organizations in Germany, England and in other countries. An international company has been formed to carry on the liquefaction of coal and in this the largest stockholders are the Royal Dutch Shell group, which is the leading petroleum combine of Europe, and the German association of dye manufacturers. The British government is also interested in this method of making artificial oil fuel and a plant for the purpose of investigating the Bergius process has been erected in England. Two experimental plants are maintained in South Germany, employing 150 men.

The discovery of how to convert coal into liquid products is not a lucky accident but the achievement of long and laborious scientific research, such as gave Germany the supremacy in the manufacture of indigo and other synthetic dyes before the war. Dr. Bergius began his study of the composition of coal in 1912 and ex-



YIELDS FROM BITUMINOUS COAL when subjected to various processes. Diagram prepared by Dr. Bergius.

cept for the interruption of the war the investigation has been carried continuously on ever since at the cost of millions of dollars.

The essential principle of the process consists in combining hydrogen gas with coal by means of high heat and pressure. The coal is first ground into small pieces less than a tenth of an inch in diameter, and then mixed with heavy oil to a thick pasty mass. This is placed in a light steel retort and heated to about 800°F. under a pressure of about 3,000 pounds per square inch. Most of the carbon unites with the hydrogen giving a complex mixture of gaseous, liquid and solid compounds similar to those coming from natural wells. In the case of lignite, a low-grade brown coal, as much as ninety per cent of the carbon is transformed into such marketable products. The nitrogen contained in the coal is transformed into ammonia or liquid bases. A ton of common bituminous coal will yield three hundred pounds of gasoline, four hundred of heavier oils suitable for Diesel internal combustion engines, hundred and twenty pounds of lubricating oils and hundred and sixty pounds of fuel oils. As a rule about forty-five gallons of marketable gasoline can be expected from a ton of soft coal. The second fraction of heavier oils is used in impregnating another batch of powdered coal. Among the products of the process is a quantity of carbolic acid or phenol a familiar antiseptic and also a component of bakelite, used in the radio and the phonograph.

A difficulty of the process, formerly regarded as insuperable, is the high cost of hydrogen. But Bergius gets a sufficient quantity of hydrogen out of the gaseous products of the reaction. Methane, one of these gases, gives four times its volume of hydrogen, when decomposed by steam. The Bergius process can be annexed to an ordinary gas-producing plant, converting the coke into more valuable oils and enabling inferior coal to be used. Dr. Bergius was asked whether his process would pay in the United States but declined to commit himself on the ground of his inexperience with American conditions. He ventured, however, to estimate that the various oil products could be made here at a cost of about ten dollars a ton.

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Coal Competes With Farms

Coal may come into competition with crops and the factory supplant the farm in many cases. This was demonstrated by General Georges Patart before the coal conference.

During the war General Patart was in charge of the manufacture of explosives for the French army and after the war had secured the political independence of France he has de-

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Coal Conference

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voted his talents to promoting the economic independence of France by studying the possibilities of obtaining a supply of motor fuel and organic chemicals from domestic sources. In 1921 he invented a method for the manufacture of methyl alcohol from coal and water, which opens the way for the production of an infinite variety of compounds that have hitherto been derived from vegetable or animal sources. Methyl alcohol, otherwise known as methanol or wood alcohol, has been made by the destructive distillation of wood, leaving charcoal as the residual product in the retort. Recently synthetic methanol, made in Germany from coal by a method similar to the Patart process, has come into the American market in large quantities at a price much lower than it can be distilled from wood here. But General Patart estimates that a factory could be set up in the United States at a cost of half a million dollars, which would turn out twenty tons of methanol a day at a cost of twenty cents a gallon. This would enable the United States to meet German competition.

Low grade coal and waste can be utilized as the raw material. The first step in the process is to get the carbon into a gaseous form, which is easily done by passing steam over the hot beds of coal. The product is "water-gas," a mixture of hydrogen and carbon monoxide, the deadly gas that is given off by running an automobile engine in a closed garage. Adding more hydrogen and passing the mixture at high pressure and temperature over a metallic oxide acting as a catalyst, the carbon, hydrogen and oxygen combine to form methanol or a variety of other compounds of these three elements. A ton of bituminous coal will produce a minimum of 800 pounds of methyl alcohol or 480 pounds of butyl alcohol, and this yield may be increased at least 30 per cent. Butyl alcohol has recently come into extensive use in this country as a solvent for cellulose lacquers used on automobiles and furniture as substitute for varnish and paint. It is now made by the fermentation of corn. The new lacquers and airplane dope and artificial leather also make use of acetone and various acids and ethers which likewise may be made synthetically from coal. Methanol by passing its vapor over hot copper is easily transformed into formaldehyde, which under the name of formalin is a familiar disinfectant. Formal-

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STUDY HELPS FOR SCIENCE CLASSES

These articles will be found to be especially useful in class work

GENERAL SCIENCE

Nobel Prize Awards, p. 131. Collector of Earthquakes, p. 131. Egypt's Inscriptions Saved, p. 139. Anniversaries of Science, p. 143. Articles marked with * in classifications below.

BIOLOGY

Bear Story of Past,* p. 135. Anti-Evolution in Arkansas, p. 137. Finds New Walnut, p. 143.

HYGIENE

Hughes Heads Association, p. 135. First World Sex Conference, p. 137. Cause of Measles, p. 139.

CHEMISTRY

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PHYSICS

Shooting Around Moon,* p. 131. World Wide Radio Service, Aids Weather Prediction,* p. 133.

(This will fit on a 3 x 5 card.)

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News-Letter Features

Born over four years ago, on March 13, 1922, of the demand and interest of those individuals who had caught a glimpse of *Science Service's* news reports to newspapers, the SCIENCE NEWS-LETTER has since proved interesting to laymen, scientists, students, teachers and children.

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Regular articles tell of the happenings in the *skies* and in the great *outdoors.*

Photographs aid in the telling of the week's science.

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A hydrogen stream directed into an arc between tungsten electrodes produces a hotter flame than the one used for oxy-acetylene welding.

Marine engineers find that doors made of plywood glued between thin sheets of metal do not warp under the severe weather conditions encountered at sea.

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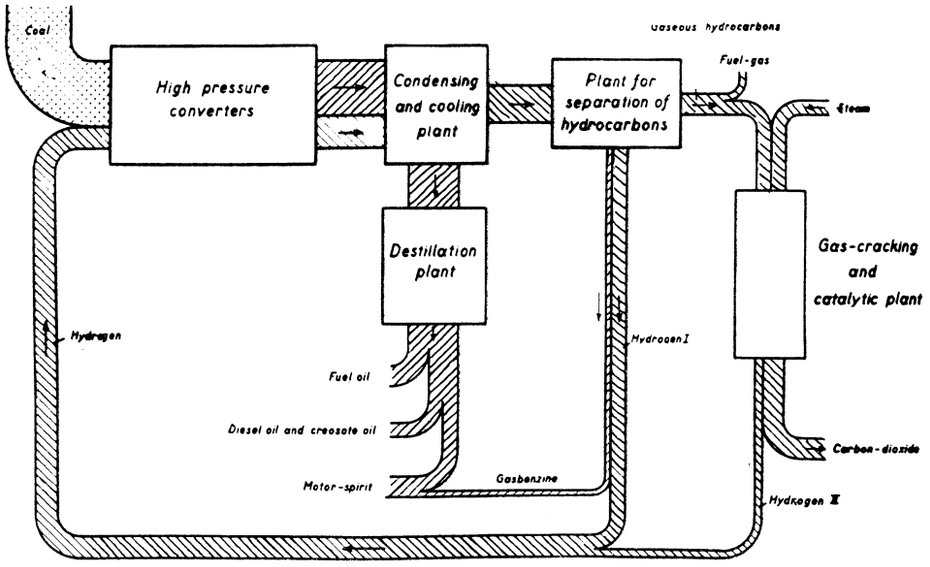

HOW BERGIUS PROCESS CONVERTS COAL TO OIL. This diagram was prepared by Dr. Bergius himself and shows a Bergin plant operating in connection with a plant for the separation of hydrocarbons from the gas.

Coal Conference

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dehyde combined with carbolic acid, also one of the by-products of the process, makes synthetic resins, such as bakelite, which are used for electrical insulation in radio receivers. It has been proved possible to make sugar out of formaldehyde, although this preparation is, at present, merely a laboratory curiosity.

The material for making many fruit flavors and perfumes are found among the products of this process for the liquefaction of coal. Wintergreen oil, a favorite flavor of gum-chewers, is made by combining methanol with salicylic acid, which is likewise a synthetic compound. Substances similar to those found in oil of turpentine are also formed, and this suggests the possibility of sometime making camphor, menthol and rubber from common coal and water. It would be possible though not profitable, to make by such means oils and fats suitable for soapmaking or even those edible. As General Patart pointed out in conclusion, agriculture is essentially an expensive process, involving a large amount of land, a long period of growth, high cost of cultivation and uncertainty of yield. Acetic acid, indigo, and various dyes and drugs are now made synthetically and no one can foresee the end of this new development of applied chemistry.

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Oil Famine Forestalled

"We have not yet a world famine of petroleum, but when it comes there will be available methods for overcoming it by means of the newer chemistry of coal."

This was the statement of Dr. Franz Fischer, director of the Kaiser Wilhelm Institute for Coal Research at Mulheim in the Ruhr, who spoke before the coal conference.

He backed up his claim showing samples of synthetic petroleum and other forms of motor fuel produced by his process, which consists essentially of passing a mixture of hydrogen and carbon monoxide over finely divided iron or cobalt which serves as a catalyst, that is an agent to accomplish the combination. Half the gases combine in the first passage over the metals and uncombined gases may be again brought into contact with the catalyst. The waste gases that formerly flared from the top of blast furnaces may be employed. The water-gas may also be made from low-grade or refuse coal by passing steam over it when hot.

The Bergius process for the liquefaction of coal requires that the retorts be raised to a red heat and subjected to a pressure of 200 atmospheres but in the Fischer process ordinary air pressure is used and the temperature need not be over 450°F.

Fischer's main motor fuel, which he called synthol, is an oil consisting of various compounds such as the chemist classes as alcohols, ketones, aldehydes and the like. The compounds all contain oxygen and so differ from the natural petroleum which consists solely of carbon and hydrogen.

Dr. Arthur D. Little, Boston chemist, pointed out that if we should have to depend upon synthetic motor fuel

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ARCHÆOLOGY

Bear Story of Past

A bear story, part of which is a million years or more old and part of which has just been finished, was told to the National Academy of Sciences by Dr. John C. Merriam of the Carnegie Institution of Washington. It concerned the fossils of an extinct race of giant bruins which he and his associates discovered in the wilderness of central Oregon, in what is known as the John Day country.

The most critical features of their find were furnished by several molar teeth, which were so closely similar to those of fossil bears found in the Siwalik hills of northern India that it has been necessary to assign the American fossils to the Indian genus, though they constitute a slightly different species. There seems to be little doubt that the wanderings of the extinct Asiatic bruins brought them eventually to western America via a land bridge or a chain of closely set islands in the Bering sea region.

An interesting circumstance connected with their finding, according to Dr. Merriam, is the fact that certain bits of crown and root broken off and missing in the original specimens which he brought in ten years ago, were found this summer by his son Charles W. Merriam, a student at the University of California. The younger Merriam spent his holidays this year combing over the ground his father had searched in 1916, and brought in every fragment of bone he found. Quite by accident Dr. Merriam and one of his associates found that two of the fragments fitted exactly into breaks in the previously incomplete specimens.

These extinct bears, Dr. Merriam stated, were giants of their kind. They were as large as very large specimens of modern grizzly bears, but were shorter in the head and with more massive jaw bones.

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MEDICINE

Hughes Heads Association

Charles Evans Hughes has been elected president of the American Association for Medical Progress to succeed the late Dr. Charles W. Eliot, former president of Harvard University.

For some time in the past Mr. Hughes has served as honorary vice-president of the organization which informs the public concerning the methods and discoveries responsible for man's increasing control over animal and human diseases.

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made by Fischer's process it would require all our present output of coal for it takes sixteen hundred pounds of coal to produce a barrel of oil. Government geologists report that our petroleum fields will be exhausted in six years if we continue to use it at the present rate, yet we recklessly waste what German chemists are trying to make.

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"Low Temperature"

To get the most out of bituminuous coal the main method that has been in use for the past hundred years is to heat it at high temperature in tight retorts. This divides it into three parts, gaseous, liquid and solid. The gas is used for lighting and heating in cities. The liquid oil and tar can be worked up into thousands of useful commodities, including dyes and drugs. The solid coke finds employment in reducing metals from their ores.

But the new methods of distilling coal make a more economical separation of the by-products by using less heat at the start, although what these experts call "low temperature," some 800 degrees, seems to the layman very high. The researches that Prof. S. W. Parr has carried on for twenty-five years at the University of Illinois on the measurement and utilization of the heating value of coal have at last reached the point of practical application. The vast midcontinental area of bituminous coal known as the Illinois field is estimated to have a reserve supply of fuel twice that of the combined reserve of Pennsylvania and West Virginia and in area it is three times as large as all the European fields. This coal has been regarded as inferior to that of the Appalachian region because it was formerly supposed to be incapable of coking. But Prof. Parr has worked out a method of converting it into a strong dense coke, suitable for domestic use since it gives a smokeless fire. The method consists essentially in heating the coal in two stages. In the first stage the coal is heated for fifteen minutes in a closed rotating drum at a temperature below the point where it softens into a pasty mass. The coal is then poured into a retort and heated to 1,350 degrees Fahrenheit for half an hour.

Coal was first discovered on this continent by Father Hennepin 250 years ago on the north side of the Illinois river opposite Starved Rock. Professor Parr also noted that this year is the hundredth anniversary of the first scientific investigation of the heating value of coal reported in a paper read by Marcus Dull before the Philosophical Society of Philadelphia in 1826.

Another solution of the smoke problem was offered by C. V. McIntire who has during the past two years devised a method of making artificial anthracite at a demonstration plant put up for the purpose at Fairmont, West Virginia. Anthracite was originally bituminous coal but heat and pressure acting through geologic ages have reduced its volatile matter and increased its density. Mr. McIntire has imitated nature's method of manufacture but speeded the process so it does not take millions of years to effect the transformation. The coal is first heated at comparatively low temperature to drive off the valuable by-products, gas, tar and oil. This leaves in the retort a solid residue of semi-coke which is pressed into briquettes which are reheated to render them dense and smokeless. The yield from a ton of coal is 1480 pounds of semicoke, 31 gallons of tar, two gallons of light oil and three thousand cubic feet of rich gas.

A novel process of coal distillation, turning out a different series of products was described by Harald Nielson, a Danish expert working in England. This avoids the difficulty inherent to the old apparatus, that coal is a poor conductor of heat and while the heat from the outside is spreading to the inner parts of the mass, the volatile oil and tar is being broken up by contact with the red hot steel shell. In the Nielson process external heating is done away with. The coal is run continuously through an inclined rotating retort lined with firebrick while a stream of hot producer gas is passed through the fuel in the opposite direction. This gas flows through the spaces between the pieces of coal, heating up the whole mass evenly and at any desired rate, while carrying off the vapors through the cooler and without cracking them.

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Talking birds speak through the larynx, without using the tongue.

Most of the world's commercial supply of iodine comes from the nitrate fields of Chile.

A beaver trap, by which beavers can be caught alive for propagation purposes, has been invented by a government biologist.