Shale Oil

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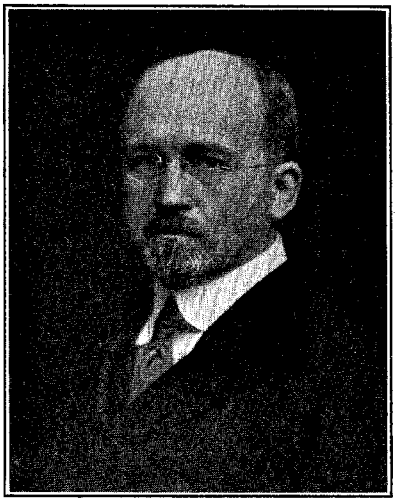
THE DRAINING of natural resources is deplorable but the material gain resulting from their exploitation should not be overlooked. The approaching exhaustion of American petroleum has been compensated for in a large measure by the advances of American industries which this petroleum has made possible. Crude petroleum and "topped" petroleum are used as fuel in competition with coal. The present primary use of petroleum, however, is in the form of refined products, of which gasoline and lubricants are the most important. At present gasoline yields more than one-half the total revenues, though in volume it constitutes only one-fourth of the entire output.



Allman & Co.
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THE GASOLINE SITUATION

The petroleum requirements of this country are closely bound up with the automobile industry. In 1900, when automobiles first became commercial, the yearly per capita consumption of petroleum in the United States was 35 gal.; in 1910 it had risen to 96 gal., in 1920 to 210 gal., and last year the increase, in spite of the financial depression, was still another 21 gal. per person. All this is in spite of a continual increase in gallons of gasoline obtained from each 100 gal. of crude oil. In 1915 each 100 gal. of crude oil gave 11 gal. of gasoline, but six years later the development of cracking had increased this to approximately 26 gal. If all the petroleum used in America were subjected to the cracking process, the amount obtained would be but about 40 gal. for each 100 gal. of crude petroleum.

In the last six years the gasoline used in the United States per automobile has decreased from 600 gal. per year to approximately 400 gal. per year, owing not to a decrease of mileage per car but to an increased efficiency of carburetors and engines. Were it not for this increased efficiency, we should already have reached our limit of gasoline consumption and with it probably a price of at least 40 cents a gallon.

Since 1921 the United States has been consuming more petroleum than it produces. This excess has been largely provided by Mexico and last year showed an importation of more than 120,000,000 bbls., that is, approximately 26 per cent of the American production. The Geological Survey and Bureau of Mines have lately shown that American production is approximately at its peak and that in a very few years the output of oil in the United States will begin to decline. Moreover, about a year ago the Geological Survey called attention to the fact that we should not expect to find any more large fields of petroleum in the United States—in other words, that practically all of the possibilities in the way of large petroleum fields in this country have been well prospected and that now we can calculate fairly closely what the production will be in the future.

On the other hand, the use of motor vehicles in this country is continually increasing. At present there are about 10,000,000 passenger cars, trucks, and tractors in use, and it is certain that the saturation point is more than 15,000,000 and perhaps will exceed 20,000,000 machines. With this expected larger demand for gasoline on one hand, and, on the other, even less petroleum available in a few years than we have at present, there arises a question as to how the motor fuel deficit is to be met. Of course, importations of oil can be made from Russia, Persia, Mesopotamia, and South America (the present Mexican fields are of short-lived type), but such an importation basis means that we shall be on the same basis as other importing countries have been, that is, the consumer will purchase his gasoline at from 60 to 75 cents a gallon. If our automobile industry and the many industries that depend on automobile transportation are to prosper, we must have a domestic supply of motor fuel and at a price more reasonable than 60 cents a gallon. Thirty-five or forty cents a gallon will probably be considered a fair price by the consumer.

Alcohol and benzene and the synthetic motor fuels having a mixture of these two as their base, will meet a small, but only a very small, portion of the needs. The total amount of these two motor fuels available in America is but a small percentage of the 20,000,000 gal. of gasoline now used daily.

OIL SHALE RESOURCES

In the last two years another source of motor fuel has begun to be considered seriously in America. In Europe oil shale has been used for nearly a century for the obtaining of petroleum. Indeed, the word "petroleum" was used for shale oil for a generation before Colonel Drake drilled the first oil well (Titusville, Pa., 1859). Oil shale does not contain petroleum, but by heating oil shale a petroleum distils from which a motor spirit similar to ordinary gasoline may be obtained.

The European oil shales yield 20 to 22 gal. of oil per ton of shale mined. In this country we have large deposits of shales that give double this yield of oil. The largest of these are the Green River deposits in Colorado, Utah, and Wyoming, but there are also deposits in Kentucky, Indiana, and Ohio, and some of equal extent in New Brunswick and Nova Scotia. Many of these will yield a barrel (42 gal.) of oil per ton of rock. For a typical oil shale view see Fig. 1. It is not commonly appreciated how large these oil shale deposits are. In the Green River section alone, there are known deposits yielding a barrel or more of petroleum per ton. These are sufficient to furnish more than five times the total world production since the commercial development of well petroleum 60 years ago.

EXPERIMENTAL WORK

In the last two years "conversations" regarding shale oil possibilities have been followed by real experimental and small-plant operations, so that to-day we have several processes in course of trial. It is as yet a question whether we have found the best method of obtaining oil from the shale. It should be

said in passing that the American shales do not work satisfactorily when retorted in the standard Scotch retort, and that, accordingly, modifications of this retort or retorts on new principles must be designed. So far the developments have been largely in the hands of mining engineers or of men without technical training. Only lately have chemical engineers taken an active hand in the industry.

It should be mentioned in this connection that perhaps the two most active nonfinancial organizations that have been working on shale oil are the United States Bureau of Mines and the Colorado School of Mines. The first has been criticized as being too conservative in its view in connection with this new industry; the second has been equally criticized for too optimistic a view.

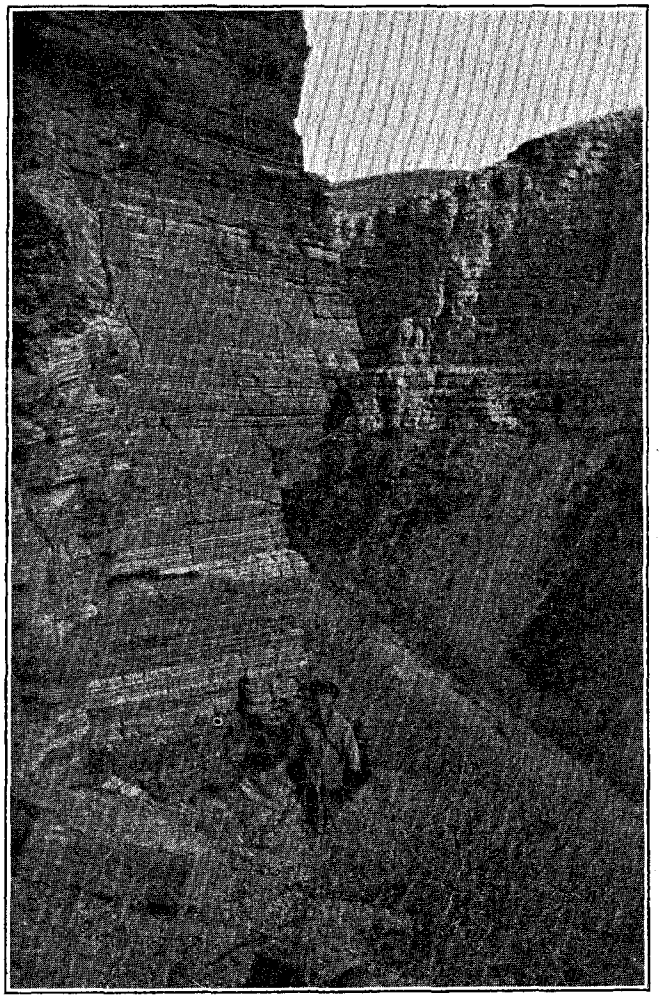

FIG. 1—OIL SHALE CLIFFS IN COLORADO

Patents almost without number, most of which have their prototypes in the early Scotch industry, have lately issued from the Patent Office. A number of these have fallen into the hands of promotion companies and are now being made the basis of stock-selling operations. At present, few except the inventor himself believe that any of these retorts is certain to be practicable when used on a large scale.

One plant, the Catlin Shale Products Co., Elko, Nevada, has apparently passed beyond the primary troubles in retorting, and has built a refinery to handle the crude shale oil and furnish the market with refined products. This plant has a capacity of approximately 15,000 gal. (350 bbls.) a day, a small capacity compared with commercial well petroleum plants.

About a year ago, it was shown that the organic matter in shale decomposes on heating, not to give petroleum directly but first to give a heavy solid or semisolid bitumen, and that petroleum is formed by a secondary cracking process from the first formed semisolid bitumen. This cracking process by which petroleum is formed is a liquid-phase process similar to the well-known phenomenon of the cracking of petroleum to give gasoline. Accordingly, it is not surprising that when shale oil is further cracked to give a motor spirit, the product carries 60 to 70 per cent of unsaturated hydrocarbons.

It was further found in the experimental work just referred to that decomposition of the organic material of the shale to give a semisolid bitumen occurred at a quite definite temperature (400° to 410° C.), and that the cracking process to obtain a petroleum from this took place approximately at but 20° higher.

The same investigation also showed to be incorrect the common belief that on heating, gasoline is the first product; on higher heating, kerosene; and on still higher heating, lubricating oils, etc. In other words, all these products are formed simultaneously by the cracking of the semisolid bitumen first formed.

It has not yet been possible to obtain heavy type lubricants, such as a cylinder oil, from shale oil. On the other hand, recent work has shown that excellent lubricants of light body can be made. It is worth mentioning that these lubricants, unlike ordinary well petroleum lubricants, do not decrease in viscosity rapidly on heating and, accordingly, in light use, such as in an automobile, the mileage obtained has been unexpectedly great.

Considerable gas is produced in the making of shale oil. Under the best conditions the amount of this gas is not sufficient for the fuel required in the retorting process. In Scotland they have supplemented the gas by using local coal for the shale retorts. With the American shales, which are richer in organic material than the Scotch, there is enough carbonaceous residue left (20 per cent) in the shale to permit it to be burned in a gas producer; in fact, one American plant is now regularly using this shale residue in a producer to furnish producer gas for the retorting of the shale. Most engineers would state offhand that a fuel running more than 75 per cent ash would not burn in a producer, but it does.

BY-PRODUCTS

In the French and Scotch shale-oil plants the production of ammonia in the process is as important as the production of oil. The American shales give less ammonia, but still enough to make it worth while to recover it. If the shale is retorted at only moderate temperatures, as most American shales will be, there is obtained a large percentage (up to 20 per cent) of nitrogenous constituents in the oil. These nitrogenous constituents are largely pyridine and isoquinoline derivatives. Up to the present time, no commercial outlet for these products has been worked out. They will, no doubt, compete in the future with the nitrogen bases obtained directly or indirectly from coal tar.

Some of the western oil shales give considerable quantities of paraffin, a few as high as 30 per cent of the weight of the oil. The eastern and some of the larger western deposits have an asphaltic base and give little or no paraffin.

Irresponsible promoters have claimed that the residue from oil shale retorting carries considerable amounts of platinum, gold, and other precious metals, phosphates, and soluble potash. These claims have no basis of fact, except possibly a small percentage of potash which has been rendered soluble by the retorting process.