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PETROLEUM SUPPLIES AND HYDROGENATION

A bill known as S. 1243, introduced by Senator O'Mahoney of Wyoming, has for its stated object the authorization of "the construction and operation of demonstration plants to produce synthetic liquid fuels from coal and other substances in order to aid in the prosecution of the war, to conserve and increase the oil resources of the nation, and for other purposes." The Bureau of Mines, acting under the direction and authority of the Secretary of the Interior, is the agency designated to carry out the purposes of the Act. Hearings on the bill were held during August 1943 by a joint subcommittee of the Senate Committee on Public Lands and Surveys and a subcommittee of the Committee on Mines and Mining of the House of Representatives. A report on the hearings has recently been published by the Government Printing Office under the title Synthetic Liquid Fuels.

In many hearings before Congressional committees or subcommittees, discussions and statements as shown in published reports are often made by witnesses who have not had adequate experience in the technical fields concerning which they testify. From the report of these hearings on synthetic fuels, however, one gains the impression that most witnesses were thoroughly informed on the matters they discussed. There was a rather surprising unanimity of opinion on the need for planning now on utilization of synthetic fuels to supplement our decreasing domestic petroleum supplies.

It is not the purpose here to comment on the merits of the bill itself, but rather, because of the large amount of authoritative testimony given, to set forth a few of the highlights of the subject matter as presented by some of the expert witnesses.

Brief extracts of the testimony are given below:

"In Europe the development of synthetic oil has been dictated by necessity. It has been an essential ingredient of survival. In fact, a substantial - if not a major part - of the fuel employed by our Axis enemies, particularly Germany, for fighter planes, bombers, tanks, trucks, and other ground vehicles, as well as the Diesel fuel for submarines, is the synthetic type made from brown coal.

"The Japanese have exploited the oil-shale deposits of Manchukuo and have built plants to produce a substantial part of their liquid-fuel requirements therefrom.

"Only the United States, apparently lulled by the delusion that we possessed an infinite supply of petroleum, has neglected to develop synthetic-oil facilities to the stage where they could be utilized when necessary."

.....Ralph K. Davies, Deputy Petroleum Administrator for War.

"In modern warfare as we know it today, liquid fuels are absolutely essential. Over half (in north Africa 65 percent) of the tonnage of all supplies for our Army overseas is petroleum products."

.....Brig. Gen. E. R. Covell, Director, Fuel and Lubricant
Division, Quartermaster General's Office.

"You will note that the overwhelming proportion of crude reserves of the world, outside of the United States lies in Russia - 8,500,000,000; Venezuela, 5,600,000,000; Dutch East Indies, 1,50,000,000; and the Persian Gulf countries grouped together, 16,450,000,000." (all in barrels, Ed.)....

"I am impressed at the present time by the higher grade of the prospects which we know in the foreign countries when compared to those in the future in the United States. That is to say, the oil is easier to find abroad, and is found in larger quantities, I might add parenthetically, because we have done the easiest things in the United States already. I might add that the 300 fields that have been found abroad in the last 20 years have had an average estimated ultimate production of about 100,000,000 barrels each, while the average field found at the present day in the United States does not exceed 2,000,000 barrels, average, each.

"Now, I want to call your attention here to the geographic distribution of these areas in the Near East and in Russia, and their overwhelming importance in the world's oil trade of the future. These areas are as far as possible removed on this globe from the United States. Bahrein, here, where there is an American refinery at the present day, is exactly 12,000 miles from San Francisco in both directions."

.....James Terry Duce, Director, Foreign Division, Petroleum Administration for War.

"The next point which I might discuss is the trend of exploratory drilling during the last few years. In spite of the fact that these new discoveries have fallen off, the efforts of the industry to find new oil have been substantially increased.

"The number of geophysical crews, which is one of our best measures of the exploratory effort, has gradually increased. Around 1937 there were about 200 crews in the field, and at the present time this number has increased to approximately 350, which is the maximum for all time.

"So that the effort of the industry, as far as finding oil is concerned, has been consistently increased, although the tendency to find the oil has decreased.

"The same thing is true also of the number of wildcat wells drilled. In 1937, 2,224 wildcat wells were drilled and in 1941, 3,264. So you see that there has been a very definite increase in wildcat drillings. although the discoveries have fallen off."

.....William B. Heroy, Director of Reserves, Petroleum Administration for War.

"When we entered the present war we complacently assumed that our supplies of crude petroleum were adequate for any emergency - that our chief and only worry might be the problem of distribution or, in other words, transportation. As the war has progressed the demand has increased at an unprecedented rate. Civilian use has been continuously curtailed to divert more and more oil to war use, and yet the demand increases insatiably. The draft on many of our producing oil fields is now heavier than it should be if our chief objective was solely economic and efficient operation. The search for new sources of supply has been greatly accelerated, yet since 1938 there has been an average decline in the annual addition to our reserves. Thus a disconcerting and probably significant

element is introduced into the national picture. Once again the specter arises to plague us as to whether we have at last gone 'over the top' and are now on the slow decline toward inadequate reserves."....

"The production of liquid oils from coal or oil shale comparable to those derived from crude petroleum should occasion little wonder. The raw materials are all hydrocarbon substances. Geologic evidence indicates preponderantly that all were derived chiefly from living organisms, either plant or animal or both. Compared to normal crude oil, coal contains an excess of carbon; hence to bring it up to the grade of crude oil, hydrogen must be added. Accordingly, the German process is commonly referred to as the 'hydrogenation of coal.'

"Oil shales contain finely comminuted fragments of organic matter, which have apparently been arrested in their conversion by natural distillation to liquid oil. Essentially the problem of producing liquid oil from coal, oil shale, or other solid hydrocarbons, falls into the general pattern of the very flexible chemistry of the hydrocarbon group and the basic processing will be fundamentally related."....

"Another important factor that may further increase the demands on our coal reserves is the rapid depletion of coal of high rank and quality in many foreign countries which may result in increased exportation of coal from the United States. Therefore, the future demands on our coal reserves are not quantitatively predictable but may well be far greater than the maximum production for any year in the past (678,211,904 net tons in 1918.)"....

"Now, with regard to the oil shales, the Geological Survey has estimated that price permitting, approximately 92,000,000,000 barrels of crude oil is recoverable from oil-shale deposits of the United States. This is approximately double the sum of all the oil produced to date, plus the present estimated reserve. Of this estimated quantity 75,000,000,000 barrels lie in oil shales of Tertiary age that crop out chiefly in northwestern Colorado and northeastern Utah and subordinately in Wyoming and Nevada. The estimated total quantity includes also approximately 17,000,000,000 barrels believed to be recoverable from black shales of Devonian age in Indiana and Kentucky. Since those estimates were made (1928), apparently large additional deposits of oil shale of Ordovician age have come to light through exploratory surveys in Nevada. It is germane to point out here that in order to use this great potential resource of mineral fuel it would be necessary to establish a mining industry comparable to the bituminous coal-mining industry at its peak of productivity during the last World War."

.....W. E. Wrather, Director, U. S. Geological Survey.

"Crude oil and natural gasoline are produced and consumed at a rate estimated at more than 1,400,000,000 barrels per year, whereas our known crude oil reserves are only approximately 20,000,000,000 barrels. Our present rate of production exceeds the rate of new discoveries several fold and this situation has existed for the past 5 years.

"For example, last year the rate of discovery of new fields and extension of old fields was only 60 percent of production during the same period. Based on present information with regard to our proved reserves and the rate of consumption and production, estimates with regard to the length of time which our petroleum supplies will last are as low as 14 years and, with present techniques of finding oil, the life expectancy of our petroleum supplies barely exceeds 30 years. However, it cannot all be produced in this time for the most efficient production, which means that we shall have to resort to imports to meet our

requirements. To complete the picture of our natural-fuel resources: at the present rate of production of 3 trillion cubic feet per year our natural-gas reserves of about one hundred trillion cubic feet will last in the order of only 30 years.

"On the other hand, our oil shale deposits will produce an estimated 92 billion barrels of oil, and our coal deposits which are our largest single natural-fuel resource in round figures amount to an estimated three thousand billion tons.

"It is apparent that coal is the principal source of our fuel supplies for the future, and it is quite certain that with the necessary development there is sufficient coal available to supply both our liquid and solid fuel needs for more than a thousand years.

"Fortunately, the technical and scientific requirements for the production of synthetic liquid fuels from coal and natural gas have been prepared and the ground work is laid for the rapid development of commercial processes leading to the production of practically unlimited supplies of liquid fuels from our resources of greatest abundance, namely coal, oil shales, and natural gas."....

"There are two principal processes for the production of synthetic fuels from coal and natural gas. One of these is the Bergius process, which was developed to a commercial stage by the I. G. Farbenindustrie in Germany and which comprises direct hydrogenation of coal or preferably mixtures thereof with hydrocarbons, to motor fuel and intermediate products. Commercial production by this process began in Germany in 1926 and has increased to an estimated production of approximately 95,000 barrels or more of gasoline per day. The Imperial Chemical Industries at Billingham, England, built and operated a similar direct coal hydrogenation plant, having a capacity of 3,500 barrels of gasoline per day.

"The second process, known as the indirect process, is that of Fischer-Tropsch, wherein coal, lignite, or natural gas is first converted to water gas, or more specifically a mixture of carbon monoxide and hydrogen and then the mixture of gases in proper proportions is passed over a catalyst at relatively low pressures (1 to 10 atmospheres) and temperatures preferably of the order of 350° to 400° F. to produce gasoline, Diesel oil, waxes, and other products.

"The Fischer-Tropsch process has also been developed in Germany with four installations, having a total estimated capacity of about 7,000 barrels of gasoline per day in 1940, which from information received by us has been increased severalfold since."....

"Now, as to the Bergius process for direct hydrogenation of coal: This process is carried out by mixing a small amount - usually less than 1 percent - of a catalytic material such as a compound of tin with approximately equal parts of finely powdered coal or lignite and heavy oil previously obtained from the process, and pumping this paste into a high-pressure chamber together with hydrogen gas at pressures of 3,000 to 8,000 pounds per square inch. The temperature of the reacting mass is maintained at 800° to 900° Fahrenheit.

"The oil product from the reaction vessel is separated from the solid residue of ash-forming material and unliquefiable carbonaceous matter and is distilled into light-, middle-, and heavy-oil fractions. The light oil is further treated by passing it into a vapor-phase zone containing a fixed catalyst such as molybdenum or tungsten sulfide. The gasoline product has an octane rating of 70 to 75 which, by the addition of tetraethyl lead, can be increased to from 80 to 85 or higher.

"Four or five tons of high-volatile bituminous coal are required for the production of 1 ton of gasoline - 0.56 to 0.70 short tons of coal per barrel of gasoline.

"This figure includes the coal needed for power, steam, and hydrogen used in the process; 6.5 tons of sub-bituminous coal, or 9 tons of lignite, are required for the production of 1 ton of gasoline - 0.90 ton to sub-bituminous coal or 1.25 tons of lignite, respectively, per barrel of gasoline. These figures are based on recycling the oils heavier than gasoline to form lighter oils. It is possible to operate the process so that a portion of the yield consists of heavier oils similar to kerosene and fuel oil and the Bureau of Mines has developed a modification for the production of a heavy bunker C oil by hydrogenation at lower pressures of about 1,000 pounds per square inch.

"High-pressure hydrogenation has developed into an extensive technology for the synthetic production of motor fuels and lubricating oils. In general, the reaction results in conversion of approximately 60 percent of the coal into oils and tars or products corresponding to 'synthetic crude oils' capable of producing relatively high-octane gasoline. The hydrogenation process is also adaptable to the treatment of heavy asphaltic petroleum, shale oils, and tars."....

"Fischer-Tropsch process: In the indirect hydrogenation process known as the Fischer-Tropsch process coal, lignite, or natural gas is reacted with steam to form water-gas, a mixture of carbon monoxide and hydrogen. The mixture of gases in proper proportion, after purification, is passed over a catalyst at relatively low pressures (1 to 10 atmospheres) and temperatures ranging from 360° to 530° F.

"Iron or cobalt catalysts alone or mixed with various oxides, have been found to be satisfactory. By increasing the pressure and using a somewhat different catalyst, for example iron containing various alkalies, a mixture consisting of alcohols, ketones, and aldehydes resulted, thus forming the basis for the production of various chemical derivatives and products.

"Seventy-two percent of the theoretical yield or 1.4 gallons of synthetic oil per 1,000 cubic feet of synthetic gas has been obtained.

"That is, by 'synthetic gas' there, we mean the water gas we get from the coal. We get about 1.4 gallons per thousand cubic feet. When natural gas is employed about 3 to 5 gallons of crude-oil-like product per 1,000 cubic feet is produced. One ton of the primary products is obtained from about 4.5 tons of coke which, in turn, requires the carbonization of 5 to 6 tons of bituminous coal or about 0.70 ton of coal per barrel of motor fuel.

"In other words, here again, as the previous witness indicated, you can use manufactured gas from coal, you can use natural gas, you can use coke; you can use anything that has carbon in it that will burn, and the yield depends on the quality of the raw material.

"The octane rating of the gasoline is quite low (about 50-octane) and as is usual, increases with the lower-boiling fractions. Reforming and adding tetraethyl lead to the gasoline will bring it up to a fairly satisfactory motor gasoline.

"The Diesel oil on the other hand, as would be expected, due to its high paraffinicity has a high-octane value, so that the process is eminently suited to produce this product. The paraffin wax and naphthenes have been found quite useful for the production of synthetic fatty acids by oxidation and subsequent conversion into soaps. The conversion of the olefin components of the lower-boiling fractions into lubricating oils by polymerization employing aluminum chloride has also been established.

"In other words, in addition to being able to get gasoline, Diesel oil, wax, and things of that kind from the Fischer-Tropsch process, you can, by further manipulation, produce good quality lubricating oil.

"The first Fischer-Tropsch industrial plant was put into operation in Germany in 1936 and by 1940 over 1,000,000 tons of liquid products were being produced annually in Germany by this process. Plants have also been built in other countries."

.....Bruce K. Brown, Assistant Deputy Petroleum Administrator
for War.

"Now, coming to compressed hydrocarbon gases, in Europe there are 110,000 motor vehicles, busses and trucks that are operating on natural gas, methane and ethane, propane from the coal hydrogenation units, the Fischer-Tropsch process, and natural gas wells, and some trains are operating on compressed gases. Natural gas is largely methane. You can compress that under 4,000 or 5,000 pounds' pressure in the cylinder, liquefying it, and you operate your motorcar just the same as if you had gasoline in the tank. Germany and Italy have many filling stations exactly the same as our gasoline filling stations, only the gasoline is under these high pressures. The tanks are rather heavy, they weigh from 150 to 200 pounds, and some of the trucks have as many as six or eight of them under the running board.".....

"Many European cities are utilizing the methane gas from the sewage of the cities and compressing it into a liquid for motor fuel. They are also using, in some motor vehicles, a mixture of carbon monoxide and hydrogen under high pressure as a motor fuel. I bring that in to indicate that the water gas produced from coke or natural gas, if you wanted to use that kind of a mixture, can be a form of motor fuel.

"They are also using acetylene in Europe with or without ammonia as a motor fuel, deriving their acetylene from coal. I do not know the manufacturing cost of making acetylene from coal, but I would not be surprised if it is the order of about 5 cents per pound of acetylene."

.....Gustav Egloff, Director of Research, Universal Oil
Products Co., and President, American Institute of
Chemists.

AGRICULTURAL LIMING MATERIALS USED IN 1942

According to Rock Products, September 1943, Oregon used 26,500 tons of liming materials on farms in 1942. This quantity of liming material contained 50 percent, or 13,250 tons, of effective calcium oxide, and is equivalent to 7 pounds of effective oxide per acre of Oregon's cropland.

Statistics of other states present an interesting comparison. Illinois, the largest consumer of liming materials on farms, used 3,773,000 tons of such materials having an effective calcium oxide content of 1,584,660 tons. The unit figure for Illinois was 157 pounds of calcium oxide per acre of cropland. Kentucky had the largest unit consumption, with 186.5 pounds of calcium oxide per acre of cropland. In Kentucky the total amount used was 1,469,804 tons of liming materials containing 606,842 tons of effective calcium oxide.

All of the six New England states used 312,607 tons of liming materials containing 159,196 tons of the oxide. The average unit figure was 84 pounds per acre of cropland. The lowest unit use was in Maine with 53 pounds per acre of cropland. The greatest unit use was in Connecticut with 140 pounds.

The six Mid-Atlantic states of New York, New Jersey, Pennsylvania, Delaware, Maryland, and West Virginia consumed 1,821,437 tons of liming materials containing 967,393 tons of oxide. The highest unit use was in West Virginia with 137 pounds; the lowest was in Delaware with 50 pounds.

Ten Midwestern states (Ohio, Indiana, Illinois, Kentucky, Michigan, Wisconsin, Minnesota, Iowa, Kansas, and Missouri) used a total of 13,374,498 tons of liming materials having a lime oxide content of 5,621,784 tons. The average unit figure for these states was 75 pounds of oxide per acre of cropland.

Some of the southern states as well as the Pacific Coast states used a very small amount of lime on farms. In 1942 Texas used only 2,327 tons of liming materials containing 1,004 tons of lime oxide, or 0.06 pound of oxide per acre of cropland.

California used only 2.1 pounds of calcium oxide per acre of cropland, and Washington used 2 pounds.

A far wider use of lime on farms has been urged by state and federal farm bureau for years. Farmers realize the need for liming and in those states where lime can be delivered cheaply enough the largest unit amounts are used. In Oregon the price to the farmer is high compared to the East and Midwest, and the effect of price is reflected in the figure for unit consumption.

PAST TENTS

Note: For several years we've been on the point of starting a "Past Tents" series in the Ore.-Bin, but each time.....well, never mind. Anyway, it starts with this issue.

What engineer or geologist is there among us who doesn't have "a past"....that is, who of our genus cannot open his book of memories to an unselected page, and read thereat a yarn or anecdote about when he camped on an Andee and such-and-such happened, or about the time while surveying in the Upsidedown Lake country that the Indian guide sat down on a hornets' nest, or about when.....you get it.

Such accounts, based on true experiences, set the engineer and geologist apart from run-of-mine humans who are born, who live, and then die without veering from a fixed, prosaic groove. In truth, most men in our calling have done more Daniel Booning than most of us have stopped to realize.

Contributions to this series of "Past Tents" from any and all of the profession are herewith solicited and welcomed. Prize for the first story accepted from outside our department will be an 11x14-inch enlargement from a camera shot by the writer, taken of a certain scene in the Yukon a few years ago. It's worth framing.

(If the title, "Past Tents," a seemingly obvious name, has been previously used by anyone for a story or series such as this we are not aware of it. If through lack of adequate search we are plagiarizing, we are truly sorry.)

No. 1. "Murder in the Meadow"

I took a good long look through the alidade telescope at the distant stadia rod, trying to count the big red dots which seemed to be moving up and down, dodging the little lambent heat devils that were making a writhing serpent of the four-inch wide, painted rod.

(It was August, somewhere around Junction City, Kansas, and as hot as it can get on the limestone-edged mesas of that country. My buddy and I were mapping structure to get a line on oil possibilities. Our boss had cautioned us to be very careful and diplomatic with the country people because a couple of crafty oil promoters had been through recently, had gypped the local ones out of some leases and bonus money, and had left the natives in general quite hostile to strangers that even smelled of oil. It seemed one rancher had sworn to shoot any oil man on sight.)

Another glimpse through the eyepiece - to set the middle hair on a given dot - and a somewhat startling object moved slowly into the field of view. It was a pair of grey, floppy-eared mules hitched to an old-fashioned buckboard, driven by a dyed-in-the-wool, old western plainsman. Even in 1915, this was a disappearing type in that part of the country.

I twisted the focusing screw a mite and moved the instrument slightly in order to take a better look at the approaching outfit, still a quarter mile away. The high magnification of the transit brought the object up to within yards of me.

The driver wore a dilapidated ten-gallon hat, blue shirt, and corduroy trousers tucked in the top of cowboy boots, one of which was resting on the step of the conveyance. The man was elderly, gaunt, and mustachioed; and he kept looking intently in my direction. The sleepy mules jogged slowly toward me along the dusty road which I now noted ran within a dozen yards of where my plane table and tripod were set up.

By the time I'd waved the redman on, calculated elevation and corrected distance for the shot, drew a new line on the plane table map, and made jottings in my notebook, the western stranger had moved up almost opposite me. Still he stared, as I now could plainly see through the corner of my eye. It was a bit disconcerting, this scene from a Pearl White or Bill Hart thriller - at least, my imagination started doing didoes. That old sinner in the buckboard (I thought) probably could shoot the buttons off my hip pockets without stopping the mules.

And then came reality, indeed.....As the vehicle came just opposite me and not thirty feet away, old 'Kit Carson' hollered, "Whoa," and his deep voice seemed to come out of the earth. I wasn't feeling so well. The man glared at me for a moment without moving. My condition didn't improve. Then, cat-like, he hopped out over the wheel of the buckboard, pulled a club about four feet long out of the back, bent over and picked a slab of rock out of the road, and started over toward the fence in my direction.

Now, gentle reader, you doubtless have heard your wife (otherwise, the object of your affections) say, while describing the plays at a particularly vicious bridge game, "I was just petrified!" - And you knew damn well that she wasn't petrified or paralyzed or anything like that. Well, mister, your wife probably never stood by a geologist's plane table in the edge of a meadow in central Kansas - separated by twenty feet and a two-wire fence from a mad-man holding a club in one hand and a five-pound hunk of Permian limestone in the other. There are times when one's misdeeds pass fleetingly in review. For me, this was one of those times.

And then my mustachioed ogre dropped his eyes, dismissing me, twisted his club into the slack top wire of the fence, and turned the club propeller-like a couple of turns thus stretching the wire taut. Dropping the club, he then walked over to the nearest post, took a staple from his pocket, and, using the slab or rock as a hammer, drove the staple into the post, thus fastening the newly tightened fence wire. Then he sauntered back to the buckboard, vaulted up into the seat, and called, "Gitty-up," to the mules.

I sat down weakly in the shade of the plane table.

E.K.N.

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