ENGINEERING

Synthetic Liquid Fuels

Petroleum reserves are limited, but the answer to independence from relying on other nations for fuels lies in synthetics. Bureau of Mines research is progressing.

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Radio talk given on "Adventures in Science" over the Columbia Broadcasting System.

➤ THE ENORMOUS drain of the war upon this country's supply of petroleum has brought us face to face with the realization that our remaining reserves are limited. And the demand is increasing steadily to provide power for automobiles, planes, ships, locomotives, industrial plants, and household heating units. Peacetime oil requirements are greater than those of the peak war year. We no longer have a reserve capacity for emergency use.

Our government has an answer—synthetic liquid fuels, the fuels of the future.

Oil Scarcity

We now seem to be passing from an era of abundant oil to an era of oil scarcity, so far as crude oil supplies in this country are concerned. We can not produce more from known fields without irretrievable loss. Oil is now being withdrawn from the wells at or near the maximum efficient rate. The cost of finding oil has risen sharply, and unprecedented volume of exploratory drilling has failed to locate the additional new reserves needed.

We are importing oil. But we should not place too great dependence on foreign sources of petroleum. We must develop auxiliary domestic fuel sources, to use in emergencies and, incidentally, to hold down the price that we must pay for foreign oil. This means we must develop synthetic liquid fuels—oil and gasoline obtained from coal, oil shale, and other materials.

In 1944, Congress directed the Bureau of Mines to design, build, and operate synthetic liquid fuel demonstration plants. Those will serve as models for private enterprise in a coming new industry which may well attain mammoth proportions.

Our coal and oil shale can make us wholly independent of foreign sources for many generations to come. But this will be true only after practical conversion of coal and shale has been achieved and large plant capacity provided. The Bureau's synthetic fuels program is the foundation for the establishment of this vitally important industry.

German Production

Germany was the leading European producer of synthetic fuels. Lacking enough petroleum, the Germans fueled their army and air force almost exclusively with oil and gasoline extracted from coal. But technicians from industry and the Bureau of Mines, following closely in the wake of our invasion troops, collected all of her plant and laboratory secrets and since then have added refinements of their own.

There are five major processes and sources of synthetic fuels, any or all of which may come into use in this country as petroleum supplies decline to the point where the higher-cost synthetics become commercially competitive with natural petroleum products.

Five Processes

Alcohols can be made from the fermentation of vegetable matter.

Natural gas is converted to liquid fuel by the gas synthesis process. Then there is distillation of oil shale.

The liquefaction of coal or lignite by the high-pressure hydrogenation process. Then there is conversion of water gas from coal or lignite by the gas-synthesis process.

All of these potential sources of liquid fuels are under study in the United States. The Department of Agriculture is investigating costs and manufacturing steps for the production of alcohol and other liquid fuels from agricultural residues, such as corn cobs. Private industry has announced plans for the construction of two commercial plants to convert natural gas to gasoline. Oil shale distillation and coal liquefaction are being studied by the Bureau of Mines.

At Pittsburgh, Bureau of Mines scientists have improved both the direct hydrogenation and indirect gas synthesis methods of converting coal to oil. In the hydrogenation process, lower pressures and lighter equipment are among the keys to production economy. Bureau of Mines men have found a way to convert coal to a distillable oil at relatively low pressures by employing special solvents and very active catalysts. Another radical departure from European practice is the discovery that coal may be hydrogenated in a dry or powder state. This simplifies the process by eliminating several costly and complicated steps, together with the equipment required for them.

Gas synthesis produces a superior grade of Diesel oil—a factor which interests our navy. We are investigating both processes, and our engineers today could build an improved hydrogenation plant with an over-all heat efficiency of 56% compared to a 29% maximum efficiency attained in the typical German plant.

Synthetic Liquids

The Bureau of Mines is burning an underground Alabama coal seam to determine how practical it is to produce a useful combustible gas without the expense of mining coal, apart of its synthetic fuels research. If as successful as is hoped, it may produce an almost inexhaustible source of synthetic liquid fuels and cheap electric power. Preliminary results are encouraging in the Bureau of Mines experiment, conducted with the aid of the Alabama Power Company. Although the gas produced thus far is not as rich as Bureau scientists believe possible, it still offers promise of many potential uses. It not only can be used for manufacturing synthetic gasoline and oil, but offers a new and novel source of heat and fuel for either steam or gas turbines and the generation of electric power.

If tests demonstrate that underground gasification is practicable, this country could tap innumerable coal deposits not now worth the expense of mining. This might even supplant conventional mining in part. It would result in a more complete recovery, for coal mines usually leave as much as 35 percent of their reserves in the ground.

Significant discoveries in getting fuel from oil shale have been made. Bureau of Mines chemists at the oil shale research and development laboratory in Laramie, Wyo., have developed a thermal solution process which employs hot solvents to extract oil from the shale. With it, they have obtained more oil out of the shale than the assay estimated was in the shale. The Bureau's oil shale demonstration plant near Rifle, Colo., will be put in operation during the next two or three months. Coal, however, is this country's real future source of fuel. Excluding atomic energy materials, coal comprises 98.8% of our mineral-fuel energy reserves, whereas oil shale amounts to only 0.8%, petroleum to 0.2%, and natural gas to 0.2%.

Bureau of Mines research findings and patents will be made available to all industry, large and small, and to any interested citizen. A technical advisory committee composed of some of industry's leading coal and petroleum experts has been named to assist the Bureau and is kept abreast of all plans and developments.

We are not waiting until a crisis and the Nation's economy and security are in jeopardy. When we are spending more than 10 billion dollars a year to maintain an army and navy, it does not appear unreasonable to spend at least one two-thousandth of that sum —or $5,000,000—to make sure that the planes, tanks, and ships will be able to move.

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PSYCHOLOGY

Problems from Brain Maps

Frustration or too much motivation may narrow brain maps, formed in learning, causing psychological difficulties of men and nations.

➤ INADEQUATE "brain maps," narrowed in the learning process by too intense motivation or too much frustration, may be the key to the psychological difficulties of men and nations, Dr. Edward C. Tolman, University of California psychologist and expert on animal behavior, declared in the annual Faculty Research Lecture in Berkeley.

Both rats and men, Dr. Tolman said, form in their brains what he calls "cognitive maps" of the environment during learning. On a simplified scale, for example, a rat running through a maze to a goal such as food or water forms in its brain a "cognitive map" of the maze environment.

If the rat is permitted to roam the maze when well fed and with plenty to drink, it appears to learn nothing. But if later placed in the maze when hungry, the rat readily proves it has learned by going to the goal. Under these optimum conditions the rat has been able to form a broad cognitive map of the environment.

If, on the other hand, the rat learns the maze when hungry and thirsty, its cognitive map is narrowed by intense motivation. The correct route to the goal is fixated in the brain and if this is blocked, the strain of intense motivation and frustration makes it difficult for the rat to learn a new route.

This mechanism of too strong motivation and too much frustration is seen at the human as well as the animal level, Dr. Tolman declared. The "cognitive maps" of children may be narrowed by an overintense striving for material wealth. When this is not forthcoming, the individual takes out his frustration on "out-groups."

"Over and over again," he said, "men are blinded by too intense motivations into blind and unintelligent and, in the end, desperately dangerous hates of outsiders. The expression of these displaced hates ranges from discrimination against minorities to world conflagrations."

"We dare not let ourselves or others become so over-emotional, so hungry, so ill-clad, so over-motivated that only narrow strip maps are developed. We must subject our children and ourselves to the optimal conditions of moderate motivation and to the absence of unnecessary frustration whenever we put them and ourselves before the great God-given maze which is our human world."

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In territory formerly German but now Polish, there is an estimated reserve of nearly 15,000,000,000 tons of brown *coal;* this coal cannot be stored over ground for periods of time because it has up to 50% water content.

ENGINEERING

Metals for Jet Engines Tested in Special Dugout

➤ SPINNING, RED-HOT metal disks in a special dugout at the Westinghouse Research Laboratories in Pittsburgh are going to help develop parts for future jet engines.

Heated to temperatures above 1,400 degrees Fahrenheit, the disks will spin at speeds of 1,200 miles per hour until they fly apart. The disks, made of specially developed alloys, will reveal the maximum strength of the materials to help engineers plan new alloys for engines.

The "metal torture" tests will be made in a dugout sunk 10 feet below floor level and lined with sandbags.

Metals to be tested are used in the rotors of present gas-turbine engines where they stand up under terrific stress and temperature. In the tests, actual operating conditions will be exceeded to find out how much heat and stress is needed to break up the metal.

From the tests in the dugout, Westinghouse engineers hope to devise principles from which they can predict the behavior of metals at any speed or temperature.

The disks, which will whirl at 35,000 revolutions per second, are one foot in diameter and one inch thick.

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SANDBAG DUGOUT—To measure the strength of jet engine alloys, Westinghouse scientists use a high-speed motor to whirl the metal disks being tested.