CHEMISTRY

Oil for Defense

"Liquid Gold" May Play Role Coal Had in World War; Products Include Explosives, Dyes and Drugs

By JAMES STOKLEY

See Front Cover

IN THE first World War, it was coal that was the great mother raw material, making possible explosives, dyes, drugs and a whole spectrum of chemical products.

In the present emergency, America is turning more and more to "liquid gold," oil or petroleum, and the gases, natural or those produced from oil, that go with it. From petroleum, chemical research has shown the way to make a large variety of essential war materials: toluene to make TNT for the dive bombers; synthetic rubber to counter the threat of Japanese aggression in the East Indies, synthetic glycerine, and a host of other substances.

In addition, of course, there still remains the use of oil and oil products for their own sake; gasoline for airplanes, for the tanks and the tractors to pull the big guns, oil for the Diesel locomotives and engines of ships that carry supplies and men.

Coal tar, source of so many useful chemicals, was at one time a waste product in gas manufacture. In like manner, at the time of the last war, gases given off in connection with the refining of gasoline were wasted. Either they were discharged into the air, or were burned in a flaming torch to eliminate any hazard from them.

Dr. Robert E. Wilson, group executive of the Petroleum Section of the National Defense Advisory Commission, who has been responsible for much of the research which has brought out the uses of these gases, explains their two principal sources as follows:

"First, what is essentially natural gas dissolved in the crude which comes off in the process of distillation and, second, the larger quantity of 'cracked' gases which are produced as a by-product of cracking. This process of breaking up large molecules into smaller ones suitable for gasoline, like most crushing operations, results in the production of a certain amount of 'fines,' or molecules too small to go into gasoline. These boil below ordinary temperatures and hence come off as gas. For many years, practically the only use for such gases was to burn them as refinery fuel. Indeed, they attracted so little attention that no accurate analyses of their constituents were available until recent years."

Propane, a gas that boils at 42 degrees below zero Fahrenheit, was one of the first of these gases to find an application. This can be liquefied, even at a temperature of 100 degrees, if subjected to a pressure of about 200 pounds per square inch. Liquid propane has helped to carry city comfort into the country, for it is the "bottled gas" that enables farmers' wives to use gas ranges and ovens, even though far away from metropolitan gas mains.

In a paper in the technical journal, *Chemical Industries,* Henry N. Wade, president of Parkhill-Wade, gives some of the latest information about this liquefied petroleum gas, or "L. P. G.," as he designates it for convenience.

"During the first years of the L. P. G. business, from 1922 to 1928," he states, "practically all sales were of the 'bottle gas' type. In this period the total sales grew from about 200,000 gallons per year to about 2,600,000. In 1928 appear the first substantial sales for 'industrial' use, amounting to 400,000 gallons for the year. This type of application was simply a logical expansion of the bottle gas idea, extending the use of the fuel to all sorts of firing which require absolute cleanliness or exceptionally sensitive control, or both. . . . Since 1928 the industrial use has grown from 400,000 gallons annually to 128,000,000 in 1939, while in the same period the bottle gas business has increased from 2,600,000 to 84,600,000 gallons."

In general, Mr. Wade points out, these are situations where natural gas would be used if it were available. They include the firing of ovens in bakeries, baking drying enamel on sheet metal parts, burning vitreous enamel on stoves, plumbing fixtures, etc., melting glass and blowing glassware, firing high grade pottery, heat treating and annealing tool steels, and dehydrating fruit and vegetables. It is also used in place of more expensive acetylene to mix with oxygen for welding.

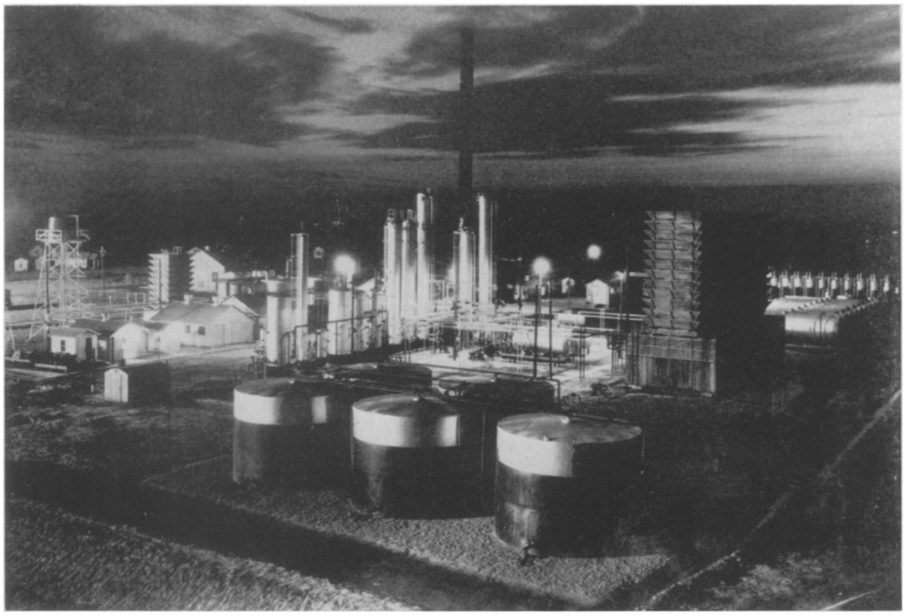
Perhaps, one of these days, you will have L. P. G. in your automobile, for it is already being widely used, in California especially, as a motor fuel for trucks and buses. Although the mechanism of the car must be changed to take such fuel, there seem to be certain advantages.

In addition to propane, there is also butane, which becomes a vapor just above the freezing point of water. Of course, engine temperatures are far above this, so no liquid is sent over from the carburetor into the cylinder to dilute the oil. It burns more cleanly and thus eliminates disagreeable odors in exhaust gases.

Mr. Wade tells of a passenger bus, belonging to a large fleet, which was converted for some of the first experiments. "After a few weeks," he says, "the operator noticed that this particular bus, which was on short interurban service, turned in more fares than any of the other outwardly identical buses on the same run. The operating company received several letters from habitual riders on the line, asking what had been done to that bus to eliminate fumes, and why the rest of the buses could not be fixed up the same way."

Even more romantic, perhaps, is the way in which these gases serve as the bricks from which the chemist can build a multitude of other useful substances. The ethylene glycol that you use in your auto radiator in winter as an anti-freeze was one of the first compounds to be made from them on a large scale.

Alcohol, one of the most important of all industrial chemicals, comes from the gases. Dr. Wilson says that now about half of our requirements of industrial alcohol can be supplied from two large plants operating on cracked gas. This



LATE ACTIVITY
Modern refineries work at night to take care of America's modern needs.

is more than a hundred ordinary breweries or distilleries could produce. Further, it is purer than alcohol produced by fermentation, which means that, though the immediate effects of internal use are the same, the morning after is not so bad with the synthetic product.

Two important kinds of synthetic rubber, including one that is now actually on the market in the form of tires, start with petroleum gases, while a third could be made from this source if necessary. They are the origin of an important new plastic, vinylite. Theoretically, soaps and fats could be made from them, but such a process is not as yet commercially practicable. Propane, combined chemically with chlorine, is used to make a new anesthetic, cyclopropane.

From propylene, another chemical relative of propane, it has been found possible to make glycerine, important in many chemical industries, particularly for explosives. Though this has not yet been put on a commercial basis, it might well be done if defense needs require greatly increased amounts of glycerine.

It is not from the gases but from the parts of petroleum that go into gasoline itself, that toluene is made. This is the basis of TNT, most important of the high explosives used in shells and bombs. Up to now it has been chiefly obtained from coal tar, but at least two large plants are to be built shortly to provide it from petroleum. These will be important links in the defense chain that is being forged for our protection.

Most dramatic has been the way that these researches have improved gasoline itself. With only an increase of about five times in the amount of crude oil going into the refineries since 1916, the production of gasoline in the United States, says Dr. Wilson, has increased about twelve-fold. This has been made possible by great increase in efficiency. Formerly, refiners merely extracted the 19% of gasoline already present in the crude. Now, thanks to cracking methods which convert the heavier portions of the crude oil into gasoline, producers secure a 44% yield. It would, indeed, be possible to secure more than 90%, but there is still a demand for other petroleum products which prevents this.

From the petroleum gases comes an increase of the gasoline yield. A process called polymerization, the opposite of cracking, recombines the small gas molecules into the medium-sized ones suitable for gasoline. More than 600,000 gallons of such polymerized gasoline are now being made daily.

By a related process compounds are made which, though expensive, are proving of immense value to the aviation industry, for with them super-aviation fuels can be made with octane numbers as high as 100. With high degree of freedom from knock, much higher compression ratios can be used in the engines, resulting in greater efficiency, with smaller fuel loads and lower engine weight per horsepower. These factors are equally welcome in a commercial plane, where they allow higher pay loads, and in military aircraft, permitting more bombs to be carried, or a longer cruising radius.

With petroleum assuming such an increasingly important place, one naturally wonders about the potential supply. This seems ample, for the present at least, but such research methods as these must go on to assure their most efficient use. Figures on the world's petroleum are given in a recent paper by John W. Frey of the petroleum conservation division of the Department of the Interior in the *Geographical Review,* published by the American Geographical Society of New York.

"In 1939," he says, "the world production of crude oil was about 2,100,000,000 barrels, of which more than three-fourths was produced in the western hemisphere, a little more than one-eighth in Europe, and about one-tenth in Asia." Of course, in some parts of the world there is a great potential supply that may be realized in the future, but now, he states, "the United States and Russia are the only great world powers that have self-sufficient production."

He concludes with a warning:

"The United States produces about 60 per cent of the world's oil and consumes about 55 per cent. The economic and social structure built on oil during the past 30 years differentiates this country from all others. It is almost impossible to find a shred of American life that is not affected by oil. No other industry has a more highly developed technology or a more efficient personnel. Violent economic consequences have been generated by the uncontrolled development in most states and production in excess of demand has on several occasions in the past decade placed the industry in a perilous condition. The present known reserves are satisfactory for the immediate future, but the magnitude of the base of demand, now a billion and a third barrels a year, has such far-reaching effects that a continuous supply at low cost is of national interest.

"The prevention of avoidable waste has been in the hands of the states for a number of years, and there are states in which the objectives of the laws and the administration leave little to be desired; but this cannot be said of all the states. The lack of coordination in the matter of waste is a national problem—one that we cannot afford to meet with careless indifference. Only through the wise use of this vital and irreplaceable fluid energy can this country avoid many of the extremely serious difficulties that confront other nations."

Science News Letter, November 9, 1940

PHYSICS

Electron Microscope May Be Combined With Television

THE electron microscope, now being made commercially in this country as well as in Europe, can be advantageously combined with television, according to U. S. Patent 2,219,113, just granted Martin Ploke, Dresden, Germany. He has assigned his rights to the Zeiss-Ikon Aktiengesellschaft, also of Dresden.

The size of the light waves themselves sets a lower limit to the dimensions of objects visible through an ordinary microscope. Electrons, behaving like waves of much smaller size, are used in the electron microscope to form the image, and they reveal smaller details. Though the electrons cannot be focussed with lenses, this is accomplished with coils of wire, setting up electrical and magnetic fields to bend the electron beams.

In his patent specifications, Mr. Ploke says that when the object to be examined is bombarded with electrons heat is produced, and that his invention avoids this.

In one arrangement, he uses a beam of X-rays to throw a shadow of the object being examined on a thin metal foil closing one end of a vacuum tube. Where the X-rays fall, electrons are given off; these are focussed, by electrical and magnetic means, on a sensitive television transmitting surface. The currents can be amplified many times, and the picture viewed on a television receiver.

Though the patent does not mention it, another advantage seems to be that the object under examination is in the open air, while in one form of electron microscope, now on the American market, the object must be in an evacuated chamber. Also, if desired, the television receiver could be some distance away, with a wire, or even a radio connection, to the microscope proper.

X-rays, being of much shorter wave length than light rays, reveal details as well as the electrons. For use where such extreme magnifications, of 20,000 diameters or more, are not desired, Mr. Ploke also describes a device using ultraviolet waves, shorter than visible light, though not as short as X-rays. These form an image of the object on a window at one end of the tube, electrons are given off where the rays fall, these are focussed on a fluorescent screen at the other end, where they are changed to light, and the magnified image is clearly seen.

Science News Letter, November 9, 1940

Bread sold in England is now standardized to four loaf sizes.

Serbia's *gypsies* are vanishing, says an anthropologist, who reports that they are settling in gentile villages, adopting village trades and manners, forgetting Romani speech, and marrying gentiles.

● RADIO

Frederick Osborn, official of the American Eugenics Society will discuss "Mothers and Fathers of Tomorrow" as guest scientist on "Adventures in Science" with Watson Davis, director of Sci-eugenics Society will discuss "Mothers and Fathers the Columbia Broadcasting System, Thursday, Nov. 14, 3:45 p.m. EST, 2:45 CST, 1:45 MST, 12:45 PST.

Listen in on your local station. Listen in each Thursday.