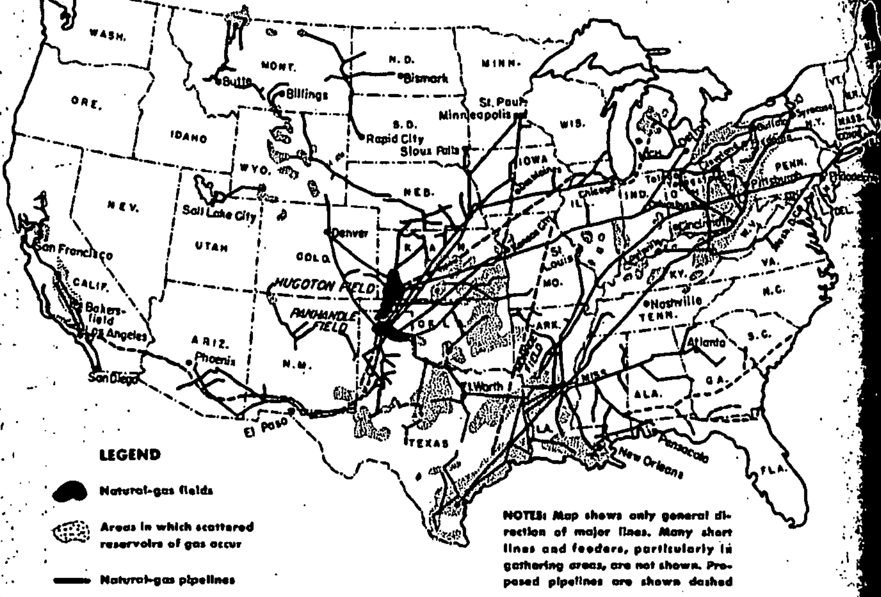
MAJOR GAS FIELDS AND PIPELINES



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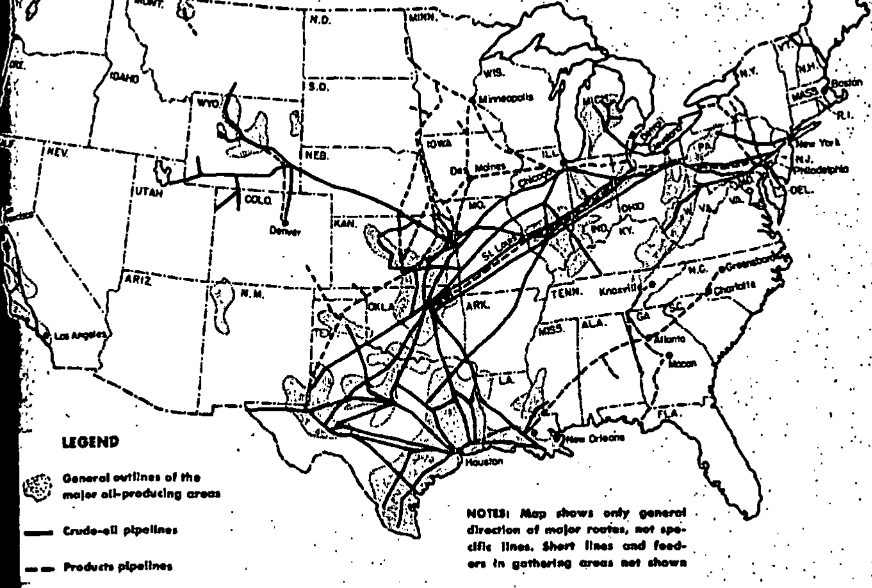

sixth hydrogen. Fuels other than coal may be used; in many parts of the world producer gas is made from waste.

Byproduct Gases. Commercial *butane* and *propane* are essentially byproducts of manufacture of natural gasoline and of certain refinery operations. As supplied, propane (C_3H_8) is essentially pure, while butane (C_4H_{10}) usually contains a small amount of propane. Both have high heating values, are easily liquefied at low pressure. They are widely used as "bottled" fuels.

Blast-furnace gas, a byproduct of iron-making, has the lowest heating value of any commercial gas, about 90 Btu per cu ft. It is close to three-quarters nitrogen and carbon dioxide, the only important combustible constituent being carbon monoxide. Raw gas, which usually contains a high concentration of solid impurities, is normally washed before use. Unwashed gas, however, has been successfully burned in boiler furnaces (POWER, Nov 1938, pp 588-591).

In recent years, use of gas produced by digesting sewage sludge has become common practice in disposal plants. *Sewage gas,* or *sewage-sludge gas,* runs about two-thirds methane and one-third carbon dioxide, with small amounts of hydrogen, nitrogen and usually some hydrogen sulphide. Heating value is about 650 Btu per cu ft. Although mostly used in engines, this gas is also burner fired.

OIL

Petroleum and its byproducts furnish practically all commercially used liquid fuels. Geologists believe decomposition of minute marine growths or possibly, at times, of vegetable matter formed the oil that lies trapped in pools between layers of the earth's crust. This *crude oil* consists of 83-87% carbon and 10-14% hydrogen, plus traces of oxygen, nitrogen and sulphur. The hydrogen and carbon are combined as *hydrocarbons.*

Crude oil moves from well to refinery mainly by pipeline and tanker. Although virtually every state boasts some refining capacity, ten have almost 90% of the nation's total. Fuel oils move from refineries to nearby markets by truck, tank car and barge, with tankers serving seaboard areas.

Refining Processes. Since practically all liquid fuels are either products or byproducts of refining, the way they are made has more to do with their fuel qualities than the source of the crude. Refining consists of seperating and, usually, recombining the hydrocarbons of the fuel oil into specialized products like gasoline, fuel oil, etc. Basic process is simple distillation, which separates the hydrocarbons into groups or "fractions" having the same range of boiling points. From light to heavy, typical fractions are: (1) naphtha (2) gasoline (3) kerosene, and (4) gas oil. These are the *distillates;* the remainder, or *residual,* is a heavy fuel oil. Products of simple distillation are called *straight-run.*

Simple distillation is sometimes the whole story, but in modern refining it is only the beginning. To secure greater gasoline yields, fractions heavier than gasoline are usually *cracked,* that is, decomposed by heat and pressure, with or without a catalyst. Of the new hydrocarbons resulting, some are lighter and some heavier; these are likewise separated according to boiling range. Cracking, unlike simple distillation, actually changes the hydrocarbon structure so crude oil yields more valuable lighter hydrocarbons (gasoline) and proportionately less heavy ones.

Commercial Fuel Oils. Fuel oils used commercially may be either distillates or residuals, and either straight run or cracked. Straight-run products become increasingly less common as refinery practice leans more heavily on cracking, and are, in general, premium grades. Thus the great bulk of commercial fuel oils are cracked products; distillates form the source for lighter grades used in domestic and some commercial and industrial burners, whereas residuals supply the heavy oils for larger commercial and industrial units.

Refinery wastes, which have little or no commercial value, are usually burned at the refinery or in adjacent plants. They include acid sludge, tars and tank cleanings or "bottoms."

Specific Gravity. Since hydrogen has a much higher heating value and lower atomic weight than the other principal element in fuel oil, it's easy to see that the proportions of carbon and hydrogen affect both specific gravity and heating value. Because of this, specific gravity forms a reliable guide to an oil's heating value (see table on p 77).

Specific gravity in *degrees API* (American Petroleum Institute) is found by dividing *specific gravity with respect to water* (at 60 F) into 141.5 and subtracting 131.5 from the answer. Gravity in *degrees Baume* is found in the same way except the numbers are 140 and 130, respectively. For practical engineering work, the two gravity scales may be considered the same.

Viscosity. The relative ease or difficulty with which an oil flows is its *viscosity.* It is measured by the time in seconds a standard amount of oil takes to flow through a standard orifice in a device called a viscosimeter. The usual standard in this country is the *Saybolt Universal,* or the *Saybolt Furol,* for oils of high viscosity. Since viscosity changes with temperature, tests must be made at a standard temperature, usually 100 F for Saybolt Universal and 122 F for Furol.

Viscosity indicates how oil behaves when pumped and, more particularly, shows when preheating is required and what temperature must be held.

Flash and Pour. *Flashpoint* represents the temperature at which an oil gives off enough vapor to make an inflammable mixture with air. Results of a flashpoint test depend on the apparatus, so this is specified as well as temperature. Flashpoint measures oil's volatility and indicates maximum temperature for safe handling.

Pour point represents lowest temperature at which an oil flows under standard conditions. Including pour point in a specification insures that an oil will not give handling trouble at expected low temperature.

By centrifuging a sample of oil, amount of *water and sediment* can be found. These are impurities and while it is not economical to eliminate them, they should not occur in excessive quantities (not more than 2%). Incombustible impurities in oil, from natural salts, from chemicals in refining operations, or from rust and scale picked up in transit, show up as *ash.* Some ash-producing impurities cause rapid wear of refractories and some are abrasive to pumps, valves and burner parts. In the furnace, they may form slag coatings.

All tests above are covered by ASTM standards, which should be consulted for details of apparatus and methods (*ASTM Standards on Petroleum Products and Lubricants,* American Society for Testing Materials, 1916 Race St, Philadelphia 3, Pa.).

Fuel oils have a tendency to deposit