CHAPTER-9
STORAGE, TRANSPORTATION and REFINERY

When we drill wells in a productive field and start production, we need to store and/or transport the fluids to the market. When several oil production wells are present then connection of surface lines could be made in bundles. At the wellhead the separators (single or two stage) can be utilized. They are used to separate the remaining gas in solution by adjusting pressure in the separator. Water is separated due to the gravity difference. Crude oil is fed into crude oil line and gas is flowed through the gas lines.

9.1 Storage of Crude Oil

The storage of crude oil, refinery products and natural gas is an important subject. It is needed to store them when they are not used. The necessary conditions must be satisfied during storing. Crude oil is stored in large tanks after produced. When we look at an oil field, we can see large storage tanks clustered together in what is called tank farm. These may run in size from a few hundred to several thousand barrels capacity, according to the production of the wells. In the really big tank farms, it is quite common to see tanks of 55,000- and 80,000-barrels capacity. Other groups of storage tanks may be seen at key points along pipelines, at ports where oil is loaded on tankers, and at the refineries to which crude oil goes to be processed for the market. An enormous amount of crude petroleum is constantly kept stored in such tanks in all parts of the world. The produced natural gas is liquefied before storage. It is also stored in underground formations. Natural gas is injected into suitable formations when market demand is low. Then it is produced when demand is high.

9.2 Transportation of Crude Oil

Transportation is a vital factor in the petroleum industry. In the early days, when the refineries were near the oil fields, oil in its various forms was readily transported in barrels by wagons, barges, and railways. In recent years, however, great oil fields have been developed in regions far away from the centers of population and industry. The crude oil taken from these fields is carried to refineries near the big markets by pipeline or tanker, depending upon whether it is being moved overland or by water. Railroad tank cars and even trucks are sometimes used to carry crude oil from the fields that cannot be reached by pipelines.

The oil tanker is very important not only because that is the only way to take the petroleum across seas and oceans but also because it is the cheapest method of transporting large quantities. Tankers of tremendous size today sail the seas. Displacements of hundreds of thousands of metric tons are not unusual. One such giant ship can carry millions of barrels of oil at a time. Extremely large tankers are known as supertankers. It is cheaper to operate these ones than the small ones but pose special problems. Port facilities can not accommodate large tankers. Special deep water offshore ports have to be built.

Tankers are built with many safety and fire prevention devices and sophisticated navigational equipment such as radar, sonic depth finders, and gyroscopic compasses.

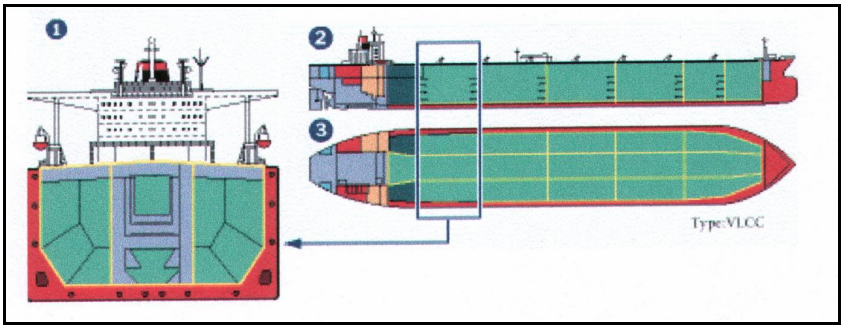


Figure 9-1 The View of a Basic Tanker

1) frontal cross-section
2) lateral cross-section
3) cross-section view from above

9.3 Pipelines

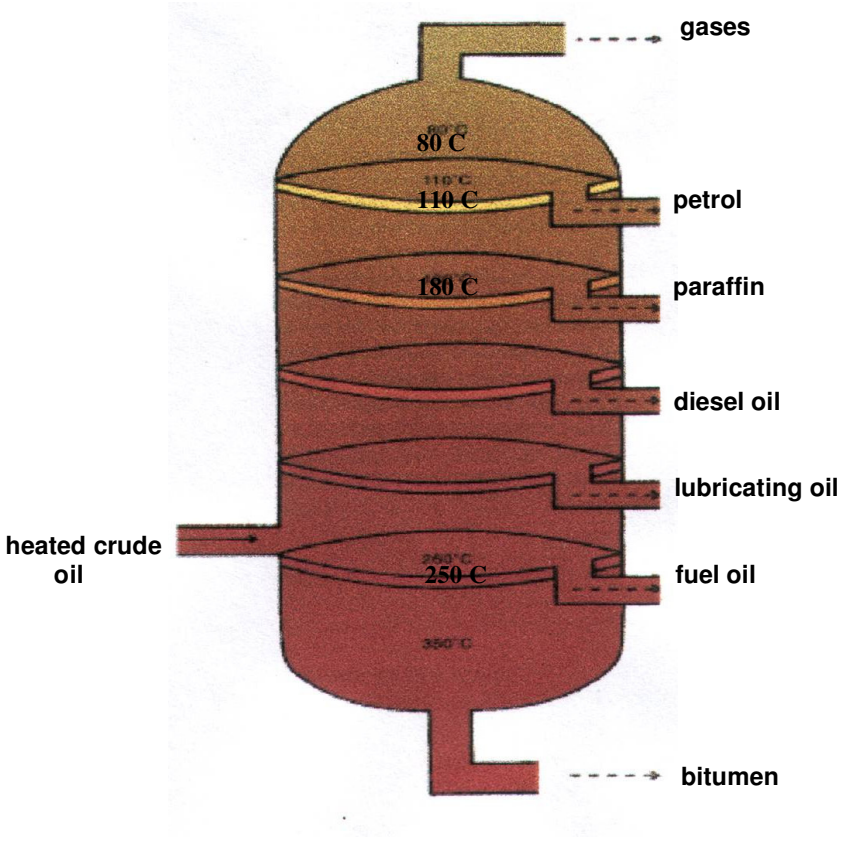
A large percentage of the world petroleum moves by pipeline at some stage of its production to the market place. The pipelines carry crude oil from producing fields to refineries where it is converted into gasoline and other products and also move natural gas to consumers. Some crude oil moves by pipeline to marine terminals where it is loaded on tankers, which carry to the refineries. Some natural gas is converted into liquefied gas (LNG) which at –250 F can be shipped in special carriers at low pressure. Pipelines usually range in size from 8 inch to 48 inch in diameter. To move natural gas by pipeline, compressors are used to compress the gas to some 100 times normal atmospheric pressure. Computers are used to calculate density, temperature, and pressure, flow rate and other data and coordinate the operation of equipment. Modern pipelines are monitored by electrons sensors, which can detect drops in pressure that might indicate a leak.

A large percentage of the world's petroleum is moves by pipelines. The major oil-producing nations have built a total of many hundreds of thousands of kilometers of oil pipelines. In the United States, one famous example is the Little Big Inch, built during World War II to carry oil from the Texas fields to New York. It is now carrying natural gas. Canada and Soviet Union are also important pipeline builders. A number of pipelines have been built

and are under construction in the great oil fields of the nations of the Middle East.

9.4 Refineries

Crude oil is often a dark, sticky liquid that cannot be used without changing it. The first part of refining crude oil is to heat it until it boils. The boiling liquid is separated into different liquids and gases in a distillation column. These liquids are used to make petrol, paraffin, diesel fuel etc.



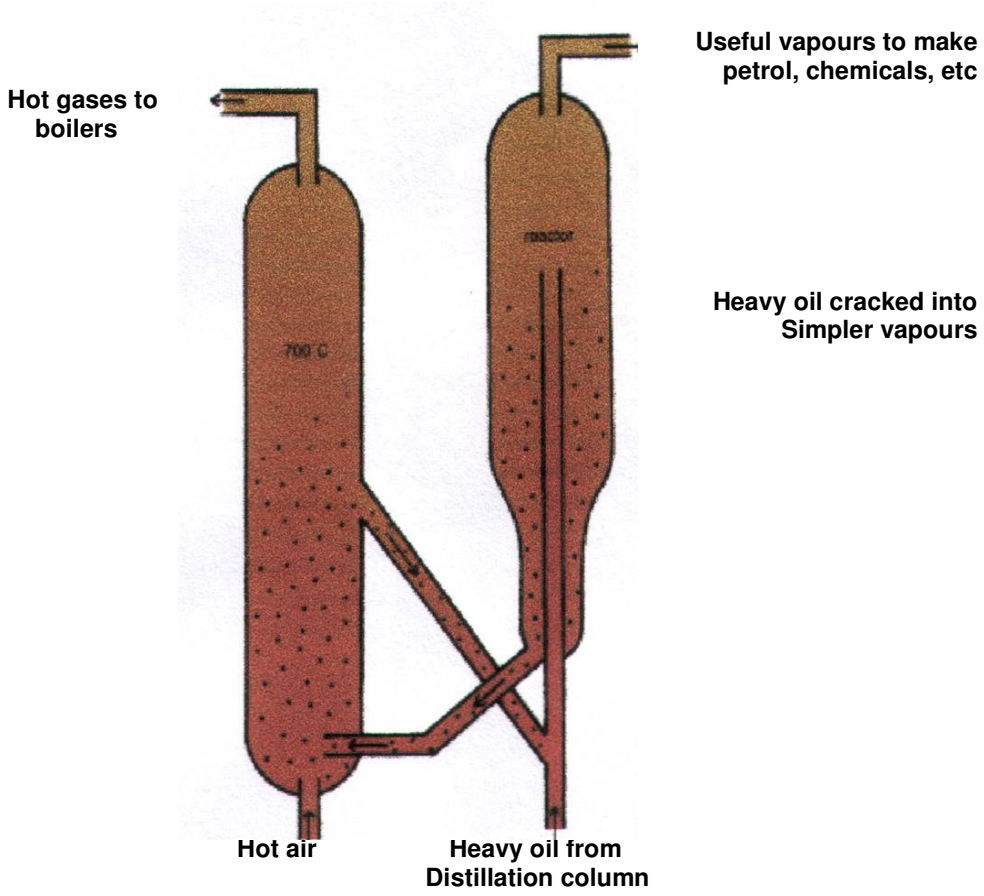


Figure 9-2 Basic Distillation Units

Crude oil is a mixture of different chemical called hydrocarbons. The boiling oil turns into a mixture of gases in the column. The gases flow up the column which is hottest at the bottom and cooler at the top. The gases cool down as they go up the column until they condense (turn back into liquid again). The separated liquids and gases, after cleaning and further processing, are used to make many products. Liquids from refining oil still have to be changed to make them more useful. Sometimes it's to make them clean enough to be used. Sometimes it's to turn some of the unwanted liquids into things people want to buy. The heavier liquids are in less demand from customers so are turned into lighter products that are in demand. One of the processes is called catalytic cracking. It breaks down some of the heavy liquids from the distillation column.

The heavy liquids are changed into simple and more useful liquids and gases. Cracking is just one of many chemical changes in an oil refinery. In an oil refinery and in a chemical works, crude oil and gas are turned into hundreds of useful products.

Thousands of people are employed to make sure all these useful products get to the millions of people in Britain and overseas who want to buy them everyday. Many thousands of people are employed in Britain's oil and gas industry. Many of these work to get petrol and diesel fuel to where it is wanted . Britain's 10,000 filling stations for motorists, lorry drivers, taxis and buses.

Once oil has been produced from an oil field, it is treated with chemicals and heat to remove water and solids, and the natural gas is separated. The oil is then stored in a tank, or battery of tanks, and later transported to a refinery by truck, railroad tank car, barge, or pipeline. Large oil fields all have direct outlets to major, common-carrier pipelines.

9.5 Basic Distillation

The basic refining tool is the distillation unit. In the U.S., after the Civil War, more than 100 still refineries were already in operation. Crude oil begins to vaporize at a temperature somewhat less than that required to boil water. Hydrocarbons with the lowest molecular weight vaporize at the lowest temperatures, whereas successively higher temperatures are required to distill larger molecules. The first material to be distilled from crude oil is the gasoline fraction, followed in turn by naphtha and then

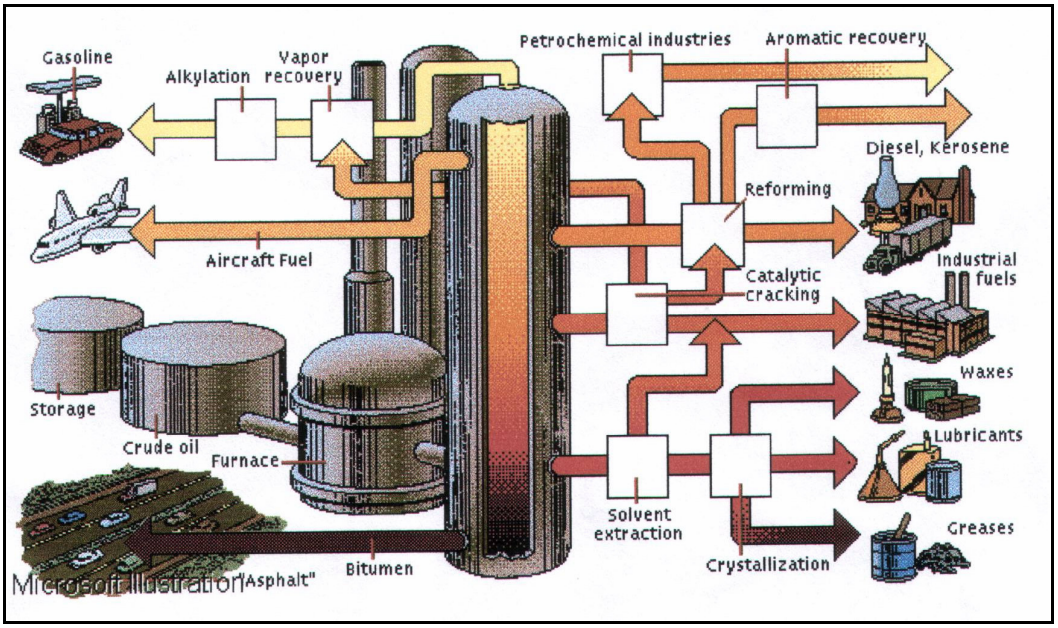


Figure 9-3 Petrochemical Industry

by kerosene. The residue in the kettle, in the old still refineries, was then treated with caustic and sulfuric acid, and finally steam distilled thereafter. Lubricants and distillate fuel oils were obtained from the upper regions and waxes and asphalt from the lower regions of the distillation apparatus. In the later 19th century the gasoline and naphtha fractions were actually considered a nuisance because little need for them existed, and the demand for kerosene also began to decline because of the growing production of electricity and the use of electric lights. With the introduction of the automobile, however, the demand for gasoline suddenly burgeoned, and the need for greater supplies of crude oil increased accordingly.

9.6 Thermal Cracking

In an effort to increase the yield from distillation, the thermal cracking process was developed. In this process, the heavier portions of the crude oil were heated under pressure and at higher temperatures. This resulted in the large hydrocarbon molecules being split into smaller ones, so that the yield of gasoline from a barrel of crude oil was increased. The efficiency of the process was limited, however, because at the high temperatures and

pressures that were used, a large amount of coke was deposited in the reactors. This in turn required the use of still higher temperatures and pressures to crack the crude oil. A coking process was then invented in which fluids were recirculated; the process ran for a much longer time, with far less buildup of coke. Many refiners quickly adopted the process of thermal cracking.

9.7 Alkylation and Catalytic Cracking

Two additional basic processes, alkylations and catalytic cracking, were introduced in the 193 Os and further increased the gasoline yield from a barrel of crude oil. In alkylation's small molecules produced by thermal cracking are recombined in the presence of a catalyst. This produces branched molecules in the gasoline boiling range that have superior properties—for example, higher antiknock ratings—as a fuel for high-powered engines such as those used in today's commercial planes.

In the catalytic-cracking process, the crude oil is cracked in the presence of a finely divided catalyst. This permits the refiner to produce many diverse hydrocarbons that can then be recombined by alkylations, isomerization, and catalytic reforming to produce high antiknock engine fuels and specialty chemicals. The production of these chemicals has given birth to the gigantic petrochemical industry, which turns out alcohols, detergents, synthetic rubber, glycerin, fertilizers, sulfur, solvents, and the feedstock's for the manufacture of drugs, nylon, plastics, paints, polyesters, food additives and supplements, explosives, dyes, and insulating materials. The petrochemical industry uses about 5 percent of the total supply of oil and gas in the

U.S.

In 1920 a U.S. barrel of crude oil, containing 42 gallons, yielded 11 gallons of gasoline, 5.3 gallons of kerosine, 20.4 gallons of gas oil and distillates, and *5.3* gallons of heavier distillates. In recent years, by contrast, the yield of crude oil has increased to almost 21 gallons of gasoline, 3 gallons ofjet fuel, 9 gallons of gas oil heavier residues.

9.8 Oil Refining and Fractional Distillation

Crude oil is refined into products such as gasoline, asphalt, and waxes by a process called fractional distillation. During the process, the parts, or fractions, of crude oil are divided out successively by their increasing molecular weight. For instance, gasoline has a low molecular weight and vaporizes at a fairly low temperature. This means that at the appropriate temperature, while all of the rest of the oil is still in liquid form, gasoline may be separated out. The remaining oil goes through the same process at a slightly higher temperature, and jet fuel is divided out. Repeating the distillation process several times will separate out several constituents of crude oil, which are then processed and put to a wide range of uses.