LIQUID FUELS

Petroleum or crude oil is a deep brown oil consisting of mainly hydrocarbons, paraffins, naphthenes and aromatics in varying proportions. Sulfur, nitrogen and oxygen are present in the form of derivatives of hydrocarbons in the oil. The average ultimate analysis shows C ⇒ 83–87%, H ⇒ 11–14%, S ⇒ 0.5–3%, N ⇒ 0.1% and O ⇒ 2–3%. Practically all metals are found in petroleum, the most common are Si, Fe, Al, Ca, Mg, Ni.

Occurrence: The crude oil has been derived from the organic matter originally present in marine sediments. The dead organic matter settles down to the bottom of shallow seas and lagoons. The settled debris is attacked by anaerobic bacteria, whereby most of the organic compounds are destroyed and the remaining unsaturated fatty oils and fatty acids undergo polymerization.

Classification of petroleum. There are three main types petroleum according to chemical nature:

(*a*) Paraffin-base crude composed of saturated hydrocarbons upto $C_{35}H_{72}$ which are semi-solids, called waxes.

(*b*) Asphalt-base crude contains mainly naphthenes and cycloparaffins with smaller amounts of paraffins and aromatics.

(*c*) Mixed base crude contains both the above type of compounds but rich in waxes. About 90% crude produced at present fall in this last category.

Petroleum

Drilling: Oil is brought to the surface by drilling holes upto the oil bearing surface. By the hydrostatic pressure of natural gas the oil is pushed up or it is pumped up by means of a pump. Two coaxial pipes are lowered to the oil reservoir, through the outer pipe compressed air is forced, whereby the oil is forced out through the inner pipe. This crude oil is sent to the refineries for further processing and refining of the crude oils (Fig. 18.5).

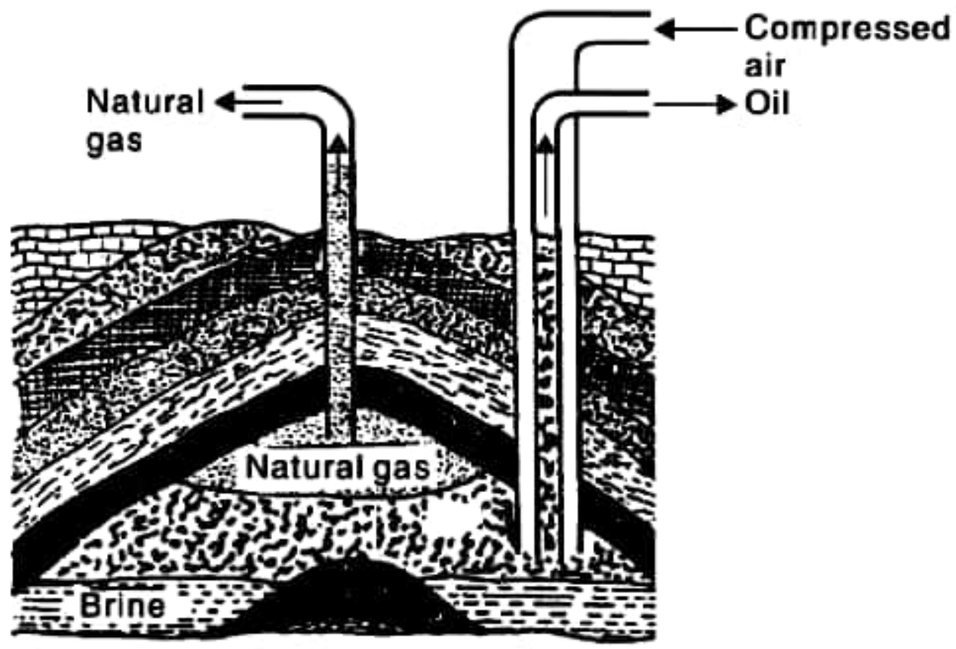

Fig. 18.5 Mining of crude oil and use of air-lift pump.

Refining: After removal of dirt, water and natural gas, the crude oil is separated into fractions by distillation and the fractions obtained are subjected to simple purification procedures or complex treatments to yield different petroleum products. All these steps are under petroleum refining which include:

1. **Coltrell's process.** Crude oil is intimately mixed with water forming an emulsion. The water is separated from the oil by passing the emulsion through Coltrell's electrostatic precipitator.

2. **Removal of objectionable compounds.** Sulfur compounds have objectionable properties of pollution so they are removed prior to distillation as copper sulfide by treatment with copper oxide.

3. **Petroleum distillation.** The crude oil is subjected to distillation to about 400°C temperature in an iron retort whereby all volatile components except the solid residue are distilled out. These are separated in a fractionating column consisting of a tall tower where the higher boiling fractions condense first. This distillation is a continuous process and the following fractions are obtained (Fig. 18.6) (Table 18.3).

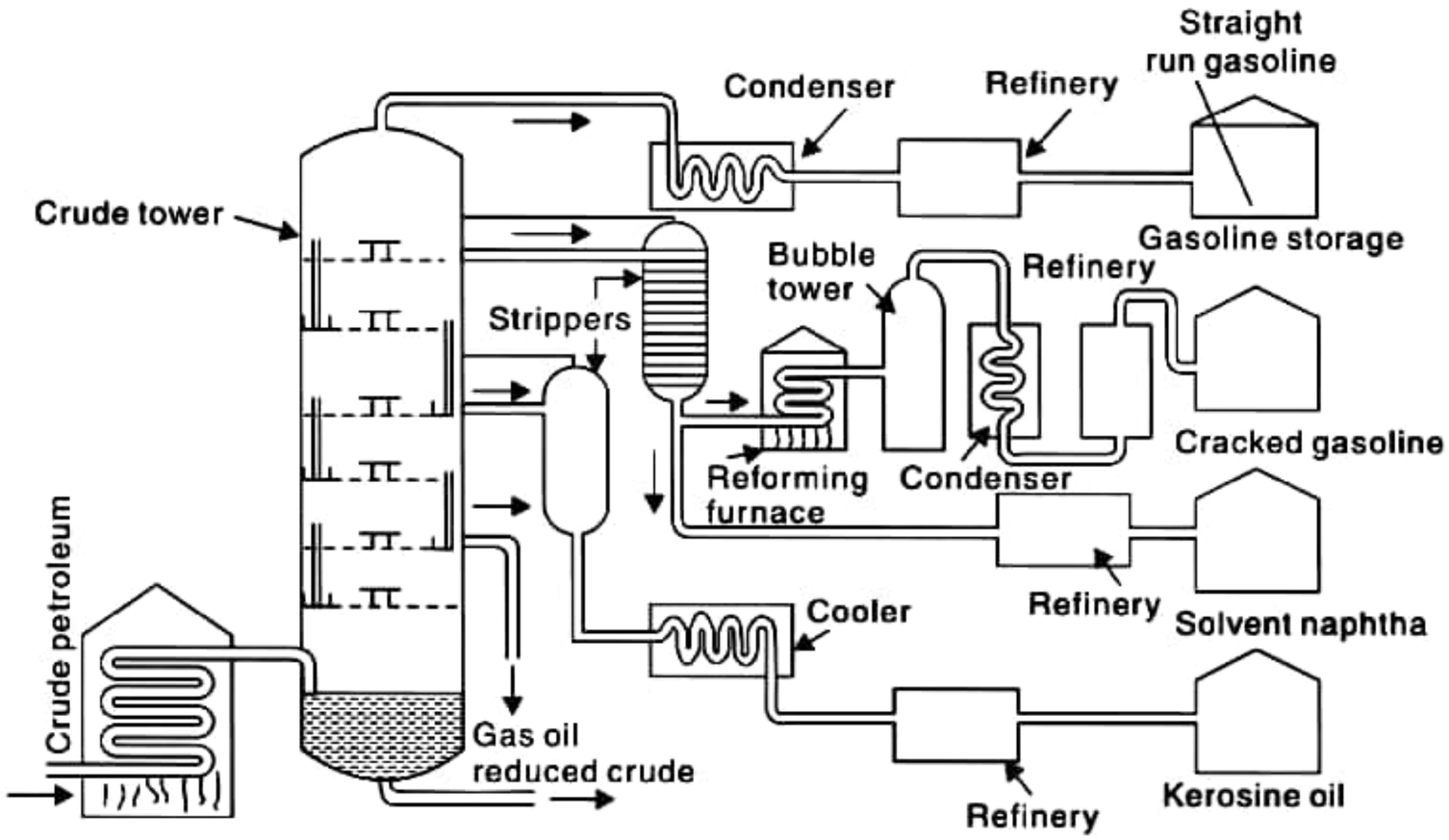

Fig. 18.6 Petroleum distillation.

(*a*) **Gasoline** is obtained upto 200°C. The naphtha is condensed and subjected to refining for the removal of sulfur, diolefins after refractionating.

(*i*) Petroleum ether boiling between 40°C–70°C and

(*ii*) Benzene boiling between 70°C–90°C and

(*iii*) Gasoline boiling between 90°C–200°C all are obtained.

Its calorific value is 14,250 kcal/kg and is used as a fuel for internal combustion engines in automobiles and aircrafts.

(*b*) **Solvent naphtha** is obtained as a side steam between 200°C–250°C. This contains some gasoline, which is passed back to the main fractionating column. Naphtha contains 6-10 carbon atoms.

(*c*) **Kerosene oil** is obtained between 250°C–300°C. The lower boiling fraction mixed with it is returned to the main column. Bottom liquid is refined and finally can be used as domestic fuel having calorific value of 1100 kcal/kg.

(*d*) **Gas oil** is obtained between 300°C–350°C. This is passed through a cooler and then extracted with liquid SO_2 to remove sulfur. It is used as a diesel engine fuel with calorific value of 11000 kcal/kg.

(*e*) The *residual liquid* coming out from the bottom on subsequent treatment yields lubricating oil, vaseline, grease, paraffin wax, asphalt-bitumen, petroleum, coke etc.

Table 18.3: Common fractions from crude

Fraction	*Boiling range*	*Composition*	*Uses*
Uncondensed gas	Within 30°C	C_1 to C_4	As domestic or industrial fuel under the name LPG (Liquefied petroleum gas)
Petroleum ether	30°C–70°C	C_5–C_7	As a solvent.
Gasoline or petrol	90°C–200°C	C_5–C_9	As a motor fuel solvent and dry washing
Naphtha	200°C–250°C	C_9–C_{10}	As a solvent
Kerosene oil	250°C–300°C	C_{10}–C_{16}	As fuel for domestic and industrial uses
Diesel oil	300°C–350°C	C_{10}–C_{18}	As a fuel for diesel engine
Heavy oil	320°C–400°C	C_{17}–C_{30}	For different fractions