



## 19CH101 – ENGINEERING CHEMISTRY FOR CIRCUIT BRANCHES

### Unit-4

## FUELS AND COMBUSTION

### PETROLEUM

Petroleum or crude oil is a naturally occurring brown to black coloured viscous oil formed under the crust of earth, on shore or off shore. Chemically it is a mixture of various hydrocarbons with small amounts of N, O, S compounds.

The approximate composition of petroleum is

C = 80 - 84%

H = 10 - 14 %

S = 0.1 - 0.5 %

N+ O = Negligible

### Classification

Petroleum is classified on the basis of various types of hydrocarbons

- i) Paraffin based oil - Contains mainly n - alkanes  
(Ex : Pennsylvanian and gulf coast oil)
- ii) Asphalt base oil - Contains aromatic and alicyclic hydrocarbons.  
(Ex: Californian oil)
- iii) Mixed base oil - Contains higher proportion of aromatics and naphthenes (cyclo alkanes)  
(Ex : Mexican oil)

## REFINING OF PETROLEUM

### Definition

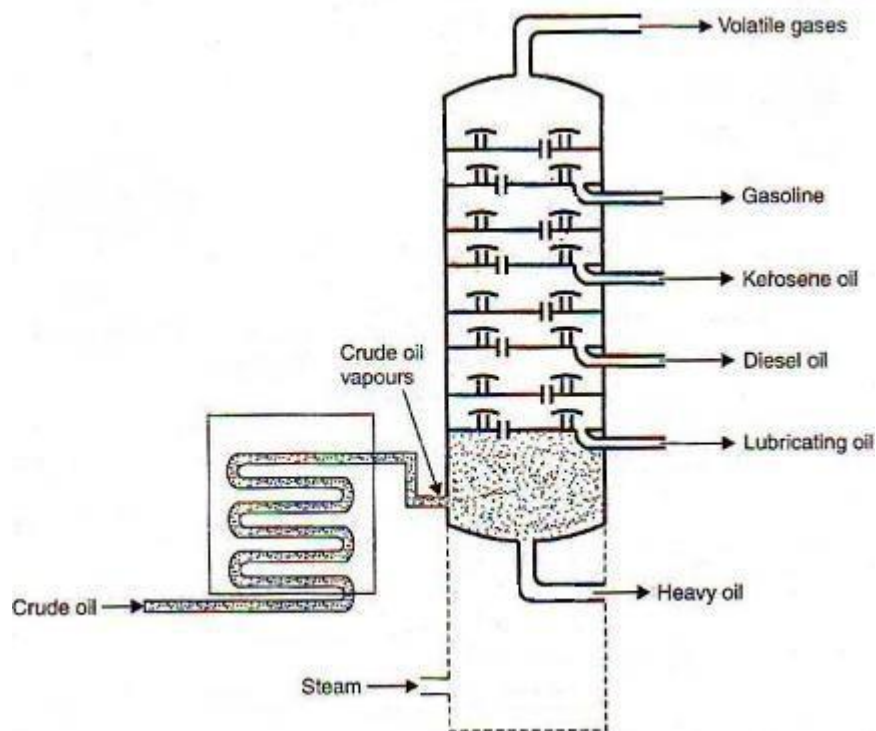
The process of removing impurities and separating out the oil into various fractions having different boiling points is known as refining of petroleum.

### FRACTIONAL DISTILLATION

The purified crude oil is heated in a furnace called oil heater where the temperature will be around 400o C. Here the oil gets vapourised. The hot vapours are then sent to the fractionating column

It is a tall cylindrical tower consisting of a number of horizontal stainless steel tray at short distances. Each tray is provided with a small chimney, which is covered with a loose cap. The tower will be hot at the lower end and comparatively cooler at the upper end.





When the oil vapours go up in the tower, they become cool and condense. The heavier compounds having higher boiling points get cooled first and condensed in the trays whereas the fractions having lower boiling points condense near the top of the tower.

Lower fractions are used after purification while the high boiling point fractions are subjected to cracking operation to get more useful lower fractions. The gasoline obtained by this fractional distillation is called straight-run gasoline.

### **Some important fractions of petroleum**

#### **i) Petrol (or) Gasoline (C<sub>5</sub>-C<sub>9</sub>)**

- o It is a low boiling fraction of petroleum obtained between 40 - 120°C.
- o It is a mixture of hydrocarbons pentane to nonane (in terms of carbon atoms C<sub>5</sub> - C<sub>9</sub>).
- o Its calorific value is about 11,250 kcal/kg.
- o It is used as fuel in ICE of automobiles and aero planes.
- o Its antiknock value can be improved by the addition of Tetra Ethyl Lead (TEL).

**Uses :** It is used as a fuel in IC engine and also used in dry cleaning and as a solvent.



### ii) Naphtha (C9-C10)

It is a colourless, light fraction obtained between 1200C to 1800C during fractional distillation of petroleum. It is a mixture of hydrocarbons such as nonane and decane.

**Uses:** Naphtha is also called as white spirit, which is generally used in dry cleaning and as thinner for varnish, floor and furniture polishes etc. The lightest portion of the distillate is used as solvent for fats and rubbers, whereas the heaviest portion of the same is used as a fuel.

### iii) Kerosene (C10-C16)

It is relatively a high boiling fraction obtained between 180-250oC during fractional distillation of petroleum. It is a mixture of hydrocarbons such as decane to hexadecane. Its approximate composition is C = 84%, H = 16%, > 0.1% S. Its calorific value is about 11,100 kcal/kg.

**Uses:** It is mainly used as a domestic fuel in stoves and lamps. It is also used as jet engine fuel and for making oil gas.

**iv) Diesel (C15-C18)** It is also a high boiling fraction obtained between 250- 320oC during fractional distillation of petroleum. It is a mixture of hydrocarbons such as C15H32 to C18H38. Its calorific value is about 11,000 kcal/kg.

**Uses :** It is used as a very good diesel engine fuel.

### v) Heavy oil or Residual fuel oil (C17 – C30)

The left over portion of petroleum after distilling off all the lighter fractions are called Fuel Oil. The approximate composition of fuel oil is C = 86%, H = 12%, S = 1%, H<sub>2</sub>O = 0.6%; sediments = 0.4%. Its calorific value is about 9200 kcal/kg.

The following fractions are obtained on further vacuum distillation of the fuel oil.

i) Light fuel oil = 350 -420oC

ii) Heavy neutral oil = 420-500oC

**Uses:** It is used as fuel for ships and also used in metallurgical furnaces. Gasoline is also obtained from oil by cracking process.

### vi) Asphalt

Asphalts are obtained by

i) The oxidation of residual heavy oil in presence of air at higher temperature.

ii) The deep vacuum distillation of residual heavy oil.

Asphalts are available in the market in liquid, semi-solid and solid forms.

**Uses:** It is used for road making and making water-proofing roofs. It is also used for the manufacture of water proofing concrete and water proofing paints.