MODULE – IV

FUELS AND COMBUSTION

4.3 Petroleum (Liquid fuel)
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4.3 Petroleum (Liquid fuel)

Petroleum or crude oil is **dark greenish brown viscous liquid found deep in earth'scrust.** It is a mixture of various hydrocarbons.

4.3.1 Composition of Crude oil (petroleum)

Constituents	Percentage (%)
C	80- 87
H	11-15
S	0.1 – 3.5
N + O	0.1 – 0.5

4.3.2 Refining of Petroleum or crude oil

- The **crude oil** is a mixture of oil, water and unwanted impurities.
- The process of removing impurities and separating crude oil into various fractions is called as refining of petroleum.

Steps of refining

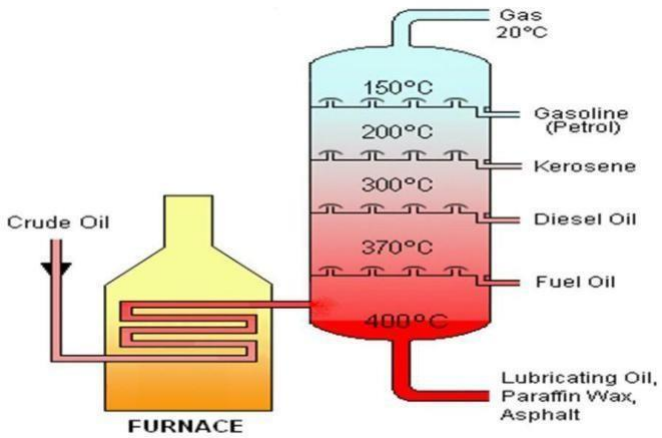
i) Separation of water (Cottrell's process)

The crude oil is an emulsion of oil and salt water. The crude oil is allowed to flow between two highly charged electrodes. Here the water droplets combine to form large drops which separate out from oil.

ii) Removal of sulphur compounds

Sulphur compounds are removed by treating crude oil with copper oxide. The copper sulphide formed is separated by filtration.

iii) Fractional distillation



- Purified crude oil is heated to 400˚C in an iron retort. The oil gets vapourised. The hot vapours are passed up a 'fractionating column'.
- The fractionating column is a tall cylindrical tower containing a number of horizontal steel trays at short distances.
- As the vapours go up they become cooler and get condensed at different trays.

Various fractions obtained during fractional distillation

Name of the fraction	Boiling point	Range of C- atoms	Uses
Uncondensed gases	Below 30˚C	$C_1 – C_4$	Fuel as LPG
Gasoline or petrol	40 – 150	$C_5 – C_9$	Fuel for IC engine
Kerosene	180 – 200	$C_{10} – C_{16}$	Fuel
Diesel	250 - 300	$C_{15} – C_{18}$	Diesel engine fuel
Heavy oil	320 - 400	$C_{17} – C_{30}$	Fuel for ship

Fractions of heavy oil

No	Name of the fraction	Uses
1	Lubricating oils	As lubricants.
2	Petroleum jelly(Vaseline)	Medicines and cosmetics.
3	Grease	As lubricant.
4	Paraffin wax	Used in candles, boot polishing.
5	Pitch	Making road, water proof roofing.

4.3.3 Synthetic petrol (Synthetic liquid fuel)

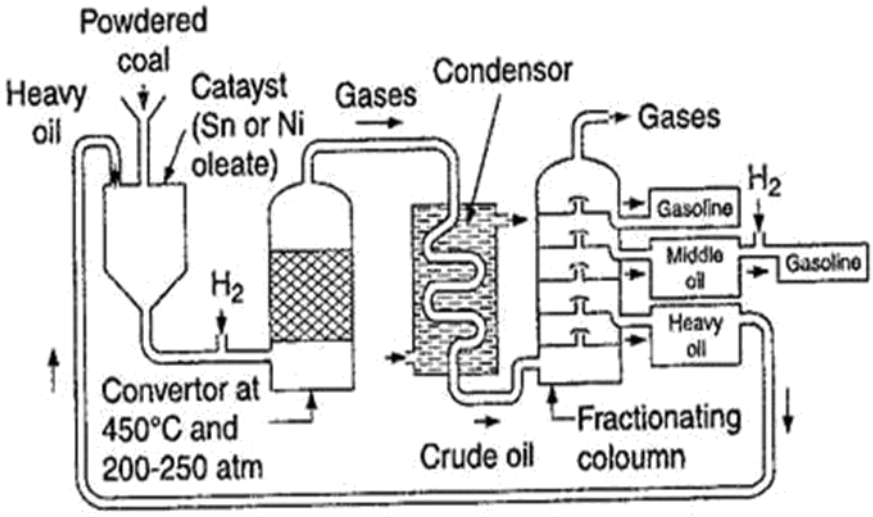
Hydrogenation of coal

Coal is hydrogen deficient compound. If coal is heated with hydrogen at high temperature and high pressure, it is converted into gasoline. **This process of preparation ofliquid fuel from solid coal** is called hydrogenation of coal.Two methods are available for hydrogenation of coal. They are

i) Bergius process (direct method)

ii) Fischer – Tropsch Method (indirect method) Bergius process

- In this process, the **finely powdered low ash coal, heavy oil**, and **catalyst powder** (**tin oleate or nickel oleate**) is mixed to form a **paste**.
- The paste is heated with hydrogen at a temperature of **400 -450˚C** and a pressure of **200 – 250 atmospheres for about 1.5 hours** in a convertor.



- During this process, hydrogen combines with coal to form **saturated higherhydrocarbons** which further decomposes to yield **low – boiling liquid hydrocarbons (crude oil) while passing through a condenser.**
- Crude oil obtained is subjected to fractional distillation to yield i) Gasoline ii) Middle oil iii) Heavy oil.
- The yield of gasoline is about 60% of coal used.
- The middle oil is further hydrogenated yield more gasoline.
- The heavy oil is recycled for making paste with fresh coal dust.

4.3.4 Knocking

Premature and instantaneous ignition of petrol-air mixture in an internal combustion engine leads to an explosive sound which is known as knocking.

Cause for knocking

- In an internal combustion engine, a mixture of gasoline vapour and air at 1:17 ratio is used as a fuel.
- Due the presence of some impurities in gasoline the rate of oxidation becomes high and the final portion of the fuel – air mixture ignites instantaneously, producing an explosive sound. This is known as knocking.

Effects of knocking

- Carbon deposits on the combustion chamber.
- Mechanical damage.

- Noise and roughness.
- Decreases the power output and efficiency.

Ways to reduce knocking

1. Adding Tetra – Ethyl Lead (TEL) as anti- knocking agent.
2. Adding aromatic phosphates as anti- knocking agent.
3. Retarding spark.

4.3.5 Octane number

- It expresses the knocking characteristics of petrol.
- Octane number is defined as **the percentage of iso-octane present in amixture of iso- octane and n-heptane.**

  Iso-octane has antiknock value (octane number) – 100 (less knocking).

  n-heptane has antiknock value (octane number) – 0 (more knocking)
- The octane number of fuel can be improved by,

  -blending petrol of high octane number with petrol of low octane number.

  -the addition of antiknock agents like tetra ethyl lead (TEL)

4.3.6 Cetane number

- The knocking property of diesel is expressed by cetane number.
- Cetane number is defined **as the percentage of cetane present in a mixture ofcetane and 2 – methyl naphthalene.**

  Cetane has cetane number = 100.So less knocking.

  2 – Methyl naphthalene has cetane number =0. So it shows high knocking.
- The cetane number of diesel oil can be increased by, adding additives called pre-ignition dopes. (e.g.) Ethyl nitrite, Iso – amyl nitrite etc.