Macromolecules

A polymer consists of a large number of simple monomeric structural units which are repeated over and over again to form a gaint molecule called a **macromolecules**

The simple unit is called the repeat unit.

In the Polymers,

$$----A-A-A-A----A-B-A-B-A-B---,$$

The repeat units are A and A−B.

The monomeric structural unit of Polyethylene is

$$-CH_2-CH_2-$$

For Natural rubber

$$\cdots-CH_2-\underset{\underset{CH_3}{|}}{C}=CH-CH_2-CH_2-\underset{\underset{CH_3}{|}}{C}=CH-CH_2-CH_2-\underset{\underset{CH_3}{|}}{C}=CH-CH_2-$$

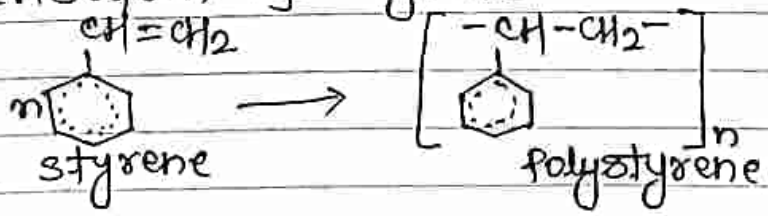
The repeat unit is $-CH_2-\underset{\underset{CH_3}{|}}{C}=CH-CH_2-$

e.g.

⇒ 1 Polyethylene ⇒ Polyethylene is obtained by the Polymerisation of ethylene.

$$\underset{\text{Ethylene}}{n\,CH_2=CH_2} \longrightarrow \underset{\text{Polyethylene}}{(-CH_2-CH_2-)_n}$$

2 Polystyrene ⇒ Polystyrene is obtained by the Polymerisation of styrene.



3 Polyvinyl chloride (PVC) ⇒ PVC is prepared from the monomer vinyl chloride which is obtained from the catalytic addition of hydrogen chloride to acetylene.

$$\underset{\text{Acetylene}}{CH \equiv CH} + HCl \xrightarrow{\text{Catalyst}} \underset{\text{Vinyl chloride}}{CH_2 = CH - Cl}$$

$$n\, CH_2 = \underset{Cl}{CH} \longrightarrow \left(-CH_2 - \underset{Cl}{CH} - \right)_n$$

Vinyl chloride PVC

4 Poly (methyl methacrylate) (PMMA) ⇒ PMMA is obtained by the polymerization of methyl methacrylate.

The monomer is prepared from acetone through the cyanohydrin reaction.

$$\underset{\text{Acetone}}{CH_3 - \overset{O}{\overset{\|}{C}} - CH_3} + HCN \longrightarrow \underset{\text{Acetone cyanohydrin}}{CH_3 - \underset{CH_3}{\overset{OH}{C}} - CN} \xrightarrow[CH_3OH]{H_2SO_4} \underset{\text{Methyl Methacrylate}}{CH_2 = \overset{CH_3}{C} - \overset{O}{\overset{\|}{C}} - O - CH_3} + (NH_4)_2SO_4$$

$$n \left[CH_2 = \underset{COOCH_3}{\overset{CH_3}{C}} \right] \longrightarrow \left[-CH_2 - \underset{COOCH_3}{\overset{CH_3}{C}} - \right]_n$$

Methyl Methacrylate PMMA

⇒ Polyethylene

- LDPE (Low-density Polyethylene)
- HDPE (High-density Polyethylene)

HDPE ⟹ HDPE consists of linear unbranched chain.

LDPE ⇓ LDPE consists of several short and long Branches.

$$\cdots - CH_2 - \underset{\substack{CH_2 \\ CH_2 \\ CH_2 \\ \vdots}}{CH} - CH_2 - CH_2 - CH_2 - \underset{\substack{CH_2 \\ CH_2 \\ \vdots}}{CH} - CH_2 - CH_2 - \underset{\substack{CH_2 \\ CH_2 \\ CH_2 \\ \vdots}}{CH} - CH_2 - CH_2 - \cdots$$

Since HDPE is almost unbranched, its chain can be close-packed in the solid state. Such close packing would not be possible in the case of branched LDPE. Thats why the former polymer has higher density than the latter.

⇒ HDPE is stronger and chemically more inert than LDPE.

⇒ Polystyrene is used for making bottles and Jars, refrigerator linings and films and frames.

⇒ PVC is used in making Phonograph records because it is a tough and rigid material.

⇒ <u>Degree of Polymerization</u>

The degree of Polymerization represents the no. of structural or monomeric units contained in a polymer.

It is generally designated by the symbol P.

The molar mass M of the Polymer is related to P by equation

$$P = \frac{M}{m}$$

Where m = Molar Mass of the monomeric unit

Thus,

$$\boxed{M = mP}$$