M.Sc. Sem. I
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D(P)

Macromolecules

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

The simple unit is called the repeat unit.

In the Polymers,

$$\cdots\text{-A-A-A-A-}\cdots\text{A-B-A-B-A-B-}\cdots,$$

The repeat units are A and A–B.

The monomeric structural unit of Polyethylene is

$$-CH_2-CH_2-$$

For Natural rubber

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

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

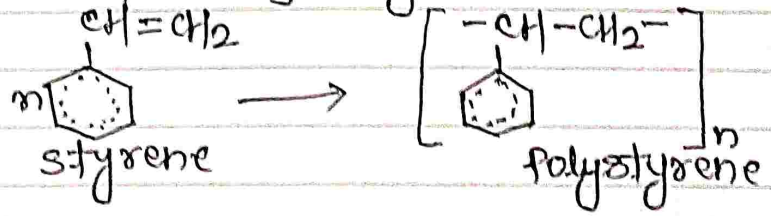
e.g.

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

$$n\,CH_2=CH_2 \longrightarrow (-CH_2-CH_2-)_n$$

Ethylene → Polyethylene

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.

Teacher's Signature :

$CH \equiv CH + HCl \xrightarrow{\text{Catalyst}} CH_2 = CH - Cl$

Acetylene — Vinyl chloride

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

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.

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

Acetone — Acetone cyanohydrin — Methyl Methacrylate

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

Methyl Methacrylate — PMMA

⟹ Polyethylene

- LDPE (Low-density Polyethylene) ⇓
  - LDPE consists of several short and long branches.
- HDPE (High-density Polyethylene) ⟹ HDPE consists of linear unbranched chain.

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

Teacher's Signature :

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.

⇒ Degree of Polymerization

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,

$$\boxed{M = mP}$$