

Polymers and polymerization

Polymers- Polymers are the long molecule formed by repetitive addition of building blocks units called monomers.

Polymerization-The chemical process leading to the formation of polymer is known as polymerization.

Degree of polymerization-The no of monomeric units contained in a polymer is known as Degree of polymerization.

Functionality- It denotes the no of bonding sites in a polymer.

Classification of polymers

a. **Copolymers**- Polymers which are obtained by repeated combination of two or more type of monomers.

Example-

1. Nylon -66 is copolymer of hexamethylenediamine and adipic acid
2. Buna-S is copolymer of 1-3 butadiene and styrene
3. Terylene is copolymer of ethylene glycol and terephthalic acid

b. **Homopolymer** - Polymers which are obtained by repeated combination of only one type of monomers.

Example-

1. Polythene is $(-\text{CH}_2=\text{CH}_2-)$ is a homopolymer of ethylene
2. PVC is homopolymer of vinyl chloride
3. Polypropylene is homopolymer of propylene $(\text{CH}_3-\text{CH}=\text{CH}_2-)$

2. Based on tacticity-Tacticity means orientation of side groups around the main back bone chain in three dimensional structure of polymers.

1. **Isotactic**-Side groups are all on same side.

2. **Syndiotactic**-Arrangement of side groups are on alternative fashion.

3. **Atactic**-Arrangement of side groups is at random around the same chain.

3) Based on origin

a. Natural-Found in nature

Example-Starch, cellulose

b. Semi-synthetic-modification in natural products.

Example-Nitro-cellulose

c. Synthetic-Formed artificially.

Example-Bakelite

4) Based upon structure-

a. Linear-monomers linked in straight line.

Example-PVC

b. Branched-monomers linked two dimensionally.

Example-Glycogen

c. Crosslinked-three dimensional polymer.

Example-Bakelite

5) Based on intermolecular force of attraction.

a. **Elastomers**-Having weak intermolecular force of attraction. amorphous and high elasticity.

Example-natural and vulcanised rubber

b. **Synthetic fibers**-Having strong intermolecular force of attraction like H-bonding or dipole-dipole, between polymer chain.

High tensile strength, least elasticity,

Molecules are strong, thin and thread like, so they are closely packed, having high M.P. and low solubility.

Example-Nylon-66

c. **Plastics**-They are glassy and hard material, with high thermal stability. They are of two types-

Plastics

1) **Thermoplasts**-Moderate intermolecular force of attraction,

These are linear polymers(no cross links)

Hard but soften on heating and again hard on cooling.This property can be repeated without change in their property.

Example-polythene,polystyrene

Plastisizers-These are the substances which are added in certain plastics to make them soft on heating.

Example-Di-n is added in butylephthalate PVC to make it soft and workable.

2) **Thermosets**-In these polymers extensive crosslinks are formed between polymer chain on heating,so they become infusible ,i.e.cannot be moulded again.

Example-Phenol formaldehyde

Urea formaldehyde

Anelinealdehyde Resin

6) On the basis of their configuration.

a. Tactic polymers-successive asymmetric carbon shows same configuration along the planer zigzag polymer main chain. It is of two types,

Isotactic-all R-groups are on the same side of the chain.

Syndiotactic-All R-groups located alternatively

Atactic-R groups on successive asymmetric carbon are randomly distributed above and below the planer zigzag polymer main chain.

7) On the basis of chemical structure-

a. Organic polymers-Example-PVC

b. Inorganic polymers-

Example-glass, silicon, rubber


8) On the basis of type of atoms in chain backbone.

a. Homochain-Backbone made by same type of atoms.

Example-PVC

b. Heterochain-Backbone made by different type of atoms.

Example-silicon polymers



8) On the basis of molecular weight of different molecules present in the polymers;

a. Monodispersed system-Each molecule has same molecular weight.

b. Polydispersed system-Each molecule has different molecular weight.

9) On the basis of synthesis-

Addition polymers-Formed by combination of simple molecules without elimination of by-products.

$$M(\text{polymer}) = n * M(\text{monomers})$$

Example-Polythene

Condensation polymers-Formed by combination of simple molecules with the elimination of by-product like water, NH_3 etc

Example-Urea formaldehyde

10) **On the basis of mechanism-**

a. **Chain growth mechanism**-In this process the polymers are formed by successive addition of the monomeric units to the growing chain having a reaction intermediate(carbocation,carboanion,free radical)

Example-Teflon,PVC,polystyrene

b. **Step growth polymerization**-The polymers formed through a series of stepwise condensation reaction involving bifunctional or polyfunctional monomers are called Step growth polymers.It proceeds by stepwise fashion.

Monomers → Dimers → Trimers → oligomers → polymers

Example-polyesters