

Unit 15

Polymers

- Polymers** are macro-sized, high molecular mass compounds, formed by the combination of a large number of simple molecules or repeating units. These simple molecules or repeating units which combine to give polymers are called **monomers**. The process of joining together of a large number of the monomers is termed as **polymerization**. A polymer formed from one type of monomers is called **homopolymer**, e.g., polyethene, PVC, polyacrylonitrile, etc. A polymer formed from two or more different monomers is called **copolymer**, e.g., Nylon-6,6, polyester, bakelite, etc. The number of times a monomer unit is repeated in a polymer, is called its degree of polymerization.

CLASSIFICATION OF POLYMERS

Classification based on

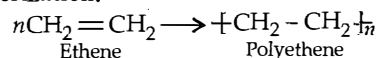
Source/Origin	Structure	Molecular forces	Synthesis
1. Natural polymers	1. Linear polymers	1. Elastomers	1. Addition polymers
2. Synthetic polymers	2. Branched chain polymers.	2. Fibres	2. Condensation polymers
3. Semi-synthetic polymers	3. Cross-linked polymers	3. Thermo-plastics	
		4. Thermosetting	

- Natural polymers** are substances of natural origin and are mainly found in plants and animals, e.g., starch, cellulose, proteins, etc.
- Synthetic polymers** are those polymers which are prepared in the laboratories, they are also called man-made polymers, e.g., teflon, terylene, synthetic rubber, etc.
- Semi-synthetic polymers** are mostly derived from naturally occurring polymers by chemical modifications, e.g., vulcanised rubber, cellulose nitrate, etc.
- Linear polymers** are those polymers in which monomers are linked together to form linear chains, e.g., polyethene, polyester, nylon, etc.
- Branched chain polymers** are those in which the monomers are joined to form long chains or branches of different lengths, e.g., glycogen, starch, etc.
- Cross-linked polymers** are those in which the monomer units are cross-linked together to form a three-dimensional network. They are also called three-dimensional network polymers, e.g., bakelite, melamine, etc.

- Elastomers** are polymers having very weak intermolecular forces between the polymer chains. The weak forces permit the polymer to be stretched. Elastomers, thus, possess elastic character, e.g., vulcanised rubber.
- Fibres** are polymers which have strong inter-molecular forces between the chains. These are either hydrogen bonds or dipole-dipole interactions, e.g., Nylon-6,6.
- Thermoplastics** are those polymers in which the intermolecular forces of attraction are intermediate between those of elastomers and fibres. These polymers do not have any cross-links between the chains, they can be easily moulded on heating, i.e., thermoplastics soften on heating and become hard on cooling, e.g., polyethene, polystyrene, PVC, etc.
- Thermosetting polymers** have extensive cross links formed between polymer chains on heating. They undergo the permanent change on heating, e.g., bakelite, melamine, etc.

METHODS OF POLYMERISATION

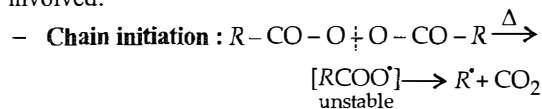
- Addition or Chain growth polymerisation** : A polymer formed by direct addition of repeated monomers without the elimination of by product molecules is called **addition polymer** and the phenomenon is known as **addition polymerization**.



Mechanism of chain growth polymerization involves a series of reactions, each of which consumes a reaction particle and produces a similar one. These reactive particles may be free radicals or cations or anions to which monomers get added by a chain reaction. It is an important reaction of all kinds of compounds having C=C bond.

Chain growth polymerization follows two basic mechanisms :

- Free-radical mechanism** : This type of polymerization is initiated by organic peroxide or other reagents which decompose to give free radicals. Following steps are involved.



- **Chain propagation** :

