
CBSE Class-12 Chemistry Quick Revision Notes

Chapter-15: Polymers

- **Polymers:**

Polymers are high molecular mass substance consisting of large number of repeating structural units. As polymers are single, giant molecules i.e. big size molecules, they are also called macromolecules

- **Monomers:**

The simple molecules which combine to form polymers are called monomers.

- **Polymerization:**

The process of formation of polymers from respective monomers is called polymerization

- **Classification of Polymers:**

A. Based on source of availability, it is classified into

- a) Natural polymers: Polymers obtained from nature, mostly plants and animals. Examples - Cellulose, starch, etc.
- b) Synthetic polymers: Polymers prepared in laboratory. Examples - Teflon, Nylon 6,6 , Synthetic rubber (Buna - S) etc.
- c) Semi synthetic polymers: Polymers derived from naturally occurring polymers by carrying out chemical modifications. Examples - Rayon (cellulose acetate), cellulose nitrate, etc.

B. Based on the structure of polymer, it is classified into

- a) Linear polymers: Polymer consists of long and straight chains. Examples - High density polythene, polyvinyl chloride, etc.
- b) Branched chain polymers: Polymers contains linear chains having some branches. Examples - Low density polythene
- c) Cross linked or network polymers: Polymers in which monomer units are cross linked together to form a 3 dimensional network polymers. Examples - Bakelite, melamine, etc.

C. Based on the mode of polymerisation, it is classified into

I. Addition polymers: Polymers are formed by the repeated addition of monomers with double and triple bonds. It is further classified into,

Homopolymers: Polymers formed by the polymerisation of a single monomeric species. Examples - Polythene, Polystyrene.

Copolymers: Polymers formed by addition polymerisation of two different monomers. Examples - Buna-S, Buna -N.

II. Condensation polymers: Polymers formed by repeated condensation reaction between two different bi-functional or tri-functional monomeric units with elimination of simple molecules. Examples - Nylon 6, 6, Nylon 6.

D. Based on Molecular forces, it is classified into

- a) Elastomers: Polymer chains are held together by weakest intermolecular forces. Polymers are rubber – like solids with elastic properties. Examples - Buna – S,

Buna – N, Neoprene

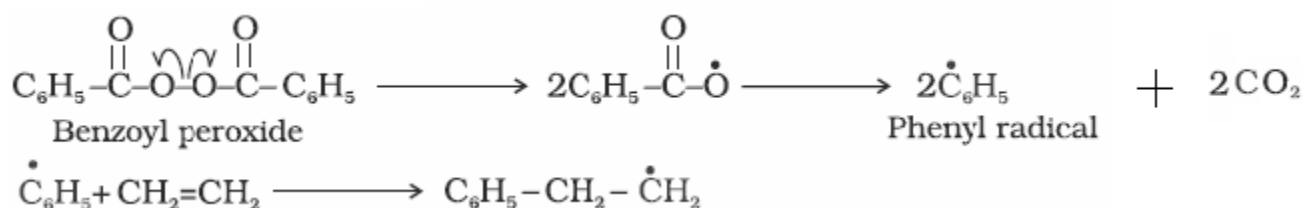
- b) Fibre: Polymers have strong intermolecular force like hydrogen bonding. Fibres are the thread forming solids which possess high tensile strength and high modulus. Examples - Nylon 6, 6, Polyesters.
- c) Thermoplastic polymers: Polymers are held by intermolecular forces which are in between those of elastomers and fibres. These polymers are capable of repeated softening on heating and hardening on cooling. Examples - Polythene, Polystyrene.
- d) Thermosetting polymers: Polymers are cross linked or heavily branched molecules, which on heating undergo extensive cross linking in moulds and eventually undergo a permanent change. Examples - Bakelite, Urea-formaldehyde resins

• **Addition Polymerisation or Chain Growth Polymerisation:**

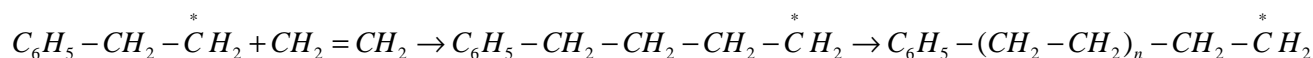
Addition polymerisation is called chain growth polymerisation because it takes place through stages leading to increase in chain length and each stage produces reactive intermediates for use in next stage of the growth of chain. Most common mechanism for addition polymerisation reactions is free radical mechanism

• **Steps involved in addition polymerisation:**

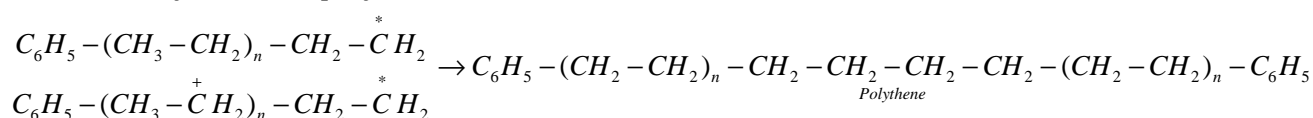
Step 1: Chain initiating step: Organic peroxides undergo homolytic fission to form free radicals which acts as initiator. Initiator adds to C-C double bond of an alkene molecule to form a new free radical



Step 2: Chain propagating step: Free radicals formed by homolytic cleavage adds to a double bond of monomer to form a larger free radical. Radical formed adds to another alkene molecule to form a larger free radical. This process continues until the radical is destroyed. These steps are called propagation steps.

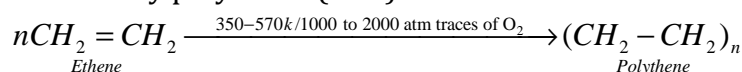


Step 3: Chain terminating step: For termination of the long chain, free radicals combine in different ways to form polythene. One mode of termination of chain is shown as under:



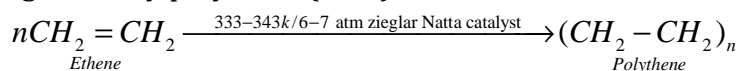
• **Important Addition Polymers:**

a) Low density polythene (LDP)



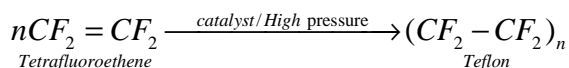
It is used in the insulation of electricity carrying wires and manufacture of squeeze bottles, toys and flexible pipes

b) High density polythene(HDP)



It is used for manufacturing buckets, dustbins, bottles, pipes, etc.

c) Polytetrafluoroethene (Teflon)



It is used in making oil seals and gaskets and also used for non – stick surface coated utensils

d) Polyacrylonitrile



It is used as a substitute for wool in making commercial fibres as orlon or acrilan.

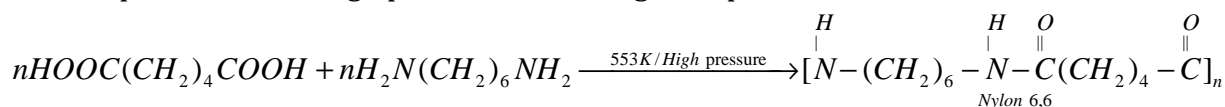
- Condensation Polymerisation or Step Growth polymerization:

Polymerisation generally involves a repetitive condensation reaction between two bi-functional monomers. In condensation reactions, the product of each step is again a bi-functional species and the sequence of condensation goes on. Since, each step produces a distinct functionalized species and is independent of each other, this process is also called as step growth polymerisation.

- Condensation Polymers:

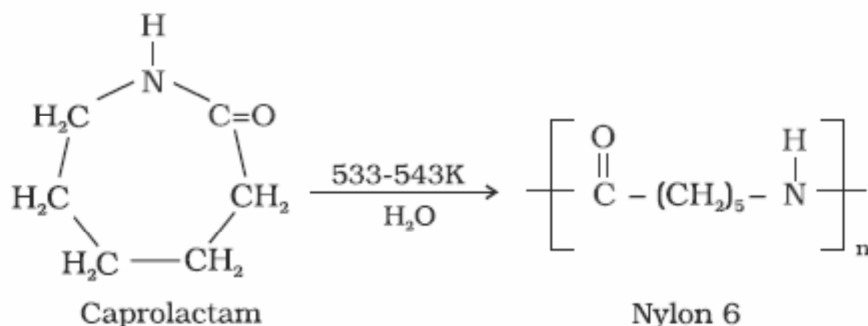
1. Polyamides: Polymers possess amide linkage (-CONH-) in chain. These polymers are popularly known as nylons. Examples:

(a) Nylon 6, 6: It is prepared by the condensation polymerisation of hexamethylenediamine with adipic acid under high pressure and at high temperature.



It is used in making sheets, bristles for brushes and in textile industry.

(b) Nylon 6: It is obtained by heating caprolactam with water at a high temperature

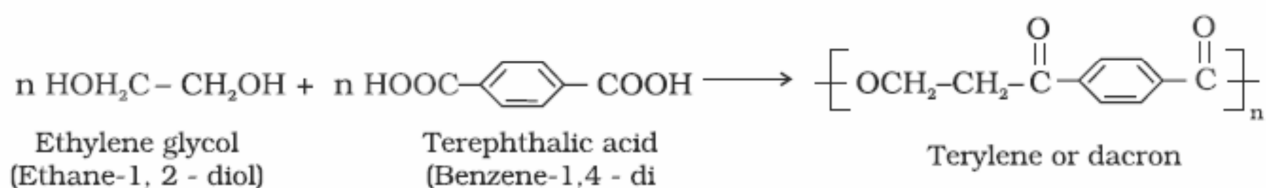


It is used for the manufacture of tyre cords, fabrics and ropes.

2. Polyesters: These are the polycondensation products of dicarboxylic acids and diols

Example: Terylene or Dacron

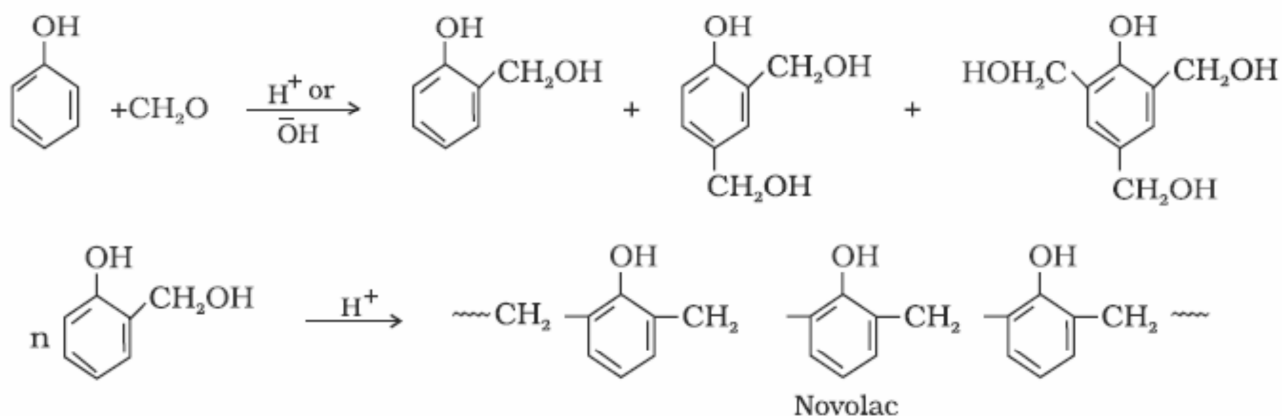
- a) Terylene or Dacron: It is manufactured by heating a mixture of ethylene glycol and terephthalic acid at 420 to 460 K in the presence of zinc acetate-antimony trioxide catalyst.



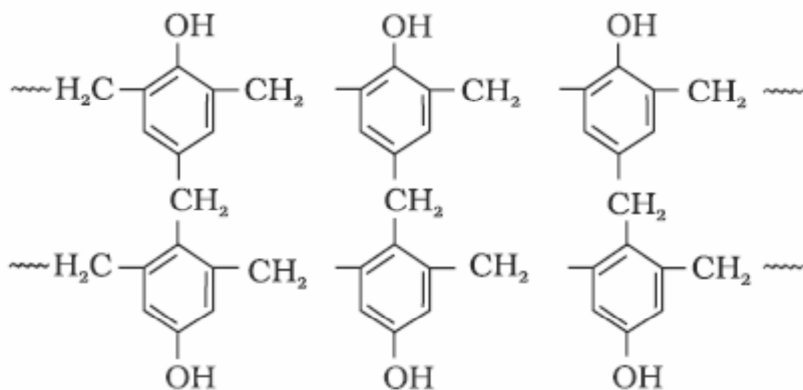
It is used to crease resistant and is used in blending with cotton and wool fibres and also as glass reinforcing materials in safety helmets, etc.

3. Phenol - formaldehyde polymer (Bakelite and related polymers)

- a) Bakelite: These are obtained by the condensation reaction of phenol with formaldehyde in the presence of either an acid or a base catalyst. The initial product could be a linear product – Novolac used in paints.

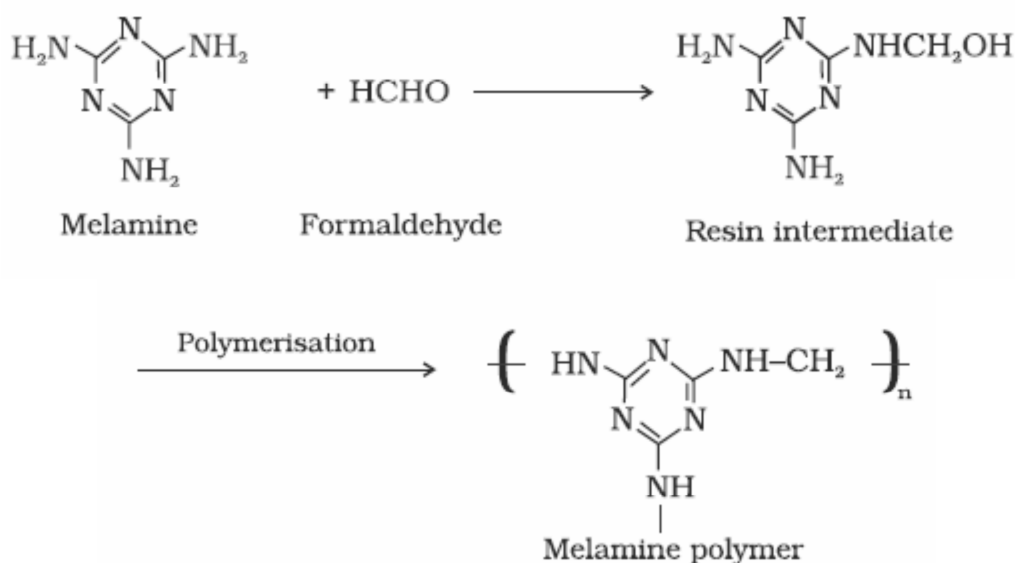


- b) Novolac on heating with formaldehyde forms Bakelite



It is used for making combs, phonograph records, electrical switches and handles of various utensils

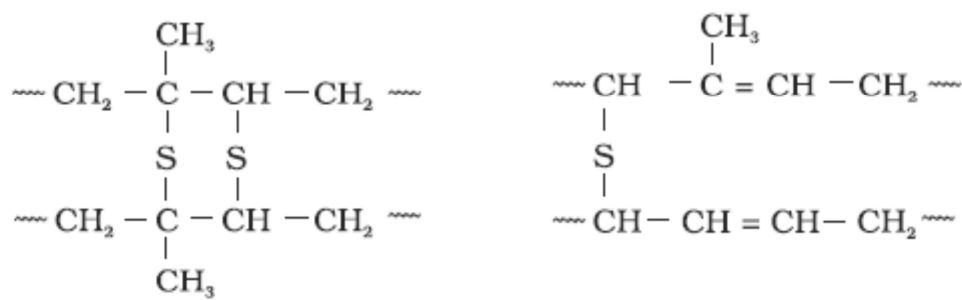
4. Melamine – formaldehyde polymer: Melamine formaldehyde polymer is formed by the condensation polymerisation of melamine and formaldehyde



It is used in the manufacture of unbreakable crockery

- Vulcanisation of rubber:**

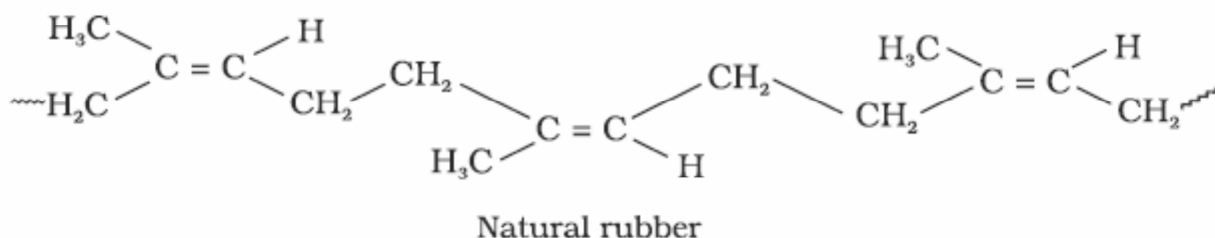
The process of heating a mixture of raw rubber with sulphur and an appropriate additive in a temperature range between 373 K to 415 K to improve upon physical properties like elasticity, strength etc.



Sulphur cross links in vulcanised rubber

- Classification of rubber:**

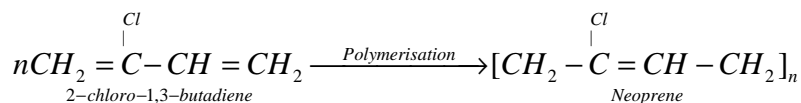
- Natural rubber: Natural rubber is a linear polymer of isoprene (2-methyl-1, 3-butadiene) and is also called as *cis* - 1, 4 - polyisoprene.



- Synthetic rubber: Synthetic rubbers are either homopolymers of 1, 3 - butadiene derivatives or copolymers of 1, 3 - butadiene or its derivatives with another unsaturated monomer.

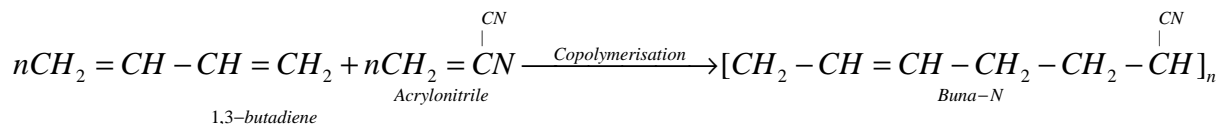
- Examples of synthetic rubber:

A) Neoprene or polychloroprene



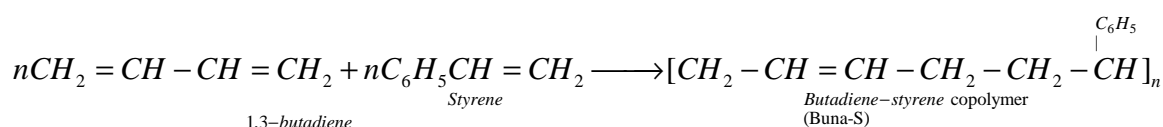
It is used for manufacturing conveyor belts, gaskets and hoses

B) Buna - N



It is used in making oil seals, tank lining, etc. because it is resistant to the action of petrol, lubricating oil and organic solvents

C) Buna - S

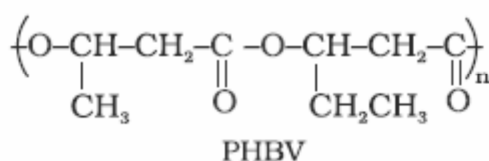
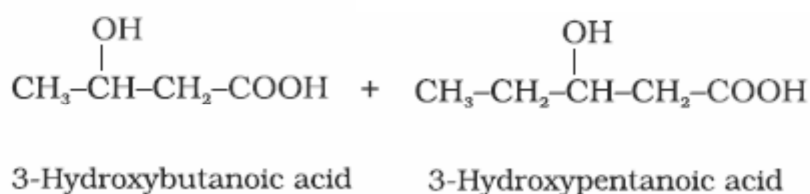


- Biodegradable Polymers: Polymers which are degraded by microorganisms within a suitable period so that biodegradable polymers and their degraded products do not cause any serious effects on environment.

- Examples of biodegradable polymer:

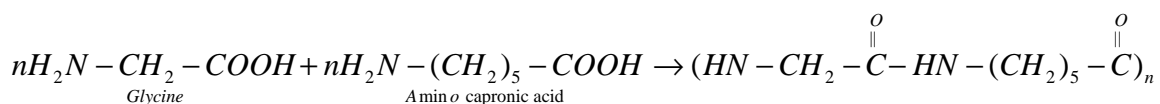
a) Poly - β -hydroxybutyrate - co- β -hydroxy valerate (PHBV):

It is obtained by the copolymerisation of 3-hydroxybutanoic acid and 3 - hydroxypentanoic acid



It is used in speciality packaging, orthopaedic devices and in controlled release of drugs.

- b) Nylon 2-nylon 6: It is an alternating polyamide copolymer of glycine($\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$) and amino caproic acid ($\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$)



- Commercially important polymers along with their structures and uses:

Name of Polymer		Structure	Uses
	Propene	$\begin{array}{c} CH_3 \\ \\ (CH_2-CH)_n \end{array}$	Manufacture of ropes, toys, pipes, fibres, etc.
Glyptal	(a) Ethylene glycol Manufacture of (b) Phthalic acid	$\left(OCH_2-CH_2OOC \begin{array}{c} \diagup \diagdown \\ \text{C}_6\text{H}_4 \end{array} CO \right)_n$	Manufacture of paints and lacquers
	Styrene	$\begin{array}{c} C_6H_5 \\ \\ (CH_2-CH)_n \end{array}$	As insulator, wrapping material, manufacture of toys, radio and television cabinets
Polyvinyl chloride (PVC)		$\begin{array}{c} Cl \\ \\ (CH_2-CH)_n \end{array}$	Manufacture of rain coats, hand bags, vinyl flooring, water pipes