




# Polymers



# Polymers

- **Polymers and Polymerisation**
- **Polymers are defined as very large molecules having high molecular mass. These are formed by joining of repeating structural units called monomers on a large scale. The monomer units are linked to each other by covalent bonds. The process of formation of polymer from respective monomers is called polymerisation.**
- **Classification of Polymers**
- **On the Basis of Source**
  - (i) Natural polymers** These polymers are found in plants and animals eg, proteins, cellulose, starch, resins and rubber etc.
  - (ii) Semi-synthetic polymers** These polymers are derived from natural polymers by chemical methods. eg, cellulose acetate (rayon), cellulose nitrate.



**(iii) Synthetic polymers** These are man made polymers. eg, plastic (polythene), synthetic fibres, buna-S etc.

- **On the Basis of Structure**

- (i) Linear polymers** Polymers consist of long and straight chains, eg, high density polythene, polyvinyl chloride etc.

- (ii) Branched chain polymers** Polymers consist of linear chains with some branches eg, low density polythene.

- (iii) Cross linked or network polymers** eg, bakelite, melamine etc.

- **On the Basis of Mode of Polymerisation**

- (i) Addition polymers or chain growth polymers** These are formed by addition reactions between monomer molecules having multiple bonds eg, polythene SBR.

- These are the product of addition polymerisation or chain growth polymerisation.

- (ii) Condensation polymers or step growth polymers** These are the products of condensation polymerisation. eg, terylene, nylon-6 6, nylon-6 etc.



- **On the Basis of Monomers involved**

- (i) **Homopolymers** These are formed by polymerisation of single monomeric species. **eg, polythene, polypropene etc.**

- (ii) **Copolymers** These are formed by polymerisation of two or more different monomer units. **eg, buna-S, buna-N etc.**

- **On the Basis of Molecular Forces**

- (i) **Elastomers** These are rubber-like solids with elastic properties. They have weak inter molecular forces. **eg, buna-S, buna-N, neoprene etc.**

- (ii) **Fibres** Fibres are the thread forming solids and have intermolecular hydrogen bonding. **eg, nylon 6 6, polyesters (terylene) etc.**

- (iii) **Thermoplastic polymers** These polymers possess intermolecular forces of attraction, intermediate between elastomers and fibres **eg, polythene, polystyrene, polyvinyls etc.**

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- **(iv) Thermosetting polymers** These polymers are cross linked or heavily branched molecules eg, bakelite, urea-formaldehyde resins etc.

- **Examples of Addition**

- **Homopolymers**

- (i) Polymer Polytetrafluoroethene (Teflon) Monomer**  
**Tetrafluoroethene ( $\text{CF}_2 = \text{CF}_2$ )**

- Uses** For making oil seals and gaskets, non stick surface coated utensils.

- (ii) Polymer Polythene (Polyethylene)**  
**Monomer Ethene ( $\text{CH}_2 = \text{CH}_2$ )**

- Polythene is of two types, low density polythene and high density polythene.

- (iii) Polymer Poly acrylonitrile**  
**Monomer Acrylonitrile ( $\text{CH}_2 = \text{CHCN}$ )**

- Uses:** Substitute for wool in making commercial fibres as orlon or acrilan.



**(iv) Polymer Polypropene.**

**Monomer Propene**

**Uses** In manufacture of ropes, toys, pipes, fibres etc.

**(v) Polymer Polystyrene.**

**Monomer Styrene, ( $\text{CH}_2 = \text{CH}-\text{C}_6\text{H}_5$ )**

**Uses:** As insulator, wrapping material, manufacture of toys, radio and television cabinets.

**(vi) Polymer Polyvinyl chloride (PVC)**

**Monomer Vinyl chloride ( $\text{CH}_2 = \text{CH}-\text{Cl}$ )**

**Uses :** In manufacture of rain coats, hand bags, vinyl flooring, water pipes.

**(vii) Polymer Natural rubber or polyisoprene liner polymer**

**Monomer Isoprene (2-methyl-1,3-butadiene)**

- Natural rubber can be stretched like a spring and exhibits elastic properties.

**(viii) Polymer Neoprene (synthetic rubber)**

**Monomer Chloroprone (2-chloro-1, 3-butadiene)**



**Uses:** In manufacture of conveyor belts, gaskets and hoses.

- **Examples of Addition Copolymers**

- (i) Polymer Butadiene-styrene (Buna-S)**

**Monomers** 1,3-butadiene ( $\text{CH}_2 = \text{CH}-\text{CH} = \text{CH}_2$ ) and styrene ( $\text{C}_6\text{H}_5-\text{CH} = \text{CH}_2$ ).

**Uses :** Buna-S is quite tough and is a good substitute for natural rubber. It is used for the manufacture of auto tyres, floor tiles, footwear components, cable insulation etc.

- (ii) Polymer Buna-N**

**Monomers** 1,3-butadiene ( $\text{CH}_2 = \text{CH}-\text{CH}=\text{CH}_2$ ) and acrylonitrile ( $\text{CH}_2=\text{CHCN}$ ).

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



## ▪ Examples of Condensation Copolymers

### (i) Polymer Nylon 6 6

**Monomers** Adipic acid

$[\text{HOOC}(\text{CH}_2)_4\text{COOH}]$  and hexamethylene diamine

$[\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2]$

**Uses:** Nylon 6 6 is used in making sheets, bristles for brushes and in textile industry.

### (ii) Polymer Terylene or dacron

**Monomers** Terephthalic acid and ethylene glycol

**Uses:** Blending with cotton and wool fibres and also as glass reinforcing materials in safety helmets etc.

### (iii) Polymer Phenol-formaldehyde polymer (bakelite)

**Monomers** Phenol  $[\text{C}_6\text{H}_5\text{OH}]$  and formaldehyde (HCHO)

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



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- (iv) Polymer**            **Melamine-formaldehyde polymer**  
**Monomer**            **Melamine and formaldehyde (HCHO).**  
**Uses**                **In manufacture of unbreakable crockery.**
- (v) Polymer**            **Urea-formaldehyde resin**  
**Monomers**           **Urea (NH<sub>2</sub>CONH<sub>2</sub>) and formaldehyde (HCHO)**  
**Uses**                **For making unbreakable cups and laminated sheets.**
- (vi) Polymer**           **Glyptal (alkyd resin)**  
**Monomers**           **Ethylene glycol and phthalic acid**  
**Uses**                **In manufacture of paints and lacquers.**
- **Examples of Condensation**  
**Homopolymers**  
**Polymer**   **Nylon-6.**  
**Monomer** **Caprolactum**  
**Uses**       **Nylon 6 is used for the manufacture of tyre cords, fabrics and ropes.**



- **Vulcanisation of Rubber**

- **Natural rubber becomes soft at high temperature (7335 K) and brittle at low temperature (<283 K). It has high water absorbing capacity. It has high water absorbing capacity. It is easily attacked by oxidising agents and soluble in non-polar solvents.**
- **To improve these properties, vulcanisation of rubber is carried out. The process involves the heating of raw rubber with sulphur and appropriate additive at a temperature 373–415K. Sulphur forms cross links at reactive sites of double bonds and makes the rubber stiffened.**
- **Biodegradable Polymers**
  - (i) **Polymer Poly  $\beta$ -hydroxybutyrate-co-  $\beta$ -hydroxy valerate(PHBV)**  
**Monomers 3-hydroxy butanoic acid and 3-hydroxy pentanoic acid**



**(ii) Polymer Nylon-2-nylon-6**

**Monomers Glycine ( $\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$ ) and amino caproic acid  
[ $\text{H}_2\text{N}-(\text{CH}_2)_5\text{COOH}$ ]**



# Check your Knowledge

**Q . Natural rubber is a polymer of**

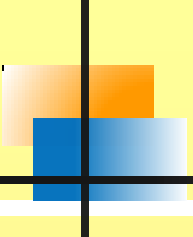
- (a) Butadiene**
- (b) Ethyne**
- (c) Styrene**
- (d) Isoprene**

**Ans (d)**

**Q. Which of the following polymers is prepared by condensation polymerization ?**

- (a) Styrene**
- (b) Nylon-66**
- (c) Teflon**
- (d) Rubber**

**Ans (b)**



**Q . Which percentage of sulphur is used in the vulcanization of rubber?**

- (a) 5%**
- (b) 3%**
- (c) 30%**
- (d) 55%**

**Ans (a)**

**Q. Chain transfer reagent is**

- (a)  $\text{CCl}_4$**
- (b)  $\text{CH}_4$**
- (c)  $\text{O}_2$**
- (d)  $\text{H}_2$**

**Ans (a)**



**Q . Bakelite is obtained from phenol by reaction with**

**(a) HCHO**

**(b)  $(\text{CH}_2\text{OH})_2$**

**(c)  $\text{CH}_3\text{CHO}$**

**(d)  $\text{CH}_3\text{COCH}_3$**

**And (a)**

**Q. The monomer of Buna-S rubber are**

**(a) Styrene and Butadiene**

**(b) Isoprene and butadiene**

**(c) Vinyl chloride and sulphur**

**(d) Butadiene**

**Ans (a)**



**Q . Which one of the following statements is not true ?**

- (a) Buna –S is a copolymer of butadiene and styrene.**
- (b) Natural rubber is a 1,4-polymer of isoprene.**
- (c) In vulcanization, the formation of sulphur bridges between different chains makes rubber harder and stronger.**
- (d) Natural rubber has the trans-configuration at every double bond.**

**Ans (d)**



**Thank you .**