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Review on Polymer types, properties and application

Harpreet kaur
Assistant Professor,
Guru kashi University, Talwandi Sabo, Bathinda.

Abstract : Polymer is a long chain molecule that is composed of multiples of simpler units called monomers. Monomers are large number of repeating units of identical structure. Polymers can be natural or synthetic .Natural polymers are silk, cotton, wool etc .Synthetic polymers include polyethylene, nylon etc. Polymers are used in various industries. Nylon and polyester are synthetic fibres. Natural fibres are cotton, wool and silk.

Natural rubber is natural elastomer. Nitrile and butyl rubber are synthetic elastomers. Polymeric delivery systems are used to achieve controlled or sustained drug delivery. Methyl cellulose and Chitosan polymers are used for drug delivery.

Index Terms - Polymer, natural polymers, and synthetic polymers.

I. INTRODUCTION

The meaning of word "polymer" is "many parts". Polymer is composed of multiples of simpler units called monomers. Polymers are classified into natural polymers and synthetic polymers. Natural polymers are derived from nature. Synthetic polymers are produced by synthetic routes. In vulcanization process, transformation of sticky latex of natural rubber to useful elastomer takes place for tyre use.[1]

Polymers are used in many industrial applications.Polyamides such as nylon, Polyacrylonitriles are used in various industrial applications. Polyolefins such as polyethylene , poly vinyl chloride and polypropylene have industrial applications. Elastomers are capable of recovering their shape after being stretched to great extents. Butadiene based elastomers polyisoprene, polychloroprene are used in various industries.Cellulose is a natural polymer composed of glucose units. Cellulose is obtained from natural resources such as wood.[2]Starch is also referred as a polysaccharide, because it is a polymer of the monosaccharideglucose. Starch molecules include amylose and amylopectin are present in plants.

2. PROPERTIES

The most basic property of a polymer is the identity of its constituent monomers. A second set of properties, known as microstructure, essentially describe the arrangement of these monomers within the polymer at the scale of single chain.[3] how the bulk polymer interacts with other chemicals and solvents at macro scale .[4,5]

2.1 Chemical Property

The attractive forces between polymer chains play a large part in determining polymersProperties. The intermolecular forces in polymers can be affected by dipoles in the monomer units.

2.2 Mechanical properties.

The tensile strength of a material maximum stress the material can bear before permanent deformation ,when it is allowed to be stretched or pulled.[6]

2.3 Elasticity

Polymer chains are stretched and then return to their original form when force is removed. All polymer except glassy or partially crystalline states show the property of high elasticity.

3. CLASSIFICATION [7]

3.1 Classification based on the source of origin, which is classified in two types:

- **Natural polymers:**

Polymers derived from plants or animal are called natural polymers. Examples are wool, cotton, silk etc.

- **Synthetic Polymers**

Synthetic polymers are manmade polymers. Nylon, terylene, polyethene, polystyrene, nylon, pvc, backlite, Teflon etc.

3.2 The classifications based on the structure are three types of polymers as follows:

- **Linear polymers**:

  Monomers are linked with each other and form a long straight chain. These chains have no any side chains. Examples are Polyethene, PVC, Nylons, polyesters etc.
- **Branched polymers:**

The polymers made up of linear chains with smaller chains as branches of main chain are called Branched polymers. Example is polypropylene.

- **Network or cross linked polymers**:

A polymer in which long chain molecules are attached to each other forming a three dimensional network is called cross linked polymers. Examples are polyurethanes, epoxy resins.

3.3 The classifications based on polymerization process are two types as follows:

- **Addition polymers:**

The polymers formed by the addition of monomers without generation of by products are called addition polymers. Addition polymers include polystyrene, polyethylene, polyacrylates etc.

- **Condensation polymers:**

They are formed by the combination of two monomers by release of small molecules like water, alcohol etc. Examples are Nylons, polyesters, polyurethanes epoxies etc.

3.4 The classification based on molecular forces: tensile strength, toughness, elasticity are mechanical properties of polymers. These properties depend upon intermolecular forces like van-der Waals forces and hydrogen bonding.

- **Elastomers:**

These are polymers with weak intermolecular forces .Elastomers are polymers that are very elastic. Examples are natural rubber ,neoprene and polybutadiene .

- **Fibers:**

Fibres are thin, long flexible thread like structures. Natural fibres are obtained from nature. Examples are cotton, silk and wool etc. Synthetic fibres are manmade examples are rayon, nylon, acrylic etc.

- **Thermoplastic polymers:**

Thermoplastic is type of polymer that can be moulded or reshaped by heating. Examples of Thermoplastics include polyethylene, polypropylene, polyvinyl chloride, polystyrene and nylon etc.

- **Thermosetting polymers:**

Thermosetting polymers when moulded once cannot be softened by heating. . Examples are Bakelite and melamine.

3.5 The classification based on the homogeneity of Polymers:

- **Homopolymers :** Homopolymers consists of only one type of repeating unit.
- **Copolymers:** Copolymers are polymers consisting of more than one type of repeating unit.

3.6 The classification based on growth polymerization, implies two types:

- **Chain growth polymers**

A chain growth polymer is formed when molecules of the same monomer or different monomers add together on a large scale to form the polymer. Example is Teflon.

- **Step growth polymers**

Step growth polymerization is step wise reaction between bi functional and multifunctional monomers in which high molecular weight polymers are formed. Example is Dacron.

4. APPLICATIONS OF POLYMERS

4.1 Chitosan and methyl cellulose: Polymers are used in Drug Delivery. Natural-based polymers such as methyl cellulose and chitosan are used for controlled drug delivery.[8]

4.2 Polyolefin: Polyolefin include polyethylene, Polyvinyl chloride, polyvinyl styrene etc. Polyethylene is most important petrochemical. Low density polyethylene is produced by free radical polymerization. [9]The principal commercial applications HDPE include blow moulded containers, crates, drums gas tanks and blow film.Polypropylene It is a light weight plastic. Main uses are pipe sheet and blow moulded containers .Polystyrene is is used in manufacture of form and bead for insulation and

packaging materials.Polyvinylchloride is co polymer of polyvinyl chloride. It is the largest volume commodity plastics .Rigid grade PVC is used as sheet, pipe and window profiles.

4.3 Elastomers: Butadiene based elastomers Polybutadiene has good resilience, abrasion resistance. It has important properties for tire applications.[10] Nitrile rubber has improved oil and aromatic solvent resistance. It is used in the manufacture of gasket , tubing and gasoline hose etc. Polychloroprene shows good resistance to attack by oxygen and gas. It is used as material for gaskets, tubing seals and gasoline hose.

4.4 Polyamides: Polyamides have many industrial applications in carpets, apparel , tire reinforcement etc.

5. CONCLUSION

Polymers have wide range of applications in medical field and other industries. Polymer-based pharmaceuticals are key elements to treat many lethal diseases that affect a great number of individuals such as cancer or hepatitis. Methyl cellulose and chitosan are being used in drug delivery system. Polymers are raw materials for the products we use everyday including fibreglass, plastic bags, polyethylene, cups etc It is need of hour to train persons to carry out research and development in polymer science and engineering.

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