Biopolymers: Anindispensableentity for mankind

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Abstract:

Polymers have become essential part of life. One can't think of life without polymers, reason being their innumerable physical and engineering characteristics. Most prominent quality of polymers is their low cost and durability.However, seize to strength ratio of polymers is large as compared to metals. Heat capacity of polymers is also less. Structural strength of polymers is also poor which make them unsuitable for heavy structures. Above all polymer are non biodegradables they may persist in environment for centuries. Due to this disability many countries have imposed restrictions on their use.

Low price, long life and readiness to adopt any shape has made polymers invulnerable. Non bio degradability of synthetic polymers shifted the quilt towards the invention of biopolymers. Scientists found the solution in biopolymers. They can be biosynthesized by living organisms or chemically synthesized from biological matter. The biopolymers are natural polymers formed by living organisms. Biopolymers are monomeric units which are bound covalently to form large molecules. Unlike polymers the biopolymers are biodegradable which decompose in bio-products with time after the expiry of intended purpose. Mainly there are three classes of biodegradable polymers namely polysaccharides, polypeptides and poly nucleotides Biopolymers mostly find applications in manufacturing, packaging, biomedical engineering and food industry. Difference between natural and synthetic polymers is discussed. Advantages of biopolymers over polymers are compared. Present study enlists brief overview of biopolymers.

Keywords: ***Polymers, Biopolymers, Biodegradable***

Abbreviations: ***PVC, PVDF, Tg, DNA, RNA***

Introduction: Polymers are macromolecules composed of smaller and multiple units of monomers. They are foundation of many materials and minerals. When the counting of monomer is very large then polymer is called high polymer. They make up man made materials like rubber, plastic, glass, paper and concrete and constitute the basis of many minerals like feldspar, quartz and diamond. Polymers can be natural or synthetic. Natural polymers are further divided into organic and inorganic polymers. Organic polymers play an important role in living things by providing structural material and participating in indispensable life processes.Examples include cellulose, lignin, proteins and various resins. Almost the solid part of al plants are made up of cellulose and lignin. Many inorganic polymers such as diamond and graphite are found in nature. They are made up of carbon. In precious element diamond the carbon atoms are linked in three dimensional structure to give hardness whereas graphite is used as lubricant where

carbon atoms can slide over.Polymers of amino acids and nucleic acids are well in demand. Synthetic polymers are hydrocarbons produced in different chemical reactions. Example include ethylene and propylene where one monomer is added to another in growing chain. A special class of polymer is mixed organic-inorganic polymer. Best example of this class are silicones where silicone and oxygen atoms are alternatively attached to carbon atoms. Synthetic rubbers are manufactured from polybutadiene, polychloroprene and polyisoprene. Polystyrene and poly vinyl chloride (PVC) are used in the manufacturing of thermoplastics. Macromolecular polyacetals have nitrogen and oxygen atoms in the backbone chain alongwith carbon atoms. Due to high melting, crystalline structure and abrasion resistant property they are just like metals and are used in the manufacturing of mechanical gears.Polyurothene, polyacrelate, polyamides andpolyvinyledenefluorides (PVDF) are other important examples of synthetic polymers.[1-4]

Types of polymers: Mainly there are four types of polymers:-

A. Thermoplastics: In such polymers the main chain molecules are primarily bonded linearly and secondarily bonded with Van Der Wall forces to each other. Thermoplastics are crystalline aswell as amorphous. They take the shape of viscous liquid above transition temperature (Tg). Thermoplastics can be recycled as they can be melted and re melted easily.

B. Elastomers: In such polymers the main chain molecules are weakly bonded by intermolecular forces. In the presence of external force they change shape and come to original shape after removal of external force. Elastic rubber is one example of such polymer.

C. Thermosets : When heated such polymers undergo complete transformation. For example melamine formaldehyde and bakelite.

D. Fibers : In these polymers main chain molecules have differential rings and are linked by hydrogen bonding. They are thin and long just like threads. For example nylon, Dacron and silk. [5]

Disadvantages of polymers:

• Most of the polymers cannot be recycled.

▪ Disposal of polymers is a big problem as they don't decompose into natural byproducts.

• Have low melting points hence unsuitable for high temperature applications.

• Have low structural strength hence large structures cannot be prepared.

• Unlike metals the seize to strength ratio is very large.

• Cannot be machined at high speeds like metals.

• Cannot be used in heat applications as heat capacity is far less as compared to metals.

• Are bad conductor of electricity.

• Are chemical resistant. [6]

Biopolymers or biodegradable polymers : Worldwide scientists and

academicians firmly believe that polymers can be accepted whole heartedly had been they are eco-friendly. Disadvantages of polymers gave advent to biopolymers. Biopolymers are either chemically synthesized or biologically synthesized from natural material or living organisms. In such polymers the monomeric units are covalently bonded and make large molecules. [7]

Class of biopolymers : According to the monomer used and structure there are three classes of biodegradable polymers (biopolymers). [8]

- **A. P**olynucleotides: More than thirteen nucleotide monomers are linked to form a long polymeric chain such as DNA and RNA.
- **B. P**olypeptides : They are polymers of amino acids such as actin, collagen and fibrin.
- **C. P**olysaccharides : They are branched or linear polymericmeric carbohydrates. For example alginate, cellulose and starch.

  Other examples of biopolymers include cutin, cutan, lignin, melanin and natural rubbers. They are polymers of isoprene, complex polyphenolic and long chain fatty acids.

Conventions of biopolymers

- **A. N**ucleic acids: Conventionally nucleic acids are listed by nucleotides from 5' numbered carbon of ribose ring to 3' numbered carbon end.
- **B. S**ugar : These polymers are joined by glycosidic bonds and can be branched or linearly linked. The placement of linkage may vary.
- **C. P**olypeptides : Conventionally the amino acid residues are listed from amino acid terminus to carboxylic terminus for example proteins.

Characterization of structure : Structural sequence information. may be obtained by various biophysical techniques. Edman degradation or spectrometry techniques are used to find protein sequence. Gel or capillary electrophoresis is used to determine amino acid sequence. Mechanical properties are measured by optical tweezers and atomic force microscopy. [9,10]

Important biopolymers: They are alginate, cellulose, collagen, gelatin, silk fibroin and starch.These important biopolymers find innumerous applications in day today's life.

Uses of biopolymers : Bio polymers find applications in the biomedical and industrial field.

- **A. B**iomedical: Due to biocompatible properties of biopolymers they are used for medical devices, pharmaceuticals and tissue engineering. Their mechanical properties are best utilized in drug delivery, regenerative medicines and tissue engineering. Chitosan and collagen are widely used in biomedical.
- **B. I**ndustrial: In industry the biopolymers are used in packaging. After the intended purpose the packaging material is decomposed into natural byproducts such as biomass, carbon dioxide, inorganic salts, nitrogen and water. Chitosan is used for water purification. It

purifies water by a process called chelation. Chitosan is used as flocculant which decompose in the environment within weeks. [11,12]

Conclusion : Polymers were widely used almost in every field because of low price and good engineering properties. Only drawback was their non friendliness with ecosystem. Polymers persist in environment for centuries and centuries. Scientists and academicians found the solution in biopolymers which are biodegradable and of course are very cost effective too.

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