PHARMACEUTICAL POLYMER: A REVIEW

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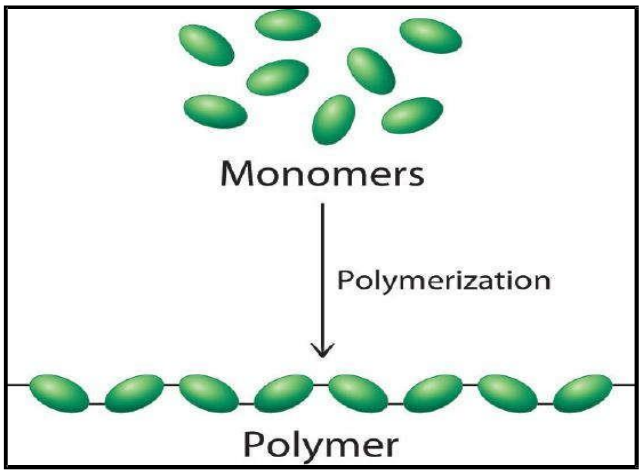
ABSTRACT

Polymers are macro molecules contain low and high molecular weight material in Conventional and Novel Drug Delivery system the Pharmaceutical Polymers play an important role in Pharmaceutical formulation. Different polymer use in Different dosage forms and drug delivery system for the drug release is sustaining, extending, modifying, controlling and targeting based. The designing of polymers for various applications in pharmacy based on proper selection of surface and bulk properties. Binder, suspending agent, emulsifying agent, coating agent, adjuvant are commonly used as pharmaceutical aids. Packaging materials used both in conventional and controlled drug delivery system. In this article briefly review Pharmaceutical polymers and their classification and applications of polymers drug delivery system.

KEYWORDS: Polymers, Pharmaceutical aid, Conventional Dosage forms, Controlled drug delivery system, Packaging material.

INTRODUCTION

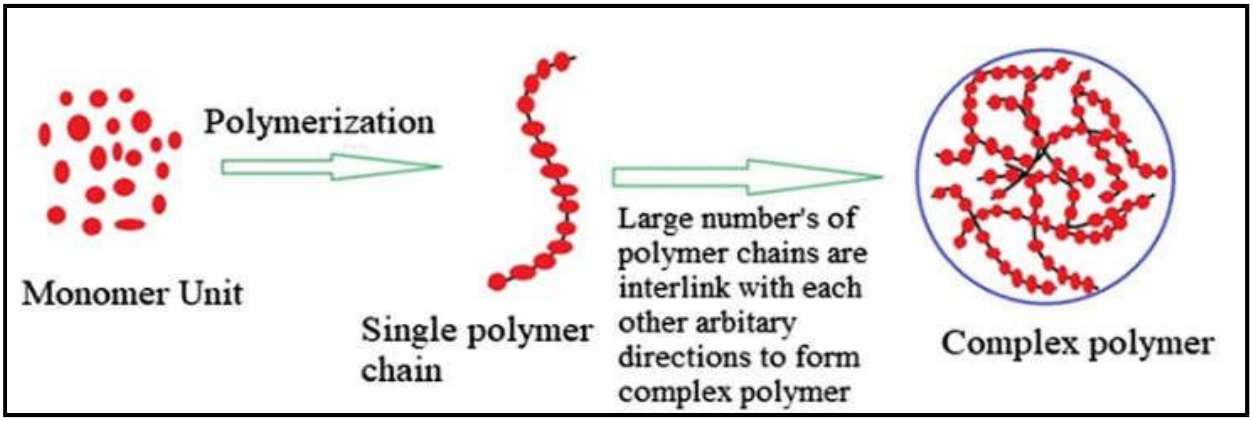
"Polymer" word is derived from Greek roots "Poly" meaning many and "Meroe" meaning parts. Polymers are considered to be a subset of macromolecules. Polymers have very large molecular weights made up of repeating units (or monomers) throughout their chains. The same or different types to form a polymer small molecule that combines with other molecules are called as Monomer. If two monomers are attached to each other is known as a dimer. If three monomers are attached to each other is known as a trimmer, if four monomers are attached to each other is known as a tetramer, if five monomers are attached to each other is known as a pen tamer. If 30 to 100 monomer units present is called as Oligomer and if Products containing more than 200 monomers called a polymer. Monomers are generally classified as functional and olefin. Polymers can have different chemical structures, physical properties, mechanical behavior, and thermal characteristics. The binder's in tablets to viscosity and flow controlling agents in liquids, suspensions and emulsions polymer use in pharmaceutical applications for different formulation. For masking unpleasant taste of a drug, to enhance drug stability and to modify drug release polymer can be used. The rate of the drug release from a matrix product depends on the initial drug concentration and relaxation of the polymer chains.



PROPERTIES

The wieldy used property of a polymer is identity of its constituent monomers. Microstructure is the second set of properties essentially describe the arrangement of these monomers within the polymeratthescaleofasinglechain.TheChemicalproperties:-thenano-scale, explain how the chains interact through physical Properties & the macro-scale, they explain how the bulk polymer interacts with other chemicals and solvents Almost four types of properties Polymer:-

1) Chemical Properties
2) Mechanical Properties
3) Transport Properties
4) Elasticity Properties



1. Chemical Property:-

The attractive forces of polymer chains play a large part in determine Chemical properties. Because polymer chains are long, these inter chain forces are amplified near the attractions between conventional molecules. The intermolecular forces in polymers can be affected by dipoles in the monomer units. Polymers contain amide or carbonyl groups can form hydrogen bonds between adjacent chains.

2. Mechanical properties:-

Involve its behavior under stress. These properties tell a polymer scientist or engineer what The bulk properties of a polymer are those most often of end-use interest. These properties tell how the polymers are actually looks like on a macroscopic scale. The mechanical properties of polymer are one of the features that distinguish them from small molecules. The mechanical properties of a polymer they need to know when considering how a polymer can be used.

3. Transport properties:-

The transport properties such as diffusivity relate to how rapidly molecules move through the polymer matrix. These are important properties in many applications of polymers for films and membranes are used. The term melting point, applied to polymers, transition from a crystalline or semi-crystalline phase to a solid amorphous phase but not a solid-liquid phase transition.

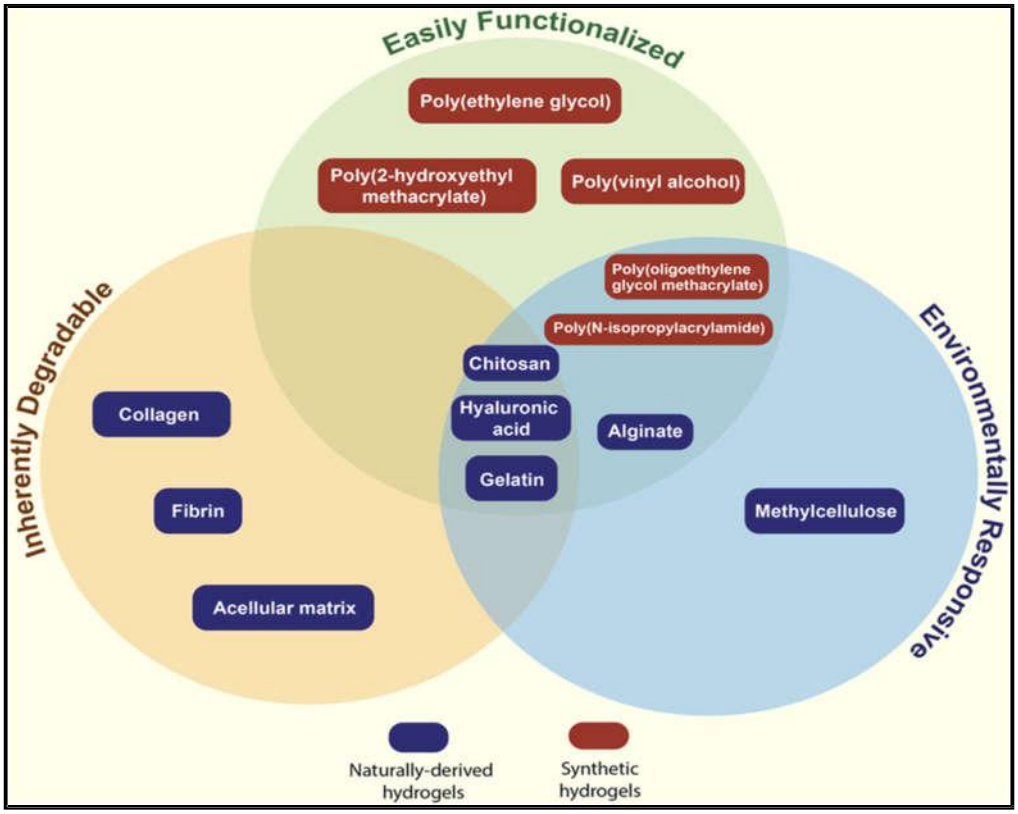
4. Elasticity properties:-

In these elasticity properties most elastic materials, such as metals, plastic used in springs, the elastic properties is caused by bond distortions. When force is applied, bond lengths are separate from the (minimum energy) equilibrium and strain energy is stored electro statically.

Types of Polymers Used in Packaging and Their Characteristics and Application

Sr. No.	Type of Polymer	Chemical Formula	Type of Polymer	Characteristics	Common Applications
1.	Polyethylene(PE)	$(C_2H_4)_n$	High-Density Polyethylene(HDPE) Low-Density Polyethylene(LDPE) Linear Low-Density Polyethylene(LLDPE)	Excellent strength, durability, and resistance to heat, chemicals, and water	Bottles, bags, containers, shrink wrap, pharmaceutical packaging
2.	Polypropylene (PP)	$(C_3H_6)_n$	Homo-polymer polypropylene(PP-H), Block-Copolymer polypropylene(PP-B), and Random-Copolymer polypropylene(PP-R)	Excellent strength- to weight ratio, durability, and resistance to heat, moisture, and chemicals	Bottles, containers, packaging film, pharmaceutical packaging
3.	Polystyrene(PS)	$(C_8H_8)_n$	Expanded Polystyrene (EPS) Crystal Polystyrene(CPS)	Rigidity, clarity, and ease of processing	Packaging food products, electronics,
4.	Polyethylene terephthale (PET)	$(C_{10}H_8O_4)_n$	VirginPET,Recycled PET (rPET), Amorphous PET (APET) and Glycol-modified PET(PETG)	Excellent barrier properties, durability, and transparency	Bottles, jars, trays, pharmaceutical packaging
5.	Polyvinylchloride (PVC)	$(C_2H_3Cl)_n$	Unplasticized PVC (uPVC),Plasticized PVC (pPVC), Chlorinated PVC (CPVC),Foam PVC And Biocompatible PVC	Excellent chemical resistance, durability, and flexibility	Bottles, blister packaging, shrink wrap, pharmaceutical packaging

6.	Polycarbonate (PC)	$(C_{15}H_{16}O_2)_n$	General Purpose Polycarbonate, Flame Retardant Polycarbonate, Optical Glass Polycarbonate, Recycled Polycarbonate and UV Resistant Polycarbonate	Excellent impact resistance, transparency, and durability	CD/DVD cases, eyeglasses, medical devices, pharmaceutical packaging
7.	Polyamide(PA)	[(NH-(CH2)5-CO)x]n	(Nylon6or Nylon6/6)	Excellent strength, durability, and resistance to heat and chemicals	Tubes, bags, films, pharmaceutical packaging



1. CLASSIFICATION

1. BASED ON ORIGIN

i) Natural Polymers:-

a) Protein-based: Albumin, gelatin

b) Polysaccharides: Agarose, alginate, hyaluronicacid

ii) Synthetic Polymer:-

A) Biodegradable

a) Polyesters: Poly(lactic acid) (PLA), poly (glycolic acid) (PGA)

b) Poly anhydrides: Poly (sebacicacid) (PSBA),poly (adipicacid) (PAPA)

c) Polyamides: Poly (amino carbonates) (PIC), polyamine acids (PAA)

d) Phosphorus-based: Polyphosphates, polyphosphonates.

e) Others: Poly (cyanoacrylates) (PCA), polyurethanes, polyorthoesters

B) Non-biodegradable

a) Cellulose derivatives:Carboxymethylcellulose(CMC),ethylcellulose(EC),celluloseacetate

b) Silicones: Poly dim ethyl siloxane (PDS),Colloidal silica

c) Acrylic polymers: Polymethacrylates (PMA), polyhydro (ethylmethacrylate) (PHEM).

d) Others: Polyvinylpyrrolidone (PVP), ethylvinylacetate (EVA)

iii) Semi-synthetic Polymer:-Cellulose nitrate, methyl cellulose

2. BASEDONBACKBONE

a) Polymers with carbon chain backbone: Polyethylene, polypropylene, polystyrene

b) Polymerswithheterochainbackbone:Poly(ethyleneoxide),poly(propyleneoxide)

1. Based on the presence of carbon

a) Organic Polymers: Polymer is back bone chain is essentially made of carbon atoms is termed an organic polymer. hydrogen, oxygen, nitrogen, are example of organic Polymers

b) Inorganic Polymers: The molecules of inorganic polymers contain no. carbon atom in their chain backbone. Glass and silicone rubber are examples of inorganic polymers.

2. Based on the types of monomer

a) Homo polymer: single type of repeat units is called a homopolymer, e.g. polystyrene

b) Copolymer: It is made up of two different monomers is called as copolymer, styrene butadiene

3. Based on the Polymerization process

a) Addition polymers: polythene, polypropene, polystyrene

b) Condensation polymers: Nylon-6,6Nylon-6,Terylene,glyptal

4. Based on the Line structure

a) Linear Polymer: high density polyethylene

b) Branched Polymer: comb like polymers, star polymers, dendrimers, low density polyethylene

c) Cross-linked Polymer: Vulcanized rubber Novolac, melamine-formaldehyde.

5. Based on thermal characteristics/thermo response

a) Thermo plastic polymers: Polyolefin's, nylons, linear poly-esters, sealing wax

b) Thermo setting polymers: cross-linked epoxy resins, poly-carbonates, poly-isoprene,

6. Based on interaction with water

a) Non-biodegradable hydrophobic Polymers: E.g. Polyvinylchloride

b) Soluble Polymers: sodium CMC, sodium alginate

c) Insoluble polymers: Chitosan (soluble in dilute acids), ethyl cellulose

d) Hydro gels: Polyvinyl pyrrolidone

7. Based on stimuli response

a) Photo responsive polymers: Polyacrylic acid
b) PHresponsivepolymers: Chitosan,albumin,gelatinet

c) Inflammation responsiv polymers:Hyaluronic acid.

d) Temperatureresponsivepolymers:Poly(N-alkylsubstitutedacrylamides)
e) Poly (N-vinyl alkyl amides)
f) Electro-ResponsivePolymers: Polythiophene, Sulphonated polystyreneetc.

g) Redox-Responsive Polymers: Polyanhydrides, Poly(lactic/glycolic acid)

h) Enzyme-Responsive Polymers: Pectin, Chitosan, Amylase

8. Based on Morphology

a) Crystalline Polymers: Syndiotacticpolypropylene.

b) Amorphous polymers: Atactic polypropylene.

9. Based on tacticity

a) Isotactic polymers: Isotactic polypropeneetc.

b) Syndiotactic polymers: Syndiotactic polypropylene

c) Atactic polymers: Atactic polypropylene.

10. Based on Charge

a) Cationic: Amino Dextran, Chitosan,

b) Anionic:Chitosan:EDTA,CMC,Pectin,Sodium Alginate, Sodium CMC, Xanthangum

c) Non-ionic: Hydroxy Ethyl Starch, HPC, poly (ethylene oxide),

11. Based on Potential

a) Covalent: PVP, Scleroglucan

b) Hydrogen bond: Cyanoacrylate

12. Based on bio-adhesive forces

a) Electrostatic interaction: Acrylate (hydroxylatedmethacrylate),poly(methacrylicacid),

13. Based on Physical properties

a) Elastomers: Natural rubbers, synthetic rubber.

b) Plastic: polyethylene, polystyrene.

c) Fibres:saran,vinyon,orlan

APPLICATION

1. PHARMACEUTICAL USES OF NATURAL POLYMER

- **Using Polymers in Drug Delivery: -** Biomimetic coatings, biodegradable scaffolds for tissue regeneration, naturally- derived hydrogels, sustained release systems these are the natural based polymer.

- **Novel Colon Targeted Drug Delivery System Using Natural Polymers:-** Pectin as a Carrier and Diltiazem Hcl And Indomethacin as a Model Drugs are used to Developed A Novel Colon Targeted Tablet Formulation. These tablets are evaluated for Average Weight, Hardness and Thickness test.

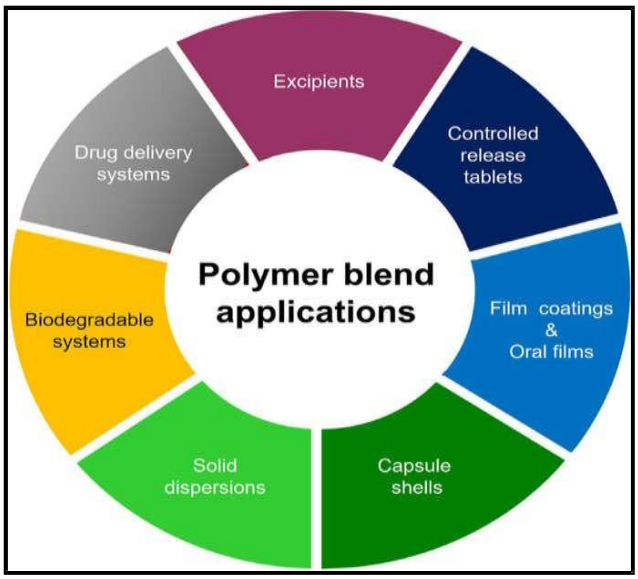
- **Use of cellulose: -** Polymeric delivery systems are intended to achieve controlled or sustained drug delivery system. Hdroxy-propyl methylcellulose, hydroxyl-propyl cellulose, microcrystalline cellulose and hydroxyl-ethyl cellulose is used for production of time controlled delivery systems these is naturally occurring biopolymer cellulose.

2. INDUSTRIAL APPLICATION OF POLYMER

- **Use of Guar Gum: -** It is used in pharmaceutical industries as Gelling or Thickening, Suspension, Stabilization, Emulsifying, Preservative, Water Retention/Water Phase control, Binding etc. guar used as a protective colloid in Skin care products, creams and lotions for cosmetic use. It is used in toothpaste and shaving cream for easy expel out from the container. It provides better properties as compared to substitutes.

- **Textile application: -**Rubber produced as a fiber sometimes called elastic, has significant value for use in the textile industry because of its excellent elongation and recovery properties.

- **Use of Rubber:-** The use of rubber is used as ranging from household to industrial products,enteringtheproductionstreamattheintermediatestageorasfinalproducts.Tiresandtubes are the largest consumers of rubber. The remaining 44% are taken up by the general rubber goods (GRG) sector, which includes all products except tires and tubes.



CONCLUSION:

Just as nature has used biological polymers as the material of choice, mankind will chose polymeric materials as the choice material. Humans have progressed from the Stone Age, through the Bronze, Iron, and Steel Ages into its current age, the Age of Polymers. An age in which synthetic polymers are and will be the material of choice. The large number of current and future applications of polymeric materials has created a great national need for persons specifically trained to carry out research and development in polymer science and engineering.

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