POLYMERS

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Polymer & Monomer

- Polymerization is the process of converting small, low molecular weight organic molecules into long, high molecular weight organic molecules either by addition reaction or by condensation reaction. The small molecules are called monomers and the products are called polymers.

Homo-polymer & Co-polymer

- Homopolymers are formed by the polymerisation of a single monomer. The repeating units of homopolymers are derived only from one monomer. Examples includes polythene which is a homopolymer of ethene.
- In copolymers, the repeating units are derived from two types of monomers. Example includes *Buna−S*, which is a copolymer of 1,3−*butadiene* and *styrene*.

Degree of polymerization

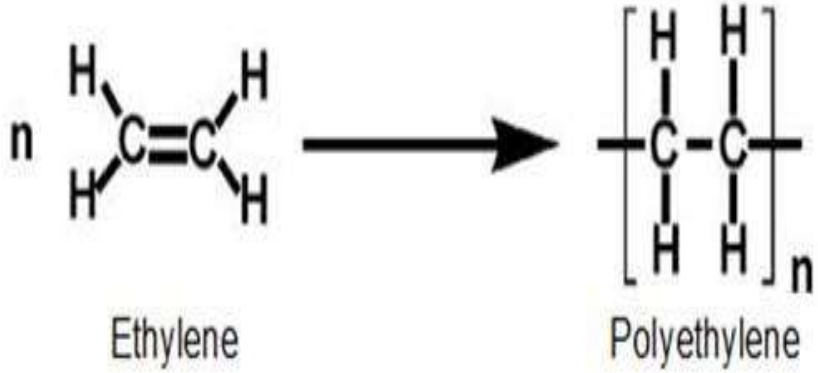
- The degree of polymerization, or DP, is the number of monomeric units in a macromolecule or polymer molecule. For most industrial purposes, degrees of polymerization in the thousands or tens of thousands are desired. This number does not reflect the variation in molecule size of the polymer , it only represents the mean number of monomeric units.

There are two types of polymerization.

- Addition polymerization
- Condensation polymerization

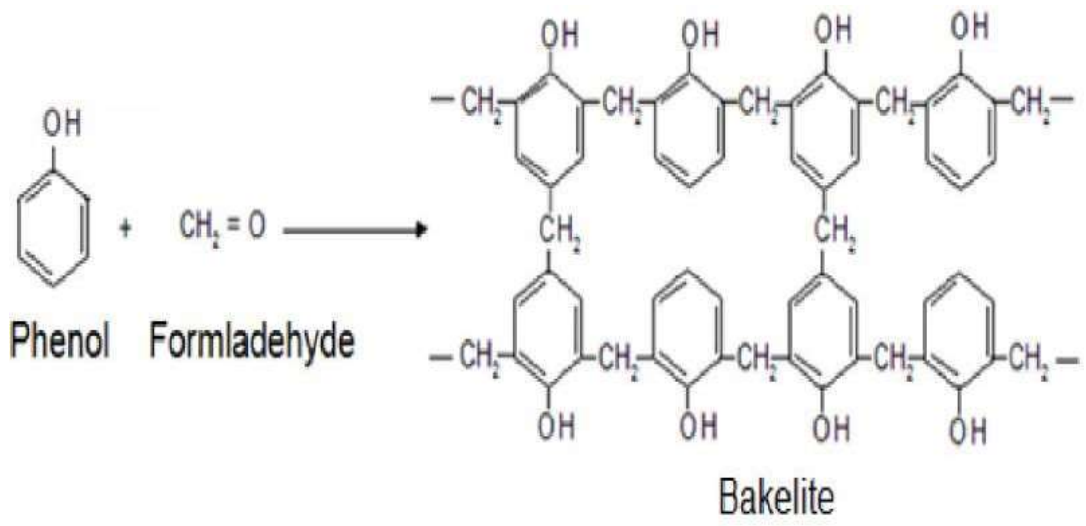
Addition polymerization

- In this type of polymerization, polymers are formed by simple addition reaction between small molecules containing double or triple bonds.
- Example: Formation of polyethylene or polythene.



Condensation polymerization

- In this type of polymerization, polymers are formed by the reaction between small molecules with elimination of molecules like H_2O, H_2S, NH_3, etc.
- Example: Formation of Bakelite



Types of plastics

- Plastics are classified into two types.

Thermoplastics

- They are the resins which soften on heating and set on cooling. Thus, they can be remoulded any number of times and used.
- Example: Polythene, PVC, nylon, etc.

Thermosetting plastics

- They are the resins which set on heating and cannot be resoftened. Hence, their scrap cannot be reused.
- Example: Bakelite (Phenol-formaldehyde resin), urea-formaldehyde resin, etc.

Differences between thermoplastics and thermosetting plastics

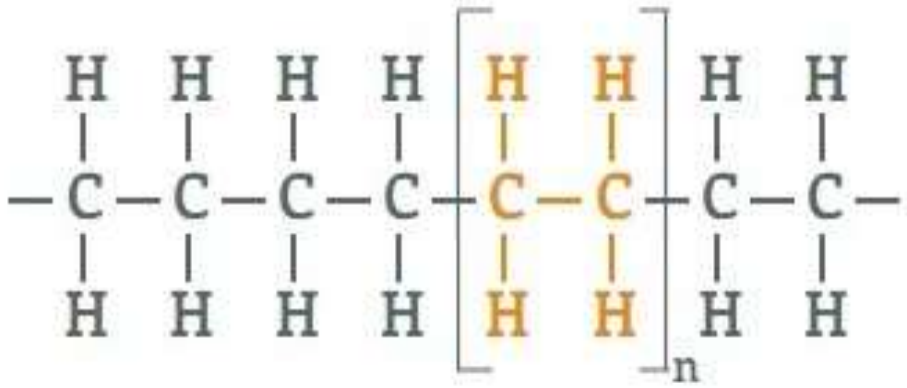
Sl. No.	Property	Thermoplastics	Thermosetting plastics
1	Action of heat	They soften on heating and set on cooling every time	**They set on heating and cannot be resoftened**
2	Type of bonding between adjacent polymer chains	The polymer chains are held together by weak force called Vander Waal's force of attraction	**The polymer chains are linked by strong chemical bonds (covalent bonds)**
3	Solubility	They are soluble IN organic solvents	They are insoluble IN organic solvents
4	Expansion due to heating	They expand very much on heating	**Their expansion is only marginally on heating**
5	Type of polymerization	They are formed by addition polymerization	They are formed by condensation polymerization
6	Scrap recovery	Scrap can be reused	**Scrap cannot be reused**
7	**Example**	**Polythene, PVC, nylon**	**Bakelite**

POLYTHENE

- Polythene is made from the polymerization of ethylene (or ethene) monomer. It's chemical formula is $(C_2H_4)n$.

- It is a lightweight, durable thermoplastic with variable crystalline structure. It is one of the most widely produced plastics in the world.

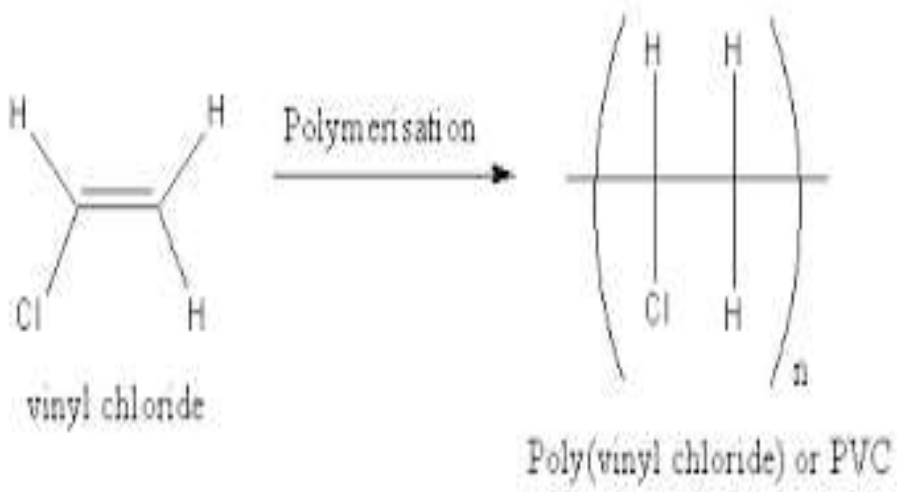
- Polyethylene is used in applications ranging for films, tubes, plastic parts, laminates, etc. in several markets (packaging, automotive, electrical, etc.).



Molecular Structure of Polyethylene

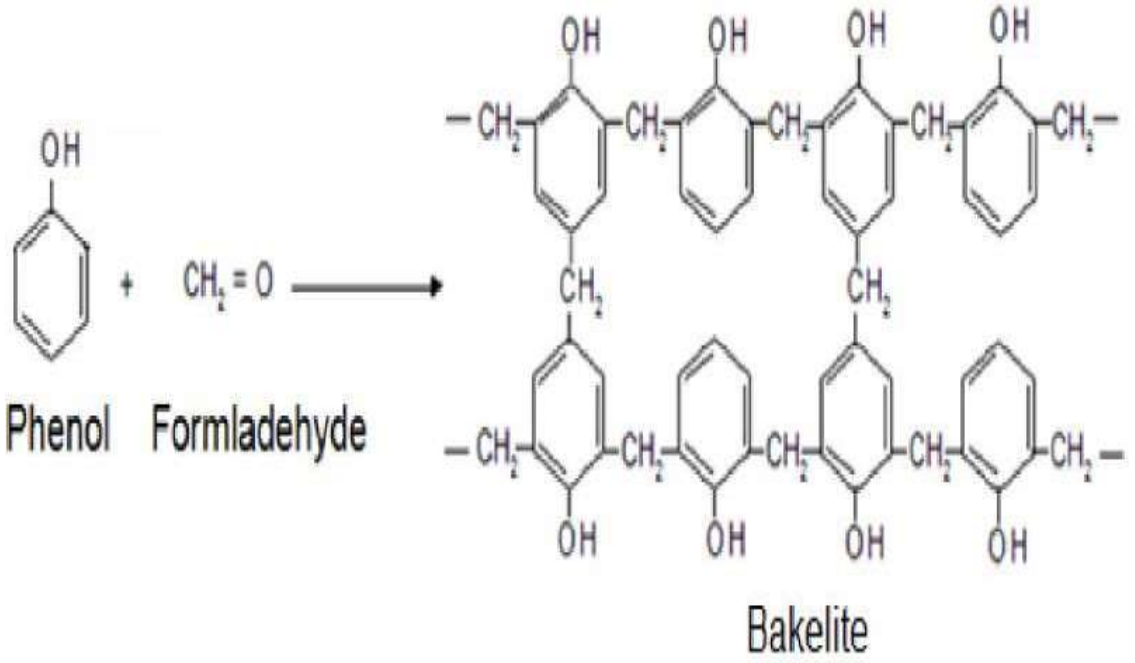
POLYVINYL CHLORIDE(PVC)

- PVC is produced by polymerization of vinyl chloride monomer (VCM).
- It is a white, brittle solid material available in powder form or granules.
- Due to its versatile properties, such as lightweight, durable, low cost and easy processability, PVC is now replacing traditional building materials like wood, metal, concrete, rubber, ceramics, etc.
- PVC is an thermoplastic polymer widely used in building and construction industry to produce door and window profiles, pipes (drinking and wastewater), wire and cable insulation, medical devices.



BAKELITE

- Bakelite is formed by the condensation reaction between phenol and formaldehyde. This polymer is known as novolac .Water is eliminated as by product.
- Bakelite due to its high resistance to electricity and heat is used in automotive components and industrial applications.
- Due to its excellent insulating properties it is used for making switches and other electrical appliances.
- It is also used to make various kitchenware products like frying pans etc.
- It is also used to make jewelry articles and toys.

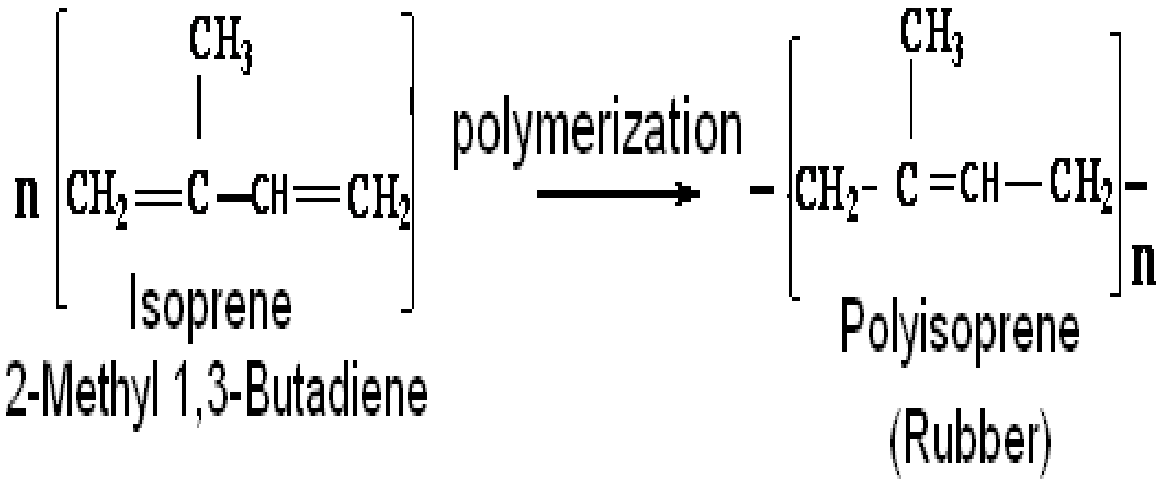


RUBBER

- Rubber is a natural elastic polymer of isoprene (C_5H_8). It is obtained from the milk of rubber called 'Latex'.

The natural rubber cannot be used in industries because it has the following defects.

- It becomes soft and sticky during summer.
- It becomes hard and brittle during winter.
- It swells up in oils.
- It flows plastically due to prolonged stress.
- Chemicals easily affect natural rubber.



Vulcanization

- Vulcanization is compounding of rubber with sulphur.
- Vulcanization is process of heating the natural rubber with sulphur at 140°C in CO_2 atmosphere.
- The double bonds present in rubber chain opened and cross linked through sulphur atoms. Hence it becomes very hard.

Properties of vulcanized rubber

- Vulcanized rubber has very little electrical and thermal conductivity. Hence, it is mainly used for electrical insulation purposes.
- It has high elasticity and tensile strength.
- Corrosive chemicals and oils do not affect it.
- It is also not affected by atmosphere.

Advantage of vulcanised rubber over raw rubber

- Uncured natural rubber is sticky and can easily deform when warm, and is brittle when cold. So it cannot be used to make articles with a good level of elasticity.
- The reason for un-elastic deformation of un-vulcanized rubber can be found in the chemical nature: rubber is made of long polymer chains. These polymer chains can move independently towards each other, and this will result in an irreversible change of shape.
- By the process of vulcanization, crosslinks are formed between the polymer chains, so the chains cannot move independently anymore. As a result, when stress is applied the vulcanized rubber will deform, but upon release of the stress, the rubber article will go back to its original shape.

QUESTIONS

- What is polymerization? What are the types of polymerization?
- How polythene is formed?
- What are Homo-polymer and Co-polymer?
- List the differences between thermoplastics and thermosetting plastics.
- What is rubber?
- What is vulcanization?
- Give any two defects of natural rubber?
- What is the Advantage of vulcanised rubber over raw rubber?
- Write preparation, structure and uses of Bakelite?
- Write the composition and uses of PVC ?