Polymers: —

A polymer is large molecule of very high molecular mass formed by the repeated combination of a very large number of one or more types of small molecules called monomers.

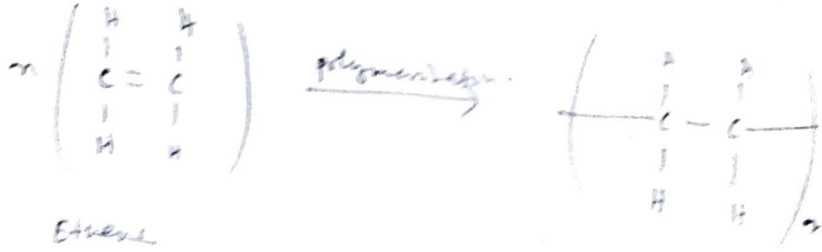
Polymerisation: —

The process by which monomer molecules combine together to form a polymer is called polymerisation.

or

Polymerisation is the chemical combination of a number of similar or different molecules to form a single large molecule.

For example, the polymer polyethene is obtained by the chemical combination of a large number of ethylene molecules as given below.



Monomer: —

Monomer is the building unit of polymer. It is a simple molecule which repeatedly combines with other molecules of the same or different type to form a polymer.

Ex: In polythene, ethene is the repeating unit. Hence ethene is the monomer.

Classification of polymers on the basis of structure: —

On the basis of structure, polymers can be classified into following three categories.

(i) Linear polymers: —

The polymers in which the constituent monomers unit are joined together to form long chain straight chain are called linear polymers or straight chain polymers.

In linear polymers, the polymeric chains usually stack on over another to form a well packed structure.

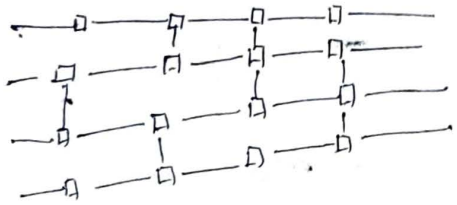
(ii) Branched chain polymers:-

The polymers which consist of both chains (made of monomer units) attached to the main chain (linear chain) are called branched chain polymers.

Due to presence of branching, branched chain polymer molecules are unable to pack themselves in a compact manner. They are usually irregularly packed. This is why branched chain polymers have low density, lower melting point and lower tensile strength as compared to linear polymers.

(iii) Cross-Linked polymers:-

The polymer in which the adjacent polymeric chains link together through side chains to form a three dimentional network structure are called Cross-Linked polymers.



Due to presence of cross links, cross-Linked polymers are hard, rigid and brittle.

Classification of polymers on Basis of Nature of Repeating Structure unit:-

On the basis of nature of repeating structural unit, polymers can be classified into following two categories.

1. Homo polymers. 2. Co-polymers.

1. Homo polymers:-

polymers in which the repeating structural units are derived from only one type of monomer units are derived from only one type of monomer units are called homopolymers. Such polymers are obtained by polymerization of single monomer species.

For example, polyethene is a polymer of this type. It is formed by polymerization of ethylene molecule and consists of the same repeating unit $-(CH_2-CH_2)-$ all over.

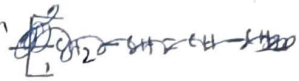
$n\ (CH_2 = CH_2)$ —polymerisation→ $-(CH_2-CH_2)_n-$

Ethylene (monomer) — polyethene (polymer)

2. Co-polymers! —

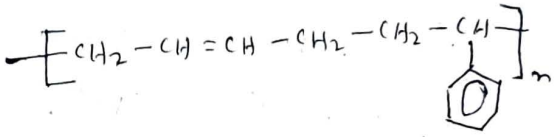
polymers in which the repeating structural units are derived from two or more types of monomer units are called 'co-polymers'. Such polymers are synthesised by polymerisation of two or more than two different monomers.

For example, Styrene-butadiene rubber is a co-polymer. It is synthesised by the polymerisation of styrene and butadiene.

$n\left(CH_2 = CH - CH = CH_2\right) + n$  —polymerisation→ 

Butadiene

Styrene



Styrene-butadiene polymer.

Some commercially important polymers! —

1. polyethylene (polythene)

preparation! —

It is prepare by addition polymerisation of ethylene. In this method ethylene is polymerised at a high pressure of the order of 1000-5000 atm. and at 520K in presence of a trace of oxygen

$n\ (CH_2 = CH_2) \xrightarrow[520K,\ O_2]{1000-5000\ atm.} -(CH_2-CH_2)_n-$

Ethylene. polyethene.

properties! —

It is chemically inert, tough and extremely poor conductor of electricity. It is pliable over a range of temperature.

uses! — It is used in making films, moulded toys, insulation wire, pipe and squeeze bottles, bottle, containers etc.

2. Poly propylene :-

Preparation :-

It is prepared by heating propylene with ziegler - natta catalyst in an inert solvent

$$n(CH_3-CH=CH_2) \xrightarrow[\text{catalyst}]{\text{Ziegler-Natta}} -\left(-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-\right)_n$$

propylene

poly propylene.

Properties :-

polypropylene is quite resistant to acids and alkalies. It is harder and stronger than polyethene. It has high tensile strength.

uses :-

It is used as a packing material for textiles, food etc. as liners in bags and for making heat shrinkable wraps for records etc. It is also used for making ropes. polypropylene rope is extremely strong for its weight.

Polyvinyl chloride :- (PVC)

It is prepared by the polymerisation of vinyl chloride in the presence of peroxide in an autoclave under pressure.

$$n(CH_2=\underset{\displaystyle Cl}{\underset{|}{CH}}) \xrightarrow[\text{peroxide}]{\text{pressure}} -\left(-CH_2-\underset{\displaystyle Cl}{\underset{|}{CH}}-\right)_n$$

vinyl chloride

polyvinyl chloride.

Properties :-

polyvinyl chloride is also known as Koroseal. It is a hard and horny material. It gives a very useful plastic when plasticized with tricresyl phosphate.

uses :-

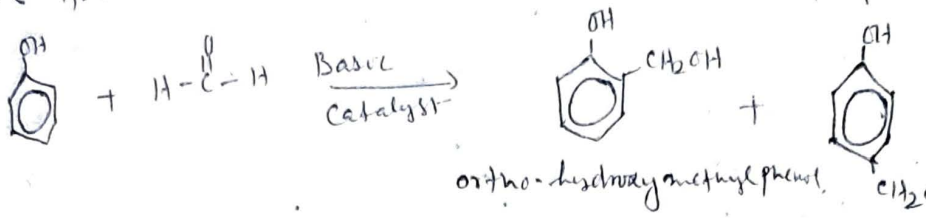
It is used in making rain coats, hand bags, plastic dolls, phonographs records, shower curtains, hospital sheetings, Lacquers, garden hose, inflatable water toys, vinyl flooring sheets and shoe soles. It is also used as an insulating material in wires and other electrical goods.

Phenol - formaldehyde resins (Bakelite)

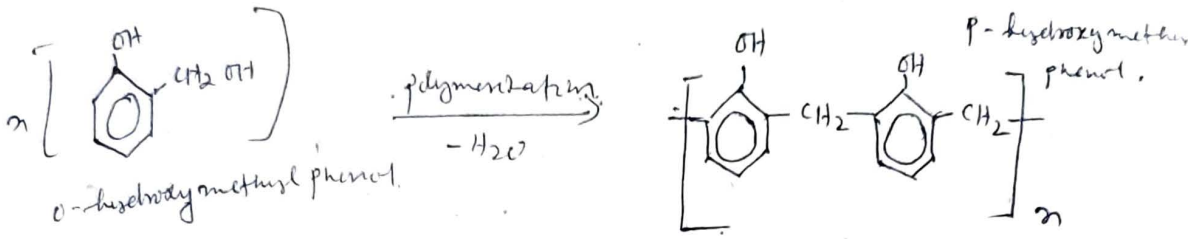
These are condensation polymers and are obtained by the reaction of phenol with formaldehyde.

preparation:-

9-H is prepared by the reaction of phenol and formaldehyde in the presence of basic catalyst. The process involves formation of methylene bridges at ortho or para or at both ortho and para positions. Thus, a linear or cross-linked polymer called phenol-formaldehyde resin or bakelite can be prepared.



ortho-hydroxymethyl phenol

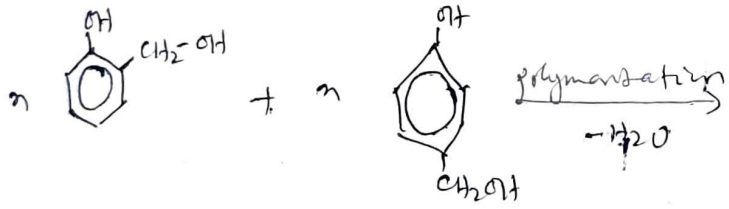


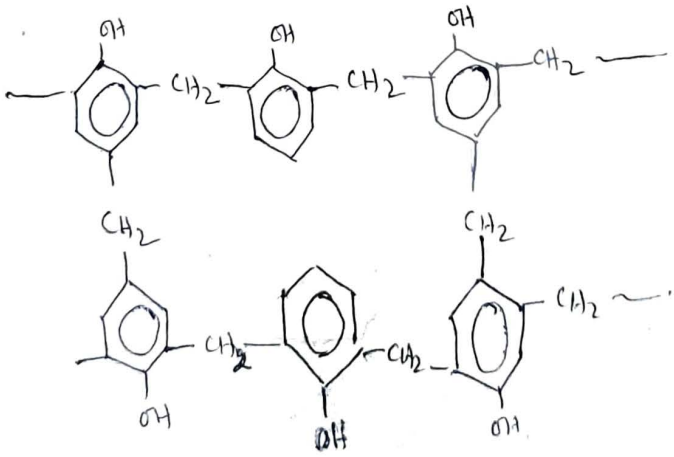
o-hydroxymethyl phenol

p-hydroxymethyl phenol.

Linear polymer (Novolac)

The linear polymer called Novolac is used in paints. Novolac on heating with formaldehyde undergoes cross linking to form an infusible solid mass called Bakelite.





properties:-

9-H is cross linked polymer and is a thermostable in nature. Low degree of polymerisation leads to the formation of soft bakelites. They are used as binding glue for laminated wooden planks and in vernishes and lacquers.

Bakelites having high degree of polymerisation are hard. They are used for making combs, fountain pen barrels, phonograph records, electrical goods eg. Switches and plugs

formica table-tops etc.

Natural Rubber:—

The main source of natural rubber is the tree Hevea brasiliensis. This tree is grown on plantation mostly in ceylon and the malay peninsula.

The rubber is obtained from the latex collected from the cuts made in the bark containing about 25 to 45% of rubber along with other impurities such as proteins, fatty acids, resins and water.

In order to obtain rubber from latex the latex is treated (i) with an acid such as acetic acid which coagulates the crude rubber which is comprised of 90-95% of rubber hydrocarbons, 2-4% of proteins and 1-4% of resins.

(ii) The latex mixed with appropriate compounding materials and then precipitated directly from the solution in the desired shape.

Structure of Rubber:—

It is the polymer of isoprene, and can be represented as

$$n\left(CH_2=\underset{CH_3}{\overset{|}{C}}-CH=CH_2\right) \longrightarrow \left(CH_2-\underset{CH_3}{\overset{|}{C}}=CH-CH_2\right)_n$$

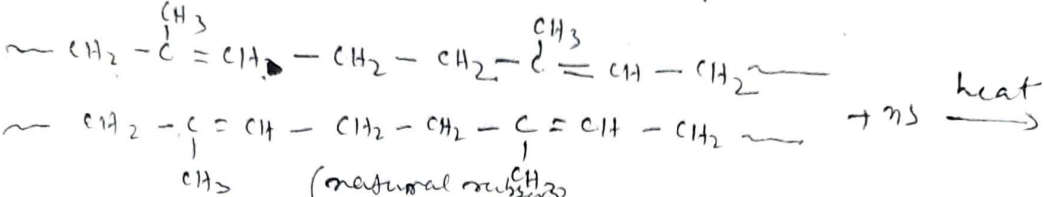
isoprene → polyisoprene (natural rubber).

Vulcanization of rubber:—

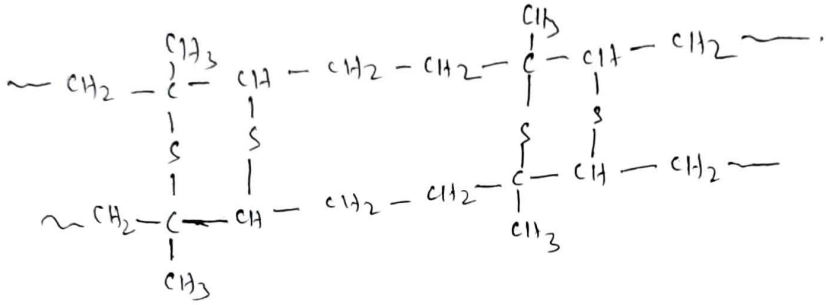
The natural rubber is a gummy material with poor elasticity. It has almost no cross-links. Therefore, it gets permanently deformed on being stretched. In order to improve its usefulness, —S—S— poly sulphide cross links are introduced in its structure through a process known as Vulcanization.

Vulcanization is carried out by heating natural rubber with 3-5% Sulphur at 110°C for about 20-30 minutes. This introduces —S—S— cross links between the adjacent hydrocarbon chains present in natural rubber. The rubber thus obtained is called vulcanized rubber.

When vulcanized rubber is stretched, the hydrocarbon chains can straighten out but they cannot slip past each other due to the presence of -S-S- poly sulphide cross-links. The vulcanized rubber can be stretched only to a limited extent when tension is removed, the chain get coiled up again and the rubber resumes its original shape.



(natural rubber)



(vulcanized rubber)

Superiority of vulcanized rubber over natural Rubber:—

The vulcanized rubber is superior to the natural rubber in following respect.

(i) It possesses a very good tensile strength. It can bear a load of 2000 kg/cm² before it breaks where as natural rubber only bear load of 200 kg/cm².

(ii) It has excellent resilience i.e, it turns to its original shape when the applied force is removed.

(iii) It possesses a much lesser tendency to absorb water as compared to the natural rubber.

(iv) It possesses a much greater resistance to oxidation, chemicals, abrasion and wear and tear as compared to natural rubber.

(v) It is a better electrical insulator.

(vi) It has a better workability as compared to natural rubber. Its working temprature is in the range -40°C to 100°C. On the other hand, the natural rubber is workable only in the temprature range 10°C to 60°C.

(vii) It is resistant to organic solvent such as petrol, benzene etc. on the other hand the natural rubber is soluble in above solvents.

uses of Rubber:—

(i) Rubber is largely used in the manufacture of tyres, gaskets, V-belts for power transmission, conveyer belts, hoses etc.

(ii) It is used for lining metal tanks used in chemical plants.

(iii) It is used for making rubber mounting which reduce machine vibrations and noise.

(iv) It is used for making toys, sports material etc.

(v) Foam rubber is used in the manufacturing of mattresses, cushions etc.