**Polymer notes**

 **Unit V & VI**

**Preparation properties and application of Bakalite**-

Bakalite is industrially produced by three steps-

**Step-1**- in this step the phenol is reacted with excess of formaldehyde to form a mixture of three compounds called mono, di and tri methylol phenol.

Phenol + formaldehyde monomethylol phenol + dimethylol phenol + trimethylol phenol

**Step-2**- in this step mono, di and tri methylol phenol condense randomly in the presence of acid

 Or base catalyst. In the presence of acid catalyst, when phenol formaldehyde ratio is

 Greater than one, a leaner compound is formed which is called Novolac, and in the

 Presence of base catalyst when phenol formaldehyde ratio is less than one, then again a linear compound is formed called Resol.

Mono + di + trimethylol phenol

 Acid catalyst base catalyst

 Novolac Resol

**Step-3-** in this step the Novolac or Resol can be converted separately in three dimensional structure called phenol formaldehyde resin or Bakelite.

Novolac or Resol Phenol formaldehyde resin or Bakelite.

**Properties of Bakelite**-

1. Bakelite is a scratch resistance, thermal resistance material.
2. It has excellent heat and moisture resistance.
3. It is dark colored pinkish brown material.
4. It has excellent dimensional stability.
5. Due to the presence of free –OH groups it is reactive towards Alkalis.
6. It is a perfect insulator of heat and electricity.

**Applications of Bakelite**-

1. Being a insulator of heat and electricity, it is used in the manufacturing of electrical insulator parts such as switches, plugs, circuit breakers, bulb holders etc
2. Being a heat insulator, it is used for covering of heater handles, pressure cooker handles.
3. It is also used as ion exchange resin.

**Preparation, properties and applications of Urea formaldehyde**-

 Urea formaldehyde is industrially produced by two steps-

Step-1- in this step urea is reacted with excess of formaldehyde to form a mixture of two compounds called mono methylol urea and Di- methylol urea.

NH2 NH-CH2OH NH-CH2OH

C=O + HCHO C=0 + C=O

NH2 NH2 NH-CH2OH

Urea Formaldehyde monomethylol Dimethylol

 Urea urea

**Step-2**- the mono and di methylol urea condense rendemoly to form a three dimensional network structure called UF- Resin.

Monomethylol urea + Dimethylol urea Urea formaldehyde resin

 N CH2 N

C=O C=O

N CH2 N

Structure of UF- Resin

**Properties of UF**-

1. UF- resin is light in colour
2. It is also a insulator of heat and electricity
3. It is resistant to various chemicals
4. It has dimensional stability, but it’s heat and moisture resistance is inferior than Bakelite.

**Applications of UF-resin**-

1. UF resin is also used in the manufacturing of electrical parts such as switches, plugs etc
2. It is used as cation exchange resin
3. It is also used as adhesive, and for the lamination of paper and wood.

**Preparation, properties and applications of Poly vinyl chloride**-

PVC is industrially produced by the free radical polymerization of vinyl- chloride monomers

nCH2=CH -(CH2=CH)n-

 Cl Cl

**Properties of PVC**-

PVC is hard and rigid material, it’s hardness is removed by adding Plasticizers like tri-cresyl phosphate.

Presence of Cl-atoms on the alternate carbon atom of PVC increases intermolecular interaction, which makes PVC extremely hard and rigid material.

PVC is colorless, odorless and inflammable material.

It has excellent chemical stability, but is soluble in ethyl chloride and tetrahydrofuran.

It has excellent oil resistance and resistance to weathering.

**Application of PVC**-

1. It is used in acid recovery plants and in the plants handling hydrocarbon, many of which adversely affect the polyolefins.
2. Since it has excellent resistance to weathering, it is widely used in construction industry. It is used for making pipes for drainage and guttering. It also replaces wood for making window frames that never corrode.
3. It is also used for making bottles and containers for the storage of veniger, mineral water, cosmetics, detergents and bislery.

**Preparation properties and applications of Polyvinyl acetate**-

It is industrially produced by the emulsion or suspension polymerization of vinyl-acetate monomers in the presence of benzoyl peroxide as catalyst.

nCH2=CH -(CH2-CH)n-

 COOCH3 COOCH3

Vinyl- acetate monomer Polyvinyl acetate

**Properties**-

1. It is colorless, odorless, and transparent material.
2. It is an amorphous material and has low Tg value (20oC)
3. It is insoluble in water but soluble in organic solvents.
4. It is a sticky material.

**Applications**-

It is used for-

1. The production of water based emulsion paints.
2. Making chewingum.
3. Making records
4. Finishing textiles and other textile fibres.
5. Bonding paper, leather, textiles etc.

**Preparation, proprtties and applications of Buna-S or SBR**-

It is industrially prepared by free radical polymerization of 1,3- Butadiene and Styrene monomers in 3:1 ratio.

nCH2=CH-CH=CH2 + m CH2=CH (-CH2-CH=CH-CH2)n-(CH2-CH)m-

 C6H5  C6H5

1,3 butadiene Styrene Styrene butadiene rubber

**Properties**-

It has-

1. High abrasion resistance
2. High load bearing capacity
3. Resilience
4. It swells in oil and solvents
5. It is easily oxidized in the presence of traces of ozone
6. It can be vulcanized.

**Applications**-

It is used in the manufacturing of –

1. Automobile tyres
2. Shoe soles
3. Foot wear components
4. Insulation of wires and cables
5. Carpet backing
6. Gaskets
7. Adhesives and
8. Tank linings.

**Preparation properties and application of Buna- N or Nitril rubber**-

It is industrially produced by free radical co-polymerization of 1,3- butadiene and Acrylonitril monomers in the ratio of 3:1.

nCH2=CH-CH=CH2 + m CH2=CH (-CH2-CH=CH-CH2)n-(CH2-CH)m

 CN CN

**Properties**-

1. Due to the presence of CN group nitril rubber is less resistant to alkalis than natural rubber.
2. Excellent resistance to oil, chemicals, sunlight, acids, salts, solvents etc.
3. Compared to natural rubber nitril rubber is more resistant to heat.
4. It has excellent abrasion resistance.

**Applications**-

It is used in the manufacturing of-

1. Conveyer belts
2. Lining of tanks
3. Gaskets
4. Printing rollers
5. Oil resistance foams
6. Automobile parts and high altitude aircrafts
7. Hoses and adhesives.

**Preparation properties of Natural rubber**-

Natural rubber is obtained by free radical polymerization of isoprene monomers (2-methyl 1,3-Butadiene).

 CH3 CH3

CH2=C CH=CH2 -(CH2-C=CH-CH2)

Isoprene Polyisoprene

**Drawbacks of Natural rubber**-

1. Natural rubber is soft at room temperature but becomes brittle at room temperature, thus it can be used in limited temperature range.
2. It is attacked by oxidizing agents like conc. HNO3, H2SO4 etc.
3. It has very weak tensile strength
4. It has large water absorbing capacity
5. It is easily oxidized in air, therefore it is less durable.

The drawbacks of natural rubber can be removed by the process of vulcanization, in which natural rubber is heated at 135oC for 1 to 4 hours in the presence of sulphur. Due to this di- sulphide of monosulphide bonds are formed between different polyisoprene chains.

 CH3 CH3

(CH2-C=CH-CH2)n (CH2-C-CH-CH2)n

 S S

 +

(CH2-C=CH-CH2) (CH2-C-CH-CH2)n

 CH3 CH3

 Vulcanized rubber

**Applications of polymers**-

**Applications of polymer in Electronics**-

Polymers are used in electronic components, electronic devices, as insulators, and semiconductors.

New materials such as carbon nanotubes and organic molecules with conducting and semiconducting properties enables a new generation of plastic electronic displays for cellular phones and other portable devices.

Plated plastics is lighter and lesser expensive than metal shells used to shield connectors. Optical films for LCD backlightening applications into flat displays for televisions, notebook, personal computers and automotive global positioning syatems (GPS) units.

Light activated power plastics that can be coated on to computers, cellphones and other electrical devices to harness the energy of light to recharge batteries.

**Application of polymers in medical field**-

Polymers are used in medical field in many ways-

1. Polyolefins, PTFE, polyesters, polyurethane, acrylics and silicones are used as biocompatible implants.
2. Polyethylene used in surface joints, chest valve and diaphragm.
3. PTFE is used in blood vessel replacement.
4. PET in Knit arterial prosthesis and non- absorbable suturs.
5. PMMA and Polyhydroxyethyl methaacrylate in contact lenses.
6. Silicon adhesives for covering burns and making artificial skin.
7. Cellulose acetate and polyamide membranes are used in dialysis.
8. Urea formaldehyde polymer has antibacterial and antifungal properties.
9. Polymeric drugs have delayed action, prolonged activity, decreased rate of drug metabolism and drug execration.

**Application of polymer in agriculture**-

Polymers are used in agriculture field due to the following reasons-

1. Increasing the water holding capacity of the soil.
2. Increasing water use efficiency.
3. Enhancing soil permeability.
4. Reducing irrigation frequency.
5. Stopping soil erosion.
6. Reducing compaction tendency.
7. Enhancing plant performance.

Two types of polymers are used in agriculture field-

1. Water soluble polymers
2. Water insoluble polymers

Examples of water soluble polymers are polyethylene glycol, polyacrylates, polyacrylamide.

Water insoluble polymers are also called gel forming polymers; they are cross linked network polymers.

Examples of water insoluble polymers are-

Cross linked polyacrylates, cross linked polyacrylamide.

**Applications of polymer in construction-**

1. The applications of polymers in construction is as follows-
2. PVC is used for flooring, window framing, and drainage pipes
3. Polyurethane foam is used as foaming material in construction.
4. Polycarbonates are used as substitute for glasses in doors and windows.
5. Teflon and polyvinyl acetate are used as coating and binding agents.
6. Buna n is used as sealing and binding agent in construction industry.