# Co4:

1. \*\*Differentiate between thermoplastic and thermosetting resins:\*\*

Thermoplastic resins are polymers that can be softened by heating and hardened by cooling, and this process is reversible. They can be remolded or reshaped upon heating. Examples include polyethylene, polypropylene, polystyrene, and polyvinyl chloride (PVC).

Thermosetting resins, on the other hand, undergo a chemical change during the curing process, forming a cross-linked network structure that cannot be melted or reshaped by heating. Once cured, they maintain their shape and properties upon heating. Examples include phenol-formaldehyde resins (Bakelite), epoxy resins, and urea-formaldehyde resins.

2. \*\*Cationic, anionic, and free radical addition polymerization mechanisms:\*\*

a. \*\*Cationic polymerization:\*\* In this mechanism, the monomer is activated by a Lewis acid (cationic initiator) to form a carbocation, which then propagates by adding more monomers. Example: Polymerization of isobutylene using BF3 as the initiator.

b. \*\*Anionic polymerization:\*\* Here, the monomer is activated by a strong base (anionic initiator) to form a carbanion, which then propagates by adding more monomers. Example: Polymerization of styrene using n-butyllithium as the initiator.

c. \*\*Free radical polymerization:\*\* This mechanism involves the formation of free radicals, which then initiate the polymerization by adding monomers. The radicals are typically generated by thermal or photochemical decomposition of an initiator. Example: Polymerization of vinyl chloride using benzoyl peroxide as the initiator.

3. \*\*Impact of doping of conducting polymers:\*\*

Conducting polymers, such as polyacetylene, polyaniline, and polypyrrole, have a conjugated π-electron system along their backbone, allowing for the delocalization of electrons. However, in their pristine state, they have limited electrical conductivity. Doping introduces charge carriers (electrons or holes) into the polymer chain, significantly increasing their electrical conductivity.

There are two types of doping:

a. \*\*p-type doping (oxidative doping):\*\* Involves the removal of electrons from the polymer chain, creating positive charges (holes) that act as charge carriers. Example: Doping of polyaniline with oxidizing agents like iodine or FeCl3.

b. \*\*n-type doping (reductive doping):\*\* Involves the addition of electrons to the polymer chain, creating negative charges that act as charge carriers. Example: Doping of polyacetylene with reducing agents like sodium naphthalide.

Doping enables the use of conducting polymers in various applications, such as biosensors, energy storage devices, and electromagnetic shielding.

4. \*\*Preparation, properties, and engineering uses of:\*\*

i. \*\*Polyvinyl chloride (PVC):\*\*

Preparation: Free radical polymerization of vinyl chloride monomer using initiators like benzoyl peroxide or azobisisobutyronitrile.

Properties: Tough, rigid, good chemical resistance, low cost, can be made flexible by adding plasticizers.

Engineering uses: Pipes, window frames, cable insulation, flooring, packaging materials.

ii. \*\*Bakelite:\*\*

Preparation: Condensation polymerization of phenol and formaldehyde under heat and pressure.

Properties: Rigid, heat-resistant, excellent electrical insulator, durable.

Engineering uses: Electrical insulators, automotive parts, household appliances, billiard balls.

iii. \*\*Urea-formaldehyde resin:\*\*

Preparation: Condensation polymerization of urea and formaldehyde under acidic or basic conditions.

Properties: Hard, heat-resistant, good adhesive properties, low cost.

Engineering uses: Adhesives, molding compounds, electrical insulators, particleboard, and plywood.

5. \*\*Preparation, properties, and engineering uses of Polyethylene:\*\*

Preparation: Free radical polymerization of ethylene monomer using Ziegler-Natta or metallocene catalysts at high temperature and pressure.

Properties: Lightweight, flexible, good chemical resistance, excellent electrical insulator, low cost.

Engineering uses:

- Low-density polyethylene (LDPE): Plastic bags, films, containers, bottles.

- High-density polyethylene (HDPE): Pipes, bottles, containers, toys, crates.

- Ultra-high molecular weight polyethylene (UHMWPE): Bulletproof vests, artificial joints, gears, and bearings.

Polyethylene is widely used in various industries, including packaging, construction, automotive, and consumer goods, due to its versatile properties and low cost.

# C03:

1. \*\*Desalination Process:\*\*

Desalination is the process of removing dissolved salts and minerals from saline water, such as seawater or brackish water, to produce fresh water suitable for human consumption, industrial use, or agriculture.

Classification of desalination methods:

a. \*\*Thermal desalination processes:\*\*

- Multi-stage flash distillation (MSF)

- Multi-effect distillation (MED)

- Vapor compression distillation (VCD)

b. \*\*Membrane desalination processes:\*\*

- Reverse osmosis (RO)

- Electrodialysis (ED)

c. \*\*Other processes:\*\*

- Ion exchange

- Freezing desalination

- Solar desalination

Comparison of desalination methods:

- Thermal processes are energy-intensive but can handle high salinity levels.

- Membrane processes (RO) are more energy-efficient but have limitations in handling high salinity and require pretreatment.

- Thermal processes have higher capital and operating costs compared to RO.

- RO has lower energy consumption and smaller footprint compared to thermal processes.

- Electrodialysis is suitable for brackish water desalination but not for seawater.

- Solar desalination is a renewable energy-based process but has a lower production rate.

2. \*\*Ion Exchange Process of Water Softening:\*\*

The ion exchange process is used to remove hardness-causing ions, such as calcium (Ca²⁺) and magnesium (Mg²⁺), from hard water. It involves the exchange of these ions with sodium ions (Na⁺) present in the ion exchange resin.

The process is as follows:

- Hard water is passed through a column containing cation exchange resin in the sodium form (Na⁺-R⁻).

- The calcium and magnesium ions in the hard water are exchanged with the sodium ions on the resin, resulting in softened water.

- The resin becomes saturated with calcium and magnesium ions over time and needs to be regenerated.

- Regeneration is typically done by passing a concentrated sodium chloride (NaCl) solution through the resin, which displaces the calcium and magnesium ions and replaces them with sodium ions.

The chemical reactions involved are:

Softening process:

Ca²⁺ + 2(Na⁺-R⁻) → (Ca²⁺-R⁻) + 2Na⁺

Mg²⁺ + 2(Na⁺-R⁻) → (Mg²⁺-R⁻) + 2Na⁺

Regeneration process:

(Ca²⁺-R⁻) + 2NaCl → CaCl₂ + 2(Na⁺-R⁻)

(Mg²⁺-R⁻) + 2NaCl → MgCl₂ + 2(Na⁺-R⁻)

3. \*\*Advantages of Hot Lime Soda Process over Cold Lime Soda Process:\*\*

The hot lime soda process has several advantages over the cold lime soda process for water softening:

a. Higher efficiency: The hot process is more efficient in removing temporary and non-carbonate hardness compared to the cold process.

b. Complete removal of calcium and magnesium: In the hot process, both calcium and magnesium are completely removed, while the cold process may leave behind some residual hardness.

c. Removal of silica: The hot process can effectively remove silica from water, which is not possible in the cold process.

d. Reduced sludge volume: The sludge produced in the hot process has a higher density, resulting in a smaller volume compared to the cold process sludge.

e. Lower chemical consumption: The hot process requires a lower dosage of lime and soda ash compared to the cold process for the same level of hardness removal.

4. \*\*Alkalinity and its Types:\*\*

Alkalinity is a measure of the water's ability to neutralize acids and resist changes in pH. It is primarily caused by the presence of bicarbonate (HCO₃⁻), carbonate (CO₃²⁻), and hydroxide (OH⁻) ions in water.

Types of alkalinity:

a. \*\*Bicarbonate alkalinity:\*\*

This is caused by the presence of bicarbonate ions (HCO₃⁻) in water.

HCO₃⁻ + H⁺ ⇌ H₂CO₃ (carbonic acid)

b. \*\*Carbonate alkalinity:\*\*

This is caused by the presence of carbonate ions (CO₃²⁻) in water.

CO₃²⁻ + H⁺ ⇌ HCO₃⁻

c. \*\*Hydroxide alkalinity:\*\*

This is caused by the presence of hydroxide ions (OH⁻) in water.

OH⁻ + H⁺ ⇌ H₂O

5. \*\*Analysis of Water Samples:\*\*

Given:

- KP sample: 100 mL requires 28 mL of 0.01 M EDTA solution

- VS sample: 100 mL requires 32 mL of 0.01 M EDTA solution

- KLU sample: 100 mL requires 16 mL of 0.01 M EDTA solution

The amount of EDTA required for titration is directly proportional to the hardness of the water sample. Higher EDTA consumption indicates higher hardness.

Based on the given data:

- The VS sample required the highest amount of EDTA (32 mL), indicating that it has the highest hardness among the three samples.

- The KP sample required 28 mL of EDTA, suggesting moderate hardness.

- The KLU sample required the lowest amount of EDTA (16 mL), indicating the least hardness among the three samples.

Therefore, the order of hardness of the water samples is:

VS sample > KP sample > KLU sample

Recommendation:

For applications requiring soft water, such as domestic or industrial use, the KLU sample would be the most suitable choice due to its low hardness. However, if the water is intended for drinking purposes, further treatment may be required to remove other contaminants and ensure its potability.