SAP ID - 60004200132
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MAEER's MIT

Engineering Chemistry

Term Test 1 Assignment.

1) Distinguish between temporary and permanent hardness.

Ans

Temporary Hardness	Permanent Hardness
i) It is due to bicarbonates and carbonates of Ca^{+2}, Fe^{+2}, Mg^{+2}, etc.	i) It is due to chlorides, sulphates, nitrates of Ca^{+2}, Fe^{+2}, Mg^{+2} etc. other than carbonates and bicarbonates.
2) It is known as carbonate and alkaline hardness.	2) It is known as non-carbonate or non-alkaline hardness.
3) Temporary hardness leads to formation of loose deposits of carbonates and hydroxides of Ca^{+2}, Mg^{+2} respectively, if used in boilers.	3) Permanent hardness leads to formation of adherent scales.
4) Temporary hardness can be removed by simple techniques such as boiling and filtering	4) Permanent hardness cannot be removed by simple techniques such as boiling and filtering.

2) Explain the preparation of solutions required in EDTA titration.

Ans Various steps for preparation of solutions required in EDTA titration are:

1) Preparation of standard hard water : Dissolve 1g of pure, dry $CaCO_3$ in minimum quantity of dilute HCl. Boil it to dryness to expel excess of acid and CO_2. Dissolve the residue in distilled water to make 1 litre solution. Each ml of the solution contains 1mg of $CaCO_3$ equivalent hardness.

2) Preparation of EDTA solution : Dissolve 4g of pure EDTA and 0.1g $MgCl_2$ in 1 litre distilled water.

3) Preparation of Indicator: Dissolve 0.5g Eriochrome Black-T in 100 ml of alcohol.

4) Preparation of Buffer solution : Add 67.5 g of NH_4Cl to 570 ml of concentrated ammonia solution and then dilute with distilled water to 1 litre.

3) With the help of neat and labelled diagram explain deionization process.

Ans Ion-exchange resins are insoluble, cross-linked, long-chain organic polymers with a microporous structure and the functional groups attached to the chain which are responsible for the ion exchanging properties. They may be classfied as follows:

i) Cation Exchange Resins (RH^+): Resins containing acidic functional groups ($-COOH$, $-SO_3H$ etc) are capable of exchanging their H^+ ions with other cations. Their exchange reaction with other cation is shown as:

$$2RH^+ + M^{+2} \longrightarrow R_2M + 2H^+$$

Amberlite IR-120 and Dowex-50 are some of the examples of commercially available cation exchange resins.

ii) Anion Exchange Resins ($R'OH^-$): Resins containing basic functional ($-NH_2$, $=NH$) as hydrochloride are capable of exchanging their anions with other anions. Their exchange with other anions is shown as:

$$R'OH^- + X^- \longrightarrow R'X^- + OH^-$$

Amberlite-400 and Dowex-3 are some of the examples of commercially available anion exchange resins.

Principle : When raw water passes through cation exchanger resin, all cations from water are absorbed in exchange of H^+ and when it passes through anion exchanger resins, all anions are absorbed in exchange of OH^-. Thus, the water obtained is of distilled quality.

Process : The hard water is passed first through cation exchange column, which removes all the cations like Ca^{+2}, Mg^{+2} etc from it and equivalent amount of H^+ ions are released from this column to water.

Reaction :

$$2RH^+ + Ca^{+2} \longrightarrow R_2Ca^{+2} + 2H^+$$

$$2RH^+ + Mg^{+2} \longrightarrow R_2Mg^{+2} + 2H^+$$

Then the hard water is passed through anion exchange column, which removes all the anions like SO_4^{2-}, Cl^- etc. present in the water and equivalent amount of OH^- ions are released from this column to water.

Reaction:

$$R'OH^- + Cl^- \longrightarrow R'Cl^- + OH^-$$

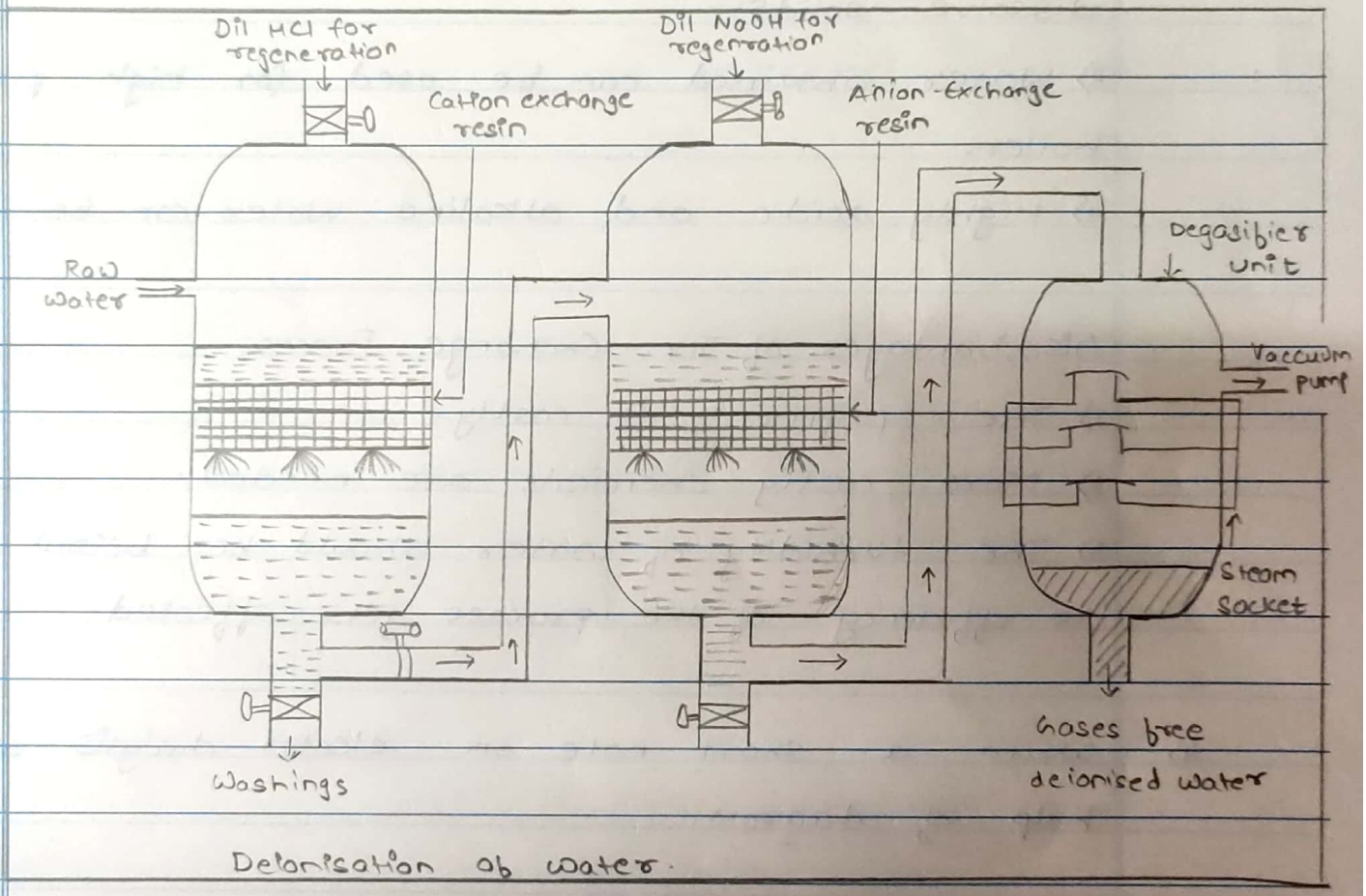
$$2R'OH^- + SO_4^{2-} \longrightarrow R_2'SO_4^- + 2OH^-$$

$$2R'OH^- + CO_3^{2-} \longrightarrow R_2'CO_3^{2-} + 2OH^-$$

H^+ ions released from cation exchange and OH^- ions released from anion exchange columns combine to produce water molecule.

$$H^+ + OH^- \longrightarrow H_2O$$

As the water coming out is free from all ions, the process is called as deionization or dimineralisation process.



Deionisation of water.

Regeneration: The exhausted cation exchanges is regenerated by passing a solution of dilute HCl or dilute H_2SO_4. The regeneration can be represented as

$$R_2Ca^{+2} + 2H^+ \longrightarrow 2RH^+ + Ca^{+2}$$

The exhausted anion exchanger is regenerated by passing a solution of dilute NaOH. The regeneration can be represented as

$$R_2'SO_4^{2-} + 2OH^- \longrightarrow 2R'OH + SO_4^{2-}$$

Advantages of Ion-Exchange Process:

1) It produces water of very low hardness (2ppm).
2) Treated water contains negligible amount of total dissolve solids.
3) Water obtained can be used for high pressure boilers.
4) Highly acidic and alkaline water can be softened.

Disadvantages of Ion-Exchange Process.

1) The equipment is costly.
2) More costly chemicals are needed.
3) The turbidity of water should be below 10ppm as efficiency of the process gets affected.

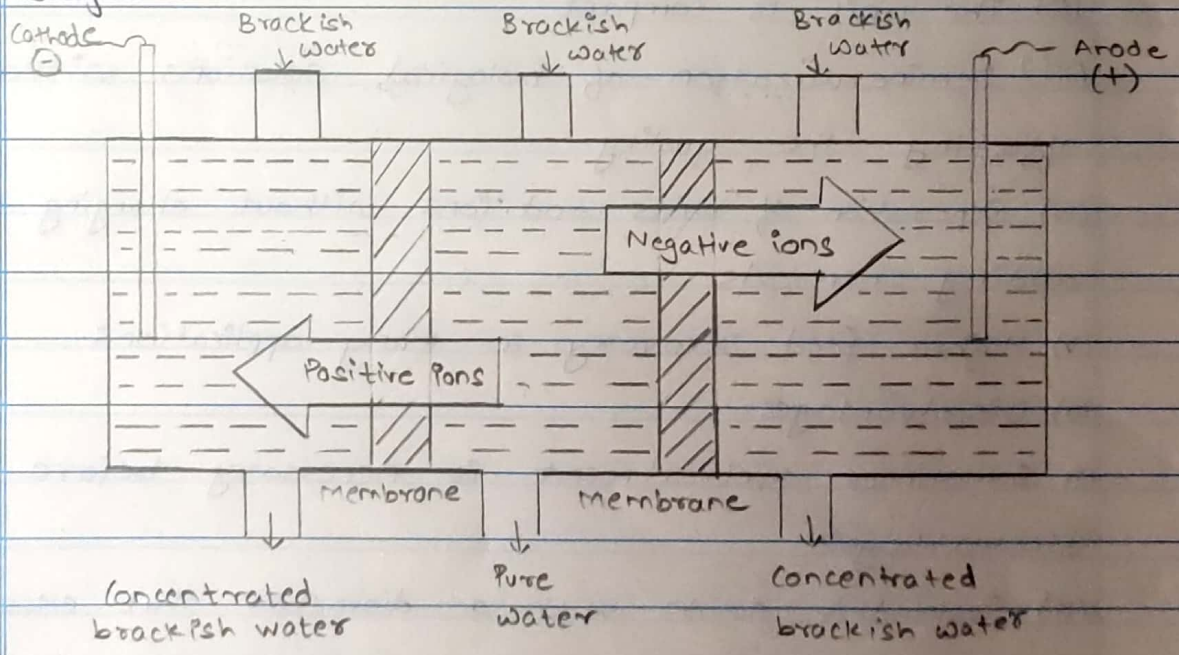
4) Write a short note on electro-dialysis with the help of diagram.

Ans 1) Electrodialysis (ED) is an electro-membrane process in which ions are transported through ion-permeable membranes from one solution to another under the influence of potential gradient.
2) Most salts dissolved in water are ionic, being positively or negatively charged. This ions are attracted to electrodes with an opposite charge.
3) Membranes can be constructed to permit selective passage of either anions or cations.

4) It is an electrically driven membrane seperation process that is capable of seperating, concentrating and purifying selected ions from aqueous solution. The process is based on the property of ion-exchange membranes to selectively reject anions or cations.

5) Electrodialysis is based on the fact that the ions present in the saline water migrate towards respective electrode through ion-selective membranes under the influence of applied emf.

Diagram:



6) The unit consists of electrodes and ion selective membranes. This membranes are thin and rigid which are also permeable to either cation or anion. The anode is placed near anion selective membrane. While the cathode is placed near the cation or anion.

7) Under the influence of an applied emf across the electrodes cations move toward the cathode and anions move towards the anode through respective membranes. There is depletion of ions in the central compartment while it increases in the two side compartments.

8) Desalinated water is taken out from the central compartment and brackish water is replaced by fresh samples.

9) Advantages:

(i) Easy operation and variability of ED equipment.

(ii) The unit is compact.

(iii) Demineralization of biological solutions without affecting the quality.

(iv) Seperation of salts and ions without changing phase and adding chemicals.

(v) Higher feed recovery in many applications.

10) Disadvantages:

(i) Sometimes pretreatment is necessary before the electrodialysis.

(ii) Suspended solids with a diameter that exceeds 10 μm need to be remove else they may plug the membrane pours.

(iii) Substances such as large organic anions, colloids, iron oxides and manganese oxide can disturb the selective effect of the membrane.

5) Write a short note on reverse osmosis with the help of diagram.

Ans i) When two solutions of unequal concentrations are seperated by semi-permeable membrane flow of solvent takes place from low concentrations solution to high concentrations solutions side due to osmosis.

ii) If a hydrostatic pressure in excess of ostomic pressure is applied on higher concentration solution side, solvent starts moving from higher concentration to lower concentration side compartment through semi-permeable membrane, this is the principle of reverse osmosis.

iii) Thus, in the process of reverse osmosis pure solvent is seperated from its contaminants, rather than removing contaminants from water. This membrane filtration is also called 'super filtration' or 'hyper filtration'.

iv) Advantages:

1) Reverse osmosis can be used to remove ionic as well as non-ionic, colloidal and high molecular weight organic matter.

2) It removes colloidal silica which is not removed by demineralization.

3) The process is economical, simple, highly reliable and has low capital and operating cost.

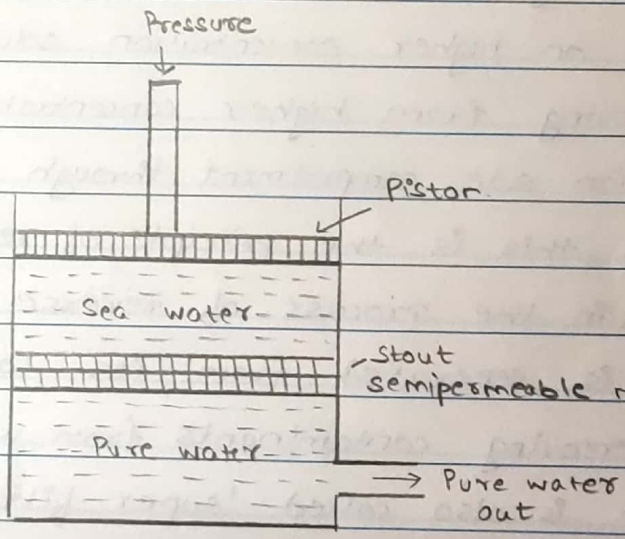
4) The life of the semipermeable membrane is about two years and can be replaced.

v) Disadvantages :

i) RO units use a lot of water but have production efficiency close to 48%.

2) It is not practical for household systems to have low back pressure as it recovers only 5-15% of water that enters the system. This add to the load on the household septic system.

Diagram:



Reverse Osmosis

6) Due to low capital cost, simplicity, low operating cost reverse osmosis is used for desalination and purification of brackish and sea water for drinking and industrial use.

6) Define monomer, polymer and degree of polymerization.

Ans. Monomers:

1) The small molecules which combine with each other to form polymer molecules are termed as monomers.

2) A monomer is a molecule that can be bonded to other identical molecules to form a polymer. Monomers may combine with each other through covalent bonding to give rise to complex and long chains of polymers.

Polymer:

1) Polymers are complex and giant molecules and are different from low molecular weight compounds.

2) A substance which has a molecular structure built up chiefly or completely from a large number of similar units bonded together is called a Polymer.

Degree of Polymerization:

1) The number of repeating units present in the polymer molecule is called degree of Polymerization.

2) The size of the polymer molecule is decided by the degree of polymerization.

7) Explain classification of Polymers.

Ans Polymers can have different chemical structure, physical properties, mechanical behaviour, thermal characteristics etc can be classified as follows:

a) Natural and Synthetic polymers:

Depending on the origin, polymers can be grouped as natural or synthetic.

i) Polymers isolated from natural material are called natural Polymers. Typical examples are cotton, silk, wool and rubber.

2) Polymers synthesized from low molecular weight compounds are called synthetic polymers. Typical examples are PVC, nylon and terylene.

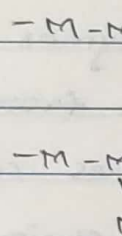
b) Organic and Inorganic Polymers:

i) A polymer whose backbone chain is essentially made of carbon atom is termed as organic polymer. The majority of synthetic polymers are organic.
Eg: polyethylene, polypropene, PVC, etc.

2) If the backbone chain of polymer contains atoms other than carbon, then it is called inorganic polymer.
Eg: silicon polymer, polyphosphate, etc.

c) Homopolymers and co-polymers.

1) When the polymer is obtained by polymerization of a large number of identical monomers it is called homopolymer.



-M-M-M-M Linear Polymer.

-M-M(M)-M-M Branched Polymer.

eg: Polyethene ⇒ $n CH_2 = CH_2 \rightarrow +CH_2-CH_2+_n$

Ethene Polyethylene.

Polystyrene ⇒ $n CH_2 = CH(C_6H_5) \rightarrow +CH_2-CH(C_6H_5)+_n$

2) When the polymer is obtained by polymerization of two or more different monomers, it is called co-polymer.

1) When two different units are distributed randomly throughout, it is random polymer.

2) When two different units are distributed alternatively through the chain, it is alternatively co-polymer.

3) When sequence of one polymer is followed by sequence of other monomer and thus the chain continues, then the polymer is known as block co-polymer.

d) Linear, Branched and Cross-linked Polymers.

1) The linear polymers are the polymers molecules in which each repeating structural part is joined to two other such monomers. The bifunctional monomers generally form the linear polymers.

2) The branched polymers are the polymer molecules that have short branches growing out from the main chain or branch. These short branches comprise of the same repeat units as the main chain.

3) When the monomer molecules are connected to each other by covalent ~~bonds~~ bonds to form a three dimensional network like polymer molecule, it is called as cross-linked polymer.

For example: Bakelite (phenol formaldehyde resin)

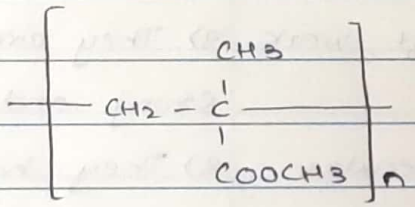
8) Distinguish between thermo plastics and thermosetting polymers.

Thermoplastics	Thermosetting plastics
1) Softens on heating and stiffen on cooling reversibly, by the action of heat.	1) On heating, they are converted into an infusible mass and once set, can't be reshaped.
2) They are formed by addition polymerization.	2) They are formed by condensation polymerization.
3) Contain long chains with negligible cross-links.	3) Contains three-dimensional array of network.

4) They can be remoulded, reshaped and can be used.	4) The cannot be remoulded and reused.
5) They are soluble in organic solvents, some swell-up in solvent.	5) They are usually insoluble in any solvents.
6) They can be reclaimed from the wastes.	6) They cannot be reclaimed from waste.
7) They are usually soft, weak and less brittle.	7) They are usually hard, strong and more brittle.
8) They have low molecular weight as compared to thermosetting.	8) They have high molecular weight as compared to thermoplastics.
9) Neighbouring polymeric chain are held together by weak Vander Waal's forces.	9) Neighbouring polymeric chains are held together by strong covalent bonds in the form of crosslinks.
10) Heating and cooling do not alter chemical nature. Only physical changes are involved on heating.	10) Chemical changes occur on heating.
11) For example: Polyethylene, polystyrene, PVC, nylon etc.	11) For example: phenol formaldehyde, urea formaldehyde, etc.

9) Give sythesis, properties and uses of PMMA.

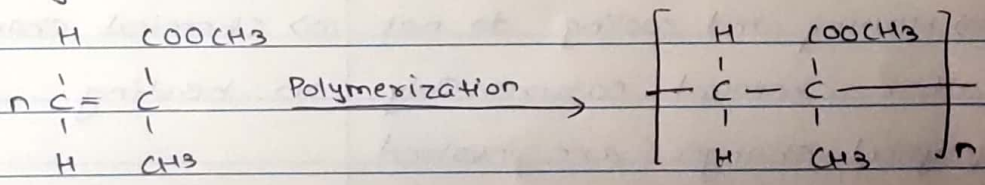
Ans. 1) Polymethyl methacrylate (PMMA) or lucite or Plexiglass is the best known plastic from the acrylates because of its outstanding optical properties. This polymer has the following structure.



2) Synthesis;

(i) The monomer used is methyl methacrylate. Polymethyl methacrylate is obtained by polymerization of methyl methacrylate in presence of acetyl peroxide or hydrogen peroxide. It is an acrylic polymer.

(ii)



(PMMA)

3) Properties:

(1) It is colourless, transparent, hard and fairly rigit material.

(2) It is amorphous because of the presence of bulky side groups in the molecules.

(3) It has high sofetening point of about 130°C to 140°C and becomes rubber like at a temperature about 65°C.

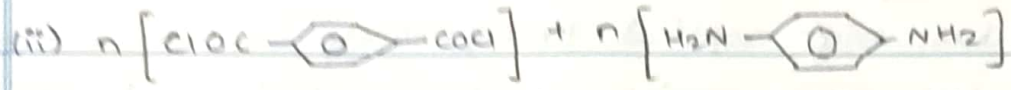
(4) It has high optical transparency.
(5) It has high resistance to sunlight and ability of transmitting light accurately, even in curved sections.
(6) It has low chemical resistance to hot acids and alkalies.
(7) It has low scratch resistance.

4) Uses:
(1) It is used for automotive applications such as in tail and signal light lenses, dials etc.
(2) For making aircraft light fixtures, bomber noses, gun turrets, cockpit canopies, transparent models of complicated mechanisms.
(3) For making bone splints, artificial eyes, dentures, emulsions, paints, adhesives, wind screens, jewellery, TV screens, guards etc.
(4) It's sheets are used for signs, glazing skylights and decorative purpose.

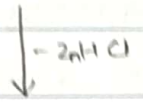
10) Give synthesis, properties and uses of Kevlar.

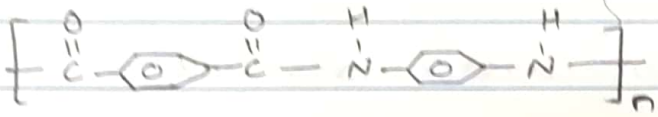
Ans 1) Kevlar is an aromatic polyamide with benzene rings linked to the amide groups -CONH-.

2) Synthesis:
(i) It is prepared by poly condensation between aromatic dichloride and aromatic diamines.

(ii) 

Terephthalic acid dichloride p-Aminoaniline





Kevlar.

3) Properties:

(i) It is exceptionally stoong.

(ii) It has high heat stability and flexibility.

(iii) It is more rigid than nylon.

4) Uses:

(1) It is used in the aeraspace and aircraft industries.

(2) It is used in car parts (tyres, brakes, etc)

(3) It is used in ropes, cables, bullet proof vests, motor cycle helmets etc.