I- B.Tech I-semester End Examinations (supply)
- December - 2025
Engineering chemistry (R22CH102BS)
(common for ECE, CSE & IT)

Time: 3 hrs max. marks: 60

PART-A

1.(a) What are the salts responsible for the temporary and permanent hardness of water?

Ans: Temporary hardness: caused by bicarbonates of calcium and magnesium
- calcium bicarbonate [$Ca(HCO_3)_2$], magnesium bicarbonate [$Mg(HCO_3)_2$]

Permanent Hardness: caused by chlorides and sulphates of calcium and magnesium - $CaCl_2$, $MgCl_2$, $CaSO_4$, $MgSO_4$.

(b) Distinguish scale and sludge:

Ans: Scale: Hard, crystalline deposits firmly sticking to boiler surfaces.
Sludge: Soft, loose, muddy deposits that settle at the bottom of boilers.

(c) Summarize Octane number of petrol.

Ans: It is a measure of the antiknocking quality of petrol defines by comparing it with a mixture of iso-octane (100) and n-heptane (0).

(d). Why are gaseous fuels more advantageous than solid fuels?

Ans: Gaseous fuels are more advantageous because they burn more efficiently with better control produce less smoke and ash, and have higher calorific efficiency than solid fuels

(e) Define reduction potential.

Ans: Reduction potential: It is the tendency of an electrode to gain electrons and undergo reduction measured relative to the standard hydrogen electrode.

(f): Identify the advantages of glass electrode.

Ans: Advantages of glass electrode: It gives accurate pH measurements, works in colored or turbid solutions, and is not affected by oxidizing or reducing agents.

(g). What is galvanic corrosion.

Ans: Galvanic corrosion: It is the corrosion that occurs when two dissimilar metals are electrically connected in the presence of an electrolyte, causing the more active metal to corrode.

(h). The rate of metallic corrosion increases with increase in temperature. Discuss the reason.

Ans: Increase in temperature accelerates electrochemical reactions and ion mobility, thus increasing the rate of metallic corrosion.

(i). What is natural rubber? Explain.

Natural rubber: It is an elastic polymer obtained from latex of rubber trees, mainly composed of cis-1,4 polyisoprene, and is known for its high elasticity & resilience.

(j): Identify classification of conducting polymers.

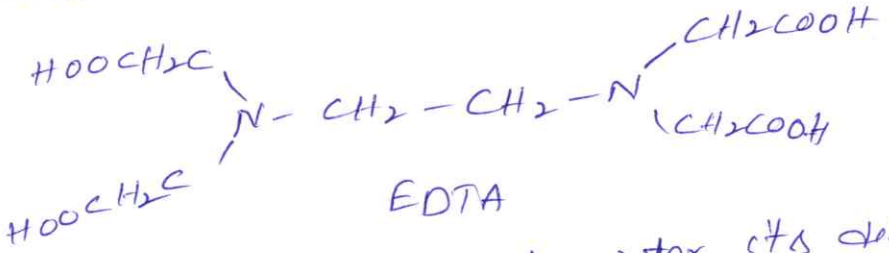
Ans: Classification of conducting polymers.

1. Intrinsically conducting polymers 2. Extrinsically conducting (doped) polymers.

PART-B

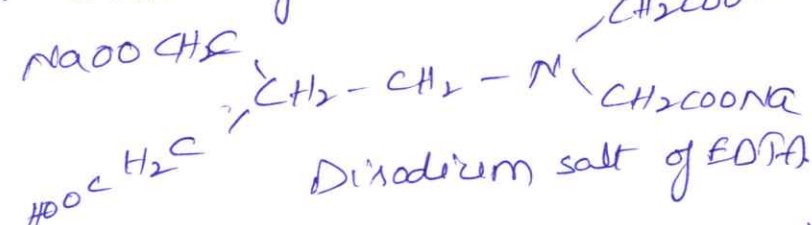
Q 2. Examine the estimation of hardness of water by EDTA method.

Ans: This is a complexometric method where "Ethylene Diamine Tetra Acetic acid "(EDTA)" is the reagent.



EDTA

Since, EDTA is insoluble in water, its disodium salt is used as complexing agent.



Disodium salt of EDTA

Principle: The amount of hardness causing ion (Ca^{+2} & Mg^{+2}) can be estimated by titrating the water sample against EDTA using EBT (Eriochrome Black-T) indicator. at pH of 9-10 inorder to maintain the pH, buffer solution ($NH_4Cl + NH_4OH$) mixture is added only at this pH such a complexation is possible.

When the EBT indicator is added to the water sample it forms wine red coloured weak complex with Ca^{+2} + Mg^{+2} ions.

$$[Ca^{+2}/Mg^{+2}] + EBT \xrightarrow[9-10]{pH} [Ca^{+2}/Mg^{+2} - EBT]$$

wine red coloured weak complex

When this solution is titrated against EDTA, it replaces the indicator from the weak complex form stable EDTA complex. when all the hardness causing ions

are complexed by EDTA, The indicator is set free. The colour of the free indicator is sky blue. Thus the end point is the change of colour from wine red to sky blue.

$$[Ca/Mg\text{-}EBT] + EDTA \xrightarrow[9-10]{PH} [Ca/Mg\text{-}EDTA] + EBT$$

wine red coloured weak complex — stable complex — sky blue

Experimental procedure:

(i) Standardisation of EDTA: pipette out 20 ml of standard hard water into a clean conical flask. Add 5 ml of buffer solution and 2-3 drops of EBT indicator and titrate it against EDTA solution taken in Burette. The end point is the change of colour from wine red to sky blue.

* Let the volume of EDTA consumed be 'x' ml.

(ii) Estimation of total hardness of water sample:

pipette out 20 ml of given hard water sample into a clean conical flask & titrate it against EDTA as before.

* let the volume of EDTA consumed be 'y' ml.

(iii) Estimation of permanent hardness of water sample:

Take 100 ml of same hard water sample in a 250 ml beaker. Boil it for 15 minutes. During Boiling temporary hardness gets removed. cool & filter the solution & make upto 100 ml in a standard flask by adding distilled water.

Pipette out 20 ml of the made up solution into a clean conical flask & titrate it against EDTA as before.

* let the volume of EDTA consumed be 'z' ml.

Calculations:

(i) Standardisation of EDTA:

Volume of standard hard water $= V_1 = 20$ ml

molarity of standard hard water $= M_1 = 0.01$ M

Volume of EDTA consumed $= V_2 = x$ ml

strength of EDTA solution $= M_2 = ?$

According to volumetric law $M_1V_1 = M_2V_2$

$$M_2 = \frac{M_1V_1}{V_2}$$

Strength of EDTA $(M_2) = \frac{20 \times 0.01}{x \text{ ml}}$

(ii) Estimation of total hardness of water:

Volume of hard water sample $= V_3 = 20$ ml

Molarity of hard water sample $= M_3 = ?$

Volume of EDTA consumed $= V_4 = y$ ml

strength of EDTA solution $= M_4 = M_2$

∴ According to volumetric law $M_3V_3 = M_4V_4$

$$M_3 = \frac{V_4M_4}{V_3} = \frac{y \times M_2}{20}$$

∴ Total hardness $= \frac{y \text{ ml} \times M_2}{20} \times 100 \times 1000$ ppm

i.e Total hardness $= \frac{\text{Volume of EDTA} \times \text{strength of EDTA}}{\text{Volume of Hard water sample}} \times 100 \times 1000$ ppm.

(iii) Estimation of permanent hardness of water sample:

Volume of hardwater sample containing permanent hardness $= V_5 = 20$ ml

Strength of hard water sample containing permanent hardness $= M_5 = ?$

Volume of EDTA solution $= V_6 = z$ ml

Strength of EDTA solution $= M_6 = M_2$

According to volumetric law

$$M_5V_5 = M_6V_6$$

$$M_5 = \frac{M_6V_6}{V_5}$$

$$= \frac{2ml \times M_2}{20ml}$$

Permanent hardness $= \frac{2ml \times M_2}{20} \times 100 \times 1000$ ppm

i.e permanent hardness

$$= \frac{\text{Volume of EDTA} \times \text{strength of EDTA}}{\text{Volume of Hard water sample containing Permanent hardness}} \times 100 \times 1000 \text{ ppm.}$$

(iv) · Estimation of temporary Hardness of water sample:

Temporary Hardness of water sample

= Total hardness - permanent hardness.

Q3. Discuss the ion-exchange process of water softening.

Ans: **Ion-Exchange process:**

Ion exchange process includes the exchange of anions and cations of dissolved salts with H^+ and OH^- ions for this two types of ion exchangers are used.

(i) cation exchange resin (or) cation exchanger

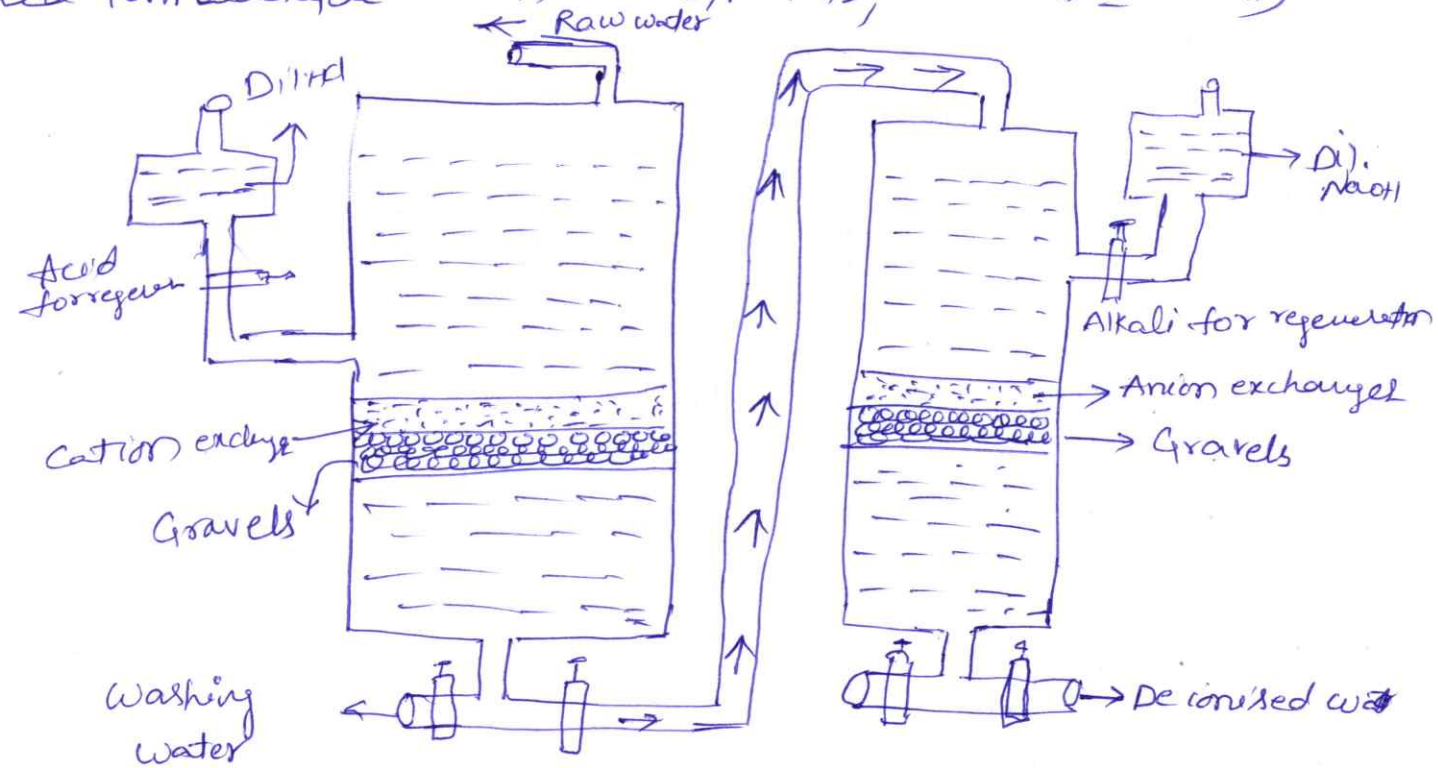
(ii) Anion exchange resin (or) Anion exchanger

cation exchanger: This resin containing acidic functional group ($-COOH$, $-SO_3H$) are capable of exchanging their H^+ ions with other cations of hard water.

Ex:- styrene divinyl benzene copolymer, sulphonated coals, sulphonated polystyrene (RSO_3H, $RCOOH \equiv R-H$).

Anion exchanger: This resin containing basic functional group ($-NH_2$, $-OH$) are capable of exchanging their OH^- ions with other anions of hard water.

Ex: phenol formaldehyde, Amine formaldehyde copolymer urea formaldehyde resin ($R-OH$, $R-NH_2$, $R-NR_3OH \equiv R-OH$)



Raw water is passed through cation exchange and the removal of cation takes place as follows. when water is passed through cation exchange and the removal of cations takes place as follows.

All the Ca^{+2} & Mg^{+2} ions present in hard water are exchanged with H^+ ions of the resin therefore Ca^{+2} and Mg^{+2} ions go into the resin and H^+ ions passed into hard water.

$$2RCOOH + Ca^{+2} \longrightarrow (RCOO)_2Ca + 2H^+$$

$$2RCOOH + Mg^{+2} \longrightarrow (RCOO)_2Mg + 2H^+$$

Now the water is passed into 2nd container called anion exchanger. Its filled with anion exchanger resin (R-OH). All the anion present in hard water are exchanged with OH^- ions of resin. Therefore Anions go into the resin and OH^- ion pass into hard water.

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

$$2R-OH + SO_4^{-2} \longrightarrow R_2SO_4 + 2OH^-$$

The H^+ ions liberated by cation exchange resins and OH^- ions liberated by anion exchange resins combine to form water molecule.

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

Thus water coming out finally from the two exchangers is called deionised or demineralisation.

Regeneration process: on using exchangers for sometime to remove the hardness of water the H^+ ions of cations exchange resins are completely replaced by cations.

Therefore the resins gets deactivated and they have loose the capacity to remove the capacity of hardnes of the They can be regained by passing dil. HCl sol^n through cation exchange.

$$(RCOO)_2Ca + 2HCl \longrightarrow 2RCOOH + CaCl_2$$

Similarly anion exchange reson can be regained by passing dil. base (dil. NaOH) solution.

Q4. Explain proximate analysis of coal with its significance. How is it carried out?

Ans: Proximate analysis:

In this analysis the % of 'C' is indirectly determined. This analysis includes % of moisture, volatile substances, ash content & carbon

(a) Moisture:

A known mass of finely powdered coal is taken in a crucible. It is heated upto 110°C for an hour & cooled to room temperature in a desiccator. The moisture is removed as water vapour & the process is repeated till the constant weight is obtained

$$\% \text{ of moisture} = \frac{\text{loss in weight of coal}}{\text{weight of coal}} \times 100$$

(b) Volatile matter: The above sample is taken & heated at 950°C in the absence of air for 7 min. It is then cooled to room temperature and weighed. The loss of weight is noted as volatile matter & is removed from coal at 950°C.

$$\% \text{ of volatile matter} = \frac{\text{loss in weight due to removal of volatile matter}}{\text{weight of coal}} \times 100$$

(c) Ash content:

Coal (free from moisture & volatile matter) is heated in a crucible at about 700°C in the presence of air. It undergoes combustion & results in the formation of ash. Crucible is cooled at room temperature & weighed. The mass of ash is then determined.

$$\% \text{ of ash} = \frac{\text{mass of ash}}{\text{mass of coal}} \times 100$$

(d) carbon: Since main component of coal is carbon, it can be determined by the difference between 100 & the sum of the percentage of moisture, volatile matter, Ash.

% of carbon = 100 − (% of moisture + % volatile matter + % of ash)

Significance of Analysis:

(i) Moisture: High moisture content in the fuel reduces calorific value increases the cost of transportation & causes wastage of heat. Hence the lesser the moisture content the better is quality of a fuel.

(ii) Volatile matter:

A coal containing high volatile matter burns with long flame, high smoke & low calorific value volatile matter also influences the design of the furnace since the higher volatile matter, larger is the combustion space required

(iii) Ash:

(a) Ash reduces heating value of coal
(b) Ash content increases cost of transportation, handling, storage & disposal.
(c) It determines the quality of coal. Hence, the lesser the % of ash, the better is the quality of coal.

(iv) Fixed carbon:

The higher the fixed carbon in a coal, the greater is its calorific value.

Q.5. What are the advantages of catalytic cracking process? construct and describe moving bed catalytic process.

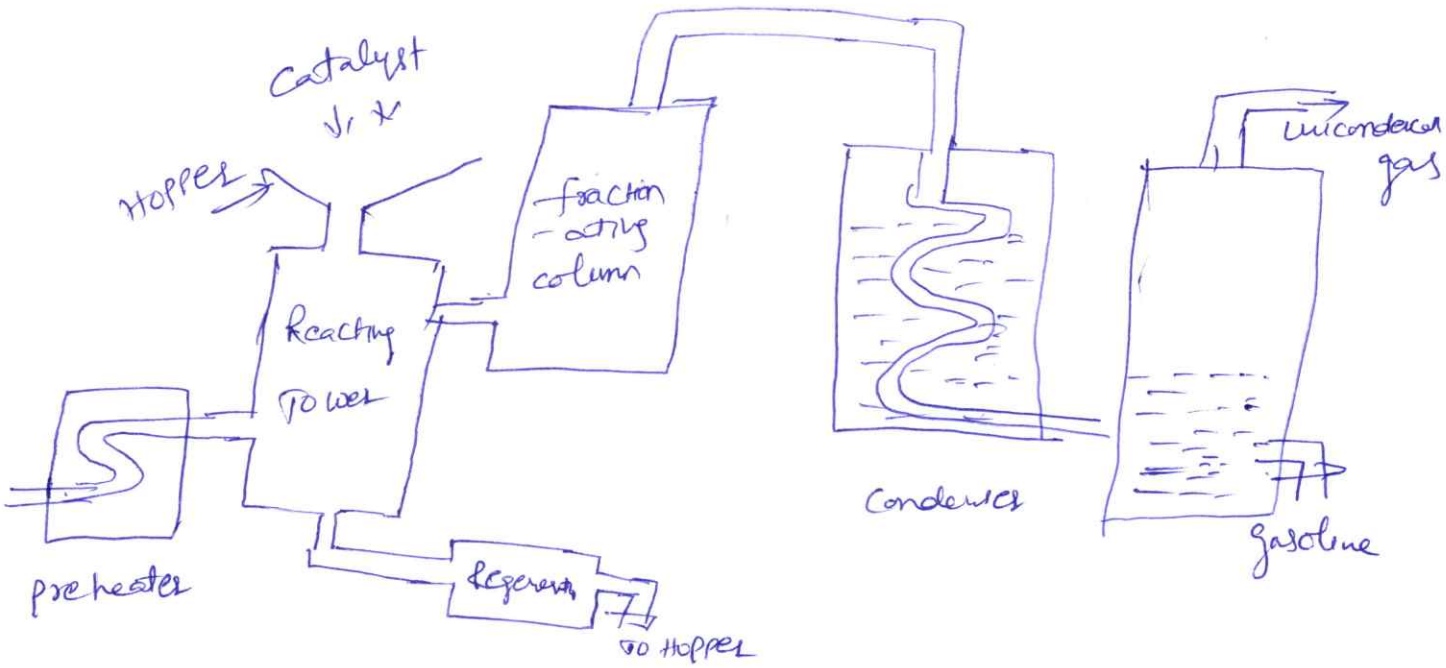
Ans: catalytic cracking:

catalyst are used, the belt is alumeko silicate with some metal oxide (ca, mg, fe, cr, Na). This process completes at low temperature & low pressure compared to thermal process. 300-450°C temperature

1-5 Kg/cm² pressure.

Moving-bed catalytic cracking:

This proces is also called as moving bed catalytic cracking. In order to carryout catalytic cracking continuously fludized catalyst is used. The catalyst is very finely powered & then circulated in the gas stream. Cracking takes place on the surface of the turbulent catalyst bed as it circulates with the oil vapours in the reactor maintained at temperature of 530°C & pressure 3-5 Kg/cm². Here cracking of heavier molecules to lower molecules occur which move upto the top of reactor and enter into the fractionating column and sent to a cooler. where gasoline gets condensed. The exchaused catalyst is taken into the regenerator, where its carbon content is reduced and the catalyst can be reused.



Q 6. (a) Derive Nernst's equation for the calculation of cell emf.

Ans: consider the following Redox reaction

$$M^{n+} + ne^- \rightleftharpoons M$$

for such a redox reversible reaction, the free energy change (ΔG) and its equilibrium constant (K) are inter related as

$$\Delta G = -RT \ln K + RT \ln \frac{[\text{Product}]}{[\text{Reactant}]}$$

$$= \Delta G^0 + RT \ln \frac{[\text{Product}]}{[\text{Reactant}]} \longrightarrow (1)$$

where ΔG^0 = Standard free energy change

The above equation (1) is known as Vant Hoff isotherm.

The decrease in free energy ($-\Delta G$) in the above reaction will produce electrical energy. In the cell, if the reaction involves transfer of 'n' number of electrons, then 'n' faraday of electricity will flow. If E is the emf of the cell. then the total electrical energy (nEF) produced in the cell is

$$-\Delta G = nEF \text{ (or)}$$

$$-\Delta G^\circ = nE^\circ F \longrightarrow (2)$$

where $-\Delta G$ = decrease in free energy change

(or) $-\Delta G^\circ$ = decrease in standard free energy change

comparing eqn (1) & (2). it becomes

$$-nEF = -nE^\circ F + RT \ln \frac{[M]}{[M^{n+}]} \longrightarrow (3)$$

Dividing the above eqn (3) by $-nf$

[$\because$ the activity of solid metal $[M] = 1$]

$$E = E^\circ - \frac{RT}{nf} \ln \frac{1}{[M^{n+}]}$$

In general $E = E^\circ - \frac{RT}{nf} \ln \frac{[\text{product}]}{[\text{Reactant}]}$

(or) $$E = E^\circ + \frac{RT}{nf} \ln [M^{n+}] \text{ (or)}$$

$$E = E^\circ + \frac{2.303\,RT}{nf} \log [M^{n+}]$$

when, $R = 8.314$ J/K/mole, $F = 96500$ coulombs

$T = 298$ K (25°C), the above eqn becomes

$$E = E^\circ_{red} + \frac{0.0591}{n} \log [M^{n+}]$$

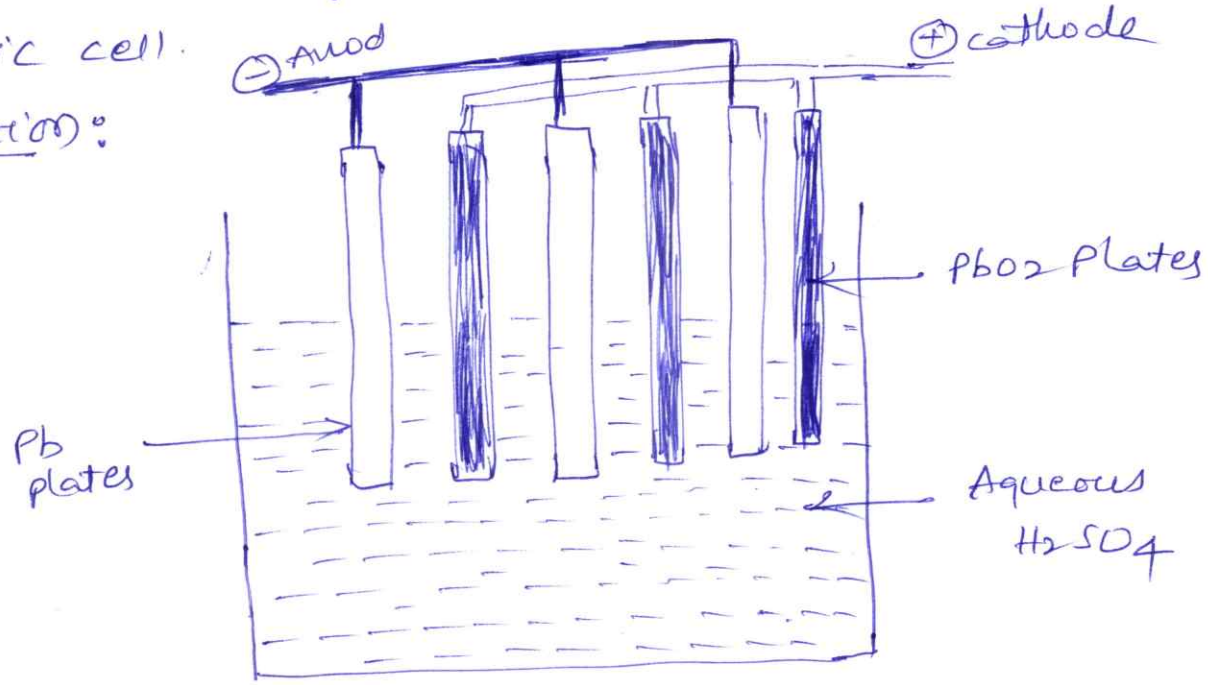
In general $$E = E^\circ_{red} + \frac{0.0591}{n} \log c$$

$$E = E^\circ_{Oxd^n} - \frac{0.0591}{n} \log [M^{n+}]$$

Q 6.b summarize the construction of lead-acid battery with the reactions occuring during discharge.

Ans: A lead acid storage cell is a secondary battery, which can operate both as a voltaic cell and as an electrolytic acell. when it acts as a voltaic cell, it supplies electrical energy and becomes "run down" when it is recharged, the cell operates as an electrolytic cell.

Description:



The cell may be represented as

$$Pb\,|\,PbSO_4\;\|\;H_2SO_{4(aq)}\;|\;PbO_2\,|\,Pb$$

A lead-acid storage battery consists of a number of (3 to 6) voltaic cells connected in series to get 6 to 12 V battery. In each cell, the anode is made of lead. The cathode is made of lead dioxide PbO_2 or a grid made of lead packed with PbO_2. A no. of lead plates (anodes) are connected in parallel and a number of PbO_2 plates (cathodes) are also connected in parallel. various plates are seperates from the adjacent

one by insulators like rubber or glass fibre. The entire combinations is then immersed in dil. H_2SO_4 having a density of 1.30 gm/ml

Working (Discharging)

When the lead-acid storage battery operates, the following reaction occurs.

At anode: lead is oxidized to Pb^{2+} ions, which further combines with SO_4^{2-} forms insoluble $PbSO_4$

$$Pb + SO_4^{2-} \underset{\text{charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} PbSO_4 + 2e^-$$

At cathode: PbO_2 is reduced to Pb^{2+} ions, which further combines with SO_4^{2-} forms insoluble $PbSO_4$

$$PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \underset{\text{charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} PbSO_4 + 2H_2O$$

overall cell reaction during use (discharging):

$$Pb + PbO_2 + 2H_2SO_4 \underset{\text{charging}}{\overset{\text{discharging}}{\rightleftharpoons}} 2PbSO_4 + 2H_2O + \text{Energy}$$

From the above cell reactions it is clear that, $PbSO_4$ is precipitated at both the electrodes and H_2SO_4 is used up. As a result, the concentration of H_2SO_4 decreases and hence the density of H_2SO_4 falls below 1.2 gm/ml. So the battery needs recharging.

Q7. Define fuel cell. Explain the construction and working of H_2-O_2 fuel cell. What are the advantages and limitations of fuel cell?

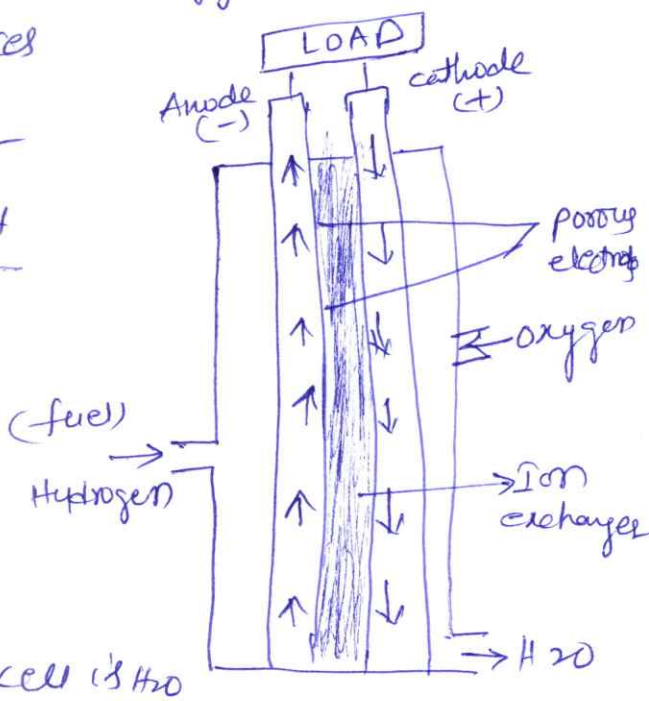
Ans: **Fuel cell:** Fuel cell is a voltaic cell, which converts the chemical energy of the fuels directly into electricity without combustion.

fuel + oxygen → oxidation product + electricity

Eg: Hydrogen-oxygen fuel cell, methyl alcohol – oxygen cell

Hydrogen - oxygen fuel cell

The cell consists of two inert porous electrodes and an electrolyte solution 25% KOH. Through the anode hydrogen gas bubbled and through the cathode oxygen gas is bubbled. Where the following rxn's takes places



cell rxn's: Anode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$

cathode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

Net rxn: $2H_2 + O_2 \rightarrow 2H_2O$

The standard emf of cell

$E^\circ = E^\circ_{oxdn} + E^\circ_{redn}$

$= 0.83 + 0.40$

$E^\circ = 1.23\,V$

The only product discharge by the cell is H_2O

It may be pointed that the electrodes must meet the following requirement (i) Be good conductors (ii) be good electron sources (iii) Not to be consumed by the electrolyte heat con electrode reactions.

Applications: Hydrogen oxygen fuel cells are used as auxiliary energy source in space in space vehicles. The weight of the fuel battery sufficient for 15 days in space is approximately 250kg.

Q8. Discuss Electrochemical corrosion. Explain its mechanism.

Ans: Electrochemical corrosion involves flow of electron current between the anodic and cathodic areas. The anodic reaction involves in dissolution of metal as corresponding metallic ions with the liberation of free electrons.

$$M \longrightarrow M^{n+} + ne^-$$

On the other hand, the cathodic reaction consumes electrons with either by

(a) Evaluation of Hydrogen

(b) Absorption of oxygen

It is depending on the nature of the corrosive environment

(a) Evaluation of Hydrogen

Corrosion occurs, usually in acidic environments the rusting of iron takes place in acidic environment in the following way

$$Fe \longrightarrow Fe^{2+} + 2e^- \quad \text{(oxidation)}$$

These electrons flow through the metal, from anode to cathode where H^+ ions, of acidic solution are eliminated as hydrogen gas

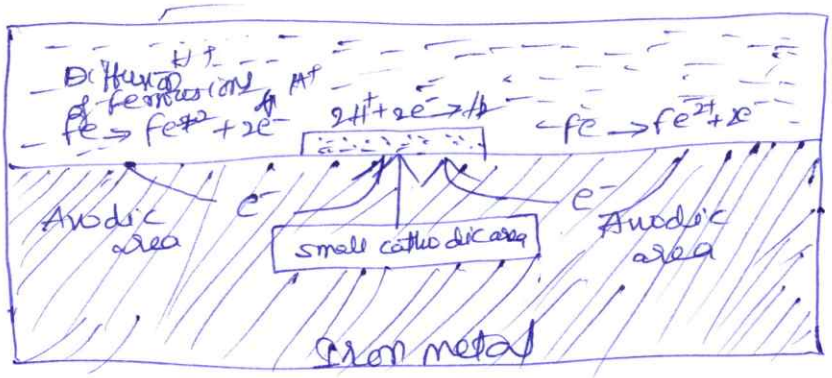
$$2H^+ + 2e^- \rightarrow H_2\uparrow \quad \text{(red}^n\text{)}$$

Thus Fe^{+2} ions are liberated at anode and H_2 gas is liberated at the cathode. The overall reaction in acidic medium is

$$Fe + 2H^+ \longrightarrow Fe^{+2} + H_2\uparrow$$

Thus, this type of corrosion causes, displacement of hydrogen from the acidic sol^n by metal ions

consequently all metals above hydrogen in the electrochemical series having a tendency to get dissolve in acidic soln with simultaneous evolution of hydrogen

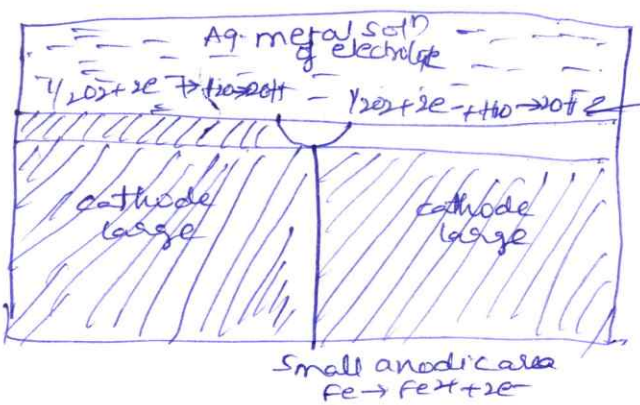


→ It may be pointed here that in hydrogen evaluation of hydrogen corrosion. The anodes are usually very large areas, where as cathodes are small areas.

(b) Absorption of oxygen

Rusting of iron in neutral aqueous solution of electrolytes (like NaCl soln) in the presence of atmospheric oxygen is a common example of this type of corrosion.

The surface of iron is usually coated with a thin film iron oxide. However if this iron oxide film develops, some anodic areas are created on the surface while the well metal parts acts as cathodes. It follows that the anodic areas are small surface parts, while nearly the rest of the surface of the metal forms large cathode.



At the anodic areas of the metal iron dissolves as ferrous ions with liberation of electrons.

$$Fe \rightarrow Fe^{2+} + 2e^- \quad (oxd^n)$$

The liberated electrons flows from anodic to cathodic areas. Through iron metal, where electrons are intercepted by the dissolved oxygen gas

$$1/2\ O_2 + H_2O + 2e^- \rightarrow 2OH^- \quad (red^n)$$

The Fe^{+2} ions and OH^- ions diffuse and when the meet ferrous hydroxide is precipitated.

$$Fe^{+2} + 2OH^- \rightarrow Fe(OH)_2 \downarrow$$

(i) If enough oxygen is present, ferrous hydroxide is easily oxidised to ferric hydroxide

$$4\ Fe(OH)_2 + O_2 + 2H_2O \rightarrow 4Fe(OH)_3$$

This product is called yellow rust

(ii) If the supply of oxygen is limited, the corrosion product may be black i.e Fe_3O_4.

Q9 a) Mention various factors influencing the rate of corrosion.

Ans: The rate and extent of corrosion depends on the following factors.

1- Nature of the metal: when two metals are in electrical contact, the more active metal or the metal having negative reduction potential undergoes corrosion. The rate of corrosion depends upon the differences in their positions and greater is the difference, the fast is the corrosion of the anodic metal.

(2) Galvanic series: Electrode potential of various metals and the alloys in common use are measured by immersing them particularly in sea water and the values have been arranged in decreasing order of activity and is called as Galvanic series

3. over voltage: The overvoltage of a metal in the corrosive environment is inversly proportional to corrosion rate. For example, when a metal say Zn is placed in 1N H_2SO_4 it undergoes corrosion forming a film evalving hydrogen gas. The initial rate of corrosion is slow because of the higher over voltage i.e. 0.70V of zinc metal. But when a small amount of impurities like $CuSO_4$ is added, some copper gets deposited on the zinc metal, thus hydrogen over voltage reduces to 0.33 volts. The reduction in over voltage of corroding metal increase the corrosion rate.

4. Purity of metal: when the metal is 100% pure, the metal will not undergo any type of corrosion. Thus the presence of impurities in a metal create heterogeneity and thus galvanic cells are set up with anodic and cathodic area in the metal. Higher the percent of impurity, faster is the corrosion of the anodic metal.

5. Nature of the oxide film:

The nature of the oxide film formed on the metal surface decides the extent of corrosion which can be decided by the pilling Bedworth Rule.

(i) In the case of alkali and alkaline earth metals such as Mg, Ca etc form oxide whose volume is less than the volume of the metal.

6. Nature of corrosion product:

Solubility: If the corrosion product is soluble in the corroding medium, the corrosion rate will be faster.

Volatility: If the corrosion product is volatile, it volatilizes as soon as it is formed, there by leaving the underlying metal surface exposed for further attack. This causes rapid and continuous corrosion leading to excessive corrosion.

Nature of Environment

1. Temperature: Increase in temperature increases the rxn rate as well as the diffusion rate so that the rate of corrosion is increased.

2- Humidity: Humidity of air is directly related to the corrosion rate. Critical humidity is the relative humidity above which the atmospheric corrosion rate of the metal increases sharply. The basic principle of enhancement of corrosion in humid conditions is that atmospheric gases like CO_2, O_2 etc. dissolves in water to produce the electrolyte which is essential for electrochemical corrosion

3. Presence of corrosion gases: In industrial areas atmosphere is polluted with acidic gases like CO_2, SO_2, H_2S and fumes of HCl, H_2SO_4. These gases produces electrolyte which are acidic and increase the electrochemical corrosion. Similarly in the marine atmosphere, the electrolyte produced will have more chloride ions (Cl^-) which increases the rate of corrosion.

4. Presence of solid suspend particles:

Particles like NaCl, $(NH_4)_2SO_4$ along with moisture act as powerful electrolyte and thus enhancy the electrochemical corrosion.

5. Effect of PH: Generally acidic medium is more corrosive than alkaline medium the corrosion of iron in oxygen free water is very slow upto PH-5. But in presence of oxygen the corrosion rate iron is very high at PH-5 But PH-4.

6. Nature of ions present: Anions like silicates in the presence of medium leads to the formation of insoluble reaction products which stops further corrosion. Where as the chloride ions (Cl⁻) in the medium destroys the protective oxide film & expose the metal for further corrosion.

7. Formation of oxygen concentration cell:

Increase in oxygen in one part of the metal which becomes cathodic & the less oxygenated part becomes anodic and the oxygen concentration cell setup resulting in corrosion.

$2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ (cathodic reaⁿ)

The reaction takes place with more oxygen concentration.

$Fe \rightarrow Fe^{2+} + 2e^-$ (anodic reaⁿ)

The reaction caused the ionisation of the metal i.e corrosion in the anodic region where there is less oxygen concentration.

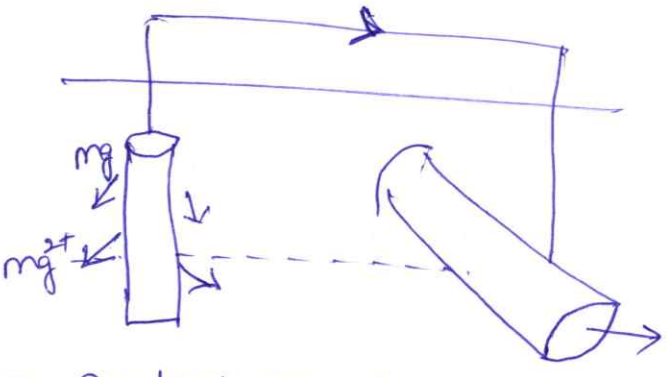
→ corrosion of pipelines, cables etc. passing from one kind of soil to another are due to the differential aeration in the soil.

9

(b) Explain sacrificial anodic protection method of controlling corrosion.

Ans: Sacrificial anodic protection method:

In this protection method, the metallic structure (to be protected) is connected by a wire to a more anodic metal. So that all the corrosion will takes place only on the anodic metal. The artificially made anode these gets gradually corroded, protecting the original metallic structure. And hence this process is other wise known as "sacrificial anodic protection". metals commonly used as sacrificial anodes are Zn, mg, Al and their alloys



Applications:- protection of buried pipelines, underground cables, marine structures, water tanks etc...

10Q: Develop the free radical polymerization mechanism of PVC.

Ans: Free radical polymerization mechanism of PVC

The homolytic fission of a bond gives free radicals. free radicals initiates and propagates the polymerisation as follows.

a- Initiation: Initiators are unstable compounds & undergo homolytic fission to produce free radicals which reacts with π electrons of the monomer to produce monomer free radicals.

$I_2 \xrightarrow{h\nu/\Delta} I^{\cdot} + I^{\cdot}$

Free radical

$I^{\cdot} + CH_2=CH(Cl) \longrightarrow I-CH_2-CH^{\cdot}(Cl)$

monomer free radical

(b) Propagation:

The monomer free radicals reacts with a number of monomers rapidly resulting the chain growth with free radical site at the end of the chain producing a living polymer.

$I-CH_2-CH^{\cdot}(Cl) + CH_2=CH(Cl) \longrightarrow I-CH_2-CH(Cl)-CH_2-CH^{\cdot}(Cl)$

Growing chain.

$I-CH_2-CH(Cl)-CH_2-CH^{\cdot}(Cl) + n.\,CH_2=CH(Cl) \longrightarrow I-CH_2-CH(Cl)\left[CH_2-CH(Cl)\right]_n CH_2-CH^{\cdot}(Cl)$

(Living Polymer)

By adding fresh monomer to the living polymer with free radical site again chain growth starts. Hence it is known as living polymer.

(c) Termination: Termination takes place in two ways.

(i) Self Termination: In this step on growing polymer combine with other growing polymer produce a dead polymer.

$I-CH_2-CH(Cl)\left[CH_2-CH(Cl)\right]_n CH_2-CH^{\cdot}(Cl) + \dot{C}H(Cl)-CH_2\left[CH(Cl)-CH_2\right]CH(Cl)-CH_2-I$

$\downarrow$

$I-CH_2-CH(Cl)\left[CH_2-CH(Cl)\right]_n CH_2-CH(Cl)-CH(Cl)-CH_2\left[CH(Cl)-CH_2\right]CH(Cl)-CH_2-I$

(ii) Termination by disproportionation:

Hydrogen from the growing chain is abstracted by other growing chain, utilising the lone electron for getting stabilised

$I-CH_2-CH(Cl)\left[CH_2-CH(Cl)\right]_n CH(Cl)-CH^{\cdot}(Cl) + \dot{C}H_2-CH_2\left[CH(Cl)-CH_2\right]_n CH(Cl)-CH_2-I$

$\downarrow$

$I-CH_2-CH(Cl)\left[CH_2-CH(Cl)\right]_n CH=CH(Cl) + CH_2-CH_2\left[CH(Cl)-CH_2\right]_n CH(Cl)-CH_2-I$

Q 11. Outline why natural rubber need vulcanization. How is it carried out?

Ans: Vulcanization of Rubber:

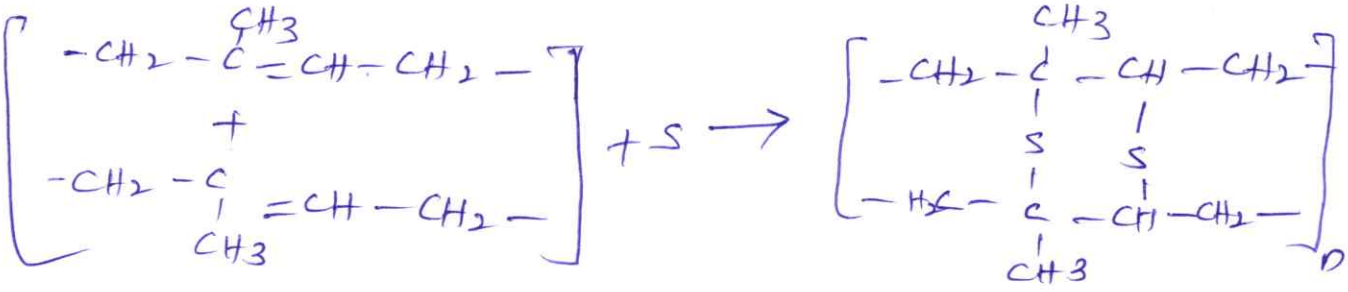
The process of vulcanization consists of heating the raw rubber with sulphur to about 110–140°c to improve the quality of rubber is called vulcanization

The added sulpher combines chemically at the double bonds of rubber chains and cross links of the linear polymer chains resulting in a three dimensional network structure. Thus the rubber loses plastic state and acquires elastic state.

The most important vulcaniser is sulphur some chemicals like elemental sulphur, hydrogen sulphide, sulpher dichloride, benzoyl chloride and zinc oxide are added to rubber

"For vulcanization 5–3%. Sulphur is required. Strength, toughness, brittleness are depends upon the percentage of sulphur added".

If the percentage of sulphur is more than 32%. that rubber is called ebonite or vulcanite or hard rubber.



Advantages of Vulcanization:

Vulcanized rubber has

(i) Good tensile strength

(ii) low water absorption tendency

(iii) Good durability

(iv) Higher resistance to oxidation

(v) High stiffness

(vi) Good resistance to change in temperature

(vii) Good resistance to swelling in organic solvents.