

8.1) Types of Corrosion:-

- 1.) Uniform Corrosion → Uniform corrosion is considered an even attack across the surface of a material and is the most common type of corrosion. It is also the most benign as the extent of the attack is relatively easily ~~is~~ judged, and the resulting impact on material performance is fairly easily evaluated due to an ability to consistently reproduce and test the ~~the~~ phenomenon.
- 2.) Pitting Corrosion → Pitting is a localized form of corrosion, in which either a local anodic point, or more commonly a cathodic point, forms a small corrosion cell with the surrounding normal surface. Pits typically penetrate from the surface downward in a vertical direction.

Types of Pitting Corrosion:-

a) Through Pits

Narrow deep



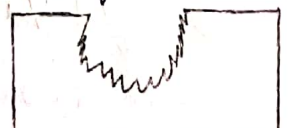
Shallow deep



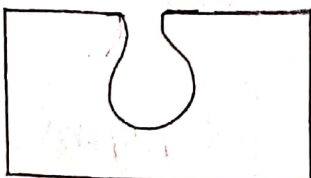
elliptical



Vertical grain attack



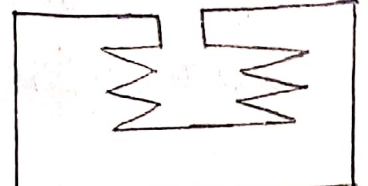
b) Sideway Pits Subsurface



Undercutting



Horizontal grain attack



- 3.) Crevise Corrosion → It occurs in shielded areas where oxygen is restricted. These smaller areas allow for a corrosion agent to enter but do not allow enough circulation within, depleting the oxygen content, which prevents repassivation.
- 4.) Intergranular Corrosion → It can be caused by impurities present at these grain boundaries or by the depletion or enrichment of an alloying element at the grain boundaries. It occurs along or adjacent to these grains, seriously affecting the mechanical properties of a metal while the bulk of the metal remains intact.
- 5.) Stress Corrosion Cracking → It may result from external stress such as actual tensile loads on the metal or expansion/contraction due to rapid Temp. change. In stress corrosion, the majority of the surface usually remains intact; however, fine cracks appear in the microstructure making the corrosion hard to detect.
- 6.) Galvanic Corrosion → It is the degradation of one metal near a joint or juncture that occurs when two electrochemically dissimilar metals are in electrical contact in an electrolytic environment.

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Prevention Control Methods

- 1.) Metal type → one simple way to prevent corrosion is to use a corrosion resistant metal such as aluminium or stainless steel.
- 2.) Protective Coating → the application of a paint coating is to act as a barrier to prevent the transfer of electrochemical charge from the corrosive solution to the metal underneath.
- 3.) Environmental Measures → Corrosion is caused by a chemical reaction b/w metal and gases in the surrounding environment. By taking measures to control the environment, these unwanted reactions can be minimized.
- 4.) Electroplating → It is the process by which a metal (I) is coated with a thin layer of another metal (II) using electrolysis. In this way, the new metal coating protects the metal (I) from corrosion.
- 5.) Galvanization → This process involves coating iron with a thin layer of zinc. It is generally done by dipping iron in molten zinc.
- 6.) Sacrificial Coatings → It involves coating the metal with another metal. Types:
1) Cathodic protection
2) Anodic protection
- 7.) Corrosion Inhibitors → These are chemicals that react with surface of the metal or the surrounding gases to suppress the electrochemical reactions leading to corrosion.

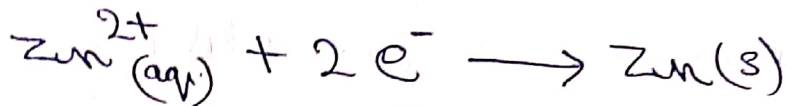
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Q.2) (a.) given ; $T_{\text{temp}} = 25^\circ\text{C} = 298\text{K}$
conc.ⁿ of $\text{ZnSO}_4 = 0.1\text{M}$

$\therefore 0.1\text{M ZnSO}_4$ sol.ⁿ is 95% dissociated

$$[\text{Zn}^{2+}] = 0.1 \times \frac{95}{100} = 0.095\text{M}$$

\therefore The electrode reac.ⁿ is



Now, using Nernst Eq.ⁿ

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{n} \log \frac{1}{[\text{Zn}^{2+}]}$$

$$E_{\text{Zn}^{2+}/\text{Zn}} = E_{\text{Zn}^{2+}/\text{Zn}}^\circ - \frac{0.059}{2} \log \frac{1}{(0.095)}$$

$[\because n=2]$

$$= -0.76 - 0.0302$$

$$[\because E_{\text{Zn}^{2+}/\text{Zn}}^\circ = -0.76]$$

$$\therefore \boxed{E_{\text{Zn}^{2+}/\text{Zn}} = -0.7902\text{V}}$$

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Q.2) (B) λ_m^∞ for $\text{Ba}(\text{OH})_2 = 457.6 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$
 λ_m^∞ for $\text{BaCl}_2 = 240.6 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$
 λ_m^∞ for $\text{NH}_4\text{Cl} = 129.8 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$

Now, we know



$$\therefore \lambda_m^\infty [\text{Ba}(\text{OH})_2] + 2 \lambda_m^\infty (\text{NH}_4\text{Cl}) = 2 \lambda_m^\infty (\text{NH}_4\text{OH}) + \lambda_m^\infty \text{BaCl}_2$$

$$457.6 + 2(129.8) = 2 \lambda_m^\infty (\text{NH}_4\text{OH}) + 240.6$$

$$\therefore \lambda_m^\infty (\text{NH}_4\text{OH}) = 238.3 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

Q.3) (a) Calculation of CaCO_3 equivalents:

<u>Constituents</u>	<u>Multiple factor</u>	<u>CaCO_3 equivalent</u>
$\text{Mg}(\text{HCO}_3)_2 = 73 \text{ mg/L}$	$100/146$	$73 \times \frac{100}{146} = 50 \text{ mg/L}$
$\text{Ca}(\text{HCO}_3)_2 = 162 \text{ mg/L}$	$100/162$	$162 \times \frac{100}{162} = 100 \text{ mg/L}$
$\text{MgCl}_2 = 95 \text{ mg/L}$	$100/95$	$95 \times \frac{100}{95} = 100 \text{ mg/L}$
$\text{CaSO}_4 = 136 \text{ mg/L}$	$100/136$	$136 \times \frac{100}{136} = 100 \text{ mg/L}$

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\therefore Temporary Hardness of water due to $Mg(HCO_3)_2$
and $Ca(HCO_3)_2 = 100 + 50 = 150 \text{ mg/L or ppm}$

\therefore Total hardness of water = $50 + 100 + 100 + 100$

$$\Rightarrow 350 \text{ ppm or mg/L}$$

Q.3 / (b.) An ion exchange is the reversible exchange of ions b/w a liquid and a solid. This process is generally used to remove undesirable ions from a liquid and substitute acceptable ions from the solid (resin). The devices in which ion exchange occurs are commonly called deionizers.

Calculation of $CaCO_3$ equivalents:

<u>Constituents</u>	<u>multiplication factor</u>	<u>$CaCO_3$ equivalent</u>
$MgCl_2$ (7.3 mg/L)	$100/73$	$7.3 \times \frac{100}{73} = 10$
$Al_2(SO_4)_3$ (34.2 mg/L)	$100/114$	$34.2 \times \frac{100}{114} = 30$
$MgCl_2$ (9.5 mg/L)	$100/95$	$9.5 \times \frac{100}{95} = 10$

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$$\begin{aligned}\text{Lime requirement} &= \frac{74}{100} [\text{HCl} + 3 \text{Al}_2(\text{SO}_4)_3 + \text{MgCl}_2] \times \frac{\text{Vol.}^m \text{ of Water}}{100\% \text{ purity}} \\ &= \frac{74}{100} (10 + 90 + 10) \times 100000 \times \frac{100}{90} \\ &= 9.04 \text{ Kg}\end{aligned}$$

$$\therefore \text{Lime required} = 9.04 \times \frac{110}{100} = 9.944 \text{ Kg}$$

(using 10% excess)

$$\begin{aligned}\text{Soda requirement} &= \frac{106}{100} [\text{HCl} + \text{Al}_2(\text{SO}_4)_3 + \text{MgCl}_2] \times \frac{\text{Vol.}^m \text{ of Water}}{100\% \text{ purity}} \\ &= \frac{106}{100} (10 + 90 + 10) \times 100000 \times \frac{100}{98} \\ &= 11.8 \text{ Kg}\end{aligned}$$

$$\begin{aligned}\therefore \text{Soda required (using 10\% excess)} &= 11.8 \times \frac{110}{100} \\ &\Rightarrow 12.98 \text{ Kg}\end{aligned}$$

Q.4 (a) 10 L of NaCl contains ~~1.0~~ $1.0 \times 10 = 10$ gm of NaCl

CaCO₃ Equivalent:- $2 \text{NaCl} = \text{CaCO}_3$
 $2 \times 58.5 = 100 \text{ gm}$
 $58.5 = 50 \text{ gm}$

Thus, 10 gm of NaCl Equivalent to $10 \times \frac{50}{58.5}$ gm of CaCO₃

1000 L of H₂O contains $\Rightarrow 10 \times \frac{50}{58.5}$ gm of NaCl as CaCO₃

$$= \frac{10}{1000} \times \frac{50}{58.5} \text{ gm of NaCl as CaCO}_3$$

$$\therefore 1 \text{ L of H}_2\text{O contains} = \frac{10}{1000} \times \frac{50}{58.5} \times 1000 \text{ mg NaCl excess}$$

$$\Rightarrow \boxed{8.54 \text{ ppm}}$$

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Q.4)(b) Conc.^n of NaCl = 58.5 mg/L

Vol.^n of NaCl solⁿ = V

Vol.^n of hard water to be softened = 10L

Hardness = 100 ppm

$$H = \frac{50 \times \text{Conc. of NaCl (mg/L)} \times \text{Vol.}^n \text{ of NaCl (L)}}{58.5 \times \text{Vol.}^n \text{ of hard water (L)}}$$

$$100 = \frac{50 \times 58.5 \times V}{58.5 \times 10}$$

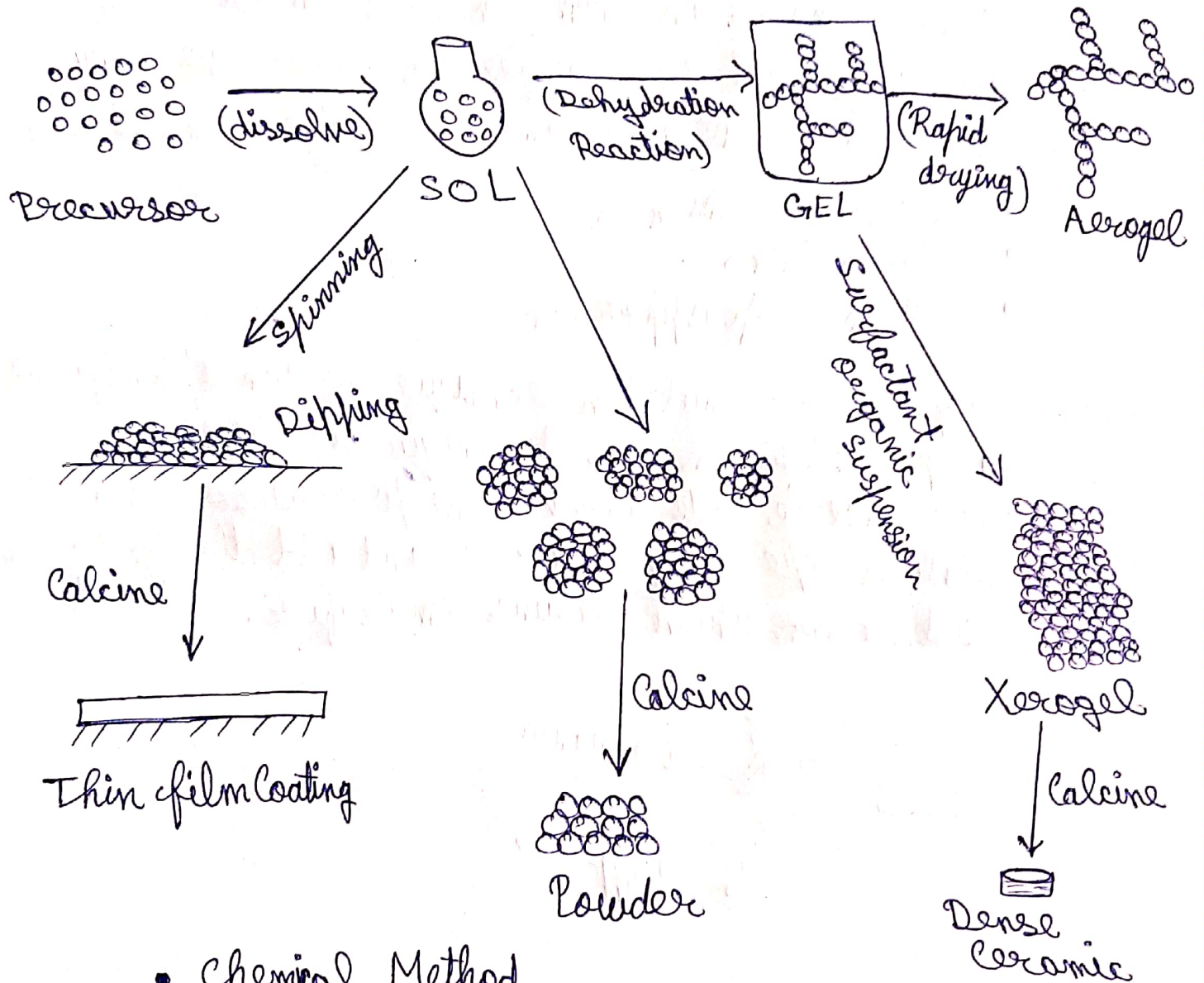
$$V = \frac{1000}{50}$$

$$\therefore \boxed{V = 20L}$$

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8.5) Sol gel Method

Sol gel processing refers to the hydrolysis and condensation of alkoxide-based precursors such as $\text{Si}(\text{OEt})_4$ (tetraethyl orthosilicate)



- Chemical Method
- Solution Phase
- Bottom-up Approach

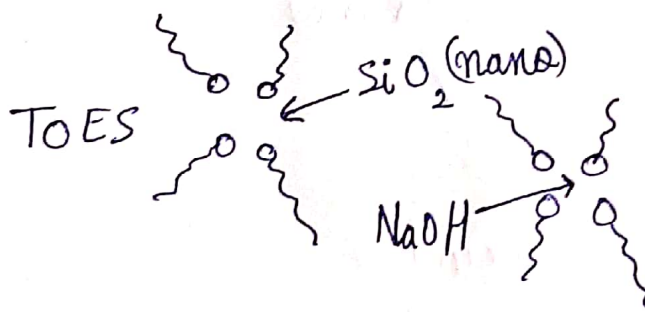
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Micro - Emulsion Synthesis

If a surfactant possessing balanced hydrophilic and lipophilic properties is used in the right concentration, a different oil and water system will be produced. The system remains an emulsion, but exhibits some characteristics that are different from the milky emulsions. These new systems are "microemulsions".

- Chemical Method
- Solution Phase
- Bottom-up Approach

In case of Micro-emulsion technique we can optimize the size of nanoparticles. In this technique we prepare reverse micelle. We dissolve the precursor and the catalyst separately in water and add the ~~to~~ aq. sol. in oil ~~both~~ bath which contains emulsifier.



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