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Engineering Chemistry

Assignment - I

Name: Vansh Sharma
Course: B.tech CSE (AI & ML)
Enrollment Number: 2427010625
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Ques-1 How many grams of $FeSO_4$ are required to dissolve per litre to prepare a water sample of 210.5 ppm hardness?

Ans 210.5 ppm $= 210.5$ mg/L $CaCO_3$ equivalent

MM ($CaCO_3$) $= 100$ g/mol , MM ($FeSO_4$) $= 151.91$ g/mol

Amount of $FeSO_4$ $= \frac{210.5 \times 151.91}{100} = 319.85$ mg/L

$= 0.31985$ g/L

Ques-2 Calculate temp. & perm. hardness of a water sample containing
$Ca(HCO_3)_2 = 162$ mg/L ; $Mg(HCO_3)_2 = 73$ mg/L
$MgCl_2 = 95$ mg/L , $CaSO_4 = 136$ mg/L.

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Ans Temp. hardness = $Ca(HCO_3)_2 + Mg(HCO_3)_2$
Perm. hardness = $MgCl_2 + CaSO_4$

$CaCO_3$ equivalent = 100 g / mol

~ $Ca(HCO_3)_2 = (162/162) \times 100 = 100$ mg/L

~ $Mg(HCO_3)_2 = (73/146) \times 100 = 50$ mg/L

☆ Temporary Hardness = 100 + 50 = 150 mg/L

~ $MgCl_2 = (95/95) \times 100 = 100$ mg/L

~ $CaSO_4 = (136/136) \times 100 = 100$ mg/L

☆ Permanent Hardness = 200 mg/L

Ques-3 A water sample contains
Ca^{+2} = 30 mg/L, Mg^{+2} = 24 mg/L,
CO_2 = 24 mg/L, HCl = 50 mg/L, K^+ = 10 mg/L
Cal. quantities of line (90% pure) & soda (94% pure) to soften 1000 l of Water.

Ans ~ $Ca^{+2} = (30/40) \times 100 = 75$ mg/L $CaCO_3$
~ $Mg^{+2} = (24/24) \times 100 = 100$ mg/L $CaCO_3$
~ $CO_2 = (24/44) \times 100 = 54.55$ mg/L $CaCO_3$
~ $HCl = (50/36.5) \times 100 = 136.99$ mg/L $CaCO_3$

Lime ($Ca(OH)_2$) required = CO_2 + HCl + Mg^{+2}
= 291.54 mg/L $CaCO_3$

$= (291.54/100) \times 74 = 215.74$ mg/L

☆ For 1000 L = 215.74 g

With 90% purity = 215.74/0.9
= 239.71 g

Soda required = $Ca^{+2} + Mg^{+2}$

= 175 mg/L $CaCO_3$

= $(175/100) \times 106 = 185.5$ mg/L

☆ For 1000 L = 185.5 g

☆ With 94% purity

Lime = 239.71 g
Soda = 197.34 g

Ques-4 A standard hard water contains 0.15 g of $CaCO_3$ per L. About 20 ml of this solution require 25 ml of EDTA sol^n & 100 ml of sample water require 18 ml EDTA. Sample after boiling require 12 ml EDTA sol^n. Calculate temporary hardness (ppm).

Ans 20 ml standard × 150 mg/L = 25 ml EDTA
EDTA strength = $(20 \times 150)/25$ = 120 mg/L $CaCO_3$ per ml EDTA

→ Total Hardness = 100 x 18 = 18 x 120
= 2160 mg / L ÷ 100 ml
= 216 ppm

→ Permanent Hardness = 100 ml boiled x
12 ml EDTA
= 1440 mg / L ÷ 100 ml
= 144 ppm

→ Temp hardness = 72 ppm

Ques-5 What are ion exchange resins ? How can you purify water by using these resins ? What are advantages of this method over Zeolite method ?

Ans Ion exchange resins are polymeric materials with functional Groups that exchange ions with water impurities, they purify water by removing cations & anions leaving pure H_2O.
It is better than Zeolite method because it removes all ions & produces deionized water.

Ques-6 Briefly describe the free radical mechanism of polymerization of 1, 3 butadiene.

Ans (1) Initiation:
Free radical (R·) adds to 1-3-butadiene, forming allylic radical

(2) Propagation:
Radical adds to another 1-3-butadiene, forming polymer chain (1, 4 or 1, 2 addⁿ).

(3) Termination:
Two radicals combine or disproportionate, ending chain Growth.

Ques-7 Equal masses of polymers with MM $M_1 = 10000$ & $M_2 = 100000$ are mixed together. Calculate number & weight avg of MM.

Ans Equal masses, assume 1g each:

- $n_1 = 1/10000 = 0.0001$ mol
- $n_2 = 1/100000 = 0.00001$ mol

- $M_n = (1+1)/(0.0001 + 0.00001) = 2/0.00011$
  $= 18,181.82$ g/mol

- $M_w = (1 \times 10000 + 1 \times 100000)/2 = 55000$ g/mol

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Ques-8 Complete following reactions

i) $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_2 \downarrow + 2H_2O$

ii) $MgCl_2 + Ca(OH)_2 \rightarrow Mg(OH)_2 \downarrow + CaCl_2$

iii) $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 \downarrow + 2NaCl$

iv) $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 \downarrow + H_2O$

Ques-9 Briefly describe the cationic polymerization of 1, 3 butadiene.

Ans → Initiation: H^+ / Lewis Acid adds to 1, 3 - butadiene, forming Carbocation.

→ Propagation: Carbocation adds to another 1, 3 - butadiene, favoring 1, 4 addition due to stability.

→ Termination: Chain Growth stops by loss of H^+ or reac^n with Nucleophile.

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