Applied chem. Sums + Que Bank

With S.H.W — equivalence based :- ①

Que Calculate the hardness of water sample whose 20 ml required 30 ml of EDTA ; 10 . of $CaCl_2$ solution whose strength is equivalent to 30 mg of $CaCO_3$ per 200 ml, required 20 ml of EDTA .

Prepⁿ of S.H.W.

200 ml of S.H.W containing 300 mg of $CaCO_3$ eq.

$\therefore$ 1 ml of SHW $\equiv \frac{300}{200} = \frac{3}{2}$ mg of $CaCO_3$ eq.

$\boxed{1 \text{ ml of S.H.W} \equiv 1.5 \text{ mg of } CaCO_3 \text{ eq.}}$ — ①

(I) Titration :- Strength of S.H.W $\equiv$ Strength of $CaCl_2$ solⁿ

$\therefore$ 10 ml of S.H.W $\equiv$ 10 ml $CaCl_2$ solⁿ

(given that 10 ml $CaCl_2$ taken, whose strength is equivalent to S.H.W)

Thus 10 ml of S.H.W required 20 ml of EDTA.

10×1.5 mg of $CaCO_3$ eq $\equiv$ 20 ml of EDTA

or 20 ml of EDTA $\equiv$ 10×1.5 mgs of $CaCO_3$ eq. ($\because$ 1 ml S.H.W $\equiv$ 1.5 mg of $CaCO_3$ eq ①)

$\therefore$ 20 ml of EDTA $\equiv$ 15 mgs of $CaCO_3$ eq.

$\therefore$ $\boxed{1 \text{ ml of EDTA} \equiv \frac{15}{20} \text{ mgs of } CaCO_3 \text{ eq}}$

$\equiv \boxed{.75 \text{ mgs of } CaCO_3 \text{ eq}}$ — (ii)

(II) Titration :-

20 ml of Sample requires 30 ml of EDTA

$\equiv 30 \times .75$ mgs of $CaCO_3$ eq

($\because$ 1 ml EDTA $\equiv$ .75 mg of $CaCO_3$ from ①)

20 ml of sample $\equiv$

$\therefore$ 1000 ml Sample $\equiv \frac{30 \times .75 \times 1000}{20}$ mg of $CaCO_3$ eq

$\equiv \boxed{1125 \text{ ppm}}$

Scanned by CamScanner

Calculation of hardness water sample (3)

Que. If 50 ml of a sample of Hard water consumes 15 ml of 0.01 M EDTA. What is the hardness of the water sample?

with
ans

Sol^n

$\boxed{0.01M\ EDTA \equiv 0.01M\ CaCO_3\ eq \equiv 1\ mg/ml}$

0.01M EDTA. (Disodium salt is used).

1M EDTA (Disodium salt) $\equiv$ 1M $CaCO_3$ eq.

0.01 M EDTA (disodium salt) $\equiv$ 0.01M $CaCO_3$ eq.

For 1M $CaCO_3$ eq. we dissolve mol. wt. 1 mol of $CaCO_3$ means

1 molar (1M) means

mol. wt = 100 g / L

$\boxed{1M \equiv 100g\ CaCO_3\ eq. / L}$ ($\because$ $CaCO_3$ mol. wt. = 100)

$\therefore$ $0.01M \equiv \frac{100}{100}$ g / L

$\left(\frac{1}{100}M\right) \equiv 1$ g / L

0.01M or $\frac{1}{100}$ M $\equiv$ 1 g / L

$\therefore$ For 0.01M $\equiv$ 1 g $CaCO_3$ eq. / L

$\equiv$ 1000 mg $CaCO_3$ eq. / 1000 ml

$\equiv$ 1 mg / 1 ml.

$\therefore$ 15 ml of 0.01M EDTA (Bivalent) $\equiv$ 15 ml of 0.01M $CaCO_3$ eq. (Bivalent)

$\therefore$ 15 ml of 0.01M $CaCO_3$ eq. $\equiv$ 15 mg $CaCO_3$ eq.

($\because$ 15 × 1 mg $CaCO_3$ eq)

Scanned by CamScanner

Applied chem. Sums + Que. Bank

With S.H.W — equivalence based :- (1)

Que Calculate the hardness of water sample whose 20 ml required 30 ml of EDTA, 10. of $CaCl_2$ solution whose strength is equivalent to 30 mg of $CaCO_3$ per 200 ml, required 20 ml of EDTA.

Prepⁿ of S.H.W.

200 ml of S.H.W containing 300 mg of $CaCO_3$ eq.

$\therefore$ 1 ml of S.H.W $\equiv \frac{300}{200} = \frac{3}{2}$ mg of $CaCO_3$ eq.

$\boxed{1 \text{ ml of S.H.W} \equiv 1.5 \text{ mg of } CaCO_3 \text{ eq.}}$ — (I)

(I) Titration :-

Strength of S.H.W $\equiv$ Strength of $CaCl_2$ solⁿ.

$\therefore$ 10 ml of S.H.W $\equiv$ 10 ml $CaCl_2$ solⁿ

(given that 10 ml $CaCl_2$ taken whose strength is equivalent to S.H.W)

Thus 10 ml of S.H.W required 20 ml of EDTA.

10×1.5 mg of $CaCO_3$ eq $\equiv$ 20 ml of EDTA

or 20 ml of EDTA $\equiv$ 10×1.5 mgs of $CaCO_3$ eq.

($\because$ 1 ml S.H.W $\equiv$ 1.5 mg of $CaCO_3$ eq (I))

$\therefore$ 20 ml of EDTA $\equiv$ 15 mgs of $CaCO_3$ eq.

$\therefore$ $\boxed{1 \text{ ml of EDTA} \equiv \frac{15}{20} \text{ mgs of } CaCO_3 \text{ eq}}$

$\equiv \boxed{.75 \text{ mgs of } CaCO_3 \text{ eq.}}$ — (II)

(II) Titration :-

20 ml of Sample requires 30 ml of EDTA

$\equiv 30 \times .75$ mgs of $CaCO_3$ eq

($\because$ 1 ml EDTA $\equiv$ .75 mg of $CaCO_3$ from (II))

20 ml of sample $\equiv$

$\therefore$ 1000 ml Sample $\equiv \frac{30 \times .75 \times 1000}{20}$ mg of $CaCO_3$ eq

$\equiv \boxed{1125 \text{ ppm}}$

(4)

ex - 100 ml of water sample has hardness equivalent to 12.5 ml of 0.08 N $MgSO_4$. What is its hardness in ppm.

Soln

12.5 ml of 0.08 N $MgSO_4$ $\equiv$ 12.5 ml of 0.08N $CaCO_3$ eq.

(bivalent salt) $\equiv$ (bivalent salt.)

for 1N we dissolve 50 g/L

so for 0.08 N $\equiv$ 50 x 0.08 g/L

$\equiv$ 4.00 g/L

$\equiv$ 4000 mg/1000 ml.

$\therefore$ 4 mg/ml.

$\because$ 1 ml $\equiv$ 4 mg $CaCO_3$ eq.

$\therefore$ 12.5 ml $\equiv$ 4 x 12.5 mgs of $CaCO_3$ eq.

$\because$ 100 ml water (given) $\equiv$ 4 x 12.5 mg of $CaCO_3$ eq.

$\therefore$ 1000 ml of water $\equiv$ $\frac{4 \times 12.5 \times 1000}{100}$ mg of $CaCO_3$ eq/L

$\equiv$ $\boxed{500 \text{ ppm}}$

(given in Shashichawla Back side exercize in water chptr.)

Alternatively :- (5)

ex

~~$12.5 \times 0.08 \times 50 \equiv 50$ g $CaCO_3$ eq.~~ ~~$.050 \times 1000$ / 50.000~~

~~100 ml water $\equiv$ 50,000 mg $CaCO_3$ eq.~~

~~$\therefore 1000 \equiv \frac{50,000 \times 1000}{100}$~~

Alternative Method.

$\equiv 12.5 \times 0.08$ ml of 1N $CaCO_3$ eq.

$\equiv$ 1 ml of 1N $CaCO_3$ eq.

$\equiv .001$ L of 1N $CaCO_3$ eq.

$\equiv .001 \times 50 = .050$ g $CaCO_3$ eq.

100 ml water $\equiv$ 50 mg of $CaCO_3$-eq.

$\therefore$ 1000 ml of water $\equiv \frac{50 \times 1000}{100}$ mg of $CaCO_3$ eq.

$\equiv \boxed{500 \text{ ppm}}$

($\because$ 1L $\equiv$ 50 g $CaCO_3$ eq
$\therefore$ .001 L = $50 \times .001$ $\equiv .050$ g $CaCO_3$ eq)

Ex - A water sample contains 204 mg of $CaSO_4$ per litre, what is the hardness in terms of $CaCO_3$ eq.

$$\text{mgs of } CaCO_3\text{eq}/L = \frac{\text{mg of } CaSO_4/L \times 100}{\text{mol. wt of } CaSO_4 \ (136)}$$

$$= \frac{204 \times 100}{136}$$

$$\equiv \boxed{150 \text{ mg } CaCO_3 \text{ eq}/L}$$

$$\equiv 150 \text{ ppm}$$

(I) 1 gm mole of one bivalent salt $\equiv$ 1 gm mole of another bivalent salt.

(mol. wt.) (mol. wt.)

1 gm mol (mol. wt.) / L $\equiv$ 1 gm mole (mol. wt.) / L

1M $\equiv$ 1M

(II) 1 gm equivalent / L (of one salt bivalent) $\equiv$ 1 gm equivalent / L (of another bivalent salt)

1 N $\equiv$ 1 N.

(III) 1M of $CaCO_3$ eq. $\equiv$ 100 g / L

0.01 M or $\frac{M}{100}$ $\equiv$ $\frac{100}{100}$ g / L = 1 g / L

$\equiv$ or 100 × 0.01 = 1 g / L

.01M $\equiv$ 1000 mg / 1000 ml $\equiv$ $\boxed{1 mg / 1 ml.}$

$CaCO_3$ eq. soln

Disodium salt (bivalent)

So suppose given $\boxed{15 \text{ ml of } 0.01 \text{ M EDTA}}$. $\equiv$

It means $\equiv$ 15 ml of 0.01M $CaCO_3$ eq.

$\equiv$ 15 ml × 1 mg $CaCO_3$ eq. ($\because$ 1 ml $\equiv$ 1 mg)

$\equiv$ $\boxed{15 \text{ mg } CaCO_3 \text{ eq.}}$

(1)

Ex. 100 ml of water sample has a hardness equivalent to 12.5 ml of 0.08 ml of 0.08 N $MgSO_4$. What is its hardness in ppm?

Soln. 100 ml of water sample $= 12.5$ ml of 0.08 N $MgSO_4$

$= 12.5 \times 0.08$ ml of 1 N $MgSO_4$

$= 1$ ml of 1 N $MgSO_4$

$\boxed{1 \text{ ml of } 1N\ MgSO_4 \equiv 1 \text{ ml of } 1N\ CaCO_3 \text{ eq}}$

$= 0.001$ L of 1 N $CaCO_3$ eq.

$\because$ 1 L $\equiv$ 50 g of $CaCO_3$ eq.

(eq. wt. of $CaCO_3 = 50$)

$\therefore$ 0.001 L $\equiv 0.001 \times 50$

$\equiv \boxed{0.05 \text{ g } CaCO_3 \text{ eq}}$

~~0.05 g × 1000 mg $CaCO_3$ eq.~~

given → 100 ml water

Since 100 ml water $\equiv 0.05$ g $CaCO_3$ eq.

$\therefore$ 1000 ml water $\equiv \dfrac{0.05 \text{ g } CaCO_3 \text{eq} \times 1000}{100}$

$\equiv 0.5$ g

$\equiv 0.5 \times 1000$

$\boxed{\equiv 500 \text{ mg/L or ppm}}$

Q. Calculate the hardness of water sample whose 20 ml required 30 ml EDTA, 10 ml of $CaCl_2$ solution, whose strength is equivalent to 300 mg of $CaCO_3$ per 200 ml required 20 ml of EDTA.

Ans. **Prepn of S.H.W** —

300 mg of $CaCO_3$ eq. / 200 ml

∵ 200 ml (S.H.W) containing 300 mg of $CaCO_3$ eq.

∴ 1 ml S.H.W $\equiv \frac{300}{200} = \frac{3}{2} = 1.5$ mg.

$\boxed{1 \text{ ml S.H.W} \equiv 1.5 \text{ mg. } CaCO_3 \text{ eq.}}$

(I) Titration of S.H.W with EDTA :-

S.H.W whose strength is equivalent to $CaCl_2$ soln.

∵ 1 ml of S.H.W containing 1.5 mg $CaCO_3$ eq.

It's strength is 1.5 mg / 1 ml S.H.W.

Strength of S.H.W $\equiv$ Strength of $CaCl_2$ soln.

1.5 mg / 1 ml of S.H.W $\equiv$ 1.5 mg / 1 ml of $CaCl_2$ soln.

Thus volumes also same. So we can assume volume of S.H.W taken for titration 10 ml.

10 ml $CaCl_2$ $\equiv$ 10 ml S.H.W.

10 ml of S.H.W $\equiv$ 20 ml EDTA

10 × 1.5 mg of $CaCO_3$ $\equiv$ 20 ml EDTA

15 mgs of $CaCO_3$ $\equiv$ 20 ml EDTA.

or (3)

20 ml EDTA $\equiv$ 15 mg. of $CaCO_3$ eq.

$\therefore$ 1 ml EDTA $\equiv \frac{15}{20}$ mgs of $CaCO_3$ eq.

$\boxed{\therefore \text{ 1 ml EDTA} \equiv 0.75 \text{ mgs of } CaCO_3 \text{ eq.}}$

IInd Titration (unknown hardwater sample / EDTA)

20 ml water sample $\equiv$ 30 ml of EDTA

$\equiv 30 \times 0.75$ mgs of $CaCO_3$ eq.

$\therefore$ 20 ml of water sample $\equiv$ 22.50 mgs of $CaCO_3$.

$\therefore$ 1000 ml of water sample $\equiv \frac{22.50 \times 1000}{20}$ mgs of $CaCO_3$ eq

$\boxed{\text{Total hardness} \equiv 1125 \text{ ppm}}$

Que 3. How many gms of $CaCl_2$ dissolved in 1 L of water gives 300 ppm of hardness?

Ans. mgs of $CaCO_3$ eq/L $\equiv$ mgs of $CaCl_2$/L $\times \frac{100}{111}$
or (hardness in ppm)

$300 \equiv$ mgs of $CaCl_2 \times \frac{100}{111}$

$\therefore$ mgs of $CaCl_2 \equiv \frac{300 \times 111}{100}$

$= 333$ mgs.

$\equiv \boxed{.333 \text{ gms}}$

EDTA Method (If S.H.W not given) (4)

Que. 50 ml of a sample water consumed 15 ml of 0.01 M EDTA before boiling and 5 ml of the same EDTA after boiling. Calculate the degree of total hardness and perm. & temp. hardness.

Ans (Before boiling) → 50 ml of water sample ≡ 15 ml of 0.01M EDTA.

∴ 1000 ml water ≡ $\frac{15}{50} \times 1000$ ml of 0.01 M EDTA

≡ 300 ml of 0.01M EDTA.

convert into normal soln. (M = 2 × N)

∴ 300 × 2 ml of 0.01N EDTA

≡ 600 ml of 0.01 N EDTA.

≡ ·6 L of 0.01N EDTA ≡ ·6 L × ·01 ml of 1N EDTA

→ 0.6 × 0.01 L of 1N EDTA

0.6 × 0.01 L of 1N EDTA ≡ 0.6 × ·01 L of 1N $CaCO_3$ eq.

∴ 0.6 × 0.01 L of 1N $CaCO_3$ eq

(∵ 1L ≡ 50 g $CaCO_3$ eq (∵ 1N soln))

∴ 0.6 × 0.01 × 50 g of $CaCO_3$

Total hardness ≡ 0.30 g or 300 mg/L or 300 ppm

b) after boiling :-

(5)

50 ml of ~~sample~~ boiled water $\equiv$ 5 ml of 0.01M EDTA

$\therefore$ 1000 ml of boiler water $\equiv \frac{5 \times 1000}{50}$ ml of 0.01M EDTA

$\equiv$ 100 ml of 0.01M EDTA.

$(\because M = 2 \times N)$

$\equiv \therefore$ 100 X 2 ml of 0.01 N EDTA

$\equiv$ 200 ml of 0.01 N EDTA

$\equiv \boxed{200 \times 0.01 \text{ ml of } 1N \text{ EDTA}}$.

$\equiv$ 0.2 L X 0.01 L of 1N EDTA)

0.2X0.01 L of 1N EDTA $\equiv$ 0.2 X 0.01 L of 1N $CaCO_3$ eq.

$\equiv$ 0.2 X 0.01 L of 1N $CaCO_3$ eq.

$\equiv$ 0.2 X 0.01 X 50 g of $CaCO_3$ eq,

$(\because$ 1L $\equiv$ 50 g. $CaCO_3$ eq for 1N solns.)

$\equiv$ 0.1 g $\equiv$ 100 mg of $CaCO_3$ eq.

Thus $\boxed{\text{permanent Hardness} \equiv 100 \text{ mg/L or ppm.}}$

[illegible]
(Calcium oxalate) was obtained from
250 ml of a water sample.
Express the Calcium content in ppm.
(mol. wt. of Calcium oxalate 146.112)

$\because$ 146.112 g of Calcium oxalate $\equiv$ 40 g of Ca^{2+}

$\therefore$ 0.110 g ---"--- $\equiv \dfrac{40}{146.112} \times 0.110$

$\equiv \boxed{0.0301138\ g}$

$\because$ 250 ml water $\equiv$ 0.0301138 g.

$\therefore$ 1000 $\equiv \dfrac{0.0301138 \times 1000}{250}$

$\equiv$ 0.120 g/L

$\equiv \boxed{120\ mg/L}$

(7)

ex. A water sample contains 204 mg of $CaSO_4$ per litre. Calculate the hardness in terms of $CaCO_3$ eq.

Soln

$$\text{mgs of } CaCO_3 \text{ equivalents}/L = \frac{\text{mg of } CaSO_4/L \times 100}{136}$$

$$= \frac{204 \times 100}{136}$$

$$= 150 \text{ mg}/L$$

Hardness $= \boxed{150 \text{ ppm}}$

~~Since water~~

Since quantity of $CaSO_4$ in mg/L is given.

mgs of $CaCO_3$/L will be calculated and mg of $CaCO_3$ eq./L

= hardness.

= 150 mg of $CaCO_3$ eq/L

$= \boxed{150 \text{ ppm.}}$

Ex. Alternate method :- (given page No. 4)

EDTA method

Ex) 50 ml of a sample consumed 15 ml of 0.01M EDTA before boiling and 5 ml of the same EDTA after boiling. Calculate Total, Temp, perm. hardness.

Soln: (I) given 15 ml of 0.01M EDTA (Before Boiling)

$\equiv$ 15 ml of 0.01M $CaCO_3$ eq.

$\therefore$ 15 ml of 0.01M EDTA $\equiv$ 15 ml of 0.01M $CaCO_3$ eq.

$\equiv 15 \times 0.01$ ml of 1M $CaCO_3$ eq.

$\equiv 0.15$ ml of 1M $CaCO_3$ eq.

$\equiv .00015$ L of 1M $CaCO_3$ eq.

$\equiv .00015 \times 100$ g $CaCO_3$ eq.

$\equiv 0.015$ g $CaCO_3$ eq.

$\equiv 0.015 \times 1000$ mg $CaCO_3$ eq.

$\equiv 15$ mg $CaCO_3$ eq.

($\because$ 1L $\equiv$ 100 gm $CaCO_3$ eq.)
$\therefore$ .00015 L $\equiv$ .00015 × 100)
$=$ .015 g $CaCO_3$ eq.

$\because$ 50 ml of water $\equiv$ 15 mg $CaCO_3$ eq.

$\therefore$ 1000 ml of water $\equiv \dfrac{15 \times 10\cancel{00}^{20}}{\cancel{50}}$

$\equiv$ 300 mg of $CaCO_3$ eq / L

$\boxed{\text{Total hardness} = \therefore 300 \text{ ppm}}$

(II) After Boiling (Noncarbonate/perm. Hardness)

5 ml of 0.01M EDTA $\equiv$ 5 ml of 0.01M $CaCO_3$ eq.

$\equiv 5 \times 0.01$ ml of 1M $CaCO_3$ eq.

$\equiv .05$ ml of 1M $CaCO_3$ eq.

$\equiv .00005$ L of 1M $CaCO_3$ eq.

$\equiv .00005 \times 100$ g $CaCO_3$ eq.

$\equiv .005$ g $CaCO_3$ eq.

$\equiv 5$ mg $CaCO_3$ eq.

50 ml of hard water $\equiv$ 5 mg of $CaCO_3$ eq.

$\therefore$ 1000 ml of water $\equiv \dfrac{5 \times 100\cancel{0}}{\cancel{50}} = \boxed{100 \text{ PPM}}$ Noncarbonate

$\boxed{\text{Carbonate Hardness} = 300 - 100 = 200 \text{ ppm}}$

~~CHEMISTRY OF ENGINEERING MATERIALS~~

F.I.B :- FILL IN THE BLANKS
(ONLY FOR KNOWLEDGE OF PATTERN)

1) Tannin or Legnin is added to boiler feed water to avoid Caustic embrittlement

2) Na_2SO_4 is added to boiler water to block hair cracks ~~in the ratio~~ so that the ratio : $\frac{[Na_2SO_4 \text{ conc.}]}{[NaOH \text{ conc.}]}$ is kept as 1:1, 2:1 and 3:1 in boilers working respective 10, 20, 30 pressure boilers.

3) Drinking water has 85-100 ~~25-100~~ ppm range of hardness.

4) Hard water is good for health

5) Soft water is good for industry but not good for health

6) Trade name of Sodium hexameta phosphate is Calgon.

7) Hardness of boiler feed water should be below 0.2 ppm.

8) Sand filter water has impurity of SiO_2 which form hard scale of $CaSiO_3$ (Calcium Silicate)

9) $CaSO_4$ is insoluble at high temperature because of increased ionization at high temp. and it's Ionic Product becomes

greater than solubility product.

10) But in high pressure boilers:
$CaCO_3$ is soluble due to formation of $Ca(OH)_2$.

$$CaCO_3 + H_2O \longrightarrow Ca(OH)_2 + CO_2\uparrow$$

11) $CaSO_4$ is insoluble at high Temp. in high Pressure boilers because of increased ionisation and less availability of water for solvation at high Temperature.

(12) Small quantity of $MgCl_2$ is undesirable in boiler feed water to avoid boiler corrosion due chain production of HCl:

$$MgCl_2 + \underset{\text{(boiler feedwater)}}{H_2O} \longrightarrow Mg(OH)_2 + HCl$$

$$HCl + \underset{\text{(boiler)}}{Fe} \longrightarrow FeCl_2 + H_2\uparrow$$

$$FeCl_2 \xrightarrow{H_2O\text{ (Boiler feed water)}} Fe(OH)_2 + HCl$$

(Chain Production)

* Deaeration — Jain & Jain page no - (11) with diagram

High Temp, low pressure and large exposed surface (provided by perforated plates) reduces the dissolved oxygen in water.

(13) Partial Removal of concentrated water through a tap at the bottom of boiler, when the extent of hardness in the boiler becomes alarmingly high, is known as Blow down operation.

14) 'Carry over' occurs in 'priming'.

~~15) Priming and foaming occur together and improper judgement of actual height of water column happens. makes it difficult to maintain boiler pressure.~~

15). At room temp water usually contains 8 ppm of dissolved oxygen.

16) Castor oil is anti-foaming agent.

17) multiplication factor of $CaCO_3$ is 1.

18) Priming can be avoided by controlling rapid change in steaming velocity.

19) If the scales are brittle, it can be removed by giving thermal shocks.

20) $CaCO_3$ scales are removed by 5-10% HCl.

21) In Paper Industry SiO_2 of hardwater causes cracks in the paper.

21) $CaSO_4$ Scales are removed by EDTA, since Ca-EDTA complex is high soluble in water.

21) $CaCl_2$, $MgCl_2$, $MgSO_4$, $MgCO_3$ are examples of sludges.

22) $CaSO_4$, $CaCO_3$, $Mg(OH)_2$ are examples of Scale

23) 'Wet steam generation' happens in priming.

24) The phenomenon of carrying over water along with impurities by steam is called 'Carry Over'.

25) 'Carry Over' is mainly due to priming and foaming.

26) Foaming happens due to reduction in surface tension.

27) Antifoaming agent counteracts reduction in surface tension.

28) Priming and foaming usually occur together.

29) In textile industry Fe, Mn, Cr salts create coloured spots on the fabric.

29) Aluminium compounds ~~remove~~ ($NaAlO_2$ & $Al_2(SO_4)_3$) are used to avoid foaming.

30) The Iron in cracks forms Anodic part and corrodes.

$$\overset{+}{\text{Fe}} \mid \underset{NaOH}{\text{Conc.}} \parallel \underset{NaOH}{\text{Dil}} \mid \text{Fe}$$

Anode / Stressed part: Cracks, rivets, Bends, joints in Boilers.

Stressed part - Anode

Plane (cathode) part of the Boilers

~~Stress Corrosion~~

~~Concentration cell Corrosion due to diff. conc. of NaOH in different parts of boiler.~~

31) The above cell is concentration cell formed in boiler due to cracks and conc. NaOH. Thus this 'Caustic embrittlement' is the example of concentration cell corrosion.

32) Caustic embrittlement is the case of stress-corrosion also, because craks are stressed part and form Anodic part.

33) Ideal reagent for removing O_2 to avoid boiler corrosion is Hydrazine (NH_2-NH_2)

34) Filtering water through limestone

$$CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$$

Limestone

removes CO_2 but increases hardness.

35) Very low concentration of Na_2SO_3 (5–10 ppm) is maintained in boiler feed water to remove O_2, rather adding Na_2SO_3 intermittantly as it produces corrosive H_2SO_3.

36) Calgon is better ~~con~~ Internal condition agent then phosphate conditioning.

37) For phosphate conditioning pH is maintained above 9.5 – 10.5.

38) Alternative indicator in complexometric titration to EBT is ~~Cal~~ Calmagite.

39) Internal conditioning agents form soluble complex with hardness causing salt, so hardness is removed.

40) $NaAlO_2$ is an Internal conditioning agent

SUPERVISOR'S INITIAL	
DATE	

SUPPLEMENT

Exam. Seat No.

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
MATUNGA, MUMBAI-400 019.

Subject ____________ Section ____________ Date ____________

Four step reaction

Caustic Embrittlement :- (Reactions)

At Anode. (Cracks)

I $Fe \rightarrow Fe^{2+} + 2e^-$

$\downarrow \bar{O}H$ (Cathode)

$Fe(OH)_2$

$\downarrow$

$Fe_2O_3 \cdot H_2O$

$\downarrow$

I $Na_2CO_3 + H_2O \rightarrow 2NaOH + CO_2\uparrow$ (treated water)

$\boxed{Fe_3O_4 \text{ magnetite}}$ protective layer

II dissolves $\downarrow$ 4 Conc. NaOH $(Fe_3O_4 + 4NaOH)$

$2NaFeO_2 + Na_2FeO_2 + 2H_2O$.

Main Reaction

As soon as Fe_3O_4 magnetite destroys water reacts directly with Iron as

III $\boxed{3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2}$

IV. Caustic alkali may also react with Iron to form hydrogen -

$\boxed{Fe + NaOH \rightarrow NaFeO_2 + H_2}$

2

Caustic embrittlement is case of

(I) Stress - Corrosion

(II) Concentration Cell Corrosion

$$\overset{+}{\text{Anode Fe}} \;|\; \text{Conc. NaOH} \;||\; \text{Dil NaOH} \;|\; \overset{-}{\text{Fe}}$$

(cracks, joints)

~~Anode~~

(II) $CaCO_3$ is scale formed in low ~~boiler~~ pressure boiler, but in high pressure boiler, it is soluble as $Ca(OH)_2$.

React^n (Imp) - $CaCO_3 + H_2O \longrightarrow \underset{\text{soluble}}{Ca(OH)_2} + CO_2\uparrow$

At high Temp pressure $CaCO_3$ forms $Ca(OH)_2$ which is soluble so $Ca(OH)_2$ does not cause hardness, it is soluble so does not cause scale.

(III) At high pressure boilers $CaSO_4$ scale is formed because at high Temp ~~[illegible]~~

$CaSO_4$. Ionisation of $CaSO_4$

increases, so its Ionic Product ~~increases~~ becomes greater than solubility product. ~~so ppts~~ ~~and~~ so in high pressure boilers $CaSO_4$ ~~ppt~~ precipitates out as scale. , its solubility decreases and $CaSO_4$ scales formed in high pressure boilers.

(iii) Acids from Dissolved Salts cause boiler Corrosion :-

For example small amount of $MgCl_2$ causes high corrosion because HCl produced in chain like reactions

(Reactions important)

$$MgCl_2 + 2HCl \longrightarrow Mg(OH)_2 + 2HCl$$

$$Fe + 2HCl \longrightarrow FeCl_2 + H_2$$

(boiler)

$$FeCl_2 + 2H_2O \longrightarrow Fe(OH)_2 + 2HCl.$$

SUPERVISOR'S INITIAL

DATE

SUPPLEMENT

Exam. Seat No.

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
MATUNGA, MUMBAI-400 019.

Subject ______ Section ______ Date ______

Boiler Troubles

Boiler Corrosion

1) Removal of oxygen

(1) Adding Hydrazine :

Expected questions:-

Que-(1) why Hydrazine is an ideal chemical for removal of dissolved oxygen?

Ans. $N_2H_4 + O_2 \longrightarrow N_2 + H_2O$
hydrazine (harmless)

Since harmless N_2 is only produced, so Hydrazine removes oxygen without increasing concentration of dissolved solids /salts. On the other hand Na_2SO_3 (sodium sulphites) and Na_2S sodium sulphides on reaction with oxygen gives Na_2SO_4 which under high pressure decompose to give SO_2 which enters steam pipes and appears as corrosive H_2SO_3 (sulphurous acid) in steam condensate.

Que (2) why pure Hydrazine is used for water treatment?

Ans. Hydrazine is explosive, inflammable liquid so its 40% aqueous solution is used for safety. 40% aqueous solution of hydrazine is quite safe.

Que 3. Why Hydrazine ~~must~~ not be used in excess?

Ans. Excess Hydrazine must not be used because excess of it decomposes to give NH_3 which causes corrosion of some alloys like Brass etc. used in condensor tubes.

$$\boxed{3N_2H_4 \longrightarrow 4NH_3 + N_2}$$

Que 4. Why Na_2SO_3 (Sodium Sulphite) used in treatment of boiler feed water should have a very low ~~concent~~ concentration of 5–10 ppm, as a rule. and not added intermittently?

Ans. If Na_2SO_3 or Na_2S used for removal of oxygen, ~~under~~ they give Na_2SO_4

$$\boxed{2Na_2SO_3 + O_2 \longrightarrow 2Na_2SO_4}$$

$$\boxed{Na_2S + 2O_2 \longrightarrow Na_2SO_4}$$

Under high pressure Na_2SO_4 decomposes to give SO_2, which enters the steam pipes and appears as corrosive H_2SO_3 sulphurous acid, in steam condensate. So, as a rule a very low concentration of 5–10 ppm of Na_2SO_3 in the boiler is maintained, rather than adding intermittently.

Que 5 Why CO_2 when removed by ~~passing~~ filtering water through lime-stone ($CaCO_3$), hardness increases.

$$\boxed{CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2}$$

Que 4 — Why even small amount of $MgCl_2$ cause corrosion of Iron to large extent?

Ans — Mineral acids are very important cause of ~~corrosion~~ boiler corrosion. If $MgCl_2$ is present in boiler feed water, it can hydrolyse to produce HCl.

$$\boxed{MgCl_2 + H_2O \longrightarrow Mg(OH)_2 \downarrow + 2HCl}$$

Liberated acid reacts with boiler material (Fe) to form $Fe(OH)_2$ which in turn converted to rust.

$$Fe + 2HCl \longrightarrow FeCl_2 + H_2$$
$$FeCl_2 + 2H_2O \longrightarrow Fe(OH)_2 + 2HCl$$
$$2Fe(OH)_2 + O_2 \longrightarrow Fe_2O_3 \cdot H_2O$$

Thus a small amount of HCl may cause extensive corrosion since HCl is produced in a chain like manner. Consequently presence of even a small amount of $MgCl_2$ cause corrosion to large extent.

But as the boiler water is generally alkaline ~~so~~ hence acid is usually neutralized.

Que — Why 'Sodium phosphate' is preferred to Na_2CO_3, as softening agent in water treatment.

Ans. To avoid 'Caustic embrittlement' by caustic alkali produced in boiling water in boilers due to following reaction —
$$\boxed{Na_2CO_3 + H_2O \longrightarrow 2NaOH + CO_2}$$

Que-5 why Oils and alkali present in boiler feed water produce persistant bubbles ?

Ans - Oils and alkali react to form soaps which generally lowers the surface tension of water and thus increase the foaming tendency of the liquid. (by reducing surface tension)

Remedy - The above ~~process~~ trouble ~~is cau~~ caused in boilers is called 'Foaming'. So ~~we at~~ to

(I) avoid foaming we add (1) antifoamining agent e.g. Castor oil which counteracts the reduction of surface tension. ~~and~~ Castor oil spreads on the surface of water and ~~does not allow~~ neutralizes the reduction is surface tension.

(II) For avoiding foaming or reduction in surface tension, Aluminium compds are added e.g.

~~These~~ (i) Sodium Aluminate $NaAlO_2$

(ii) Aluminium Sulphate $Al_2(SO_4)_3$

which hydrolyse to $Al(OH)_3$ flocks and entrap the ~~dr~~ oil drops. The flocks of $Al(OH)_3$ containing oil droplets are removed by filtration through

~~&~~ Anthrafilt filter bed.

SUPERVISOR'S INITIAL

DATE

SUPPLEMENT

Pages - 4

F/18 A

Exam Seat No.

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

MATUNGA, MUMBAI-400 019.

Subject ______ Section ______ Date ______

Que - Because of improper judgement of actual height of water column, the maintenance of boiler pressure becomes difficult.

Que - A boiler feed water should have what permitted values of hardness and alkalinity ?

1) Hardness should be $\boxed{\text{below } 0.2 \text{ ppm}}$
ideally = 0 ppm

2) Caustic Alkalinity (due to $\overline{OH}$)
shd be betⁿ $\boxed{0.15 \text{ and } 0.45 \text{ ppm}}$

3) Soda Alkalinity - (Due to Na_2CO_3)
shd be betⁿ $\boxed{0.45 - 1 \text{ ppm}}$

Que Why boiler feed water should not have SiO_2 ?

Que why $CaSO_4$ forms scale in high pressure boilers -

Ans At high Pressure / Temp - Solubility of $CaSO_4$ decreases, as water evaporates its ~~Ion~~ Ionic product becomes greater than its solubility product $K_{sp} < K_{\text{Ionic Product}}$

Scanned by CamScanner

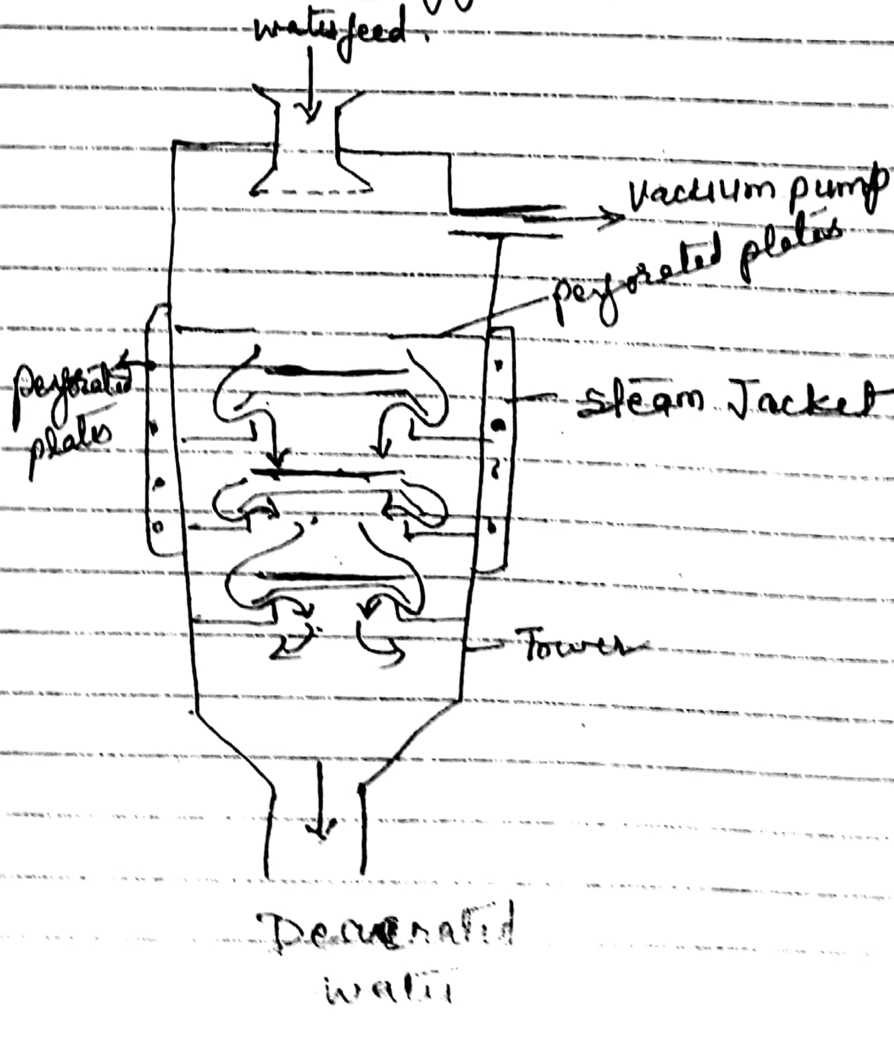
Q. What is Mechanical Deaeration ? (Diagram)

OR

How dissolved O_2 (or any other gas) is removed from boiler feed water.

Ans. [Jain & Jain page - NO - 11]
[Mechanical Deaeration.]

Ans - (Key line) — " High temperature, low pressure and large exposed surface (provided by perforated plates) reduces the dissolved oxygen in water."



(Solved problems - 2014-15)

1

(1) How many grams of $FeSO_4$ dissolved per litre gives 400 ppm of hardness?

Sol^n

$$\text{mgs of } CaCO_3 \text{ eq} = \frac{\text{mgs of } FeSO_4 \times 100}{\text{eq. wt.} \times 2}$$

$$= \frac{\text{mgs. of } FeSO_4 \times 100}{152}$$

$$\boxed{\text{mgs of } CaCO_3 \text{ eq}/L = \text{mgs of } FeSO_4/L \times \frac{100}{152}}$$

$$\underset{(ppm)}{\text{Hardness}} = \text{mgs of } CaCO_3 \text{ eq} \,/\, L \text{ of water.}$$

400 ppm hardness means = 400 mgs of $CaCO_3$ eq/L

$$\therefore \boxed{400 = \text{mgs of } FeSO_4 \times \frac{100}{152}}$$

$$\therefore \text{mgs of } FeSO_4 = \frac{400 \times 152}{100}$$

$$= 608 \text{ mgs.}$$

✓ $\boxed{\text{gms of } FeSO_4 = 0.608 \text{ gms}}$

Scanned by CamScanner

0.5 gm of $CaCO_3$ was dissolved in HCl and the solution was made up to 500 ml with distill water. 50 ml of above solⁿ required 45 ml of EDTA solⁿ for titration. 50 ml of hardwater sample required 20 ml of EDTA and after boiling & filtering required 15 ml EDTA solⁿ. Calculate the Carbonate and non-Carbonate hardness in ppm, °Fr and °Cl units.

<u>Solⁿ</u> preparation of S.H.W.

$\because$ 0.5 gm $CaCO_3$ eq. in 500 ml water

= 500 mg $CaCO_3$ eq. in 500 ml water

S.H.W = $\boxed{\therefore \text{ 1 mg } CaCO_3 \text{ eq.} / \text{1 ml of water}}$ S.H.W.

$\boxed{\text{1 ml of S.H.W.} \equiv \text{1 mg } CaCO_3 \text{ eq.}}$

<u>Ist Titration</u> :- S.H.W/EDTA.

50 ml of S.H.W $\equiv$ 50 ml of EDTA

$\therefore$ 50 mgs of $CaCO_3$ eq. $\equiv$ 50 ml of EDTA

<u>OR</u> $\therefore$ 50 ml of EDTA $\equiv$ 50 mgs $CaCO_3$ eq.

$\therefore$ 1 ml of EDTA $\equiv \frac{50}{50}$ mgs of $CaCO_3$ eq.

$\therefore$ $\boxed{\text{1 ml of EDTA} \equiv \text{1 mgs of } CaCO_3 \text{ eq.}}$

~~Total Hardness :-~~ 3

(II) Titration - hard water sample / EDTA.

50 ml of hard water sample $\equiv$ 20 ml of EDTA

$\equiv$ 20 × 1 mg of $CaCO_3$ eq

($\because$ 1 ml EDTA $\equiv$ 1 mg $CaCO_3$ eq from I^{st} Titration)

~~50 ml~~ hard water sample $\equiv$ 20 mgs of $CaCO_3$ eq.

$\therefore$ 1000 ml of hard water sample $\equiv \frac{20 \times 1000}{50}$

$\equiv$ 400 mg of $CaCO_3$ eq / L

$\boxed{\text{Total hardness} \equiv 400\ \text{ppm}}$

(III) Titration (Boiled water / EDTA)

50 ml of ~~Boiled~~ Boiled water $\equiv$ 15 ml of EDTA

$\equiv$ 15 × 1 mg of $CaCO_3$ eq.

50 ml boiled water $\equiv$ 15 mgs of $CaCO_3$ eq.

$\therefore$ 1000 ml of boiled water = $\frac{15 \times 1000}{50}$

$\therefore$ $\boxed{\text{Non Carbonate hardness} = 300\ \text{ppm}}$

Carbonate hardness = Total hardness − ~~Carbonate~~ Non carbonate

= 400 − 300

Temp or Carbonate hardness = $\boxed{100 \text{ ppm}}$

~~I~~ Hardness Results :- (In all units

(I) Total hardness = $\boxed{400 \text{ ppm} = 40^\circ Fr = 28^\circ Cl}$

(II) Non carbonate hardness = $\boxed{300 \text{ ppm} = 30^\circ Fr = 21^\circ Cl}$

(III) Carbonate hardness = $\boxed{100 \text{ ppm} = 10^\circ Fr = 0.7^\circ Cl}$

since
1 ppm = 0.1 °Fr = 0.07 °Cl

(3)

Q.1 - State true or false :- (2014-2015 Que. paper)

a) Soap does not give leather with hard water.

Soln. True (~~Expla~~ Justification ↓)

$$Ca(HCO_3)_2 + 2C_{15}H_{31}COONa \longrightarrow (C_{15}H_{31}COO)_2Ca \downarrow + NaHCO_3$$

(hard water) Soap (sodium palmitate) (scum)

$$MgSO_4 + 2C_{17}H_{35}COONa \longrightarrow (C_{17}H_{35}COO)_2Mg \downarrow + Na_2SO_4$$

Soap (sodium stearate) ppt (scum)

Hard water has hardness causing salts Bicarbonates, chlorides, Nitrates, sulphates of calcium, Magnesium, Manganese, Aluminium, Iron or other heavy metal ions. These salts react with soap and precipitate out and hinder leather formation.

(ii) Temporary hardness is caused by chlorides.

Soln - This statement is false. Chlorides cause permanent hardness.

Justification :- Temporary hardness is caused by bi-carbonates of calcium, magnesium, Iron, Aluminium or other heavy metal ions.

(Give reactions for justification)

Temporary hardness is removed by boiling. Bicarbonates are decomposed in to insoluble carbonates and Hydroxides.

[Chlorides cause permanent hardness]

$$Ca(HCO_3)_2 \xrightarrow[\Delta]{Boil} CaCO_3 + CO_2 + H_2O$$

$$Mg(HCO_3)_2 \xrightarrow[\Delta]{Boil} Mg(OH)_2 + 2CO_2$$

$$MgCl_2 \xrightarrow[Boil]{\Delta} \times$$

Chlorides not removed by boiling so do not cause Temp. hardness. Chlorides cause permanent hardness.

1(c) ~~1 ppm hardness is equal to 0.1°Cl~~ (T)

Soln This statement is 'false'

justification - ~~1 ppm hardness = 0.07°Cl~~

1 ppm hardness = 0.1°Fr.

1(d) In EDTA method end point is blue to wine red.

Soln - Statement is 'False'

Justification - End point colour change is wine red to Blue.

when Indication is added to hard water sample first unstable M-Indicator complex is formed. Then when titrated with EDTA, more stable M-EDTA complex, is formed which is colourless.

but free Indicator gives Blue colour

$$\underset{\text{(hardwater)}}{M^{2+}} + \underset{\text{Indicator}}{EBT} \xrightarrow[NH_4Cl + NH_4OH]{\text{Buffer Sol}^n \; pH = 8-10} \underset{\substack{\text{(unstable)} \\ \text{winered.}}}{M-EBT} \longrightarrow \underset{\text{(more stable complex)}}{M-EDTA} + \underset{\substack{\text{(Blue)} \\ \text{free indicator}}}{EBT}$$

3-b) –

principle of EDTA method :–

$$\underset{\text{(hard water)}}{M^{2+}} + \underset{\substack{\text{Indicator} \\ \text{(Eriochrome Black-T)}}}{EBT} \xrightarrow[\substack{pH = 8-10 \\ NH_4Cl + NH_4OH}]{\text{Alkaline Buffer Sol}^n} \underset{\substack{\text{(Wine-red)} \\ \text{metal Indicator} \\ \text{Complex} \\ \text{(unstable)}}}{M\text{-}EBT} \xrightarrow{EDTA} \underset{\substack{\text{Colorless} \\ \text{more stable} \\ \text{complex}}}{M\text{-}EDTA} + \underset{\substack{\text{(free Indicator} \\ \text{Blue)}}}{EBT}$$

3 (C) How is temp. Hardness of water removed? (reactions must) (Balanced)

Sol^n - By Boiling the water, soluble Bicarbonates decompose into insoluble Carbonates or hydroxides.

$$Ca(HCO_3)_2 \xrightarrow[\text{Boil}]{\Delta} CaCO_3\downarrow + CO_2\uparrow + H_2O$$

white scum/ppt (Soft-scale)

$$Mg(HCO_3)_2 \xrightarrow[\text{Boil}]{\Delta} Mg(OH)_2\downarrow + 2CO_2$$

white ppt.

Soft loose ppt

Removed by filtration.

Note - Some important points for calculations:- or formulas for calculations -

(I) $\boxed{\text{gms/Litre} = \text{eq. wt} \times \text{Normality}}$

(II) $\boxed{\text{Molarity} = \text{normality} \times 2}$ (for bi valent salts)

(III) $\boxed{\text{Mol. wt} = \text{eq. wt} \times 2}$ for bivalent salts.

(IV) $\boxed{\text{eq. wt} = \dfrac{\text{Mol. wt}}{\text{valency}}}$ $\boxed{\text{mol. wt} = \text{eq. wt} \times \text{valency}}$

(iv) $\boxed{1M = 2N \text{ sol}^n \text{ for bivalent salts.}}$

(v) Volume of 1 Molar sol^n (1M) = 2 × volume of 1N sol^n

(vi) mg/L of $CaCO_3$ eq. = hardness

(vii) mg/L of $CaCO_3$ eq (ppm) = $\dfrac{\text{mgs of Impurity salt given/L} \times 100}{\text{eq. wt} \times 2}$.

(viii) Hardness ppm = $\dfrac{(\text{mgs of Impurity/L}) \times 100}{\text{eq. wt} \times 2}$.

Scanned by CamScanner

(11)

1) a water sample contains 408 mg of $CaSO_4$ / L Calculate hardness in terms of $CaCO_3$ eq.

Soln = $\boxed{\text{No. of } CaCO_3 \text{ eq. present in one L} = \text{Hardness}}$

$$\boxed{\therefore \text{No. of } CaCO_3 \text{ eq.} = \frac{\text{mass of } CaSO_4 \times \text{mol. wt. of } CaCO_3}{\text{eq. wt. of } CaSO_4 \times 2}}$$

$\therefore$ No. of $CaCO_3$ eq of $CaSO_4$ present in one L $= \frac{408 \times 100}{68 \times 2}$

$= \frac{408 \times 100}{136}$

$$\boxed{\text{Hardness} = 300 \text{ ppm}}$$

---

ex - How many grams of $MgCO_3$ dissolved per litre gives 84 ppm of hardness?

Ans 84 ppm hardness, it means 84 mgs of $CaCO_3$ eq present in one L

No. of mg $CaCO_3$ eq (for $MgCO_3$) $= \frac{\text{mass (gms) of } MgCO_3 \times 100}{\text{eq. wt. of } MgCO_3 \times 2}$

$= \frac{\text{mass (}\cancel{\text{gms}}\text{ mg) of } MgCO_3 \times 100}{42 \times 2}$

$\frac{84 \times 42 \times 2}{100}$ = mass (mg) of $CaCO_3$

$= 70.56$ mg $= \boxed{70.56 \times 10^{-3} \text{ gm}}$

Ex. 200 ml of water sample has a hardness equivalent to 25 ml of 0.08 N $MgSO_4$. Find Hardness in °Fr

As normality is gm equivalents / L soln.

$\therefore$ no. of gm eq of $MgSO_4$ = Volume of $MgSO_4$ × Normality

$$= \frac{25 \times 0.08}{1000} = 2 \times 10^{-3}$$

$$\text{No. of gm eq} = \frac{\text{wt in gms}}{\text{eq. wt.}}$$

weight in gms of $MgSO_4$ present in 200 ml of water

$$= 2 \times 10^{-3} \times \text{eq. wt. of } MgSO_4.$$

$$\therefore \text{per Litre} = 2 \times 10^{-3} \times \text{eq. wt. of } MgSO_4 \times \frac{1000}{200}$$

$$= 10^{-2} \times \text{eq. wt.}$$

$$\text{Hardness} = \text{wt. in gms of } MgSO_4 / \text{L water} \times \frac{100}{\text{eq. wt. of } MgSO_4 \times 2}$$

$$= 10^{-2} \times \text{eq. wt. of } MgSO_4 \times \frac{100}{\text{eq. wt. } MgSO_4 \times 2}$$

$$= 50 \times 10^{-2} \text{ gm/L}$$

$$= \boxed{500 \text{ mg/L}} = \boxed{500 \text{ ppm}}$$

$$= 500 \times .1 = 50\,°Fr. \quad (1 \text{ ppm} = 0.1\,°Fr = .07\,°Cl.)$$

(II) Another method (given in Jain & Jain)

ex. 200 ml of water sample has a hardness equivalent to 25 ml of 0.08 N $MgSO_4$. Find hardness in °fr.

Soln First find out hardness in ppm

$$\boxed{1\ ppm = 0.1\ °fr}$$

given — hardness in 200 ml water $\equiv$ 25 ml of 0.08 N $MgSO_4$

$\equiv$ 25 × 0.08 ml of 1 N $MgSO_4$

$\because$ $\underbrace{25 \times 0.08}$ ml of 1N $MgSO_4$ $\equiv$ $\underbrace{25 \times 0.08}$ ml of 1N $CaCO_3$ eq.

$\equiv$ 2 ml of 1N $MgSO_4$ $\equiv$ 2 ml of 1N $CaCO_3$ eq.

$\equiv$ 2 ml of 1N $CaCO_3$ eq.

$\equiv$ 0.002 L of 1N $CaCO_3$ eq.

$\because$ 1 L of $CaCO_3$ eq $\equiv$ 50 g of $CaCO_3$ eq

$\therefore$ 0.002 L $\equiv$ 50 × 0.002 g of $CaCO_3$ eq

$\equiv$ 0.1 g of $CaCO_3$ eq.

$\equiv$ 100 mg of $CaCO_3$ eq.

Since given 200 ml water has same hardness

200 ml water (hard) $\equiv$ 100 mg of $CaCO_3$ eq.

$\therefore$ 1000 ml water (hard) $\equiv \frac{100}{200} \times 1000$

$\equiv$ 500 mg $CaCO_3$ eq/L

$\equiv \boxed{500\ ppm}$

✓ Ans-

$\boxed{500\ ppm = 50\ °fr}$

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

Matunga, Mumbai – 400 019.

(Autonomous)

Programme:	F.Y.B.TECH (SEMESTER-I)	Duration:	1.5 Hours
Examination:	IN SEMESTER TEST-1	Max. Marks:	30
Course :	Applied Chemistry-I	Date:	24/08/2015

Instructions:

1. *Figure in the right hand side indicates full marks.*
2. *Write all sub-questions from a question together.*

(Atomic weights: C = 12, O = 16, Na = 23, Ca = 40, Mg = 24, H = 1, Cl = 35.5, S = 32)

1. State True or False with reason.Justify your answer. (2x5=10)

a) Soap does not get wasted with use of soft water.

b) Presence of $Ca(OH)_2$ causes permanent hardness in water.

c) Presence of $CaCl_2$ in water causes scale formation.

d) 0.1 ppm hardness is equal to 1 °Cl.

e) Priming can be avoided by adding sodium aluminate.

2. a) Calculate different types of hardness in ppm, OCl, OFR of a sample of water containing – $MgCl_2$ = 19 mg/L, $MgSO_4$ = 24 mg/L, $CaSO_4$ = 13.6 mg/L, $Mg(HCO_3)_2$ = 7.5 mg/L, Na_2SO_4 = 142 mg/L $Ca(HCO_3)_2$ = 8.1 mg/L. (5)

b) 0.45 g of $CaCO_3$ was dissolved in 500 mL of distilled water. 100 mL of this standard hard water consumed 25 mL of EDTA. 25 mL of hard water sample consumed 5 mL of EDTA. 50 mL of boiled hard water sample consumed 8 mL of EDTA. Calculate temporary hardness. (5)

3. a) Write about the problems caused by use of hard water in any 2 industries. (2)

b) Write the reaction(s) involved in following condition (6)

i) Use of Hydrazine & sodium sulphite for reducing boiler corrosion.
ii) Corrosion of boiler due to $MgCl_2$.
iii) Effect of highly alkaline water on boiler.

c) How is temporary hardness in water eliminated? (2)

"ALL THE BEST"

Question paper NOV. 2018 CSE (questions from water & refractory/glass)

(I) FIB –

1) A good refractory in general should have ________ porosity

2) As the temp. increases the solubility of $CaSO_4$ ________

3) Dissolved oxygen in boiler feed water is best removed by adding. ________

(II) Answer in short :–

1) Write the reaction of fattyacid soap with Ca-perm-hardness of water.

(III) what is refractory ? Mention any four uses of refractories. Write any four characteristics of a good refractory.

(IV) what are the steps involved in manufacturing of glass.

(V) Calculate the hardness of water sample whose 20 ml required 30 ml and 20 ml EDTA, before and after boiling. 10 ml of $CaCl_2$ soln whose strength is equivalent to 300 mg of $CaCO_3$ per 200 ml required 20 ml of EDTA.

~~100 g/L~~ ~~100000 mg/1000 ml~~ ~~100 mg/ml~~

1M = 100 g $CaCO_3$

.01M 1 g $CaCO_3$