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Engineering Chemistry

1) 20 ml of standard hard water (containing 1.2g $CaCO_3$ per litre) required 35 ml of EDTA. 50 ml of hard water sample required 30 ml of same EDTA. 100 ml of hard water sample after boiling required 25 ml of same EDTA. Calculate various hardness.

→ Step 1: Strength of hard water = 1.2 g/l

$= \frac{1200}{1000}$ mg of $CaCO_3$ per ml

= 1.2 mg of $CaCO_3$ per ml.

Step 2: 20 ml of standard hard water = 35 ml of EDTA

20 ml of standard hard water = (20 × 1.2) mg of $CaCO_3$

∴ 1 ml of EDTA = $\frac{20 \times 1.2}{35}$ = 0.685 mg of $CaCO_3$

Step 3:

50 ml of hard water sample = 30 ml of EDTA

∴ 1000 ml of hard water sample = $\left(\frac{1000}{50} \times 30\right) \times 0.685$

= 411 ppm

∴ Total Hardness = 411 ppm.

Step 4

100 ml boiled hard water = 25 ml of EDTA

∴ 1000 ml of boiled hard water = $\frac{1000 \times 25}{100} \times 0.685$

= 171.25 ppm

∴ Permanent hardness = 171.25 ppm.

Now,

Temporary hardness = Total hardness - Permanent hardness

= 411 - 171.25

= 239.75 ppm.

∴ Total hardness = 411 ppm, Permanent hardness = 171.25 ppm

Temporary Hardness = 239.75 ppm.

Pg 2) 0.5 gm of $CaCO_3$ was dissolved in HCl and the solution made up to 500 ml with distilled water. 50 ml of the solution requires 45 ml of EDTA solution for titration. 50 ml of hard water sample requires 15 ml of EDTA and after boiling and filtering required 10 ml of EDTA solution. Calculate temporary hardness and total hardness of water.

→ Step1

Strength of standard hard water = 0.5gm $CaCO_3$ / 500 ml water
= 500 mg $CaCO_3$ / 500 ml water
= 1 mg/ml

Step 2

50 ml of standard hard water = 45 ml EDTA solution

∴ 45 ml of EDTA solution = 50 mg $CaCO_3$ equivalent

∴ 1 ml of EDTA solution = $\frac{50}{45}$ mg $CaCO_3$ equivalent.

NOW,

50 ml water sample = 15 ml of EDTA solution.

∴ Hardness of sample = $\left[15 \times \frac{50}{45}\right]$ mg $CaCO_3$ equivalent for 50 ml hardness

∴ Hardness per litre of sample = $\left[15 \times \frac{50}{45}\right] \times \frac{1000}{50}$ mg/l

∴ Total hardness = 333.33 ppm

Step 3

50 ml water sample after boiling = 10 ml EDTA solution

∴ Permanent hardness of sample = $\left(10 \times \frac{50}{45}\right)$ mg CaCO3 for 50ml

∴ Permanent hardnese of 1 litre sample = $\left(10 \times \frac{50}{45}\right) \times \frac{1000}{50}$ mg/l

∴ Permanent hardness = 222.22ppm.

∴ Temporary hardness = Total hardness - Permanent hardness

= 333.33 - 222.22

∴ Temporary hardness = 111.11 ppm.

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Hence,

Total hardness = 333.33ppm, Permanent hardness = 222.22ppm

Temporary hardness = 111.11 ppm.

3) In the process of determination of Hardness, standard hard water sample was prepared by dissolving 2.5 g $CaCO_3$ and making solution up to 1 litre. 50 ml of above hard water required 45 ml of EDTA. 50 ml of unknown hard water sample consumed 30 ml EDTA solution using Erio-Black T indicator. The unknown hard water sample was boiled and filtered. 50 ml of this boiled solution required 20 ml of EDTA. Calculate hardness of all types of unknown hard water sample.

→ Step 1

Strength of water sample = 2.5 g/ litre

= 2500/1000 mg of $CaCO_3$ per ml

= 2.5 mg of $CaCO_3$ per ml.

Step 2

50 ml of standard hard water = 45 ml of EDTA.

50 ml of standard hard water = (50 × 2.5) mg of $CaCO_3$

∴ 1 ml of EDTA = $\frac{50 \times 2.5}{45}$

= 2.777 mg of $CaCO_3$ equivalent.

Step 3

50 ml of hard water sample = 30 ml of EDTA

∴ 1000 ml of hard water sample = $\left(\frac{1000}{50} \times 30\right) \times 2.777$

∴ Total hardness = 1666.2 ppm

Step 4 :

10 ml boiled hard water = 20 ml of EDTA

∴ 1000 ml of boiled hard water = $\frac{1000}{50} \times 20 \times 2.777$

= 1110.8 ppm

∴ Permanent hardness = 1110.8 ppm

∴ Temporary hardness = Total hardness - Permanent hardness

= 1666.2 − 1110.8

= 555.4 ppm.

Hence,

Total hardness = 1666.2 ppm, Permanent hardness = 1110.8 ppm,
Temporary hardness = 555.4 ppm