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Experiment No. 1

Estimation of total hardness of water

* Aim - To estimate total hardness of water by EDTA method by double burette method.

* objective - To determine the hardness of a water sample by complexometric titration method. Ethylene di amine tetra acetic acid (EDTA) is used as chelating agent. It forms complex with divalent cations such as Ca_2+ and $Mg2+$ ions in stoichiometric amount and thus hardness can be determined as ppm of $CaCO_3$.

* Apparatus: Burette, conical Flask, 100ml volumetric Flask, Beaker, watch glass, Burette stand etc.

* Chemicals: Na_2EDTA solution, 0.01 M $ZnSO_4$, Buffer Solution (pH=10), Hard water sample, Eriochrome Black-T [EBT] etc.

* Part B - standardization of Na_2EDTA solution by double burette method.

· observation table ·

Burette 1 - Na_2EDTA solution (0.01M) approx
Burette 2 - $ZnSO_4$ solution (0.01M)
Indicator - Eriochrome
Black-T End point - Wine red to blue

* Part B - Standardization of Na_2EDTA solution by double burette method.

· Reaction - $Na_2EDTA + Zn^{2+} \rightarrow [EDTA(Zn^{2+})\ complex]^{2-} + 2Na^+$

Burette1	Na_2EDTA	X_1 =	X_2 =	X_3 =
Burette2	$ZnSO_4$	5ml	6ml	7ml

· Calculations:-

To calculate exact molarity of EDTA (0.01M)

$M_1 \times V_1 = M_2 \times V_2$

EDTA = $ZnSO_4$

$\therefore M_1 \times V_1 = 0.01 \times 5$

$M_1 = 0.01 \times 5 / 4.9$

$= 0.0102M$

$M_2 = 0.0103M$

$M_3 = 0.0101M$

$\therefore$ Molarity of EDTA = $M' = \frac{M_1 + M_2 + M_3}{3}$

$= 0.01M$

$\therefore$ Exact molarity of EDTA is 0.01M

* Part C- To find out total hardness of given water sample.

Observation table:-

Burette 1 - Na_2EDTA solution (0.01 M)
Burette 2- Hard water sample
Indicator - Eriochrome
Black-T Endpoint - Wine red to blue

* Part C:- To find out total hardness of given water sample.

- Equations:-

$Ca^{2+} + HIn^{2-} \longrightarrow CaIn^{-} + H^{+}$

Indicator (Blue) — Metal ion Indicator complex (wine Red)

$CaIn^{-} + H_2Y^{2-} \longrightarrow CaY^{2-} + HIn^{2-} + H^{+}$

Metal-EDTA complex (colourless) — Free Indicator (Blue)

Burette 1	Na_2EDTA	V_1 =	V_2 =	V_3 =
Burette 2	Hard water sample	5ml	6ml	7ml

- Calculations:

EDTA and Ca^{2+} (or Mg^{2+}) ions form 1:1 complex

1 mole of EDTA = 1 mole of Ca^{2+} (or Mg^{2+}) = 1 mole of $CaCO_3$

1 mole of EDTA = 100g of $CaCO_3$

Thus 1000ml of M EDTA = 100 g of $CaCO_3$

1ml of 1M EDTA = 100 mg of $CaCO_3$

1ml 0.01 M EDTA = 1mg of $CaCO_3$

$\therefore Y_1$ ml of M' $Na_2EDTA = \frac{Y_1 \times M'}{0.01} = A_1$ mg $CaCO_3$

$\therefore A_1 = \frac{2.1 \times 0.01}{0.01} = 2.1$ mg

$H_1 = 200 \times 2.1 = 420$ ppm

$\therefore A_2 = 2.6$ mg

$\therefore H_2 = 167.33 \times 2.6 = 435.06$ ppm

$\therefore A_3 = 3.1$ mg

$\therefore H_3 = 142.85 \times 3.1 = 442.83$ ppm

Hardness of given sample $= \frac{H_1 + H_2 + H_3}{3} = \frac{1297.89}{3}$

$= 432.63$ ppm of $CaCO_3$

* Results:

Exact molarity of EDTA solution is = 0.0102 M

Total hardness of given sample of water = 432.63 ppm of $CaCO_3$

* Conclusion -

The total hardness of a given sample of water was estimated to be 432.63 ppm of $CaCO_3$ by EDTA method by double burette method.

* Questions -

Q. 1) Explain the significance of determination of hardness of water.

Ans → For determining suitability of water for domestic and industrial purpose. type of hardness and determination of magnitude of hardness is important.

Q. 2) Why is the end point of titration is wine red to blue?

Ans → ① In this titration EBT is used as an indicator
② It forms less stable wine red coloured complex with metal ions But when Na_2EDTA is added, metal indicator complex dissociates setting metal ions free.
③ They immediately form stable colourless complex with EDTA.
④ As a result, solution appears blue.
⑤ Appearance of blue colour is taken as end point of titration.

Q 3) Why and how is the pH value adjusted to about 10?

Ans → The EDTA forms a stable complex in basic medium, thus the alkaline buffer of $NaOH$ and NH_4Cl of pH-10 is used.

Q 4) As per WHO norms, what is the standard value of hardness for drinking water?

Ans → According to WHO, hardness is in the range 10-500mg of $CaCO_3$ per litre for drinking water.

Q 5) What is portable water, deionized water, saline water, brakish and mineral water?

Ans → ① Portable water is fresh water that is sanitized and safe for drinking.

② Deionized water is water that has been treated to remove all ions and dissolved mineral salts.

③ Saline water is water that contains a high concentration of dissolved salts.

④ Brackish water is water occoring in natural environment having more salinity than freshwater but less than seawater.

⑤ Mineral water is water from a mineral spoiling (spring) that contains various minerals such as salts and ~~soffe~~ sulfur compounds.