Date 06:11:15

Expt. No. 04

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AIM OF THE EXPERIMENT-

Determination of the hardness of water from a water sample by EDTA method.

APPARATUS REQUIRED-

Burette, pipette, conical flask, test tube, measuring flask.

CHEMICAL REQUIRED-

Eriochrome Black-T Indicator (EBT), standard disodium EDTA solution Buffer solution.

THEORY-

Hardness is the property of water which prevent the lathering of soap. originally it was defined as soap consuming capacity of water sample. The hardness of water is generally due to the presence of water of certain salts of ca, mg and other heavy ions like Al^{3+}, Fe^{3+} & Mn^{2+} dissolved in it. A sample of hard water when treated with soap (sodium or potassium salt of higher fatty acid like olic acid, palmitic acid or stearic acid) does not produce lather but on the other hand forms insoluble. while scum or precipitate which do not possess any detergent action. This is due to the formation of insoluble soaps of calcium & magnesium. Hardness is of two types- a) Temporary hardness.
b) permanent hardness.

Temporary Hardness- It is caused by the presence of dissolved bicarbonates of ca, mg & other heavy metals & the carbonates of iron. Temporary hardness can be removed by boiling of water when bicarbonates are decomposed producing insoluble carbonates

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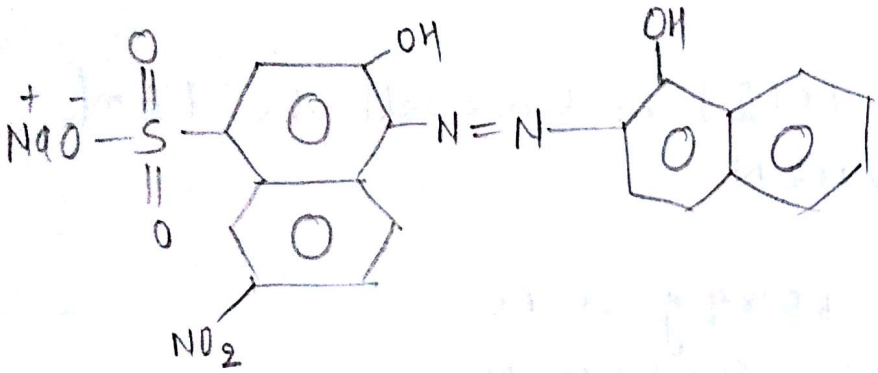
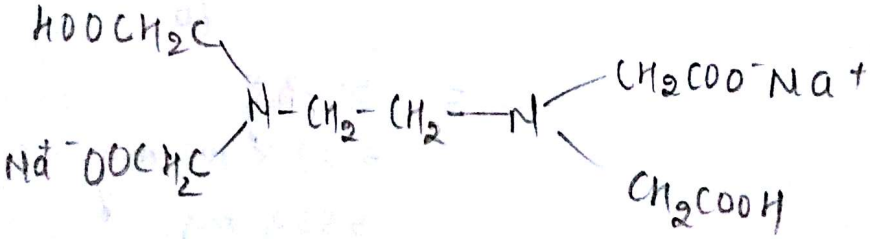
Eriochrome Black - T



(sodium-1-1(1-hydroxy, 2-naphylato)-6-nitro-2-naphtol-4 sulphonate.)

EDTA -



(disodium salt of EDTA)

ore hydroxides which are deposited as a crust at the bottom of the vessel.

Permanent hardness - It is due to the presence of dissolved chlorides & sulphates of calcium, magnesium, iron and heavy metals. Hence the salts responsible for permanent hardness are $CaCl_2$, $MgCl_2$ etc.

Hardness of water is generally expressed in term of equivalent amount of $CaCO_3$. The reason for choosing $CaCO_3$ as the standard for reporting hardness of water its the ease in the calculation as its molecular weight is 100 and it is the most insoluble salt that can be precipitated in the water treatment.

UNITS OF HARDNESS-

Parts per million (ppm) - It is defined as the number parts by weight $CaCO_3$ present per million (10^6) parts by weight of water i.e. 1 ppm = 1 part of $CaCO_3$ equivalent Hardness in 10^6 part of water.

Milligrams per litre (mg/lit) - It is defined as the no. of milligrams of $CaCO_3$ in 1L of water. 1 mg/Lit = 1 ppm of water.

CHEMICAL REACTION-

- $H_3Ind \xrightarrow{+H^+} H_2Ind^- \xrightarrow{+H^+} HInd^{2-} \xrightarrow{+H^+} Ind^{3-}$
  wine red (pH < 7) | Blue (pH 7-11) | yellow Orange pH > 11

- $\begin{bmatrix} Ca^{2+} \\ mg^{2+} \end{bmatrix} + H_2Ind^{2-} \longrightarrow \begin{bmatrix} Ca^{2+}\text{-Ind complex} \\ mg^{2+}\text{-Ind complex} \end{bmatrix} + H^+$
  unstable (wine red)

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Tabulation-1

For total hardness -

Sl. No.	Vol. of water Sample (in ml)	Vol. of EDTA (in ml)			Remark
		IBR (a)	FBR (b)	diff (b-a)	
1	50	0	5.8	5.8	Rough
2	50	5.8	12.0	6.2	
3	50	12.0	17.0	5	Concordant Reading
4	50	17.0	22.0	5	
5	50	22.0	27.0	5	

$V_1 = 5$ ml

- $[Ca^{2+}$ – 2nd complex
  Mg^{2+} – 2nd complex
  unstable wine red$]$ $+ Na_2H_2 \longleftrightarrow$ $[Ca$-EDTA complex
  Mg-EDTA complex
  Stable$]$

$+ H_2Ind^{2-} + H^+$

PROCEDURE –

Determination of total hardness –

50 ml of Hard water Sample was pippette out into a 250 ml conical flask, 10 ml of buffer solution was added & 2-3 drops of Eriochrome black-T indicator was added. The Solution was titrated with M/100 EDTA solution from the burette until colour changes from wine red to blue.

Determination of Temporary & permanent hardness –

250 ml of hard water Sample was taken in a large beaker and gently boiled for about 1 hour (It was then cooled filtrated into a 250 ml for measuring flask and the volume was made upto the mark. 50 ml of solution was taken and was proceeds as above way.

Temporary hardness is calculated by substracting permanent hardness from total hardness.

CALCULATION –

1000 ml 1(M) EDTA $\cong$ 100 g of $CaCO_3$

5 ml 0.2(M) EDTA $\cong \frac{100 \times 5 \times 0.02}{1000}$ g of $CaCO_3$

$\cong$ 0.01 g of $CaCO_3$

50 ml solution contains 0.01 g of $CaCO_3$

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Tabulation - 2

fore permanent hardness -

Sl. No.	Vol. of water Sample (in ml)	Vol. of EDTA (in ml)			Remark
		IBR a	FBR b	diff. (b-a)	
1	50	0	4.8	4.8	Rough
2	50	4.8	9.0	4.2	Concordant Reading
3	50	9.0	13.2	4.2	
4	50	13.2	17.4	4.2	

$V_2 = 4.2$ ml

1000 ml solution contains = $\frac{0.01 \times 1000}{50}$ g of $CaCO_3$

= 0.2×1000 mg of $CaCO_3$

= 200 mg of $CaCO_3$

Hence total hardness = 200 ppm ✓

1000 ml 1(M) EDTA ≅ 100 g $CaCO_3$

4.2 ml of 0.02M " ≅ $\frac{100 \times 4.2 \times 0.02}{1000}$ g of $CaCO_3$

≅ 0.0084 g of $CaCO_3$

50ml solution contains = 0.0084 g of $CaCO_3$

1000 ml solution contains = $\frac{0.0084 \times 1000}{50}$ g of $CaCO_3$

= 0.168 g of $CaCO_3$

= 168 mg of $CaCO_3$

∴ permanent hardness = 168 ppm ✓

Temporary hardness = Total hardness − permanent hardness.

= 200 − 168

= 32 ppm. ✓

CONCLUSION−

The total hardness, permanent hardness & temporary hardness was found to be 200 ppm, 168 ppm & 32 ppm Respectively.

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13/11/15

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