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(3) ESTIMATION OF TOTAL HARDNESS, PERMANENT AND TEMPORARY HARDNESS BY EDTA METHOD:

AIM:- To estimate the amount of total hardness, permanent hardness and temporary hardness of a given sample of water by EDTA method using ammonium buffer (PH=10) and eriochrome black-T indicator.

APPARATUS REQUIRED :-

Burette, pipette, conical flask, standard volumetric flask, Funnel, Beaker - 250 ml.

REAGENTS REQUIRED :-

EDTA solution, standard hard water, sample water, Eriochrome black-T indicator (EBT), NH_3NH_4Cl buffer solution (PH=10).

PRINCIPLE :- Disodium salt of Ethylene diamine tetra acetic acid (EDTA), is used to determine the total hardness of the given hard water. When EDTA is added, the indicator is replaced by EDTA and stable complex is formed. This is the end point for the titration between EDTA and hard water.

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TABLE - 1

DETERMINATION OF EDTA

S.NO	Vol. of hard water (in ml)	BURETTE READS		Volume of EDTA	Indicator
		Initial	Final		
1	20	0	19.8	19.8	EBT
2	20	0	19.8	19.8	

CALCULATION :-

1ml of standard hard water = 1mg of $CaCO_3$

Volume of standard hard water = 20 ml

20ml of standard hard water = 20ml of $CaCO_3$

Volume of EDTA solution = 20 mg $CaCO_3$.

Volume of EDTA consumed = V_1 ml = 19.8

Therefore 1ml of EDTA will be = $\frac{20}{V_1}$ mg of equivalent $CaCO_3$

$= \frac{20}{19.8} = 1.0101$ mg of $CaCO_3$

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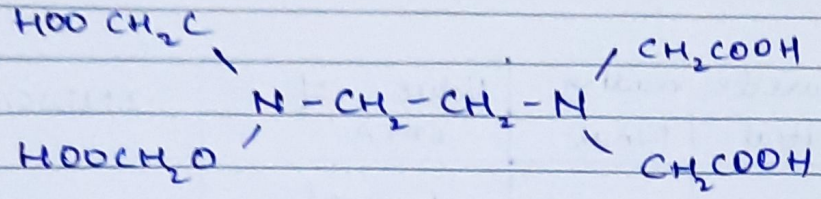
Ethylene diamine tetra acetic acid (EDTA) is a tetra carboxylic acid which the following formula



The entire reaction between Ca, Mg ions & EB-T is represented as follows.

$$\begin{bmatrix} Ca^{2+} \\ Mg^{2+} \end{bmatrix} + EBT \longrightarrow \begin{bmatrix} Ca^{2+} \\ Mg^{2+} \end{bmatrix} - EBT$$ wine red (unstable)

$$\begin{bmatrix} Ca^{2+} & EBT \\ Mg^{2+} \end{bmatrix} + EDTA \begin{bmatrix} Ca^{2+} & EDTA \\ Mg^{2+} \end{bmatrix} + EBT \text{ (Blue)}$$

When the sample water is, boiled, bicarbonates of calcium and magnesium are converted into carbonates and hydroxides, which can be removed by filtration.

The permanent hardness which is not removed by boiling is once again estimated by EDTA.

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TABLE - 2

DETERMINATION OF TOTAL HARDNESS

S.NO	Vol of sample hardwater	Burette reading		Vol. of EDTA	Indicator
		INITIAL	FINAL		
1.	20ml	0ml	10.4ml	10.4 ml	EBT
2.	20ml	0ml	10.4ml	10.4 ml	

Volume of EDTA consumed = V_2 ml (from table -2)
= 10.4 ml

Now, if 1 ml EDTA = $\frac{20}{V_1}$ mg $CaCO_3$ = 1.0101 mg

Then V_2 ml EDTA = $\frac{20}{V_1} \times V_2$ mg $CaCO_3$
= 10.50 mg $CaCO_3$

If 20 ml sample hard water taken } = $\frac{20}{V_1} \times V_2$ mg $CaCO_3$

Then 1000 ml will contain = $\frac{(20/V_1)\, V_2}{20} \times 1000$ mg $CaCO_3$

$= \frac{10.50}{19.8} \times 1000$

$= 0.5225 \times 1000$

$= 525.25$ ppm

TABLE-3

DETERMINATION OF TOTAL HARDNESS

S.NO	Volume of Boiled water	Burette reading		Value of EDTA	INDICATOR
		Initial	Final		
1	20ml	0ml	5.2ml	5.2ml	EBT
2	20ml	0ml	5.2ml	5.2ml	

Volume of EDTA consumed = V_3 ml.

If 1ml EDTA = $\frac{20}{V_1}$ mg $CaCO_3$ = 1.0101 mg

Then V_3 ml EDTA = $\frac{20}{V_1} \times V_3$ mg $CaCO_3$ = 5.252 mg $CaCO_3$

The boiled hard water sample is equivalent to permanent hardness = $\frac{20}{V_1} \times V_3$ mg $CaCO_3$

Then 100ml will contain = $\frac{\left(\frac{20}{V_1}\right) \times V_3 \times 1000 \text{ mg}}{20}$

$= \frac{V_3}{V_1} \times 1000$ mg $CaCO_3$

= 262.626 ppm

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PROCEDURE :- Pipette out 20ml of standard water into a clean conical flask. Add 5ml of the buffer & 3 or 4 drops of two Erichrome Black-T- Indicator. The solution turns to wine red in colour. Titration (Titrate) the wine red coloured solution against EDTA taken in the Burette.

DETERMINATION :-

Take 100ml of the hard water sample in a 250ml beaker & boil gently for about one hour. Filter into a 100ml standard flask and make the value up to the mark. Take 20ml of this solution & proceed the titration in the same way.

RESULT :-

The total hardness of sample hardwater = 525.25ppm

The permanent hardness of sample hardwater = 262.62 ppm

The temporary hardness of sample hardwater = 262.63 ppm

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