

Experiment no. 1

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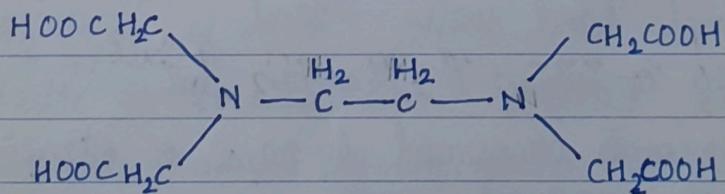
Determination of hardness (Ca^{2+}) of water using EDTA - complexometry method.

Aim :- To determine the total hardness, permanent hardness and temporary hardness in the given sample of hard water by EDTA method. A sample of standard hard water (1ml contains 1 mg of CaCO_3) and a standard EDTA solution are provided.

Apparatus Required :- Burner, Pipette, Conical flask and measuring jar.

Reagent Required :- EDTA, sample water, ammonia buffer, EBT.

Principle :- Ethylene Diamine Tetra Acetic acid (EDTA) is a diamine tetra carboxylic acid. It is a well known complexing agent. The structure of EDTA is represented as :



Disodium salt of EDTA is used to estimate the various hardness of the given hard water. When EDTA is added to hard water, it reacts with calcium and magnesium ions present in the hard water to form stable EDTA metal complexes. From the volume of EDTA consumed, hardness can be calculated. Miochrome black-T is used as an indicator. The indicator forms a complex with metal ion present in the hard

TITRATION - I

Standardization of EDTA

Burette solution : EDTA

Pipette solution : Std. hard water

Additional addition : Ammonia buffer (5 ml)

Indicator : EBT (3 to 4 drops)

Colour change : Wine red to steel blue

STANDARD HARD WATER VS EDTA

S.N.	Volume of Std. hard water (ml)	Burette reading (ml)		Volume of EDTA	Concordant value (V_1) ml	Indicator
		Initial	Final			
1.	20	0	20.2	20.2		
2.	20	0	20.2	20.2	20.2	EBT

CALCULATION :-

20.2 (V_1) ml of EDTA is consumed by 20ml of standard hard water.

1 ml of standard hard water contains 1mg of CaCO_3 .

20 ml of standard hard water contains 20 mg of CaCO_3

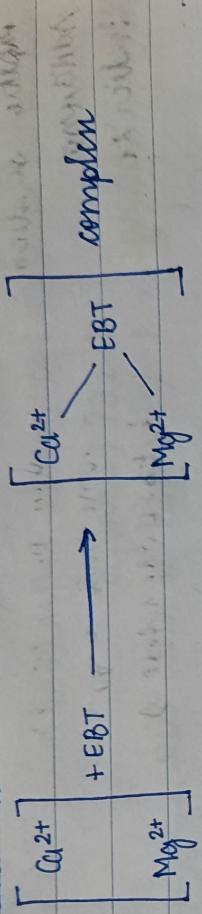
$$\underline{20.2} (\mathcal{V}_1) \text{ ml of EDTA solution} = 20 \text{ mg of } \text{CaCO}_3$$

$$= \frac{20}{\mathcal{V}_1} \text{ mg of } \text{CaCO}_3 \text{ equivalent}$$

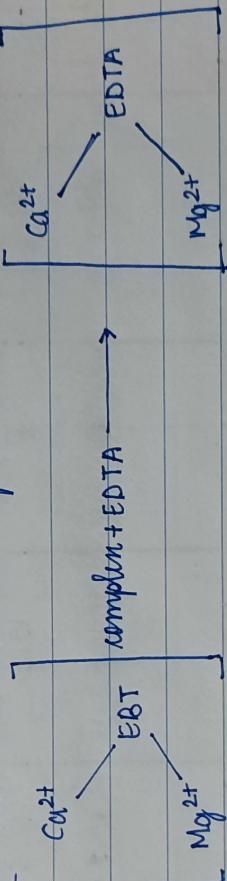
$$= 0.99 \text{ mg of } \text{CaCO}_3 \text{ equivalent}$$

2.

water and produce wine red colour.



When EDTA is added to the hard water, the metal ions form a stable metal complex with EDTA by leaving the indicator from the complex. When all the metal ions are taken by EDTA from the indicator metal ion complex, the wine red colour changes into steel blue, which denotes the end point.



Procedure :-

TITRATION - I

Standardization of EDTA

The burette is washed with distilled water and then rinsed with a little amount of the given EDTA solution. It is then filled with the EDTA solution up to zero level without air bubbles. Initial reading of the burette is noted. 20 ml of standard hard water solution is pipetted out into a clean conical flask. 5ml of ammonia buffer and 2 drops of eosin chrome black-T indicator are added. The solution turns wine red colour. It is then titrated against EDTA taken in the burette. The change of wine red and colour to steel steel blue colour is the end point. The final reading in the burette is noted. The difference in the burette reading

TITRATION - II

Estimation of Total Hardness

1. In Titration

In titration solution : EDTA + 20 ml water
Pipette solution : Sample hard water (20ml)
Additional solution : Ammonia buffer (5ml)

Indicator : Phenolphthalein EBT (3 drops)
Addition of sample hard water to titrant until colour disappears

Given : Hard water contains 100 mg of CaCO_3 per ml.

SAMPLE OF HARD WATER VS EDTA

S.No	Volume of sample hard water (ml)	Burette reading (ml)	Volume of EDTA (ml)	Concordant value (V_2) ml	Indicator
	Initial	Final			
1.	20	0	17.2	17.2	EBT
2.	20	0	17.2	17.2	

CALCULATION :-

Volume of sample hard water = 20ml

Volume of EDTA consumed (V_2) = 17.2 ml

17.2 (V_2) ml of EDTA is consumed by 20ml of sample hard water

1 ml of EDTA solution = $\frac{20}{V_2}$ mg of CaCO_3 equivalent

(V_2) ml of EDTA

$$= \frac{20}{V_2} \times V_2 \text{ mg of } \text{CaCO}_3 \text{ equivalent}$$

$$= (20/20.2) \times 17.2 \\ = \frac{20}{V_2} \times \frac{V_2}{20} \times 1000 \text{ mg of } \text{CaCO}_3$$

$$\text{Total hardness} = \underline{\underline{851.98 \text{ ppm}}}$$

gives the volume of the EDTA solution. The titration is repeated to get the concordant value. Let the volume of EDTA be V_1 ml.

TITRATION - II

Estimation of total hardness

Inactly 20 ml of the given sample of hard water is pipetted out into a clean conical flask. 5 ml of ammonia buffer solution and 2 drops of Eriochrome black-T indicator are added. The solution turns wine red in colour. This solution is titrated against EDTA solution taken in the burette. The change of wine red colour into steel blue colour is the end point. The titration is repeated to get the concordant value. Let the volume of EDTA be V_2 ml.

TITRATION - III

Estimation of permanent hardness

About 100 ml of given sample of hard water is taken in a clean breaker and boiled till the volume is reduced to 50 ml. It is then cooled and filtered. The filtrate is made up to 100 ml. 20 ml of this made up solution is pipetted out into a conical flask. 5 ml of ammonia buffer solution and 2 drops of Eriochrome black-T indicator are added. The solution turns steel blue in colour. This solution is titrated against the EDTA taken in the buffer. The change of colour from wine red to steel blue is the end point. The titration is repeated to get the concordant value. Let the titre value be V_3 ml. The permanent hardness of the water sample can be calculated from the volume of EDTA, V_3 ml.

TITRATION - II

Estimation of Permanent hardness

- Burette solution : EDTA
- Pipette solution : Boiled water (20 ml)
- Additonal solution : Ammonia Buffer (5 ml)
- Indicator : EBT (2 drops)
- Calibration : Wine red to steel blue

BOILED HARD WATER VS EDTA

S. No.	Volume of Boiled hard water (ml)	Initial reading (ml)	Final reading (ml)	Volume of EDTA (ml)	Concordan value (V_3) (ml)	Indicator
1	20	0	10.5	10.5	10.6	EBT
2	20	0.1734	10.5	10.5		

CALCULATION :-

Volume of boiled sample hard water

Volume of EDTA consumed (V_3)

10.5 ml (V_3) of EDTA is consumed by 20 ml of boiled sample hard water.

1 ml of EDTA solution
 $= \frac{20}{V_1} \text{ mg of } \text{CaCO}_3 \text{ equivalent}$

$(V_2) \text{ ml of EDTA}$

$= \frac{20}{V_1} \times V_3 \text{ mg of } \text{CaCO}_3 \text{ equivalent}$

$1000 \text{ ml of Boiled sample hard water contains}$
 $= \frac{20}{V_1} \times \frac{V_3}{20} \times 1000 \text{ mg of } \text{CaCO}_3 \text{ equivalent}$

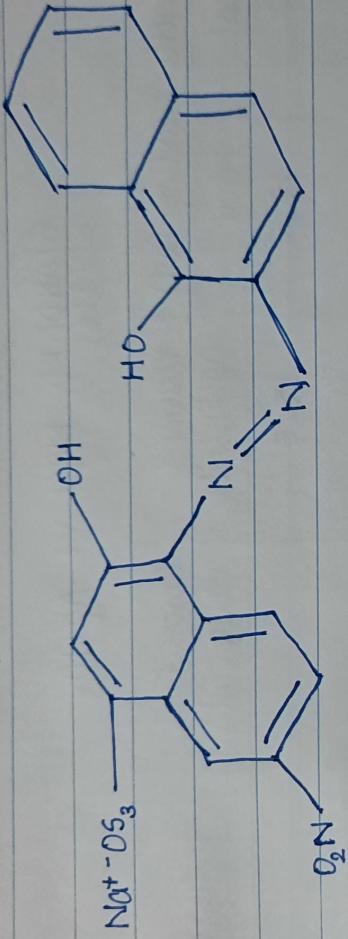
$$= \frac{20}{20.5} \times \frac{10.5}{20} \times 1000$$

$$= 519.80 \text{ ppm}$$

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Estimation of Temporary Hardness

Temporary hardness of the water is calculated by subtracting permanent hardness from total hardness.



Structure of EBT

Result :-

The given water sample contains

- Total hardness = 851.48 ppm
- Permanent hardness = 519.80 ppm
- Temporary hardness = 331.68 ppm

ESTIMATION OF TEMPORARY HARDNESS OF THE WATER

Total hardness - Permanent hardness
861.48 - 610.80

Impurity tolerance of the given water sample = 331.68 ppm