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THAKUR COLLEGE OF ENGINEERING & TECHNOLOGY

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1st cycle of NAAC Accreditation : • "A" Grade for 5 years (w.e.f. 30-10-2017)

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Subject :- Chemistry

Experiment / Tutorial / Assignment No. :- 3

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DETERMINATION OF PERMANENT HARDNESS OF WATER



• Aim:

To determine the Permanent Hardness of Water sample by complexometric method.

• Objectives:

After performing this practical, the learner will be able to:

PRO1: Understand the apparatus set up for titration.

PRO2: Understand the relation between consumption of EDTA and Standard Hard Water (SHW).

PRO3: Calculate the Strength of EDTA solution.

PRO4: Estimation of Permanent Hardness of Water.

• Apparatus and Chemical used:

Burette, Pipette, Conical flask, Beaker, EDTA, Buffer solution, Standard Hard Water (Strength 1mg/ml), Boiled & Filtered hard water sample, EBT indicator, etc.

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PART-I: Standardisation of EDTA

Observations:

- Solution in Burette: EDTA solution
- Solution in Conical Flask: 10 ml of SHW + $\frac{1}{2}$ T.T. Buffer Solution.
- Indicator: EBT (1-2 drops)
- End point: Wine Red to Blue.
- Pilot Reading: 8.0 ml to ~~9.0~~ ml
9.0

Observation Table:

Sr. No.	Initial Reading (ml)	Final Reading (ml)	Difference (ml)
1	0.0	4.0 8.9	4.0 8.9
2	0.0	4.0 8.9	4.0 8.9
3	0.0	4.0 8.9	4.0 8.9

Constant Burette Reading = $\frac{4.0 \text{ ml}}{8.9}$

Calculations:

10 ml S.H.W. = 8.9 ml of EDTA

Also, 1 ml of S.H.W. = 1 mg of CaCO_3 .

\therefore 10 ml of S.H.W. = 10 mg of CaCO_3 .

Thus, 8.9 ml of EDTA = $\frac{10}{8.9}$ mg of CaCO_3 .

\therefore 1 ml of EDTA = $10/8.9 = 1.128$ mg of CaCO_3 .

\therefore 1 ml of EDTA = 1.128 mg of CaCO_3 .

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PART-II: Estimation of Permanent Hardness

Observations:

- Solution in Burette: EDTA solution.
- Solution in Conical Flask: 10 ml of boiled filtered W.S. + $\frac{1}{2}$ T.T. Buffer solⁿ.
- Indicator: EBT (1-2 drops)
- End point: Wine Red to Blue.
- Pilot Reading: 3.0 ml to 4.0 ml

Observation Table:

Sr. No.	Initial Reading (ml)	Final Reading (ml)	Difference (ml)
1	0.0	4.0	4.0
2	0.0	4.0	4.0
3	0.0	4.0	4.0

Constant Burette Reading = 4.0 ml

Calculations:

10 ml of boiled filtered hard water = 4 ml of EDTA (CBR)

But, 1 ml of EDTA = 1.128 mg of CaCO_3 (From Expt. 1) .. eq I

\therefore 10 ml of boiled & filtered hard water =

= Value from eq I \times (CBR) mg of CaCO_3 .

= 1.128×4

= 4.512 mg of CaCO_3 .

.... eq II

\therefore For 1000 ml of boiled & filtered hard water

= $100 \times$ Value from eq II mg of CaCO_3 .

= 100×4.512

= 451.2 mg of CaCO_3 .

\therefore Permanent Hardness of Water = 451.2 mg / litre or ppm.

- Result & Discussion:

PRO1: Usage of Pipette for Taking the Sample, funnel for avoiding spillage, Burette for drop by drop Analysis & conical flask for easier Handling & Observations, Overall Improve Accuracy of the Experiment.

PRO2: EDTA replaces EBT from Pre-existing Metal-EBT sample, to form Metal-EDTA complex, as it is Hexadentate & more stable, resulting in Colour change from Wine-Red to Colourless. The EBT solution remaining in the flask shows the Blue Colour.

PRO3: Strength of EDTA solution is found using Standard Water Sample. This value is expressed in Mg of CaCO_3 as it has Mol.wt. 100, hence easier for calculation & is highly insoluble. Doing this procedure thrice results in Accurate Readings for CBR.

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PRO4: Strength of boiled & filtered Hard Water Sample is Found by the Same Procedure. Then using Eq. 1 Permanent Hardness of Water is Calculated. Temporary Hardness is further calculated by subtracting the values of Total Hardness & Permanent Hardness, As boiling & filtering removes these impurities.

- Conclusion:

Permanent Hardness of given Boiled & Filtered Water sample is calculated using Complexometric Method.

• Precautions:

While performing the practical, the learner must;

1. Ensure that glassware are cleaned.
2. Ensure burette is holding properly to burette stand.
3. Ensure that there is no leakage of burette before starting the titration.
4. Ensure that lower meniscus of burette is adjusted to zero.

• Quiz:

1] Define Permanent Hardness.

⇒ The Type of Hardness of Water which cannot be removed by Boiling is called as Permanent Hardness.

2] Write the salts causing Permanent Hardness.

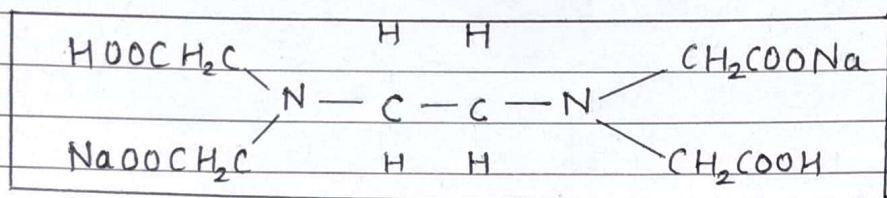
⇒ Permanent Hardness is caused by Salts of Calcium, Magnesium & Iron, mainly Halides $[Cl^-]$, Sulphates $[SO_4^{2-}]$ & Nitrates $[NO_3^-]$.

3] State the principle of EDTA.

⇒ EDTA is Ethylenediaminetetraacetate, an Hexadentate ligand that combines with Metal ions by donating its 6 electron pairs. Because of this property of EDTA it is used in Complexometric Titrations.

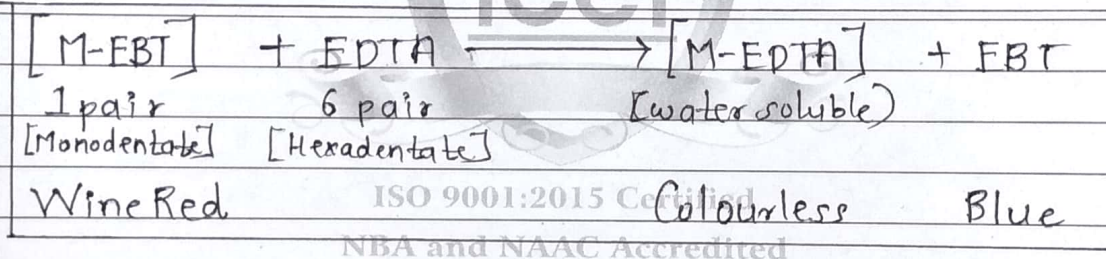
4] Draw the structure of Sodium Salt of EDTA & represent the formation of unstable & stable complex during Complexometric titration.

→ Disodium salt of EDTA is generally used in Complexometric Titrations. It is preferred over standard EDTA because of its



Higher Solubility in water.

- EDTA displaces EBT from Metal-EBT complex to form Metal-EDTA complex. This is because EDTA is a Hexadentate & provides more stability to the complex than a Monodentate like EBT.



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Objective	PRO 1	PRO 2	PRO 3	PRO 4	Total
Weight	20	20	20	20	Score
Points					
Score					
Earned points (EP) =	Marks in 100 = EP * 20				
Total Score/80 =	=				