EXPERIMENT NO. 7

Aim: To determine the Total Hardness in given water sample by complexometric titration method.

Apparatus required: Burette, conical flask, pipette, beaker and Funnel.

Chemical required: 0.1 M- EDTA, 0.01 M - $CaCO_3$, EBT Indicator ,buffer solution (NH_3 / NH_4Cl) and given water sample.

Theory: The hardness of water can be determined by complexometric titretion and EDTA is used as complexing agents. The Ca^{2+} and Mg^{2+} are present in water and titrated with EDTA using as a EBT indicator.

Chemical Equations:

I) The EBT indicatior forms an unstable complex with Ca^{2+} or Mg^{2+} at pH of 9 to 10. The complex is wine red in colour.

$$Ca^{2+}/ Mg^{2+} + EBT \longrightarrow [Ca/ Mg -EBT]$$
$$\text{(Unstable complex – Wine red)}$$

II) As this solution is titrated against EDTA, the free Ca^{2+} or Mg^{2+} ions in water forms stable metal ion EDTA complex.

$$Ca^{+2}/ Mg^{+2} + EDTA \longrightarrow [Ca/ Mg -EDTA]$$
$$\text{(Stable complex - Colourless)}$$

III) The free metal ions are complexd, the EDTA replaces Ca or Mg ions from the unstable indicator and the indicator is free. Since the indicator is blue.So, the end point is appearance of blue colour.

$$[Ca/ Mg -EBT] + EDTA \rightarrow [Ca/ Mg -EDTA] + EBT$$
$$\text{Wine red} \qquad\qquad \text{Colourless} \qquad \text{Blue}$$

Procedure :

i) **Standardization of EDTA / $CaCO_3$**

1. EDTA is filled in burette.
2. 10 ml $CaCO_3$ is pipette out in a conical flask.
3. 5 ml of buffer is added in the conical flask.
4. 2-3 drops of EBT (Indicator) is also added.
5. Titrate against the EDTA solution till the colour of the solution changes from wine red to blue.
6. Note the final reading and repeat to get three concordant readings.

ii)   EDTA Vs Water Sample

1. EDTA solution is filled in the burette.
2. 10 ml of water sample is pipette out in conical flask.
3. Add 5 ml of buffer solution and 2-3 drops of EBT indicator.
4. Titrate against the EDTA solution till the colour of the solution changes from wine red to blue.
5. Write the final reading and repeat to get three concordant readings.

Observations:

i)   Standardization of EDTA

Solution in burette   =   EDTA

In conical flask   = $CaCO_3$ (10 ml)

Indicator   =   EBT

End Point   =   Wine Red to Blue

Observation Table:

Serial no.	Burette Reading		Volume of EDTA (ml)
	Initial	Final	
1	0	11.5	11.5
2	11.5	23	11.5

ii)   EDTA Vs Water Sample

Solution in burette   =   EDTA

Solution in flask   =   Water Sample (10 ml)

Indicator   =   EBT

End Point   =   Wine Red to Blue

Observation Table:

Serial no.	Burette Reading		Volume of EDTA (ml)
	Initial	Final	
1	0	12.5	12.5
2	12.5	25	12.5

Calculations :

    i)   Standardization of EDTA (EDTA/CaCO₃)

$M_1 V_1$	=	$M_2 V_2$
(EDTA)		(CaCO₃)
M_1	=	$M_2 V_2 / V_1$
$M_{1(EDTA)}$	=	$0.1 \times 10 / 11.5$
	=	0.086 M

    iii)   EDTA Vs Water sample

|		
M_1 V_1	=	M_2 V_2
(Water)		(EDTA)
$M_{1(water)}$	=	M_2 V_2 / V_1
	=	$0.086 \times 12.5 / 10$
	=	0.107 M
Strength	=	Molarity of hard water x Molecular mass of CaCO3
	=	0.107×100 g / L
	=	10.7×1000
	=	1070 ppm

Result: Total Hardness of water sample is 1070 ppm.

Precautions:

1. The burette, pipette and conical flask should be rinsed with distilled water.
2. The colour change near the end point is very slow and thus should be observed carefully.

Structure:

    EBT (Eriochrome Black T)   Molecular formula- $C_{20}H_{12}N_3NaO_7S$
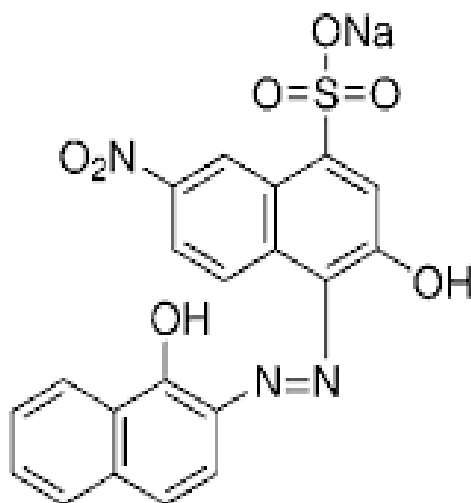
EDTA (Ethylene Diamine Tetra Acitic Acid)

Chemical formula: $C_{10}H_{16}N_2O_8$