

EXPERIMENT - 2a

Aim: To determine temporary and permanent hardness in water sample using standard Ethylene Diamine Tetra Acetic Acid (EDTA) (M/100) solution.

Requirements:

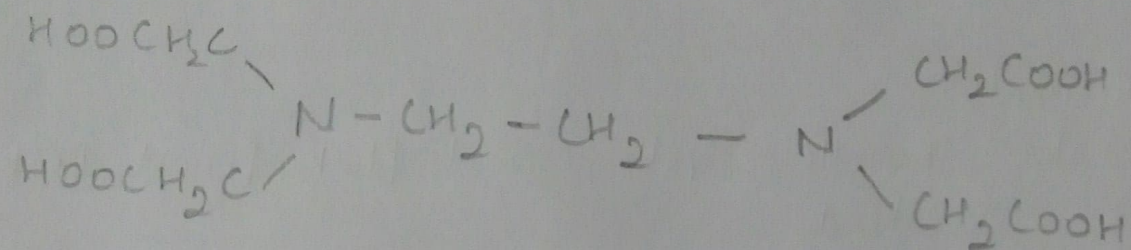
- (a) Apparatus: Burette, Pipette, conical flask, Funnel, Beaker, Burette stand.
- (b) Chemicals: Standard EDTA solution, Hard water, Boiled water Buffer solution ($\text{NH}_4\text{Cl} + \text{NH}_4\text{OH}$)
- (c) Indicator: Eriochrome black T (Solochrome Black) EBT (Sodium-1(1-hydroxyl-2-naphthyl azo)-6-nitro-2-naphthol-4-sulphonate).

Principle:

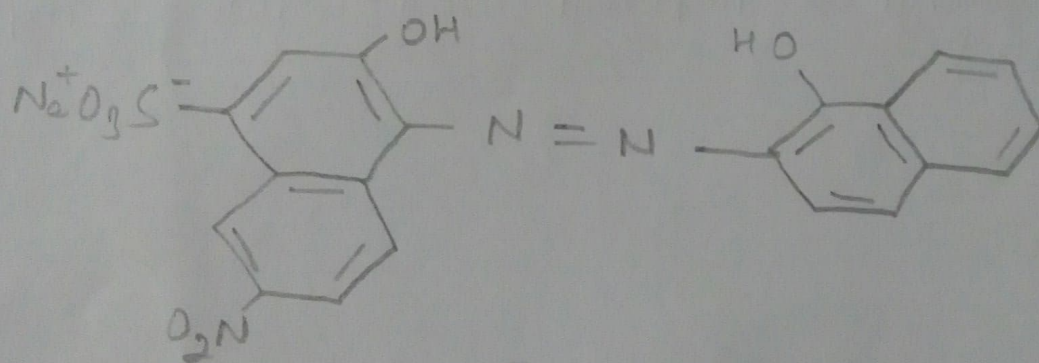
Hardness is a property of water. Hardness can be defined as the soap consuming capacity of water. It occurs due to the presence of carbonate, bicarbonate, sulphate and fluoride salt in water.

When EBT is added in given hard water sample at pH-10 it generates wine red / Brown red color due to the formation of unstable complex with calcium and magnesium ions of water sample.

INDICATOR STRUCTURE :

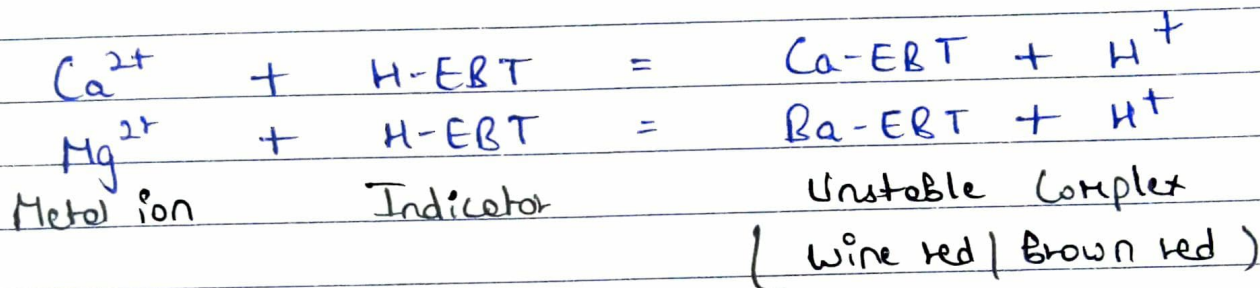
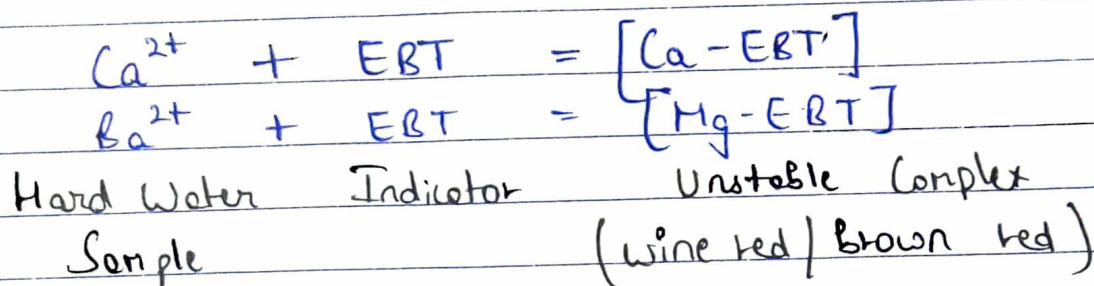


Ethylene diamine tetra-acetic acid

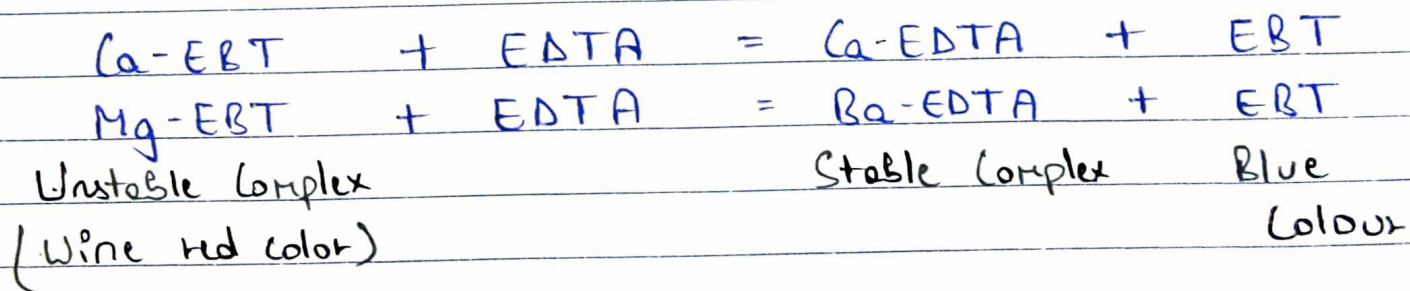
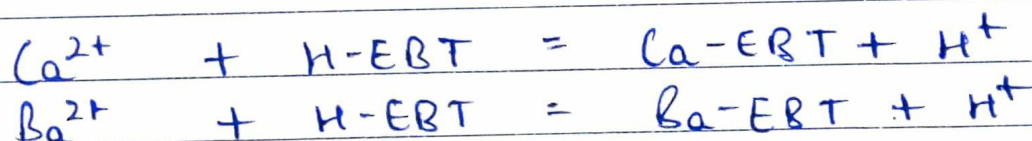


Eriochrome Black-T

Sodium-1-(1-hydroxy-2-naphthylazo)-6-nitro-2-naphthol-4-sulphonate



The unstable Brown red color is titrated against standard EDTA solution. It forms a stable Blue color complex. It indicates the equivalence or end point.



Procedure:

- (1) Rinse the glass apparatus properly with distilled water. Fill the buret with standard EDTA solution. Take out 10ml hard water in a conical flask and add 2ml buffer solution in it to maintain the pH of the solution.



Now add 1 drop of indicator EBT in the given hard water sample in conical flask. The solution acquires wine red / Brown red color.

- (2) Start titration with this wine red / brown red coloured solution against standard EDTA solution drop wise with continuous shaking till the color of solution changes from wine red to blue. Note down the reading and repeat the process to get concordant readings.
- (3) Similarly rinse the glass apparatus properly with distilled water. Fill the burette with standard EDTA solution. Take out 10ml Boiled filtered water (free from temporary hardness) in a conical flask and add 1-2 buffer solution in it to maintain the pH of the solution. Now add 1-2 drop of indicator EBT in the given Boiled filtered water sample in conical flask. The solution acquires wine red / Brown red color.
- (4) Start titrating this wine red / Brown red coloured solution against standard EDTA solution drop wise with continuous shaking till the color of solution changes from wine red to blue. Note down the reading and repeat the process to get concordant readings.

Observations :

(1) Observation Table for Hard Water

S.No	Volume of hard Water (ml)	Burette Reading		Vol. of standard EDTA sol ⁿ (ml)
		Initial Reading (ml)	Final Reading (ml)	
1.	10	0	14	14
2.	10	0	13.8	13.8
3.	10	0	14	14
4.	10	0	14	14

(2) Observation Table for boiled Filtered Tap Water

S.No	Volume of Boiled Water (ml)	Burette Reading		Vol. of standard EDTA solution (ml)
		Initial Reading (ml)	Final Reading (ml)	
1.	10	0	6.5	6.5
2.	10	0	6.5	6.5
3.	10	0	6.3	6.3

Concordant Reading for Hard Water
= 14 ml

Concordant Reading for Boiled Water
= 6.5 ml

Calculations:

EDTA forms 1:1 complex with Ca^{2+} and Mg^{2+}

\therefore 1000ml of 1M EDTA = 1 Mole of CaCO_3 = 100gm of CaCO_3

$$1 \text{ ml of } \frac{1}{100} \text{ M EDTA} = \frac{100 \text{ gm of } \text{CaCO}_3}{1000 \times 100} = 1 \text{ mg of } \text{CaCO}_3$$

$$V \text{ ml of } \frac{1}{100} \text{ M EDTA} = V \text{ mg of } \text{CaCO}_3$$

10ml of Hard Water contains Vmg of CaCO_3

\therefore Total Hardness in given water sample in terms of CaCO_3 = 10.9 mg/L

Permanent hardness in given water sample in terms of CaCO_3 = 5.2 mg/L

Temporary hardness in given water sample in terms of CaCO_3 = (10.9 - 5.2) / 1
= 5.7 mL

Calculations:

- (A) Total hardness in the given water sample in terms of CaCO₃ hardness:

$$\left[\frac{\text{Volume of standard EDTA solution}}{\text{volume of hard water sample solution}} \right] \times 1000 \text{ ppm} = 14 \text{ mg/L}$$

- (B) Permanent hardness in the given water sample in terms of CaCO₃ hardness:

$$\left[\frac{\text{Volume of standard EDTA solution}}{\text{volume of Boiled water sample solution}} \right] \times 1000 \text{ ppm} = 6.5 \text{ mg/L}$$

- (C) Temporary hardness in the given water sample in terms of CaCO₃ hardness:

$$\begin{aligned} \text{Temporary hardness} &= [\text{Total hardness} - \text{Permanent Hardness}] \\ &= 7.5 \text{ mg/L} \end{aligned}$$

End Point:

Equivalence point or END POINT in this complexometric titration is when wine red / Brown red color changes to blue, of the sample water with hardness.

Result:

- (1) The permanent hardness in the given hard water is 6.5 mg/L
- (2) The temporary hardness in the given Boiled filtered water sample is 7.5 mg/L

Precautions:

- (1) Glass apparatus should be cleaned properly.
- (2) Always distilled water should be used for reagent preparation.
- (3) Titration should be done drop wise and with regular shaking of sample solution.
- (4) The pH of solution should be maintained during the process of titration.
- (5) End point should be observed correctly.
- (6) Standard solution in burette should be free from leaks and bubbles.