

## 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 ammonia buffer (pH=10) and epichrome black-T indicator.

### ★ APPARATUS REQUIRED:

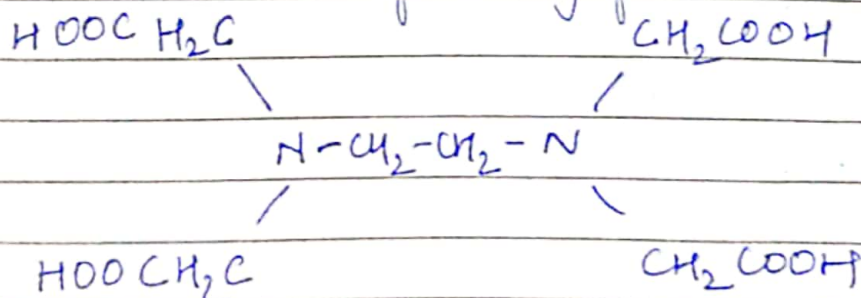
Burette, Pipette, Conical flask, Standard Volumetric flask, Funnel, Burner, Beaker 250 ml.

### ★ REAGENTS REQUIRED:

EDTA Solution, Standard hard water, Sample water, Epichrome black-T indicator (EBT),  $\text{NH}_3\text{-NH}_4\text{Cl}$  buffer solution (pH=10).

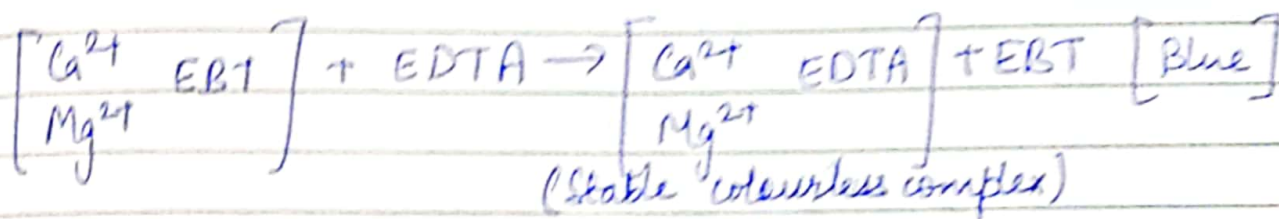
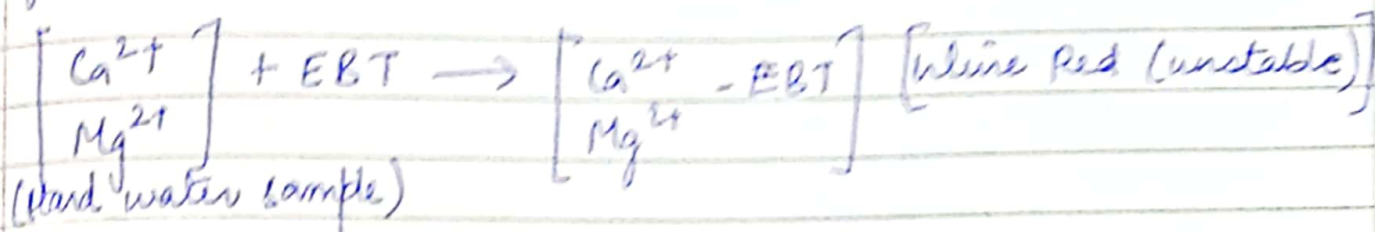
### ★ PRINCIPLE:

- Disodium salt of ethylene diamine tetra acetic acid (EDTA), is used to determine the total hardness of the given hard water.
- Ethylene diamine tetra acetic acid is a tetra carboxylic acid which has the following formula:



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→ The entire reaction between Ca, Mg ions and EB-T is as follows:



#### \* PROCEDURE:

##### (1) Standardisation of EDTA:

- Pipette out 20 ml of standard hard water into a clean conical flask.
- Add 5 ml of the buffer solution and 3 or 4 drops of the Eriochrome Black-T indicator.
- The solution turns wine red in color. Titrate the wine red coloured solution against EDTA taken in the burette.
- The change from wine red to steel blue colour is the end point.
- Repeat the titration for concordant values. Let the titer value be  $V_1$  ml.

##### (2) Determination of total Hardness:

- Pipette out 20 ml of the sample hard water into a clean conical flask.
- Add 5 ml of buffer solution and 3 or 4 drops Eriochrome Black-T indicator.

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- The change of wine red to steel blue is the end point.  
 → Repeat the titration for concordant values. Let  $V_2$  be the volume of EDTA consumed.

### (3) Determination of Permanent Hardness:

- Take 100 ml of the hard water sample in a 250 ml beaker and boil gently for about one hour. Then let it cool.  
 → Filter it into a 100 ml standard flask and make the volume upto a mark.  
 → Take 20 ml of this solution and proceed the titration in the same way.  
 → The volume of EDTA used corresponds to the permanent hardness of the water sample. Let the titer value be  $V_3$  ml..  
 → Temporary hardness is calculated by subtracting permanent hardness from total hardness.

### \* OBSERVATIONS AND CALCULATIONS:

#### (1) TABLE 1: (Std. Hard Water vs EDTA solution)

S.No.	Volume of Std. hard water (ml)	Burette Reading		Vol. of EDTA (ml)	Indicator
		Initial	Final		
1	20	0	19	19	EBT
2	20	0	19.1	19.1	EBT
3	20	0	19.1	19.1	EBT

∴ Concordant value of vol. of EDTA = 19.1 ml

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1 ml of std. Hard Water = 1 mg of  $\text{CaCO}_3$   
 Volume of std. hard water taken = 20 ml  
 20 ml of std. Hard Water = 20 mg of  $\text{CaCO}_3$ .  
 Volume of EDTA consumed =  $V_1$  ml  
 $V_1$  ml EDTA solution = 20 mg  $\text{CaCO}_3$ .

$\therefore$  1 ml EDTA will be =  $\frac{20}{V_1}$  mg of equivalent  $\text{CaCO}_3$ .  
 $\Rightarrow$  1.04712 mg  $\text{CaCO}_3$

(2) TABLE 2: (Sample Hard Water vs EDTA sol.)

S.No.	Volume of sample hard water (ml)	Burette Reading		Vol. of EDTA	Indicator
		Initial	Final		
1	20	0	9.4	9.4	EBT
2	20	0	9.3	9.3	EBT
3	20	0	9.3	9.3	EBT

Concordant Value of Vol. of EDTA = 9.3 ml

Volume of EDTA consumed =  $V_2$  ml

Now, if 1 ml of EDTA = 1.04712 mg

Then,  $V_2$  ml EDTA =  $\frac{20}{V_1} \times V_2$  mg  $\text{CaCO}_3 \Rightarrow 9.73821$  mg  $\text{CaCO}_3$

Then, 1000 ml will contain =  $\frac{(20/V_1) V_2 \times 1000 \text{ mg } \text{CaCO}_3}{20}$   
 $= \frac{V_2}{V_1} \times 1000 \text{ mg } \text{CaCO}_3$

$\Rightarrow$  486.910 ppm

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$\therefore$  Total Hardness = 486.910 ppm

(3) TABLE 3: (Boiled sample hard water vs EDTA sol.)

S.No.	Volume of Boiled Water (ml)	Burette Reading		Vol. of EDTA	Indicator
		Initial	Final		
1	20	0	5.3	5.3	EBT
2	20	0	5.2	5.2	EBT
3	20	0	5.2	5.2	EBT

Concordant value of vol. of EDTA = 5.2 ml

Volume of EDTA consumed =  $V_3$  ml

If 1 ml EDTA = 1.04712 ml

Then,  $V_3$  ml of EDTA =  $\frac{20}{V_1} \times V_3$  mg  $\text{CaCO}_3$

$$\Rightarrow \underline{5.44502 \text{ mg CaCO}_3}$$

Then, 1000 ml will contain =  $\frac{(20/V_1) \times V_3 \times 1000 \text{ mg CaCO}_3}{20}$

$$\Rightarrow \frac{V_3 \times 1000 \text{ mg CaCO}_3}{V_1}$$

$$\Rightarrow \underline{272.251 \text{ ppm.}}$$

$\therefore$  Permanent Hardness = 272.251 ppm.

(4) Estimation of Temporary hardness:

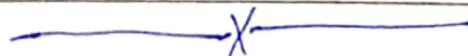
→ The temporary hardness of the given water sample = Total Hardness - Permanent Hardness

$$\Rightarrow 486.910 - 272.251 \Rightarrow \underline{214.659 \text{ ppm}}$$

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★ RESULT:

- The total hardness of sample hard water =  $486.910$  ppm
- The permanent hardness of sample hard water =  $272.251$  ppm
- The temporary hardness of sample hard water =  $214.659$  ppm



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