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Water Technical

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- Hardness is the soap consuming capacity of water
- Due to HCO_3^{2-}, SO_4^{2+}, Cl^- of Ca^{2+} & Mg^{2+}.

$$Ca^{2+} + C_{15}H_{31}COONa \longrightarrow C_{15}H_{31}COOCa\downarrow + Na$$

Soap. Insoluble.

- Types

Temporary	Permanent
(1) HCO_3^- of Ca^{2+} & Mg^{2+}	Cl^-, SO_4^{2-} of Ca^{2+} & Mg^{2+}
(2) Can be removed by boiling	Can not be removed.
(3) Alkaline / Carbonate HCO_3^{2-}, CO_3^{2-} & OH^- of Ca & Mg	Non alkaline / non Carbonate

=) Hardness is expressed in terms of $CaCO_3$ eqts. as MM = 100 and most insoluble salt.

= Equivalents of $CaCO_3$ = $\frac{M \times \text{eqwt of } CaCO_3}{E}$

ie. $\boxed{\frac{M}{E} \times 50}$

Units

(i) ppm : parts per million (No. of parts of $CaCO_3$ eq in 10^6 parts of water)

(ii) mg/l : No of mg of $CaCO_3$ eq in 1 l of H_2O. ie 10^6 mg of water

(iii) °Fr : No of parts of $CaCO_3$ eq in 10^5 parts of H_2O

(iv) °Cl " " " " " " 70,000 " " "

Relation $7°Cl = 10°Fr = 100 ppm$.

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EDTA method.

Hardness of water can be determined by complexometric titration. EDTA is used as complexing agent. The Ca^{2+} and Mg^{2+} present in hard water are titrated with EDTA using EBT as indicator Estimation is based on principle.

(i) Indicator EBT (Eriochrome BlackT) blue coloured dye, forms unstable complex with Ca^{2+} and Mg^{2+} present in hard water at PH 9 to 10. The complex is wine red in colour.

$$Mg^{2+}/Ca^{2+} + EBT \xrightarrow{9-10} [Mg^{2+}/Ca^{2+} - EBT]$$

Unstable Complex (Wine Red)

(ii) As this soln. is titrated with EDTA free Ca^{2+} and Mg^{2+} in water form stable Metal ion EDTA Complex.

$$Mg^{2+}/Ca^{2+} + EDTA \longrightarrow \{Mg^{2+}/Ca^{2+} - EDTA\}$$

colourless.

This process continues with the result EBT is set free and the appearance of blue colour occur.

$$[Mg^{2+}/Ca^{2+} - EBT] + EDTA \longrightarrow \{M^{2+} - EDTA\} + EBT$$

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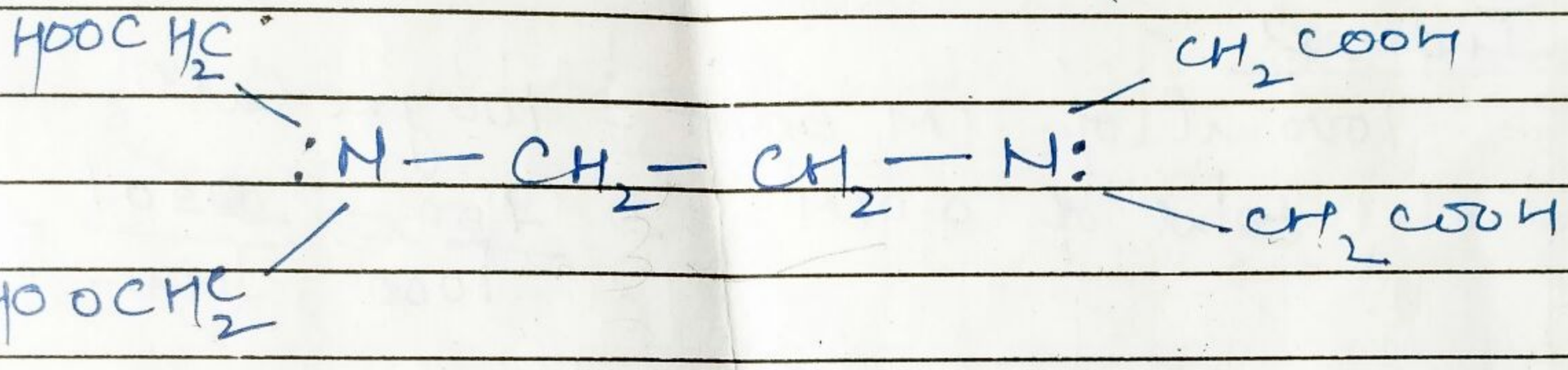
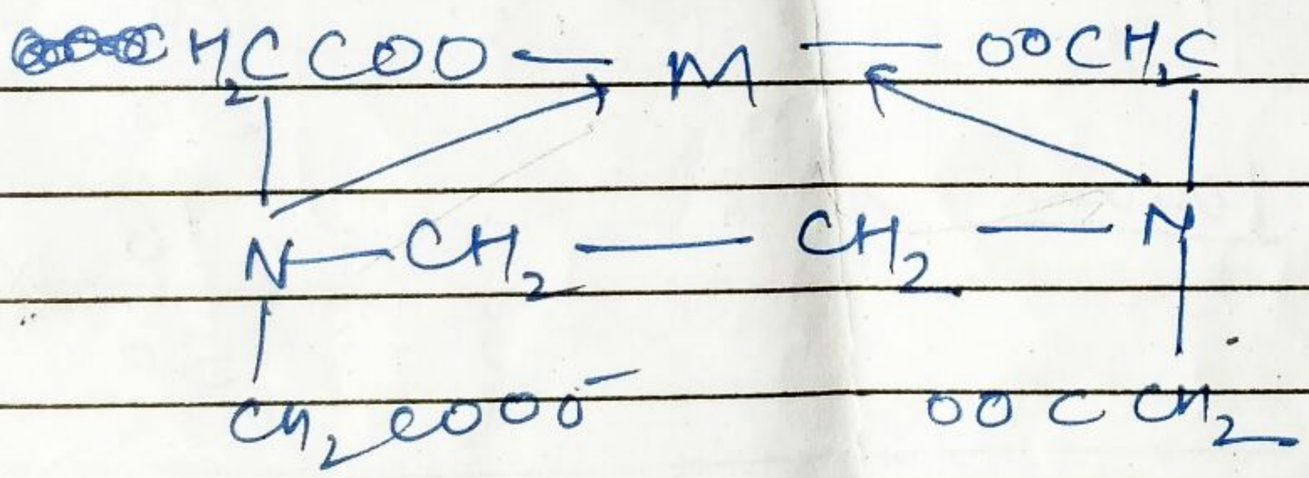
So the EDTA used corresponds to hardness of water. Temp hardness is removed by boiling and permanent hardness is determined as above.

EDTA structure. (Ethylene Diamine tetra acetic acid.)
(hexadentate)



Forming Complex.



Calculations: It forms 1:1 complex with M^{2+}.

1000 ml of 1M EDTA = 1 mole of $CaCO_3$ = 100 gm $CaCO_3$.

1 ml of 0.01 " = $\frac{1}{1000} \times \frac{1}{100} \times 100$ gm = 1 mg of $CaCO_3$

V ml of 0.01 M EDTA = 1 X V = x mg $CaCO_3$.

y ml of Water contains = x mg of $CaCO_3$

1000 ml of " " = $\frac{x}{y} \times 1000$ mg of $CaCO_3$.

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Water sample (y) = 50 ml.

(0.01M) EDTA (V) = 10 ml.

hardness = ? in mg.

direct = $\frac{V}{y} \times 1000$. ie $\frac{EDTA}{Water} \times 1000$.

$\frac{10}{50} \times 1000$

Indirect :-

1000 ml of 1M EDTA = 100 gm $CaCO_3$

~~1~~ ml of 0.01M = $\frac{\cancel{100}}{1000} \times \frac{\cancel{0.01}}{\cancel{100}} = \frac{1}{1000}$ gm =

V ie 10 ml of 0.01M = $1 \times 10 =$ 10 mg

y ml ie (50 ml) of Water contains = 10 mg of $CaCO_3$.

1 " " $\frac{10}{50}$.

1000 ml of " = $\frac{10}{50} \times 1000$.

3.10

(water) y = 100 ml

V = 20 ml.

hardness = ?

1000 ml of 1N EDTA = 100 gm $CaCO_3$.

1 ml of 0.01N = $\frac{\cancel{100}}{1000} \times \frac{1}{\cancel{100}} =$ 1 mg

V ie 20 ml of 0.01(N) = $\frac{20 \text{ mg}}{2.} =$ (10)

If N is given, divide by 2.

100 ——— 10

1 ——— $\frac{10}{100}$

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1000 = $\frac{10}{\cancel{100}} \times \cancel{1000}$ = 100 mg/l

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So formula is if M of EDTA then

$$= \frac{V}{y} \times 1000$$

if N of EDTA is given then

$$\frac{V/2}{y} \times 1000$$

V = Vol of EDTA

y = Vol of Water

Alkalinity

Total amount of those substances in water which increases the conc of OH^- either due to dissociation or hydrolysis.

or

Measure of ability of H_2O to neutralise acids. Chemically due to HCO_3^-, CO_3^{2-}, OH of Na, K, Ca & Mg borates, Silicates and phosphates (to little extent)

Based on anion alkalinity

(I) Caustic (OH^-, CO_3^{2-})

(II) Bicarbonate (HCO_3^-)

Combinations

(a) $OH^- + CO_3^{2-}$ (b) $CO_3^{2-} + HCO_3^-$

Note $(OH^- + HCO_3^-)$ ✗ as they form $CO_3^{2-} + H_2O$