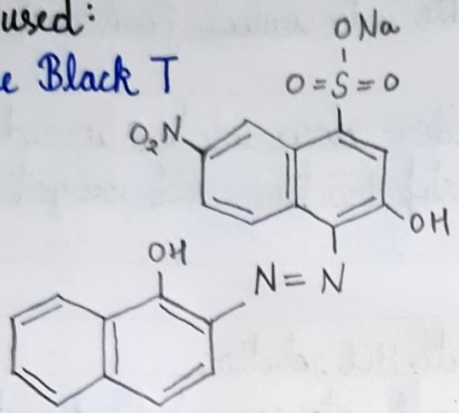
Indicator used:

Eriochrome Black T



Reactions involved:

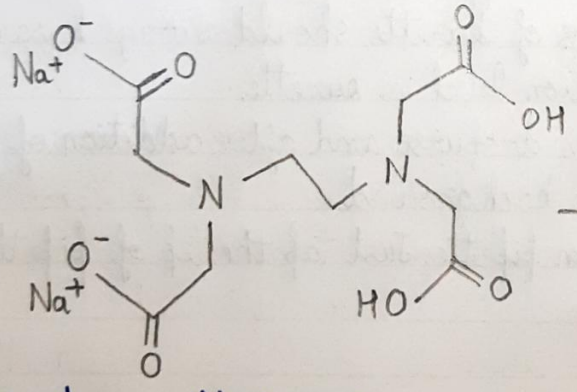
$$\left[\begin{matrix}Ca^{2+}\\Mg^{2+}\end{matrix}\right] \xrightarrow[\text{Buffer solution}]{\text{EBT (Blue)}} \left[\begin{matrix}Ca\text{-}EBT\\Mg\text{-}EBT\end{matrix}\right] \xrightarrow{EDTA} \left[\begin{matrix}Ca\text{-}EDTA\\Mg\text{-}EDTA\end{matrix}\right] + EBT\,(Blue)$$

Hard water

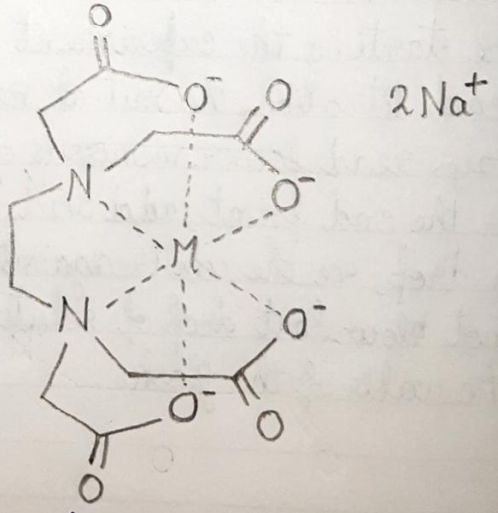
(pH = 9-10)

Wine red colour
Unstable complex

Colourless
Stable complex



Disodium salt of EDTA



Ca/Mg EDTA chelate structure

Date 14/01/2021

Expt. No./ Name : ----------

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Experiment 4.

Aim:

To determine the amount of permanent, temporary and total hardness of given water sample using standard N/50 EDTA solution.

Apparatus required:

Measuring cylinder, pipette, wash bottle, standard flask, burette, beaker, conical flask.

Reagents required:

Water, EDTA, Eriochrome black T, buffer.

Theory:

Water that doesn't produce lather with soap solutions rather produces white precipitate or scum is known as hard water. Hardness in water is due to the presence of dissolved salts of calcium and magnesium in the form of bicarbonate, chloride & sulphate in water. It is unfit for drinking, bathing, washing and it also forms scales in boilers. Hence, it is necessary to estimate the amount of hardness producing substance present in water sample. Once it is estimated, the amount of chemicals required for the treatment of water can be calculated. There are two types of hardness present in water: temporary hardness & permanent hardness. Temporary hardness can be removed by boiling the water or by the addition of lime (or calcium hydroxide). The estimation of hardness is based on complexometric titration.

Teacher's Signature : ----------

Observations:

Titration of given water sample against EDTA solution for total hardness

S.no.	Initial burette readings = V_1	Final burette readings = V_2	Volume of given Na_2EDTA sol^n used = $(V_2 - V_1)$
1.	0.0 ml	3.0 ml	3.0 ml
2.	3.0 ml	6.0 ml	3.0 ml
3.	6.0 ml	9.0 ml	3.0 ml

Titration of given water sample against EDTA solution for permanent hardness

S.no.	Initial burette readings = V_1	Final burette readings = V_2	Vol^m of standardized EDTA sol^n used = $(V_2 - V_1)$
1.	0.0 ml	2.5 ml	2.5 ml
2.	2.5 ml	5.0 ml	2.5 ml
3.	5.0 ml	7.5 ml	2.5 ml

Calculations:

Total hardness:

V_{water} = 20 ml ,, V_{EDTA} = 3 ml

$N_{EDTA} = \frac{N}{50}$

$N_{water} \times V_{water} = N_{EDTA} \times V_{EDTA}$

$N_{water} = \frac{N_{EDTA} \times V_{EDTA}}{V_{water}} = \frac{1}{50} \times \frac{3}{20} = \frac{3}{1000} N$

Hardness of water is determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA) which is a complexing agent. Since EDTA is insoluble in water, the disodium salt of EDTA is taken for this experiment. EDTA can form four or six coordination bonds with a metal ion.

Procedure:

1. Total hardness of the water sample:

(i) Pipetted out 20 ml of water sample into a 250 ml conical flask. Added 2-3 ml of pH 10 ammonical buffer & 1 drop of EBT indicator. You got a wine red colour solution.

(ii) Titrated water sample with EDTA solution until the colour changed from wine red to blue. Recorded the volume.

(iii) Repeated this 2 more times till you got concordant readings.

2. Permanent hardness:

(i) Transferred a 100 ml water sample into 250 ml beaker. Gently boiled the water for 30 minutes. Allowed the boiled water to cool to room temperature.

(ii) Filtered the water directly into a clean 100 ml volumetric flask. Filled the volumetric flask to the mark with distilled water.

(iii) Pipetted 20 ml of the filtered sample into a flask & added 2-3 ml of pH 10 ammonical buffer & 1 drop of EBT indicator.

(iv) Titrated the water sample with EDTA solution until the colour changed from wine red to blue. Recorded the volume.

(v) Repeated this 2 more times till you got concordant readings.

Teacher's Signature : _____

Total hardness with respect to $CaCO_3$ = N_{water} × Eq. wt. of $CaCO_3$

$$= \frac{3}{1000} \times 50 = 0.15\ g\ L^{-1}$$

Total hardness in ppm = N_{water} × Eq. wt. of $CaCO_3$ × 1000

$$= 0.15 \times 1000 = 150 \text{ ppm}$$

Permanent hardness:

V_{water} = 20 ml ,, V_{EDTA} = 2.5 ml

$N_{EDTA} = \frac{N}{50}$

$N_{water} \times V_{water} = N_{EDTA} \times V_{EDTA}$

$$N_{water} = \frac{N_{EDTA} \times V_{EDTA}}{V_{water}} = \frac{1}{50} \times \frac{2.5}{20} = \frac{2.5}{1000} N$$

Permanent hardness with respect to $CaCO_3$ = N_{water} × Eq. wt. of $CaCO_3$

$$= \frac{2.5}{1000} \times 50 = 0.125\ g\ L^{-1}$$

Permanent hardness in ppm = N_{water} × Eq. wt. of $CaCO_3$ × 1000

$$= 0.125 \times 1000 = 125 \text{ ppm}$$

Temporary hardness:

Temporary hardness in ppm = Total hardness − Permanent hardness

$$= 150 - 125 = 25 \text{ ppm}$$

Result:

(i) Total hardness = 150 ppm
(ii) Permanent hardness = 125 ppm
(iii) Temporary hardness = Total hardness − Permanent hardness = 25 ppm

Precautions:

(i) Before starting the experiment, the glass apparatus must be perfectly cleaned.
(ii) Always read lower meniscus of solution level in burette.
(iii) Near end point, add EDTA solution drop wise and after addition of each drop, see the colour change.
(iv) Do not blow last drop of solution from pipette. Just tap the tip of the pipette to the walls of the flask.