EXPERIMENT: 13

AIM:

EXPLAIN THE DETAILED METHOD FOR DETERMINATION OF HARDNESS OF WATER

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REQUIREMENTS

A. Glassware & Instruments

1. Volumetric glassware
2. 250 mL burette
3. Titration beakers

B. Chemicals & Reagents

1. EDTA Solution
2. Hard water Sample
3. Ammonia Buffer Solution
4. EBT Indicator

THEORY

The amount of calcium and magnesium dissolved in water is the simplest definition of water hardness. Hard water contains a high concentration of dissolved minerals, primarily calcium and magnesium. Last time you washed your hands, you may have experienced the physical effects of hard water. Depending on the hardness of your water, you might have felt a film of residue on your hands after washing with soap. Soap reacts with calcium (which is relatively abundant in hard water) to form "soap scum" in hard water. It takes more soap or detergent to clean with hard water, whether you're washing your hands, hair, or clothes.

PRINCIPLE

The hardness of water is caused by the presence of dissolved calcium and magnesium salts. It is unfit for drinking, bathing, and washing, and also causes scale formation in boilers. Consequently, it is necessary to estimate the amount of hardness-

producing substances in a water sample. Once estimated, the quantity of chemicals necessary for water treatment can be calculated. Using complexometric titration, the hardness is estimated. The hardness of water is determined by titrating with a standard solution of the complexing agent ethylene diamine tetra acetic acid (EDTA). EDTA is insoluble in water, so its disodium salt is used in this experiment. With a metal ion, EDTA can form four or six coordination bonds.

PROCEDURE

Estimation of Total Hardness

1. Take a burette that is empty and fill it with standard EDTA solution to the zero level, then tighten the knob.
2. Evaluation of the Total Toughness Pipette 20 ml of the provided water sample into a clean conical flask.
3. 3.5 ml of ammonia buffer and two drops of EBT indicator are added and titrated against EDTA using a burette.
4. The conclusion is the colour transition from wine red to steel blue. The titration is repeated until identical titrate values are obtained.

Hardness Of Permanent Water Procedure

1. 100 ml of the given water sample is pipetted into a clean beaker and cooked for twenty minutes.
2. The precipitate generated by the breakdown of transient hardness-producing salts is subsequently removed by filtration.
3. Using distilled water, the filtrate is prepared up to 100 ml in a standard measuring flask (SMF).

4. Pipette 20 ml of the prepared solution into a conical flask, add 5 ml of ammonia buffer and 2 drops of EBT indicator, and titrate against EDTA.

5. The conclusion is the colour transition from wine red to steel blue. Titration is repeated until a concordant titre value is obtained.

Temporary Hardness

The temporary hardness is calculated from the total and permanent hardness.

Temporary Hardness = Total Hardness – Permanent Hardness

REACTION

Eriochrome Black-T + Ca^{2+} /Mg^{2+} → Eriochrome Black-T-Ca^{2+} /Mg^{2+}

(Wine Red) Eriochrome Black-T-Ca^{2+} /Mg^{2+} + EDTA → EDTA-Ca^{2+}/Mg^{2+} + Eriochrome Black-T (Wine Red) (Steel blue)

CALCULATION

Observation table

S no.	Volume of Hard Water Sample (ml)	Burette reading (ml)		Volume of EDTA used (ml)
		Initial	Final	
1.				
2.				
3.				

$N_1V_1=N_2V_2$

1 ml of 0.01 M EDTA ≡ 1 mg of $CaCO_3$

V1 ml of EDTA ≡ V1 mg of $CaCO_3$

Calculation of total hardness

Volume of EDTA solution consumed = …… ml

Volume of hard water taken = …….. ml

Total hardness = Volume of EDTA solution consumed X1000/Volume of the hard water taken*ppm ……= ppm

Calculation of permanent hardness

Volume of EDTA solution consumed = …… ml

Volume of boiled water taken = …….. ml

Permanent Hardness = Volume of EDTA solution consumed X1000 Volume of the boiled water taken *ppm = ……. ppm

Calculation of temporary hardness

Temporary hardness of the given sample of water = Total hardness - Permanent hardness = ……. ppm

Alternate Method:

To calculate the harness of water

Moles of EDTA

$$\frac{0.05 \text{ X VOLUME CONSUMED}}{1000}$$

= ……

APPLICATION

1. To remove hardness of water and make it pure for drinking purposes
2. To make soaps and detergents in better quality

3. To keep the river safe and not polluted with chemicals

RESULT

The hardness of water = …….