Aquatic chemistry – Practical

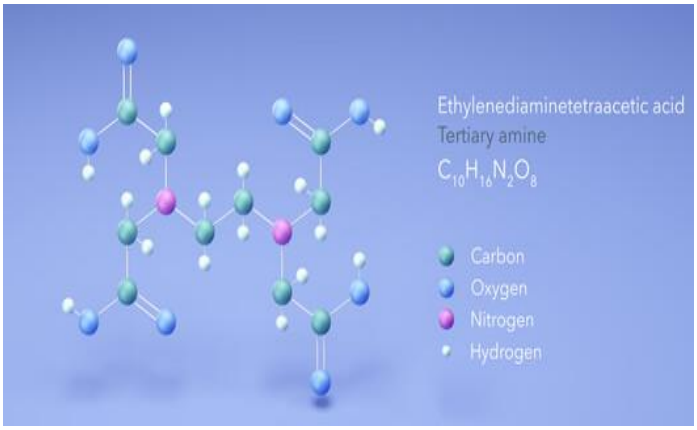
Lab. No. (4)

Determination the hardness of water samples by EDTA method.

Aim: To estimate the amount of total and Calcium hardness present in the given sample of water by EDTA titration method.

Theory:

Hardness in water is due to the presence of dissolved salts of calcium and magnesium. 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 substances present in the water sample. The estimation of hardness is based on complexometric titration. Hardness of water is determined by titrating with a standard solution of ethylene diamine tetra acetic acid (EDTA) which is a complexing agent.



The combined concentration of calcium and magnesium ions is the measure of water hardness, this hard water may include other components such as solids, oil, dissolved gas, or other negative and positive ions, but it is mainly calcium and magnesium ions dissolved in the water that make it hard, thus tending to deposit scales of calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$).

All metal-EDTA salts are colorless and require an indicator to tell us when the reaction is over. Hardness indicators are large complex organic dyes that react with EDTA to form colored complexes. Eriochrome Black T is used for the total hardness endpoint, which includes the sum of calcium and magnesium ions. Murexide indicator gives us the calcium endpoint.

Total Hardness Reaction:

$$Ca^{+2} \text{ and } Mg^{+2} + EDTA \xrightarrow{\text{Eriochrome Black T}} (Ca^{+2}\, Mg^{+2}\, EDTA \text{ complex})$$

Calcium Reaction:

$$Ca^{+2} + EDTA \xrightarrow{\text{Murexide}} (Ca^{+2}\, EDTA \text{ complex})$$

The volume difference of EDTA titrated between the total hardness analysis and the Calcium analysis is the Magnesium result.

Magnesium hardness = Total hardness - calcium hardness

Types of Water Hardness.

Hardness of water can be classified into two types:

1. Temporary hardness of water.

The presence of magnesium and calcium carbonates in water makes it temporarily hard. In this case, the hardness in water can be removed by boiling the water.

When we boil water, the soluble salts of $Mg(HCO_3)_2$ are converted to $Mg(OH)_2$, which is insoluble, and hence gets precipitated and is removed. After filtration, the water we get is soft water.

2. Permanent hardness of water.

When the soluble salts of magnesium and calcium are present in the form of chlorides and sulphates in water, we call it permanent hardness because this hardness cannot be removed by boiling.

We can remove this hardness by treating the water with washing soda. Insoluble carbonates are formed when washing soda reacts with the sulphates and chloride salts of magnesium and calcium, and thus, hard water is converted to soft water.

$$Ca^{2+}_{(aq.)} + Na_2CO_{3(aq.)} \rightarrow CaCO_{3(s)} + 2Na^{+}_{(aq.)}$$

$$Mg^{2+}_{(aq.)} + Na_2CO_{3(aq.)} \longrightarrow MgCO_{3(s)} + 2Na^{+}_{(aq.)}$$

Washing soda is a chemical compound with the formula $Na_2CO_3.10H_2O$. It is an inorganic hydrate of sodium carbonate. It was extracted from the ashes of plants growing in sodium-rich soils and hence the name soda ash. It is a white crystalline solid and a metal carbonate which is soluble in water.

PROCEDURE

Calcium hardness determination:

1. Fill a 50 mL burette with 0.02 N EDTA solution, making sure the tip is full and free of air bubbles.
2. Add 20 mL of an unknown hard water solution into a 100 mL beaker.
3. Add 2 mL of NaOH.
4. Add 100 mg of Murexide indicator.
5. Titrate with the 0.02 N EDTA until the color changes from pink to purple.

Total Hardness determination:

1. Fill a 50 mL burette with 0.02 N EDTA solution, making sure the tip is full and free of air bubbles.
2. Add 20 mL of an unknown hard water solution into a 100 mL beaker.
3. Add 10 mL of buffer to the beaker.
4. Add one or two drops of Eriochrome Black T indicator.
5. Titrate with the 0.01 N EDTA until the color changes from red to blue.

Calculation: