EXPERIMENT 6 DETERMINATION OF HARDNESS OF WATER

Structure

6.1 Introduction

Objectives

6.2 Experiment: Hardness of Water by EDTA Method

6.2.1 Principle

6.2.2 Requirements

6.2.3 Procedure

6.2.4 Observations

6.2.5 Calculations

6.2.6 Result

6.3 Precautions

6.1 INTRODUCTION

Hardness of water is almost entirely due to the presence of calcium and magnesium salts. It is expressed as ppm (mg/ litre). Hardness values for water meant for different purposes have been specified.

The most common method for the determination of hardness of water is by the ethylenediamine tetra-acetic acid (EDTA) titration.

Objectives

After studying and performing this experiment, you should be able to:

- determine the hardness of water.

6.2 EXPERIMENT: HARDNESS OF WATER BY EDTA METHOD

6.2.1 Principle

This method is based on the principle that when EDTA is added to a solution containing certain metal cations like calcium and magnesium, it complexes with them and make them unavailable for some reactions. One such reaction is the formation of wine-red colour between the cations and Chrome black T at a pH of 10. Therefore, for the determination of hardness of water, Chrome black T is added to the water at pH 10 ± 0.1 and titrated with EDTA solution till the disappearance of wine-red colour and formation of blue colour, which is the end point.

6.2.2 Requirements

Apparatus

Analytical Balance

Hot air oven

Desiccator

Volumetric flasks, 500 ml and 1000 ml

Conical flask, 250 ml and 500 ml

White porcelain dish, 250 ml

Glass rods

Reagents

i) Borate buffer: Dissolve 20 g borax ($Na_2B4O_7.10\ H_2O$) in about 400 ml distilled water. Dissolve 5 g sodium hydroxide and 2.5 g sodium sulphide (Na_2S) in 50 ml water, cool, mix with borax solution and dilute to 500 ml with distilled water.

ii) Indicator: Mix together 0.5 g of Eriochrome black T and 100 g sodium chloride and powder in a pestle and mortar.

iii) Methyl red indicator.

iv) 3N ammonium hydroxide solution.

v) Standard calcium solution: Dry calcium carbonate ($CaCO_3$) in an oven at 105°C over night and cool in a desiccator. Weigh exactly 1 g into a 500 ml conical flask. Add dilute (1+1) HCl drop by drop until all the $CaCO_3$ has dissolved. Add 200 ml distilled water and boil for a few minutes to expel carbon dioxide. Cool, add a few drops of methyl red indicator and adjust to the intermediate orange colour by adding 3N ammonium hydroxide. Transfer to a 1 litre volumetric flask and make up to volume with distilled water (1 ml = 1 mg $CaCO_3$).

vi) Standard EDTA solution: Dissolve 4.0 g of disodium salt of EDTA in 800 ml of distilled water. Standardize against standard calcium solution. Adjust the dilution of the EDTA solution such that 1 ml = 1 mg $CaCO_3$. Store in a corning glass or plastic bottle to prevent extraction of salts from ordinary glass.

6.2.3 Procedure

Take 25 ml of the water sample in a porcelain dish and add 25 ml distilled water followed by 1-2 ml of the buffer. Add a small quantity of the Eriochrome indicator and stir with a glass rod to dissolve. If the water is hard, a red colour will be formed. Titrate slowly with the EDTA solution, stirring continuously until the red tinge disappears and a permanent blue colour is produced. If the water sample has low hardness, more volume of water may be taken for titration by adding proportionate volume of the buffer. The duration of titration should not exceed 5 min measured from the time of addition of buffer.

6.2.4 Observations

Volume of water sample taken for titration = V = —— ml

Volume of EDTA solution required (titre) = V_1 = —— ml

6.2.5 Calculations

Since 1 ml of the EDTA solution is equal to 1 mg $CaCO_3$, V_1 ml EDTA solution = V_1 mg $CaCO_3$.

As V_1 mg $CaCO_3$ is present in V ml of the water sample, the hardness of the water.

$$= \frac{V_1 \times 1000}{V} = \text{ppm } CaCO_3 \text{ or mg } CaCO_3 \text{ per litre.}$$

6.2.6 Result

Hardness of the water sample = ppm $CaCO_3$ or mg $CaCO_3$ per litre.

6.3 PRECAUTIONS

The general precautions mentioned in the course 'Introduction' and those indicated in the experiments should be followed meticulously.