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Research Article

Determination of the Total Hardness of Municipality Water of Jalandhar City, Punjab

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A B S T R A C T

Water is one of the most wonderful gift and essential needs for life. It is extensively employed in the manufacturing of industrial goods as well as in drinking, bathing, sanitary practises, washing, and irrigation. But water having high hardness is considered to be the major threat to human health. From the literature survey, it reveals that 2.6 % water resources as fresh in the universe is usable. The available fresh water also hard due to contamination and pollution. Bicarbonates, chlorides, and sulphates of calcium and magnesium are what cause water to be hard. The following factors contribute to the mixing of these soluble salts with natural water:

1. Natural water that contains CO+ is transformed into soluble bicarbonates as it passes over limestone ($CaCO_3$) rocks. Water becomes hard as a result.

$$CaCO_3 + H2O + CO_2 \rightarrow Ca\ (HCO_3)_2$$

2. These salts dissolve in water when natural water flows over rocks containing calcium and magnesium chlorides and sulphates. Thus water gets hardness. It is being noticed that 1.6 billion people do not have clean water for drinking. The demand of water increases due to over population. Because of various undesirable human activities, water resources are damaged and polluted. The hardness of water is very significant for fish culture. Hard water contains bivalent of calcium and magnesium. Hard water pose serious corrosion and adverse problems in boiler industries for power generation. Hard water formation is indicated by lack of foam formation when soap is used in water and formation of lime scale in kettles and water heaters. In this paper, we are reporting total hardness of municipality water sample collected from Jalandhar city and tested by using EDTA titrimetric method.

Keywords: Water, Hardness, EDTA, Titration

Introduction

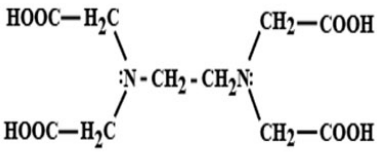
The ability of water to precipitate soap is traditionally measured by its hardness. Leather is produced by hard water, which uses a lot of soap. Water quality can be expressed by various parameters like pH, TDS (total dissolved solids) and total hardness [1]. The water hardness is usually reported in terms of mg/l. We have two types of hardness: Temporary hardness is due to the presence of dissolved bicarbonates of Calcium and Magnesium. The presence of these ions makes the water hard. Hard water is defined as water that does not produce a lather when soap is used. The presence of certain salts like Ca+2, Mg+2, and other heavy metals dissolved in water is to blame for this [2].

$2C_{17}H_{35}COONa + CaCl_2/MgCl_2 \rightarrow (C_{17}H_{35}COO)_2\ Ca/Mg + 2NaCl$

Calcium play a vital role in the biological processes of fish. It is essential for the metabolic reactions. Fish can absorb Ca directly from water. Hardness can be measured by chemical titration [Fig 1].

Figure 1.Hardness of ion

Complexometric titration: Ethylenediaminetetraacetic acid (EDTA) is a chelating agent which forms coordination complex with metal ions present in hard water. To maintain pH at 10, the buffer solutionof NH4Cl and NH4OH is used [3].



stucture of EDTA

Advantages of EDTA method

This method is definitely preferable to the other methods, because of:

(i) Greater accuracy,
(ii) Simple and convenience and
(iii) More rapid procedure [4].

Principle

Titrating the water sample against EDTA using the Eriochrome-Black-T indicator (EBT) at a pH of 8–10 can provide an estimate of the amount of the ions (Ca2+ and Mg2+) responsible for hardness. Buffer solution, which is a combination of NH4Cl and NH4OH, is added to maintain the pH. Such a complexation is only conceivable at this pH [5-7].

The EBT indicator produces a weak combination with Ca2+ and Mg2+ ions that is wine red in colour when it is introduced to the water sample.

This solution replaces the indicator from the unstable EDTA complex when it is titrated against EDTA. The indicator is released once EDTA has complexed all of the ions responsible for hardness. The free indicator is steel blue in colour. Thus, the transition from wine red to steel blue is the terminal point [8,9].

Preparation o reagents

Preparation of EDTA Solution

To make it, dissolve 4 grammes of EDTA in 1000 millilitres of distilled water.

Standard hard water

A minimum of 1 g of pure CaCO3 is dissolved in HCl before being brought up to a volume of 1000 ml with purified water.

∴ 1 milligramme of CaCO3 equivalent hardness equals 1 ml of typical hard water.

EBT indicator

100 cc of alcohol are used to dissolve 0.5 gms of EBT.

Buffer solution

6.75 gms of NH4Cl and 5.7 ml of NH3 are dissolved, and distilled water is used to dilute the solution to 100 ml.

Standardizationof EDTA Solution:

Pipette 10 ml of the calcium standard solution intoa 250 ml conical flask. Add 3 ml of the buffer solution and 2 drops of of Eriochrome Black-T as an indicator, wine red color appears due to formation of metal with EBT (**Fig.2**).Titrate this solution against EDTA which taken ina burette till wine red color beccomes bluedue to formation of metal with EDTA (**Fig.3**). This is the end point. Measure the volume of EDTA consumed [10].

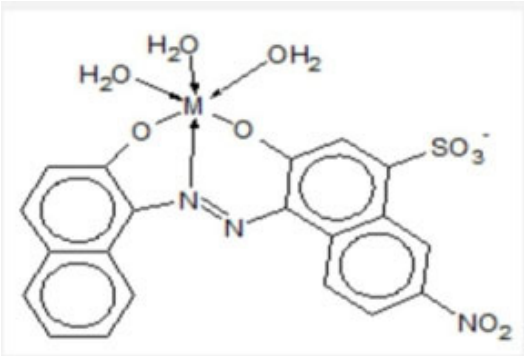


Figure 2.Structure of metal with EBT

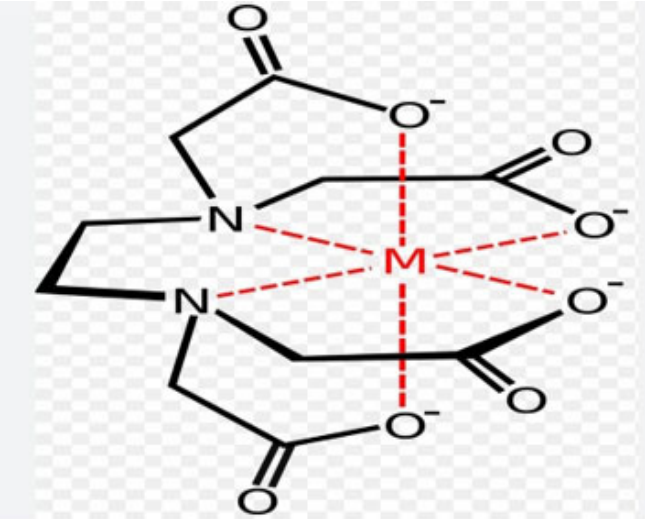


Figure 3.Structure of metal with EDTA

S. No.	Burette Readings		Volume of EDTA Consumed ($R_2 - R_1$) = .. mL
	Initial (R_1)	Final (R_2)	
1.	0	9	9
2.	9	18	9

Table 1.Standardization of EDTA

(a) Determination of Total Hardness:

Pipette 10ml of Jalandhar municipality sample hard water in a titration flask. To this 3ml of ammonia buffer and 2 drops of Eriochrome Black-T added. A wine red color appears. Titrate this solution against EDTA till wine red color changes to blue color. Record the volume of EDTA consumed (table 1) [11].

S. No.	Burette Readings		Volume of EDTA Consumed (R2 – R1) = .. mL
	Initial (R1)	Final (R2)	
1.	0	7.5	7.5
2.	7.5	15	7.5

Table 2.Determination of Total Hardness

(b) Calculation of total hardness (table 2):

Volume of EDTA (for sample water) = 7.5ml

Normality of EDTA = N_1

Equivalent weight of $CaCO_3$ = 50

Volume of sample water = 10 ml

The total amount of hardness present in water is

$$= \frac{\text{Volume of EDTA X Normality of EDTA X 50 X 100}}{\text{Volume of sample water}}$$

$$= \frac{7.5 \times 0.02 \times 50 \times 1000}{10}$$

= 750 ppm

Conclusion

Although cations are what cause hardness, it may also be divided into two types: carbonate (temporary) and non-carbonate (permanent). The amount of carbonates and bicarbonates in a solution that may be removed or precipitated by boiling is referred to as carbonate hardness. Scale builds up in kettles and hot water pipes as a result of this kind of hardness. Carbonate hardness is the amount of hardness equal to total alkalinity when total hardness is numerically larger than that of total alkalinity represented as $CaCO_3$. Non-carbonate hardness is the amount of hardness that is more than the total alkalinity and is expressed as $CaCO_3$ Non-carbonate hardness, often known as permanent hardness since it cannot be eliminated by boiling, is brought on by the combination of the hardness-causing cation with sulphate, chloride, or nitrate. Water is important natural resources, suitable for all living organisms. However, water resources are depleting dueto climate change, global warming, misuse and undesirable human activities. Therefore, preservation of water resources in a sustainable way will benefit not only present but for future generations. The WHO has suggested that the admissible total hardness for drinking water should be in the range of 500 to 650 ppm. We have studied the total hardness in Jalandhar city. Also from the experiment the total hardness content has been determined and we believe that our result will help the policy makers for further improvement of water quality.

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