

Determination of the Hardness of water from various parts of Uttar Pradesh using Complexometric titration

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Manuscript received online 02 February 2020, accepted on 08 March 2020

Abstract: Water hardness is the traditional measure of the capacity of water to react with soap, hard water requiring considerably more soap to produce a lather. In this experiment, the hardness of water sample (collected from different locations) has been determined. The calcium in the water has been measured by performing a titration with EDTA, Eriochrome black T has been used as an indicator to determine calcium content in a solution. Risky degrees of hardness is dangerous to health. There is a wrong concept that hard water is injurious to healthiness, it's not hard water, it's very hard water (>180ppm). The minerals that are complemented to body through water will be useful to health in numerous methods.

(Keywords : Eriochrome black T, EDTA)

Introduction

Water is used for a variety of purposes including drinking, Food preparation, irrigation and manufacturing. Although water covers more than 70% of Earth's surface. Less than 1% of that resource is available is fresh water and this is not evenly distributed throughout the World. Water is an inorganic, transparent, tasteless, odorless and nearly colorless chemical substance which is the main constituent of Earth's Hydrosphere. Water carries nutrients to all cells in our body and oxygen to our brain. Water allows the body to absorb and assimilate minerals, vitamins, amino acids, glucose and other substances. Water flushes out toxins and waste. Water helps to

regulate body temperature. Water is essential daily ingredient and is found in every cell in the human body. It's involved in all bodily functions from respiration and digestion, to temperature regulation and waste removal. Hard water is found at a rate exceeding 85%, as water picks up minerals such as magnesium and calcium ions from rocks and soil, leading to the hard water. Ground water contains more minerals than surface water, so it is harder than surface water. There are many exceptions, i.e., lakes in lime soil districts¹. Knowing the hardness of water is important when evaluating its use as a domestic or industrial water supply. Hard water interferes with laundering, washing, bathing and personal grooming².

Water is also the medium through which chemical reactions can take place, and allows transit, absorption, and transformation of oxygen, hormones, and nutrients. Drinking water actually reduces the body's overall level of water retention. Aside from weight loss, releasing fluids trapped in body tissue also takes the burden off the kidneys and liver, and they are able to work more effectively at removing waste products and toxins from the body. Drinking water regularly also reduces the risk of kidney stones - the concentration of minerals in the urinary system becomes more diluted, making them less likely to stick together and form a kidney stone.

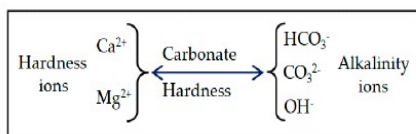


Fig 1: Description of Anions / Cations

Hard water is mainly caused by calcium and magnesium cations and to a lesser extent aluminum, iron and other cations. Total hardness includes both temporary and permanent hardness caused by the calcium and magnesium, on the basis of which water is categorized as soft or hard and very hard³.

Temporary hardness is due to the presence of calcium hydrogen carbonate $\text{Ca}(\text{HCO}_3)_2$ and magnesium hydrogen carbonate $\text{Mg}(\text{HCO}_3)_2$. Both calcium hydrogencarbonate and magnesium hydrogencarbonate decompose when heated. The original insoluble carbonate is reformed. This happens when water is boiled. Permanent hardness in water is hardness due to the presence of the chlorides, nitrates and sulphates of calcium and magnesium, which will not be precipitated by boiling. The lime scale can build up on the inside of the pipe restricting the flow of water or causing a blockage. Soft water is surface water that contains low concentrations of ions and in particular is low in ions of calcium and magnesium. Soft water naturally occurs where rainfall and the drainage basin of rivers are formed of hard, impervious and calcium-poor rocks.

Materials Required:

Burette, Pipette, Beakers, Conical flask, EDTA solution, Eriochrome black T indicator, Buffer (pH 9.2).

Experimental Section:

Take 100ml of hard water sample in a conical flask. Add a granule of Eriochrome Black T indicator and 1ml of buffer solution. Titrate the

pink solution against the EDTA in the burette. The end point is indicated by a blue color.

Results and Discussion

Water hardness can be readily determined by titration with the chelating agent EDTA (ethylenediamine tetra acetic acid). In the sample solution containing calcium and magnesium ions, the reaction takes place with an excess of EDTA by a titration process and the indicator added remains as eriochrome black T (EBT)-blue because all of the Ca^{2+} and Mg^{2+} ions present are complexed with the EDTA⁴. During this process, the EDTA reacts with the Ca^{2+} and Mg^{2+} ions and to form the EDTA-Ca and EDTA-Mg complex (Figure 2), and after the completion of this reaction, the wine red color disappears slowly because the EBT-Ca and EBT-Mg are replaced and form Ca-EDTA stable, colourless complex, while simultaneously a blue color appears due to the effect of the EBT indicator [5]. The complex that is initially formed is red after all the calcium ions have reacted, the complex then turns blue. This indicates endpoint. After the standardization of EDTA, the calcium content (hardness) in an unknown sample will be found. Thus the hardness will be calculated in parts per million.

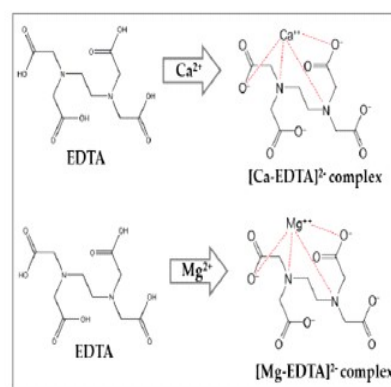


Fig-2 EDTA complex formation by the reaction with Ca^{2+} and Mg^{2+} ions.

As Water Hardness is Usually Reported in terms Of mg/L Of Calcium Carbonate.

S.No	Water Samples	Volume of Water (V ₂)	EDTA		Volume of EDTA consumed(V ₁)
			Initial	Final	
1	Pond Water	100 ml	0	10.8	10.8
2	Tap Water	100ml	0	4	4
3	Distilled Water	100ml	0	1.9	1.9
4	Drinking Water	100ml	0	4.2	4.2
5	Lake water	100ml	0	2.6	2.6
6	Yamuna Water	100ml	0	7	7

- 1) $1000 \times 10.8/100 = 108 \text{ mg/l CaCO}_3$
- 2) $1000 \times 4/100 = 40 \text{ mg/l CaCO}_3$
- 3) $1000 \times 1.9/100 = 19 \text{ mg/l CaCO}_3$
- 4) $1000 \times 4.2/100 = 42 \text{ mg/l CaCO}_3$
- 5) $1000 \times 2.6/100 = 26 \text{ mg/l CaCO}_3$
- 6) $1000 \times 7/100 = 70 \text{ mg/l CaCO}_3$

Hard drinking water is generally not harmful to one's health⁶, but can pose serious problems in industrial settings. Most of the people especially housewives dislike hard water because it does not lather well or does not taste good, but they may not be knowing that it may prolong their lives, and more especially their husbands⁷. Calcium, one of the components of hard water, can be protective because it makes water less corrosive and less likely to leach toxic trace minerals, such as cadmium and lead, out of metal pipes⁸. The potential sources of water contamination are geological conditions, industrial and agricultural activities, and water treatment plants. These contaminants are further categorized as microorganisms, inorganics, organics, radionuclides, and disinfectants⁹. The inorganic chemicals hold a greater portion as con-taminants in drinking water in comparison to organic chemicals¹⁰.

Effects of Water on Plants and Animals:

Water can become polluted by a number of sources, ranging from sewage treatment plants and factories to mining activities, paved roads and agricultural runoff, according to the U.S. Environmental Protection Agency. Water pollution has a wide variety of effects on plant life and on the environment in general. Pollution in water not only harms plant growth but also allows plants to absorb dangerous chemicals from the water and pass them on to animals that rely on them for survival. Plants also pass on these pollutants to humans who consume them. Water quality is also compromised by air pollution through acid rain. Acid rain occurs when contaminants such as sulfur dioxide and nitrogen oxide combine with moisture in the air in a process fueled by sunlight. The result is precipitation with acidic pH levels. The acid rain can cause immediate plant and animal distress or death in high concentrations. The effects are especially dire when the pH levels of waterways are altered. Soil contamination can also occur, making entire environments unfit for life.

Conclusion:

The main objective of this study is to determine the hardness in different samples of water from different areas of Uttar Pradesh for future study on the removal of hardness. The amount of Calcium Carbonate present in different water sample were estimated and reported. Hard water can cause many problems around the world, including increased scaling on water pipes, boilers, atopic eczema and odd-tasting drinking water. Hardness in natural water is caused by dissolved minerals, mainly calcium

and magnesium compounds. According to the Water Quality Association (WQA) and the United States Geological Survey (USGS), hard water is classified based on the Ca^{2+} and Mg^{2+} ion concentration in waters, as follows: 0–60 ppm as soft; 61–120 ppm as moderately hard; 121–180 ppm as hard and more than 180 ppm as very hard water. Most water utilities consider a hardness level between 50 and 150 ppm of CaCO_3 as publicly acceptable.

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Abstracted / Indexed in : Chemical Abstract U.S.A.

JC- 1418/2K20 (ISSN:0973-239X), INDIA

Journal Chemtracks Vol. 22 (1&2), 369-372, January to December 2020