

Hardness of Water : -

Hard Water :

The water which does not produce lather with soap.

Soft Water : -

The water which produces lather with soap. • Hardness of water is due to presence of soluble salts of calcium, magnesium and other heavier metals in water. • Hard water does not give lather easily with soap, but produces a white scum or precipitate with soap. • The scum or precipitate is due to the formation of insoluble soaps of calcium and magnesium ions react with soap. • Hardness of water can be classified as temporary hardness and permanent hardness.

Types of hardness: Temporary hardness : Temporary hardness is caused by the presence of dissolved bicarbonates of calcium and magnesium. This can be removed by boiling.

Permanent hardness : Permanent hardness is due to presence of chlorides & sulfates of dissolved calcium, magnesium, iron & other heavy metals. The salts responsible for permanent hardening are CaCl_2 , MgCl_2 , CaSO_4 , MgSO_4 , FeSO_4 , $\text{Al}_2(\text{SO}_4)_3$. Permanent hardness cannot be removed by boiling. This is also known as non-carbonate or non-alkaline hardness. The sum of temporary and permanent hardness is referred as total hardness of water. Although hardness of water is never present in the form of CaCO_3 as it is insoluble in water hardness of water is conveniently expressed in terms of equivalents of CaCO_3 . The hardness is expressed in terms of equivalent calcium carbonate. The reason for choosing CaCO_3 as standard for report in hardness is ease in calculations on its molecular weight is exactly 100.

Units of Hardness : 1. Parts Per Million : Parts of CaCO_3 equivalent hardness per 100 parts of water. 1 ppm = 1 part of CaCO_3 equivalent hardness in 100 parts of water.

Estimation of hardness of water by EDTA Method:

This is a complexometric method. Ethylene diamine tetraacetic acid (EDTA) in the form of its sodium yields the anion. Principle of EDTA titrations: The quick, complete and 1:1 interaction of metal ions with EDTA leading to the formation of stable complex is the basis for complexometric titrations.

Theory: The hard water is buffer to a pH value of ~10 using NH_4OH - NH_4Cl buffer and few drops of EBT indicator solution are added. EBT forms a weak complex with metal ions that has a wine-red colour.

During the course of titration of water sample against EDTA, first EDTA combines with free Ca^{2+} or Mg^{2+} ions to give very stable and colourless metal-EDTA complex. After all the free metal ions are consumed, the next drop of added EDTA solution displaces the indicator to form Metal-EBT complex. $\text{Metal} - \text{EBT} + \text{EDTA} \rightarrow \text{Metal} - \text{EDTA} + \text{EBT}$ Wine red blue At the equivalence point, there is change in colour from wine-red to blue.

Procedure: Step – 1: Standardisation of EDTA solution: The burette is filled with EDTA solution after washing and rinsing. Pipette out 50mL of standard hard water (1mL of it must contain 1mg of CaCO_3) into a 250mL conical flask, 10mL of buffer solution and 2-3 drops of EBT indicator are added and titrated against EDTA solution until the wine-red colour changes to blue. Let the volume of EDTA solution consumed be V_1 mL.

Step – 2:

Determination of total hardness of water: As per the same procedure (Step-1), 50mL of the unknown water sample is titrated against EDTA. Let the volume of EDTA solution consumed be V_2 mL

. Step -3: Determination of permanent hardness of water: 250mL of the water sample is taken in a 500mL beaker and boiled it till the volume is reduced to about 50mL. [The step causes all the bicarbonates to decompose respectively into insoluble CaCO_3 and $\text{Mg}(\text{OH})_2$]. Filter and wash the precipitate with distilled water and quantitatively collect the filtrate and washings in a 250mL conical flask and made up the volume to 250mL with distilled water. 50mL of this water sample is titrated against EDTA solution as in Step-1. Let the volume of EDTA solution consumed be V_3 mL.