Total hardness of water

Background Information

Hard water: is water containing salt of calcium, magnesium and other minerals (like Iron, aluminum, and manganese). These salts require large amounts of soap, or else it may leave sediments of pots when water vapored from these pots

Hardness can be identified as total concentration of calcium (calcium carbonate) in water measured by milligram per liter or ppm.

Classification of Hard water

 Hard water can be classified by Brown et al. method (1970) to 3 types:

1- light hardness (0-60 mg/dl)

2- moderate hardness (61-120 mg/dl)

3- severe hardness (121-180 mg/dl)

Total Hardness (As CaCO3)

0 40 80 120 180 250 425 1000
mg/L or ppm

Soft ⟷ Hard ⟷ Very Hard
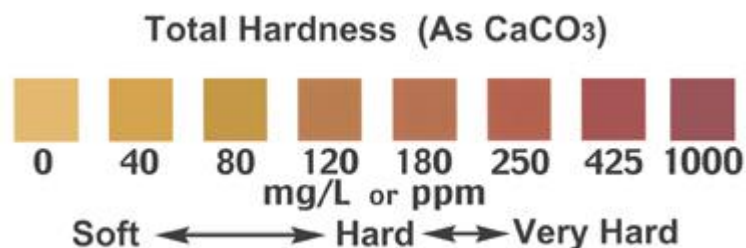
Temporary hardness

Temporary hardness is a type of water hardness caused by the presence of dissolved bicarbonate minerals (**calcium bicarbonate and magnesium bicarbonate**). Temporary hardness can be reduced either by **boiling** the water, or by the addition of lime (**calcium hydroxide**) through the process of lime softening. Boiling promotes the formation of carbonate from the bicarbonate and precipitates calcium carbonate out of solution, leaving water that is softer upon cooling.

Permanent hardness

Permanent hardness is hardness that cannot be removed by **boiling**. When this is the case, it is usually caused by the presence of **calcium sulphate /calcium chloride** and/or **magnesium sulphate /magnesium chloride** in the water, which do not precipitate out as the temperature increases. Ions causing permanent hardness of water can be removed using a water softener, or ion exchange column.

Calculation of total hardness

Materials:

1- **Buffer solution**: composed of (NH_4OH , $MgCl_2$, NH_4Cl and Na)
2- **Inhibitory solution**: composed of ($Na_2S.5H_2O$, EDTA and D.W.).
3- Indicator: (**Erichrome Black T dye**)
4- EDTA (**Ethylene diaminetetraacetic acid**)

Method:

1- Adjust the pH of 50 ml of water sample by adding few drops of buffer solution with monitoring of pH.

2- Add 1 ml of inhibitory solution

3- Add 0.2 gm of indicator dye.

4- Pipette the solution with **EDTA** solution.

5- Calculate total hardness with the following equation:

$$Total\ hardness\ (mg/l) = \frac{1000 * EDTA\ sol.\ size\ (ml)}{Water\ sample\ size\ (ml)}$$

Calculation of permanent hardness

1- Take 250 ml of water sample, and boil it for 20-30 min., then leave it to chill, and filter it.

2- Take the filtrate, and complete it 250 ml. by DW

3- Take 50 ml of this water and fellow the previous (1-4 steps) for calculation of total water hardness.

Calculation of Temporary hardness

Temporary hardness is calculated mathematically from this equation:

Temporary hardness = Total hardness - Permanent hardness