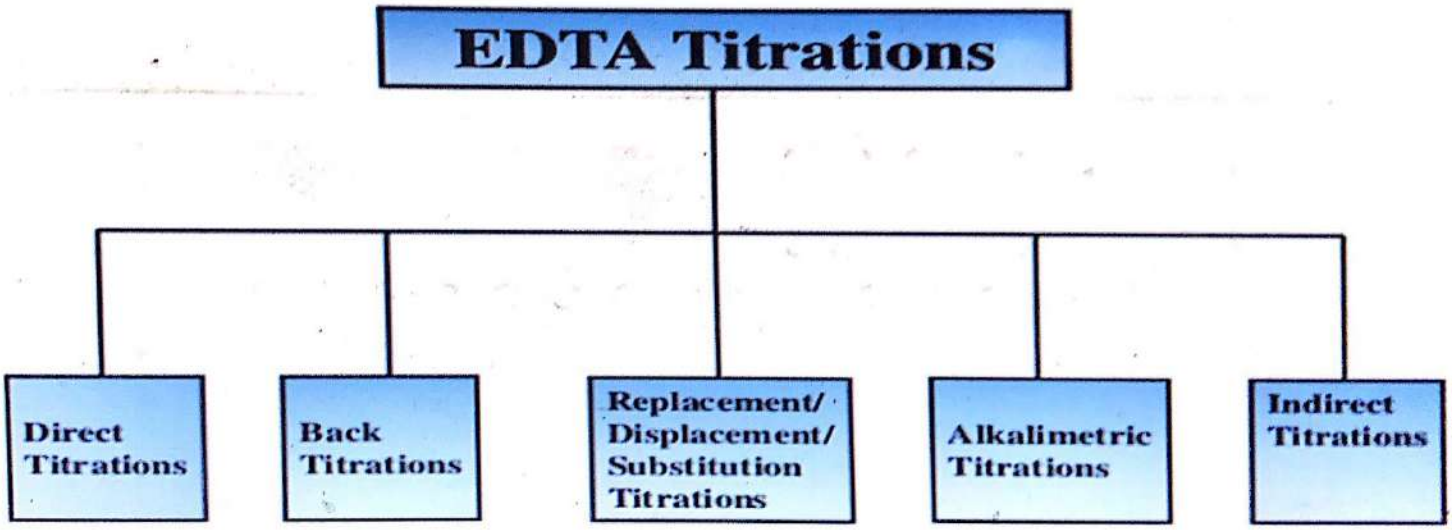
Types of EDTA Titrations:



DIRECT TITRATION:

In this type of titrations, the sample solution of metal ion, in the presence of a suitable buffer, is titrated against standard disodium EDTA solution.

M-EDTA complex must be more stable than M- Ind. complex in buffered medium.

The compound to be determined is water soluble.

The reaction between EDTA and metal must be rapid. If the reaction is slow it must be catalyzed.

M^{n+} should not be ppt. at the pH of titration. If M^{n+} is ppt. as MOH, auxiliary reagent must be added to prevent pptn. of M^{n+}.

Metal ion + Buffer + indicator Titrate with EDTA solution.

It is a simplest and most convenient method in which the standard solution of EDTA is slowly added to the metal ion solution till the end point is achieved.

The solution containing the metal ion is buffered to the desired pH and titrated directly with the standard EDTA solution.
A blank titration may be performed by omitting the sample to check the presence of impurities in reagents. Eg: ca^{2+},Mg^{2+} & Zn^{2+}ion are determined by direct titration with EDTA.

BACK TITRATION:

In a back titration an excess of EDTA is added to the metal ion solution

Excess EDTA is titrated with a known concentration of a second metal ion.

The second metal ion must form a weaker complex with EDTA than the analyte ion so the second metal does not displace the analyte ion from its complex with EDTA

when the metal-EDTA complex forms too slowly, or when the metal precipitates in the absence of EDTA.

SUBSTITUTION & DISPLACEMENT TITRATION

This type of titration is used for metal ions which form EDTA complexes which are more stable than other metals such as Mg^{2+} and Ca^{2+}.

Eg: To the calcium salt solution, ammonia-ammonium buffer is added. To this, a standard known volume of Mg-EDTA solution is added.

In the rection, stable Ca-EDTA complex is formed and Mg ions are liberated which may be titrated with a standard EDTA solution.

$$Ca^{2+} + Mg\text{–}EDTA \longrightarrow Ca - EDTA + Mg^{2+} \text{ (complex)}$$

ALKALIMETRIC TITRATION

The solution of disodium EDTA is added to a solution containing metallic ions ,complexes are formed with liberation of hydrogen ions.

The Hydrogen ions are titrated against alkali solution (standard) using an acid indicator.

Indirect Titration

This method is used to determine the ions such as Halides, phospates and sulphates that do not form complex with EDTA .

In the determination of sulphate ion, $SO4^{-2}$ ion solution is treated with excess of standard solution of Barium ion.

The formed precipitate of BaSO4 is filtered off and unreacted Barium ions present in filtrate is titrated with EDTA.

In this way, we are able to indirectly determine the amount of sulphate ion present in the sample solution.

Aim: To determine total hardness of the given water sample.

Chemicals Required: EDTA solution (M/100), Standard $MgSO_4.7H_2O$ (M/100), Erichrome Black-T, NH_4Cl-NH_3 buffer, Hard water sample.

HARDNESS OF WATER

- **Soap –destroying power of water**
- **Large quantities of soap or detergent required to produce foam /lather**

WHAT CAUSED THE HARDNESS OF WATER?

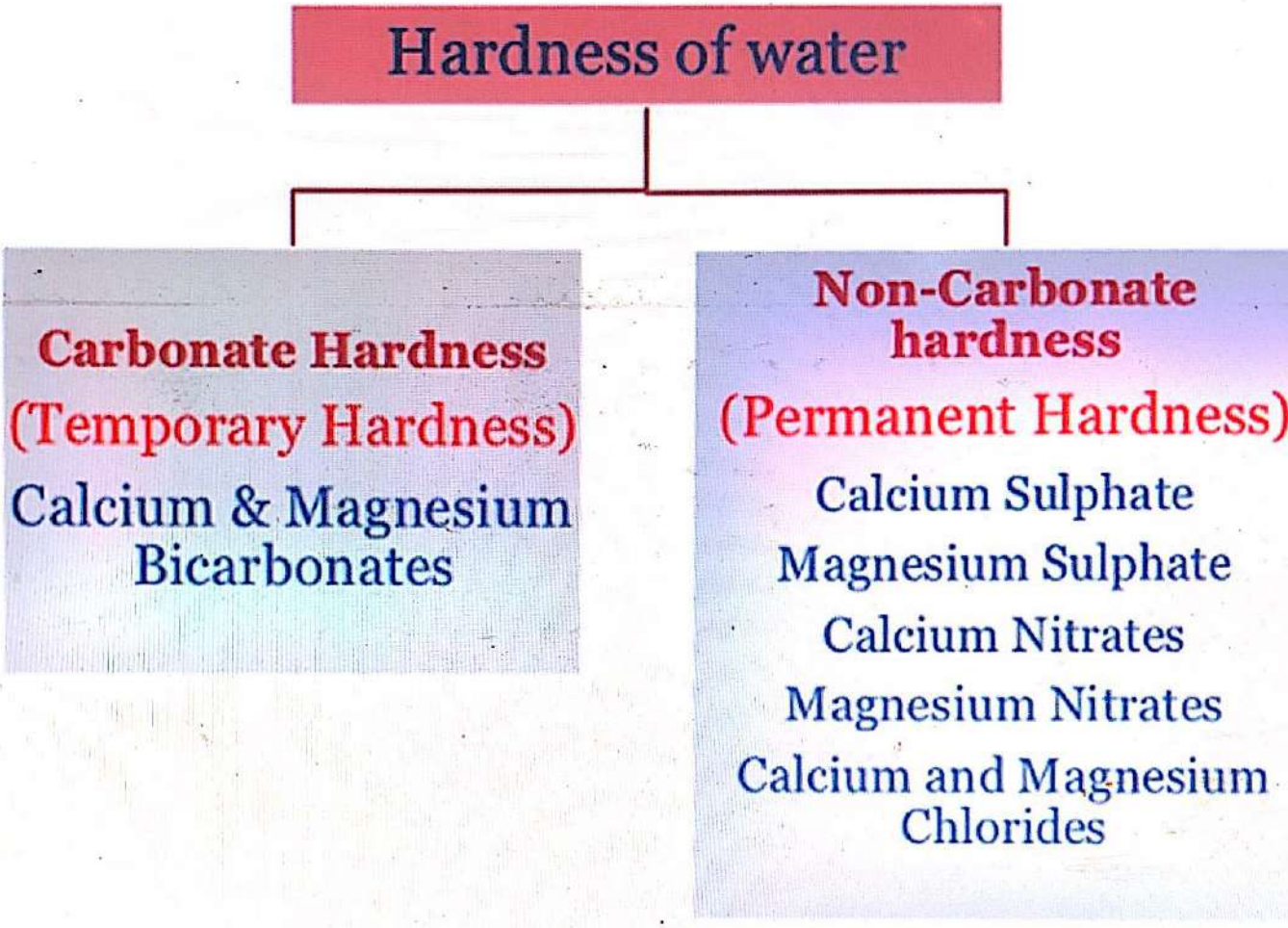
Mainly due to Four Dissolved Compounds :

1. Calcium Bicarbonate
2. Magnesium Bicarbonate
3. Calcium Sulphate
4. Magnesium Sulphate

Less Common:

1. Calcium Chlorides and Nitrates
2. Magnesium Chloride and Nitrates
3. Iron and Manganese salts
4. Aluminium Compounds

How Hardness Classified?



WHAT CAUSED THE HARDNESS OF WATER?

Mainly due to Four Dissolved Compounds :

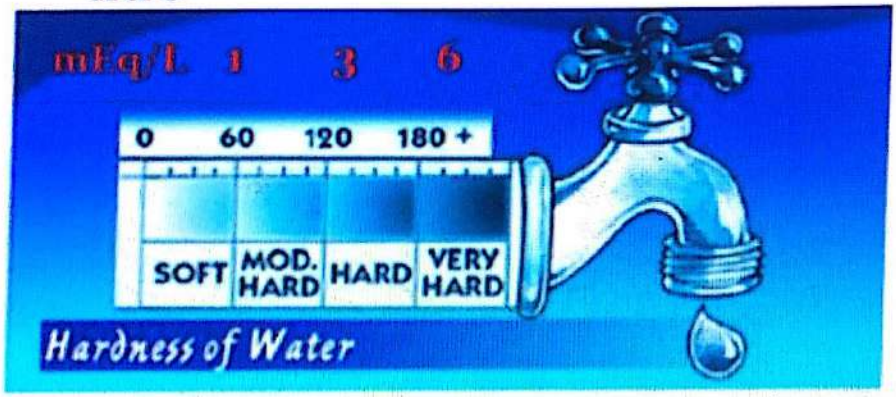
1. Calcium Bicarbonate
2. Magnesium Bicarbonate
3. Calcium Sulphate
4. Magnesium Sulphate

Less Common:

1. Calcium Chlorides and Nitrates
2. Magnesium Chloride and Nitrates
3. Iron and Manganese salts
4. Aluminium Compounds

MEASUREMENT OF HARDNESS

- Expressed as milli -equivalent per litre (m Eq/l) or mg/L
- 1 mEq /l of hardness = 50mg $CaCO_3$ (50ppm) in one litre



REMOVAL OF HARDNESS

Temporary Hardness

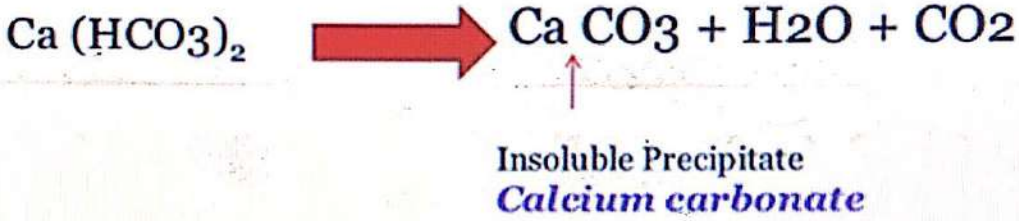
1. Boiling
2. Addition of lime
3. Addition of sodium carbonates
4. Base exchange process

Permanent Hardness

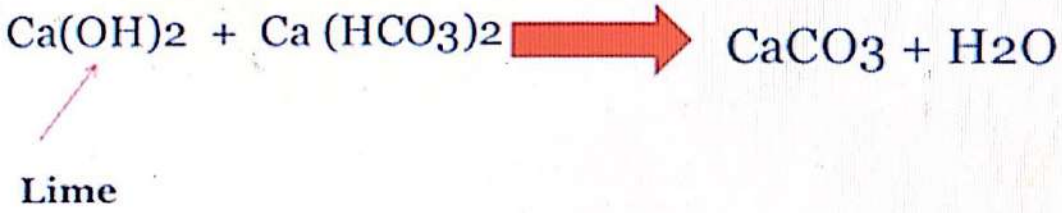
1. Addition of Sodium carbonate
2. Base exchange process

METHODS TO REMOVE HARDNESS

- **Boiling : (Expensive , no large scale use)**



- **Addition of Lime**



ADDITION OF SODIUM CARBONATE (SODA ASH)

- Removes both **temporary and permanent hardness**

$$Na_2CO_3 + Ca(HCO_3)_2 \rightarrow NaHCO_3 + CaCO_3$$

$$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3 + Na_2SO_4$$

Base Exchange Process (large scale)

1. Sodium Permutit is used ($Na_2Al_2Si_2OH_2O$)
2. Exchange Na ions for Ca and Mg ions
3. Ca and Mg Permutit is formed .
4. Removes 100% hardness

Unknown
Hap water + 10 ml Water distilled + 2 ml buffer + EBT
+ mg-EDTA

↓ titrate with EDTA

Blue colour

Repeat the process until 3 concordant reading.

Unknown boiled water (30 min) + 10 ml water + 2 ml buffer + EBT
+ mg-EDTA

(wine colour)

↓ Titrate with EDTA

Blue colour

Repeat the process until 3 concordant reading

Calculations

Standerisation

$(M_1 V_1)_{MgSO_4 \cdot 7H_2O} = (M_2 V_2)_{EDTA}$

$M_1 \times 10 = 0.01 \times 9.8$

$M_1 = \frac{0.01 \times 9.8}{10}$ (reading)

Synthetic Hard water

$(M_2 V_2)_{EDTA} = (M_3 V_3)_{Synthetic\ water}$

$0.01 \times V_2 = M_3 \times 10$

$M_3 = \frac{0.01 \times V_2}{10}$ (reading)

Tap water

$(M_2 V_2)_{EDTA} = (M_4 V_4)_{Tap\ water}$

$0.01 \times V_2 = M_4 \times 10$

$M_4 = \frac{0.01 \times V_2}{10}$ (reading)

Boiled water

$(M_2 V_2)_{EDTA} = (M_5 V_5)_{boiled\ water}$

$0.01 \times V_2 = M_5 \times 10$

$M_5 = \frac{0.01 \times V_2}{10}$ (reading)

Strength $= M_3 \times$ mol wt $=$ ____ g/L

$M_4 \times$ " $=$ ____ g/L

$M_5 \times$ " $=$ ____ g/L

Hardness = Strength $\times 10^3$ PPm

Result:- Total Hardness = Permanent + Temporary

= 200 - 170

= 30 PPm

Result Total Hardness —

Permanent " —

Temporary " —