

WATER :

Water is called as **universal solvent** because it is an excellent solvent for ionic compounds and polar covalent compounds.

3/4th of earth's surface is covered by water.

Purest form of natural water is rain water.

Potable water means which is for drinking.

Hardness of water:

- Chemically soap is sodium stearate.
- Water which gives good lather readily with soap is known as soft water.
- Water which does not give lather readily with soap but precipitates soap is known as hard water.
- When soap is added to hard water Na^+ of soap are replaced by Ca^{2+} or Mg^{2+} ions and precipitates as Ca or Mg soap.
- The disadvantages of using hard water are
 - It produces boiler scales
 - It causes wastage of soap in laundries
- Hardness of water is expressed in terms of ppm of CaCO_3 . That means the number of grams of CaCO_3 (or) its equivalent part present in 1 million grams of water is known as **hardness**.
- Hardness is of two types. They are
 - Temporary hardness
 - Permanent hardness
- Temporary hardness of water is due to the presence of the bicarbonates of Ca and Mg.
- Permanent hardness of water is due to the presence of the chlorides and sulphates of Ca, Mg, Fe.
- Temporary hardness of water can be removed by
 - Boiling
 - Clark's Method
- Boiling removes the temporary hardness as soluble bicarbonates convert into insoluble carbonates
$$\text{Ca}(\text{HCO}_3)_2 \xrightarrow{\Delta} \text{CaCO}_3\downarrow + \text{H}_2\text{O} + \text{CO}_2\uparrow$$
$$\text{Mg}(\text{HCO}_3)_2 \xrightarrow{\Delta} \text{MgCO}_3\downarrow + \text{H}_2\text{O} + \text{CO}_2\uparrow$$
- In Clark's method temporary hardness can be removed by adding a calculated quantity of milk of lime
$$\text{Ca}(\text{HCO}_3)_2 + \text{Ca}(\text{OH})_2 \rightarrow 2\text{CaCO}_3\downarrow + 2\text{H}_2\text{O}$$
If excess of lime is added it will cause permanent hardness.

Using Na_2CO_3 both temporary and permanent hardness can be removed.

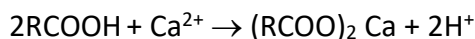
- The methods used for removing permanent hardness are
 - Permutit method
 - Ion exchange method
 - Calgon method
- Permutit is an artificial zeolite. Chemically permutit is hydrated sodium aluminum ortho silicate. Its formula is $\text{Na}_2 \text{Al}_2 \text{Si}_2 \text{O}_8 \cdot x \text{H}_2\text{O}$.
 - Gan's permutit process is also known as Base exchange process.



- The exhausted permutit is regenerated by treating 10% NaCl solution [Brine solution]
- Calgon is sodium hexameta phosphate. Its formula is $\text{Na}_2 [\text{Na}_4(\text{PO}_3)_6]$ or $(\text{NaPO}_3)_6$
- Calgon removes hardness by forming complex compounds with the Ca^{2+} and Mg^{2+} ions of hard water or by adsorption.

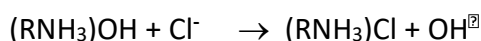
Ion exchange method:

- Deionised water is obtained in ion exchange method. It is free from all ions. It can be used in place of distilled water.
- Cation exchange resin is RCOOH or RSO_3H and anion exchange resin is RNH_3OH .
- In cation exchange resin, the cations of hard water get replaced by H^+ ions.



Resin (from hard water)

- In anion exchange resin the anions of hard water get replaced by OH^- ions.



Resin (from Hard water)

- The exhausted cation exchange resin can be regenerated by moderately concentrated H_2SO_4 solution.

Degree of hard ness:

It is expressed in PPM in terms of CaCO_3 .

It is the number of parts by weight of CaCO_3 in one million parts by weight of water

$$\text{Degree of hardness in PPM} = \frac{\text{weight of } \text{CaCO}_3}{\text{weight of } \text{H}_2\text{O}} \times 10^6$$

$$100\text{g } \text{CaCO}_3 = 162 \text{ g } \text{Ca}(\text{HCO}_3)_2$$

$$= 111\text{g of } \text{CaCl}_2$$

$$= 136 \text{ g of } \text{CaSO}_4$$

$$= 95 \text{ g of } \text{MgCl}_2$$

$$= 120 \text{ g of } \text{MgSO}_4$$

$$= 146\text{g of } \text{Mg}(\text{HCO}_3)_2$$