Hard & Soft Water

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Hard & Soft Water

The natural water of different sources may contain some dissolved or suspended impurities. Depending upon the nature of dissolved impurities present in natural water, and its behavior towards soap, water can be divided into two types.
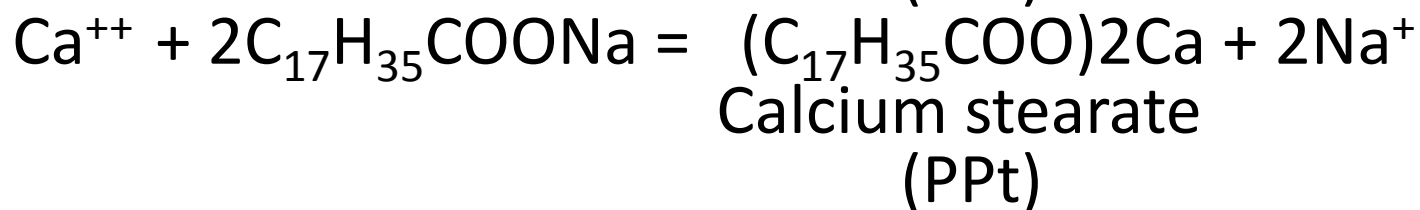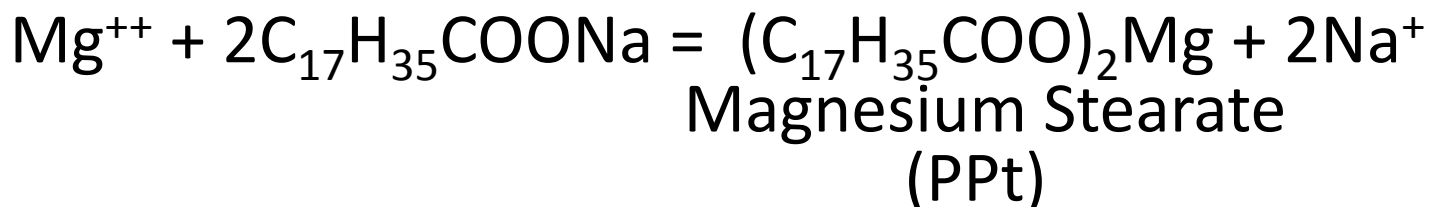
1) Soft Water
2) Hard Water

1) Soft Water and 2)Hard Water

- The water which readily produces lather with soap solution is called soft water. For examples, rain water, distilled water etc.

- The water which does not readily produces lather with soap solution is called hard water. For examples, tap water, river water, spring or underground water, sea water.

Cause of Hardness

Hardness of water is caused by the presence of the soluble bicarbonates, sulphates and chlorides of calcium and magnesium. When hard water is treated with soap (which is the sodium salt of long chain of fatty acid eg sodium stearate, $C_{17}H_{35}COONa$), the Ca^{++} and Mg^{++} ions react with the soap forming insoluble scum or curds, and no lather is produced until all the Ca^{++} and Mg^{++} ions are precipitated.

$$Mg^{++} + 2C_{17}H_{35}COONa = (C_{17}H_{35}COO)_2Mg + 2Na^+$$
Magnesium Stearate
(PPt)

$$Ca^{++} + 2C_{17}H_{35}COONa = (C_{17}H_{35}COO)2Ca + 2Na^+$$
Calcium stearate
(PPt)

Types of Hardness

- Hardness of water is of two type
  i) Temporary Hardness
  ii) Permanent Hardness

- **i)Temporary Hardness**
  The temporary hardness of water is caused by the presence of the bicarbonates of calcium and Magnesium. Temporary hardness is also called the **carbonate hardness**
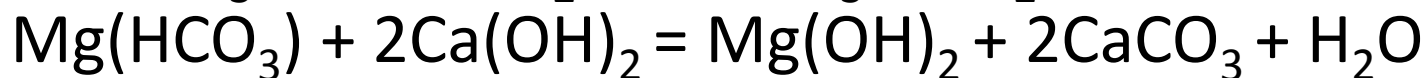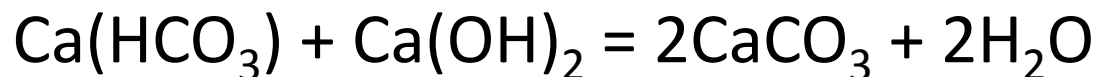
Removal of Temporary Hardness

a) By Boiling

When temporary hard water is boiled, the soluble bicarbonates of calcium and magnesium decomposes giving insoluble carbonates.

$$Ca(HCO_3)_2 = CaCO_3 + H_2O + CO_2$$
$$Mg(HCO_3)_2 = MgCO_3 + H_2O + CO_2$$

b) By Clark's Process

By the addition of calculated amount of slaked lime.

$$Ca(HCO_3) + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$
$$Mg(HCO_3) + 2Ca(OH)_2 = Mg(OH)_2 + 2CaCO_3 + H_2O$$
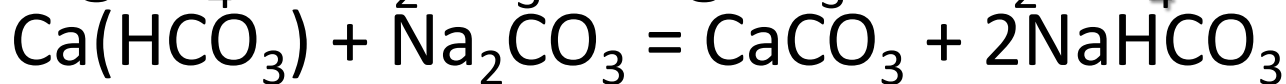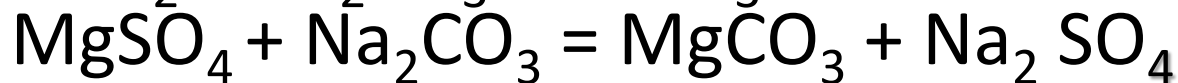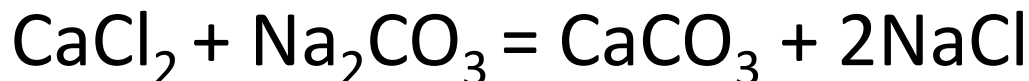
ii) Permanent Hardness

- The permanent hardness of water is caused by the presence of chlorides and sulphates of calcium and magnesium.
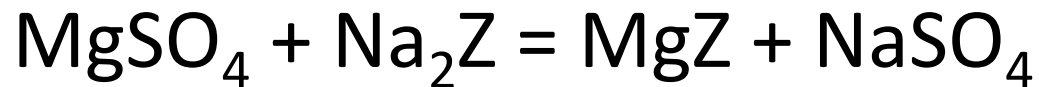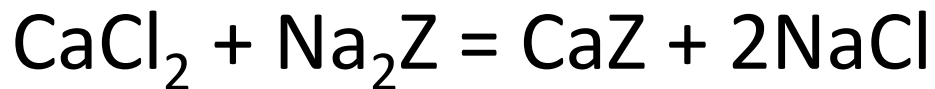**Removal of Permanent Hardness**

a) By addition of Washing Soda
Permanent hardness cannot be removed by boiling. Treatment with washing soda can remove both temporary and permanent hardness.
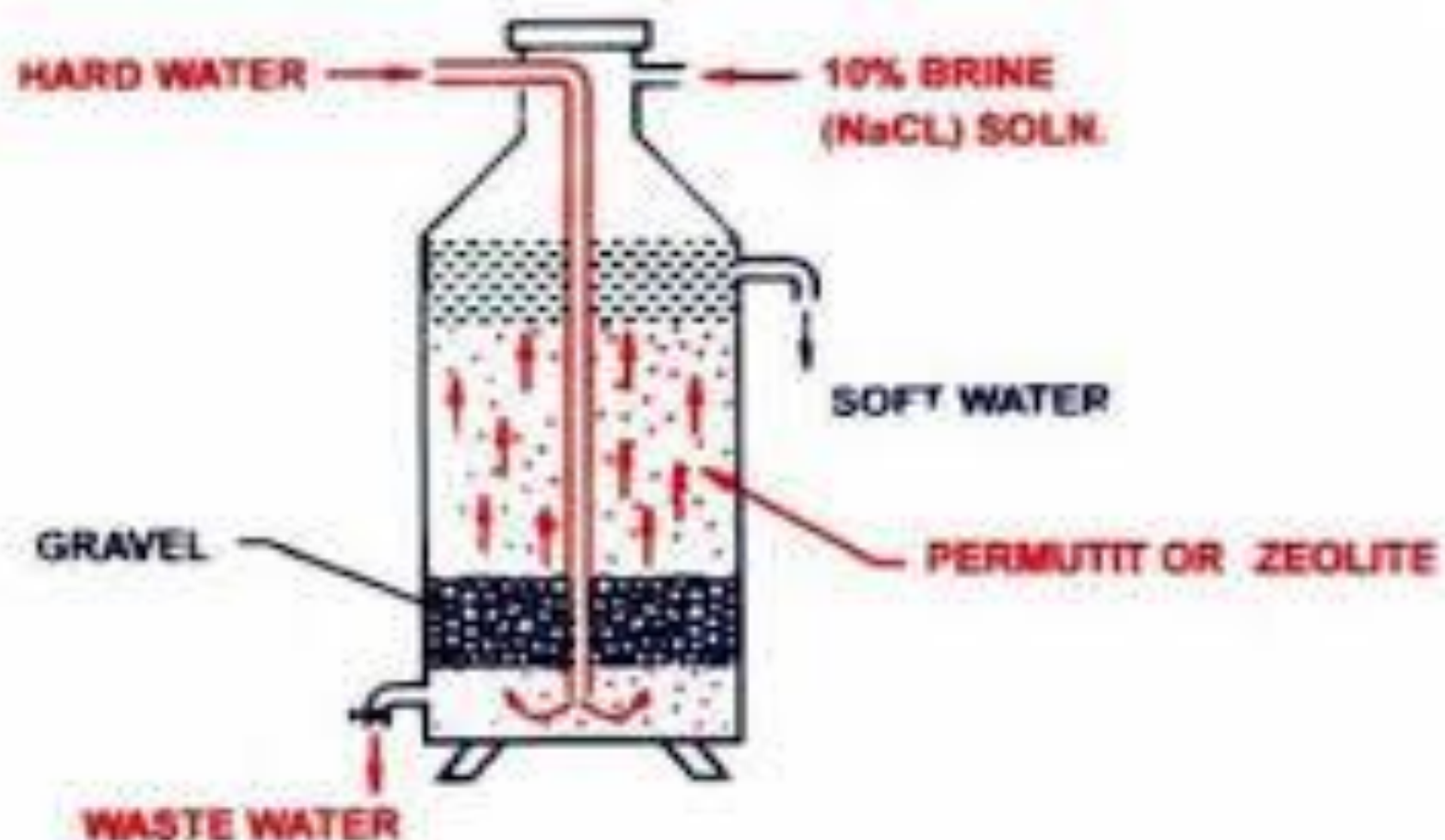
$CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$
$MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2 SO_4$
$Ca(HCO_3) + Na_2CO_3 = CaCO_3 + 2NaHCO_3$

b) By Permutit Process (Ion exchange process)

When hard water is passed through minerals called Zeolites, the bivalent Ca^{++} and Mg^{++} ions are exchanged by the Na^+ ions of Zeolite.

Zeolite is the sodium aluminium Silicate mineral ($Na_2 Al_2Si_2O_8, xH_2O$). It is usually denoted by Na_2Z, where Z stands for $Al_2Si_2O_8, xH_2O$.

$CaCl_2 + Na_2Z = CaZ + 2NaCl$
$MgSO_4 + Na_2Z = MgZ + NaSO_4$

HARD WATER → ← 10% BRINE (NaCL) SOLN.

SOFT WATER

GRAVEL

PERMUTIT OR ZEOLITE

WASTE WATER

PERMUTIT'S PROCESS OF SOFTENING OF HARD WATER

Zeolite is the sodium aluminium Silicate mineral ($Na_{2.}Al_2Si_2O_{8,}xH_2O$). It is usually denoted by Na_2Z, where Z stands for $Al_2Si_2O_{8,}xH_{2O.}$

$CaCl_2 + Na_2Z = CaZ + 2NaCl$
$MgSO_4 + Na_2Z = MgZ + NaSO_4$
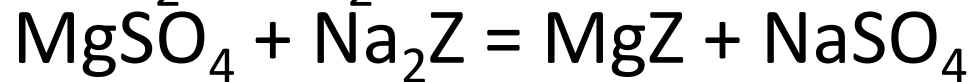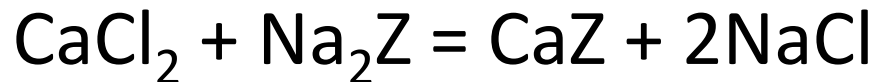
When the Zeolite is completely converted into calcium and magnesium Zeolite, Further reaction stops. But the exhausted Zeolite can be regenerated by allowing a 10% solution of NaCl to percolate through it. This process is cheap and efficient.

Exhausted Zeolite + 10%NaCl = Regenerated Zeolite