

Types of impurities :-

1) Dissolved impurities:-

- Inorganic impurities :-

Carbonates, bicarbonates, Sulphates, chlorides of calcium, magnesium, iron, potassium & aluminium

- Organic impurities :-

Organic water products, amino acids, proteins etc

Gases: O_2 , CO_2 , oxides of nitrogen & sulphur, H_2S

2) Suspended Impurities:-

Inorganic: sand & clay

Organic: Vegetable and animal matter

3) Biological Impurities:-

Pathogenic bacteria, algae, fungi

* Determination of Hardness of water using EDTA

- ① Complexometric titration method where EDTA is used.
- ② Forms different complexes at different pH.
- ③ Calcium & Magnesium ions form complexes with EDTA at pH 9-10. To maintain the pH 9-10 NH_4Cl , NH_4OH buffer solution is used.
- ④ The disodium salt of EDTA is used for complexation.
- ⑤ An alcoholic solution of Eriochrome Black-T (EBT) is used as an indicator.

- Advantages of EDTA method.

→ High accuracy.

Wide applicability.

Simple procedure.

Fast results.

Low costs.

★ Softening of water:-

Removal of hardness causing salts from water is called 'Softening of water'.

Three types of process:-

- 1] Lime-Soda Process.
- 2] Zeolite-Permutit Method.
- 3] Ion-Exchange Method / Demineralization method.

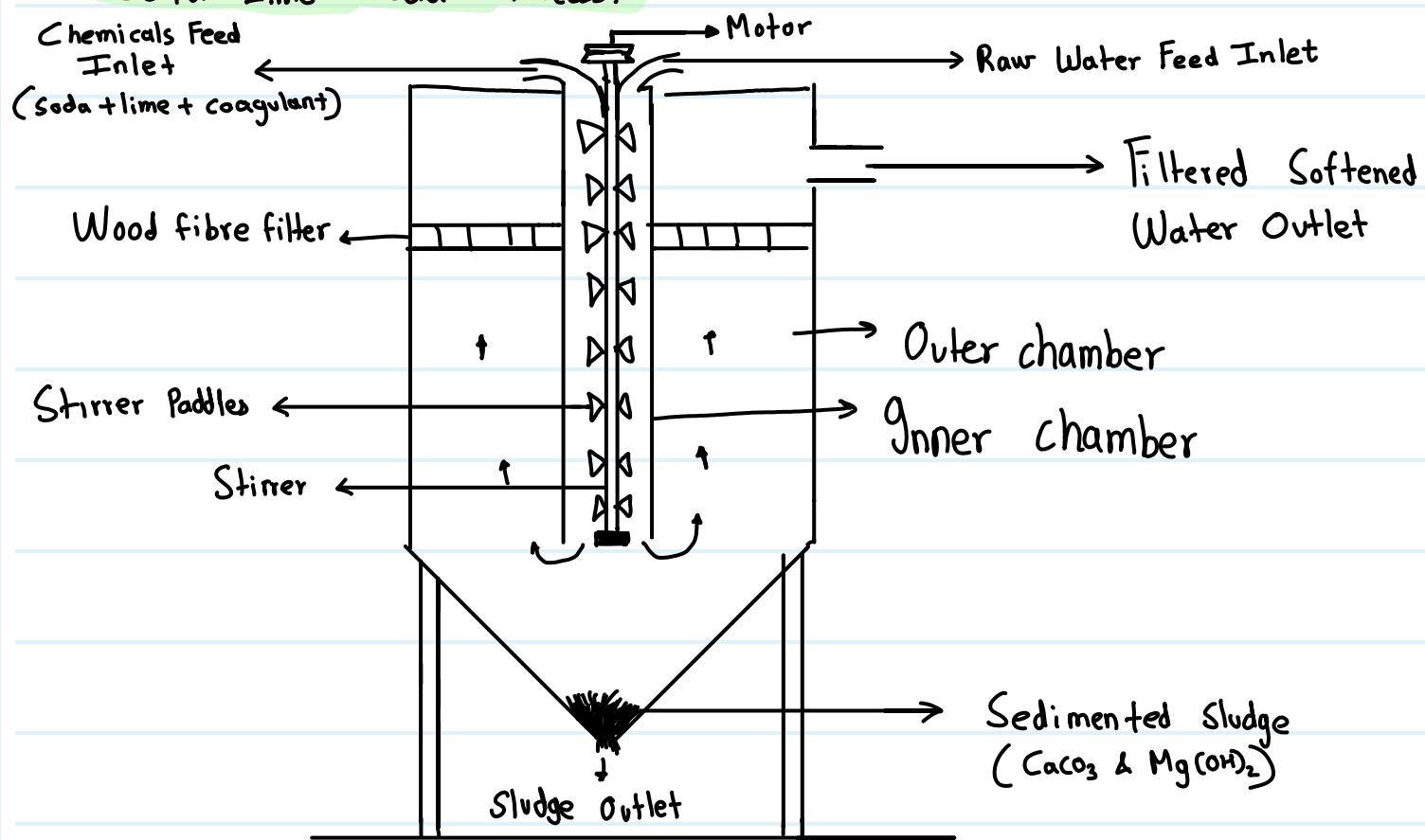
* Lime - Soda Process .

This process is based on converting soluble calcium & magnesium salts into insoluble calcium carbonate and magnesium hydroxide precipitates by addition of calculated amounts of lime $[Ca(OH)_2]$ & soda $[Na_2CO_3]$. The precipitate is removed by filtration. Any free dissolved CO_2 and acids are also removed by this process.

Different types of Lime-Soda process are:-

A

Cold Lime-Soda Process:



In this method Lime & Soda are mixed with hard water at room temperature .

Working:

- 1] Generally, the precipitates formed in this process are finely divided, in order to settle the precipitates, coagulants like alum, ferrous sulphate etc are added.
- 2] The hardwater to be softened is mixed with calculated quantity of chemicals (Lime + Soda + Coagulant) from the top into the inner chamber on vigorous stirring. The chemical reactions take place and hardness producing salts gets converted into insoluble precipitates.
- 3] The sludge is removed from the bottom of the outer chamber while the Softened water passes through a wooden fibre filter to ensure the complete removal of any residual sludge particles.
- 4] The clear softened water is withdrawn from the top of the outer chamber.
- 5] The softened water from this process contains a residual hardness of 50 - 60 ppm.

3] Hot Lime-Soda Process

Here the process is carried at temperature of 80° to 150°C at high temp.

It consists of three parts :-

- "Reaction Tank" in which complete mixing of water, chemicals and steam takes place and water gets softened.
- "Conditional Sedimentation Vessel" where the sludge settle down.
- "Sand Filter" where sludge is completely removed.

The softened water from this process contains a residual hardness of 15-30 ppm.

- Advantages of Lime-Soda process:-

- 1] This process is economical.
- 2] Mineral content of water is reduced.
- 3] This process ↑ pH of water which ↓ pathogenic bacteria.
- 4] Manganese & Iron salts are also removed by this process.
- 5] The process improves the corrosion resistance of water.

- Disadvantages of Lime-Soda Process:

- 1] Due to residual hardness, water is not useful for high pressure boilers.
- 2] Large amount of sludge is formed which creates disposal problems.



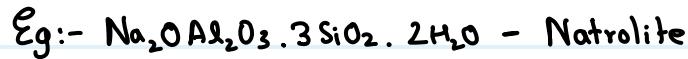
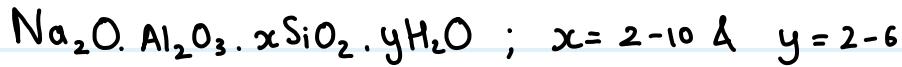
$$L = \frac{74}{100} [\text{Temporary } Ca^{+2} + 2 \times \text{Temporary } Mg^{+2} + \\ \text{Permanent } (Mg^{+2} + Fe^{+2} + Al^{+3} + H^+ (\text{HCl or } H_2SO_4)) + CO_2 + HCO_3^- - NaAlO_2] \\ \times \frac{\text{Vol. of Water}}{10^6} \times \frac{100}{\% \text{ of purity}} \text{ kg all in terms of their } CaCO_3 \text{ equivalents.}$$



$$S = \frac{106}{100} [\text{Permanent } (Ca^{+2} + Mg^{+2} + Al^{+3} + Fe^{+2} + H^+ (\text{HCl or } H_2SO_4)) - HCO_3^-] \\ \times \frac{\text{Vol. of Water}}{10^6} \times \frac{100}{\% \text{ of purity}} \text{ kg all in terms of their } CaCO_3 \text{ equivalents.}$$

* Zeolite Process

Zeolite is 'Hydrated sodium aluminosilicate'. Its general formula is:



Natural Zeolite are generally non-porous.

The artificial zeolite is called Permutit. These are prepared by heating together with chain clay, feldspar & Soda ash. These are Porous and have greater softening capacity than natural zeolite.

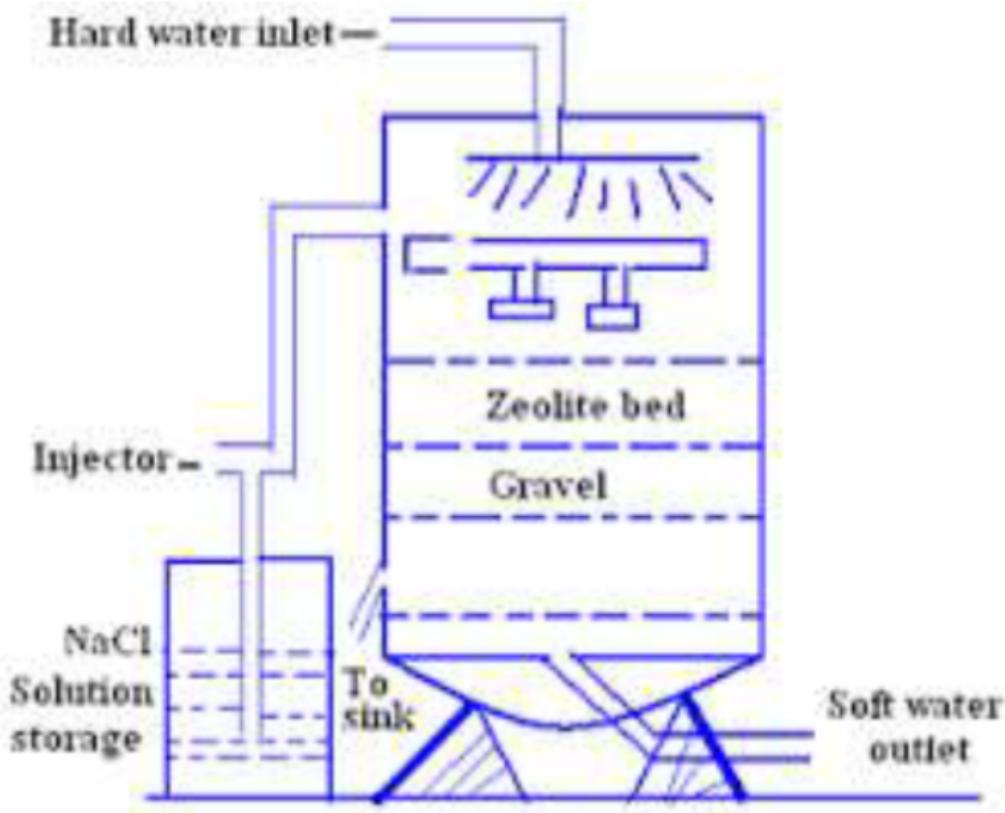
Working:-

Hard water is passed through a bed of Zeolite at ordinary temperature.

The Hard Water percolates (filtered), $\text{Ca}^{2+}, \text{Mg}^{2+}$ present in hard water are exchanged with Na^+ ions.



Regeneration of Zeolite: On Continuous passing of hard water through sodium zeolite bed it is converted to calcium & magnesium Zeolite which is known as 'Exhausted Bed'. Hence, it must be regenerated. This can be done by washing Zeolite bed with 10% sodium chloride solution.



- Advantages:

- 1] Equipment is small & easy to handle.

- 2] Requires less time for softening.

3] Water obtained from this process contains a residual hardness upto 10 ppm.

4] Easy to regenerate.

5] No sludges is formed in this process.

• Disadvantages:

1] Highly turbid water cannot be treated by this process.

2] This process exchanges only Ca^{2+} & Mg^{2+} ions by sodium ions & hence the softened water contains more sodium salts.

3] All the acidic ions like HCO_3^- , CO_3^- etc are not removed by this process.

4] Sodium bicarbonate decomposes in the boiler releasing CO_2 which leads to corrosion.

5] While Na_2CO_3 is hydrolysed to NaOH which creates caustic embrittlement of the boiler.

* BOD

It is measure of amount of oxygen required for biological oxidation of organic matter under aerobic conditions at 20°C for period of 5 days.

- Drinking water should have BOD less than 1 ppm.

$$\text{BOD} = [(\text{DO})_{\text{blank}} - (\text{DO})_{\text{incubated}}] \times \text{Dilution Factor}$$

\hookrightarrow 5 days at 20°C

$$\text{Dilution factor} = \frac{\text{Volume of sample after dilution}}{\text{Volume of sample before dilution}} = \frac{\text{Vol. taken for titration}}{\text{Total vol. to which it is diluted}}$$

• Significance of BOD

- BOD gives the extent of bio-degradable pollutants in wastewater sample.
- It helps in pollution control in water.
- It also express self-purification capacity of any water body.

* COD

gt is measure of amount of oxygen required for chemical oxidation of organic matter when refluxed in acidified potassium dichromate in presence of Ag_2SO_4 or HgSO_4 catalyst for 3 hours

- Drinking water should have COD less than 1 ppm.

$$\text{COD} = \frac{(V_b - V_t) \times N_{\text{FAS}} \times 8 \times 1000}{Y} \text{ mg/L or ppm}$$

V_b = Volume of FAS required for blank titration.

V_t = Volume of FAS required for reaction mass after time

Y = Volume of waste water sample taken

• Significance of COD

- 1] COD gives the extent of bio-degradable & non-biodegradable pollutants in wastewater sample.
- 2] gt helps in rapid determination of pollutants level in water compared to BOD.
- 3] gt is taken as a basis for calculation of efficiency & designing of water treatment plant

