

Softening of hard water

Since hard water is unsuitable for domestic as well as industrial use, it is advisable to remove or reduce the amount of hardness causing salts from the water. *The process by which we remove or reduce the hardness of water is termed as “softening” of water.*

Water Softening by Lime-Soda Process

Lime (L)-Soda (S) Softening Process

Basic Principle: The basic principle of this process is to convert all the soluble hardness causing constituents into insoluble masses (known as precipitates) by addition of calculated amount of lime Ca(OH)_2 and soda Na_2CO_3 to the hard water. The precipitates $[\text{CaCO}_3$ and $\text{Mg(OH)}_2]$ are then removed by sedimentation (a settling process) and filtration.

Types of L-S process: Based on the working temperature of the softener, it is of two types.

(1) Cold L-S Process, and (2) Hot L-S Process

Cold L-S Process: In this process calculated amount of chemicals (L & S) are added to the water at room temperature (RT).

But, at RT, the precipitates formed are very fine and do not settle down easily under the force of gravity and can easily pass through the filter too. So, in order to avoid such situation a small amount of **coagulants** like potash alum $[\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}]$, Aluminium sulfate $\text{Al}_2(\text{SO}_4)_3$, or sodium aluminate NaAlO_2 are added to the water along with L & S. Thus coagulant helps in converting fine particles to coarse particles. This process provides water with a residual hardness of 50-60 ppm.

Hard water + L + S + Coagulant \rightarrow Precipitates + soften water

1. CaCl_2 (hard water) + Na_2CO_3 (soda) \rightarrow CaCO_3 (ppt) + 2 NaCl
2. MgCl_2 + Ca(OH)_2 (lime) + Na_2CO_3 (soda) \rightarrow Mg(OH)_2 (ppt) + CaCO_3 (ppt) + 2 NaCl

Working process: Hard water and calculated amount of lime, soda and coagulant are fed from the top of the softener fitted with a paddle stirrer at RT (see Figure). Vigorous stirring ensures continuous mixing and softening takes place. The soften water rising up passes through a wood-fibre filter whereby traces of sludge are removed. The precipitates settle down at the bottom by the time the softened water reaches the outlet. Coarse precipitates are settled down and relatively finer one is retained by the wood filter. The precipitates are periodically removed through the sludge outlet.

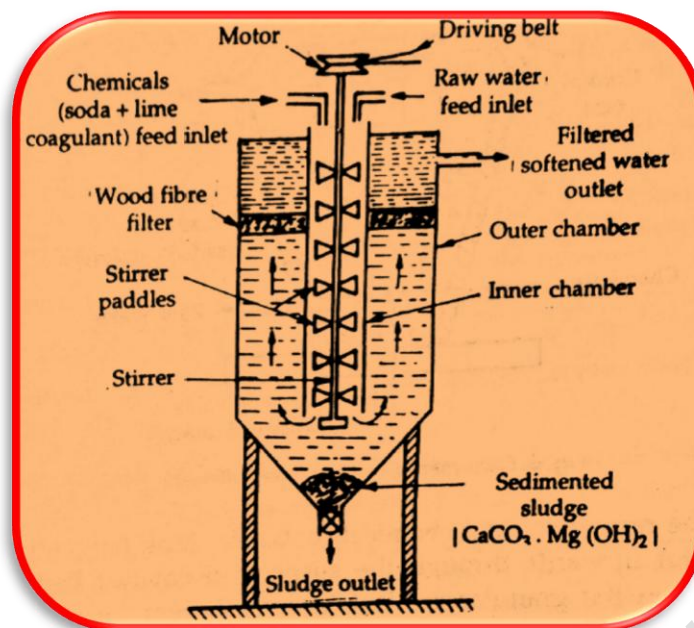


Fig. Cold L-S Softener

Limitations of cold L-S process: Some of the limitations are: (1) Residual hardness is high (50- 60 ppm), so not fit for boiler operation; (2) As it operates at RT, softening capacity is low, rate of precipitation is slow; (3) Dissolved gases are not removed; (4) Relatively more chemicals are needed (coagulant is required); (4) Bacteria are not killed; (5) need skilled operator/ supervisor; (5) disposal of huge amount of sludge is a problem

Questions:

Q. Define softening with a suitable example.

Ans. The process by which we remove or reduce the hardness of water is termed as “softening” of water. Example:- Lime-Soda process

Q. What is a coagulant? Give an example.

Ans. Coagulant is a substance which helps in settling of fine particles. Example:-Potash Alum

Q. Define coagulation. Mention a reaction between coagulant and hardness causing mass.

Ans. Coagulation is a process by which finer particles are converted into coarser particles by addition of a coagulant.



Q. What is the basic principle of L-S process?

Ans. The basic principle of this process is to convert all the soluble hardness causing constituents into insoluble masses (known as precipitates) by addition of calculated amount of lime $Ca(OH)_2$ and soda Na_2CO_3 to the hard water. The precipitates $[CaCO_3$ and

Mg(OH)₂] are then removed by sedimentation (a particle settling process) and filtration. This softening process proceeds via precipitation reaction.

Q. What is the basic principle of L-S process? Describe the cold L-S process with a neat softener diagram.

Ans. Refer above

Q. Mention the limitations of Cold L-S Process

Ans. *Limitations of cold L-S process:* Some of the limitations are: (1) Residual hardness is high (50- 60 ppm), so not fit for boiler operation; (2) As it operates at RT, softening capacity is low, rate of precipitation is slow; (3) Dissolved gases are not removed; (4) Relatively more chemicals are needed (coagulant is required); (4) Bacteria are not killed; (5) need skilled operator/ supervisor; (5) disposal of huge amount of sludge is a problem