JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Year & Sem – B.Tech I year I Sem
Subject –Engg.Chemistry
Unit – I
Presented by – Ms.Rekha Vijay
Designation - Asst.Professor
Department - Chemistry

# VISSION OF INSTITUTE

**To become a renowned centre of outcome based learning, and work towards academic, professional, cultural and social enrichment of the lives of individuals and communities.**

# MISSION OF INSTITUTE

❖**Focus on evaluation of learning outcomes and motivate students to inculcate research aptitude by project based learning.**

❖**Identify, based on informed perception of Indian, regional and global needs, the areas of focus and provide platform to gain knowledge and solutions.**

❖**Offer opportunities for interaction between academia and industry.**

❖**Develop human potential to its fullest extent so that intellectually capable and imaginatively gifted leaders may emerge.**

# CONTENTS (TO BE COVERED)

**Lime Soda method for softening of hard water.**

- Cold lime soda method
- Hot lime soda method

# LIME SODA

*INTRODUCTION :*

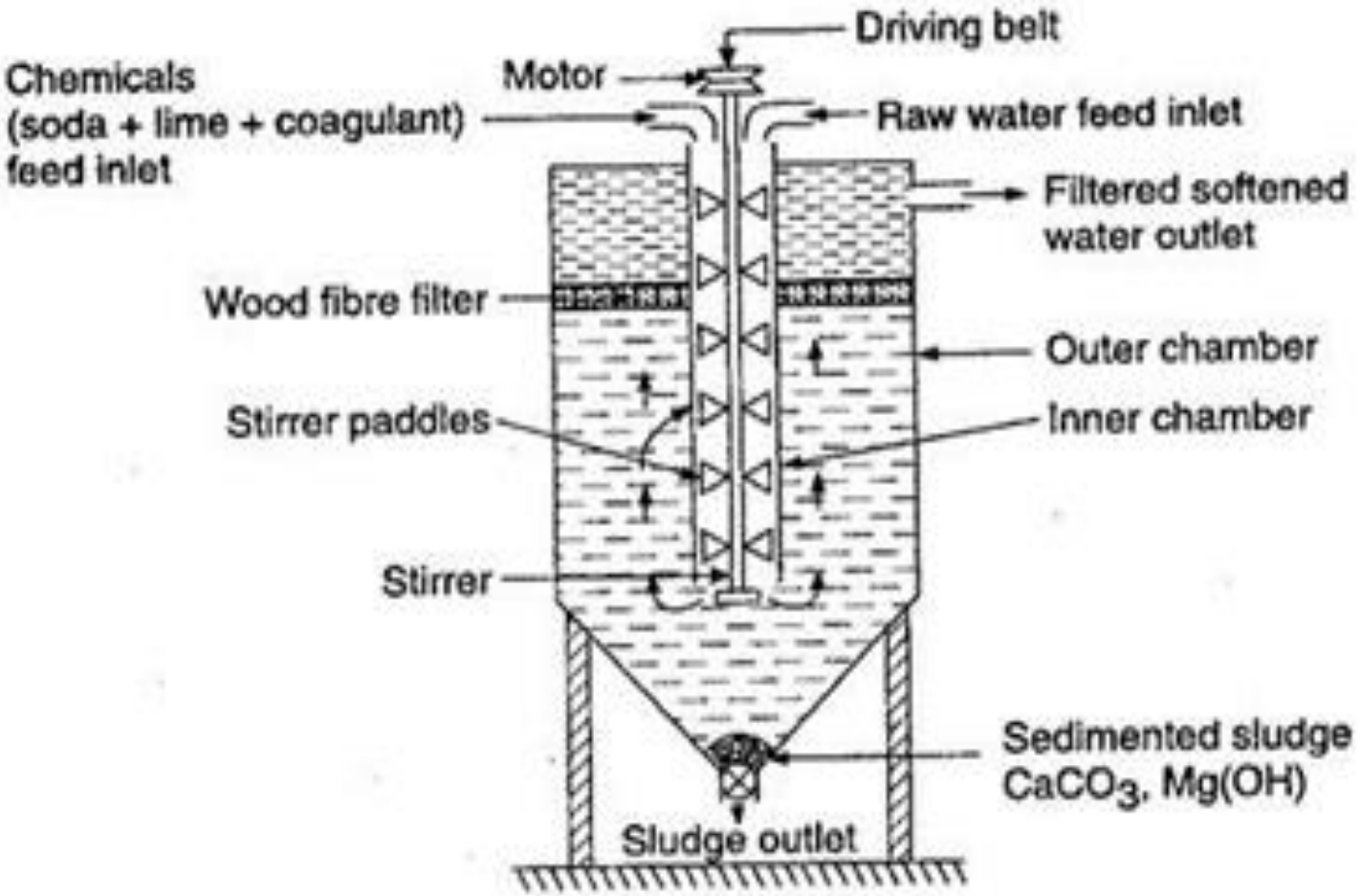
- Standard water-softening process.
- Carried out either hot or cold.
- Uses lime ($Ca(OH)_2$ and soda ash ($Na_2CO_3$) to reduce the hardness of the water by precipitating the dissolved calcium and magnesium salts as insoluble calcium carbonate and magnesium hydroxide respectively.

# Hot and Cold lime soda process

| Cold lime soda process | Hot lime soda process |
|---|---|
| 1. It is carried out at room temperature (25-30°C) | 1. It is carried out at high temperature (95-100°C) |
| 2. It is a slow process | 2. It is a rapid process |
| 3. Use of coagulant is a necessary | 3. No coagulant required |
| 4. Filtration is not easy | 4. Filtration is easy as viscosity of water is low |
| 5. Residual hardness is 60 ppm | 5. Residual hardness is 15—30 ppm |
| 6. Dissolved gases are not removed | 6. Dissolved gases are removed |
| 7. It has low softening capacity | 7. It has high softening capacity |

# COLD LIME SODA PROCESS

- In this method calculated amount of lime and soda are mixed with water at room temperature.
- At room temperature the precipitates formed are finely divided so they do not settle easily and cannot be filtered easily.
- Consequently,it is essential to add small amount of coagulants like alum,aluminium sulphate,sodium aluminate etc.
- Coagulants form gelatinous precipitate of aluminum hydroxide and entraps fine precipitate


Driving belt
Motor
Chemicals
(soda + lime + coagulant)
feed inlet
Raw water feed inlet
Filtered softened
water outlet
Wood fibre filter
Outer chamber
Stirrer paddles
Inner chamber
Stirrer
Sedimented sludge
$CaCO_3$, Mg(OH)
Sludge outlet

# Process

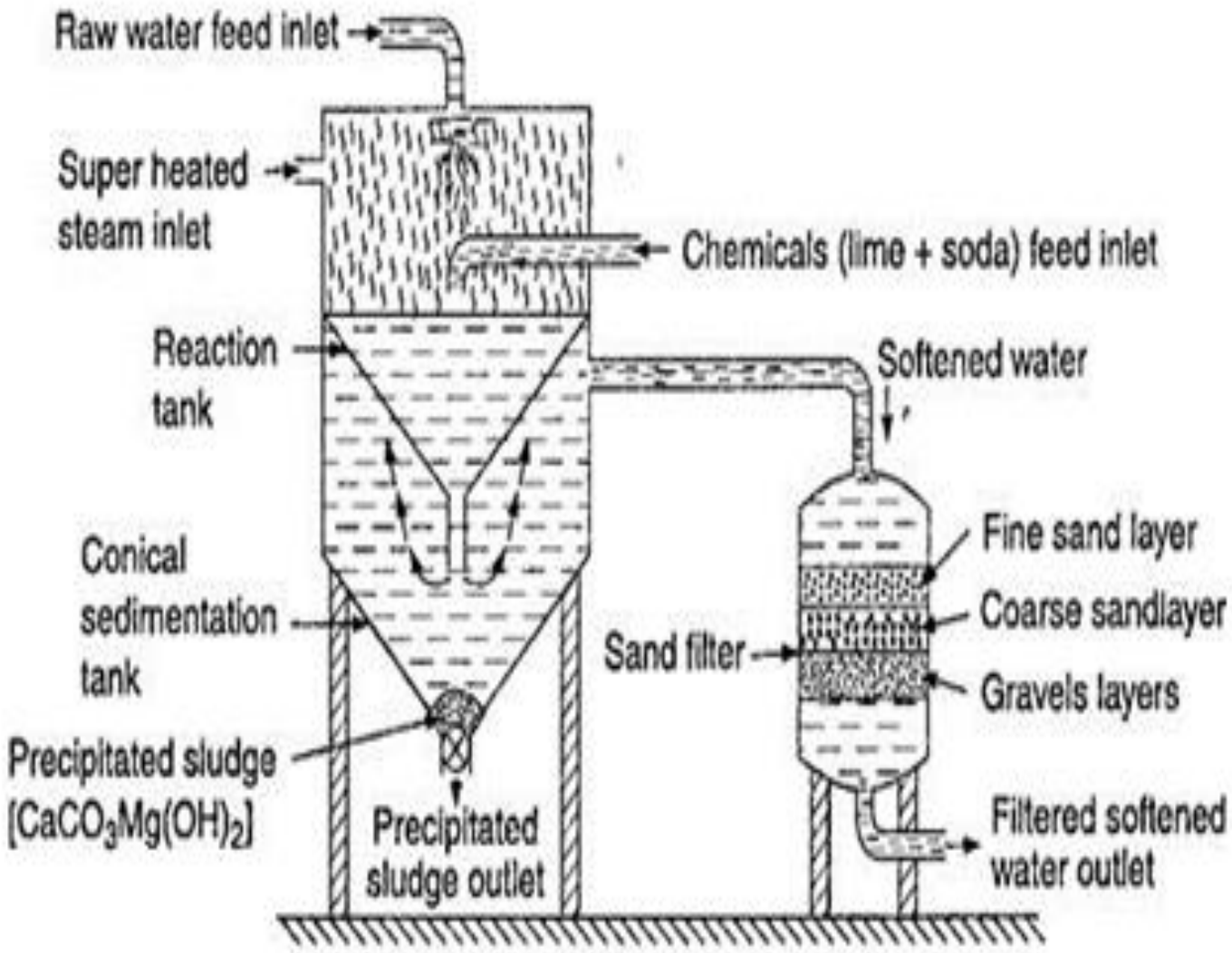
- Raw water and calculated amount of chemicals (lime,soda,coagulants) are fed from the top in to the inner vertical circular chamber, fitted with a vertical rotating system carrying a number of paddles.
- As the raw water and chemicals flow down, there is a vigorous stirring and continuous mixing so that softening of water will take place.
- The softened water comes into the chamber ,where it rises up.
- The heavy sludge of precipitates settle down in the outer chamber by the time the softened water reaches up.
- The softened water then passes through a filtering media that is made up by wood fiber to ensure complete removal of sludge.
- Filtered soft water finally flows out continuously through the outlet at the top.

# HOT LIME SODA PROCESS

In hot lime soda process hard water is treated with lime and soda at 94-100c.

**Hot lime soda plant consists of three parts:**

- A reaction tank in which raw water, chemicals and steam are throughly mixed.
- A conical sedimentation vessel in which sludge settle down.
- A sand filter which ensure complete removal of sludge from softened water.


Raw water feed inlet
Super heated steam inlet
Chemicals (lime + soda) feed inlet
Reaction tank
Softened water
Conical sedimentation tank
Fine sand layer
Coarse sandlayer
Sand filter
Gravels layers
Precipitated sludge [$CaCO_3Mg(OH)_2$]
Precipitated sludge outlet
Filtered softened water outlet

# Process

- The reaction tank has three separate inlets,one each for raw water,lime soda, and steam.
- Steam is used to increase the temperature.
- Due to high temperature ,reactions of water softening proceed faster and sludge is collected in conical sedimentation tank.
- The softened water is passed through sand filter which ensure complete removal of sludge from water.
- The resulting softened water has a residual hardness of 15-30 ppm.

# Chemical reactions of lime soda process

| S.No. | Constituent | Reactions | Need |
|---|---|---|---|
| 1. | $Ca(HCO_3)_2$ (Temp. Ca) | $Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + H_2O$ | L |
| 2. | $Mg(HCO_3)_2$ (Temp. Mg) | $Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + Mg(OH)_2 + 2H_2O$ | 2L |
| 3. | $Mg^{2+}$ (Perm. Mg from $MgCl_2$ or $MgSO_4$) | $Mg^{2+} + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow Ca^{2+}$<br>$Ca^{2+} + Na_2CO_3 \rightarrow CaCO3\downarrow + 2Na^+$ | L<br>S |
| | Or more specifically | $MgCl_2 + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + CaCl_2$<br>$CaCl_2 + Na_2CO_3 \rightarrow CaCO3\downarrow + 2NaCl$ | (L+S) |
| | and | $MgSO_2 + Ca(OH)_2 \rightarrow Mg(OH)_2\downarrow + CaSO_4$<br>$CaSO_4 + Na_2CO_3 \rightarrow CaCO3\downarrow + Na_2SO_4$ | (L+S) |
| 4. | $HCO^-_3$ (e.g., $NaHCO_3$) | $2NaHCO_3 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O + Na_2CO_3$ | (L–S) |
| 5. | $Ca^{2+}$ (Perm. Ca From $CaCl_2$ or $CaSO_4$) | $Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2Na^+$ | S |
| | Or more specifically: | $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$<br>$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3\downarrow + Na_2SO_4$ | S |
| 6. | $CO_2$ | $CO_2 + Ca(OH)_2 \rightarrow CaCO_3 + H_2O$ | L |
| 7. | $H^+$ (free acid like HCI, $H_2SO_4$, etc.) | $2H^+ + Ca(OH)_2 \rightarrow Ca^{2+} + 2H_2O$<br>$Ca^{2+} + Na_2CO_3 \rightarrow CaCO_3\downarrow 2Na^+$ | (L+S) |
| | Or more specifically: | $2HCI + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$<br>$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$<br>$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2NaCl$<br>$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3\downarrow + Na_2SO_4$ | L<br>L<br>S<br>S |
| **Note :** Aluminum and Iron salt may be present in water as contributor permanent hardness or they may be added as coagulants. | | | |
| 8. | $FeSO_4$ | $FeSO_4 + Ca(OH)_2 \rightarrow Fe(OH)_2 + CaSO_4$<br>$2\,Fe(OH)_2 + H_2O + O_2 \rightarrow 2Fe(OH)_3\downarrow$<br>$CaSO_4 + Na_2CO_3 \rightarrow CaCO_3\downarrow + 2Na^+$ | (L+S) |
| 9. | $Al_2(SO_4)_3$ | $Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3\downarrow + 3CaSO_4$<br>$3CaSO_4 + 3Na_2CO_3 \rightarrow 3CaCO_3 + 3Na_2SO_4$ | (L+S) |
| 10. | $NaAlO_2$ | $NaAlO_2 + 2H_2O \rightarrow Al(OH)_3$ + NaOH because equivalent | –1L |

# Formula for calculation of lime and soda requirement

Therefore, Lime requirement for softenening

$$= \frac{74}{100}\left[\text{T.H of } Ca^{2+} + 2 \times \text{T.H of } Mg^{2+} + \text{P.H of } (Mg^{2+} + Fe^{2+} + Al^{3+}) + CO_2 + H^+ + HCO_3^- - NaAlO_2/2\right] \times \text{Vol .of water (L)}$$

T.H = temporary hardness

P.H = Permanent Hardness

IIIly, Soda requirement for softenening

$$= \frac{106}{100}\left[\text{P.H of } (Ca^{2+} + Mg^{2+} + Fe^{2+} + Al^{3+}) + H^+ - HCO_3^-\right] \times \text{Vol .of water (L)}$$

# *ADVANTAGE*

- Very economical.
- Less amount of coagulants are required.
- To certain extent ,iron and manganese are also removed.

# *DISADVANTAGE*

- Very skilled supervision is required.
- Disposal of large amount of sludge is a big problem.
- This can remove hardness only upto 15 ppm.

JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE