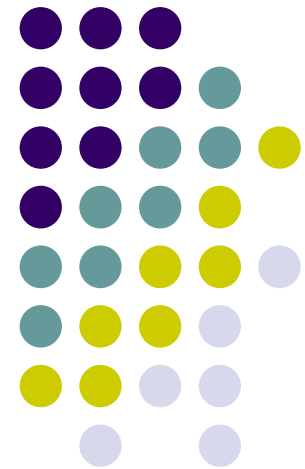


Chapter 8

Water treatment



Cooling tower



Sources of water



Sea water

Surface water (rivers, streams, lakes)

Rain water

ground water (springs, shallow wells)

Nature of impurities in water



Suspended matter (insoluble).

Colloidal material (insoluble).

Soluble salts.

Dissolved gases (CO_2 , O_2 , ...).

Removal of suspended and colloidal impurities



1. settling(sedimentation):

water is allowed to settle in large tanks, so any suspended material will settle down.

2. coagulation:

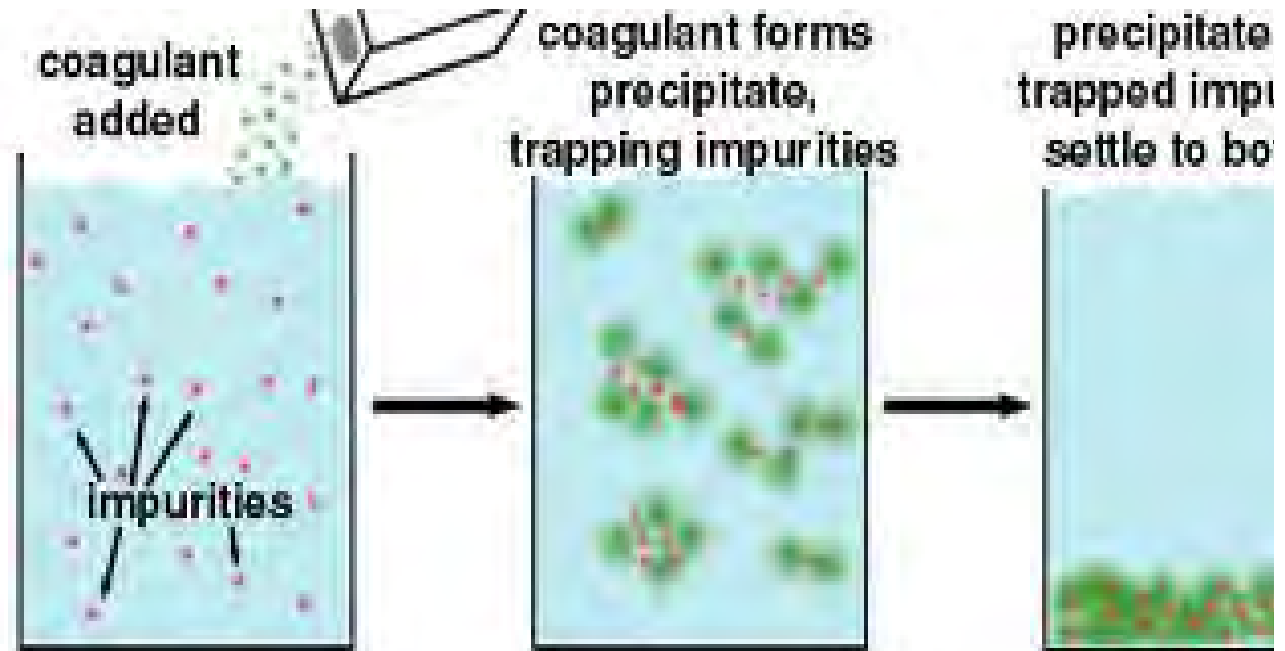
by addition of coagulant like salts of sulfate and aluminum(alum), and help to the settling of colloidal and oil drops.

Ex: $\text{Al}_2(\text{SO}_4)_3 \cdot 18\text{H}_2\text{O}$

Settlers



Coagulation Process





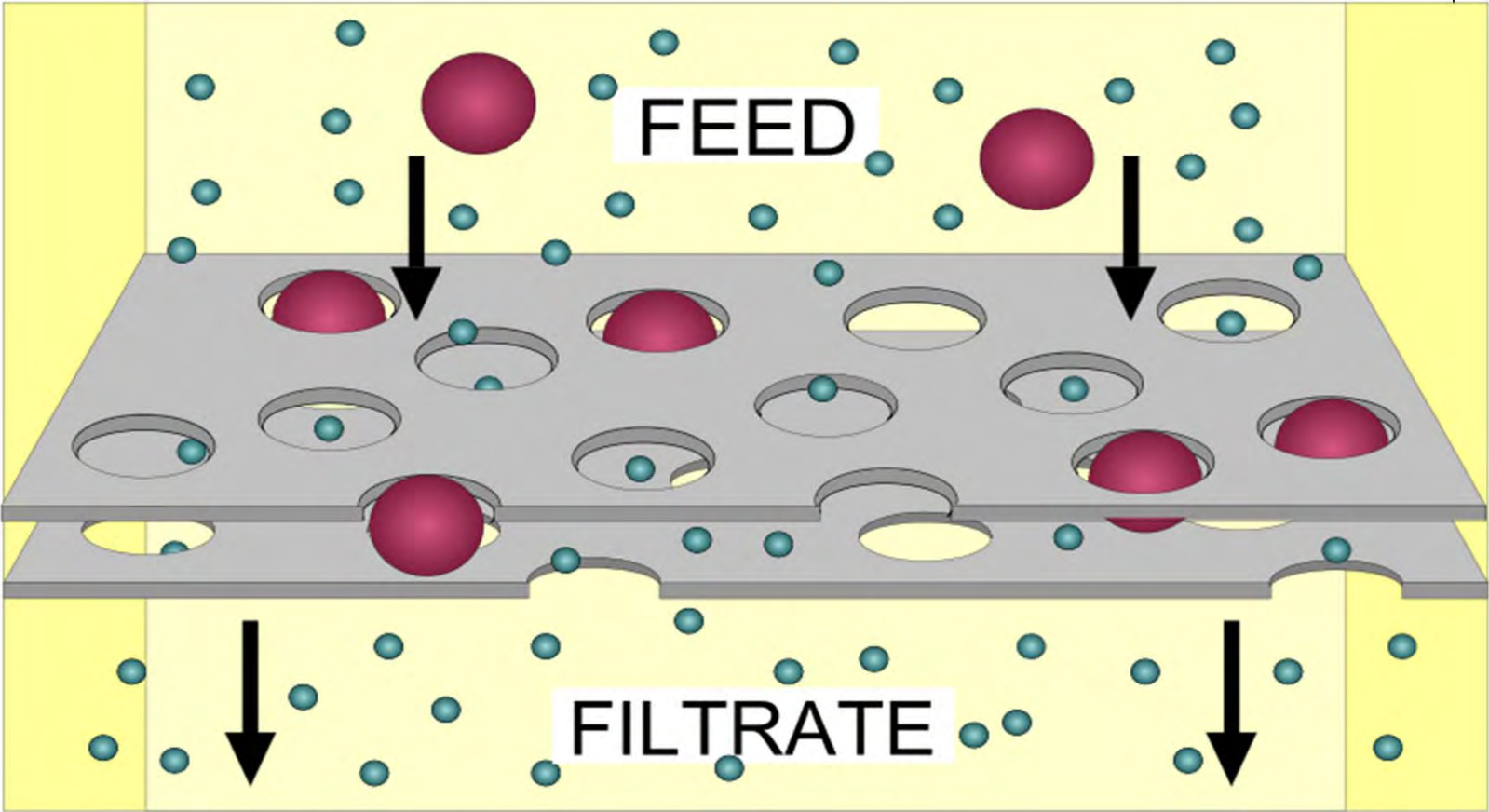
3. Settling (sedimentation):

To settle any coagulant particles with colloidal matter and oil drops.

4. Filtration :

it's carried out by passing water through rapid filter medium in order to removing any suspended and colloidal matter.

Filtration system



Removal of soluble impurities



Some industrial water should not contain any soluble impurities such as Ca, Mg, Fe salts(boiling feed water).

Removal of these soluble impurities called softening of hard water.

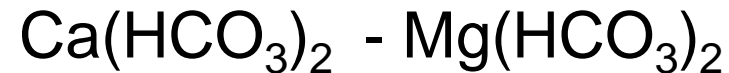


Water hardness

Ca and Mg salts dissolve in water .

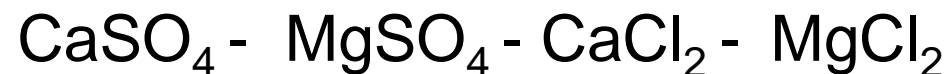
1. Temporary water hardness

due to presence of Ca and Mg salts as bicarbonates salts.



2. Permanent water hardness

due to presence of Ca and Mg salts as chlorides, sulfates or nitrates,

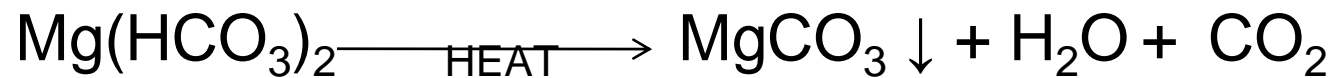
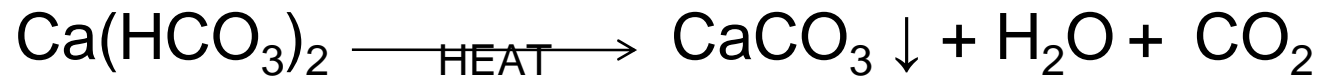


Removal of water hardness



1. Temporary water hardness

removed by boiling.



2. Permanent water hardness

removed by chemical treatment .

boilers



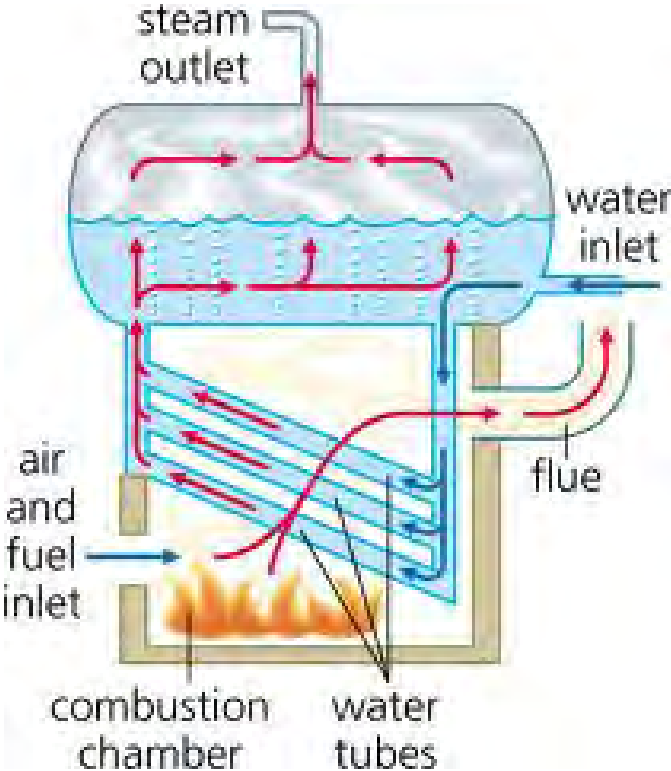
Low pressure boilers

maximum concentration of dissolved salts is
0.05ppm.

High pressure boilers

maximum concentration of dissolved salts is
0.005ppm.

Boiler



Defects of use untreated (hard)water in boilers



1. formation of scale and sludge.
2. Corrosion.

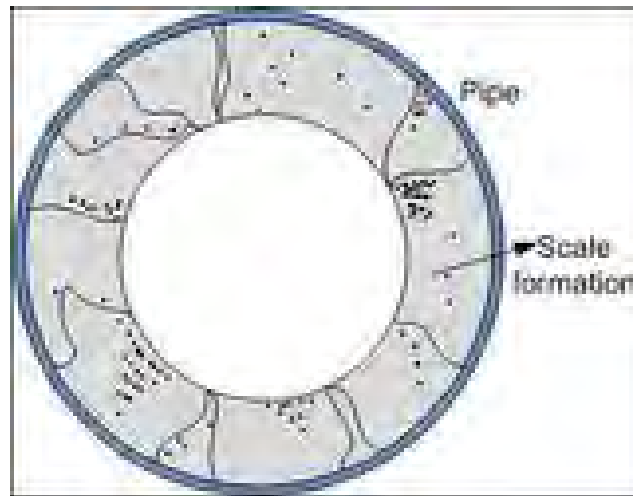
Scale:

it's insoluble salts in hot water which precipitated after boiling forming dry layer with strong adhesive on hot surfaces(heat sources).

sludge:

it's refers to the quantity of insoluble salts in hot water which precipitated after boiling forming wetted layer.

Scale formation in tubes



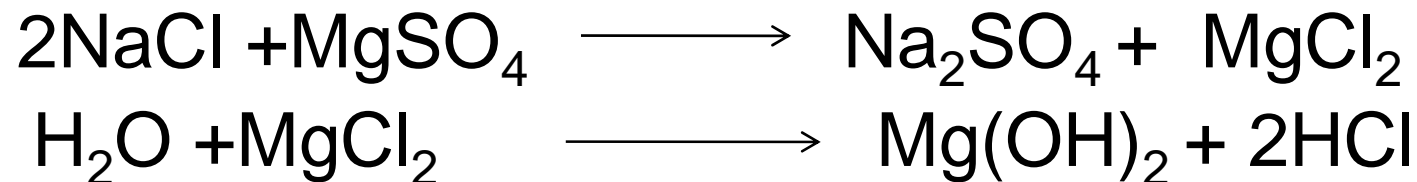
Sludge in pipes



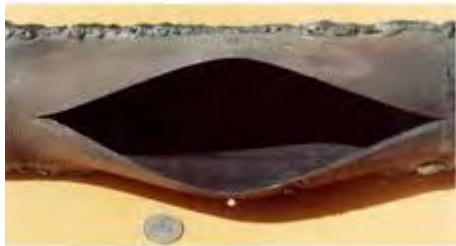
Disadvantages of scale formation in boiler



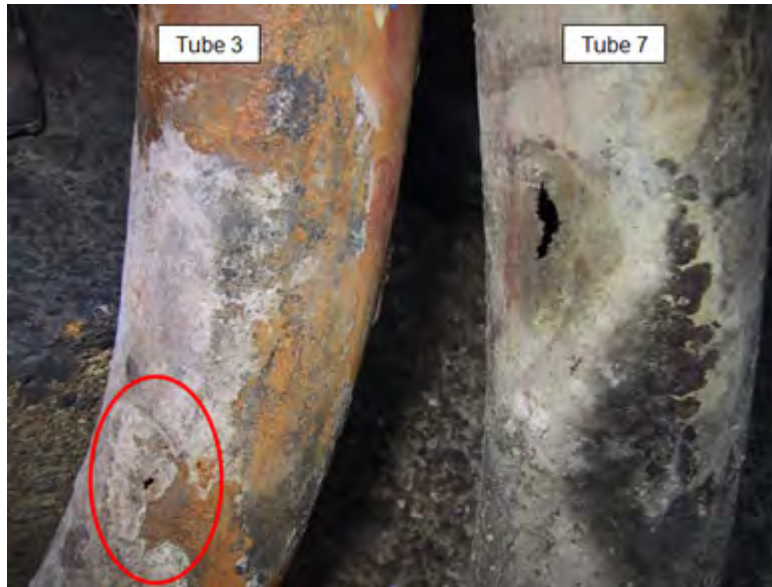
1. ***Decrease the heat transfer*** due to formation of scale which has low thermal conductivity.
2. ***Burning out or over heating.***
3. ***Decrease the efficiency of boiler***
4. ***Chemical corrosion***



Tubes overheating



Chemical Corrosion



Removal of soluble salts



1. Lime soda process
2. Ion exchange method
3. Zeolite softener
4. Reverse osmosis
5. Electrolytic technique

Ion exchange method



Resin : it's elastic material react only with salts dissolved in water and insoluble in water.

Cation exchange resin

Ions Exchange Resin

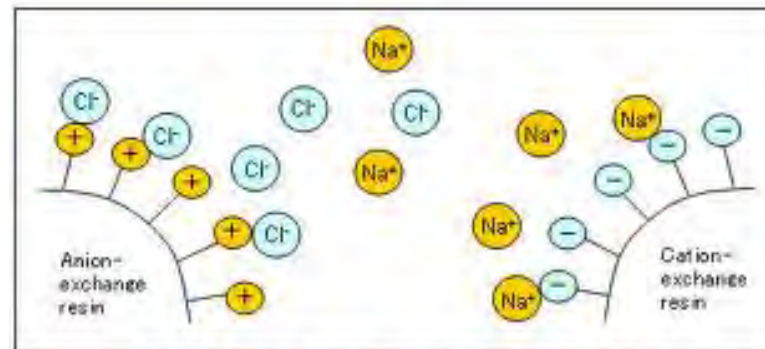
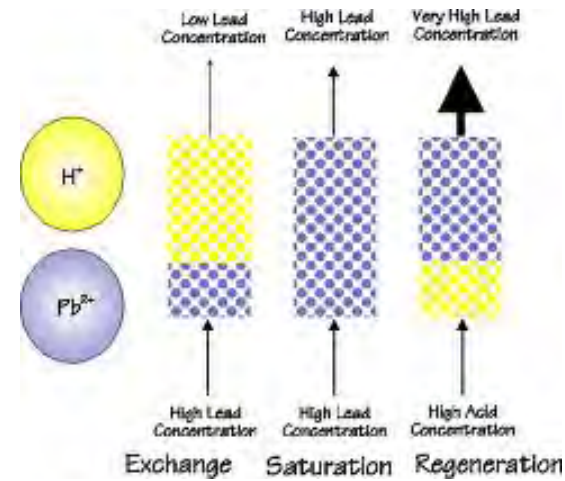
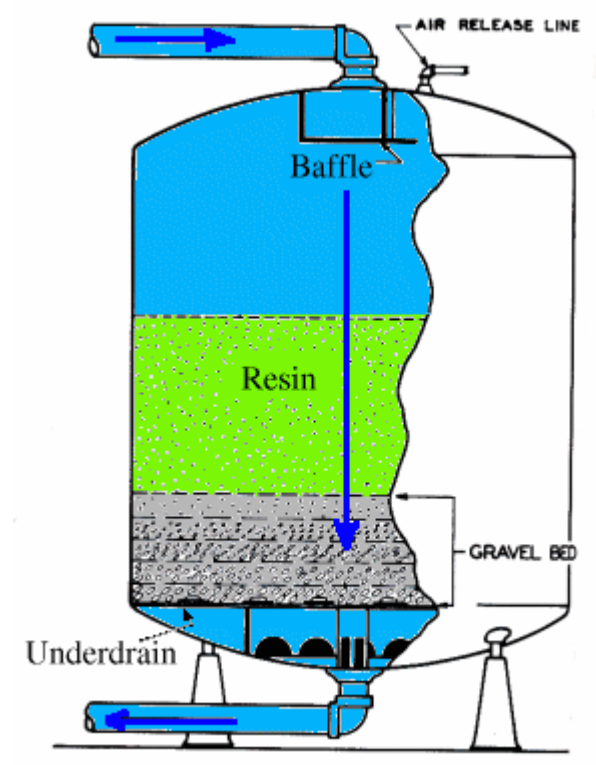


Figure 1. Pattern diagram illustrating ion exchange mode



Deaerator



Hydrazine safety labor

