



19CH101- ENGINEERING CHEMISTRY

Unit-1 WATER AND ITS TREATMENT

HARDNESS OF WATER

Hard waters are undesirable because they may lead to greater soap consumption, scaling of boilers, causing corrosion and incrustation of pipes, making food tasteless etc.,

Temporary Hardness:

If bicarbonates and carbonates of calcium and magnesium are present in water, the water is rendered hard temporarily as this hardness can be removed to some extent by simple boiling or to full extent by adding lime to water. Such hardness is known as temporary hardness or carbonate hardness.

Permanent Hardness:

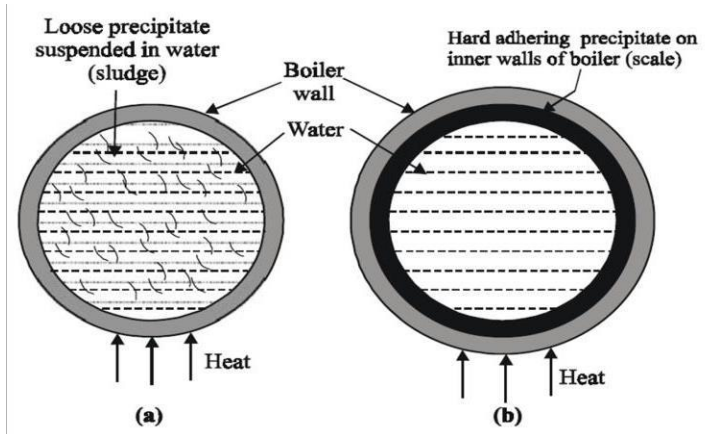
If sulphates and chlorides of calcium or magnesium are present in water, they cannot be removed at all by simple boiling and therefore, such water requires special treatment for softening. Such hardness is known as permanent hardness or non-carbonate hardness. It is caused by sulphates, chlorides of Ca and Mg.

- One French degree of hardness is equal to 10mg/l of CaCO_3 .
- One British degree of hardness is equal to a hardness of 14.25mg/l.
- Water with hardness up to 75 ppm are considered soft and above 200 ppm are considered hard and in between is considered as moderately hard.
- Underground waters are generally harder than surface waters.
- The prescribed hardness limit for public supplies range between 75 to 115 ppm.

BOILER TROUBLES

Formation of deposits (Scale and sludge) in boilers

- When water is continuously converted into steam in boilers or heat exchangers, the concentration of dissolved salts in water increases progressively.
- When the concentration of the salts reaches their saturation point, they are thrown out in the form of precipitates on the inner walls of the boilers or heat exchangers.
- The least soluble one gets precipitated first.



Sludge (Loose deposit)

If the precipitate is loose and slimy it is called sludge. Sludges are formed by substances like $MgCl_2$, $MgCO_3$, $MgSO_4$ and $CaCl_2$. They have greater solubility in hot water than cold water.

Removal of Sludge

Sludge formation can be removed by
Frequent blow down operation and Using
soft water

Disadvantages of sludge formation

- Wastage of fuel
- Decrease in efficiency and
- Danger of explosion of boiler.

Scale (Hard deposit)

On the other hand, if the precipitate forms hard and adherent coating on the inner walls of the boiler, it is called scale. Scales are formed by substances like calcium carbonate ($CaCO_3$), Calcium Sulphate ($CaSO_4$), Calcium Silicate ($CaSiO_3$) and Magnesium hydroxide ($Mg(OH)_2$).



Removal of Scales

1. At the initial stage, scales can be removed using scraper, wire brush etc.
2. If scales are brittle, they can be removed by thermal shocks.
3. By using suitable chemicals like dil. acids (for CaCO_3 scale), EDTA (for CaSO_4 scale) with which they form suitable complexes.
3. If the scales are loosely adhering, they can be removed by frequent blow down operation.

Disadvantages of scale formation

1. Wastage of fuel
2. Decrease in efficiency
3. Danger of explosion of boiler.

Priming and foaming

Priming

During the production of steam in the boiler, due to rapid boiling some droplets of liquid water are carried along with steam. Steam containing droplets of water is called wet steam. These droplets of liquid water carry with them some dissolved salts and suspended impurities. This phenomenon is called carry over. It occurs due to priming and foaming. The process of wet steam formation is called Priming.

Reasons for priming

Priming is due to

- Some dissolved salts
- High steam velocity and very high water level in the boiler
- Improper design of boiler and
- Controlling the velocity of steam
- Maintaining medium water level
- Removing oily materials present in water
- Good boiler design and



Foaming

The formation of stable bubbles above the surface of water is called foaming.

Reasons for Foaming

Foaming is due to

- The presence of oil, grease and
- The presence of finely divided particles.
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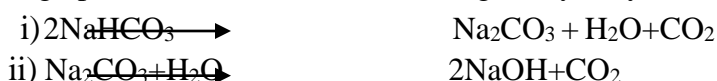
Removal of Foaming

Foaming can be removed by

- Adding certain anti-foaming chemicals like cotton seed oil, castor oil and synthetic polyamides etc.,
- Adding coagulants like Sodium aluminates and aluminium hydroxide etc.,

Caustic Embrittlement

Caustic Embrittlement means inter crystalline cracking of boiler metal. It is a type of boiler corrosion, caused by using highly alkaline water in the boiler. Boiler water usually contains small amounts of NaHCO_3 and Na_2CO_3 . In high pressure boilers, Na_2CO_3 undergoes hydrolysis to produce NaOH .



The NaOH thus formed flows into the minute hair cracks that are usually present in inner side of the boiler by capillary action. As water evaporates, its concentration increases and dissolve the iron of boiler forming Sodium ferroate.



This type of electrochemical corrosion occurs when concentration of NaOH is above 100 ppm. This causes embrittlement of boiler parts particularly stressed parts like bends, joints, rivets etc., causing even failure of the boiler.



Removal of Caustic embrittlement

Caustic embrittlement can be avoided by

- Neutralizing the alkali with a very small quantity of acid.
- Adding tri sodium phosphate as softening agent for water.
- Adding tannin or lignin which also blocks hair cracks.