Water treatment & Analysis
Lec 02

Effect of hard water on Boilers

Water in industries is used for steam generation in boilers.Water used for steam generation must be soft water ,use of hard water in steam generation causes following troubles

A. Boiler corrosion
B. Caustic embrittlement
C. Priming & Foaming
D. Scale & Sludge formation

Boiler corrosion

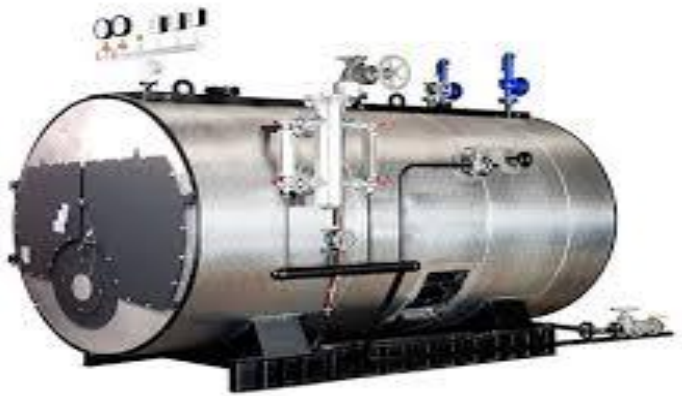
The use of unsuitable waters in boilers causes corrosion of boiler metals which further leads to (I)increases the cost of repairs and maintenance (II)Reduces life of boiler plates (III) causes leakages

Corrosion in boiler occurs due to

Dissolved gases.

Dissolved salts.

Acidity or Alkalinity of water.



Dissolved gases (O2,CO2)

Dissolved oxygen in high temp attack boiler material

$Fe+2H_2O+O_2$----------$2Fe(OH)_2 + O_2$-------$Fe_2O_3.2H_2O$ (rust)

Dissolved oxygen can be removed by adding sodium sulphite,hydrazine or sodium sulphide or Mechanical deaeration.

Dissolved CO_2 in water forms carbonic acid which has slow corrosive effect.it can be removed by adding ammonia

NH_4OH+CO_2-------- $(NH_4)_2CO_3$ OR by mechanical deaeration process

Dissolved salts,Acidity or Alkalinity

Water containing dissolved Mg salts like MgCl2 liberate acids on hydrolysis.This acid liberated will slowly corrode the boiler metal.

$MgCl_2 + H_2O$------ $Mg(OH)_2 + HCl$.

If water used in boiler has pH<7 causes corrosion in large extend ,if pH is 7 to 9.5 it may restrict corrosion to some extent.if pH is 11 to 14 corrosion will be greater extend.

Caustic embrittlement or Caustic corrosion

Caustic E is caused by highly alkaline water.During softening process Na_2CO_3 is added in water ,this Na_2CO_3 decomposes to give NaOH and CO_2

$Na_2CO_3 + H_2O$-------- NaOH +CO_2.

This NaOH makes water alkaline ,during steam generation water vaporises leaving behind caustic into minute cracks,parts like bends,joints and rivets causing failure of boilers.

It can avoided by using sodium phosphate ,or adding tannin ,sodium sulphate which blocks cracks and by adjusting alkalinity.

Priming & Foaming

When boiler is steaming some particles of water are carried away with steam ,this process is called as Priming

Caused by

Dissolved salts,High steam velocities,improper boiler designs,sudden boiling ,increase in steam rate.

Foaming is persistent foam or bubbles in boilers due to presence of oils in water.

Can be removed by adding anti foaming agent or removing oils.

Scale formation

The hard ,adherent coating formed on the inner surface of the boiler due to precipitation of dissolved salts is called as scales.

Scales are hard and adherent ,difficult to remove even with hammer and they are bad conductor of heat hence creating more trouble

Sludge formation

The soft,slimy deposits formed inside the boiler and which do not stick up permanently are known as sludge.they are formed by substances which have greater solubilities in hot water like $CaCl_2$,$MgCl_2$ etc.

Sludges are poor conductors of heat hence waste a portion of heat

Can be removed easily by brushing

Disadvantages of scale and sludge

1. Wastage of fuels
2. Lowering of boiler safety
3. Decrease in efficiency
4. Danger of explosion

Removal of scales and sludges

1. Scraper or wire brush
2. Thermal shocks ie heating boilers and then sudden cooling
3. Dissolving scales in suitable chemicals
4. Frequent blow down