BOILER TROUBLES (OR) BOILER FEED WATER

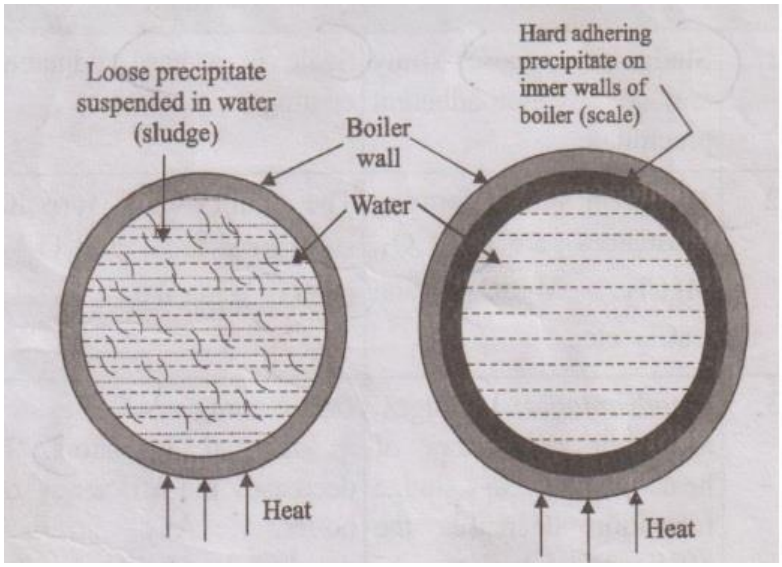
The water fed into the boiler for the production of steam is called boiler feed water. Boiler feed water should be free from turbidity, oil, dissolved gases, alkali and hardness causing substances. If hard water obtained from natural sources is fed directly into the boilers, the following troubles may arise.

Boiler troubles (or) disadvantages of using hardwater in boilers

1. Formation of Scales and sludges in boilers.
2. Priming and foaming (carry over).
3. Caustic embrittlement.
4. Boiler corrosion.

1. Formation of Scales and Sludges in boilers

When water is continuously converted into steam in boilers, 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. The least soluble one gets precipitated first.



Comparison of Scales and Sludges

Sludge

1. Sludge is a loose slimy and non-adherent precipitate.

2. The main sludge forming substance are $MgCO_3$, $MgCl_2$, $MgCO_3$, and $CaCl_2$ etc,.

3. Disadvantages

Sludges are poor conductors of heat. Excess of sludge formation decreases the efficiency of boiler.

4. Prevention

(i) Sludge formation can be prevented by using softened water.

(ii) Sludges can also be removed by "blow-down operation".

Scale

1. Scale is a hard, adherent coating.

2. The main scale forming substances are $Ca(HCO_3)_2$, $CaSO_4$, $Mg(OH)_2$.

3. Disadvantages

Scale act as thermal insulators. It decreases the efficiency of boliler. Any crack developed on the scale, leads to explosion.

4. Prevention

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.

4. If the scales are loosely adhering, they can be removed by frequent blow down operation.

2. Priming and Foaming

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 liquid 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 printing and foaming.

1. Priming

Priming is the process of production of wet steam. Priming is caused by

(i) High steam velocity.

(ii) Very high water level in the boiler.

(iii) Sudden boiling of water.

(iv) Very poor boiler design.

Prevention

Priming can be controlled by

(i) Controlling the velocity of steam.

(ii) Keeping the water level lower.

(iii) Good boiler design.

(iv) Using treated water.

2. Foaming

The formation of_stable bubbles above the surface of water is called foaming. These bubbles are carried over by steam leading to excessive priming.

Foaming is caused by the

(i) Presence of oil, and grease,

(ii) Presence of finely divided particles.

Prevention

Foaming can be prevented by

(i) adding coagulants like sodium aluminate, aluminium hydroxide,

(ii) adding anti-foaming agents like synthetic polyamides.

3. Caustic Embrittlement

Caustic embrittlement means inter crystalline cracking of boiler metal.

Boiler water usually contains a small proportion of Na_2CO_3. In high pressure boilers this Na_2CO_3 undergoes decomposition to give NaOH.

$Na_2CO_3 + H_2O \rightarrow 2NaOH + CO_2$

This NaOH flows into the minute hair cracks and crevices, usually present on the boiler material, by capillary action and dissolves the surrounding area of iron as sodium ferroate.

$Fe + 2NaOH \rightarrow Na_2FeO_2 + H_2 \uparrow$

This causes brittlement of boiler parts, particularly stressed parts like bends, joints, rivets, etc., causing even failure of the boiler.

Prevention

Caustic embrittlement can be prevented by

(i) using sodium phosphate as softening agent instead of sodium carbonate.

(ii) by adding tannin, lignin to the boiler water, which blocks the hair cracks.

4. Boiler corrosion

Corrosion in boilers is due to the presence of

1. dissolved oxygen.
2. dissolved carbon dioxide.
3. dissolved salts.

1. Dissolved oxygen

Dissolved oxygen in water is mainly responsible for the corrosion of boiler. The dissolved oxygen in water attacks the boiler material at higher temperature.

$4Fe + 6H_2O + 3O_2 \rightarrow 4Fe(OH)_3 \downarrow$

Removal of dissolved oxygen

Dissolved oxygen can be removed by chemical (or) mechanical methods.

(a) Chemical method

Sodium sulphite, hydrazine are some of the chemicals used for removing dissolved oxygen.

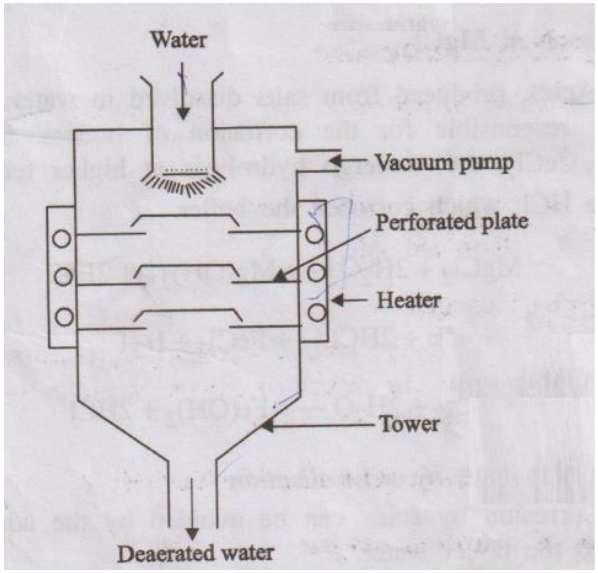
$2Na_2SO_3 + O_2 \rightarrow 2Na_2SO_4$

$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$

Hydrazine is found to be an ideal compound for removing dissolved oxygen in the water, since the products are water and inert N_2 gas.

(b) Mechanical de-aeration

Dissolved oxygen can also be removed from water by mechanical deaeration



In this process, water is allowed to fall slowly on the perforated plates fitted inside the tower. The sides of the tower are heated, and a vacuum pump is also attached to it. The high temperature and low pressure produced inside the tower reduce the dissolved oxygen content of the water.

2. Dissolved carbon dioxide

Dissolved carbon dioxide in water produces carbonic acid, which is acidic and corrosive in nature

$CO_2 + H_2O \rightarrow H_2CO_3$

Carbon dioxide gas is also produced from the decomposition of bicarbonate salts present in water.

Removal of dissolved Carbon dioxide

(a) Carbon dioxide can be removed from water by adding a calculated amount of NH4OH into water.

2NH4OH+CO2 → (NH4)2CO3 + H2O

(b) Carbon dioxide along with oxygen can also be removed mechanically by de-aeration method.

3. Dissolved MgCl2

Acids, produced from salts dissolved in water, are also mainly responsible for the corrosion of boilers. Salts like MgCl2, CaCl2, etc, undergo hydrolysis at higher temperature to give HCl, which corrodes the boiler.

$MgCl_2 + 2H_2O \rightarrow Mg(OH)_2 \downarrow + 2HCI$

$Fe + 2HCl \rightarrow FeCl_2 + H2\downarrow$

$FeCl_2 + 2H_2 O \rightarrow Fe(OH)_2 + 2HCI$

Removal of acids by neutralization

Corrosion by acids can be avoided by the addition of alkali to the boiler water.

$HCl + NaOH \rightarrow NaCl + H_2O$