JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Department of Applied Science

SUB: Engineering Chemistry

Boiler Troubles

If hard water is directly fed into boiler there are many problems such as:

- Priming
- Foaming
- Caustic Embrittlement
- Boiler corrosion

Priming

The process of formation of wet steam is called priming.

Because of priming efficiency and life of machine parts decrease.

It is caused by

- Improper construction of boiler
- Very high level of water
- High velocity of steam

Foaming

- Formation of stable bubbles above the surface of water is called foaming.
- These bubbles are carried over by steam.
- It is caused by presence of soluble impurities like alkali metal salts and oil.
- Foaming can be controlled by action of antifoaming agent like synthetic polyamides.

Caustic Embrittlement

- Caustic embrittlement is a phenomenon in which boiler material become brittle due to the accumulation of caustic substance.

- Boiler water usually contains a small proportion of Na_2CO_3. in high pressure boilers this undergoes decomposition to give NaOH. This NaOH flows in to the minute cracks, usually present on boiler material,by capillary action and dissolves the surrounding area of iron as sodium ferrite.
- This causes brittlement of boiler parts,particularly stressed parts like bends,joints,rivets etc.,causing even failure of the boiler.

During the process following reaction will take place:

$$Na_2CO_3 + H_2O \rightarrow CO_2 + 2NaOH$$

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

Caustic embrittlement can be prevented by:

- Using sodium phosphate as softening agent instead of sodium carbonate.
- By adding tannin,lignin,to the boiler water, which blocks the cracks.

Boiler corrosion

Boiler corrosion is decay of boiler material by chemical and electro chemical attack of its environment.It is due to the presence of:

Dissolved oxygen

Dissolved carbon dioxide

Dissolved salts like magnesium chloride

Dissolved oxygen

When water containing dissolved oxygen is fed into boilers the following reaction occours and corrode the boiler material (rust formation).

$$2Fe + 2H_2 + O_2 \rightarrow 2Fe(OH)_2$$

$$Fe(OH)_2 + O_2 \rightarrow 2[Fe_2O_3.2H_2O]$$

Oxygen can be reduced:

- By adding hydrazine/ sodium sulphite

$$N_2H_4 + O_2 \rightarrow N_2 + 2H_2O$$

$$2Na_2SO_3 + O_2 \rightarrow 2Na_2SO_4$$

- By mechanical deaeration method.

Dissolved carbon dioxide

When water containing bicarbonates is heated,carbon dioxide is evolved which makes the water acidic.It leads to corrosion and following reaction will take place.

$$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$$

$$CO_2 + H_2O \rightarrow H_2CO_3$$

Dissolved CO2 can be removed by:

- Treatment with ammonium hydroxide:

$$2NH_4OH + CO_2 \rightarrow (NH4)_2CO_3 + H_2O$$

- Mechanical deaeration method

Dissolved MgCl2

Acid produced from salts that are dissolved in water are mainly responsible for the corrosion of boilers.Salts like magnesium and calcium chloride undergo hydrolysis at high temperature to give HCl, which corrodes the boiler as follows

$$MgCl_2 + 2H_2O \rightarrow Mg(OH)_2 + 2\,HCl$$

$$Fe + 2\,HCl \rightarrow FeCl_2 + H_2$$

$$FeCl_2 + 2H_2O \rightarrow Fe(OH)_2 + 2HCl$$

$MgCl_2$ can be removed by:

- Internal conditioning
- External conditioning