SNS COLLEGE OF TECHNOLOGY

Vazhiamyampalayam,Coimbatore-35

(An Autonomous institution)

Accredited by **NBA-AICTE** and Re-Accredited by **NAAC-UGC with A+ Grade**

Approved by **AICTE,** New Delhi & Affiliated to **Anna University**, Chennai

DEPARTMENT OF CHEMISTRY

COURSE NAME : 23CHT102- CHEMISTRY OF ENGINEERING MATERIALS

I YEAR / II SEMESTER

UNIT IV:WATER TECHNOLOGY

TOPIC : 2.BOILER TROUBLES

BRAINSTORMING WITH RECAP

BOILER FEED WATER

DEFINITION

The setup used to produce steam in industries is known as ‘Boiler’. Water is fed to the boiler and heated to produce steam. The water fed into the boiler is known as “Boiler feed water”.

Requirements for boiler water	If not, it will cause
Free from hardness causing salts	Sludge and scale
Free from oil and greases	Foaming
Free from dissolved salts, suspended impurities	Caustic embrittlement
Free from dissolved gases, suspended salts	Boiler corrosion

Sludge and scale

If the water contains hardness causing salts like $MgSO_4$, $MgCl_2$,$CaSO_4$, $Ca(HCO_3)_2$
On evaporation, the salts are precipitated to produce *scale and sludge*.

Sludge

- Loose, slim , non-adherent precipitate
- Due to salts like $MgSO_4$, $MgCl_2$
- Due to poor conductance, they decrease the boiler efficiency to lesser extent and causing chocking in the pipelines
- It can be prevented by periodical replacement of concentrated hard water by fresh water. This process is known as “blow down” method.

Scale

- Hard, thick , adherent precipitate
- Due to salts like $CaSO_4$, $Ca(HCO_3)_2$
- Due to poor conductance, they decrease the boiler efficiency to maximum extent, cause reduced fuel economy , improper boiling, boiler explosion etc.,

It can be prevented by special methods like

- i) external treatment of ion exchange ,
- ii) Internal carbonate, phosphate, Calgon conditioning
- iii)Mechanical hard scrubbing methods.

Priming and Foaming

Due to rapid boiling, the steam may carry some water droplets along with it. This is called *wet steam* .The process of wet steam production is called ***Priming***. It can reduce the heat of the steam and cause corrosion in the pipelines.

Priming is due to

a) Improper design of boiler
b) High water level
c) High velocity of steam
d) Uneven boiling

Priming can be controlled by

i) Proper boiler design
ii) Maintaining proper water level
iii) Proper boiling

If oils and greases are present, they produce bubbles on the water surface. This will increase the wet steam production. This is known as "***Foaming***".

Foaming is prevented by adding

i) Anti foaming agents (e.g.) synthetic poly amides , castor oil
ii) Coagulants (e.g.) Aluminum hydroxide

Foaming and priming are collectively known as ' ***Carry over***".

Caustic Embrittlement

It is the intercrystalline cracking of boiler due to NaOH. NaOH content is increased due to the dissolved salts like Na_2CO_3 which is added during internal treatment.

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

This NaOH occupies the hair line cracks of boiler metal and converts the insoluble Fe into soluble Sodium Ferroate. Thus it makes the cracks bigger in bents, joints and crevices.

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

(Insoluble) (Soluble)

Prevention of caustic embrittlement

1. As softening agent, we can use sodium phosphate instead of sodium carbonate.
2. The hair line cracks can be sealed by waxy materials like Tannin and Lignin

Boiler Corrosion

It may be due to three major reasons:

i) Dissolved Oxygen ii) Dissolved CO_2 iii) Dissolved salts like $MgCl_2$

<u>i)Corrosion Due to dissolved oxygen</u>:

Dissolved oxygen in presence of water, causes corrosion.

$$4Fe + 6\ H_2O + 3O_2 \rightarrow 4\ Fe\ (OH)_3\ \text{(Rust)}$$

Prevention from oxygen

a) Chemical method -

Adding Sodium Sulphite: $2\ Na_2SO_3 + O_2 \rightarrow 2\ Na_2SO_4$

This method results in other precipitates which can have some side effects. So this method is less preferred.

Adding Hydrazine: $N_2H_4 + O_2 \rightarrow N_2 + 2\ H_2O$

This method results in inert gas and pure water, it is preferred.

Mechanical deaeration method:

This is based on the principle that at high temperature and low pressure and high exposed area, the solubility of gases in water is decreased. So, the water is fed into the mechanical deaerator which is provided with vaccum pump, heaters and perforated plates. The out coming water will be free from dissolved gases.

ii)Corrosion due to Carbon – di – oxide:

Salts like Calcium bicarbonate on heating produces CO_2 . CO_2 dissolves in water to form carbonic acid which corrodes the boiler metal.

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

$$H_2O + CO_2 \rightarrow H_2CO_3$$

Prevention from CO_2

1. Chemical method: By adding calculated amount of ammonium hydroxide

$$2NH_4OH + CO_2 \rightarrow (NH_4)_2CO_3 + H_2O$$

2. Mechanical deaeration method (similar to oxygen method)

iii)Corrosion due to Dissolved salts like $MgCl_2$

Dissolved salts like $MgCl_2$ cause acid formation. This will be prevented by alkali neutralisation.

$$MgCl_2 + 2\,H_2O \rightarrow Mg(OH)_2 + 2\,HCl \quad \text{(Corrosive acid)}$$

Neutralisation: $HCl + NaOH \rightarrow NaCl + H_2O$

SUMMARY

REFERENCES

1. O.G. Palanna, “Engineering Chemistry ”Tata McGraw-Hill Pub. Co. Ltd, New Delhi.2017.
2. Wiley, “Engineering Chemistry”, John Wiley & Sons. InC, USA.
3. P.C.Jain & Monicka Jain, “Engineering Chemistry” , Dhanapat Rai Publising Company Pvt. Ltd. 2017.
4. R. Sivakumar and N Sivakumar, “Engineering Chemistry” Tata McGraw-Hill.Pub.Co.Ltd. New Delhi.2009.

THANK YOU