

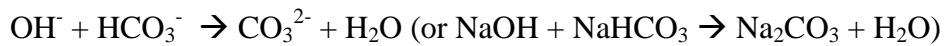
Alkalinity- A water quality parameter

It is a measure of the ability of water to neutralize the acids.

Any substances which can increase the hydroxide ion concentration $[\text{OH}^-]$ contribute towards alkalinity of water. Alkalinity is due to presence of ions like CO_3^{2-} , OH^- , HCO_3^- in the water.

N.B.: The possibility of OH^- and HCO_3^- together in water is ruled out. (Why?)

*** Because they combine to form CO_3^{2-} in water as per the following reaction:



Drawbacks of highly alkaline water

Some of the drawbacks are: 1. it causes alkaline corrosion in boiler known as caustic embrittlement.

2. It may leads to deposition of precipitates in boiler tubes and pipes.

3. Not fit for human consumption for a longer period of time.

Q. Which of the following combination is ruled out and why?

A. OH^- and CO_3^{2-}

B. CO_3^{2-} and HCO_3^-

C. OH^- and HCO_3^-

Ans. **C.** Because they combine to form CO_3^{2-} in water as per the following reaction:



Dissolved Oxygen (DO): A Water quality parameter

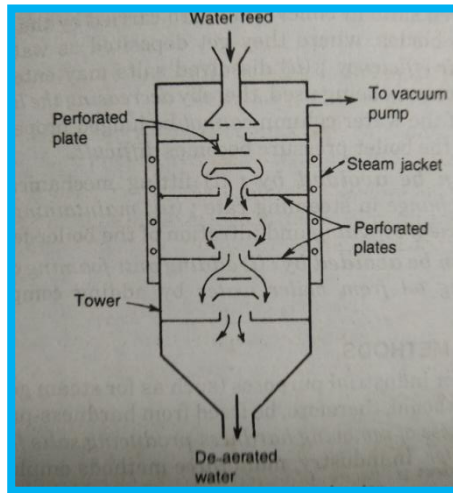
It is the most usual corrosion causing factor in boilers. DO react with the iron (Fe) of boiler in presence of water to form rust (Ferric oxide). Water usually contains 8 mg/L at RT. DO is a temperature dependent parameter.

Chemical reaction:



$\text{Fe}(\text{OH})_2$ oxidizes in presence of oxygen to form Ferric oxide ($\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$).

Removal of DO: (1) By heating (Thermal deoxygenation): In this process water is heated in a container (**known as degasifier**) to remove DO.



(2) Chemical Deoxygenation: By addition of dilute solution of Hydrazine ($\text{NH}_2\text{-NH}_2$ or N_2H_4), Sodium sulphite Na_2SO_3 and sodium sulphide Na_2S

1. $\text{O}_2 + \text{N}_2\text{H}_4 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$
2. $\text{O}_2 + 2\text{Na}_2\text{SO}_3 \rightarrow 2\text{Na}_2\text{SO}_4$
3. $2\text{O}_2 + \text{Na}_2\text{S} \rightarrow \text{Na}_2\text{SO}_4$

Q. How to remove DO by adding hydrazine to water?

Ans. $\text{O}_2 + \text{N}_2\text{H}_4 \rightarrow \text{N}_2 + 2\text{H}_2\text{O}$

Specifications for Boiler feed water

Lot of water is used in boilers of steel industries for generation of steam. But, water with specific characteristics is fit for feeding into it.

A boiler feed water should have the following characteristics:

- a. Total hardness should be either 0 or less than 2 ppm.
- b. Alkalinity should be less than 1 ppm.
- c. Should be free from acidic masses
- d. Should be free from dissolved gases like oxygen and carbon dioxide

Common problems found in a boiler

The common problems which were arising in boiler due to feeding of hard/alkaline/acidic water are as follows:

A. Formation of soft and hard precipitates known as **sludges** (MgCO_3 , MgSO_4) and **scales** (MgSiO_3 , CaSiO_3 , CaCO_3), respectively

B. Boiler Corrosion

Q. What should be the characteristics of boiler feed water?

Ans. *A boiler feed water should have the following characteristics:*

- a. Total hardness should be either 0 or less than 2 ppm
- b. Alkalinity should be less than 1 ppm

- c. Should be free from acidic masses
- d. Should be free from dissolved gases like oxygen and carbon dioxide

Boiler Corrosion

It is the decay or loss of boiler body material (usually made of iron) either due to chemical or electrochemical reactions with its environment.

Causes of boiler corrosion:

1. Presence of dissolved O_2 in water: $Fe + O_2 + H_2O \rightarrow Fe_2O_3 \cdot xH_2O$ (Rust)
2. Presence of dissolved CO_2 in water: $Fe + 2H^+$ (from H_2CO_3) $\rightarrow Fe^{2+} + H_2$
3. Presence of alkaline masses in water (e.g. NaOH): $Fe + 2NaOH \rightarrow H_2 + Na_2FeO_2$ (sodium Ferrite)
4. Presence of acidic masses in water (e.g. HCl): $Fe + 2HCl \rightarrow FeCl_2 + H_2$
5. Presence hardness causing substance like $MgCl_2$ in water ($MgCl_2 + H_2O \rightarrow Mg(OH)_2$ (ppt.) + 2 HCl)

Disadvantages:

1. Reduces the life of boiler
2. Causes leakages at joints
3. Increases the cost of repair & maintenance

Q. What is boiler corrosion? Mention some of its limitations.

Ans. Boiler corrosion is the decay or loss of boiler body material (usually made of iron) either due to chemical or electrochemical reactions with its environment.

Limitations:

1. Reduces the life of boiler
2. Causes leakages at joints
3. Increases the cost of repair & maintenance

Q. Mention some causes of boiler corrosion.

Ans. Various causes of boiler corrosion are:

1. Presence of dissolved O_2 in water
2. Presence of dissolved CO_2 in water
3. Presence of alkaline masses in water (e.g. NaOH)
4. Presence of acidic masses in water (e.g. HCl)
5. Presence hardness causing substance like $MgCl_2$ in water ($MgCl_2 + H_2O \rightarrow Mg(OH)_2$ (ppt.) + 2 HCl)