

EFFECT OF IMPURITIES IN WATER

INTRODUCTION:-

The natural water contains solid, liquid gaseous impurities and therefore, this water cannot be used for the generation of steam in the boilers. The impurities present in the water should be removed before it is use in steam generation. The necessity for reducing the corrosive nature & quantity of dissolved and suspended solids in feed water has become increasingly important with the advent of high pressure, critical & supercritical boilers.

IMPURITIES IN WATER:

The impurities present in the feed water are classified as given below-

- Undissolved and suspended solid materials.
- Dissolved salts and minerals.
- Dissolved gases.
- Other materials (as Oil, Acid) either in mixed or unmixed forms.

1. UNDISSOLVED AND SUSPENDED SOLID MATERIALS-

a) Turbidity and Sediment

Turbidity in the water is suspended insoluble matter including coarse particles (mud, sediment, sand etc.) that settle rapidly on standing. Amounts range from almost zero in most ground waters and 60,000 ppm in muddy and turbulent river water. The turbidity of feed water should not exceed 5 ppm. These materials can be removed by settling, coagulation and filtration. Their presence is undesirable because heating or evaporation produces hard stony scale deposits on the heating surface & clog fluid system. Both are objectionable as they cause damage to the boiler system. A standard amount of measurement of hardness is taken as being the amount of calcium carbonate (CaCO_3) in the water and is referred to in part per million (ppm) or grains per gallon ($\text{grains/gallon} * 17.1 = \text{ppm}$).

b) Sodium and potassium Salts

These are extremely soluble in water and do not deposit unless highly concentrated. Their presence is troublesome as they are alkaline in nature and accelerate the corrosion.

c) Chlorides

Majority of the chlorides cause increased corrosive action of water.

d) Iron

Most common soluble iron in water is ferrous bicarbonate. The water containing ferrous bicarbonate deposits becomes yellowish and reddish sediment of ferric hydroxide if exposed to air. Majority of ground surface water contains less than 5 ppm but even 0.3 ppm can create trouble in the feed water system by soft scale formation and accelerating the corrosion.

e) Manganese

It also occurs in similar form as iron & it is also equally troublesome.

f) Silica

Most natural water contains silica ranging from 1 to 100 ppm. Its presence is highly objectionable as it forms very hard scale in Boilers and forms insoluble deposits on turbine blades. In modern high pressure boilers its presence is reduced as low as 10-50 ppb.

g) Microbiological Growths

Various growths occur in surface water (lake & river). The micro-organisms include diatoms, molds, bacterial slimes, algae, manganese & sulfate reducing bacteria and many others. These can cause coating on heat exchanger and clog the flow passages and reduce the heat transfer rates.

h) Colour

Surface waters from swampy areas become highly coloured due to decaying vegetation. Colour of feed water is objectionable as it causes foaming in boilers and may interfere with treatment processes. It is generally removed by chlorination or adsorption by activated carbon.

2. Dissolved Salts and Minerals

a) Calcium and Magnesium Salts

The Calcium and Magnesium salts present in the water in the form of carbonates, bicarbonates, and sulfates and chlorides. The presence of these salts is recognized by the hardness of the water (hardness of water is tested by soap test). The hardness of water is classified as temporary and permanent hardness. The temporary hardness is caused by the bicarbonates of calcium and magnesium and can be removed by boiling. The boiling converts the soluble bicarbonates into less soluble carbonates which can be removed by simple blow down method. The permanent hardness of the water is caused by the presence of chlorides, sulfates and nitrates of calcium and magnesium and they can not be removed just by boiling because they form a hard scale on heating surfaces.

3. Dissolved Gases

(a) Oxygen

It presents in surface water in dissolved form with variable percentage depending upon the water temperature and other solid contents in water. Its presence is highly objectionable as it is corrosive to iron, zinc, brass and other metals. It causes corrosion and pitting of water lines, boiler exchangers. Its effect is further accelerated at high temperatures.

(b) Carbon Dioxide

The river water contains 50 ppm and well water contains 2 to 50 ppm of CO₂. It also causes the corrosion of stream, water and condensate lines. It also helps to accelerate the corrosive action of oxygen.

The other gases are H₂S, CH₄, N₂ and many others but their percentages are negligible, therefore, their effects are not discussed here.

4. Other materials

i. Free Mineral Acid

Usually present as sulfuric or hydrochloric acid and causes corrosion. The presence is reduced by neutralization with alkalis.

ii. Oil

Generally, the lubricating oil is carried with steam into the condenser and through the feed system to the boiler. It causes sludge, scale and foaming in boilers. It is generally removed by strainers and baffle separators.

The effects of all the impurities present in the water are the scale formation on the different parts of the boiler system and corrosion. The scale formation reduces the heat transfer rates and clogs the flow passage and endangers the life of the equipments by increasing the temperature above safe limit. The corrosion phenomenon reduces the life of the plant rapidly. Therefore, it is absolutely necessary to reduce the impurities below a safe limit for the proper working of the power plants