

# Common Boiler Feed Water Treatment in the Industry

**Nishita Kispotta**

*Student*

*Department of Mechanical Engineering*

*Kirodimal Institute of Technology, Raigarh, Chhattisgarh,  
INDIA*

**Gayatri Choudhary**

*Student*

*Department of Mechanical Engineering*

*Kirodimal Institute of Technology, Raigarh, Chhattisgarh,  
INDIA*

**Dhaneshwari Sidar**

*Student*

*Department of Mechanical Engineering*

*Kirodimal Institute of Technology, Raigarh, Chhattisgarh,  
INDIA*

**Prakash Kumar Sen**

*Faculty*

*Department of Mechanical Engineering*

*Kirodimal Institute of Technology, Raigarh, Chhattisgarh,  
INDIA*

**Shailendra Kumar Bohidar**

*Faculty*

*Department of Mechanical Engineering*

*Kirodimal Institute of Technology, Raigarh, Chhattisgarh, INDIA*

## Abstract

Water treatment for thermal power plant is conducted to prevent problems such as carry over to the turbine components, as well as corrosion and scale formation/deposition in the boiler and turbine system. Since 1959, water treatment methods have been improved to deal with equipment nonconformities. The improvement of water treatment method for aging plants, higher operational efficiency, and better environmental conservation has been high on the agenda in recent years. This technology aims to remove particles and dissolved impurities by evaporation and condensation. Distilled or row water is used for boiler make up, chemical treatment is necessary to counteract harmful substance which are present. Particularly the contaminates present in row water are inorganic sodium compound of chloride, sulphate and carbonate and the hardness (calcium and magnesium) compounds of this same material. Gases such as oxygen and carbon dioxide are present in feed water.

**Keywords: boiler feed water, impurities, water treatment.**

## I. INTRODUCTION

In the steam boiler industry, high purity feed water is required to ensure proper operation of steam generation systems. High purity feed water reduces the use of boiler chemicals due to less frequent blow down requirements. Lower blow down frequency also results in lower fuel costs. Scale buildup is reduced due to a smaller concentration of impurities in the boiler feed water. The lower level of impurities also reduces corrosion rates in the boiler. When boiler is used to run a steam turbine, turbine blade erosion is reduced due to higher purity steam generated. [1]

Water treatment for thermal power plants is conducted to prevent problems such as carryover to the turbine components, as well as corrosion and scale formation/deposition in the boiler and turbine systems. In recent years, with increased focus on water treatment methods for aging plants, higher operational efficiency and better environmental conservation, we are developing a package of new products and technologies that address the following problems:

- Powdered scale deposition for oxygenated treatment (combined water treatment; CWT)-applied plants
- flow-accelerated corrosion (FAC) and the use of hydrazine
- Turbine contamination due to the leakage of sea water. [2]

The successful operation of boilers requires accurate analysis of the water that is used, proper treatment to remove corrosive minerals and gases, and careful attention to the controls and procedures for the taking of water samples, their testing, and all required inspections.[3]

The main purpose of boiler feed water treatment is to improve maintenance, efficiency, reliability, treatment, system life and safety of boiler systems. [4]

## II. BOILER FEED WATER

A boiler is a device for generating steam, which consists of two principal parts: the furnace, which provides heat, usually by Burning a fuel, and the boiler proper, a device in which the heat changes water into steam. The steam or hot fluid is then re circulated out of the boiler for use in various processes in heating applications. The boiler receives the feed water, which has been purified in varying degrees (makeup water). The make-up water is usually natural water either in its raw state, or treated by some process before use .feed water composition therefore depends on the quality of the make-up water and the amount of condensate returned to the boiler. The water remaining in liquid form at the bottom of the boiler picks up all the foreign matter from the water that was converted to steam. The impurities must be blown down by the discharge of some of the water from the boiler to the drains. [5] Feed water purity is a matter both of quantity of impurities and nature of impurities: some impurities such as hardness, iron and silica are of more concern, for example, than sodium salts. The purity requirements for any feed-water depend on how much feed water is used as well as what the particular boiler design (pressure, heat transfer rate, etc.) can tolerate .[6]

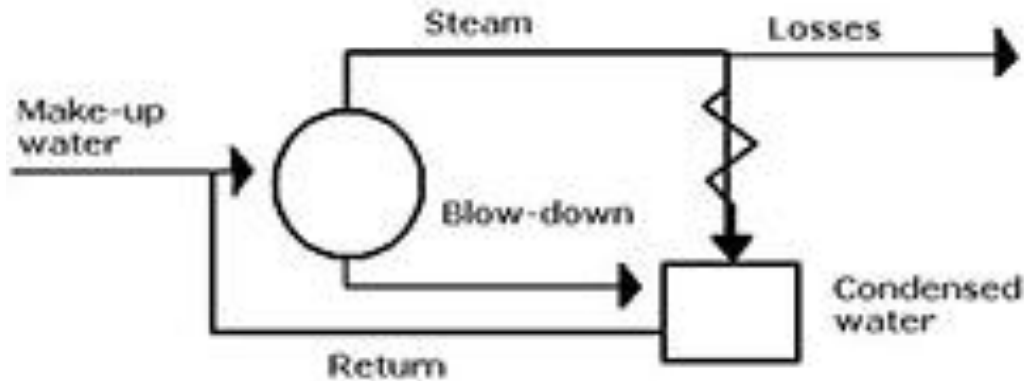


Fig. 1: Boiler feed water

### A. FEED WATER[7]

Feed Water Characteristics as per IS: 10392-1982

## III. HISTORY OF WATER TREATMENT

Parameters	Up to 20 kg/cm <sup>2</sup>	21 kg/cm <sup>2</sup> TO 39 kg/cm <sup>2</sup>	40 kg/cm <sup>2</sup> TO 59 kg/cm <sup>2</sup>	Unit
Total hardness	<10	<1.0	<0.5	Ppm as CaCO <sub>3</sub>
PH value	8.5-9.5	8.5-9.5	8.5-9.5	
Dissolved oxygen	0.1	0.02	0.01	As ppm
Silica		5	0.5	As ppm SiO <sub>2</sub>

In modern boiler through treatment of boiler feed water is extremely critical, as many problems can result from the use of untreated water in extreme pressure and temperature environments; this includes lower efficiency in terms of heat transfer, overheating, damage and high cost of cleaning. [8] Industrial water treatment had its beginnings many centuries later during the industrial revolution in the 19th century. It began with the internal treatment of boiler water used to generate steam. One quoted reference to some of the first water treatment relates that, “In the early days of Watt’s Engine, it is said that once after cleaning a boiler and refilling it, the workmen hung a bag of potatoes in the boiler to cook, forgot them, closed the boiler, and put it back in operation. Then, when the boiler was shut down again in order to chip off the scale by hand, it was found that very much less scale had formed, much of it having come down as sludge, and that which had formed was much softer and easier to remove. Probably the tale is true because for many years, engineers made it a practice of throwing some potatoes in the boiler after every cleaning.”[9]

#### IV. IMPURITIES IN BOILER FEED WATER

Impurities are substance inside a confined amount of liquid, gas or solid which differ from the chemical composition of the material or compound. Impurities are either naturally occurring or added during synthesis of a chemical product. During production impurities may be purposely, accidentally or incidentally added into the substance. [10]

The following impurities are present in the boiler water are discussing in below:-

##### A. Calcium (Ca) scale

Calcium forms with sulfates and other compounds to form calcium sulfate, calcium bicarbonate, calcium carbonate, calcium chloride, and calcium nitrate. During evaporation, these chemicals adhere to boiler tube walls forming scale. Its formation increases with the rate of evaporation so these deposits will be heaviest where the gas temperatures are highest. Scale is a nonconductor of heat which leads to a decreased heat transfer of the boiler tubes, and can result in tube failure due to higher tube metal temperatures.

##### B. Iron (Fe)

High iron is not found in raw water but high concentrations can come from rusted piping and exfoliation of boiler tubes. Iron is found in condensate return in a particle form as it does not dissolve in water. The detrimental aspect of iron is called steam turbine solid particle erosion, which causes significant erosion of steam turbine steam path components.

##### C. Oil

Oil is an excellent heat insulator, and adherence of oil on tube surfaces exposed to high temperatures can cause overheating and tube damage.

##### D. Carbon Dioxide (CO<sub>2</sub>)

Carbon dioxide can react with water to form carbonic acid (H<sub>2</sub>CO<sub>3</sub>). Carbonic acid will cause corrosion in team and return lines. Carbon dioxide can originate from condenser air leakage or bicarbonate (HCO<sub>3</sub>) alkalinity in the feed water. [11]

#### V. BOILER WATER TREATMENT PROCESS

Boiler water treatment is a type of industrial water treatment focused on removal or chemical modification of substances potentially damaging to the boiler. Varying types of treatment are used at different locations to avoid scale, corrosion, or foaming. [12] External treatment of raw water supplies intended for use within a boiler is focused on removal of impurities before they reach the boiler. Internal treatment within the boiler is focused on limiting the tendency of water to dissolve the boiler, and maintaining impurities in forms least likely to cause trouble before they can be removed from the boiler in boiler blow down. [13] Water treatment is used to improve the quality of water contacting the manufactured product e.g. semiconductors, and/or can be part of the product e.g. beverages, pharmaceuticals, etc. In these instances, poor water treatment can cause defective products. Domestic water can become unsafe to drink if proper hygiene measures are neglected. [14]

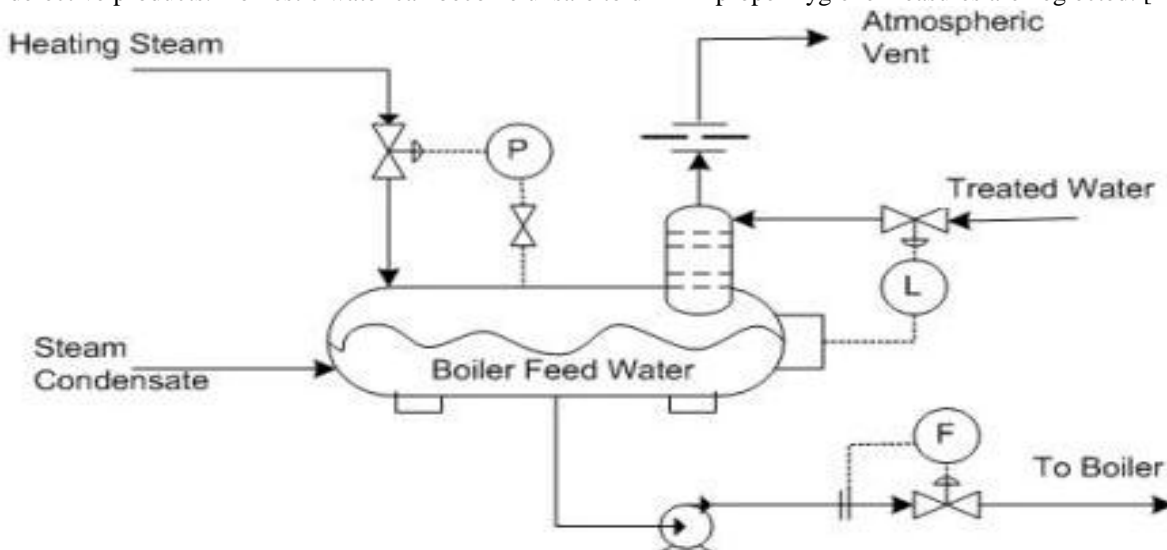


Fig 2 Boiler feed water treatment [15]

The boiler feed water treatments are as follows:-

##### A. Coagulation and flocculation

Coagulation and Flocculation is a process where by adding aluminum sulfate to the raw water, settlement can be achieved in a considerably shorter time. In traditional water treatment, certain chemicals are added to raw water to remove impurities. While

some particles will spontaneously settle out from water on standing (a process called sedimentation), others will not. To cause particles that are slow to settle or are non-settling to settle out more readily, a soluble chemical or mixture of chemicals is added to the water. Such a chemical is called a coagulant and the process is called coagulation. [16]

### **B. Sedimentation**

Some particles will spontaneously settle out from standing water (a process called sedimentation). Sedimentation is used to remove the majority of settle able solids from coagulated/flocculated raw water. The solids are removed before the water passes to the filter hence reducing the solids load on the filter and increasing the efficiency of the Treatment plant [17]

### **C. Flotation**

The natural flotation process differs from the flotation with air. In the first case, the material particles lighter than the water (oils, greases) eventually associated with gas bubbles have the tendency to raise to the stationary liquid surface. In the flotation process with air, the material particles heavier than the water are transported to the liquid surface by attaching them with air bubbles. [18] It is process for removing suspended particles from liquid by bringing particles to the surface of the liquid. The influent feed liquid can be the raw water, waste water or liquid sludge. The flotation system consists of four major components air supply, pressurizing and flotation chamber. [19]

### **D. Filtration**

Filtration is another important element of the treatment process. This process involves the water passing through a bed of fine particles, usually sand. This process is called sand filtration. Other materials are also used in the filtration process. Generally they are layered. Originally filtration was a slow process, however because the sand filtration processes become less effective at removing fine suspended particles at higher water flow rates. The water must be pretreated – coagulated and flocculated – before passing through the filter bed. Such high rate direct filtration processes are widely applied to raw water with low levels of suspended matter. [20]

## **VI. CONCLUSION**

Water treatment process for thermal power plants have been examined and improved as a counter measure against equipment damage due to factors such as corrosion and scale deposition. Abnormalities in water quality can be a precursor of problems and therefore serious problems can be prevented by analyzing the data and taking necessary measures. The water treatment in modern Western plants, namely, pretreatment in clarifiers, Demineralization and condensate polishing. Boiler water treatment has become firmly established of steam plant throughout the world only the demise of the steam locomotive in every day operation has left a legacy of doubt in the minds of some person involved with heritage steam operation. It is anticipated that the contents of this section has helped to open up the understanding of the benefits of water treatment system and that universal adoption of treatment will yield saving for owners, maintainers and operator water treatment thus offers significant benefits to the maintenance and safety of boiler.

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