BOILER WATER TREATMENT

INTRODUCTION

A boiler is a closed vessel in which water under pressure is transformed into steam by the application of heat. In the boiler furnace, the chemical energy in the fuel is converted into heat, and it is the function of the boiler to transfer this heat to the contained water in the most efficient manner. When water is boiled into steam its volume increases about 1,600 times, producing a force that is almost as explosive as gunpowder. This causes the boiler to be extremely dangerous equipment that must be treated with utmost care.

The process of heating a liquid until it reaches its gaseous state is called evaporation. Heat is transferred from one body to another by means of (1) radiation, which is the transfer of heat from a hot body to a cold body without a conveying medium, (2) convection, the transfer of heat by a conveying medium, such as air or water and (3) conduction, transfer of heat by actual physical contact, molecule to molecule.

BOILER TYPES

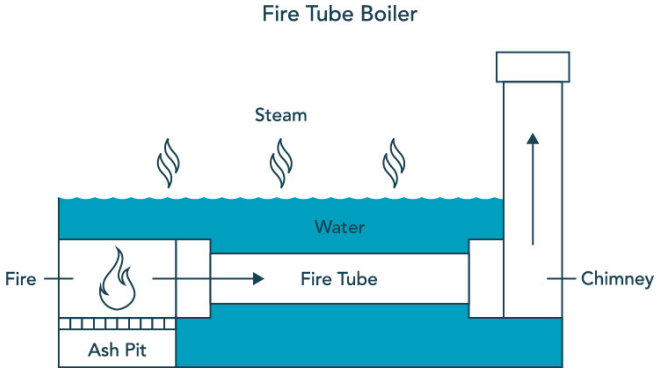
Two principal types of boilers are used for industrial applications:

- **Fire Tube Boilers:** Products of combustion pass through the tubes, which are surrounded by water.

- **Water Tube Boilers:** Products of combustion pass around the tubes containing water. The tubes are interconnected to common channels or headers and eventually to a steam outlet for distribution to the plant system.

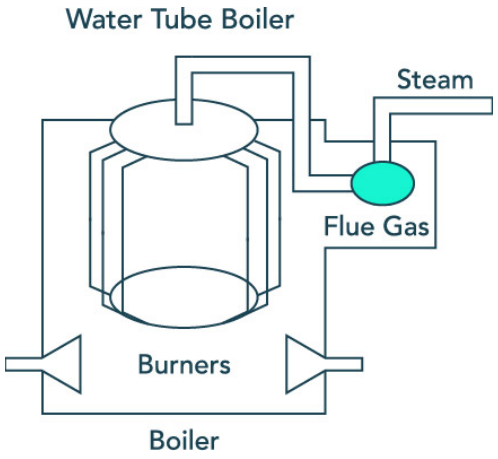
Fire Tube Boiler:

Fire tube or "fire in tube" boilers; contain long steel tubes through which the hot gasses from a furnace pass and around which the water to be converted to steam circulates. (Refer Figure 2.2). Fire tube boilers, typically have a lower initial cost, are more fuel efficient and easier to operate, but they are limited generally to capacities of 25 tons/hr and pressures of 17.5kg/cm^2.



Water Tube Boiler:

Water tube or "water in tube" boilers in which the conditions are reversed with the water passing through the tubes and the hot gasses passing outside the tubes (see figure 2.3). These boilers can be of single- or multiple-drum type. These boilers can be built to any steam capacities and pressures, and have higher efficiencies than fire tube boilers



Packaged Boilers:

The packaged boiler is so called because it comes as a complete package. Once delivered to site, it requires only the steam, water pipe work, fuel supply and electrical connections to be made for it to become operational. Package boilers are generally of shell type with fire tube design so as to achieve high heat transfer rates by both radiation and convection.

PROBLEMS OF BOILER WATER

Water, the raw material for making steam, contains various types and amounts of impurities. Completely pure water, although desirable for steam generating system is non-existent.
Impurities in the water supplied for a boiler system may be classed as:

- Dissolved soilds
- Dissolved gases
- Suspended matters

The major problems associated with boiler feed water impurities are:

- Scaling/deposition
- Corrosion-oxygen attack, caustic corrosion
- Boiler water carryover

Toroidal conductivity sensors and instruments should be used for scrubber control since the sensors are highly resistant to fouling. They are also recommended due to the high conductance of many of these scrubbing solutions and by-products.

Scale / Deposition

Scale is one of the most common deposit related problems. Scale is a buildup of solid material from the reactions between the impurities in water and tube metal, on the waterside tube surface. Scale acts as an insulator that reduces heat transfer, causing a decrease in boiler efficiency and excessive fuel consumption. More serious effects are overheating of tubes and potential tube failure (equipment damage). Fuel wasted due to scale may be approximately 2-5 percent depending on the scale thickness. Salts that have limited solubility in the boiler water form scale. These salts reach the deposit site in a soluble form and precipitate when concentrated by evaporation. Sludge is the accumulation of solids that precipitate in the bulk boiler water or enter the boiler as suspended solids.

Oxygen Attack

The most common causes of corrosion inside boilers. Dissolved oxygen in feed water can become very aggressive when heated and reacts with the boiler's internal surface to form corrosive components on the metal surface. Oxygen attack can cause further damage to steam drums, mud drums, boiler headers and condensate piping.

Water reacts with iron to form magnetite only in the absence of oxygen. The presence of oxygen promotes the formation of Hematite or Red Iron Oxide which is non-protective. Oxygen corrosion takes the form of localized deep pitting and can quickly lead to tube failure.

Preventing oxygen corrosion is quite simple: Keep oxygen out!

Acid Attack

Another common causes of corrosion. Acid attack happens when the pH of feed water drops below 8.5. The carbonate alkalinity in the water is converted to carbon dioxide gas (CO^2) by the heat and pressure of the boilers. CO^2 is carried over in the steam. When the steam condenses, CO^2 dissolves in water to form carbonic acid (H_2CO_3) and reduces the pH of the condensate returning to the boilers. Acid attack may also impact condensate return piping throughout the facility.

Boiler Water Carryover

This is a contamination of steam with boiler water solids High concentrations of soluble or insoluble solids in boiler water can stabilize and strengthen the bubbles surface in boiler water, giving rise to foaming. Steam generated can carry the foams into the process. Substances such as oil, alkali, greases, organic matter and suspended solids are known to cause foaming. A sudden surge of boiler water caused by a rapid change in load causes priming. Priming can result in carryover of boiler water solids into the steam, by allowing small droplets of water to be released into the steam space. Such carryover causes contamination in the many processes for which steam is used.

BOILER WATER CONTROL

To assure acceptable steam purity, the American Boiler Manufacturers Association (ABMA) specifies boiler water composition limits (Table 1) by operating pressure. Requirements for boiler water composition become more stringent as operating pressures increase.

Areas of some water tube boilers experience heat flux rates as high as 250,000 Btu/hr/ft^2, far greater

than in boilers in service when the ABMA, limits were established. Combined with dimensional restrictions on modern units, this has raised the need for new guidelines to replace the outdated ABMA limits. Table 2 from the ASME Research Committee on Water in Thermal Power Systems reflects the need for feed water to be extremely pure. These new guidelines will continue to be refined. Table 1 & 2 mentioned, below.

INSTRUMENTATION: BOILER WATER TREATMENT

The most important instrumentation control in a boiler is Conductivity and pH which is measured in different streams starting from Boiler feed water, Boiler Water and then Condensate return.

pH Control

In boiler Water control pH play a vital role pH has to be maintained slightly towards alkaline so as to prevent corrosion. Maintaining pH close to alkaline will help to maintain a passivation layer which protects the boiler from corrosion attack. The typical pH level maintained in different points of boiler is included in table, below.

Conductivity Control

Conductivity is key parameter which needs to be paid attention in a boiler as it directly relates to energy savings, lack of conductivity control leads to operational problems like scaling inside the boiler internals which also links to fuel consumption. Mainly conductivity control is required in two different areas of boiler on in controlling the mineral level in boiler through Blow down. The more the blow down more is the wastage of water and energy, inadequate bleed off will lead to operation problems.

The second area of attention is the condensate recovery, as condensate is very purest form of water in certain cases due to contamination condensate quality can get affected. We cannot lose more condensate as the enthalpy content of the same is high which will optimize the cost of operation of a boiler. The more the condensate recovery in a boiler cost of operation of boiler will be less.

One more area where we should have a monitoring of conductivity is the Boiler feed water which can affect the cycles of concentration of the boiler.

CONCLUSION

pH and conductivity control in boiler feed water is critical. Key benefits include:

- Reduces potential for carryover into the steam system
- Eliminates excessive blowdown which wastes water, chemical, and energy
- Eliminates overfeeding chemical to address high solids excursions
- Reduces time operators spend testing and adjusting system