Steam Boiler Water Treatment

Boilers can be complicated systems to maintain. It seems easy enough that water heats to steam, and that steam provides heat and or power. For such a seemingly simplistic operation, care and maintenance can be anything but simple. Proper boiler treatment can prevent or correct a multitude of hazardous and costly situations.

The three potential problems associated with boiler water are corrosion, scale, and condensate corrosivity. Corrosion can occur in many key areas of a boiler. It can shorten the life of the boiler, or at the least, increase the costs associated with maintaining a boiler. Internal boiler corrosion is normally the result of oxygen attack and/or low pH and is potentially dangerous due to the pressures and temperatures associated with an operating boiler.

Boiler scale is caused by impurities being precipitated out of the water directly on heat transfer surfaces or by suspended matter in water settling out on the metal and becoming hard and adherent. Evaporation in a boiler causes impurities to concentrate. This interferes with heat transfers and may cause hot spots. Scaling mechanism is the exceeding of the solubility limits of mineral substances due to elevated temperature and solids concentration at the tube/water interface. The deposition of crystalline precipitates on the walls of the boiler interferes with heat transfer and may cause hot spots, leading to local overheating. The less heat they conduct, the more dangerous they are.

Condensate or condensed steam, is pure water. Because of the lack of dissolved solids, condensate is easily made acidic by carbonic acid that forms during condensing. Carbon dioxide evolves from alkalinity in the boiler water and I carried throughout the steam piping. As the steam condenses, the carbon dioxide combines with oxygen to form carbonic acid.

The above potential threats can be solved by mechanical and chemical means. Oxygen will more readily leave the boiler feedwater when it is heated, and the addition of an oxygen scavenger will consume any remaining oxygen. Scaling can be controlled by reducing the amount hardness and alkalinity in the boiler feedwater. The use of scale inhibitors interrupts the formation of scale and will condition the precipitant for easy removal during blow-down. Controlling the boiler feedwater alkalinity will also control how much carbon dioxide will leave with the steam from a boiler thereby minimizing the formation of carbonic acid. Using a neutralizing amine will keep the pH of the condensate in an acceptable range.

Boiler Water Treatment

Targets of successful boiler water treatment are to prevent scale to minimize corrosion and carryover.

Major benefits of boiler water treatment:

- Save energy losses and stabilize fuel consumption
- Increase life of the boiler
- Ensures optimum heat transfer
- Reduces unnecessary shutdown / maintenance bills
- Saves from frequent acid cleaning costs

Problems in boiler water come from:

1. Scale formation
2. Corrosion
3. Foaming / carryover
Boiler efficiency is decreased as follows:

A. Scale Formation

<table>
<thead>
<tr>
<th>Thickness of scale (inches)</th>
<th>Loss of efficiency due to boiler scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/64</td>
<td>4%</td>
</tr>
<tr>
<td>1/32</td>
<td>7%</td>
</tr>
<tr>
<td>1/16</td>
<td>11%</td>
</tr>
<tr>
<td>1/8</td>
<td>18%</td>
</tr>
<tr>
<td>3/16</td>
<td>27%</td>
</tr>
<tr>
<td>1/4</td>
<td>28%</td>
</tr>
<tr>
<td>3/8</td>
<td>48%</td>
</tr>
<tr>
<td>1/2</td>
<td>60%</td>
</tr>
</tbody>
</table>

Factors for scale formation in a boiler:

- Water contains many dissolved solids
- Calcium and magnesium are the major hardness components & primary source of scale in boiler and feed system heat exchanger equipment.
- Deposits will cause the temperature of the metal to increase until overheating, metal softening, blistering and failure occurs.

B. Factors for corrosion in boiler

- Dissolved oxygen cause hematite (red rust)
- Chloride stress corrosion and Transgranular cracking will occur where there is stainless steel.
- Oxygen pitting, high levels of dissolved oxygen will result in pitting and scabs will form over the pits.
- Caustic stress corrosion where there are deposits present hydroxyl ions will collect and cause corrosion, crating and grouping of tube metal.
- Acid attack: An excess of hydrogen ions will corrode tube metal, which will create a methane gas, which will stress the tube and cause it to crack.

Corrosion in your boiler can reduce its life and may cause serious accidents
C. Corrosion control in steam and condensate lines

Corrosion of steam and condensate lines is one of the most costly problems facing facilities. After boiler corrosion may incur cost penalties such as:

1. Repair cost: The largest expense is not repairing; it is the loss of production during repair.
2. Steam leaks: Usually, steam leaks are not serious enough to cause boiler shutdown, but do drain a system of valuable latent heat, also increased fuel usage is needed to compensate for the energy lost through the leaks.

D. Foaming / Carryover

- System slugs will normally break and release dry steam in the steam drum.
- A high concentration of suspended dissolved solids in boiler water will stabilize steam slugs and prevent them from breaking.
- This will result in carryover, which enables wet steam and water to impinge on turbine blades, valves, and create water hammer which can damage piping and pipe hangers.

**Maximum limits for different boiler water to get good quality steam.**

<table>
<thead>
<tr>
<th>Boiler Pressure (PSIG)</th>
<th>Total Dissolved Solids (TDS)</th>
<th>Alkalinity (PPM)</th>
<th>Silica (PPM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-300</td>
<td>3500</td>
<td>700</td>
<td>125</td>
</tr>
<tr>
<td>301-450</td>
<td>3000</td>
<td>600</td>
<td>90</td>
</tr>
<tr>
<td>451-600</td>
<td>2500</td>
<td>500</td>
<td>50</td>
</tr>
</tbody>
</table>

KNK Water Treatment is a direct distributor for DuBois Chemicals and proudly offers treatment programs, feed systems and control equipment.

**Products:**

- Water Treatment Product Guide
- Drum-free Powder in a Bag in a Box (PBB)

**Additional Info:**

- Boiler Inspection, Cleaning and Storage Brochure