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Boiler Tube Performance

By ANTHONY A. MIELE

Boiler tube performance may be affected by one or more of the following conditions:

1. Foaming
2. Corrosion
3. Scale formation
4. Caustic embrittlement
5. Sooty surfaces

The above conditions not only affect the life of the tube but also the thermal conductivity of the tube.

Foaming which is caused by soluble sodium salts and is aggravated by solids, oil or grease. This causes a mass of bubbles to form in the steam space. The result is that thermal conductivity is reduced tremendously. The concentration of sodium salts must be reduced below 200 to 300 gr per gallon in order to eliminate foaming.

If the boiler tube has been rid of scaling, and the feed water contains oxygen, corrosion of the tube will result. This is very harmful because it not only lowers the thermal conductivity but the life of the tube may be shortened.

Corrosion in as short a time as one week may cause the boiler tube to burn out and thus result in a shut down of the boiler. A shut down of a boiler is very expensive and extreme care should be taken in order to reduce corrosion.

Because oxygen in the feedwater causes corrosion, it should be removed by one of the two methods: 1. De-activator. 2. De-aerator.

The De-activator is rarely found but it is a large tank filled with layers of iron sheets over which the water passes and corrodes the iron. This corrosion of the sheets absorbs the oxygen in the water so therefore the water is free of oxygen before entering the boiler.

In the De-aerator, the boiler water enters a closed heater and flows by gravity through a float-regulated valve into the separator tank where a reduced pressure exists. The water, when flowing over the heating tube, partially flashes into vapor thus releasing the non-condensable gases. An air ejector lifts the vapor into a surface condenser where the vapor is condensed and the air passes through the ejector.

Corrosion may be reduced by having a thin layer of scale form on the tube surface. If there is oxygen in the water, it will not be able to come

in contact with the metal because of this thin layer of scale so therefore corrosion is prevented at the cost of a lower thermal conductivity.

The deposit of layers of salt on the surface of the boiler tube is known as scale formation. The layer is baked and hardened so therefore the thermal conductivity is reduced tremendously.

In lower pressure boilers the scale formation may be prevented by the use of soda ash but at higher pressures it decomposes so that the desired reaction between the soda ash and the iron does not take place.

In high pressure boilers, phosphate salts are used to prevent scale formation.

Scale formation like sludge, is greatly reduced if the feedwater were pure water, evaporated feedwater or lime-soda treated water. These methods are not entirely adequate because there is always a leakage of some raw water into the boiler.

Caustic embrittlement is a term applied to the condition of boiler metal in which small hairline intercrystalline cracks appear. These cracks are usually found around high stress riveted joint which below the water line. This embrittlement is due to the presence of caustic soda and the cracking is due to sodium hydroxide.

As the hot gases pass around the tube, soot drops and cakes on the surface of the tubes. This sooty surface lowers the thermal conductivity. This condition may be prevented by blowing excess air through the tube thus carrying the soot away.

Most of the conditions mentioned above are functions of the feedwater. An analysis of the feedwater should be taken because it differs even within a given locality. With the aid of the water analysis, a treatment of this raw water should be made so that it would give the best condition in the boiler.

In many places evaporators are used to rid the water of suspended solids and some of the soluble salts. Distilled water from these evaporators is used especially for make up water.

It is quite evident that there must be a close watch on the feedwater so as to assure fine tube performance. It is not unusual to find tubes filled solid with sludge and scale, and it is obvious that such tubes are useless.

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Bursting of tubes is caused many times by over heating of the metal due to the poor thermal conductivity of the tube. This poor thermal conductivity may be caused by scale or sludge.

In a closed plant cycle, the problem of feedwater is reduced to that of make up water so that it offers no danger to the tubes but the make up water should pass through an evaporator before entering the boiler thus assuring good feedwater. In this type of a cycle the tube should give finer performance because it should have a high thermal conductivity and a longer life.

In an open cycle the problem of feedwater is large and important. Because of imperfect treatments the tubes will eventually become full of scale and sludge. The performance of these tubes will not be as good as those in a closed cycle.

The choice of treatment for a certain type of feedwater must be done with care. Years ago, water treatment was an art because the facts involved were not known but today water treatment is being placed on a scientific basis.



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