

Impact on Steam Boilers

The pictures below show both graphitic corrosion and baked-on sludge deposits.



Recommendations

Systems where treatment should be considered are:

- Process applications
- Contaminated condensate
- Large make-up water requirements
- System components requiring corrosion inhibitor
- Extremely hard water
- Make-up water supply with higher than 30 ppm of chloride

Beware of the foam... Water treatment chemicals should be thoroughly reviewed before they are introduced into the boiler and heating system. Of particular concern are foaming agents that will interfere with the disengagement of the steam at the boiler waterline. For this reason, foaming agents cannot be tolerated in steam boilers.

To test the boiler water treatment chemicals, mix a small amount of the chemical

intended for the boiler with water. In a ventilated area, put this mixture into a pan and bring to a "rolling boil" on the stove. If the mixture foams, it is not suitable for the boiler.

Recognized treatment compounds used for oxygen scavenging and corrosion protection should not affect the life of the elastomer sealing rings. Ask the treatment supplier to test a sealing ring in the proposed compound to eliminate any doubt. (COMPOUNDS CONTAINING PETROLEUM SHOULD NOT BE USED.)

Without Chemical Treatment

- If chemical treatment is not used, at the end of each heating season, drain and refill the boiler with fresh water to 4-6 inches above the normal water line. Bring the boiler to pressure for 15 minutes per the boiler manual to drive off excess oxygen. The boiler is ready for summer storage.
- When the chloride level is above 400 ppm, or the total dissolved solids (TDS) are above 1000 ppm, drain and refill the boiler with fresh water and bring the boiler to pressure for 15 minutes per the boiler manual to drive off excess oxygen.

These steps will help prevent corrosion caused by high conductivity, but may not prevent under-deposit corrosion.

☰ Today's water is not 1950's water

What has changed and how does it affect a steam boiler?

Road Salt



Water Softeners



**EPA Rule 1991
Copper and Lead Migration**

**Weil-McLain
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Road Salt

Over the past decades the use of salt to keep the highways free of ice has resulted in an increase of chlorides in ground water. This increase in chlorides has also been found in municipal water supplies.

Water Softeners

Over the past decades the use of water softeners has increased. The salt used to recharge resin tanks has increased the chloride levels in ground water. This increase in chlorides has also been found in municipal water supplies.

EPA Rule 1991 Copper and Lead Migration

June 7, 1991, EPA issued "Lead & Copper Rule" to protect public health by reducing lead and copper entering drinking water from corrosion of older plumbing materials.

20% to 25% of the public water systems use phosphate families of chemicals to comply.

Polyphosphates react with soluble metals by sequestering (binding) the metal.

Orthophosphates form a domestic water supply pipe coating.

Cast Iron Corrosion in a Steam Boiler

Corrosion of a cast iron steam boiler can happen in the presence of conductivity, oxygen, and heat.

The rate of corrosion increases when the conductivity between the anode (iron) and the cathode (graphite) increases. Conductivity increases due to increases in Totally Dissolved Solids (TDS). Chlorides are a part of the TDS measurement.

Oxygen reacts with iron to form iron oxide (rust). Oxygen is needed for the corrosion process to continue.

Heat energy is needed for the reaction process. The higher the heat energy the faster the reaction rate.

Why does a steam boiler corrode while a water boiler does not?

Steam boilers are like a still. When steam leaves the boiler all the material in the boiler water stays in the boiler. As additional water is added to the boiler more dissolved solids are also added. When 100% of the water has been replaced, all the original concentrations are doubled. When the water has been replaced 5 times, the concentrations will be 6 times the original amounts.

How does a higher chloride concentration in make-up water affect the life of a boiler?

Without any other factors changing, a boiler that lasted twenty years, with a chloride concentration in the make-up water of 10 ppm, may only last about 6-7 years if the chloride concentration is increased to 30 ppm. A 15% increase in the rate of water make-up may further reduce the life of the boiler an additional year.

What does corrosion from high chlorides look like?

It is common for corrosion from a high chloride water environment to be called graphitic corrosion. Graphitic corrosion happens when the metallic constituents are leached or converted to corrosion products, leaving the graphite intact. The corroded material will have the shape of the original cast iron but the strength of graphite.

Polyphosphates and Orthophosphate in Steam Boiler Water

Historically, cast iron boiler manufacturers do not recommend boiler water chemical treatment. The reason being the rust forming on the cast iron surface is passivating. As the thickness of the rust increases, the rate of rust formation decreases. Unless the rust is removed, the boiler can last for decades. Also, excessive amounts of boiler chemical will cause the boiler to foam, resulting in carryover problems.

The phosphate chemicals used by water treatment plants are different than the phosphate chemicals used for boiler water treatment. The phosphate chemicals used by water treatment plants are intended to coat the surface of the water supply pipe while the phosphate chemicals used in boiler water treatment, combined with boiler water blow down, are intended to prevent deposits. With the difference in phosphate chemicals it is possible for sludge to form and then be baked on the hotter metal surfaces at the boiler water line. These deposits can cause "under-deposit corrosion".

These deposits will increase the rate of corrosion, and further shorten the boiler life.