Care and Maintenance of Steam Systems

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Brrr. It's been a cold winter so far. Good thing we've all got heating systems that take care of us and take care of themselves, right?

Of course not. One of the primary concerns in a heating system is maintenance. Lack of maintenance can ultimately lead to premature boiler failure, which does not reflect well on a capital improvement program and makes for an even colder season.

Care and maintenance includes:

- proper chemical treatment
- daily blowdown
- proper inspections

Contaminants in Steam Systems

Steam systems require careful attention to water treatment needs. After being used for heating or power, the steam condenses and is returned to the boiler through the condensate lines. Not all of the water that was turned to steam comes back. Steam systems need makeup water to compensate for the water lost as the steam circulates through a system. Both the condensate and the makeup water can bring contaminants into the system.

In fact, the feedwater that is piped into the boiler *usually* contains solids. These solids join the solids that were left behind by the water that has already turned to steam. The concentration of solids in the water increases *every time* makeup water is added to a boiler, so these solids must be treated or purged to prevent problems. Steam systems are most affected by scale, foaming and carryover, and corrosion. Sludge buildup and caustic embrittlement can also reduce boiler efficiency.

Scale in Boilers

Scale in boilers inhibits efficient heat transfer. Scale buildup of 1/8 inch can reduce heat transfer by 15 percent. Take a look at how scale increases your energy costs:

Steam Generation lbs/hr	Scale Condition		
	1/64 in. (2% heat loss)	1/32 in. (4% heat loss)	1/16 in. (6% heat loss)
5,000	$5,600	$11,600	$18,000
10,000	$11,200	$23,200	$36,000
20,000	$22,400	$46,400	$72,000
50,000	$56,000	$116,000	$180,000

Assumptions:

1) 100 psi boiler operating on natural gas 24 hours/day, 365 days/year

2) Gas cost = $0.40/therm ($4.00/M Cu. Ft.)

3) Boiler efficiency = 80%

Scale in boilers needs to be controlled to ensure system efficiency. Sodium phosphate compounds can be added to boiler water to help prevent scale formation. The sodium phosphate compound helps precipitate scale-forming material so that the precipitated material can be blown down in boilers.

Boilers can be cleaned with power tools designed to cut or knock scale from the tubes. In firetube boilers, scale forms on the outside surface of the tubes. The scale is knocked loose by running a vibrating hammer or rattler through the tube. When the scale is knocked loose, it can then be flushed down a boiler drain.

In watertube boilers and cooling tower condensers, scale forms on the inside of the tubes. The scale is removed from the inside surface by using rotary brushes or cutters. This procedure is called rodding.

Foaming and Carryover in Boilers

Foaming is an excess of turbulence on the surface of the water in the boiler. This is caused by a high concentration of impurities in the water. Foaming prevents the operator from determining if the water level in the boiler is correct or not.

Carryover happens when the water level is too high and particles of liquid water from the boiler are transported into the steam lines. Carryover is harmful because these small water droplets can cause damage to the steam pipes as they change direction in the lines.

There are several ways to prevent foaming and carryover.

- Using silicone and ethoxylated-alcohol reduces foaming.
- Maintaining an appropriate schedule for blowdowns can reduce foaming and carryover.
- Using a centrifugal separator with vanes that take water out of steam before it goes into the lines can prevent carryover.

- A daily test of the condensate water can determine if carryover is occurring. If the condensate has a high TDS (total dissolved solids) reading or chemicals are present, carryover is occurring.

A surface skimming blowdown valve is one method for controlling impurity levels. This valve, unlike a regular valve, has a meter scale attached to it so that the operator can adjust how open the valve is. By opening this valve in precise measurements, boiler water impurities can be removed gradually over a long period of time by skimming water from the top of the boiler.

When maintenance work is done on a boiler, extreme care should be taken to prevent oil from getting into the system. Oil is harmful because it makes sludge sticky and increases the possibility of foaming and carryover. Oil in water will act as insulation on the water side of metal surfaces, causing an increase of the temperature of that part of the metal. This can eventually lead to blistering.

If a small amount of oil gets into the system:

- add a highly alkaline compound,
- boil
- flush

To combat large amounts of oil:

- drain the boiler
- clean with a commercial solvent.

Corrosion in Boilers

Corrosion can be a serious problem in boiler maintenance. Chemicals are used to prevent corrosion that can come from high pH (alkalinity) or from oxygen dissolved in the water. Corrosion in boilers also occurs when water is too acidic.

Boiler water should be maintained at a pH of 10.1 to 11. Sodium hydroxide can be used to increase pH. In steam boilers, a slightly alkaline water system will help control scale and prevent corrosion in the steam lines. In the closed loops of hot-water systems and chilled-water systems, it will prevent rust and corrosion.

Steam that leaves the boiler is usually acidic and requires neutralizing or filming amines treatment to prevent corrosion in the steam and condensate lines. However, amines **cannot** be used if the steam is used for humidity control in an air-handler system.

Oxygen carryover into the steam and condensate lines can lead to pitting corrosion. Pitting corrosion is directly related to the dissolved oxygen that is present in boiler water systems. Sodium sulfite can be fed into a boiler to prevent pitting caused by dissolved oxygen. Sodium sulfite should be fed directly and simultaneously to the area where the feedwater make-up is occurring. If a condensate tank is used in the steam system, the treatment should occur in the condensate tank. A high feedwater temperature reduces the oxygen level in the water, therefore it is recommended to keep the feedwater temperature as high as possible. The presence of 30 to 60 ppm of residual sodium sulfite in boiler

water will help remove dissolved oxygen because sodium sulfite acts as an oxygen scavenger. However, too much sodium sulfite can cause an acidic condition. A precise chemical treatment is important to keep costs and maintenance reasonable.

Sludge in Boilers

Suspended solids are dispersed and eliminated from the system through periodic blowdown. Chemicals are used to disperse suspended solids, which are then purged from the boiler through blowdown. The water column, feedwater controller, and city water make-up controller need to be blown down as well to reduce sludge and ensure that the float mechanisms work properly.

Blowdown is the release of water from a valve that draws water from the bottom of the boiler. In boilers, this process causes calcium and magnesium to precipitate, fall out of solution, and create sludge. After these minerals are changed into sludge, they can be purged by blowdown.

Polymers, tannins, lignins, and alginates can be used as sludge conditioners. These organic materials surround the scale precipitates and prevent them from adhering to metal in the boiler. The chemicals used to cause calcium and magnesium to precipitate and form sludge are a combination of sodium hydroxide, sodium carbonate, and sodium phosphate and organic treatment such as lignins or tannins. Some of the chemicals commonly found in boiler water and heating water systems are listed below.

Chemical	Closed water system	Steam boiler
Corrosion Inhibitors		Caustic—adds alkalinity to systems Sulfite—oxygen pitting inhibitor Neutralizing Amines—corrosion inhibitor
	Sodium Nitrite Sodium Metaborate Sodium Molybdate Phosphonates	
Scale Inhibitor		Polymers Phosphonates EDTA-Chelants Phosphate

Boiler Blowdown Connection

Steam boilers are designed with two blowdown connections: one to remove the dirt and oil that collect on top of the water in the boiler (the evaporation surface) and one to purge the boiler of sediments that collect on the bottom of the boiler shell.

The device used to bleed off water on the top of the boiler is called a surface blowdown. A surface blowdown (or skimmer) uses a special metered ball valve which can be adjusted. For instance, a valve can be set to allow 1/2 gallon of water an hour to be skimmed off of the surface of the boiler. The valve setting would be set to 0.5. This process allows the water to be exchanged with new water over a period of time, for

instance 24 hours. **Blowdown connections should be opened on a daily basis to remove foreign matter from the heating system.**

More Information

This article is adapted from BOMI International's The Design, Operation, and Maintenance of Building Systems, Part 1. *This is one of several BOMI courses recently approved by the US Green Building Council for maintaining your LEED-AP credential. More information regarding this is available by calling 1-800-235-2664, or by visiting* ***BOMI International's website****.*