THE ENERGY OBSERVER

Energy Efficiency Information for the Facility Manager

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Steam Trap Maintenance

The Energy Observer summarizes published material on proven energy technologies and practices, and encourages users to share experiences with generic energy products and services. This quarterly bulletin also identifies informational sources and energy training for facility managers and staff. ***The Energy Observer*** is a service of the **Energy Office, Michigan Department of Labor & Economic Growth.**

This issue discusses an often overlooked but important component of steam heating systems — the steam traps. Neglecting maintenance of this component wastes energy and can lead to expensive repairs for equipment failure and/or damage.

Definition and types

Steam traps are automatic valves that release condensed steam or condensate from a steam system while preventing the loss of live steam. Steam traps are designed to maintain steam energy efficiency for performing specific tasks such as heating a building or maintaining heat for process use. Once steam has transferred heat through a building or process and becomes hot water, the trap opens to remove it from the steam side and it is returned to the boiler via condensate return lines for reheating. Some systems discharge the condensate into the atmosphere or down a drain, both of which are energy wasteful and costly practices.

Steam traps are commonly classified by the process that causes them to open and close. The three main categories of steam traps are mechanical, thermostatic, and thermodynamic. Some traps combine the characteristics of these basic categories, as in the fixed orifice.

Mechanical steam traps are driven by the *difference in density* between condensate and steam. The denser condensate rests on the bottom of any vessel containing the two fluids. As more condensate is generated, its level in the vessel will rise. This action is transmitted to a valve via either a "free float" or a float and connecting levers in a mechanical steam trap.

Thermostatic steam traps are driven by the *difference in temperature* between steam and sub-cooled condensate. Valve actuation is achieved by the expansion and contraction of a bi-metallic element or a liquid filled bellows.

Thermodynamic steam traps are driven by the *difference in pressure* applied by steam and condensate, with a disc that rises and falls depending on fluctuations in pressure between steam and condensate. Steam will tend to keep the trap down and closed, and as the pressure increases it reduces the pressure in the upper chamber and allows the disc to move up for condensate discharge.

Fixed orifice steam traps contain a set orifice in the trap body and continuously discharge condensate. They are designed to be self-regulating. As the rate of condensation decreases, the condensate temperature will increase, causing a throttling in the orifice and reducing capacity due to steam flashing on the downstream side. An increased load will decrease flashing and the orifice capacity will become greater.

Maintenance

In steam systems that have not been maintained for 3 to 5 years, between 15% to 30% of the installed steam traps may have failed; thus allowing live steam to escape into the condensate return system. Maximum steam loss occurs when a trap fails in the fully "open" position. The table on the following page reveals how much steam can be lost by a trap stuck in the "open" position. Clearly, monitoring steam traps should be a high priority. Leaking traps should account for less than 5% of your trap population. A weekly, monthly, or annual survey is recommended, depending on the steam pressure used, and will likely reveal significant losses.

Care must be taken to minimize condensate backup, which can lower steam quality and increase the potential for water hammer. Water hammer occurs when a volume of condensate, called a

Leaking Steam Trap Discharge Rate*

Trap Orifice Diameter, inches	Steam Loss, lb/hr			
	Steam Pressure, psig			
	15	100	150	300
1/32	0.85	3.3	4.8	–
1/16	3.4	13.2	18.9	36.2
1/8	13.7	52.8	75.8	145
3/16	30.7	119	170	326
1/4	54.7	211	303	579
3/8	123	475	682	1,303

* From the Boiler Efficiency Institute. Steam is discharging to atmospheric pressure through a re-entrant orifice with a coefficient of discharge equal to 0.72.

Source: U.S. Dept of Energy

slug, is whisked through the steam system at high speeds and when it reaches an obstruction in the piping, such as a valve, T-Junction, or bend, it is stopped abruptly. This impact not only wastes energy, but can destroy equipment as well. In some systems slug flow can be as high as 82 mph and dangerous if it blows out a valve or strainer.

The two most common causes of steam trap failure are:

1) Over sizing, which causes traps to work too hard. In some cases, this can result in blowing of live steam. For example, an inverted bucket trap can lose its prime with an abrupt change in pressure. This will cause the bucket to sink, forcing the valve open.
2) Dirt build-up. While dirt is always being deposited in the steam system, excessive build-up can cause plugging or prevent a valve from closing. Dirt is usually produced from pipe scale or from over-treating chemicals in a boiler.

The mechanical procedures for repairing and/or replacing a steam trap are beyond the scope of this article. However, one of the best ways to routinely check steam trap integrity is to set up a steam system maintenance program that includes regular testing and documentation.

Diagnostic tools

There are two main types of diagnostic tools which help assess steam trap functioning. An infrared thermometer allows for accurate, non-contact temperature readings. An ultrasonic analyzer detects distinct sound patterns allowing the user to compare those sounds to trended sound signatures for comparison and evaluation.

Documentation

For a maintenance management program to work it is imperative to identify and document all components in the steam and condensate return system. If there are no drawings of the systems, new ones should be developed. The blueprints should outline the entire system, including boilers, main distribution lines, and the heat transfer system. Locations of heat exchangers, steam traps and valves should be included for future surveys. All devices should be tagged with identifying numbers which are then recorded on a plant or building map. Software that allows for analysis and extrapolation can also be very beneficial, especially if it accommodates steam traps, control, safety, and check valves. This information should be stored for record-keeping and future analysis. This, along with the other measures discussed, will ensure that your steam system is performing optimally and not wasting energy and money!

More information on steam traps can be found at these websites:

http://www1.eere.energy.gov/industry/bestpractices/software.html

http://www.energysolutionscenter.org/BoilerBurner/Eff_Improve/Steam_Distribution/Steam_Piping_Best_Practices.asp

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