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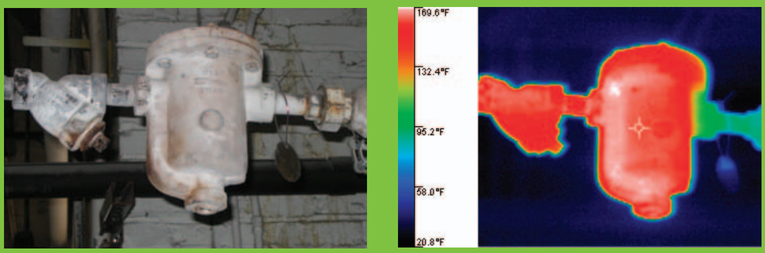
Inspecting steam systems

Application Note

According to the U. S. Department of Energy (DOE), more than 45 percent of all the fuel burned by U.S. manufacturers is consumed to raise steam. "Steam is used to heat raw materials and treat semi-finished products. It is also a power source for equipment, as well as for building heat and electricity generation. But steam is not free. It costs approximately $18 billion (1997 dollars) annually to feed the boilers generating the steam."

Generally speaking, steam is a very efficient way to transport heat energy because the amount of latent heat required to produce steam from water is quite large, and steam is easily moved in pressurized piping systems that can deliver that energy at manageable costs. When steam gets to its point of use and gives up its latent heat to the environment or to a process, it condenses into water, which must be returned to the boiler for re-conversion to steam.

Several condition-monitoring technologies are useful for monitoring steam systems to determine how well they are functioning. Among those technologies is infrared (IR) thermography, in which technicians use thermal imagers to capture two-dimensional images of the surface temperatures of equipment and structures. Thermal images of steam systems reveal the comparative temperatures of system components and thereby indicate how effectively and efficiently steam system components are operating.



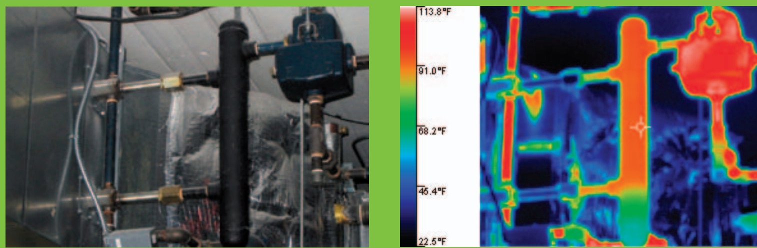
When operating correctly, as in this example, steam trap thermal images should show an abrupt change in temeperature.

What to check?

Using a combination of ultrasound and thermal inspections significantly increases the detection rate of problems in steam systems. Check all steam traps and steam transmission lines, including any underground lines. In addition, scan heat exchangers, boilers and steam-using equipment. In other words, examine every part of your steam system with a thermal imager.

What to look for?

Steam traps are valves designed to remove condensate as well as air from the system. During inspections, use both thermal and ultrasonic testing to identify failed steam traps and whether they have failed open or closed. In general, if a thermal image shows a high inlet temperature and a low outlet temperature (< 212 °F or 100 °C), that indicates that the trap is functioning correctly. If the inlet temperature



This image shows the steam feed, into the HVAC duct. The feed tube shows condensation in the bottom of the vertical tube.

is significantly less than the system temperature, steam is not getting to the trap. Look for an upstream problem—a closed valve, pipe blockage, etc. If both the inlet and outlet temperatures are the same, the trap probably has failed open and is "blowing steam" into the condensate line. This keeps the system operating but with significant energy loss. Low inlet and outlet temperatures indicate that the trap has failed closed and condensate is filling the trap and the inlet line.

Also use your thermal imager while your steam system is operating to scan: **Steam transmission lines** for blockages, including closed valves, and underground steam lines for leaks, **heat exchangers** for blockages, **boilers**, especially their refractories and insulation, **steam-using equipment** for any anomalies and **recent repairs** to confirm their success.

Consider creating a regular inspection route that includes all key steam-system components in your facility, so that all traps are inspected at least annually. Larger or more critical traps should be inspected more frequently, as the potential for loss is greater. Over time, this process will help you determine whether a hot or relatively cool spot is unusual or not and help you to verify when repairs are successful.

What represents a "red alert?"

Steam is very hot and often transmitted at high pressure, so any condition that poses a safety risk should take the highest repair priority. In many situations, the next most important kinds of problems to deal with are those that can affect production capabilities.

What's the potential cost of failure?

The cost to an operation that completely loses its steam system varies from industry to industry. Among the industries that use the most steam are chemicals, food and beverage processing and pharmaceuticals. Hourly downtime costs for these industries are estimated between $700,000 and $1,100,000 an hour.*

Viewed another way, in a 100-psig steam system, if a medium-sized trap fails open it will waste about $3,000 per year. If your facility has performed no maintenance of steam traps for three to five years, expect 15 to 30 percent of your traps to have failed. So, if you have 60 medium-sized traps on your 100-psig system, losses from "blow by" are likely to be between $27,000 and $54,000 a year.

Follow-up actions

The DOE program for Steam Trap Performance Assessment recommends "sight, sound and temperature" as the dominant techniques for inspecting steam traps. According to their data, implementing a basic annual inspection of the steam traps and associated equipment with infrared inspections will likely reduce steam losses by 50 % to 75 %.

A sensible approach to a steam system management program is to establish repair priorities based on safety, steam/energy loss, and possible impact on production and quality loss.

Whenever you discover a problem using a thermal imager, use the associated software to document your findings in a report, including a thermal image and a digital image of the equipment. It's the best way to communicate the problems you found and to suggest repairs.

*Source: Washington State Chapter of the Association of Contingency Planners

Reporting tip:

Make room on your report form to schedule a follow-up inspection. This can be something as simple as leaving a blank space labeled "follow-up thermogram" or entering an actual date. Plan your workload so that you can provide a follow-up inspection quickly after repairs have been made. Some thermographers leave the last Friday of the month as a day to do this. It not only gives you a chance to validate the repair, but also to build good will with the crew that did the repair work. More importantly, it gives you a chance to find out what was actually wrong and perhaps even see the damaged components. This is vital to your long-term growth as a thermographer.

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