Customer complaining about fuel costs on a two-pipe steam system?

Fix the radiator traps!

by George Carey

We have spent a lot of time recently talking about ways to save on fuel costs with hot water heating systems. What gets neglected or ignored is all of those steam systems that are still out there and not working properly, causing a significant waste of fuel. These systems should not be ignored. By paying attention, understanding how these systems are supposed to work and convincing your customer to *invest* in their heating system, you can greatly improve the distribution and operation of these systems.

A properly operating steam trap is key to a two-pipe steam system. Unfortunately, the trap is often the least maintained part of the system. The trap is important because, when it is working, it prevents steam from passing into the return piping, drains condensate from the radiators, and vents air from the radiators into the return piping. It is not maintained because its operation is not understood by most people who are in a decision making position: property managers, condominium board of trustee members and owners of beautiful old mansions! This lack of understanding leads most owners of radiator traps to view these valves as brass elbows.

In fact, most of these people believe that when YOU install a new steam boiler in their building, you have actually installed a new HEATING system and everything should work perfectly! It's always fun to stand in the boiler room with the service manager and the building owner and try to explain why the heating system isn't working any better after the new boiler was installed!

Pressure differential is what causes steam to move throughout a heating system. It moves from high pressure to low pressure. The steam flows from the boiler out to the cold pipes and radiators. As the steam hits the cold metal, it gives up its latent heat and condenses back into water. During this process of giving off heat, the steam drops in pressure. The steam back in the boiler senses this drop in pressure and goes chasing after it.

In a two-pipe system, the steam travels to the radiator in one pipe and the condensate returns in the other pipe. If the steam is allowed to pass into the returns, the system will start to lose its pressure differential. This eventually creates cold radiators because air becomes trapped between the steam in the supply and return pipes. Service technicians sometimes forget about air in the system, but it is an important variable. It takes up space and can prevent steam from entering radiators and pipes. Air is always present in steam systems, both before the system starts and in between cycles when the boiler cycles off. It is important to remember that while air and steam are both gases, they have different densities. Consequently, one won't go where the other is. This is why air vents are required on one-pipe steam radiators.

How A Trap Works

In a two-pipe trapped system, there shouldn't be any vents on the radiators, so one of the functions of the radiator trap is to allow air to vent out of the radiator and into the returns. A trap should also be able to snap shut in the presence of steam and re-open when the steam condenses, allowing the condensate to drain into the returns. How does a simple trap perform all three functions? Inside the brass body, a thermostatic bellows responds to changes in temperature. The bellows is filled with a volatile liquid under vacuum. The liquid is a mixture of alcohol and water that is designed to boil at 180°F at atmospheric pressure. When the liquid boils, it flashes into a vapor and expands 1,700 times in volume. Attached to the bottom of the bellows is a plug.

When steam enters the radiator, it pushes the air out through the open trap. As the steam works its way across the radiator, the temperature surrounding the trap increases to the point where the alcohol/water mixture flashes into vapor. The expansion drives the plug into the trap's seat, closing the trap. At this point, the steam is "trapped" in the radiator and cannot pass into the returns. Because the radiator is cooler, the steam condenses back into water while giving up its latent heat. The condensate begins to sub-cool. This causes the volatile liquid in the bellows to condense. The bellows contracts like an accordion, pulling the plug off the trap's seat. The trap is open, allowing the condensate to drain out of the radiator. This cycle will repeat itself until the thermostat shuts the boiler off.

Signs Of Trouble

Of course, the trap has to be working for all of this to happen. Think of what could happen if the trap isn't open on start up or can't close when the steam arrives. If the air can't get out of the radiator, the steam can't get in. That's usually when someone decides to raise the pressuretrol setting. Unfortunately, it seems to work, but not for the right reason. With higher pressure, the steam compresses the air in the piping and ra-

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diators and reaches a little further into the system. Like the old adage says, "if five pounds of sugar is sweet, ten pounds has to be sweeter." The pressure is increased even higher.

Unfortunately, with higher pressure comes higher temperature steam. Now the radiators that were getting steam before are so hot, the windows need to be opened for some relief. This is very common in commercial buildings. Ever notice windows open in the middle of the winter? It's an expensive way of providing comfort, especially with expected cost of fuel increases coming this winter.

If the trap fails in the open position, the problems are just as bad, but the culprit is more elusive. With an open trap, the steam is allowed to enter the returns, which slows the distribution of steam to the building. Eventually, the pressure in the return approaches the pressure in the supply. Without a difference in pressure, the steam stops dead in its tracks. I've seen some buildings where certain apartments won't heat at all while other apartments on either side are heating fine. However, the owner of the radiator with the bad trap never complains because his radiator still heats. If anything, he's probably too hot, but he simply opens the window!

Faulty Corrections

A service technician, when faced with cold radiators on a two-pipe system, usually will take the cover off the trap while the system is on. Many times, he is met with a puff of air, causing him to believe there is an air problem. Therefore, he installs a one-pipe air vent on a two-pipe trapped radiator—a radiator, by the way, which hasn't needed an air vent since the day it was installed.

The vent is installed and suddenly the radiator heats. Well, at least for a while. Then the water hammer and spitting vents start. This is because the steam is allowed to flow from both the supply and return risers toward the air vent. Once the steam condenses, the condensate attempts to drain down the return line. This line, though, was never sized to have condensate drain counter to the flow of steam coming up the back way. The velocity is too high, so the steam drives the condensate back towards the radiator and vent. Instead of going through all of this, the trap or traps just need to be fixed or replaced.

A Two-Pipe Steam System Is Like A Ladder

The next time you are faced with trying to convince a property manager or a homeowner that it is in their best interest to fix their traps, explain it to them this way: Think of your two-pipe heating system as a ladder. One side of the ladder is the steam supply, each rung is a radiator and the other side of the ladder is the return side of the system. The trap's main job is to prevent the steam from passing through any of the rungs into the returns.

Then imagine putting air into your car's tire with a compressor. You have to set the compressor setting higher than the pressure in your tire so that the air will be able to enter. Now, as you're putting the air in the tire, the bell is dinging away. As the tire fills with air, you notice the dinging starting to slow down. Eventually, it comes to a complete stop. The reason, of course, is that the pressures have equalized. No more air can enter the tire, just like no more steam can flow once the pressure in the returns equals the pressure in the supply mains. Bad traps cause slow, uncomfortable and inefficient heating. They need to be maintained.

If you have any questions or comments, call me 1-800-423-7187 or e-mail me at gcarey@fiainc.com.