How to Make a Steam System More Efficient

George R. Carey, Jr.
Vice President, Fluid Industrial Associates
gcarey@fiainc.com twitter: @Ask_GCarey

With focus on high efficiency and "greening" the heating industry, low temperature system designs and applying outdoor reset controls to every hydronic system, steam systems are being viewed as highly inefficient. The current approaches described are all good ones, of course, but they've resulted in the notion that steam systems *must* be converted to hydronic systems instead. Naturally, if it's an option, then converting to a forced hot water system has benefits. Unfortunately, the possibility isn't always available. That being the case, there are steps you can use to greatly improve the operation and reduce its consumption of energy.

Size the boiler correctly

It is essential to make sure your boiler is sized properly so that when the thermostat calls for heat, the boiler can produce enough steam to fill all the radiators and associated piping. When boilers are too big, they cause short-cycling, which hurts the boiler's efficiency. Conversely, if the boiler is too small, when the thermostat calls, the boiler will run forever without building any pressure, heating only a portion of the building. This is a tremendous waste of energy, expensive and not very "green."

How do you provide a properly sized steam boiler? You need to count the connected load. This means you have to walk throughout the home or building and calculate each radiator's square foot rating. Then you add up the total load in square feet and select the boiler that has the closest capacity to your connected load. This is the most effective way of making sure the boiler will meet your system's needs.

Make sure to insulate the mains

Steam is water that has enough heat added to change it to a gas state. This gas desperately wants to change back into water and it does so every time it comes in contact with something cooler that itself. Old-timers insulated the mains so that the steam the boiler produced ended up in radiators where people live, not condensing in piping downstairs. They knew that a bare steel pipe experienced heat loss five times greater than an insulated pipe.

Unfortunately, the material of choice back then was asbestos. We all know now that might not have been the best choice, but in fairness it was all they had at the time. When that asbestos insulation gets removed, you really should replace it, otherwise the boiler may become undersized, creating very warm basements with cold and unhappy people upstairs as well as higher fuel bills.

Can air get out?

Steam and air are both gases but with different densities. When the system is off, all piping and radiation above the water line is filled with air. Once the boiler starts making steam, it wants to escape the system. If the air can't get out quickly and easily, the steam will start to build pressure back in the boiler. The pressuretrol will respond to this by shutting the burner off. Of course, the steam didn't get very far into the system and what did quickly condenses, dropping the pressure. Before you can say "short-cycling," the burner is back on, steam heads out into the system, bumps up against the air, pushes, pressure increases and the burner is off again. This represents a considerable waste in fuel consumption and a very uncomfortable heating system upstairs. Resist the urge to turn the pressuretrol up to stop the short-cycling, because the issue is air! If you have a one pipe system, make sure all the radiator vents are working properly.

Over the years, rust flakes and other debris can get picked up with the steam to become lodged in the vent's port opening. This will decrease venting capacity or worse, not allow the vent to close in the presence of steam. While you are wandering through the system, check to make sure the mains are properly vented with *main* steam vents. By venting the mains with large capacity vents, steam will be able to travel to the ends of the main very quickly. This greatly improves the distribution of steam throughout the building. The result is heat moves from the boiler room to the people upstairs faster, satisfying the thermostat and turning the burner off. This saves fuel consumption, lowers your heating bill and reduces your carbon "footprint".

If you are working with a *two pipe system*, instead of vents on the radiators, you will have to contend with steam traps. Even though they look very different, a steam trap has the same responsibility to remove air from the radiator so steam can get in. A steam trap is basically a thermostatic valve that opens and closes in response to changes in temperature. During the course of a normal heating season, a trap will cycle open and close approximately 150,000 times! Every year, after so many heating seasons, component fatigue alone damages these traps. Never mind water hammer, aggressive condensate, etc. So when they finally do give up their ghosts, usually steam traps will fail in one of two manners: closed or open. If the trap fails closed, no air can get out and therefore no steam can get in. The result is a cold radiator. If the trap (or more likely traps) fails to open, now steam is allowed to pass through the radiator and into the return piping. At this point, all hell breaks

loose! Once steam makes its way into the returns, the system starts to lose its pressure differential—meaning the pressure in the return lines starts to equal the pressure in the supply mains. The steam stops dead in its tracks, because without a pressure differential there is no motive force; there is no high going to low. It's all the same pressure. The system heats poorly at best, the burner runs forever trying to satisfy the call for heat, fuel consumption is through the roof and the heating bills are excessive. There is no getting around it, traps have to be maintained.

Keep an eye on the system's pH

This is a little tidbit that Dan Holohan told me about—knowing the pH level in a steam system can help prevent or solve problems where the solution isn't all that obvious. When a boiler produces steam, one of the by-products released along with it is carbon dioxide. That happens because boiler water make-up contains carbonates and bicarbonates, which break down while the boiler makes steam. This carbon dioxide travels with steam out into the system. If it is not vented right away, it will dissolve into the condensate that is formed when steam condenses. This results in the formation of carbonic acid, which is a very corrosive substance. It will slowly "munch" away at the piping and fittings. To make matters worse, oxygen (air) mixes in with the carbonic acid to form rust (ferric hydroxide). Typically, if you were to take a pH reading on your average steam system, it would be on the lower acid side of the scale.

Some guys are into using boiler chemical cleaning agents to "clean" the boiler after a new install or after some maintenance work was done on the system. Sometimes too much of a good thing can be bad. If the pH level becomes too high, the water is no longer acidic (that's good) but a high alkaline level will cause the boiler to foam when it makes steam, and this foaming creates heating problems. When the steam exits from a boiler that is foaming, it will carry some of the foam with it. Unfortunately, the water in the foam robs the steam of its latent heat before it gets out to the radiators. The boiler makes lousy steam, it runs forever trying to satisfy the thermostat, the heating bills become excessive and the homeowner is not happy. Carry with you some pH papers so you can check out the pH level of that next trouble steam job. Ideally, try to keep the level somewhere between seven (which is neutral) and nine (slightly on the alkaline side).

By applying some of these strategies you will be reducing that steam boiler's carbon "foot print" and, more importantly, keeping your customer warm and happy. **ICM**

If you have any questions or comments, e-mail gcarey@fiainc.com, call me at (800) 423-7187 or follow me on Twitter at @Ask_Gcarey.