# Can you *really* control a one-pipe steam system?

*by George Carey*

I was recently called to come look at an interesting steam problem from a local service manager. His company had replaced a steam boiler over the summer for one of their customers. The building was a large apartment building with a one-pipe steam system. While they were going through the apartments, counting the radiation load to size the new boiler, they consistently heard comments from the tenants about how hot the apartments would get during the heating season. Therefore, when it came time to quote the Management Company on the replacement boiler, the Oil Company also included a price to replace the existing radiator vents with one-pipe thermostatic radiator valves. They explained that by installing these thermostatic valves on each radiator, the tenant could now control the output from each radiator, no longer needing to open the windows for relief and thus preventing the overheating condition.

The Management Company accepted the proposal, including the thermostatic valves. The boiler and valves where installed this past summer and everything looked great. However, once the system was turned on, the tenants experienced the same problems. The service manager assumed there must be something wrong with the valves—which is why I got the call.

### ONE-PIPE STEAM SYSTEMS

One of the more common complaints I hear regarding steam systems, particularly one-pipe systems, is the lack of ability to control the system. There always seems to be some rooms that overheat while waiting for other rooms to come up to temperature. This results from an imbalance, which unfortunately is inherent in most one-pipe steam systems.

Years ago, when these systems where installed, the heating contractor was supposed to size each pipe based upon a certain pressure drop, which depended upon the load and how long the run was to each radiator. The intent was for the steam to reach all the radiators at approximately the same time. This would happen if the pressure drop was the same for all the mains and their risers and take-offs.

However, the contractor usually just sized the piping based upon the run with the greatest pressure drop. The results were the closer radiators received steam before the farthest radiators.

How do you then overcome this unbalanced situation and prevent the closer radiators from overheating? You might be tempted to throttle the supply valve, but that can create more problems. As you throttle the valve, you reduce the diameter of the opening, which creates a velocity problem. You have to remember the steam enters the same valve from which the condensate is supposed to drain. If the passage is too small, the steam will not let the condensate drain out of the valve. In fact, it will drive it towards the vent, causing it to spit water. This is usually accompanied by water hammer and potential water level problems back at the boiler.

### AIR...

The only effective way of introducing control to one-pipe radiators is to control the air venting from the radiators. This is due to the fact that steam and air are both gases, but with different densities. This means one won't go wherever the other is. Therefore, if the air can't get out of the radiator, the steam won't enter.

This is exactly how a one-pipe thermostatic valve operates. It either allows air to be vented from the radiator or not. The thermostatic operator controls this venting based upon the surrounding air temperature. This means you can have individual radiator zoning on as many or as few radiators as are required.

### HOW?

The way this control operates is interesting. It is made up of three pieces. The valve body has a 1/8" threaded nipple, which screws into the existing 1/8" tapping on the radiator (remove the original vent). A straight-shanked 1/8" steam vent is attached to the valve, so air can be vented from the radiator. Lastly, the thermostatic operator is attached to the valve body.

This operator senses the surrounding air. Based on its setting, it either expands, closing the passageway to the event, or remains open, allowing air to be vented. One last feature, one that is very important for proper operation, is the built-in vacuum breaker. As the steam condenses in the radiator and the passageway to the vent closes because the operator is satisfied, a vacuum will form in the radiator. This will hold condensate in the radiator, creating water problems back in the boiler room. It is important that the vacuum breaker prevent any vacuum from forming in the radiator.

### PAYING ATTENTION TO DETAILS

One of the most important, and least understood, details in the instruction sheets of these non-electric valves reads as follows, "The steam supply/boiler must be cycled on/off by a room thermostat or by an indoor/outdoor reset control." This does *not* mean for the *boiler to cycle off and on by the pressuretrol*. Instead, the boiler has to shut down because the thermostat has been satisfied or the reset control has cycled the boiler off. The reason is when the boiler shuts down; all the steam in the system condenses. This allows all the vents and vacuum breakers to re-open and let the air back into the system. (This includes the radiators and the piping.)

This one detail is critical for the system to operate properly. When the boiler fires back up for the next heating cycle, the steam will push the air out of the piping through the main vents. It will also push the air out of the individual radiators through their vents, BUT only through the radiators whose thermostatic operators aren't satisfied. The operators, which are closed, have blocked the

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passageway to the vents, so the air is trapped inside these radiators and cannot get out. Therefore, the steam cannot enter the radiator, thus preventing the room from overheating! Instead, the steam will move towards the radiators whose vents are still open because the operators are still open. The thermostatic valves provide better control of the one-pipe system by controlling the release of air from radiators based upon each radiator's control valve setting.

### *Back To The Job...*

The Oil Company did a great job installing and piping the new boiler as well as all the non-electric control valves. The mistake they made, which was causing all 50 thermostatic valves to be "defective," was the way they controlled the boiler. Instead of a reset control or reuse of the old thermostat, they used a setpoint control to turn the boiler on. Once on, they let the boiler cycle its pressuretrol on and off.

The problem with this type of operation is once the setpoint control enables the boiler, there is ALWAYS pressure in the system. The boiler may be off, but it is only waiting for the pressure in the system to drop to the cut-in setting of the pressuretrol. How can a steam vent or a vacuum breaker reopen if there is a constant source of steam? And if they can't reopen to introduce more air, how can the thermostatic valves do their job?

Remember that sentence in the instruction sheet regarding the need for the boiler to cycle off and on? On initial start-up, the thermostatic operators are not satisfied, so the passageways to the vents are open. By cycling the boiler off and allowing air back into the system, the operators that have warmed up can now prevent the release of air from their individual radiators, not allowing anymore steam into the radiator.

The suggestion was made to add a reset control to the system, which would cycle the boiler on and off based upon outdoor temperature. The system has been running fine ever since, and the tenants now have individual control of their radiators. More importantly, the Management Company is satisfied because the windows are no longer wide open in the winter.

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