BY WINSTON HUFF, CPD, LEED AP

Hot Water Time to Tap

Following are some of the real-world complaints I hear about domestic hot water systems. Do they sound familiar?

- After installing low-flow faucets, it takes a long time for the hot water to reach the tap.
- We had domestic hot water recirculation problems in the building where hot water was crossing over to the cold water system. It took us a long time to realize that the problem began when the housekeeping staff installed automatic soap dispensers on the outlet of the service sink faucets.
- We had hot water problems in our surgical suite. After changing hot water circulation pumps and rerouting the piping, we discovered that the problem resulted from a lack of inline check valves on the owner-furnished scrub sinks. The mixing valves allowed the hot water to cross over to the cold water.
- My gas bill went up when I installed a hot water circulation system in my house.
- We installed a sensor-operated faucet in a toilet room, and the water was never hot. After many complaints, we realized the inline check valves were not installed.
- We have had so many renovations in this part of the hospital that we will never be able to sort out all the hot water circulation problems we have.
- The construction cost was too high, so we eliminated the hot water circulation balancing valves and the balancing contractor out of the contract to save money. Now we have a new building with little hot water.
- When the health inspector came by to inspect our building, he said one fixture never had enough hot water, so we turned all the valves, including the balancing valves, full open. Now we don't have hot water in parts of our hospital. What happened?
- Several hours before the health inspector visited a new patient tower addition to a hospital, the contractor turned on all the showerheads. Right before the inspection, the showers were shut off. During the one-hour inspection, every fixture the inspector checked for temperature passed. However, after the staff moved into the rooms, patients complained about a lack of hot water because the system was never balanced.
- Will we have hot water in the new hospital tower in the middle of the night? In the old tower, we never had hot water at night.
- We have plastic tubing for water distribution with 0.5-gallon-per-minute (gpm) sensor faucets. The water always fills cold at the faucets.

The stories go on and on. Let's take a few minutes to look at hot water solutions that help buildings run efficiently as well as obtain LEED credits. Some ways that plumbing engineers can help deliver hot water where it is needed, when it is needed, include the piping layout, insulation, heat maintenance, pump timers, and installing two-piped pumped systems.

PIPING LAYOUT

Locating plumbing fixtures that require hot water close together and close to the water heater reduces materials and decreases the amount of energy used to maintain hot water temperature. Locating fixtures in a central core of the building in close proximity to the water heater or chase is one solution. Another solution is to install fixtures back to back against a common wall, or install fixtures close together. (See Figure 1.)

The architect usually performs the fixture layout, not the plumbing engineer. Thus, to reduce the piping, the architect should work with the building users to develop a layout in which the plumbing fixtures are located close together or back to back.

Mechanical spaces with water-heating equipment should be located near hot water outlets. In multiple-floor buildings, water use fixtures should be located near a common chase. Multiple showers and flush fixtures should be located near the hot water distribution system to reduce piping materials.

PIPING INSULATION

In larger systems with remote hot water outlets, hot water typically is circulated to reduce the time for hot water to reach remote fixtures. As the water circulates through the piping, the heat energy dissipates, causing the water heater to cycle on and off, which results in additional energy use to maintain water temperature.

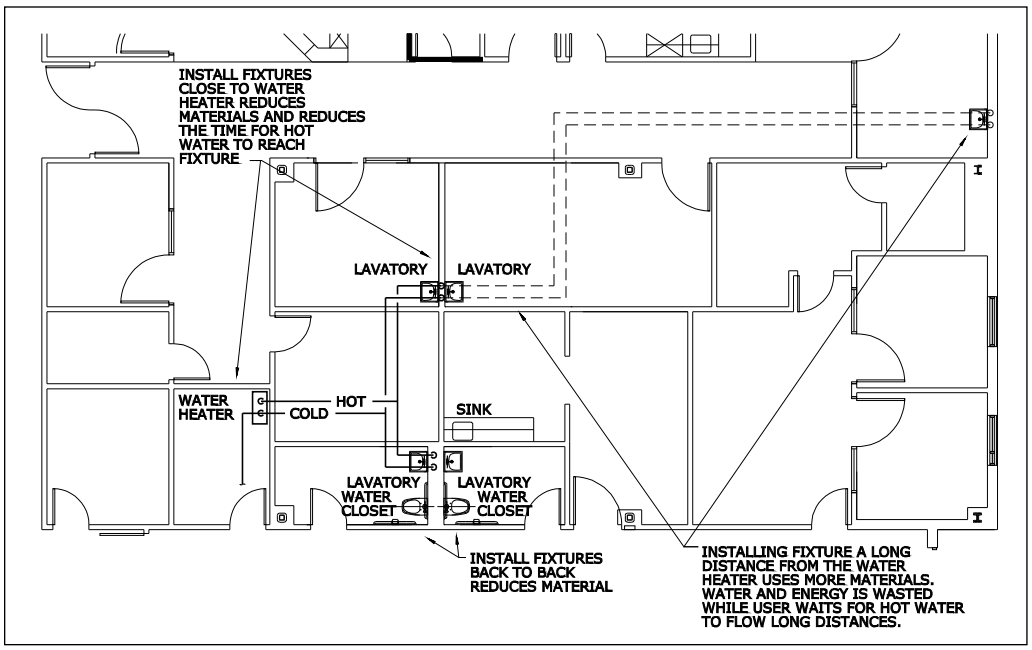

Figure 1 Floor plan with water piping layout

Installing insulation on the piping can help reduce this heat loss. All domestic hot water piping and heat recovery piping should have minimum R4 insulation per most plumbing codes and energy codes. Insulation shall be properly installed on all piping elbows to adequately insulate 90-degree bends.

On systems with self-regulating heat maintenance systems (heat tracing), the R-value of the insulation shall be coordinated. On some systems, the insulation thickness must match the pipe diameter. The plumbing engineer needs to include this in the contract documents. This is commonly overlooked by some contractors, so the plumbing engineer needs to review submittals and make sure it is picked up during installation.

Some innovative designs require higher R-value insulation. The plumbing engineer shall coordinate with the insulation manufacturer to ensure that materials are specified that will not change the UL, FM, or other listing or certification.

Insulation ratings, vapor barrier ratings, and fire and smoke ratings shall be reviewed to ensure proper specification. Close coordination with regulatory and insuring agencies, such as the fire marshal, is required by the design team.

Pipe penetrations through rated walls shall meet building codes. Materials in contact with new insulation materials, such as fire stops, shall be reviewed to ensure that materials are compatible and meet regulatory standards.

HOT WATER RECIRCULATION

Piping layout and insulation can help in projects such as small offices or residences, but most plumbing engineers design systems for larger buildings. The long wait for hot water to arrive at the tap in such systems is unacceptable to users, and it wastes clean, drinkable potable water and energy literally down the drain.

To solve these problems, a dedicated return line can be routed from the outermost hot water fixture back to the water heater with a pump that circulates the hot water to the last fixture from the water heater.

However, one problem with this type of system is that heat radiates from the pipe in the distribution system to the space around the pipe. To maintain the temperature, the water heater cycles on and off. When this pump operates 24/7, the energy usage of a building will increase.

CONTROLS

One way to reduce this cost is to install a time control on the pump so it will not operate at night or on weekends. The problem with this method is that it may be off when hot water is needed during off hours. (Hot water is still available, but the user will have to wait for it to arrive.) Such systems are covered in the ASPE *Plumbing Engineering Design Handbooks.* Every designer should follow the recommendations outlined in these books.

TWO-PIPE SYSTEMS

For retrofit applications in small office buildings or residences, a new bypass system, sometimes called a two-pipe system, does not require the dedicated return line.

This system uses the cold water supply line as the return line to the water heater. The circulator pump is used to create a pressure differential that allows the cold and cool water in the hot water supply line to bypass into the cold water supply line.

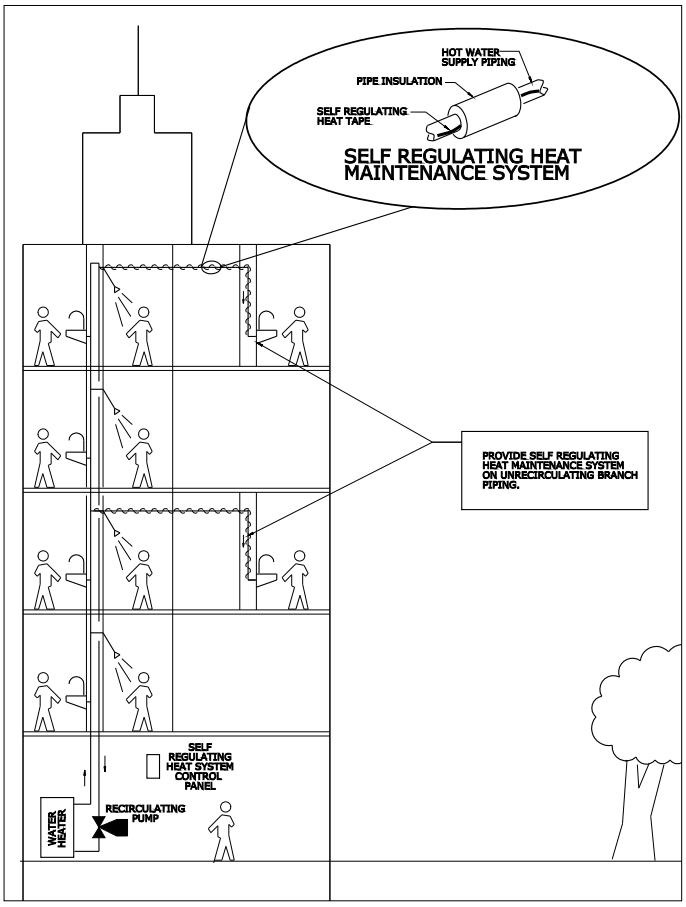

Figure 2 Self-regulating heat maintenance system on large building

Some manufacturers do this with a thermostatically controlled valve that is mounted under the faucet furthest from the water heater. The pump is installed in the hot water line usually at the water heater.

Other manufacturers do this with a thermostatically controlled valve and pump that are both installed under the faucet furthest from the water heater. This system requires a power supply near the fixture.

Like the standard recirculation system, allowing the system to run 24/7 uses more energy than a unit with a timer. Another way to control the system is to install a motion sensor or switch in the toilet room furthest from the water heater to actuate the circulating pump. In these situations, the hot water is circulated in a short time without wasting water and energy down the drain while the user waits for hot water at the tap. Using controls can reduce the energy usage of the system while supplying hot water quickly to the spout.

As the system gets larger with many hot water zones on different levels, these systems get very complicated. Larger systems require balancing valves with system balancing before the owner occupies the building. Over time, these balancing valves get changed and the system may expand. The end result is that the system is hard to maintain in an efficient way.

It is interesting to note that in most commercial lavatories, users will not wait for the hot water to arrive at the tap. Most of the time they are finished using the faucet before the hot water arrives. The end result is that the user did not wash with tempered water, and the energy that was used to heat the water does not reach the user.

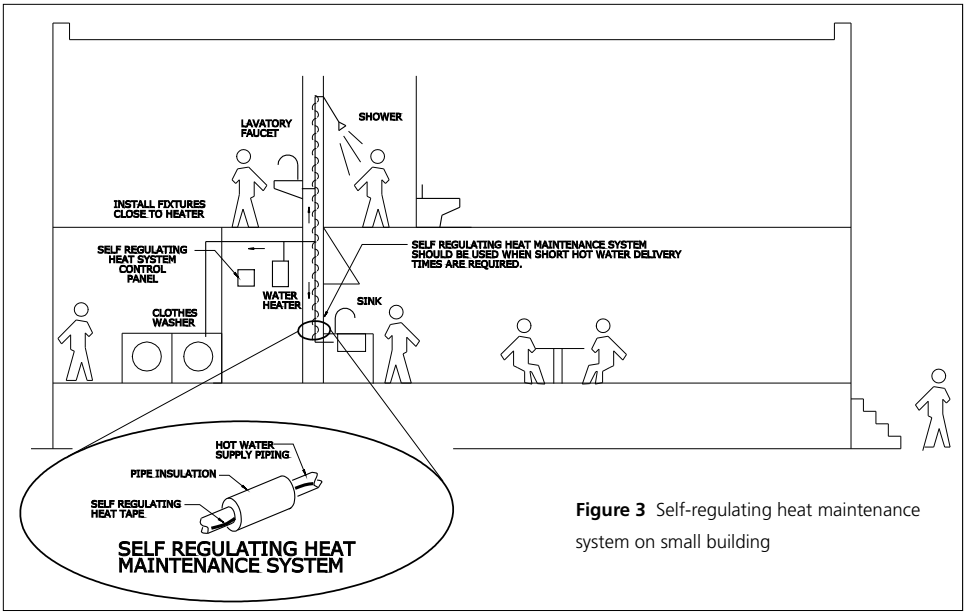

Figure 3 Self-regulating heat maintenance system on small building

HOT WATER TEMPERATURE MAINTENANCE

Another option to maintain the temperature in a hot water distribution system is the use of a hot water temperature maintenance system. This system does not have the dedicated hot water return line or the pump, and it uses an electronic controller, self-regulating heating cables, and connection kits. (See Figures 2 and 3.)

The system uses self-regulating heating cables wrapped on the hot water distribution piping under the piping insulation. These systems are made to maintain the temperature of the hot water in the pipe. The system can operate on copper or rigid plastic pipe. Check with the manufacturer to see if they are compatible with other types of pipe material. Each manufacturer has recommendations for the insulation thickness and the method of securing the piping to the copper or rigid plastic pipe.

The system requires a power distribution panel that distributes current, protects circuits, and integrates with an electronic controller. This should be located in an accessible area. More than one panel may be required on larger systems.

The system also requires a controller to regulate the temperature of the water in the pipe. Some controllers allow the control option to heat up the temperature in the piping or cycle back when the building is not in use.

These systems can be installed over the entire building hot water distribution system, or the main line may have a return line with a pump, and the branch lines could use the heat maintenance system. The advantage of this installation is that the heating cables can be installed on most of the hot water run of the piping to the fixture. When installed properly, this system can reduce the complexity of the system when compared to the pump and return piping system.

CONCLUSION

As buildings grow in complexity, low-flow fixtures add to the time it takes for the hot water to reach the tap, and building owners do not want to waste water and energy down the drain waiting for hot water, plumbing engineers will need to know the different options available to them. An efficient design will save the owner installation cost because of the reduced amount of materials and reduce operations cost with the reduced energy and water usages. PSD

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