# A Guide to Safe Water Within the Home

BY DAVE YATES AND JOHN VASTYAN

There are enemies lurking within your home. Just beyond each faucet and shower fixture, the pipes that feed them are — in most homes — filled with bacteria and parasites. Some of these, like the parasite Cryptosporidium, are quite dangerous. The good news is that there are sensible and cost-effective ways to rid your home of these unwanted guests. We'll guide you to the solutions.

Over the past two decades, there has been a push to lower water-heater thermostat settings in the United States from the previously adopted standard of 140° F to a safer setting of 120° F. The motive: safer temperatures at tap and shower. Though it did help to accomplish this, each year there are still over 100,000 injuries in the United States (leading to an average of 70 deaths) from bath and shower scalding. Yet, experts at the Centers for Disease Control say many more people die from exposure to Legionella bacteria, which are commonly found in home piping systems.

A second reason for lowering hot-water temperatures within the home is energy savings. The assumption was that your money — and precious resources — would be used with greater care.

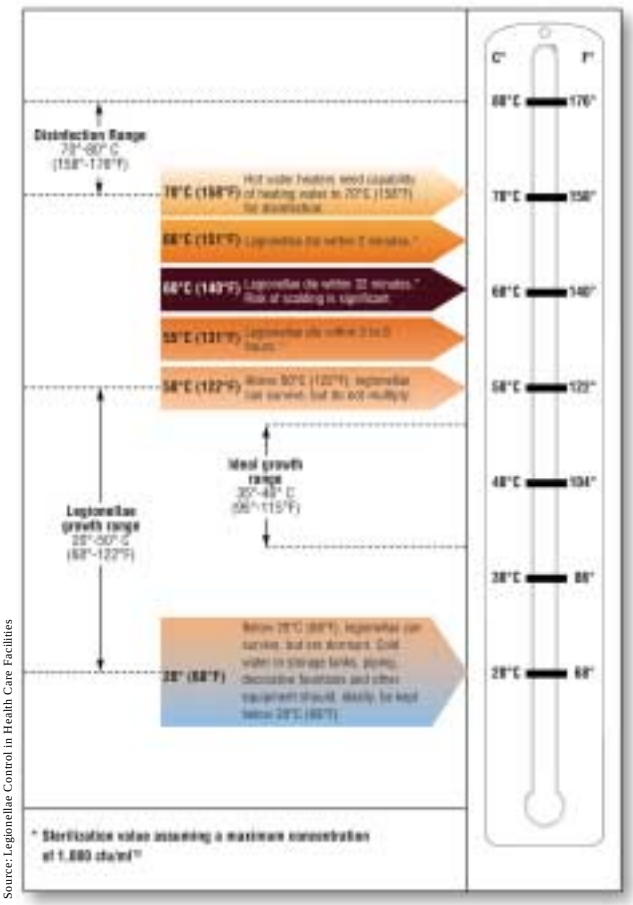
So what have we gained? We haven't eliminated scalding injuries within the home, and new insulation standards for water heaters (as well as retrofit blankets) have substantially reduced the standby heat loss of water heaters, so the energy savings from lowering the set-point temperature below 140° is reduced. But now we find we've created a potential bacteria breeding farm with all the right ingredients for raising a bumper crop of Legionella and other bugs that can make us sick, or worse!

Legionellae are opportunistic bacteria with some very interesting characteristics. At temperatures up to 55° F, lowly single-celled amoebas readily consume them. But once past that temperature point, an odd thing takes place. The Legionella becomes the aggressor and attacks the amoeba. When this happens, it inhabits the amoeba, feasts on its innards and uses its outer shell, or cyst, as a shield against bactericides such as chlorine. It soon outgrows the host and bursts forth to colonize, attach to biofilm, or be ejected from the plumbing system via a faucet or showerhead. The shower is Legionella's best weapon, by the way. Fine water mist carries the germs directly into the lungs, where they set up camp to launch an attack.

Biofilm forms when bacteria adhere to surfaces in aqueous environments and begin to excrete a slimy, glue-like substance that anchors them to the inner walls of plumbing pipes and tanks; a biofilm can be formed by a single bacterial species, but more often a biofilm consists of many species of bacteria, as well as fungi, algae, protozoa, debris and corrosion products.

If you doubt this, remove the top of your toilet tank and feel the inside wall. Just don't forget to wash your hands afterward. Here's what Legionella likes about potable-water systems:

- Biofilms — present in all potable-water piping and tanks;
- Temperatures between 55° and 135° F;
- pH of 5.5 to 8 — virtually all potable-water systems, with 7 being neutral;
- Stagnation — when you're not using water;




Source: Legionellae Control in Health Care Facilities

***How Legionella responds in a laboratory setting. Scaling and biofilm within your plumbing system will affect these numbers.***

• System volume — the bigger the playing field, the greater the number of spectators;

• Dead legs — aptly named — where the guest bathroom sits idle for months on end.

Even chlorine, our venerable ol' bactericide, isn't effective against Legionella, not even at concentrations much higher than we could safely consume. So what to do? The simplest method available for maintaining bacteria-free hot water is to elevate its temperature above 137° F and keep it at that, or higher. At 140°+ F, virtually all bacteria are killed, but not immediately (At 140° F, Legionella dies within 32 minutes; at 151° F, free-roaming Legionella dies within two minutes). Clearly, it takes time, and that's why sudden bursts of hot water won't work.

The combination of 140° F water with constant circulation is the only reliable way to kill bacteria and maintain sanitary potable-water pipes. This method maintains the set temperature within the piped system so that cooling cycles between hot-water uses don't give bacteria an opportunity to recover and grow.

Courtesy Watts Radiant

***A reverse-osmosis system is installed on the cold-water supply line and filters water at the molecular level.***

But that solution presents another challenge, of course. Scalding risks increase. It's a risky Catch-22.

Recent technology may provide the solution. The recipe for safe home plumbing has three or four key ingredients, ideally applied as a home is built. Though retrofits to existing homes can also be done, they just require a bit more time. We'll look in greatest detail at the most important of these: the mixing valves.

• Mixing valves at the heat source, and at each hot-water faucet and showerhead, are at the top of the list. The safest of these are thermostatic/pressure-balancing mixing valves. These protect users from risk of burn, even though you can now raise the temperature of water within the pipes (hot-water lines should be insulated to conserve energy). We'll return to these in greater detail.

• Constant circulation, as the term implies, means the hot water is moving

## BACTERIA STEW AND THE HOT TUB GOO

Like most folks who buy a hot tub, we wanted one as a new source of fun and relaxation. We gave little thought to bacterial issues and water-quality monitoring.

The literature for the tub gave us the impression that the additional self-metering, built-in bromine tablet dispenser was all we'd need to maintain our sanitary oasis, a source of comfort for achy bones. Large enough to accommodate six, we enjoyed soaking under snowy skies.

But then it started. Odors and murky foam along the edges. We added chemicals. And the pH tests became a daily routine. Yet we had a nagging feeling something wasn't right.

Wrongly, I'd assumed that the hot tub was no different than a pool. Then I got a startling revelation one day; it occurred to me that when you compare the volume of water between a pool and a hot tub while considering body mass, two people in the tub equates to 600 people in the pool! Imagine the havoc that wreaks on the chemical balance! I also learned that rise in water temperature, every 10° F, doubles the effect of chemical reactions.

And there are good reasons why just two bodies can create rapid chemical changes within the hot tub's environment. We people are covered with residual soap, perfume, deodorant, dead skin, loose hair, a host of body oils and good ol' goo! On top of that, we sweat profusely in hot water. You've surely noticed signs at public or health-club pools requesting you to shower before entering the hot tub, but we all plunk our unwashed bodies into one at home without a second thought. Consider a pre-wash and limit soaking time.

What's all this goo going to do for a hot-tub environment? Why, bacterial growth, of course. If you ignore the need for simple maintenance, you'll be setting up a bacterial stew. There's that Legionella thing again, and this time, we're providing the ideal temperature ranges too. There's also the risk Cryptosporidium, Giardia, E. coli and Shigella. Rounding up our basic intro to bacteria is Pseudomonas aeruginosa, a bacterium that revels in hot-tub environs, which typically causes skin rashes and can be deadly in rare cases.

Changing the water seems somehow foreign, but the formula goes like this: No more than 30 days between water changes, or divide 1/3 of the volume by the number of daily users to arrive at the frequency of complete water change-outs. Filters must be changed no less than twice a year and preferably more often. Harsh cleaning with pressure washers or chemicals can destroy good filter performance. If you start out on a daily monitoring program and avail yourself of classes gladly taught by local hot-tub dealers, you can easily avoid the stew and the goo.

*Dave Yates*

continually. The reason for this is to wash the pipes routinely at temperatures sufficient to kill bacteria. Temporary bursts of hot water don't have a lasting effect on bacteria, and — without constant circulation of hot water — the dead-leg zones fester, serving as bacterial nurseries for the rest of the home.

If you're building a new home, your plumber can easily determine the best method for constant circulation. Small pumps — and properly sized rigging of the pipes — are installed from the get-go. Otherwise, for existing homes, there are small devices that can be installed on the hot-water line to accomplish the task almost as well. Naturally, this requires more piping in order to return the hot water to the water heater, but insulating the pipes with inexpensive foam-rubber sleeves can offset the increased heat loss. While you are at it, insulate the cold-water pipes, as well, and you will prevent annoying (and sometimes damaging) condensation in summer.

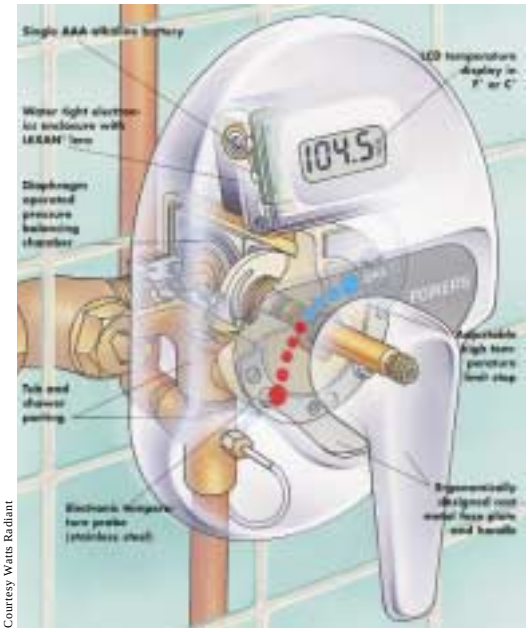
• Reverse osmosis (RO) for the cold-water line. Even the finest bottled drinking water is rarely more than water pressed through the rigorous RO filtering process. Today, water of equal quality is available at your countertop, making other sources obsolete. These systems aren't used on the hot-water side, however. They're typically installed for drinking water delivered at a separate tap at the kitchen sink, and perhaps also for the refrigerator and ice-maker. Prices typically fall within the $200 to $500 range (see www.premierh20.com, www.culligan.com, www.haguewater.com). Some bottled-water drinkers could recover their investment quickly.

An advanced, high-volume, composite membrane — the heart of the RO system — filters water down to the molecular level. The system's several stages of filtration separate purified water from rejected impurities down to 1/10,000 of a micron, eliminating up to 98 percent of all TDS (total dissolved solids) as well as contaminants like arsenic, lead, copper, chromium, hexavalent chromium, cadmium, radium, fluoride, nitrates, herbicides, pesticides, and all dirt, sand and rust. What remains is pure water with great taste and clarity. These work with chlorinated or non-chlorinated water supply.

One of the best of these systems is a zero-waste RO unit introduced last year. This system, in addition to being one of the best purifiers of drinking water, is a miser of your water supply. Rejected water is simply channeled through a connection into the home's hot-water line. All other systems typically waste 80 percent of water drawn for filtration, discharged into the wastewater stream.

• Ultraviolet (UV) light treatment for well-water systems. Strong sunlight disinfects water by permanently deactivating bacteria, spores, molds and viruses. In the electromagnetic spectrum, the UV wavelengths most effectively neutralize many of the harmful waterborne organisms.

And, unlike using chemical disinfectants to which organisms can develop immunity, UV systems kill quickly and continually. With UV systems, water is channeled through a chamber where a powerful UV light bombards the organisms with UV photons, fusing DNA and preventing reproduction.




Courtesy Watts Radiant

***Pressure-balancing tempering valves safely allow higher water-heater temperature settings.***

Back to mixing valves. We'll start with the most basic of these, the type-P valve, and work our way quickly to the newest and most effective technology (the T/P valves).

The pressure-balancing valve (type P), is designed to adjust water temperature automatically by maintaining a mix of hot and cold water within 3° F of the set point when pressure changes occur in the system. For instance, when a toilet is flushed or an appliance is turned on. While type-P valves provide an excellent way to compensate for pressure fluctuations within a plumbing system, they cannot make adjustments for sudden, or gradual, changes in supply temperature. If hot-water supply-line temperature unexpectedly increases to a dangerous level while inlet water pressure remains constant, the pressure-balancing valve will continue to pass water but at a dramatically increased temperature. These require

seasonal adjustments of the limit stop, especially important in regions where extreme weather conditions dramatically affect temperature from water sources such as lakes and rivers.

Type T, or thermostatic, mixing valves compensate for both fluctuations in temperature and pressure. Type-T valves are designed to mix hot and cold water, delivering blended water at a constant, selected temperature. The key advantage these devices have over type-P valves is that they have a temperature-sensing device. There's no need to adjust the limit stop from season to season. The valve makes the temperature correction automatically to maintain the high limit set point.

Combination valves, or type T/P, meet the most stringent performance requirements for both temperature and pressure changes. They allow water to be generated and distributed at higher temperatures to kill armies of germs while coming out of the spout at safe temperatures to the bather. They, too, require no seasonal adjustment of the limit stop.

There was a time when these valves were both expensive and not nearly as reliable as they are today. The cost has dropped dramatically as demand and orders have steadily increased.

There you have it. Mixing valves permit higher water temperatures to kill the bugs, and constant circulation of the hot-water lines will see to it that the kill zone stays active. On the cold-water side, UV systems are effective against most microorganisms, especially coliform bacteria coming into well-water systems — the reason these are most frequently prescribed. To remove any remaining impurities, and for the best-tasting water you've ever had, RO systems (whether for city water lines, or for well water) are the final step. ■

---

*John Vastyan is president of Common Ground, Uncommon Communications based in Manheim, Pa. He can be reached at 717-664-0535.*

*Dave Yates is a master plumber and owns the PHVAC firm F.W. Behler in York, Pa. He can be reached at 717-843-4920 or at behler@blazenet.net.*