



Design Strategies to Maintain Flow

Overview

The plumbing industry faces continuous pressure from an increasing number of challenges. Codes continue to evolve, presenting stricter requirements for system designers and installing contractors. Materials, tools, software and their features constantly improve, making engineers and contractors evaluate what's right for their business and their customers every day. Building science is advancing more rapidly than ever before, demanding creative solutions during the design and construction processes. Industry standards continue to be introduced and revised, which raises the bar for system performance and material requirements. One outstanding example of this is ASHRAE 188[P], the first official standard to address Legionella in building water systems. This standard should cause plumbing engineers, installers and facility operators to seriously think about the potential of their system to promote microbial growth. A myriad of potential solutions have been introduced to the market aimed at controlling or eliminating pathogens from plumbing systems. These solutions range from on-site disinfection systems, like copper-silver ionization systems and chlorine dioxide generators, to hyperchlorination and thermal disinfection. One solution designers should not overlook is taking steps to reduce the risk of microbial growth in the first place. Sound system design should acknowledge the importance of minimizing microbial growth and focus effort on reducing colonization, not just treating a bacterial problem once it's established and detected.

Two strategies that have been shown to be effective at minimizing microbial colonization in plumbing supply systems are keeping the water temperature outside the Legionella growth range and maintaining flow.

Keep water temperature outside Legionella growth range

Maintaining water temperatures outside of the growth range for Legionella makes it difficult for the bacteria to colonize. The bacteria cells become unable to reproduce at temperatures above 122°F. At temperatures above 131°F, the bacteria begin to die. The issue is complicated by the biofilm in which the bacteria may live. Because it is a protective insulating film, bacteria within the biofilm may not be subject to elevated system temperatures. This is especially important when thermally disinfecting a system. For thermal disinfection to be effective, all Legionella cells in every part of the system must be subject to temperatures of approximately 160°F for at least five minutes, including within the biofilm itself, or the disinfection process will be incomplete,

leading to future re-colonization. Similarly with chemical disinfection, disinfectants can only kill what they come in contact with. This is why it is important to try to prevent microbial growth and biofilm formation in the first place. Good design can enable all parts of the system to be maintained at a temperature above the highest colonization temperature, thereby reducing the possibility of bacteria to multiply.

Maintain water flow to reduce likelihood of colonization

The second strategy is maintaining flow, which offers several benefits. First, water in motion can make it more difficult for bacteria to establish itself along the pipe wall. When immersed in flow, bacteria does not have the opportunity to settle on the pipe surface. Second, water exchange can help maintain temperature. Stagnant water that is allowed to cool is displaced with higher temperature fresh water from the heating source, making it easier to maintain temperature. This also reduces the wait for hot water at the fixture, promoting user comfort and convenience. Think in terms of a well-designed recirculation system, from which hot water is readily available. Third, water exchange can also help maintain disinfectant residual. Once water enters a building from the municipal supply, there are no regulatory requirements for free chlorine residual. This means for fixtures that are used only occasionally, their branches become stagnant dead legs between fixture uses. Any remaining chlorine residual can dissipate or be consumed to the point of becoming ineffective as an oxidizing sanitizer. Chlorine residual can be better maintained if stagnation is avoided, or at least minimized with a fresh water exchange. All of these benefits suggest flow should be introduced where practical to reduce the likelihood of colonization within the piping network.

Recirculation strategies

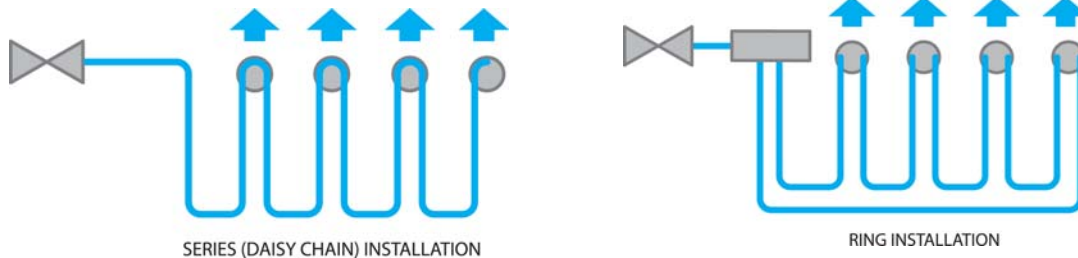
One way to promote a consistent supply temperature in a hot water system is to use recirculation. Per ASHRAE Guideline 12 in high risk facilities, the water storage temperature should not fall below 140°F. The return temperature should not fall below 124°F. If balanced so all parts of the system are subject to the design flow rate calculated to offset heat loss, this strategy can work well for risers and mains.

Branches and dead legs can pose a challenge for maintaining specific water temperatures, even with the use of a recirculation system that maintains temperature in risers and mains. It's not always possible to recirculate branch lines. It's even less likely to be able to recirculate drops serving fixtures. This means that in a branch-and-tee system, dead legs are inherent to the design. Dead legs pose an ideal environment for microbial growth: stagnant water at steady state ambient temperatures within the Legionella growth range.

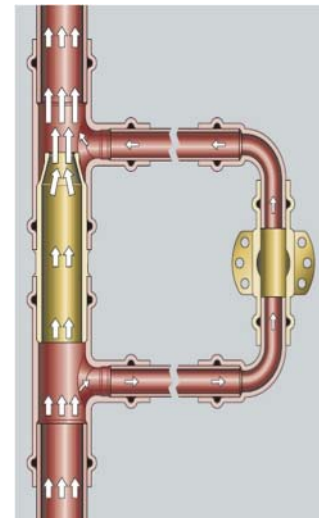
Series and Ring installations

One way dead legs can be minimized is to pipe individual fixtures in series. In other words, daisy-chain one fixture to the next. With the most used fixture at the end of the series, anytime that fixture is used, it causes flow in the remaining fixtures upstream up to their point of connection whether they are used or not. What would normally be served by a dead leg

because of non-use would now see flow through normal occupant habits even if that fixture itself is not used. If the most-used fixture is not known, the series could be terminated back to the branch, resulting in a ring. In this way, any fixture used on the ring will cause flow from both directions regardless of how close the fixture is to the branch, minimizing stagnation for a bank of fixtures.



For seldom-used remote fixtures that would typically be fed from a long dead leg off of a main or branch, flow can be induced with the use of a venturi. By taking advantage of the Bernoulli principle, a venturi can be installed in a regularly used main (or branch) to induce flow through a loop serving a remote fixture. Flow through a venturi will cause a local low-pressure zone inside the pipe at the outlet of the venturi. This localized low pressure region creates a pressure difference between the inlet of the venturi and the outlet. When the venturi is installed between two closely spaced tees, flow can be induced through a remote piping loop installed between the tees branches. This means stagnation can be minimized for fixtures connected to the remote loop because any time there is flow through the main, there is flow induced through the remote loop, even when the remote fixture is not used. Eyewash stations, classroom and laboratory sinks are great examples of typical installations that could benefit from a venturi installation.



Installing fixtures in a series or ring, or the use of a venturi and a piping loop to serve a remote fixture will often result in additional pipe and fittings required for a complete installation. This adds to the cost of a comparable branch and tee project. This cost may not be justified for low-risk facilities or buildings with occupants that are at a low-risk of infection due to Legionellosis. In higher-risk facilities like hospitals and health care facilities whose occupants may have compromised immune systems, this added cost could be deemed insignificant when weighed against the consequence of an outbreak. Premium hospitality facilities may determine the added cost outweighs the negative publicity of a Legionella outbreak caused by the plumbing system. In these instances, minimizing the risk of microbial colonization within the system could easily outweigh the added costs of installation and could reduce the costs associated with mitigation or on-site disinfection equipment. It is up to the facility owner and system designer to determine what costs are offset by their risk level.

Conclusion

As the requirements and customer demands continue to increase in the North American plumbing industry, so must plumbing system designers and installers. New solutions will have to be implemented to address modern trends in the plumbing market like Legionella. Treatment solutions alone will not necessarily eliminate the risk of microbial colonization within a plumbing system. As with most risks, design and installation professionals should consider minimizing their risk by reducing the potential for the risk to occur in the first place.

About the author:

As Product Director, Metal Systems at Viega LLC, Derek Bower brings more than 15 years of industry experience to his position. He joined Viega in 2010 as senior product engineer and was promoted to associate product manager in 2011 before his current role. Bower received his bachelor's degree in science, mechanical engineering from the University of Illinois. He holds the title of Professional Engineer (PE) and LEED AP.