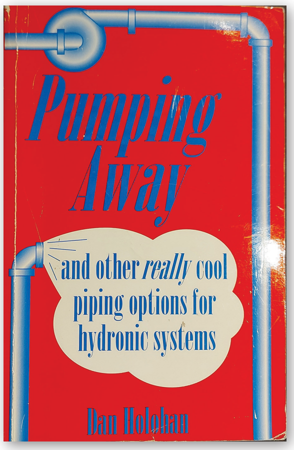
Pumping Away

George R. Carey, Jr.
VP, Fluid Industrial Associates
gcarey@fiainc.com
@Ask_GCarey

Pumping Away: And Other Really Cool Piping Options for Hydronic Systems is the title of a book that Dan Holohan published 30 years ago.

I can't believe it has been that long since the book was first published. I think *Pumping Away* accomplished two important things. Holohan's book educated the hydronics industry about why pump location is so important, as well as the benefits it provides to a hot water system when implemented correctly. However, I also believe that Holohan wanted to recognize Gil Carlson, who published a technical paper on this very subject. Carlson worked at Bell & Gossett, where he developed various theories and applications that today we consider standard design procedures. His most popular paper was titled the "Point of No Pressure Change," and covered the importance of proper pump location in a closed hydronic system.



What is meant by the proper location of a circulator in a closed system? The circulators in the system should be located so they are "pumping away" from the expansion tank. When installed in this manner, once the circulator turns on, the pressure differential it develops will be added to the system's static pressure. The static pressure is the pressure that exists throughout the system when the circulator is off—simply the weight of water. If you were to place a gauge at the bottom of a column of water 28″ high, the gauge would register one psi. That is one pound of pressure *per square inch*.

When centrifugal pumps are used in closed, pressurized hydronic systems, they are referred to as circulators; the pump is not pushing or pulling the water around the system but rather it is *circulating* the water through the system. The circulator does not create pressure, only pressure differential. In addition, the pressure on the discharge side of the circulator has to be higher than the pressure found on its inlet side.

Remember the old saying, "high pressure goes to low pressure?" In a hydronic system, think of it this way: The system is a closed, pressurized wheel. When the circulator is off, the water does not circulate through the wheel. However, when the circulator turns on, it upsets the balance that existed. The direction the water flows is determined by the higher pressure found on the discharge side of the circulator. The key difference between pressure and pressure differential is that when the circulator turns on, it does not matter if its discharge pressure increases or if its suction pressure drops, as long as the pressure on the discharge side of the circulator is higher than the pressure on its suction side. Since there *is* a difference in pressure across the circulator, the water in the system circulates. In fact, all the water in the piping circuit moves instantly. That is because water is not compressible, so when the circulator comes on and upsets the balance that existed in the circuit, all the water circulates.

Therefore, if the water in this closed hydronic system is going to circulate regardless of whether the circulator is on the supply or return, why all the fuss about its location? The answer has to do with how the circulator can change the system's static pressure. If the circulator is located on the supply, pumping away from the expansion tank, the system's pressure will be increased. If the circulator is located on the return, pumping toward the expansion tank, the pressure in the system will be decreased.

This drop in pressure can cause all sorts of problems. When exposed to a lower pressure, air that is entrained in water will come out of solution in the form of bubbles. This can cause gurgling noises, a reduction in heat transfer efficiency and quite possibly air-binding of radiation, requiring a service call to purge the air. If the circulator's pressure differential is high, it can drop the system's pressure on the top floor into a vacuum. Of course, any float vents exposed to a vacuum will draw air *into* the system.

How big does that circulator need to be to cause this situation? It depends on each individual job, but typically, the type of circulators found in most commercial jobs, such as apartment buildings, office buildings and churches, could have one of these circulators.

Point of No Pressure Change

Why can't the circulator change the system's pressure at the point where the expansion tank connects to the system? This is a question asked often, both in the field and at our hydronic seminars. Boyle's Law says that if you have a gas (air) trapped in a tank (expansion tank), its volume will shrink if you add pressure to it. Likewise, its volume will expand if the pressure is lowered. In other words, if you squeeze a gas, its pressure will rise; conversely, if you let the gas expand, its pressure will drop. How does all of this relate to hydronic systems?

To change the pressure in the expansion tank (diaphragm or steel), you have to squeeze the air that is in

continues on page 18

there. When the boiler heats the water in the system, the water expands, compressing the air in the expansion tank. This causes an increase in the system's pressure, which can be seen on the gauge of the boiler. When you open the fill valve to add more water to the system, because the piping is already filled with water, the additional water enters into the expansion tank, compressing the air, causing a rise in system pressure that is indicated on the boiler's gauge.

When a circulator turns on, does it change the volume of the water in that system? Or does it just circulate the water? Can you see the difference? If there is no change in volume of the water, then there is no change in the volume of air in the expansion, which means the pressure in the tank can't change.

If the circulator is pumping away from the expansion tank, can it take water out of the tank? If you think *Yes*, where would you put it? The piping is already filled and you can't compress water. If the circulator is pumping toward the expansion tank, can it put water into the tank? Air *is* compressible, so water can enter the tank. However, where would the water come from? If you think it could come from the piping circuit, then that means there would be a void in the piping circuit (and Mother Nature hates a void). No, when a circulator comes on, it can neither add nor remove water from the expansion tank. If the circulator can't change the volume of the water in the tank, it can't change the volume of the air (gas) in the tank, either. This means it can't change the pressure in the tank or the piping connecting the tank to the system.

Every time a circulator turns on, it "looks" for this point. Depending upon whether it's pumping away or towards the expansion tank, it either increases its discharge pressure or drops its suction pressure. This is why Carlson wrote his well renowned paper, to educate the engineering community on the "Point of No Pressure Change" and why Holohan wrote *Pumping Away*, to educate the hydronics industry about the benefits of locating circulators so they would be pumping away from the expansion tank.

Author's note: *Dan Holohan recently announced that he was retiring after 36 years of writing articles for our industry. I would like to congratulate Dan on a job well done. He has educated tens of thousands of people about steam and hot water heating systems. Dan also shared the life lessons he learned along his incredible journey and touched many of our lives, as well.*

Twenty-four years ago, I was fortunate enough to have Dan convince the late Paul Geiger, former Editor of Oilheating Journal *(now* Indoor Comfort Marketing*), to let me continue Dan's* Boiler Facts *column. Thank you, Dan, and please enjoy your well deserved retirement with your family… especially with those grandchildren!*

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