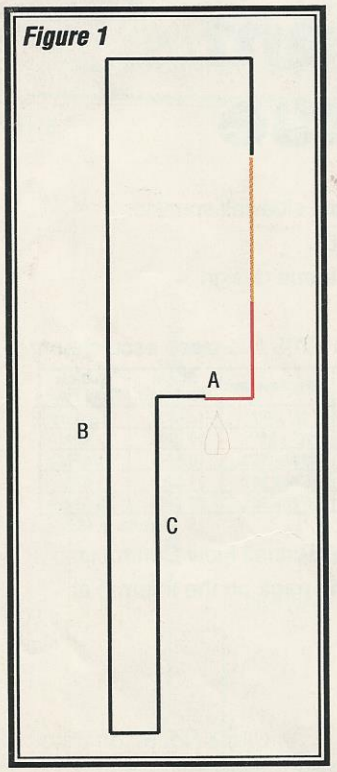
The Forgotten Hot Water Recirculating System

by William F. Albern, P.E.

Trade magazines often run articles discussing the various methods for quickly delivering domestic hot water to a fixture when a faucet is opened. For example, the September 1997 issue of *Plumbing Engineer* had two articles: One primarily discussed pumped recirculating, the other electric tracer systems. Both articles also briefly mentioned point-of-use systems, which typically consist of an electric heater under a fixture that swiftly delivers hot water to the faucet. Chapter 4, 1989 edition, of the ASPE Data Book only discusses pumped recirculating systems. Chapter 45, 1995 edition, of the ASHRAE Handbook mentions pumped recirculating systems and briefly mentions electric heat traced systems.

Figure 1



The new "Domestic Water Heating Design Manual" developed by ASPE focuses on recirculating and heat traced systems with passing mention of point of use. Each system has advocates. An unbiased engineering analysis may determine one approach to be more suitable in a particular application. But it has been a long time since I have seen a discussion of a most elementary system—the simple, passive domestic hot water recirculating system. No accessories, no other power, no pumps, no controls, nothing additional to maintain.

A passive hot water recirculating system permits the natural thermal energy of heated water to cause flow. **Figure 1** shows a vertical pipe loop. If heat is applied at point A as indicated, the water in the pipe above point A will want to rise. It has expanded as a result of being heated, weighs less per cubic foot and is more buoyant than the cold water. Because water is an incompressible fluid, if the water rises in the pipe above point A, it must fall past point B. If heat continues to be applied, eventually there will be hot water at point C. And, yes, the pressure in the loop will be higher than before any heat was applied.

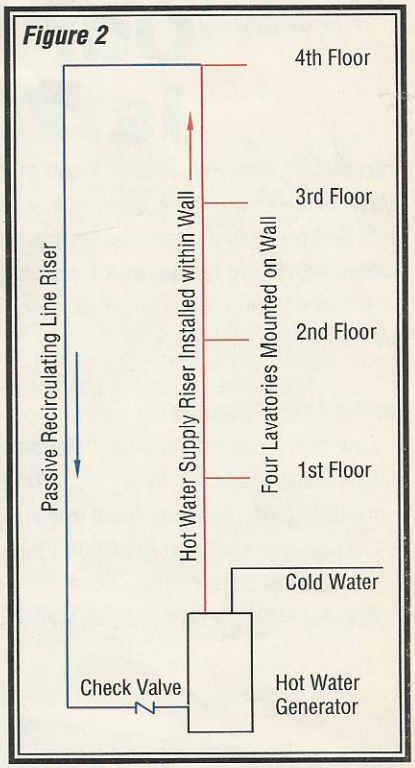
Having hot water discharge promptly is important for energy *and* water conservation. Edward Saltzberg, in his article in September 1997 *Plumbing Engineer,* states that discharging hot water within zero to 10 seconds after the faucet is opened is acceptable. He also mentions that with the new faucets (0.5 gpm), it can be quite a while before hot water, especially from a distant hot water main, flows from the faucet.

Passive system analysis

A passive system basically creates a larger storage tank inside of which the warmer water moves from the heat source at the bottom, replacing the cooler water at the top.

Figure 2 depicts a vertical riser loop with the boiler at the base of the hot water riser. Lavatories are located vertically in rooms on each floor. The hot water riser is in the wall or in a pipe chase adjacent to the lavatory locations. At the top of

Figure 2



the riser, a passive recirculating line is extended back down to the boiler. This return line could also serve another vertical stack of lavatories; a larger line may be needed to meet fixture flow requirements and not just the needs of recirculating line flow. Note the check valve at the boiler. Without this check valve, the passive recirculating line becomes a parallel hot water supply pipe.

When the system is filled, it is difficult to get water into the return riser. The water entering the hot water generator closes the check valve. When the water fills the supply riser, air is trapped in the return riser; the check valve is closed because of the water pressure in the generator. There will not be any thermal movement of water with air in the return riser. The air is compressible and is lighter in weight so it will not fall to encourage upflow in the supply riser. However, over a short period of time, the water will absorb the air, fill the recirculating riser and cause the thermal action to begin. An air vent immediately adjacent to the upstream side of the check valve will solve the problem.

Figure 3 shows the same system with a remote fixture. The supply piping could be arranged as indicated to permit the use of the passive recirculating concept. How many offsets the system could tolerate is unknown; some research is needed.

Figure 4 is an actual system installation—my home. There are approximately eight feet of rise from the top of the water heater to the start of the recirculating line under the kitchen sink to cause the thermal now. The main supply piping and the recirculating piping are both 3/4-inch. The branches to each of the four fixtures are 1/2-inch. The drawing is not to scale, but the house is 40 feet long, with the water heater and the kitchen sink at opposite ends. The laundry facility and the two bathrooms are as depicted. To test the system, I timed how long it took at first use for hot water to reach my hands at each fixture.

Figure 3

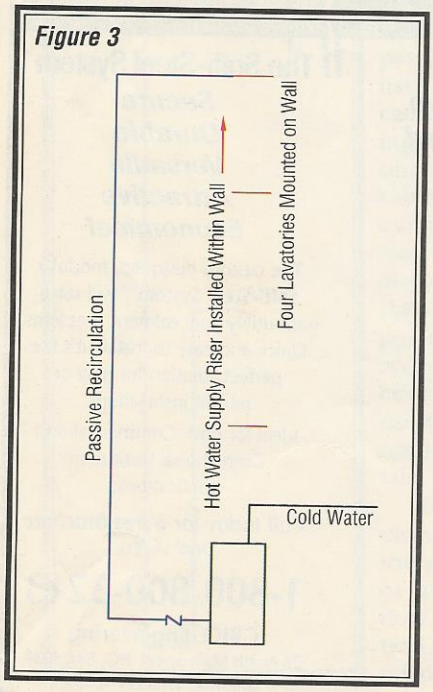
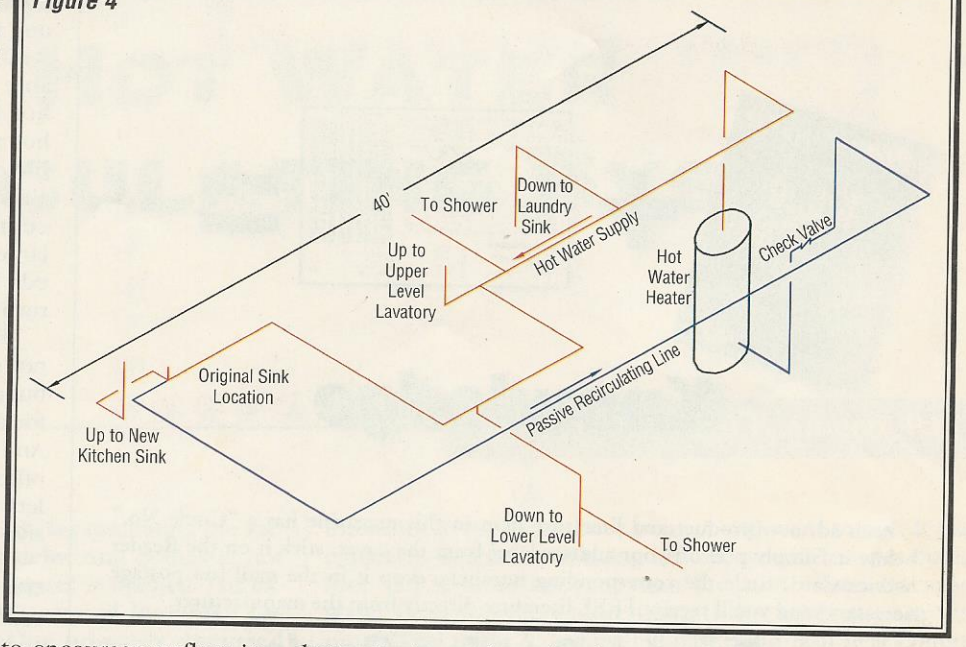


Figure 4



It would appear from the drawing that hot water should be delivered much quicker to the kitchen sink. Because the lower level lavatory is more distant from the supply pipe than the laundry sink or upper level lavatory, you'd expect it to take more time for hot water to be discharged there. But several years ago our kitchen was renovated, and the sink was relocated. Thus, the exact pipe configuration is not known. Also note that the times indicated in **Figure 4** refer to hot water flow. The water temperature being delivered at the times indicated would require mixing for use.

Passive system limitation

The passive recirculating system uses only the energy selected for water heating service: natural gas, wood, electricity—whatever has been determined most appropriate for the project. If a fuel has been selected, no other form of energy is needed to maintain hot water close to the faucet.

However, a passive system is not suitable for domestic water recirculating when the fuel is electricity with night setback of fuel unit costs. The entire concept of the recirculating system is to move hot water from the storage tank to the farthest fitting as needed. Water is moved through the storage tank. The concept of a tank with night rate is to store enough water for the next day's use during the time of low-cost electricity. The hot water is stratified in the top of the tank. As hot water is used, cold water enters the bottom of the tank. With any recirculating system, water is constantly circulated through the tank. The water temperature in the tank becomes homogeneous throughout the tank.

Such a system is also inappropriate where the hot water generator is at the very highest point of the facility. With that configuration, there is no riser to start the thermal now. How much riser is needed, five feet, 10 feet? Some research could answer the question.

It has always been a challenge to the plumbing engineer to get hot water now from the hot water faucet as soon as

the faucet is opened. It may not be a challenge of great magnitude nor one involving life and safety, but it's a difficult goal to attain at a reasonable cost. Every small facility with hot water faucets remote from the hot water generator should be complete with a passive return system, although some research of the concept is needed. For example: How large a project can be accommodated? How large must the passive return riser be?

The passive recirculating system is not suggested for complex structures, but it should at least be a consideration for all small to medium-sized facilities. And I have no doubt that a multistory office building with a core riser of toilets can be very well served by a passive system. Try it, you'll like it. PME

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