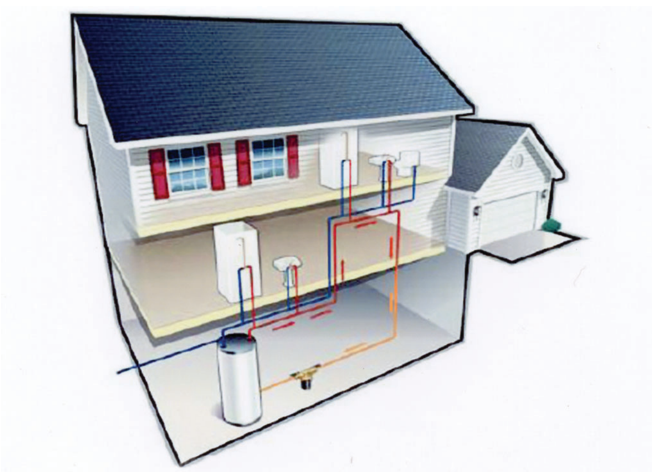
Domestic Hot Water Recirculation

By George Carey

The "greening" of America is here and it isn't going away anytime soon (if ever). People are accepting the concept of using less—whether it be gas for their automobiles, electricity in their homes, fuel usage to heat their houses or throwing away less and recycling more. Of course, most Americans don't want to be inconvenienced during this whole process—"I'll do my part, but…."



Water and the use of it has become a hot topic that needs to be addressed. Every residential home uses both hot and cold water every day. And we are quickly becoming aware of the fact that this natural resource is **not** unlimited in its supply. I am sure most of you have seen where local municipalities impose water bans or restrictions on water usage, i.e., watering lawns, washing cars, etc. Did you know that the average residential home (three bedrooms/four occupants) ***wastes*** about 12,000 gallons a year by simply waiting for hot water? In some of the larger homes, the waste can be as high as 20,000 gallons of water annually! In fact based on about 25 million homes, 288,800,000,000 gallons of water are WASTED every year!

One simple option that you can offer your customer to help stop this waste is to provide a hot water recirculation line. What is a hot water recirculation line? It is a pipe that is installed off of the hot water supply line after the farthest fixture in the home and piped back to the water heater. The line is very small, usually ?"–½" and has a small bronze circulator attached to this line. The circulator sends hot water back to the water heater and then ***recirculates*** it back out to the farthest fixture. Now whenever someone opens the hot water faucet at a sink or turns on a shower, they no longer have to wait for hot water—it is "sitting" right there waiting to be used! And that is another benefit to your customer—time. They no longer have to wait for the hot water, a common homeowner complaint.

Based on some average home sizes, length of run and pipe size, it is common to have to wait 1-2 minutes for the hot water to arrive. In addition to the inconvenience this causes, the waste of water is incredible! In fact, ASPE (American Society of Plumbing Engineers) developed new guidelines back in 1998 to help promote conservation. Specifically, the guidelines were:

- Maximum distance for unrecirculated dead end hot water supply line branches is now specified as **25 feet maximum or a maximum of 31 seconds hot water delay time to any fixture.**
- The use of low flow fixtures required by some municipalities increases the wait time for hot water at the fixture.
  - 0-10 seconds = desired
  - 10-30 seconds = acceptable
  - Over 30 seconds = unacceptable

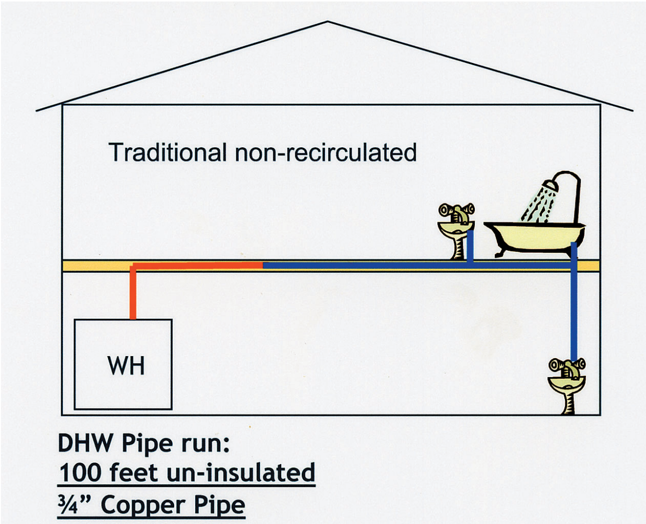
A recirculating line helps prevent waste and saves considerable time in waiting for hot water. It also saves MONEY! Assuming 12,000 gallons of water are wasted per year and using some average costs for water, fuel and sewerage costs, the total wasted water cost would be approximately $280.00. Of course, you have to factor in the installed costs for the recirculating system, but at the end of the day, the ROI (return on investment) is around 15-20%.

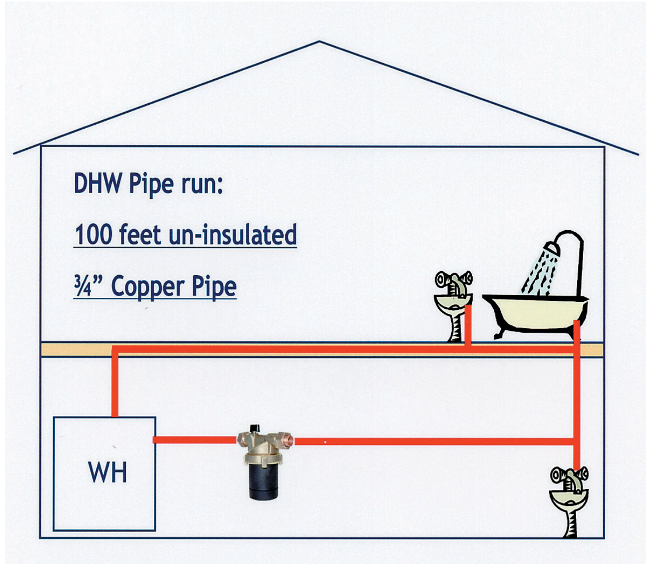
How to size the recirc line and circulator

- The recirculation flow rate will be established by the hot water supply piping's heat loss to the farthest fixture.
- The recirculation return line's heat loss does not have to be considered.
- The required flow rate to compensate for the heat loss of ***insulated*** copper pipe is typically a low flow rate.
- The recirculation return line will be equal to the length of the supply line (usually).

For example, if we had the following residential application:

100' of ¾" uninsulated copper pipe supplying hot water throughout the house to the farthest fixture.





We can see from the sizing chart that 100' of ¾" uninsulated copper pipe loses about 3000 Btu/h. The job of the recirculating pump is to recirculate enough flow in GPM to replace this lost energy.

Temperature Drop	Btu/GPM Relationship
10°	5,000 B/Hr. = 1 GPM
15°	7,500 B/Hr. = 1 GPM
20°	10,000 B/Hr. = 1 GPM

BTUH Heat Loss per 100 ft. for tubing and steel pipe

Pipe or Tube Size	Insulated Copper Tube or Steel Pipe	Noninsulated Steel Pipe	Noninsulated Copper Pipe
½"	1,600	4,000	2,300
¼"	1,800	5,000	3,000
1"	2,000	6,000	4,000
1¼"	2,400	7,500	4,500
1½"	2,600	8,500	5,500
2"	3,000	11,000	6,500
2½"	3,400	12,000	8,000
3"	4,000	15,000	9,500
4"	4,800	19,000	12,000
5"	5,700	22,500	
6"	6,600	26,000	

In sizing residential recirculating lines, the acceptable temperature drop is 10°F (instead of the standard 20°F we use for hydronic heating systems). We can then calculate the required flow rate by using the following formula;

GPM = BTU/H/ 10°F ΔT x 500 or

GPM = 3000/5000 = .60 gpm

The next step is to establish the head loss of this flow rate through the recirculating line. In this example the recirc line will be the same length as the supply main which is 100'.

Using ½" Type L Copper Piping for Return Line:

Head Loss = (Friction Loss from System Syzer) x Length Type L Copper Pipe x 1.5 (to account for fittings)

Head Loss = (1' friction loss/100ft) x 150 ft equivalent piping = 1.5 ft head loss

Head Loss ~ **1.50 ft head loss**

So what pump do you use? For domestic hot water systems, the recirculation pump must be suitable for potable water. That means the wet end must be constructed of bronze or stainless steel material. And this pump must be able to pump .6 gpm while overcoming the head loss of 1.5'. As you can see, the smallest traditional 3-piece bearing assembly-style circulator or the modern wet rotor PSC (permanent split capacitor) circulator is more than big enough.

Are there any other options?

Recently, new motor technology that is being applied to circulators has worked its way over to America and is called ECM which stands for Electronically Commutated Motors. As opposed to traditional induction motors that we have been using for years, this technology incorporates permanent magnet motors. Here are some of the basic differences and features of this new technology.

- Eliminates the requirement for input power to magnetize rotor
- Stator coils generate a rotating field to induce the permanent magnet to rotate.
- Motor is microprocessor controlled to keep the stator current in phase with the magnets of the rotor.
- The lower current requirement and no "slip" result in greater efficiency.

In the next issue, we will discuss in details the benefits of this technology and how to apply it to your hot water and heating system designs.

If you have any comments or questions call me at 1-800-423-7187 or email me at gcarey@fiainc.com.