Boiler Facts...

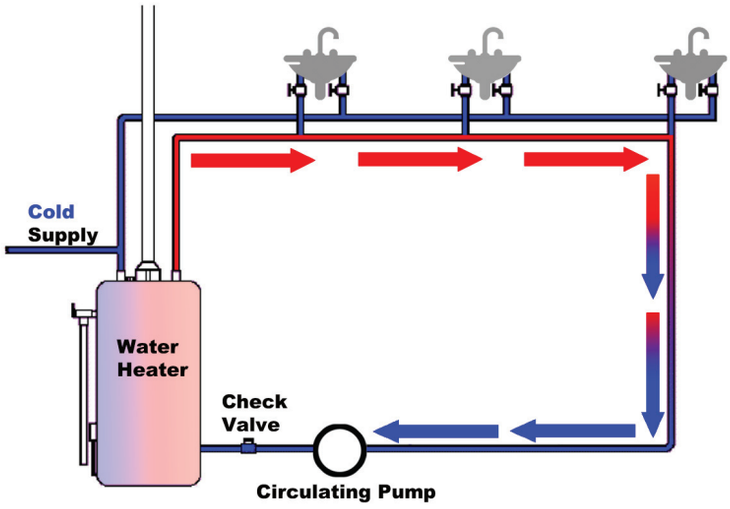
Why every home needs a DHW recirculation line

George R. Carey, Jr.
Vice President, Fluid Industrial Associates
gcarey@fiainc.com twitter: @Ask_GCarey

People here in the U.S. are accepting the concept of using less—whether gas for their automobiles, electricity in the house, fuel to heat their homes—and people are throwing fewer things away and recycling more.

The use of *water* also needs to be part of the "using less" concept. All of the major governing boards (American Society of Heating, Refrigerating and Air-Conditioning Engineers, American Society of Plumbing Engineers, Occupational Safety & Health Administration and the Veterans Affairs Administration) either have or are in the process of updating their codes and design criteria to address the subject. We are quickly becoming aware of the fact that this natural resource is *not* unlimited in its supply. Did you know that water covers 70% of the earth's surface and that 97% is salty water and only 3% is fresh water? I am sure most of you have seen where local municipalities impose water bans or restrictions on water usage, i.e.; watering lawns, etc…

Figure 1. Traditional type hot water circulating system



Did you know that the average residential home (3 bedrooms/4 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 a year! In fact, based on about 25 million homes, almost 290 billion gallons of water are *wasted* every year!

By educating your customer on the benefits of domestic hot water (DHW) recirculation, they will experience virtually instant hot water at all their fixtures, while conserving water. What is a hot water recirculation line? It is a pipe that is installed off of the hot water supply line after the furthest fixture in the home and piped back to the water heater. The line is very small, usually 1/2" and has a small bronze circulator installed on this line. The circulator circulates hot water back to the water heater and then *re-circulates* it back out to the furthest 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! That is another benefit to your customer—time. They no longer have to wait for the hot water which is 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, the American Society of Plumbing Engineers (ASPE) developed guide lines in 1998 to help promote conservation. Specifically the guidelines were:

- Maximum distance for un-recirculated 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

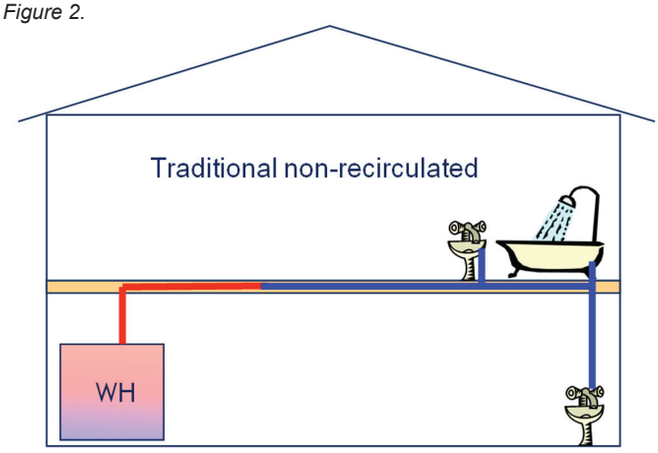
A re-circulating line helps prevent waste and saves considerable time in waiting for hot water. It also saves money! Assuming 12,000 gallons of water are wasted per year, and using some average costs for water, fuel and sewerage costs, the total wasted water cost would be approximately $280.

Four Things for Proper Sizing of DHW Recirculating Lines

1. The recirculation flow rate will be established by the hot water *supply piping's heat loss* to the farthest fixture based on a *given delta temperature*.
2. The recirculation return line's heat loss does not have to be considered.
3. The required flow rate to compensate for the heat

Reprinted from January/February issue of ICM

Figure 2.



DHW Pipe run: 100 feet un-insulated ¾" Copper Pipe

loss of *insulated* copper pipe is typically a low flow rate.

4. The recirculation return line will be equal to the length of the supply line (usually).

For example, as shown in **Figure 2**, if we had the following residential application:

- 100' of ¾" un-insulated copper pipe supplying hot water throughout the house to the furthest fixture.

We can see from the sizing chart that 100' of ¾" un-insulated copper pipe loses about 3000 btu/h. The job of the recirculating pump is to provide enough flow in gallons per minute (GPM) to replace this lost energy.

Figure 3.

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

In sizing residential re-circulating 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 delta T x 500 or
GPM = 3000/5000 = .60 gpm

Figure 4. BTUH heat loss per 100 ft for tubing and steel pipe

Pipe or Tube Size	Insulated Copper Tube or Steel Pipe	Non-Insulated Steel Pipe	Non-insulated Copper Pipe
1/2"	1,600	4,000	2,300
3/4"	1,800	5,000	3,000
1"	2,000	6,000	4,000
1 1/4"	2,400	7,500	4,500
1 1/2"	2,600	8,500	5,500
2"	3,000	11,000	6,500
2 1/2"	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	

The next step is to establish the head-loss of this flow rate through the re-circulating line. In **Figure 5**, the re-circulating line will be the same length as the supply main, which is 100 feet.

Using ½" Type L Copper Piping for Return Line:

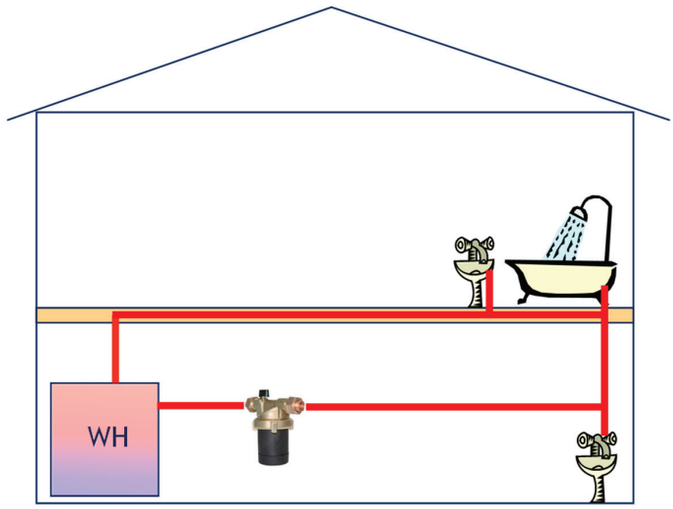
Head Loss = (Friction Loss from System Syzer) x Length Type L Copper Pipe x 1.5 (to account for fittings)

Head Loss = (1 ft 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 all the working parts exposed to domestic water are brass, bronze, stainless steel or non-ferrous in order to resist the corrosive attack of

Figure 5.



DHW Pipe run: 100 feet un-insulated ¾" Copper Pipe

oxygenated fresh water. Conventional iron body hydronic system pumps *should not* be used. 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 permanent split capacitor (PSC) circulator is more than big enough—of course over the last few years electronically commutated magnetic motors (ECM) circulators are gaining traction in North America—and with this new technology comes nice features. Because of the magnetic motor, all of the ECM pumps have a microprocessor on board and the processor offers intelligence to control the pump and its operating characteristics. So, in a simple residential DHW recirculating application, the pump's speed could be selected to more closely match the system needs and significantly reduce the KW consumption of the recirculating pump. ICM

Questions or comments: gcarey@fiainc.com, call 1-800-423-7187 or follow on Twitter at @Ask_Gcarey.

Reprinted from January/February issue of ICM