Making Hot-Water

With new pump technology, hot-water recirculation is about to get more efficient

BY DAVE YATES

I love potable hot-water recirculation systems, and not just because I sell and install them. By far, the most common reason why customers ask for my company to install recirculation pumps on their domestic hot-water systems is the long wait they have to endure before even a trickle of warm water arrives at their shower or sink. Recirculation eliminates this irritating wait and can save between 8000 and 20,000 gal. of clean drinking and bathing water per household per year. It also avoids sending your money down the drain by lessening water and sewage charges incurred if you are billed based on the gallons used in your home or business. This waste occurs despite mandated limits on showerhead flow—2 gal. per minute (gpm) for WaterSense heads; 2.5 gpm generally—that save on water once you're in the shower. The lower the flow, in fact, the longer the wait for hot water.

The traditional way to eliminate both the wait and the waste has been a mechanical recirculation system, but the pumps these systems rely on—even the more sophisticated pumps that limit recirculation to a few hours a day—incur electrical costs and contribute to heat loss through pipes. In the past year, however, a real drop in the cost of recirculation has become possible with the introduction of pumps powered by electronically commutated

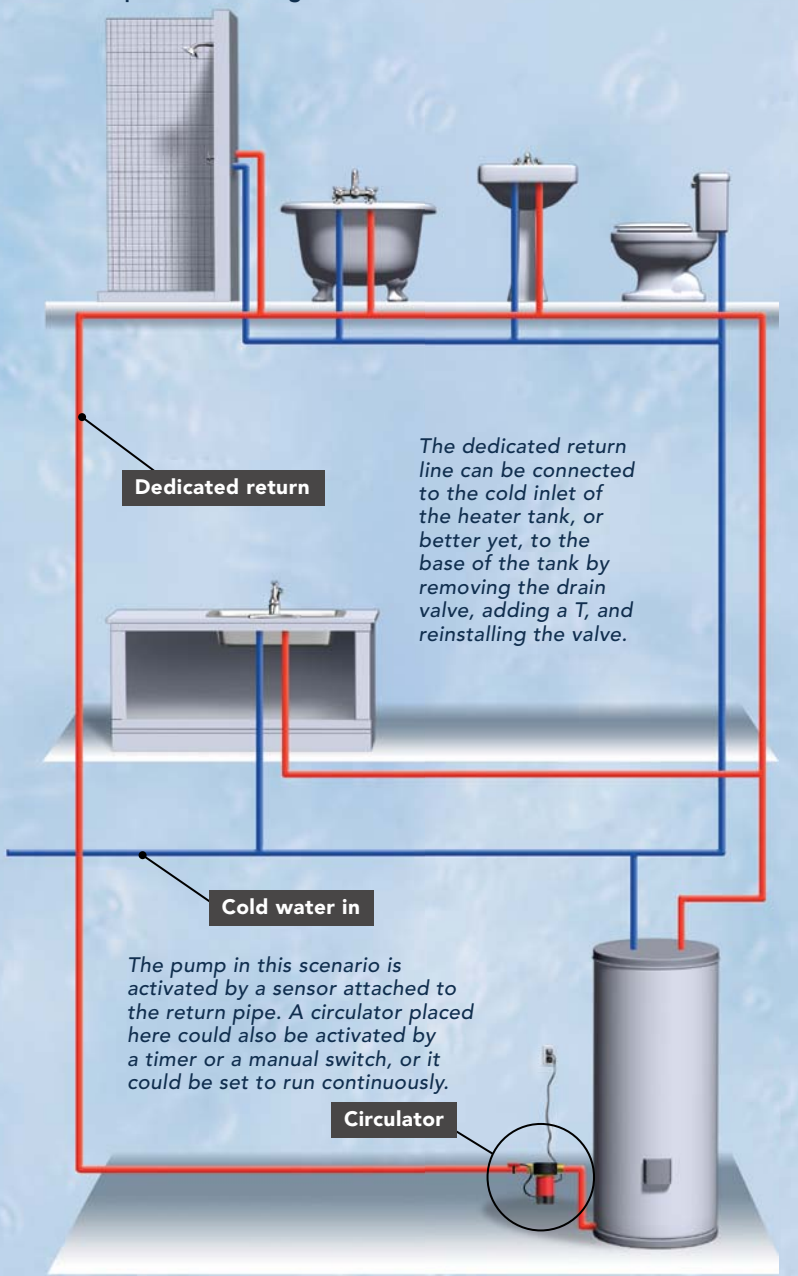
Photo: Edward Caldwell. Drawing: Toby Welles.

Recirculation Pay

RECIRCULATION: TWO SCENARIOS

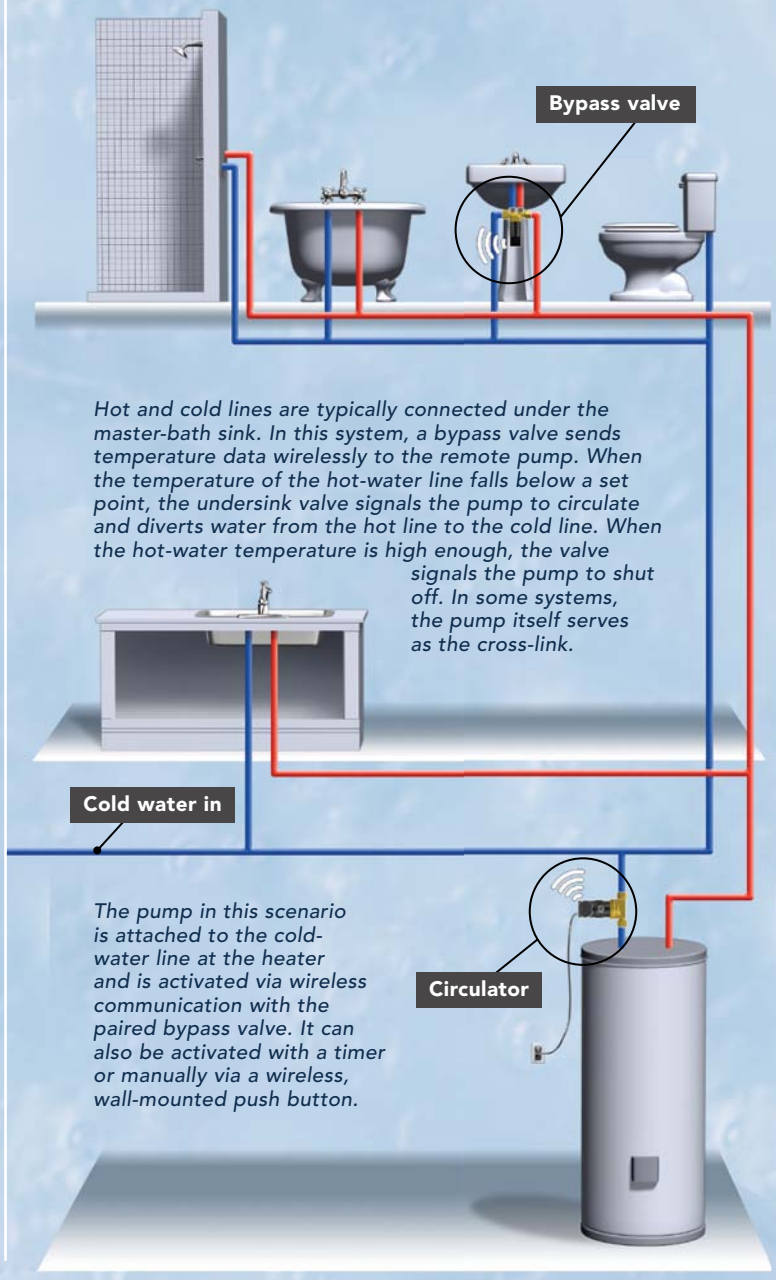
With a dedicated return line

There are several variations on how a domestic hot-water recirculation system might be installed and activated. This illustration presents a simplified view of a system with a dedicated hot-water return line. Such an arrangement eliminates complaints stemming from warm water in the cold-water lines.



Using cold-water lines as the return

When a dedicated return is not possible (in some retrofits, for example), hot and cold lines are cross-linked via a thermostatic bypass valve so that the cold line can return too-cool water from the hot-water supply back to the heater.



The new kids on the block:
ECM circulators for domestic hot water

Both Grundfos and Xylem have introduced ECM circulators for domestic hot-water recirculation in the United States. Here's a quick review of how each one operates.

GRUNDFOS COMFORT PM AUTO

The Grundfos Comfort PM Auto features a unique auto-adapt mode that enables the pump to "learn" household hot-water habits and respond proactively. Despite its sophistication, this pump is easy to set up and use, with a button on the back that makes scrolling through its various programs (auto, 24/7, temperature) a breeze. In my view, though, one of its strongest selling points is the disinfection feature that automatically circulates water every eight hours to protect against bacterial growth that can result from leaving warm, stagnant water sitting in pipes.

Grundfos Comfort PM Auto with optional sensor

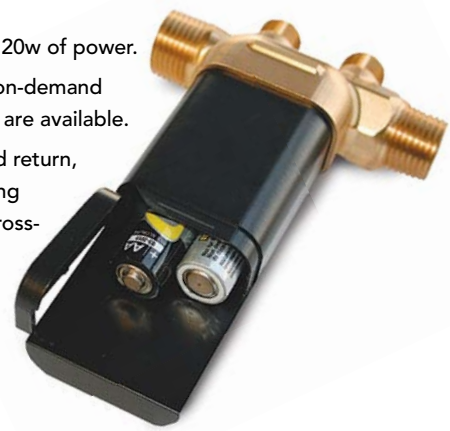
- Uses 5w to 8.5w of power.
- Varies its motor speed for efficiency.
- If no usage is detected within eight hours, the disinfection feature flushes the system for 15 minutes.
- AutoAdapt Mode: Learns hot-water-usage patterns to automatically turn on slightly in advance of demand.
- Vacation Mode: Turns on if no hot water is drawn during a 24-hour period, then automatically resumes its learned pattern upon the first hot-water usage.
- Temperature Mode: Can be set to cycle on and off based on a temperature sensor.
- Constant-Circulation Mode: Operates 24/7/365.
- Installed in a dedicated return line or in existing water-heater lines in a cross-linked system.

Bell & Gossett Ecocirc Wireless pump with timer and battery-powered valve (right)

XYLEM MODELS

Xylem makes ECM pumps under several brands, including Bell & Gossett. (Its Ecocirc Wireless is shown at left.) A key feature of Xylem's ECM circulators is their wireless technology. In cross-linked systems, this allows the remote mixing valve to activate the pump—located out of sight and hearing at the water heater—without a physical connection. The same goes for the optional wireless push-button activator, which plugs into any wall socket. The pump can also be set on a timer.

- Units use from 10w to 20w of power.
- Wireless models with on-demand sensors or push buttons are available.
- Installed in a dedicated return, under a sink, or in existing water-heater lines in a cross-linked system.



motors (ECMs) that reduce electrical-power consumption dramatically.

A recirculation primer

In both new construction and retrofits, the installation of hot-water recirculation systems is relatively simple. These systems may include a dedicated return line, or they may be cross-connected so that water that has cooled while sitting in the hot-water pipes bypasses the faucet and returns to the heater through the existing cold-water line. With a dedicated return line, water is typically circulated by a pump that either runs constantly, or is controlled by a timer or an aquastat. A cross-connected system has a hybrid T with an internal thermal valve that allows water from the hot-water pipes that has cooled to bypass fixtures and return to the heater when recirculation is activated.

There is a catch, however: The average induction-motor recirculation pump uses 87w, and that electrical draw can add up (see chart, facing page). A few of the constant or timed versions typically used in these systems are available in low-wattage and low-flow versions—as low as 33w/0.2 gpm in residential applications. How much these low-wattage versions save depends on the run time and cost of electricity. ECM pumps, however, can run on as little as 5w. They can be positioned in the system in the same way as traditional induction-motor pumps and are no more difficult to install.

Explaining ECM technology

Traditional AC (alternating current) induction motors run at one speed using full power. Their operation generates heat, which wastes energy and results in wear on the components. In addition, most induction-motor circulators used in residential applications are substantially oversize, adding to their power consumption.

ECMs are brushless DC (direct current) motors and use a permanent-magnet rotor that runs at variable speeds and requires much less energy. ECMs also run much cooler, increasing circulator efficiency and dramatically reducing power consumption. Among the more sophisticated pumps introduced in the U.S. market in recent months is the Grundfos Comfort PM Auto, a "smart" ECM pump that, according to its manufacturer, can reduce energy use by 95% over a traditional induction-motor pump. Although the upfront cost of an ECM pump

Photos: courtesy of the manufacturers

How hot-water recirculation and ECMs can save you money

It's hard to predict how much a hot-water recirculation system will save because the data varies widely based on household water use; water-heater type, efficiency, and fuel; wastewater-disposal costs; pipe runs; and whether or not the pipes are insulated. But for comparison's sake, let's look at a household that typically lets 14,000 gal. of water run down the drain annually while waiting for the desired temperature (a typical manufacturer's estimate). Energy costs are based on a chimney-vented, tank-style water heater fueled by gas at $0.015 per cu. ft. and on municipal water at $0.015 per gal., sewage disposal at $0.0117 per gal., and electricity at $0.12 per kwh. Results are rounded to the nearest dollar, except for values associated with the penny-saving ECM.

No recirculation

Cost of 14,000 gal. of wasted water: **$210**

Cost to dispose of 14,000 gal. of wasted water: **$164**

Cost to heat 14,000 gal. of wasted water: **$166**

Annual cost of waste $545

Recirculation systems compared

Pump type	Constant recirculation with 87w induction-motor pump	Aquastat-controlled recirculation with 87w induction-motor pump	Timed recirculation with 87w induction-motor pump	Recirculation with "smart" 5w ECM pump
Annual pump-operation cost	$92	$46	$23	$0.44
Heat-loss cost with bare copper pipe* (insulated pipe)	$140 ($84)	$70 ($42)	$35 ($21)	$7 ($5)
Total annual cost (insulated pipe)	$232 ($176)	$116 ($88)	$58 ($44)	$7 ($5)

***Pipe insulation makes a difference** Insulating water pipes can boost savings by 25% to 40%. In the recirculation systems above, values in parentheses represent the significantly lower cost incurred when pipes are well insulated. Heat-loss calculations are based on 50 ft. of ¾-in. copper pipe and 50 ft. of ½-in. pipe (for a total of 100 ft.) and a water temperature of 120°F.

is roughly twice that of an induction-motor pump (about $165 vs. $85), the additional cost is more than offset by the energy savings year after year.

Less energy, less cost

ECM technology for both hydronic heat and potable water has been used for more than a decade in Europe, where significantly higher electrical costs drove the shift away from induction motors. About five years ago, ECMs began appearing in the United States, first in air-based blower motors for heating-and-cooling systems and then in circulators for hydronic heating-and-cooling systems. I have been using both in my own home for the past four years and have reduced my electrical-energy consumption for moving both air and water by more than 90%. I was particularly intrigued when the same technology was introduced in the United States in pumps designed for domestic hot-water (DHW) recirculation. Unlike those used in heating applications, pumps designed for DHW recirculation are built to withstand the higher water pressure within potable-water systems and are made using either a low-lead bronze alloy or a stainless-steel impeller housing to comply with restrictions against lead in drinking water.

Putting them to the test

I first encountered ECM circulators in 2003 while attending the International Symposium on Heating trade show in Frankfurt. I was immediately impressed by their über-efficiency and low energy consumption.

When ECM pumps became available here for hydronic heating systems, I decided to do an electrical evaluation using my own home as a test case. My custom hydronic heating system had 11 induction-motor circulators (five more than the average zoned hydronic system). I monitored its electrical consumption for a year using a Kill-A-Watt meter and then replaced the older circulators with 10 low-watt zone valves and two Grundfos Alpha ECM circulators. After monitoring the electrical consumption for another year and correcting for differences in heating degree-days, I found that my power consumption had been reduced by more than 90%, saving me $334. The savings on a more common six-zone system would be $168 a year, against an initial investment of $398 (the difference between an ECM circulator and six zone valves, and six standard circulators).

Since then, ECMs have gained wide acceptance in air- and water-based heating-and-cooling systems, and most manufacturers offer ECM models for hydronic water systems. With the promise of similar reductions in power consumption, I suspect the same acceptance of ECM technology for DHW recirculation is just around the corner. □

Dave Yates is a master plumber and owner of FW Behler, a PHVAC firm in business for more than 100 years.