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Residential Water Conservation

Research Brief

On-Demand Hot Water Systems

Overview

Water heating is the second highest consumption of energy in the residential sector, accounting for 17 percent of consumed energy for the average Canadian household. Each year, residents allow millions of litres of water to run into sewers while waiting for hot water to arrive at showers and sinks. According to a 2005 study by the Lawrence Berkley National Laboratory, the amount of wasted hot water (from all fixtures/appliances) is calculated at 24 litres per day wasted while waiting for hot water to reach point of use. **(1)**

Finding ways to reduce the water and energy waste is important for both water and energy conservation. It is essential, however, that any technology is rigorously tested to ensure the true effectiveness of these systems. This brief details the benefits and drawbacks drawn from current research on two on-demand hot water systems; Tankless Water Heaters and Hot Water Re-circulation Systems.

TANKLESS WATER HEATERS

Description

On-demand, or tankless water heaters are common in Asia and Europe, and their use has been increasing in North America since about 1980. Unlike conventional tank water heaters, tankless water heaters heat water only as it is used. A tankless unit has a heating device that is activated by the flow of water when a hot water valve is opened. Once activated, the heater delivers a constant supply of hot water. The output of the heater, however, limits the rate of the heated water flow. Tankless heaters are available in propane (LP), natural gas, or electric models. They come in a variety of sizes for different applications, such as a whole-house water heater, a hot water source for a remote bathroom or hot tub, or as a boiler to provide hot water for a home heating system. They can also be used as a booster for dishwashers, washing machines, and a solar or wood-fired domestic hot water system.

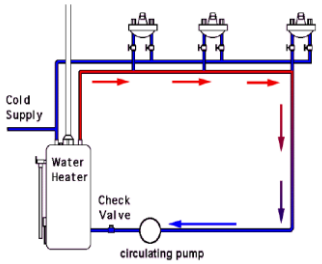
PROS (2)

- A tankless water heater is usually more energy-efficient (i.e., can reduce up to 20% of the heating bill) than a storage tank water heater.
- They never run out of hot water.
- They last five to 10 years longer than tank heaters.
- They're more efficient with no standby heat loss.
- They take up less space and can even be installed on walls, under cabinets, or in a closet.
- Smaller units can be installed under cabinets or in a closet, closer to the point of use.
- They only need enough power to heat the amount of water necessary at any given moment.
- Electric models don't produce greenhouse gases.
- Most units are operated by remote control and have up to four separate settings available.

CONS (2)

- They cost up to three times as much as a tank water heater.
- They need a minimum of 2 litres per minute (.5 gallons per minute GPM)) water flow to activate the heater, which can lead to using more water in order to get hot water.
- In colder climates, where cold water intake temperature is low, more energy is required to heat the water to a high enough temperature for use.
- Gas-fired on-demand water heaters that have a continuous pilot light use energy even when no hot water is required.
- A larger natural gas line may be needed to supply the unit with enough fuel and in addition, venting requires expensive stainless steel tubing.
- Gas units require the additional expense of an annual servicing.
- Electric models draw a large amount of electrical current 2.4 kW to 28kW as compared to conventional tanks that require about 5kW. This electrical requirement may require a major upgrade to their electrical service.
- Will not operate in a power outage because they require electricity for the electronics involved.

Traditional type hot water circulating system.



HOT-WATER RECIRCULATION SYSTEM

Description

A hot-water recirculation system is a plumbing system that moves hot water to fixtures quickly without waiting for the water to get hot. Rather than relying on low water pressure, common in most water lines, recirculating systems rapidly move water from a water heater to the fixtures. The recirculating hot-water system is installed on the water lines of the home's existing hot-water tank. When the hot water in the hot-water piping cools down below a certain point, this system draws it back to the hot-water heater to reheat it, while bringing fresh hot water from a conventional hot-water tank into the hot-water line. These systems can be incorporated into your plumbing system when building a house, or they can be added later on.

Types of Hot-Water Recirculating Pumps

There are a few different types of hot-water recirculation systems on the market; continuously circulating, timer-controlled, temperature-controlled or by the push of a button.

A) Continuous circulating: These systems continuously pump a small flow of hot-water though the piping from the water heater to the fixtures and back to the water heater. They are very wasteful of energy. These systems were popular when energy was cheap, but they are becoming rare in residential settings due to energy costs.

B) Timer-controlled: The recirculating pump is controlled by a timer (mounted on the pump) that will shut off the hot-water pump during hours when hot water is not needed. An advantage of the system is that the timer can be set to go on and off at specific timer intervals depending on demand. These types of models also consume minimal power and eliminate or reduce water wastage. This system needs an electric outlet to operate.

C) Temperature-controlled: The recirculating pump is controlled by a temperature-sensing circuit that will shut off the hot-water pump once the water temperature reaches a predetermined temperature and will switch the pump back on when the water temperature in the pipe drops below a second predetermined temperature. This system needs an electric outlet to operate.

D) Pump (Farthest Point): The on-demand pump is placed under the sink at the farthest fixture and is activated at the push of a button. The system is installed at only one fixture, usually the one that uses the most hot water. This system needs an electric outlet to operate. Since the system starts by pushing a button, hot water is not instantaneous.

Pros

- The number one benefit of a hot water circulating pump is convenience as hot water is available on demand or each time you turn on a tap for heated water.
- Beneficial in drought-stricken areas, where rebates are offered for installation
- Potential for water savings in showers and faucets.

Cons

- Even the most energy-efficient options will raise your electric or gas bills, and the money you save on your water bill is unlikely to make up for the increased costs.
- If recirculation systems pump continuously, they have the potential to use significantly more energy (400 to 800 KWH a year).
- Installation costs of $200-$400 or more
- In the retrofit variety, a small amount of warmish water will make its way into the cold pipes.
- The return line variety requires specially designed plumbing to operate. This needs to be considered early on when you're planning your build.
- Heat loss from pipes. The heat loss is significant even if the pipes are insulated. During the winter, this heat may help to heat your house. Or, it may not, depending on how the pipe is routed. This added heat may be a benefit in the winter, but it will also add heat to your house in the summer, which will just make it hotter, and may result in higher air conditioning bills.

PERFORMANCE

Provable water savings for either of the reviewed On-Demand hot water systems in this brief have *not* been well researched and may not significantly reduce water usage in residential applications. Recent research also brings into question the energy-efficiency claims of manufacturers and earlier research.

The following are case studies for Tankless Water Heaters and Recirculating Hot Water Systems.

CASE STUDIES

Tankless Water Heater Research

Case Study: Monitoring Performance of Retrofitting from Tank to Tankless Water Heaters

To better understand the relative performance of storage and tankless water heaters, Canada Mortgage and Housing Corporation (CMHC) initiated a research project completed in 23 households in Ontario. The study found that there was an average two per cent increase in water usage over conventional hot water tank and there was, on average a 46 percent reduction in natural gas used for water heating after the installation of the tankless water heater **(3)**

Recirculating Systems Research

Case Study: Residential End Uses of Water Study Update, Version 2 (REUWS 2016)

The REUWS 2016, provides an updated and expanded assessment of water use in single-family households across North America**.** Hot-water recirculating systems were one of the end uses examined in this study. The actual sample size was only 7 homes. The results of the analysis of these homes showed there was a decrease of 19 litres per household per day (lphd) in hot water used for showers and an 11 lphd increase in hot water used for faucets. Even though the impact of the recirculation systems did not reach statistical significance, the results do suggest that the devices are having an impact on hot water use, and point out the benefits of future research in this area. **(4)**

Case Study: City of San Diego: Recirculating Hot-Water Systems: Residential Survey and Feasibility Study

This study was designed to provide an expanded understanding of the typical wait time for hot water to arrive at a plumbing fixture and the variables that are likely to influence the whole-house water savings potential of recirculating systems. Data was collected at 190 homes. Projections only indicated that recirculating systems have the potential to reduce the average indoor water consumption by about 10 percent**. (5)**

Case Study: Water and Energy Savings from On-Demand and Hot-Water Recirculating Systems

Certain hot-water systems have been marketed as "green" based on tax credit eligibility or municipal mandates. Although these initiatives and mandates are assumed to provide net environmental benefits, there is surprisingly little scientific evidence documenting and quantifying the potential advantages. This research provides the first head-to-head evaluation of electric hot-water recirculation system performance compared to traditional electrical central storage system.

Three common electric water heater configurations were evaluated in the laboratory (conducted in a laboratory at the Metropolitan State University of Denver, Colorado) including one conventional system and two systems reported to be "green".

1. Conventional Hot-Water tank with no hot-water recirculation.
2. Conventional Hot-Water tank with hot-water recirculation.
3. Point-of-use on-demand (Tankless) with no storage and no hot-water recirculation.

Results from the research demonstrated that not only did the conventional hot-water tank outperform the hot-water recirculation system with respect to temperature profile during flushing, but the standard system also operated with 32-36% more energy efficiency. Although the recirculation system did in fact save some water at the tap, when factoring in the energy-efficiency reductions and associated water demand, recirculation systems actually consumed up to 26.5 litres (7 US gallons) more water per day and cost consumers more money.

On-Demand systems (tankless) operate with virtually 100% energy efficiency, but cannot be used in many circumstances dependent on scaling and incoming water temperature, and may require expensive upgrades to home electrical systems and use of low/high-efficiency showerheads**. (6)**

CONCLUSION

The potential for water and energy savings in residential household hot-water systems is substantial enough to warrant continuing and rigorous research into new technologies. At this point few studies have been large enough to evaluate the true water saving potential of On-Demand hot-water systems.

REFERENCES

1. Lutz, James*, Estimating Energy and Water Losses in Residential Hot Water Distribution Systems,* Lawrence Berkley National Laboratory, Berkley, CA, February, 2005

2. Bryant, Charles W., "How Tankless Water Heaters Work" 22 February 2008. How Stuff Works.com

3*. Monitoring Performance of Retrofitting from Tank to Tankless Water Heaters.* CMHC, Technical Series 11-101, Ottawa, ON. December 2011

4. DeOreo, W.B. & Mayer, P.W. *Residential End Uses of Water Study, Version 2, 2016* (REUWS), Water Research Foundation, Denver, CO.

5. CALFED Water Supply Reliability*, City of San Diego: Recirculating Hot Water Systems: Residential Survey and Feasibility Study,* 2007

6. Brazen, Randi, H., Edwards, Marc, *A, Water and Energy Savings from On-Demand and Hot Water Recirculation Systems,* Journal of Green Building ,Vol 8(1) 75-89, March ,2013, Denver, CO.

ADDITIONAL READING

Water Heater Guide. Office of Energy Efficiency, Natural Resources Canada, Ottawa ON. October 2012

Tankless Water Heater: They're efficient but not necessarily economical Consumer Reports Magazine, October 2008