BY WINSTON HUFF, CPD, LEED AP

New Heat Pump Water Heaters and Solar Pumps Can Reduce Energy Use

The next time you walk through your local big-box building supply store you might notice several new choices in domestic water heaters and circulation pumps. While some technologies such as solar water heaters have been around awhile, they now are available in packaged systems for the residential and small commercial markets. Manufacturers also are introducing another round of water heaters. These energy-efficient products, such as air-to-water heat pump heaters, are new technologies in most markets.

These water heaters previously were available only from specialty manufacturers, suppliers, and installers, but mainstream manufacturers now are making them available in more outlets, such as the big-box stores. Because of this, the product, installation, and maintenance costs are decreasing. With this new availability, plumbing engineers will need to know more about the proper design, installation, and operation of these systems.

This article is not intended to be a detailed design guide providing all of the technical information a designer needs to know. Rather, it is designed to introduce engineers to these systems. The major water heater suppliers now are carrying these products, and their representatives are an important resource to learn more about what products and training are available in your area.

HEAT PUMP WATER HEATERS

A technology that is becoming more common for water heaters works by heating water with an air-to-water heat pump. These heaters can reduce the amount of electrical energy used to heat water when compared to standard water heaters. (It is important to note that many types of water heaters exist. When this article refers to a "standard water heater," it is referring to the electric element type of storage water heater.)

The upfront cost is higher for the heat pump type; however, they yield a reasonable payback time frame due to the energy savings. In many areas, they also can qualify for tax credits and rebates.

They work much like an HVAC air-cooled heat pump except that the heat is rejected into the water rather than into the air (see Figure 1). Air is circulated through the top of the unit, and the heat is absorbed by the refrigerant in the evaporator coil. The refrigerant is pumped through the compressor, which raises the temperature. This hot refrigerant then is circulated through coils (condenser) in the water heater to heat the water. As the refrigerant delivers its heat to the water, it cools and condenses and then passes through an expansion valve where the pressure is reduced and the cycle starts over.

The heaters have thick non-CFC foam insulation and, as a result, have less heat loss from the tank when compared to the standard heater. Heater efficiencies are determined by an energy factor (EF), which is a measure of the water heater's energy efficiency based on the quantity of hot water produced per unit of fuel. This includes recovery efficiency (thermal transfer), standby losses when tanks are provided, and cycling losses. A higher EF indicates a more efficient unit. Heat pump heaters can have a rating of approximately 2.3 EF, while standard heaters typically are rated around 0.95 EF.

A by-product of the heater is cool air that can be used for other purposes. Manufacturers are providing accessories with fittings that allow the installation of ductwork to the heaters. Most small heaters will produce one-half ton of cooling during operation. In some locations, this cooling can be used to spot-cool workers—for example, in laundries the cooling could be directed at press operators. It will not eliminate the need for cooling, but it can offset the cooling load. It also acts as a dehumidifier, which means in some homes the heater can be located in a basement space that can benefit from the dehumidification.

If the design team is interested in harvesting the cooling, close coordination will be required to align cooling needs with cooling availability. For example, the cooling may be needed during hot times of the year and not needed during cold times.

Figure 1 Typical heat pump storage-type water heater Source: State Water Heater

The heater will use the same footprint as a standard heater except that it will need room for air circulation. Because of this, it cannot be installed in areas such as unconditioned attics. It also will not work well in very hot or very cold areas. Like most heat pumps, these heaters are more efficient in warm, humid air. They will collect condensate during operation, so the condensate line and pressure-relief piping will need to be directed to a floor drain or another suitable point of discharge.

The recovery time is longer for heat pump units when compared to standard water heaters. Most units will have backup electrical elements to heat water during high demand periods. Designers should be aware of this when sizing the water heaters for different applications. If the heaters are sized where the backup electrical element is used in most cases, it will reduce the amount of energy savings from the heater. The heaters will use less energy in installations where the peak load is rarely used.

In sustainable construction, the designer should be concerned with four major issues: energy use, water conservation, the time it takes hot water to reach the tap, and reducing the amount of piping used in construction. A whole building design that takes all four issues into consideration with the appropriate heater can reduce the amount of energy a facility uses. However, using a heat pump heater will have little effect on reducing water usage.

An important issue is how long it takes for the hot water to reach the point of use because long wait times can waste energy and water. As mentioned earlier, heat pump heaters have very efficient insulation, which reduces the heat loss during standby. Large piping systems that circulate the water 24/7 can incur a significant energy loss, which minimizes the energy savings from a heat pump heater when compared to a system without a circulation pump. To reduce some of this heat loss in small commercial and residential applications, a timer or switch should be installed on the pump to reduce the amount of time the pump operates. In some residential applications, pumps can be set up to operate when the light switch in the bathroom is switched on so the hot water is at the point of use by the time the user turns on the faucet. However, this can be impractical in large systems with many bathrooms.

Recirculation systems also lose energy when the circulation pumps are inefficient, so designers must take circulation pump energy efficiencies into consideration. New pump technologies now on the market can reduce the amount of energy the total system will use. The goal is to use less energy and water when looking at the entire water heating system and not just the water heater.

Temperature maintenance cable systems are another option to maintain water temperature and may reduce energy. These systems can reduce the wait time for hot water at the point of use in some applications. The designer will need to look at the different heater types and balance them with the different temperature maintenance systems that are available.

SOLAR WATER HEATER PUMPS AND ENERGY USAGE

This column included an article on solar thermal systems in December 2010, and PS&D published a three-part series on solar systems earlier this year. Designers must take into account some important pumping issues when considering solar heating systems.

Pumps are an important energy user in a solar system. The new packaged solar systems are supplied with a pump. On systems that are not packaged, the plumbing engineer should be aware of several issues when specifying the pump.

Solar panel systems can supplement the supply of domestic hot water and heating. These systems usually have a circulator pump that pumps heating fluid, usually a water/glycol mixture, from the panels to the hot water storage tank or heat exchanger.

Some designers have used pumps that are supplied with power from a solar voltaic panel that is located near the solar water panels. While these pumps can save energy, they must be supplied with the power during times when the sun is not shining. Thus, they are not recommended on most commercial systems.

Pumps used in solar applications also can be subject to harsh conditions. A solar pump must be designed to handle antifreeze additives that may be in the water, high water temperatures, and significant temperature fluctuations.

If the system starts at a low outside temperature, the stagnated water inside the pipes may be very cold. After the pump has started, the water may be cold for a short period and may create condensate water inside the stator. Therefore, the windings should be protected; for example, they can be double-coated. The stator housing should have drain holes, and the pump housing should be treated.

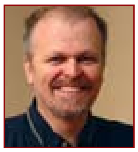
The highest temperature will be noticed in the system during stagnation if the tank is heated to the maximum and the sun is still shining. The temperature inside the collectors can reach up to more than 400°F, and the media inside the collector could be vaporized. The steam can fill the pipes, but normally it does not reach the pump. Nevertheless, the temperature can be higher than specified for a short period, and while condensing, water hammer effects might occur. Solar pumps should work with temperatures up to 280°F for a short time.

Solar systems operate with very low flows compared to other heating systems, yet with a relatively high pressure loss. Some systems have a standard circulator that reduces flow with a flow-restricting valve. This type of arrangement can waste energy. The new solar pumps on the market are made to operate at these flows and pressure rates without a flow-restricting valve.

The designer will need to be aware of the length of piping and the flow required to size these pumps. Most of the major solar water heater suppliers can help in sizing these pumps as well as the entire solar water heating system.

Several places to find more information are available. Here is a list of a few:

- Solar Energy Industries Association: seia.org
- American Solar Energy Society: ases.org
- Me Green You Green: megreenyougreen.com
- Database of State Incentives for Renewables and Efficiency: dsireusa.org
- Solar Rating and Certification Corporation: solar-rating.org
- RETScreen (free computer modelling software for renewable energy technology): retscreen.net



Winston Huff, CPD, LEED AP, is a project manager, plumbing fire protection designer, and sustainable coordinator with Smith Seckman Reid Consulting Engineers in Nashville, Tenn. He is on the U.S. Green Building Council's Water Efficiency (WE) Technical Advisory Group (TAG). He was the founding editor of Life Support and Biosphere Science and has served as its editor-in-chief. He is editor of Me Green You Green (megreenyougreen.com), a LEED credit data bank. For more information or to comment on this article, e-mail **articles@psdmagazine.org**.