How solar panels can keep you in hot water…

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One of the more effective designs for incorporating a solar energy collecting system is for domestic hot water. Relative to the installed costs, including the necessary equipment and labor, providing/supplementing domestic hot water for a home or building offers the best return on investment. This article will cover some of the basic design procedures necessary to size an appropriate system, pipe them according to suggested installation techniques and controlling options.

When sizing a solar collecting system for a domestic hot water application, you have to first establish the approximate load or usage for the application and secondly, it is strongly recommended (almost absolutely) to provide a supplemental or back-up heat source to ensure adequate domestic hot water is available whenever it is needed. The following is a quick example:

Family of 5 has an expected hot water usage of 20 gallons per person per day. (20 gallons is an accepted multiplier for establishing hot water needs) 5 X 20 = 100 gallons a day.

How many BTU/h's are required to heat the water? To determine this, you have to multiply the gallons by weight of a gallon of water (8.33 lbs per gallon) by the Delta T of water. (What temperature rise, or Delta T, do you want to achieve? 80°F is a desirable temperature rise. The water comes in from the street at 40°F and it is to be elevated to 120°F in the tank.) Calculating, 100 gallons per day X 8.33 X 80°F = 66,640 BTU/day.

What type of collector do you want to use? From last month's article, we discussed flat plate collectors and evacuated tube collectors. Each has its own advantages and limitations. For domestic hot water heating in the Northeast, flat plate panels are probably the most economical in terms of cost vs. performance.

The next step is to select the number of panels required to meet the BTU/day load for heating the domestic water. In the solar industry, there is an organization called the SRCC [Solar Rating and Certification Corporation]. This organization certifies all the manufacturers' capacity ratings for their panels (both flat plate collectors and the evacuated tube collectors.) They provide these SRCC rating sheets that list BTU/day capacities for the collectors. The performance of each panel is affected by climate, temperature differences and application (pool heating, water heating or air conditioning). Continuing with our example, one manufacturer's flat plate collector has a BTU/s.f./day rating of 22,000 BTU/day. To meet the load, you would select 3 panels.

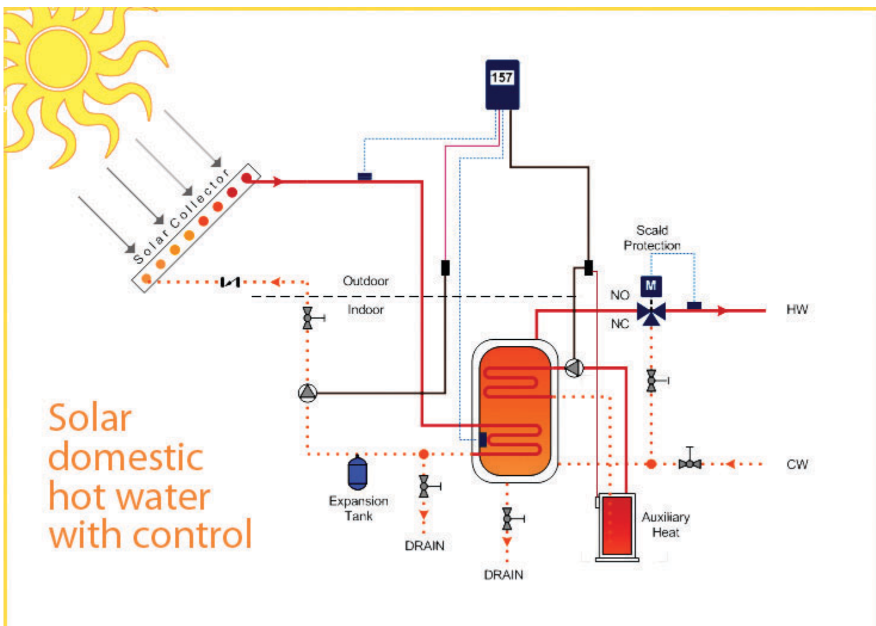
Once the number of panels has been selected, you need to determine the total flow rate requirements. Continuing with our example, the selected panel has a flow requirement of .79 gpm with a pressure drop of .25 inches water column. So in this system, the total flow that needs to be circulated through the three panels is 2.4 gpm.

Select piping size between the collectors using typical industry standards. A good rule of thumb is:

- ½" pipe will support 2-4 collectors.
- ¾" pipe will support 4-8 collectors.
- 1" pipe will support 8-12 collectors

Now you have to size the storage tank. Generally speaking, the storage tank should be sized to handle the gallons/day required for the system. In our example, we calculated a 100 gallons/day need, so a 119 gallon tank would be selected. Another school of thought suggests having a 1:1-2:1 ratio between the storage tank volume in gallons to the collector area in square feet. In our example, the tank volume is 119 gallons and the collector area is 109 square feet. This would work out to 1:1-1:0 ratio.

How do you size the solar pump? The same rules apply as they would for any other hydronic



Solar domestic hot water with control

application:

• What are my BTU needs?

• What are my flow requirements? (2.4gpm)

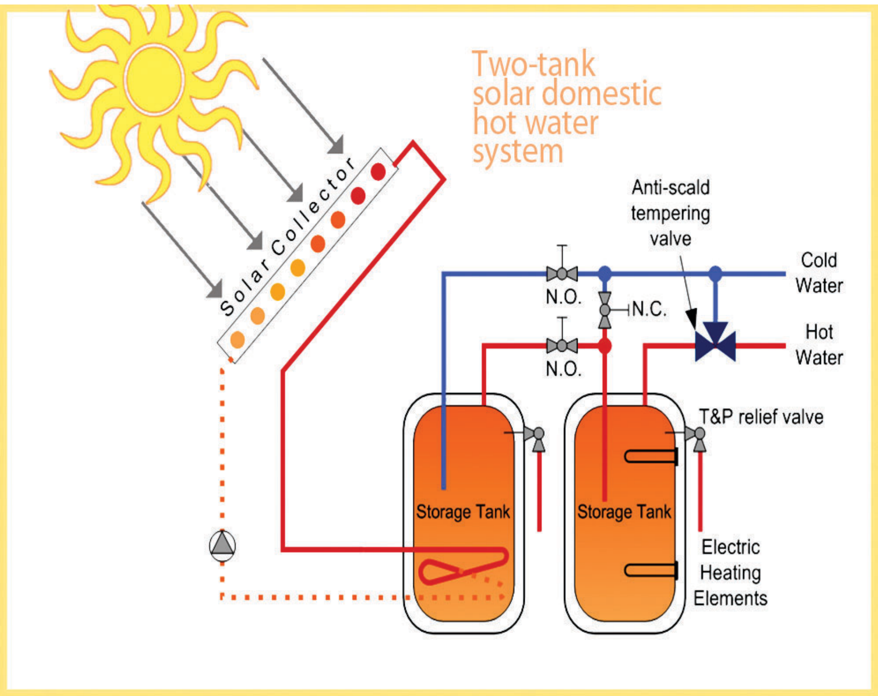
• What is the pressure drop? (3/4" pipe would be used between the storage tank and the collector panels up on the roof. How many feet of pipe multiplied by the pressure drop of 2.4 gpm flowing through ¾", plus the panel's pressure drop?)

When designing a solar collecting system for DHW, there are several different piping and control methods you can employ. Here are two of those options:

Single Tank Systems—When using a single tank approach, there are usually two heat exchanger coils inside the tank. The heat exchanger near the bottom provides the solar heating (or preheating depending upon capacity and load) of the domestic water in the tank. The upper coil/heat exchanger is supported by the supplemental heat (usually a boiler back-up) to ensure adequate domestic hot water at all times.

The warmest water stays near the top of the tank because of the lower of density of this warm water. This allows the cooler water to collect at the bottom of the tank, which maximizes the performance of the heat exchanger and keeps the collector temperature as low as possible. When cold water enters the tank, a dip tube directs the water to the bottom area of the tank. The temperature stratification that occurs ensures that the hottest water in the tank is drawn first from the top of the tank.

Of course, to protect the occupants, an anti-scald tempering valve is used to prevent scalding hot water from being delivered to any of the faucets and fixtures. Tanks can experience temperatures of at least 210°F, so ensure the tempering valve is rated as such. This valve is extremely important because of the possibility of storing scalding hot water in the tank, especially during prolonged sunny weather and light DHW demands. The solar circuit includes a circulator, fill/purging valves, pressure gauge, expansion tank, pressure relief valve, air separator, check valves and float vents with ball valve shut-offs. All of these components provide the same functionality as they do in a traditional hydronic system. By having the shut-off valve between the system and the float vents, you can protect the valves from stagnation temperatures that will occur.



Single tank systems have the advantage of a smaller footprint and as such, a reduced cost. However they can't collect as much solar energy on a yearly basis as a two tank system.

Two Tank Systems—This is also a common application, especially in systems that already have a traditional water heater (either bottom-fired or an indirect water heater). In this type of system, cold water enters the solar storage tank first. In sunny weather this tank may be able to provide all the hot water that is necessary. Of course, there will also be times when the solar can't keep up. But the solar storage tank will still raise the temperature of the cold water to some pre-heated temperature before it enters the other water heater.

For example, the entering water temperature to the solar tank may be 45°F and it is "warmed" to 85°F. This 85°F water then enters the conventional water heater through the "cold" water inlet and heat from the boiler or bottom-fired water heater raises the water to the required delivery temperature.

Remember, even though the water that leaves the solar storage tank has only been preheated, it can still represent a substantial reduction in traditional energy usage. By heating 45°F to 85-90°F, the solar collector system has reduced the required energy to heat water to 120°F by as much as 50% or more. Besides, the energy supplied at the lower temperatures is perfect for the solar portion of the system since the low temperatures greatly enhance the solar collector's efficiency.

The two tank systems normally provide greater solar energy collection annually relative to the one tank systems. This is due to the increased storage mass and the separation of the traditional energy input from the solar storage tank. It is important to remember that these tanks MUST be insulated very well or whatever energy savings you gained from the solar collector system is immediately lost to the heat loss of water to the surrounding air in the mechanical room.

To simplify and speed up the installation process, most solar manufacturers offer solar "pumping stations." These stations are pre-assembled kits that include all the necessary components such as pumps, check valves, air vents, expansion tank and the controls to operate the pump. These kits take a lot of the guesswork out of providing and locating each component properly.

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