SOLAR HEATING... does it make $ense? (Part I)

By George R. Carey

Consumers are constantly looking for advice and ideas on ways to improve, save money and even reduce their "carbon footprint" when it comes to their heating system. One method that is gaining popularity again (it was very popular back in the '70s) is solar heating. Now when most people think of solar heating, they think of that big hot orange ball in the sky that keeps the earth warm. Here are a couple "tid-bits" regarding the power of the sun:

In one hour, more sunlight falls to earth than what is used by the entire population in one year.

In one second the sun releases more energy than has been used by man since history has been recorded.

Several major international oil companies predict that renewable energy will supply as much as 50% of the world energy by the year 2040.

Solar manufacturers over the years have improved their product offerings compared to what was available in earlier years. Modern materials combined with manufacturing efficiencies have extended product life. Also, improved control packages and strategies have increased solar collector performance and modular panel and piping packages have reduced installation time and eliminated those "one-of-kind" systems. All of these improvements have made solar heating technology a viable renewable energy source.

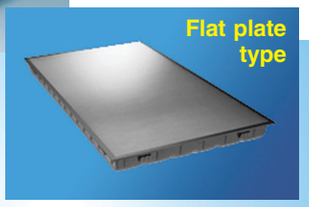
Solar radiation, a form of electromagnetic radiation, is very similar to X-rays or radio waves and much like radiant heat, which is emitted by warm floors. What is different about solar radiation, compared to other electromagnetic radiation, is its wavelength.

The energy capacity of the sun's rays outside the earth's atmosphere is approximately 430 Btu/hr/square foot. Unfortunately, this intensity is significantly reduced because the gases and vapors that surround the earth's surface absorb most of this energy. Also, the geographic location on the earth, time of the day and time of year all greatly affect the intensity of the solar radiation. On a clear day, the most intense time for solar radiation is at solar noon, which is when the sun is highest in the sky.

There are several types of systems that all fall under the solar thermal radiation classification. I would like to focus on systems that are considered active (use of circulators to move liquid through the solar collector) and that are designed to collect solar energy for heating buildings and/or domestic water.

One common characteristic of all these systems is that they use some type of collector to gather the sun's energy and use it to heat water. These collectors are typically found on the roof of a house or building. The two most common collectors are the flat plate collector and the evacuated tube collector.

A flat plate collector has an absorber sheet which is a combination of a copper sheet and copper tubing. The top side of this absorber is painted with a dark colored paint or has an electroplated surface coating that absorbs the solar radiation striking it. When the sun's rays hit this absorber, the radiation is converted to thermal energy (heat). The copper sheet transfers this energy to the copper tubing connected to the plate. The heat moves from the copper sheet to the tubes because the liquid pumping through the copper tubing is cooler than the absorber sheet. The fluid takes the heat away from the collector. To enhance its efficiency, the sides and back of this plate are insulated with materials capable of handling temperatures in excess of 350°F, and the upper surface of the flat plate is usually made of tempered glass that can withstand the extreme thermal stresses that will occur.



The other type of collector is called an evacuated tube. It consists of several glass tubes that have concentric inner and outer walls. The space between the glass tubes has been evacuated of air and acts like a Thermos® bottle. Heat transfer between the inner and outer tube is eliminated. A copper absorber strip with copper tubing is installed inside the inner glass tube. Inside this tube is a specialized fluid that, when heated, changes from liquid to vapor and rises to the top of the tube. It then flows into a small copper capsule that is connected to a manifold assembly at the top of the collector. Heat is then conducted through the copper capsule into the fluid that is circulating through the manifold. The fluid in the evacuated tube never comes in contact with the fluid in the manifold. As heat is released from the fluid in the evacuated tube, it condenses back into a liquid and flows to the bottom of the tube to repeat the cycle.

So which one is better? The answer is, "It depends." The collector with the best performance depends on the specific application. Thermally speaking, the best performing collector is governed by the temperature required by the specific load, which is dependent upon the collector's inlet fluid temperature, the outdoor air temperature and the sun's radiation intensity. If the load requires relatively high water temperature (heating with high temperature terminal units), an evacuated tube is probably the best collector of choice, even though it is more expensive than flat plate collectors.

If the application is domestic water heating or low temperature heating, then a flat plate collector is more than capable and more economical. The only accurate way to establish which collector performs more favorably is through computer simulation based upon very specific conditions in a specified climate. All of the solar panel companies provide this software as standard design equipment.

There are many methods of using solar collector systems to supplement domestic hot water or space heating production. In the process, there are different design concerns regarding stagnating conditions, freeze protection and control strategies.

In the next issue, we will cover these subjects and we'll provide a sizing example for a specific application that can be used in any residential hydronic system.

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