Article contribution to WSSHE Newsletter: Solar Thermal Systems

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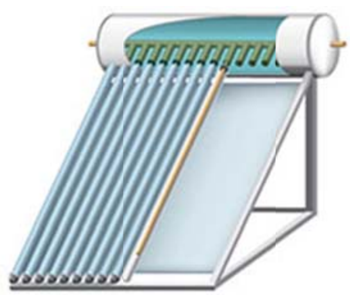
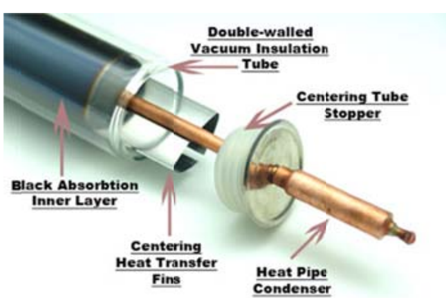
Solar hot water / thermal systems provide hospitals and residential healthcare facilities with great potential for saving money, having access to emergency hot-water supplies, and reducing carbon emissions.

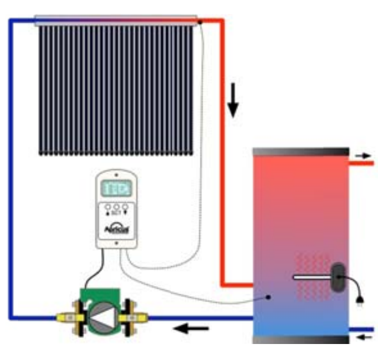
Two primary solar thermal system designs[1]:

Flat Plate Collectors: Flat plate arrays are designed to move fluid through an area covered by glass, picking up heat as the water travels through the collector, which typically consists of copper tubes fitted to flat absorber plates. The most common design is a series of parallel tubes connected at each end by two pipes, the inlet and outlet manifolds. The flat plate assembly is contained within an insulated box, and covered with tempered glass. These systems are most effective in Southern climates.

Evacuated Tube Collectors: This system, is better suited for climates with freezing weather. It uses a vacuum-tube or thermos-like design to collect and transfer heat. An insert in the middle of the tube, made of copper, contains either water or a heat-transfer liquid, and sits within the vacuum glass tube. The vacuum space between the two tubes reduces convection and conduction, ensuring minimal heat loss and energy efficiency. Water running through the array header is heated by the collected solar energy in the inner tubes, and piped out to serve a variety of functions from domestic hot water heating to manufacturing/process heating.







[1] Energy Star website: http://www.energystar.gov/index.cfm?c=solar_wheat.pr_how_it_works

Evacuated-tube systems are ideal for Northern climates, working well in overcast conditions, and in temperatures as low as minus 40 degrees Fahrenheit. In most applications, system designs are required to prevent overheating or excess heat. The cost of evacuated tube collectors can be double that of flat-plate systems or in the range of $3,000-$20,000 per 20-tube array installed. The good news for those of us in Washington state is that a local company offers an proven evacuated tube system (using headers manufactured at the Walla Walla Correctional Facility) for significantly less – installed cost for a 20-tube array is $3,000 to $3,500 for commercial and industrial applications.

Installation

The efficiency of solar hot water collectors is directly impacted by the type of system installation used. The two most common installation designs are:

Pressurized: The system is pressurized or full all the time, and typically uses glycol. Compared to water, glycol systems are approximately 30% less efficient in heat transfer.

Unpressurized: This system is often configured as a drain back design (usually employing a tank) that is open to atmosphere. Benefits of this installation type include:

1. Scalability – applies to small residential installations as well as large commercial and industrial applications.
2. Climate-neutral – functions in any climate; will not freeze or boil.
3. Efficiency – It is the most efficient for two reasons. It uses plain water, which has the highest heat transfer characteristics, and it does not have a heat exchanger between the tank and the collectors. Typical heat exchangers are 50-60% efficient in transferring heat between one side and the other. With no exchanger between the tank and collectors, the drain back system transfers 100% of the collector heat to the tank.
4. Durability – glycol (used in pressurized installations) deteriorates over time producing acids that eat piping. Pressurized glycol systems have up to 30% shorter equipment life than drain back systems.
5. With fewer parts, no exchanger, and no chemicals degradation, drain back systems are as trouble-free as possible.
6. Trouble-free translates into no regular maintenance, just an occasional checkup.

Both designs work according to the same basic principles, i.e., the sun heats up the solar collector, which transfers the heat to a fluid. The energy in the heated fluid is then available for use.[2]

Applications

Solar hot water systems have great potential to save hospitals and resident healthcare facilities money while reducing generation of carbon dioxide (carbon footprint). As an adjunct to a primary heat source, solar power can provide an enormous volume of required hot water for the following:

Shower / bath / rehabilitation hot water requirements are met or supported with solar arrays.

Laundry applications require 165 F. or higher temperatures to ensure that pathogens are killed in wash process. Solar hot water systems can deliver temperatures of up to 200 F for extended periods of time, and they can be easily controlled to ensure back-up heat is immediately integrated should there be a drop in output temperature. Systems can be used to preheat incoming air for dryers as well.

Clothes drying can be accomplished with fluid-to-air heat exchangers to heat inlet ambient air by employing circulating fluids such as oil to reach temperatures of up to 300 Fahrenheit.

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[2] Dr. Ben Gravely; http://ezinearticles.com/?Understanding-Solar-Hot-Water-Systems---The-Drain-Back-Design&id=5433901; Dec. 2, 2010

Space heating can be cost-effectively achieved by solar powered radiant floor, radiators and hydronic heating in new and existing buildings, and/or via radiators in existing HVAC systems.

Building maintenance utility costs can be significantly reduced by using hot water directly from the solar arrays or by pre-heating inlet water into a hot water heater via heat exchange for domestic hot water supply, and building and equipment clean-up. This is primarily due to the reduction in time and intensity of the boilers or hot water heaters.

As with all solar technologies, a full backup heat source is required for conditions when there is insufficient solar energy, i.e., overcast skies, snow, rain and fog. To this point, it is important to note that Germany, the country installing the greatest number of solar systems and technologies in the world, is known for its rainy, overcast weather patterns. In fact, 3% of Germany's total electricity demand is met with solar energy, and some analysts expect this to increase to 25% by 2050.[3]

Under Western Washington's similar weather conditions, one solar system is generating from 28,000 Btus of thermal energy per day in the winter, up to 44,000 Btus per day in the summer months.[4]

In addition to ensuring primary heat sources exist before installing solar thermal technologies, take care to treat or condition water circulating through the arrays to prevent scaling.

The larger picture

Often in looking at technologies or energy savings or returns on investments, we miss the larger picture. At the core, a hospital is there to protect its patients and make the community it serves healthier. By reducing its carbon footprint, a hospital reduces emissions into the community it serves, and provides examples to others of how economics do not always have to be sacrificed for the environmental good.

Energy independence is another major benefit that hospitals / healthcare gain in utilizing solar hot water systems. During the last series of environmental catastrophes, it was apparent that many hospitals were ill-equipped to deal with resulting problems. Katrina produced conditions that interfered with sterilization of instruments, and securing clean drinking water. Freezing temperatures and loss of power during the Fukushima nuclear plant disaster resulted in many patients dying during evacuation. And Hurricane Sandy showed that even in our most populated and technologically-sophisticated areas, we can be without essential services for a month or more. In fact, following Sandy, the Department of Energy issued a call for new technology innovation in non-electric heat sources, which solar energy systems could provide.[5]

Under these conditions, engineers can be at their best. In addition to providing heat sources, and domestic and process hot water, larger passive solar thermo (tank) systems store thousands of gallons of potable water which can be accessed during emergencies (note: enough hot water can be stored in insulated storage tanks during daylight hours to make the supply available for 24 hours). Or, instead of using valuable resources such as electricity and natural gas to heat water during sun/daylight hours, engineers can power critical surgical and life-support equipment, or reduce load on the grid in order to make more energy available for public use.

In summary, by utilizing solar thermal technologies, healthcare engineers contribute significantly to the triple bottom line, by which many organizations are now gauging success – people/patients, planet, and profit. Specifically, patients are protected in emergency conditions when reliable, renewable energy is available for their care; renewable energy technologies significantly decrease a hospital's environmental impact, establishing it as a standard-setter in the community; and profits increase when utility, maintenance, and other related costs are reduced through the use of renewable solar energy.

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[3] "German solar power output up 60 pct in 2011". Reuters; 29 December 2011. Retrieved March 11, 2013 from Wikipedia, "Solar Power in Germany" at http://en.wikipedia.org/wiki/Solar_power_in_Germany

[4] Silk Road Solar; www.silkroadsolar.com

[5] "Urgent Call for Innovation: Hurricane Sandy Relief – Non-Electric Heating Solution Needed", U.S. Small Business Administration; November 20, 2012; http://content.govdelivery.com/bulletins/gd/USSBA-5dc04f

Other information sources for this article:
http://en.wikipedia.org/wiki/Solar_thermal_collector
http://www.energystar.gov/index.cfm?c=solar_wheat.pr_how_it_works