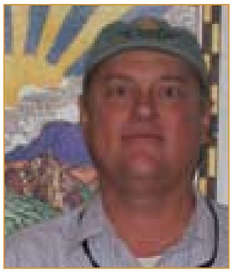
Solar Solutions

Bristol Stickney, technical director, Cedar Mountain Solar Systems, Santa Fe, N.M.



Warm-floor solar heating for concrete pools

Solar pool heat

Solar pool heating is already a much larger industry in the United States than solar home heating. Swimming pools can require a tremendous amount of heat depending upon the climate, and so pool owners always seem to be receptive to the solar heating option since a swimming pool can often double or triple their home heating bill.

The most common solar pool heating systems use unglazed plastic solar heat collectors, where water from the pool itself is circulated through the plastic collectors when it is sunny, using the filter pump as the solar collector circulator. This type system (unglazed direct) can be seen on the plastic collector websites, such as Fafco, Heliocol, Technosolis and others. (For a complete list of unglazed pool collectors certified in the United States, see the SRCC Web pages.)

Unglazed direct solar pool collectors are appropriate only for climates that do not freeze or for seasonal applications where water is drained from the collectors during times of freezing weather. In our climate (Santa Fe, New Mexico), they are considered seasonal systems, intended to extend the outdoor swimming season by providing solar heat only throughout the spring, summer and fall.

The second most common solar heated pool system applications use glazed flat plate collectors that heat the pool indirectly through an external heat exchanger. This allows the solar collector system to remain in operation all year round, even during freezing weather. In our region, the collectors are typically filled with pressurized propylene glycol mixture which feeds the hot side of the pool heat exchanger, and pool water is circulated on the cool side of the heat exchanger most often pumped by the pool filter pump. This type of system (glazed indirect) is popular with solar heating indoor pools that are used year round.

A third way of solar pool heating has emerged over the past decade that few people have ever heard of, but has become my preferred solar heating system for pools. That is the "warm floor" solar pool heating system. Concrete pools and hot tubs that are constructed on-site are made of the same elements as a slab-on-grade "radiant heated floor"; concrete, remesh and rebar in contact with the earth. Sometimes, with a little collaboration with the pool builder, some insulating material can be added around or beneath the concrete shell. When PEX hydronic heat tubing is tied to the remesh and embedded in concrete shell of the pool, you then have a direct solar heat exchanger as shown for a hot tub under construction in Figure 19-1. This type of system is a simplified version of the glazed indirect approach, but because the concrete shell of the pool is heated directly by solar hydronic fluid, I think it qualifies as a glazed direct solar heating system.

Electrical power advantage of pool floor heat

I designed my first warm floor pool more than 10 years ago for a custom home project near Santa Fe that presented many solar heating challenges to overcome. It was an off-grid enabled home that required extreme electrical efficiency. When grid power was not available, all electrical systems transferred automatically to photovoltaic (PV, solar electric) battery power. The house was large (more than 8,000 square feet) and so required a large array of solar heat collectors just for space heating. The remote location required propane deliveries as the only conventional backup heating fuel. Because of a sprawling site layout, the heat collectors had to be mounted over 200 feet from the house, and the outdoor lap pool was another 100 feet or so from the house. There was also an outdoor hot tub that required solar heat located about 100 feet in a different direction.


Figure 19-1

To save on electricity, I designed the entire hydronic heating system — including the pool and hot tub solar heat — around DC circulators that use a fraction of the pumping power of typical pumping systems available at that time. All the supply and return tubing diameters (as well as most of the embedded floor tubing) were up-sized to reduce the pumping power required to deliver hydronic heat. The solar collector circulators were directly powered by PV panels, so that solar heat collection did not require any grid power or any battery power. The 200-foot run out to the collectors (18 panels, 4' × 10'), required two solar circulator pumps each powered by its own 150 watt PV panels. The ground mounted collectors can be seen in Figure 19-2.

By putting 3/4-inch PEX (instead of the typical 1/2") into the concrete shell of the pool, I calculated that the daily solar heat provided to the pool could be delivered to the floor of the pool using a DC circulator rated just under 20 watts. I used the same approach for the remote hot tub and each floor heating zone in the house. The electrical controls for each circulator were designed so that DC power was consumed only when hydronic heat was being delivered. No wasted electricity was consumed by zone valves and transformers, since these were eliminated by using the DC equip-


Figure 19-2

Continued on page 26

Solar Solutions

Continued from page 24


Figure 19-3

ment powered by the solar electric batteries. Since the inside surface of the pool shell serves as the water side of the solar heat exchanger, the filter pump is not required when delivering solar heat to the pool water. Heat delivery happens by natural means of conduction, convection and radiation from within the concrete shell of the pool, which drastically reduces the electrical consumption while heating the pool.

The pool with the solar heated warm floor described above can be seen under construction in Figure 19-3 and in its finished form in Figure 19-4.

Other useful advantages

By using warm floor solar pool heating we gain a number of additional benefits. The solar heating equipment becomes completely separated from the conventional pool mechanical equipment. There does not need to be any plumbing or electrical connections between the solar equipment and the pool mechanical systems. The conventional gas backup boiler can be set to provide a minimum water comfort temperature for the pool user, and the solar heat boosts that temperature when ever it can, within a reasonable comfort range under its own separate temperature control. When ever the solar heat provides a temperature higher than the boiler set-point the boiler will respond normally by turning off the gas. In this way, the pool guy has his own domain and the solar guy has his. There is no question about who is responsible for what equipment and what warranty belongs to whom.


Figure 19-4

A cool solar collector is a happy solar collector. You can see this in the collector efficiency graphs included in some of my earlier articles. When circulating warm hydronic fluid through the shell of a pool, is tends to cool off much more than when running through the hot side of an external indirect heat exchanger. This cooler fluid, when returning to the solar collectors, results in higher solar thermal efficiency for the collectors, which translates to more solar heat per day delivered to the pool.

The home heating system described above was one of the most complex solar combi-systems I ever designed. (A combi-system combines solar heat collectors, DHW, space heat and other multiple heat sources and multiple heat loads into one system.) As I have mentioned before, solar heat dissipation is always a concern with these systems. There is always a possibility that, at some time during the year, the large solar heat collectors will provide more heat than is needed by the heating loads. A swimming pool provides an ideal place to dissipate extra solar heat, since free heat for the pool is almost always welcome.

When heating a pool through the floor, the heat source is at the bottom of the pool where you might expect the coldest water to settle. When the filter pump is not running, the water temperature in the pool will tend to stratify: hot water rises upward and cool water settles to the bottom. In a pool with a warm floor, water temperature tends to de-stratify even without the filter pump mixing it. A pool filter pump is generally an energy hog, requiring hundreds and often thousands of watts to operate. If it is required to run during solar pool heating, the parasitic efficiency loss can be substantial.

Over the past 10 years I have been involved with about a dozen site-built concrete pools and hot tubs that are solar heated. Some are indoors, some are outdoors. About half have employed external indirect heat exchangers and the others have been "warm floor" pools and tubs. I prefer the performance and simplicity of the warm floor systems. Building them successfully takes cooperation and collaboration with the pool builder. When it comes to structural concerns and functional details, the pool guy has the final word on the pool construction.

The DC hydronic control system briefly described above was patented by myself and Allan Sindelar, of Positive Energy in Santa Fe and originally called the SETH (Solar Electric Thermal Hydronic) control system. Brand names, organizations and manufacturers are mentioned in these articles only to provide examples for illustration and discussion and do not constitute any recommendation or endorsement. ■

***Bristol Stickney**, partner and technical director at Cedar Mountain Solar Systems in Santa Fe, N.M., has been designing, manufacturing, engineering, repairing and installing solar hydronic heating systems for more than 30 years. He holds a Bachelor of Science in Mechanical Engineering and is a licensed Mechanical Contractor in New Mexico. He is the chief technical officer for SolarLogic LLC and is involved in training programs for solar heating professionals. Visit www.cedarmountainsolar.com for more information.*

In this series of articles, I have been making the case that the key ingredients for solar/hydronic design and installation can be divided into six categories, listed below, roughly in order of their importance.

1. RELIABILITY
2. EFFECTIVENESS
3. COMPATIBILITY
4. ELEGANCE
5. SERVICEABILITY
6. EFFICIENCY

The success of any solar hydronic home heating installation depends on the often-conflicting balance between any of these six principles. Finding the balance between them defines the art of solar heating design.