



Building with the Sun

Solar Energy and Radiant Floors

by Alex Wilson

Solar energy is well suited to radiant-floor heating because the temperature requirements for the slab are low (80 to 125 F), and solar collectors are much more efficient when operated at relatively low temperatures.

But the nature of solar heat adds a number of complexities when it comes to controls and back-up requirements for radiant floors.

very young. Most solar calculation programs (such as F-Chart) cannot deal with low-temperature heat delivery. And programs for sizing radiant heating systems do not factor in solar energy.

Friedlander concentrates on making sure that the radiant slab is large enough for the heat load. That done, he looks at the total heating budget for the project and figures out how many collectors and storage tanks the

A combined solar/gas system such as this requires an even more complex (and more expensive) control. The system used by Solar Alternative (a Centra RTB Series control module) incorporates a four-way, motorized mixing valve.

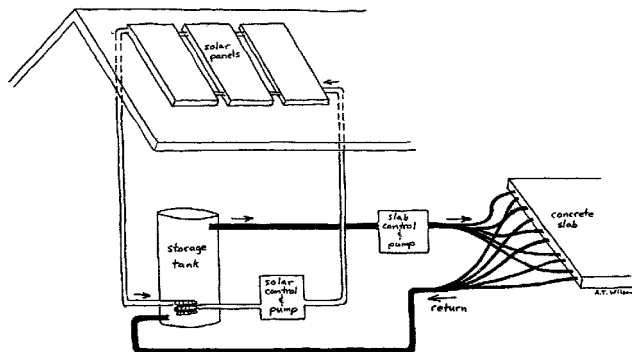
Water circulating through the slab passes through this mixing valve, and hot water from the storage tank and/or the gas boiler is mixed with it to keep the circulating water at the right temperature. When solar-heated water in the storage tank is hot enough, the water is used; otherwise, the gas unit is used.

This level of control is designed for the family wanting a fully automatic system that they don't have to worry about. Considerable savings can be achieved by using a more "manual" control system—but the owners need to know how to operate it.

Particularly with back-up systems using conventional fuel, improper operation could cause the water in the storage tank to be heated by the boiler, so that the solar collectors never work (or else work very inefficiently).

The moral of this is that solar-heated radiant floor systems are quite complex. But people who use them tend to be very satisfied. •

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Drawing by Alex Wilson

The Basic System

Solar energy can be used a number of ways in radiant floors. The easiest approach is simply to pump solar-collection fluid directly through the tubing in the slab, without using any intermediate storage.

The beauty of this approach is its simplicity, but how do you control the slab temperature? To avoid large fluctuations, the system must be carefully designed—often with the solar system significantly undersized to avoid overheating. (The French have had the most experience with this approach, but their sizing techniques have not yet crossed the Atlantic.)

specializing in radiant-floor heating systems), the science of sizing solar radiant floors is still owners can afford.

Controlling the Flow

The most complex aspect of solar-heated radiant floors is the system to control the circulation of water through the slab. Because the temperature of the water coming from the storage tank is not always the same, the control system must compensate for it.

Water usually is pumped through the slab at a constant rate (such as 2 gpm), and the rate of heating is controlled by changing the temperature of the water flowing through it.

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The other approach—the one we'll focus on in this column—uses intermediate storage.

A solar-heated radiant floor with intermediate storage uses two closed loops: one for the solar collector and another for the radiant floor.

The solar-collector loop is identical to the standard active-solar, closed-loop system for domestic hot water heaters. An antifreeze solution is circulated first through the collectors, where it picks up heat, then through a heat exchanger in the storage tank, where it releases that heat into the water.

The radiant-floor loop takes solar-heated water from the storage tank and circulates it through plastic tubing embedded in a concrete slab, delivering heat to the slab.

Like the solar loop, the floor loop is closed, meaning that the same fluid is circulated over and over. Pure water generally is used in the floor loop, but in situations where freezing might be a concern (such as in greenhouses), a separate loop of antifreeze solution may be used with a heat exchanger in the top of the tank.

The size of the solar system to be used with a radiant floor depends on the size of the slab to be heated, the heat load of the house, and the assumptions made about the percentage of heat solar energy will contribute.

According to Mathew Friedlander of Solar Alternative in Brattleboro, Vt. (a company

Proper controls for solar-heated radiant floors monitor the temperature of the outside air, the water in the floor loop and the storage tank, and the living area. If a wood stove is fired up in the living room, the controls must take that into account and lower the temperature of water flowing through the slab.

The amount of sophistication involved in the control system helps to explain its cost—as much as \$1,500.

Back-Up Heat

The system gets even more complicated when a back-up system is used to heat water for the slab. In some cases, the back-up is totally independent of the slab (as with wood stoves). Gas- or oil-fired hydronic or forced-air systems and electric baseboards also can be used as separate back-ups.

An independent back-up system is the only practical option in solar-heated radiant floors that do not incorporate intermediate storage.

Quite often, however, back-up heat is used to heat the slab. This approach makes sense because radiant-floor heat is so comfortable—and because the owner already has gone to the expense of installing the radiant system. Solar Alternative uses a high-efficiency, instantaneous gas boiler (Bosch) as back-up heat for the slab in most of its solar radiant-floor systems.