Warm Floors

Now Easier Than Ever

Radiant-panel systems a carpenter can install are perfect under a wood floor

BY RICK ARNOLD

When I answer the alarm clock in the dead of winter, I set my bare feet on the hardwood floor to get an idea of the temperature outside. If the floor is warm, I know it's cold out. My radiant-floor heating system answers the chill of a New England winter by putting the warmth where it counts: right under my feet. After four Rhode Island winters, I can say that this type of heating system is the most comfortable I've ever experienced.

A hydronic radiant-floor heating system works by pumping heated water through cross-linked polyethylene (PEX) tubes that run under the floor. The floor then functions as a huge radiator, emitting an even, low-temperature heat.

Thanks to some simple, well-designed components, the new "dry" radiant-floor heating systems (sidebar, p. 55) can be installed with basic carpentry skills. The system that I use

A simple recipe for hydronic heat. *A small stack of aluminum-backed panels, a roll of PEX tubing, several tubes of silicone, a box of screws, and an air-pressure gauge are the ingredients necessary to install a radiant floor. Add hot water for a comfortable room.*

Is a radiant floor for you?

PROS

- **Comfort.** Radiant-floor heating is more comfortable than other types of heating. When your feet are warm, the rest of your body follows. Conversely, cold feet can make you feel cold all over, even when air in the room is warm.
- **Even warmth.** A radiant floor provides even heat because the entire floor surface acts like a giant radiator. With forced-air and hydronic-baseboard heat, some parts of a room can be colder than others.
- **More-healthful heat.** Radiant heat keeps circulation of dust and other allergens to a minimum. Ductwork in an improperly maintained and filtered forced-air system can spread dust and mold throughout a house and cause respiratory problems for some people.
- **"Invisible" system.** Radiant-floor heat is silent, and without baseboard heating units or hot-air registers, you have more freedom to arrange furniture.
- **Economical operation.** Because it uses a low water temperature, a radiant floor doesn't require much energy to remain at a comfortable temperature, provided the space is well insulated. And because radiant heat is so comfortable, the thermostat often is set a few degrees lower with radiant-floor heat further reducing costs.

CONS

- **Higher installation cost.** The grooved-floor panels and PEX tubing for the addition featured here cost $1,500. Standard hot-water fin-tube baseboards for the same space and copper supply tubing would have cost around $400. Here in the Northeast, the installed cost for a full hydronic in-floor heat system, including boiler and controls, is about $12 per sq. ft.
- **Wall-to-wall carpet is out.** Although there's no harm in fully carpeting a radiant floor, doing so will diminish the efficiency of the heating system.
- **Air conditioning costs extra.** With the ductwork and blower unit needed for air conditioning already in place with a forced hot-air system, the cost of adding air conditioning is significantly less than adding it to a radiant-heated house.
- **Puncture potential.** A leak in a hydronic radiant floor can have disastrous consequences. Care must be taken whenever fasteners are driven or interior alterations are made.
- **Slow response time.** It can take hours to raise or lower the temperature of a radiant floor.

doesn't require any special framing and adds only ½ in. to the floor height.

A heating contractor designs the system

Even for a single-room addition like the one featured here, it's important to have an experienced heating contractor design the radiant-heating system. The contractor calculates the heat loss for the room(s) accounting for climate, room size, insulation values, glazing area, and the type of finish flooring to be installed.

Using specialized software, the system designer selects the diameter (usually between 5/16 in. and ⅝ in.) and spacing (usually between 6 in. and 12 in.) of tubing, the length of the tubing runs, and the water temperature and pumping requirements. Finally, the contractor recommends the control components used for monitoring and regulating the heating system.

Multiple tubes mean even heat

If one long, continuous length of PEX tubing was used for the system, it wouldn't work well. The drop in water temperature from the beginning to the end of the tube would render the last part of the system almost ineffective, and the floor would not warm evenly. To prevent this heat loss, radiant-floor heating systems rely on multiple loops, or runs, of tubing. Each run begins at a supply manifold and ends at a return manifold. To prevent the water temperature at the return manifold from dropping much below the supply temperature, each run of tube usually is limited to around 250 ft.

Your heating contractor can help you to locate the manifolds so that the runs are kept to minimum lengths and so that they

Photo left: Roe A. Osborn

PANELS INSTALL WITH JUST A SAW AND A DRILL

U-shaped end channels determine supply and return pipe locations. *Laying out the end panels first, the author can drill supply and return holes that line up with the spacing of the tubing. He located the return lines to keep each loop of PEX less than 200 ft. long.*

cover distances that are relatively uniform.

Grooved panels install quickly

Once the manifold location is established, I lay out the path of the tubing. On this project, I used Wirsbo Quik Trak. (Similar panels are made by RTI Piping Systems, Stadler-Viega, and Warmboard.) The straight-run panels measure 7 in. wide by 48 in. long with a channel in the center to accept 5/16-in. PEX tubing. Each panel is backed with a thin layer of aluminum that helps to disperse the heat and reflect it upward.

The system also includes return panels with a series of U-shaped channels to change direction. The aluminum backings for the end panels are shipped loose and must be slipped in place beneath each panel.

I start by squaring up and snapping lines representing the inside edge of the panels on all four walls to ensure that the panels fit together easily. I position the return panels on the floor and mark the entry and exit points for the supply and return ends of each run so that they are each approximately equal and about 200 ft. long.

After completing the layout, I remove the end panels and drill access holes so that the tubing can reach the manifolds on the basement wall adjacent to the addition. The addition is lower than the house's first floor, so I can drill the access holes at the base of the wall. I make the hole a bit oversize so that I can anchor the tube with silicone to prevent chafing. Often, supply and return holes are drilled through the floor, in which case I use a manufacturer's sleeve to hold the PEX in place.

Screw radiant panels directly to the subfloor

Insulation beneath the subfloor to keep the heat traveling in the right direction is the only special preparation necessary before installing the radiant panels. Insulation is required even in the conditioned space of a second-story floor.

Begin installing the panels by positioning two end panels at opposite ends of the room. They should be offset from each other by the 7-in. width of a straight panel. I don't screw down an end panel until I've fastened the straight panel that butts against it because the panels occasion-

A supply line along the outside wall puts the hottest water where it's needed most. *A combination of straight and curved tracks brings the tubing run to the outside wall. Arnold uses a circular saw with a general-purpose carbide-tooth blade to cut the aluminum-backed panels.*

Screw-down installation goes quickly. *Arnold initially secures each panel with two 1½-in. screws, taking care to align grooves in adjacent panels and to stagger panel joints by at least 2 in.*

Dry radiant-floor systems don't require poured concrete or gypsum

The good news about hydronic radiant floors is that there are workable options for all kinds of new construction and remodeling applications.

Traditional **"wet systems"** often are used for new construction. The tubing is embedded in a poured-concrete slab or in a thin, lightweight gypsum floor poured over a wood subfloor (top drawings), which creates an efficient thermal mass.

Wet systems work well with glue-down finish floors (tile, vinyl sheet, wood parquet) but can present a challenge for wood strip flooring.

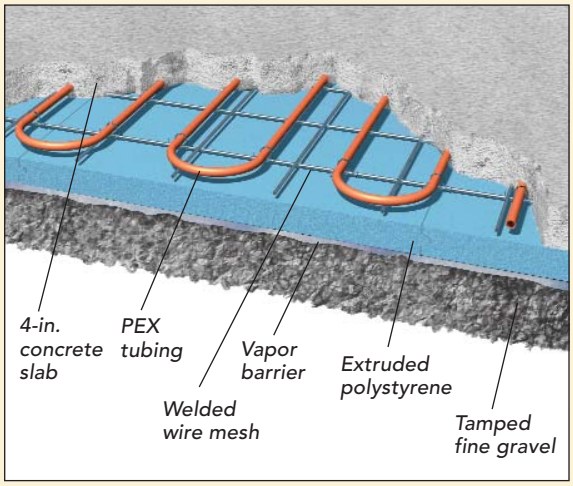
More recently, **dry systems** have been developed that use mechanical fasteners to hold the tubing and a heat-transfer plate (usually aluminum) to distribute the warmth. These systems work well with wood strip flooring.

One installation method fastens the tubing to the underside of the subfloor in combination with aluminum heat-transfer plates, a system commonly referred to as "staple up." This works well to retrofit a floor with radiant heat if the underside of the floor is accessible.

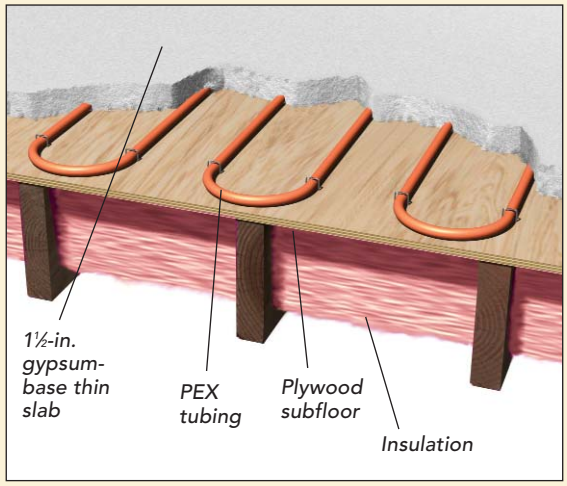
The other method, and the one I prefer, is described in this article. Manufactured panels on top of the subfloor have a quicker response time than other systems because the tubing is closer to the surface.

WET SYSTEMS

Poured-concrete slab

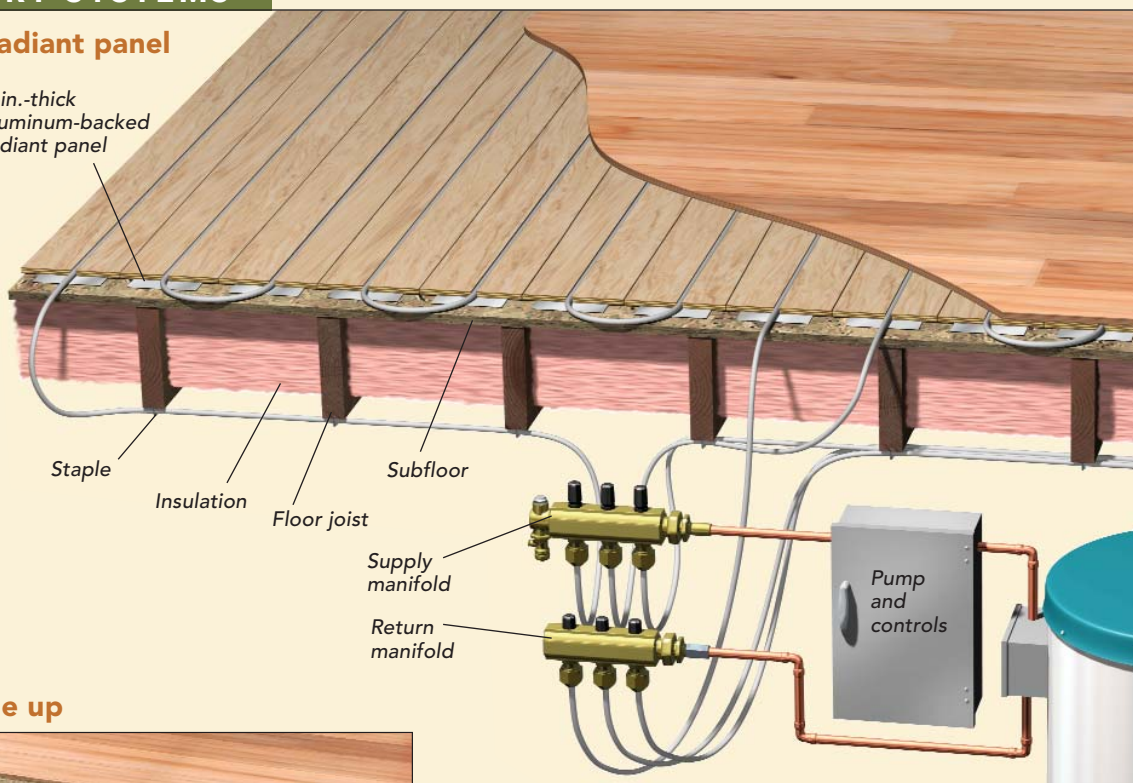


Lightweight gypsum floor

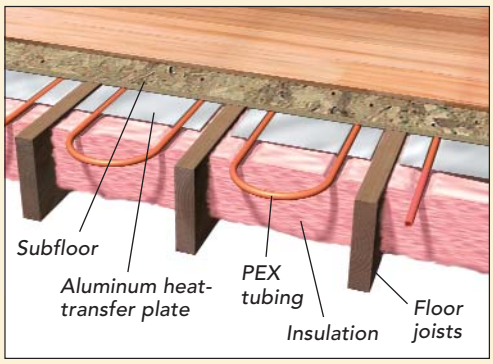


DRY SYSTEMS

Radiant panel



Staple up



Dry systems are ideal for remodeling because they add minimal weight and little or no thickness to the floor. Flexible PEX tubing goes where aluminum duct can't, and a high-efficiency water heater (rather than a boiler) can serve as the heat source in many situations.

Drawings: Toby Welles

TUBES GO IN WITH A SNAP AND A BANG

A generous bead of silicone holds the PEX in place. *Pump a continuous bead of silicone into several lengths of channel before putting the tubing in place. The silicone also increases the contact area to improve the heating efficiency.*

Slow down for the curves. *Carefully snap the tubing into the curved end panels before seating it with a mallet.*

A team of two speeds the straightaways. *One worker walks the PEX into place, and an assistant hammers it into the channel with a rubber mallet. Before the silicone dries, double-check to make sure all the tubing is seated properly.*

ally have to be adjusted. If the channels don't line up properly, the tubing won't snap into place at the transition.

I work my way up and down along the run, installing the straight panels. At this point, I put one screw at each end of the panel on opposite sides of the channel. Once all the panels are in place, I go back and drive eight additional screws into each straight panel.

Small sections of the subfloor often are not covered by the panels in a layout. They are accounted for in the heating design and have no impact on performance. However, once all of the panels are installed, the voids must be filled with ½-in. plywood. In this case, a gap that was less than the width of a 7-in. panel ran the length of the room between two of the return lines. This occurred because I started a run with a supply line along opposite outside walls and worked toward the center from each side.

After filling the gaps, I walk up and down each row, checking to make sure all of the fasteners are set below the surface. With all the panels screwed in place, it's important to vacuum the channels so that the tubing can snap in place.

Silicone locks the PEX in the channel

Before I begin with the tubing, I cap the end with tape to prevent debris from getting inside. Then I place the roll of piping on a machine called a despooler; this device allows the tubing to unroll without becoming tangled. If I don't have a despooler, I rig up something that will feed the tubing as I pull on it, much as an electrician does with a large roll of wire.

As I feed the tube into the first supply hole, a helper on the other

Test the system with air. *Leave the pipes pressurized at 40 psi to 60 psi while installing the finished floor to warn of tube punctures from errant nails or construction debris.*

Bottom photo, this page: Roe A. Osborn

side pulls through enough PEX to reach the manifold. Next, I run a generous bead of silicone in several lengths of the track before snapping the tubing into the channels. In addition to holding the PEX in place, the silicone increases the surface area of contact between the tubing and the aluminum, slightly reducing the water temperature needed to heat the floor.

I use a rubber mallet to ensure that the tubing is seated completely. If it doesn't seat fully and is not noticed until after the silicone cures, it's difficult to fix.

At the end of a run, I measure the distance from the return hole to the manifold. Then I pull out enough tubing, cut and tape the end, and insert it into the return hole. I repeat the entire process for each run. With the PEX in place, I trace each run with mallet in hand to make sure the tubing is seated properly.

Controls complete the system

At this point, I let the plumbers and heating contractors take over. They bring the runs over to the manifolds, stapling the tubing to joists along the way, and make the connections. Then they test the system by pressurizing it with about 40 psi of air while I install the finish floor.

Install a wood strip floor perpendicular to tubing runs, and use caution driving nails where the PEX deviates from straight runs along the edges of the room.

When the floor is installed, the heating or plumbing contractor returns and completes the installation by connecting the main supply and return and installing the pumps, valves, and controls. □

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Bottom right photo, this page: Joseph Kugielsky

The right wood floor over radiant heat

While traditional wet installations work well with tile floors, the moisture in concrete can present problems for wood floors. However, wood floors work well with dry-panel systems if you keep a few simple rules in mind.

- **Heat and humidity** affect the performance of wood floors, and radiant-floor heat can remove too much moisture from a floor, causing gaps to appear between floorboards. When the heating season ends, they usually swell and close. If the wood is dried excessively, the flooring may crack, a phenomenon called checking.

Although it's tough to beat the feel and look of solid wood, the dimensional stability of engineered flooring (a surface hardwood layer bonded to a plywood base) and laminate flooring (a plastic-laminate surface glued to a pressed-wood or plywood subsurface) makes them ideal with radiant-floor heat. These manufactured woods are often available in floating-floor installations that allow the floor to expand and contract as a single unit, further reducing gaps and cups.

Wood floors work well with dry panel systems if you keep a few simple rules in mind

- **If you choose solid-wood floors**, some species are more stable. The prefinished bamboo I used on this project is ideal. It's actually a grass, so it's extremely stable; and bamboo happens to be tougher than oak, so it's exceptionally durable. Other good choices include American walnut, American cherry, and oak.

When choosing hardwood flooring, remember that quartersawn wood is more stable than plainsawn, and flooring strips 2¼ in. or narrower expand and contract less than wide planks.

- **To reduce initial movement in your wood floor**, test the moisture content before installing it. I aim for between 8% and 12%, with the relative humidity in the room less than 50%. Once the floor is finished, never allow the surface temperature of the floor to exceed 85°F.
- **It's important to avoid temperature shocks** to the floor by choosing a control system that uses constant rather than intermittent water flow. The ideal setup includes two thermostats. One is connected to an outdoor sensor and automatically raises the water temperature as the outdoor temperature falls. The other thermostat, in the room, can adjust for variables such as heat gain or loss from large glazed areas.

On my own floor, I turn the system on before the heating season to prevent shocking the floor on the first cold day.

Engineered flooring offers the beauty of solid wood laminated to a plywood base that resists shrinkage when the flooring warms up.