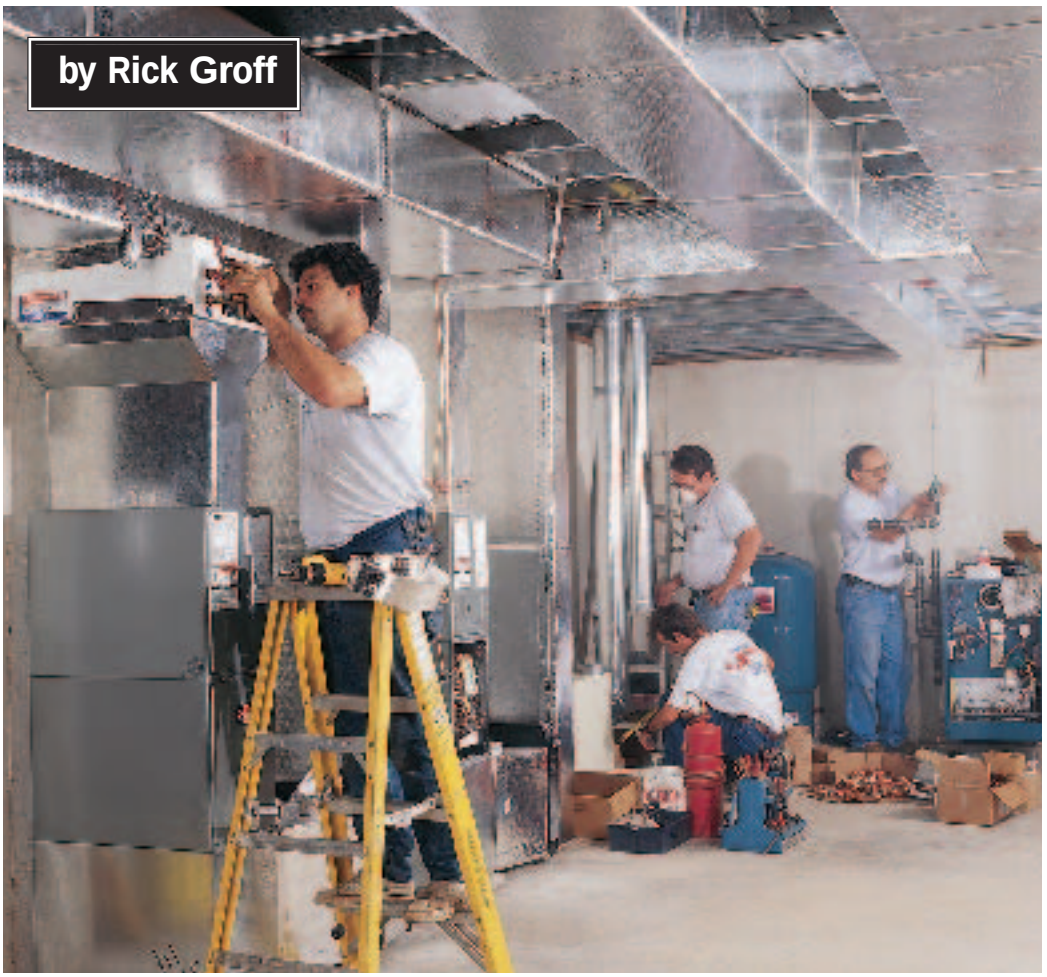
by Rick Groff



The air handler in the foreground has a cooling coil inside and a heating coil on top. During the heating season, the Burnham LP-gas-fired boiler seen in the background will supply hot water to the heating coil to provide warm air for the second floor of this home. The first floor is heated with radiant floor heat.

Hydro-Air HEATING OPTIONS

Combining hot water and forced air into a hybrid heating system offers real advantages

Choosing a heating system for a home is usually a process of balancing cost, comfort, and convenience. As an hvac contractor in Pennsylvania, I've seen a recent trend toward a unique type of hot water heating system called hydro-air. Hydro-air systems transfer heat from water to air, but they use a fan-coil heat exchanger instead of the familiar fin-tube or cast-iron baseboards. The warmed air is then distributed through traditional ductwork.

Hydro-air technology has been used for years in commercial and industrial applications with either hot water or steam as the heat source. Its popularity in the residential market is rising because it

offers excellent comfort and versatility. When selling a client on the idea of a hydro-air system, I sometimes need to overcome their preconceived notion of a monster boiler lurking in the basement, feeding hot water to standing radiators. Improvements in boilers and heat exchangers have drastically enhanced operational efficiency, reliability, and control. Huge strides have also been made in how the heated water is used once it leaves the boiler, including sophisticated microprocessor controls, flexible radiant tubing, manifolds, mixing valves, indirect-fired water heaters, and a seemingly endless variety of water-to-air heat exchanger options.

A system we installed recently provides a good example of the flexibility offered by today's hot water systems. My involvement began when a general contractor asked me to recommend a mechanical system for a custom home he was going to build in Berks County, Pa. The client wanted all aspects of the house — frame, windows, insulation, and hvac system — to be state-of-the-art. The 5,000-square-foot two-story residence, which would be built with 6-inch steel studs filled with Icynene insulation and clad with a brick veneer, was to be sited in an unsheltered setting with a design temperature of 0°F.

The client wanted radiant floor heat, but was only willing to pay for it in selected rooms. We designed a system that used a single boiler to provide heat to a radiant slab on the first floor and a forced hot air system on the second. The boiler also heated water for an indirect-fired domestic hot water heater. The heating load required 15 Btu per square foot to maintain a 70°F interior temperature when the outside temperature was 0°F. This isn't an abnormally low heating requirement, but it's pretty efficient, even for a well-insulated building with a low infiltration rate.

An hvac mechanic solders the hot water supply and return lines at the heating coil. The author prefers separate heating coils to built-in units because they allow for more accurate sizing.

Where Radiant Slabs Fall Short

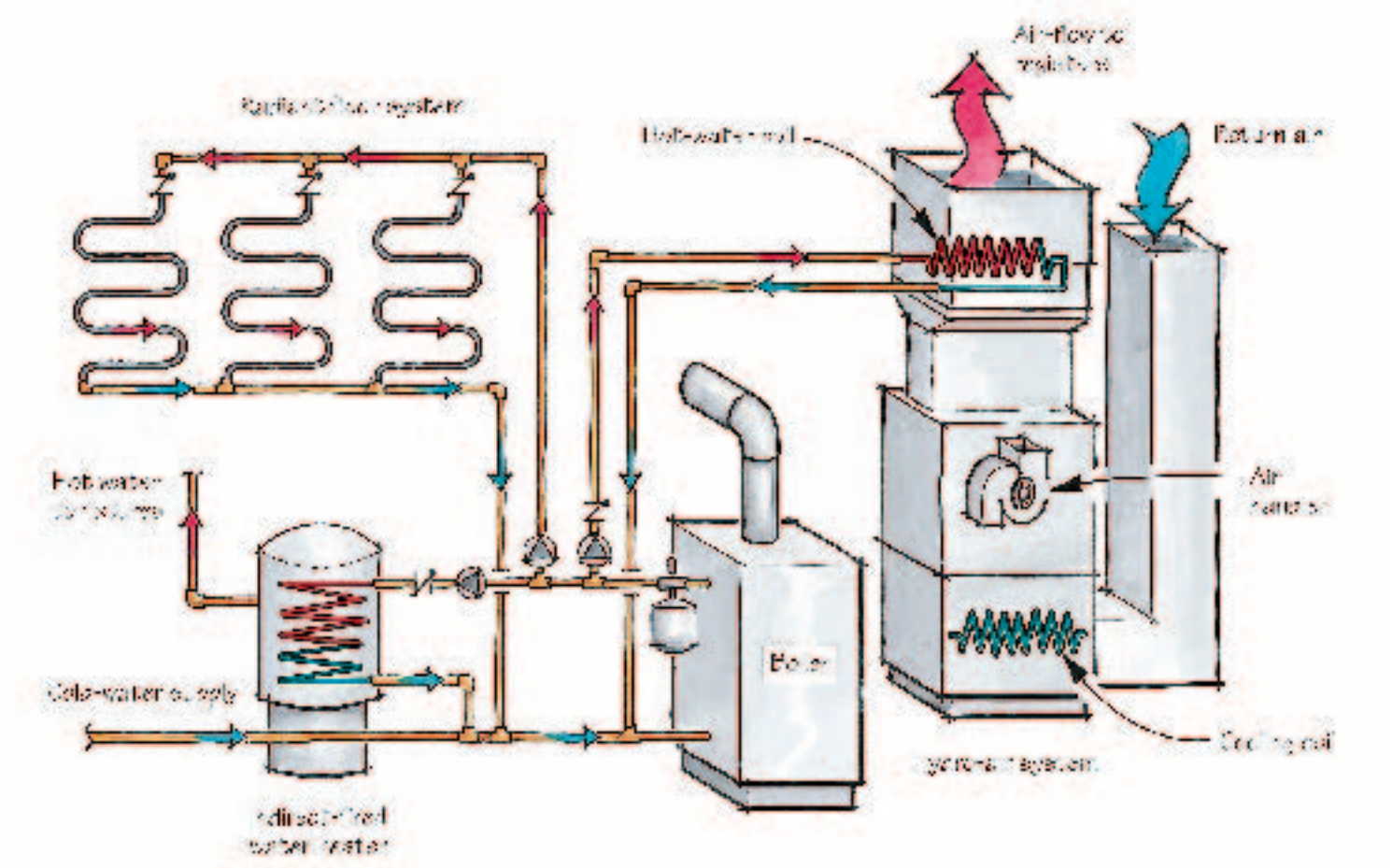
Even when cost isn't an issue, I usually recommend against using radiant heat in bedrooms, especially those on the second floor. That's because bedroom floors are likely to be covered with plush carpeting and thick padding, whose high R-value resists heat transfer from a radiant loop. In addition, bedrooms are often filled with furniture — beds, dressers, nightstands, and so on — that limits the efficiency of floor heat.

What's more, many people enjoy a somewhat cooler bedroom. Since your head is always the warmest part of your body, you feel more comfortable if your head is surrounded by cooler air than the rest of your body. Large beds with thick covers that drop to the floor can trap a significant amount of the heat emitted from a radiant floor. Since this heat can't escape to warm the air, it may cause the bed to be warmer than is comfortable.

For these reasons, bedrooms are first on my list for an alternative heating source. I often install baseboard heat with separate thermostats in these areas. But many folks dislike the appearance of baseboard; plus, baseboard units may hinder future changes in room layouts.

That's where the hydro-air option comes in. This technique uses the same ductwork as the cooling system, but the heat comes from the boiler. A separately zoned circuit is piped from the boiler to

Hydro-Air System



A hydro-air system provides the most versatility for custom homes in climates where both heating and cooling are needed. Using a boiler allows for radiant floor heat in some zones, while the heating coil, mounted to the top of the air handler, is able to share the air-conditioning ductwork. The boiler also provides domestic hot water.

a fan-coil unit in the air handler, which transfers heat from the boiler water to the cooler house air. Typically, water leaves the boiler at 180°F and returns from the coil to the boiler at about 160°.

Hydro-air systems can be used for entire homes as well. Zoning can be achieved by installing multiple systems as we did here, or by using one system with dampered ductwork. Hydro-air also works great as a retrofit for an expired heat pump, and it generally supplies greater comfort at lower operating cost during heating months.

Sizing the Water Coil

Hot water coils come in varying sizes and must be selected to meet specific heating requirements. To size coils, you need to know the exact heat loss of the area being heated, the temperature of the water coming out of the boiler, and the airflow of the system in cubic feet per minute (cfm). It's also important to calculate how much heat the ductwork loses during severe weather conditions, as well as the flow rate of the water or glycol through the coil.

Some air handlers come with built-in hot water coils. These work well as long as they have the proper capacity, but they should also fit in with the overall design of the system. Built-in coils are usually small and have high friction factors. They work fine when trunk lines are large and duct runs are of moderate length, but they can restrict airflow when runs are long and trunk lines are small. We prefer to use separate components, because it allows us to select air coils that meet the specific requirements of the job. For example, if the duct system is long and stretched out, we use a less-restrictive coil with more square inches of surface area and fewer rows of fins.

For this job we used a Rheem air handler mounted with a Rheem 69,000 Btu (at 1,450 cfm) hot-water coil. A Burnham PV-205-WNI LP-gas-fired boiler supplies heat to the coil and to a Burnham Alliance indirect-fired domestic water heater.

Sizing the Circulator

I usually figure on 4 gallons per minute (gpm), a standard circulator pump, and 3/4-inch copper tubing with a 100-foot total equivalent piping length. ("Equivalent piping length" is the length

of straight pipe plus added length to allow for fittings. If you use smaller tubing or make long pipe runs with a large number of bends, you may need a more powerful circulator.) The amount of head (the vertical distance to the air handler) and the type of fluid in the system can also affect circulator requirements. When in doubt, consult a chart or call the pump manufacturer. We generally use circulators made by Bell and Gosset, Jaco, or Grundfos. I prefer copper tubing because it makes for a professional-looking installation, but there's no reason not to use the new high-temperature PEX tubing.

A mechanic connects floor manifolds to the PEX tubing that supplies heat to the slab on the first floor.

Locating the Air Handler

Most contractors installing a hydro-air system would put the air handler for the second floor in the attic, because it's cheaper to install the air handler close to the area it supplies. Duct runs are shorter, and it takes less labor to put diffusers in the ceiling than it does to run ducts up or down stud bays. It's hard to argue with this reasoning if the bid is being awarded on price alone.

If a hydro-air system is installed in the attic, however, the liquid in it might freeze. To prevent this, contractors put a 50% glycol (a nontoxic antifreeze) solution in the water. Treating the entire boiler system makes for service headaches, so we only treat the portion that's susceptible to freezing. One way to do this is to use a liquid-to-liquid heat exchanger to transfer heat from the boiler water to the glycol solution, which is then pumped to the hot water coil in the air handler. Water for the radiant part of the system is unaffected, because it comes straight out of the boiler. Another option is to use a boiler that has a tankless coil. Typically, this coil is used to heat domestic hot water, but it can also be used to heat the glycol, provided there is enough capacity at the expected flow rate. Glycol is more viscous than water, so it's important to size piping with higher friction factors in mind. We haven't had problems using glycol, but then we always allow a lot of latitude on our piping jobs.

On the Berks County project, we decided to place the hydro-air system in the basement. The longer duct runs took more man-hours to install, but over time, energy consumption is lower when ducts run through 55°F basement air and conditioned wall cavities. Around here, the attic temperature in a well-insulated house might be anywhere from 0°F to 120°F, creating substantial heating and cooling duct losses when the system is installed in the attic. In addition, the building has better thermal integrity if there aren't any penetrations in the ceiling, which is exactly where diffusers are placed in the typical attic installation.

It also takes fewer labor hours to maintain equipment that's accessible, and air handlers that are jammed in closets or up in the attic are hard to get at. Invariably, the closet with the tiny access panel to the attic is jammed with off-season clothing. The service person might be thin enough to fit through it, but what about replacement parts?

An added bonus of placing equipment in the basement is that homeowners are less likely to hear it running, especially when they're trying to sleep in second-floor bedrooms. And there's no possibility that a leak in a glycol line or condensate drain will damage the ceiling.

Richard Groff *is one of the owners of Neffsville Plumbing and Heating Services in Lancaster, Pa. Photos by John Herr.*