FROM THE FIELD
Air-to-water heat pump technology

BY DAN FOLEY CONTRIBUTING WRITER

Over the years, I have not been afraid to try cutting edge products and to apply these new technologies to our projects. Some have worked out well while others … not so well. Do the names GlowCore or HTM ring a bell? These were products that fell into the latter category, and I have the scars to prove it. Let's just say they were ahead of their time —good in concept but poorly executed. Believe it or not, I still have one GlowCore in a dedicated snowmelt application still chugging away. It still stands, as if to mock me for cursing its existence and the midnight no-heat calls, failed ignitors, screaming pumps, leaking heat exchangers and all the other failure modes I have long purged from my brain.

We recently tried a new system that falls into the former category, the Daikin Altherma. This is an air-to-water heat pump designed for the hydronic market with COPs that approach ground source heat pumps. Think of it as a geo system but with an outdoor condenser in place of the ground loops. This system was designed for the European hydronic market, to replace fossil-fuel burning appliances. It is my understanding that other manufacturers, such as Mitsubishi, have similar systems on the way.

What differentiates the Altherma from currently available unitary equipment and even from geo units is the inverter drive compressor. This allows the compressor to vary its output to match the load, similar to the way in which a modulating condensing boiler can vary its output. This allows for very efficient operation with long run times minimizing cycling losses.

Horbaly Residence located in Montross, Va. overlooks the Potomac River. Two Viessmann Vitosol flat panel solar collectors are mounted on the upper left portion of the roof.

One thing I learned from my two trips to ISH-Frankfurt is that the Europeans are working much harder than we are at weaning themselves off of Middle Eastern oil and Russian natural gas. They have done this with a combination of solar thermal, solar PV, bio fuel, wind turbines and heat pump technologies. They understand well the political costs of being addicted to fossil fuels and are doing all they can to divorce themselves from these fuels.

The Altherma was designed to replace fossil fuel burning boilers and tie into low temperature hydronic systems. Lance Dyer, Daikin product manager says that over 200,000 Altherma units have been installed in Europe and, since its release in the U.S. a little over a year ago, close to 500 units have been installed here. This product was designed to work in cold climates. One of the first large U.S. projects was a condo complex in New Hampshire, where 140 systems have been operational for over a year.

We did our first Altherma project about a year ago and installed a second last summer. We have a third system lined up to replace a traditional cast iron boiler and DHW tank. The outside unit looks similar to any other refrigerant-based heat pump. The refrigerant is piped to an indoor hydrobox that looks just like any modern wall hung boiler. Inside the hydrobox is the refrigerant to water heat exchanger, expansion tank, circulator pump and control panels. This part of the system is piped just as a boiler system would be piped. (Note: Daikin also has a Monobloc unit that combines the heat pump and hydrobox into one outdoor chassis).

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An Altherma outdoor unit is mounted on concrete base pad.

The Altherma system can also incorporate DHW production through an indirect tank. Both of my installed systems have Viessmann solar panels connected to the DHW tank. This solar input is important for two reasons:

1. The Altherma cannot simultaneously heat and cool.
2. The solar component will qualify for the 30% uncapped federal tax credit for renewable energy sources

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(including the Altherma system).

The solar differential control interlocks with the Altherma, locking out the heat pump when solar energy is available. This mode allows for solar DHW production, while simultaneously cooling the space. This is a mode that occurs frequently during our hot, humid summers.

One important fact to keep in mind is that this system is designed for low temperature heat emitters. The maximum supply water temperature is 130 F, and it would operate at higher COPs if designed around lower water temperatures. It is a perfect match for radiant floor heat and properly sized panel radiators. It will work fine tied to air handlers, as long as the heat exchange coil is properly sized. I hear that Daikin will soon release a high temperature system that will operate with an alternative refrigerant, but that system is not available at this writing.

The Altherma system supplies hot and chilled water to this variable speed air handler.

The first system I installed incorporated both radiant floor heat in a concrete slab and two air handlers. This was in a new LEED Gold-rated house sitting on a bluff overlooking the Potomac River. The client, Lorraine Horbaly, had done her homework and actually approached me about the Altherma, which I knew nothing about. I called my local rep, Jeff Riley, Southern region manager for Thos. Somerville Co. He also knew nothing about it. A few phone calls got us pointed in the right direction, and we were on our way.

Here is what Lorraine had to say about her Altherma system:

"We have lived in the house for just over eight months, so we haven't experienced the extremes of summer. What we have experienced, however, is a quiet, energy efficient system that adequately heats and cools our home. For us, the alternative to Altherma was geo-thermal. Altherma is less expensive to install and, by all accounts from knowledgeable sources, is as energy efficient. To date, we are satisfied with our choice."

Our second Altherma system was a replacement/retrofit job in the home of nationally recognized architect David Peabody in Alexandria, Va. We replaced a conventional forced air gas furnace and electric AC system. We replaced the entire duct system, added an ERV ventilation system and added panel radiators in key locations. This mechanical upgrade was done in conjunction with building envelope upgrades and an insulation package.

Peabody commented, "Our new Daikin Altherma system has now been in for two seasons and has performed admirably. In a very cold winter, it gave us heat and hot water throughout. And we were able to keep the house cool on the warmest days last summer. The more marked difference from the old forced air system, however, is the comfort levels in the house. The ability of the Altherma to heat both via the duct system and hydronically in spot locations is, in my view, the key to that. Because we have not been through a whole year with the system yet, it is too soon to know the energy savings the system has provided."

Daikin is wise to require certification training to install their system. I attended the two-day class at its Somerville headquarters, but, even with that experience, there was a steep learning curve. It is different than any other system I have worked on, and it took some time to learn the unique terminology. To be fair, all of the information required to properly install and commission this system is contained in the I & O manuals provided with the equipment. It behooves the installer to read and understand the manuals.

An Altherma Hydrobox mounted on mechanical room wall.

To their credit, both Jeff Riley and Lance Dyer made site visits to help me set up our first installation. The second installation went a little smoother, as we learned from our missteps on the first job.

One lesson we learned the hard way is that the Altherma requires a minimum flow rate of 5 gpm. on the five-ton unit we installed (this number will vary with other size units). We had a small radiant zone that did not meet this flow requirement, causing the unit to lock out on flow when this zone called by itself. It would do this intermittently, as this zone would rarely be the only one calling. By the time we got to the site and reset the lock-out, other zones would also be calling, masking the cause of the lock-out. I finally pulled up a chair and watched the system operate until I saw the exact conditions that caused

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Foley Mechanical technicians Slavko Nisevic (l) and Juan Polanco (r) after a long day of piping the Altherma Hydrobox.

the lock-out. Lesson learned. The solutions are to design the zoning around this flow limitation, to incorporate a pressure actuated bypass valve or to pipe the hydrobox in a primary/secondary piping arrangement with a system circulator. We returned later and added a bypass valve, solving this problem.

If you plan on using the cooling component, as we did, one other important consideration is proper insulation of the piping, valves, air separator and other hydronic components in the system. If you don't insulate and seal every exposed pipe, valve and fitting, you will get condensation and dripping. Make sure to use only closed cell insulation rated for use on chilled water piping. Open cell foam insulation is no good here. When we insulate chilled water piping, we butt glue the lengths of insulation, wrap the joint with insulation tape, then glue the tape to make sure that it does not come loose. Condensation and dripping lead to mold which leads to insurance claims. Insulate properly and stay on friendly terms with your insurance agent.

My friend, Robert Brown, owner of Northeast Radiant Technology LLC in Gardiner, Maine, installed an Altherma system in his shop. The design temperature there is -4 F. The system has been in operation for a full year. Rob datalogged his system over the harsh Maine winter and recorded COPs that ranged from the low 2s to the mid 3s, with an average around 2.5. This is amazing for an air source heat pump in his climate. Rob's system is connected to a radiant slab with reset control and ran below 100 F supply water temperature for most of the winter. Rob indicated that the system ran with negligible use of the back-up electric resistance heating element. Typically, the back-up element did not energize until ambient temperatures fell below -8 F. These are temperatures we rarely, if ever, see in my market.

As the price of fossil fuels continues to climb and supplies drop, alternative technologies will come into play. The Altherma is one technology currently available that meets this need, without grossly changing how we design our mechanical systems. We intend to use this system on future projects and can't wait to see what other technologies will be available in the future of our ever-changing industry. ●

***Dan Foley** is owner of Foley Mechanical, Inc. His company has 14 full-time & two part-time employees. His primary focus is on radiant and hydronics with large custom homes. Foley also does service, replacement, HVAC, sheet metal, controls, piping, renewables (geo and solar thermal), which services the Washington, D.C. metro area.*