getting grounded with GEOTHERMAL HEAT-PUMP Technology

Tapping into the thermal energy beneath their feet, contractors and technicians can open up a world of efficiency for consumers.

Photos courtesy of Rehagen Heating and Cooling Inc., Westphalia, MO.

A ground-source heat pump is a self-contained unit, combining the compressor, condenser, evaporator coil and blower in a single cabinet that is typically installed indoors.

BY SONNY HAMPTON

Air-source heat pumps have long been a component of conventional home heating/cooling systems. For homeowners in climates with moderate heating and cooling needs, heat pumps offer an energy-efficient alternative to furnaces and air-conditioners, using a compressor, condenser and evaporator coil to move heat from the cool outdoors into a home in the winter. The process reverses in the summer, as the heat pump transfers heat from inside the home to outside.

Ground-source heat pumps utilize the same technology and components as their air-source counterparts, while providing up to 45% more efficiency. While both systems *move*—rather than *create*—heat to ensure a comfortable living space, ground-source heat pumps absorb or dissipate heat energy from or to the ground.

STARTING OFF

As the name indicates, an ASHP bases its need to heat or cool a home on the temperature of the outside air, which can vary significantly during the year. Conversely, a GSHP relies on the relatively constant temperature of the earth (55°F–65°F) or the earth's groundwater to transfer heat energy to and from a home.

According to the DOE, this allows a geothermal system to reach efficiencies ranging between 300%–600% in the coldest of winters, compared to 175%–250% for air-source heat pumps on cool days. [*Editor's Note: The DOE notes that GSHPs use 25%–50% less electricity than conventional heating/cooling systems—meaning GSHPs use one unit of electricity to move three units of heat. The EPA states that GSHPs can reduce energy consumption, as well as related emissions, up to 44% compared to ASHPs and up to 72% compared to electric-resistance heating with standard A/C equipment.*] Also, a ground-source heat pump can be used in more extreme climatic conditions than air-source heat pumps. [*Editor's Note: As an example, GSHPs maintain relative humidity of about 50%, making them very effective in humid climates.*]

A geothermal system takes advantage of the fact that ground temperatures are warmer (in the winter) or cooler (in the summer) than the surrounding air. During the heating cycle, the system absorbs heat from the ground using a continuous length of buried pipe (an earth loop). A GSHP then transfers the heat from the earth loop into a refrigeration circuit, which then delivers it into the home in the form of forced air or hot water (delivered via a conventional duct or radiant floor system).

In the cooling mode, the process reverses. The GSHP moves heat from the house to the earth loop, where it is returned to the ground. Once the heat is removed, the air is recycled cool and conditioned.

INS AND OUTS

In most cases, a GSHP is a self-contained unit, with the compressor, condenser, evaporator coil and blower combined into a single cabinet that is typically installed indoors. However, split systems also are available, which allows the coil to be added to a forced-air furnace using the existing blower.

Split systems are the norm for air-source heat pumps, with one coil located indoors and another outdoors. Supply and return ducts connect to a central fan, which is located indoors.

As is the case with air-source heat pumps, GSHP manufacturers offer various models for different applications. In addition to design differences (packaged or split systems), GSHPs differ from one another according to their use. Some, such as open-loop systems, are intended to be used only with higher-temperature ground water. Others will operate at entering-water temperatures as low as 25°F, such as closed-loop systems. Most residential units, however, operate within a temperature range between 20°F–110°F, making them available for use in a variety of applications.

Contractors can choose either water-to-air or water-to-water GSHPs. Most GSHPs are water-to-air units that use a conventional air handler to distribute heated or cooled air through a home's ductwork. However, water-to-water (hydronic) units also are available; these heat pumps provide heating/cooling solutions for applications such as radiant floor or pool heating; snow and ice melting; and domestic hot-water applications.

Some GSHPs can provide an entire home's hot-water needs. A hot-water assist or desuperheater option can be added to most geothermal heat-pump systems, which

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›› HVACR contractors and technicians typically install water-to-air GSHPs that employ a conventional air handler to move warm or cold air through a building.

heats water *before* it enters the home's hot-water tank providing even greater energy savings. In the summer, the desuperheater uses the excess—heat that would otherwise be transferred to the ground—to heat most, if not all, of a home's water. During the fall, winter and spring, when the desuperheater is not producing as much excess heat, the home can rely on either a storage or on-demand water-heater to heat water. According to many manufacturers, a geothermal heat-pump system can supply 50%–60% of the annual hot-water requirements for an average family.

GSHP models also differ in their efficiency ratings, known as COP and EER. As is the case with ASHPs, GSHP efficiency is impacted by the unit's components and the way it is controlled.

Single-stage compressors, for example, are designed to operate at one stage and one capacity. Multi-stage compressors, conversely, operate at multiple stages and capacities that increase or decrease the compressor's speed depending on heating and cooling demands—and in the process, improve efficiencies at all levels of operation.

ECMs also impact heat-pump efficiency by maintaining a specific cfm, regardless of what is happening in the system's ductwork. Energy is conserved, quiet operation is ensured, and slow starts promise comfort and increased unit longevity.

One of the most important factors that impacts the unit's efficiency is the temperature of the ground itself; however, like many HVAC applications, proper sizing is fundamental.

GETTING GROUNDED

If a GSHP is not properly sized, it will not deliver the energy efficiency, quiet, comfort and longevity it should. Oversized equipment will cycle on and off more frequently, reducing system efficiency and delivering marginalized comfort. Conversely, undersized equipment will run longer than necessary because it is not large enough to deliver the desired amount of conditioned air.

Proper sizing begins with a heat-gain/heat-loss calculation that goes beyond square footage to consider all those things that affect heat gain/loss in a structure. The sizing process is no different than it is for an air-source heat pump, which heavily involves ACCA's *Manualw* Residential Load Calculation. Ductwork, too, should be properly sized based on the cfm delivery of a system's equipment. The range for ductwork in a geothermal system is typically 360 cfm–400 cfm per ton. [*Editor's Note: For more on this topic, see "Sizing Up a Geothermal System" in the April 2009* RSES Journal.]

In fact, the biggest difference between an ASHP and a GSHP is not the equipment or the steps required to properly size the equipment, but the earth loop that enables the system to tap into the free renewable energy stored below the earth's surface. This system of small-diameter, high-density polyethylene underground pipes can be installed horizontally or vertically in the ground, or in a pond. These pipes carry an environmentally friendly alcohol solution that transfers heat energy to or from the structure.

The loop is sized to the heat load/heat gain, equipment, type of soil and climate where the geothermal system is being installed. Many geothermal equipment manufacturers offer training and software designed to help with sizing calculations. WaterFurnace International Inc., for example, offers GeoLink Design Studio—geothermal design and ener-

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gy-analysis software that helps generate designs and proposals for residential and light-commercial projects.

In addition, loop training is available through the International Ground Source Heat Pump Association that includes details to understand the differences in soil, best installations for particular locales, and more. However, many contractors choose to subcontract this portion of the installation process.

OPPORTUNITY ABOUNDS

Selling and installing geothermal systems does not have to be complicated. By taking advantage of subcontracted services and working with a manufacturer that offers dealer training and support, contractors can make the transition from conventional ASHP systems to geothermal home-comfort systems that utilize GSHPs—and do so relatively easily. This allows contractors—and their technicians—to position themselves for unprecedented growth in a market fueled by eco-conscious homeowners looking for environmentally friendly, high-efficiency systems, as well as economic incentives in the form of tax credits, rebates and financing plans that encourage geothermal-system investment.

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