Geothermal Heat Pumps

The earth under our homes is one of nature's most efficient energy storage systems. Unlike the air, it has very stable temperatures.

Here in Pennsylvania, at depths between 50 and 500 feet, the earth stays a constant 50 to 55 degrees Fahrenheit year-round. Because of its constant temperature, the earth is warmer than winter air and cooler than summer air, making it an excellent medium for all-season heat exchange. This earth connection allows properly sized and installed geothermal heat pumps to keep your home comfortable on the coldest winter days.

Geothermal, also known as ground-source heat pumps, move ground heat into a home for winter heating, and from a home to the ground for summer cooling. They come in two basic types: an earth-coupled (closed-loop) system and a groundwater (open-loop) system.

Closed-loop geothermal heat pumps come in three types:

- Horizontal ground-loop
- Vertical ground-loop
- Pond/lake loop

In each type of system, the heat pump and loop form a sealed, pressurized unit, through which water or a water and antifreeze solution is circulated, removing or replacing heat. The most common antifreeze solutions used are propylene glycol and methyl alcohol. Both are biodegradable and present no hazard to the environment.

The only acceptable loop materials are flexible, high-density polyethylene or polybutylene pipe. If installed properly, some of these products carry a 50-year warranty. To create the horizontal, vertical or pond/lake loops, the pipe and fittings are connected with a special heat fusion process to form strong, leak-proof joints.

With the heat pump indoors and the loop underground, where both are protected, maintenance requirements are practically zero. The product life cycle is similar to that of a refrigerator, which shares much of the same technology, or about 20 years.

In a typical horizontal ground-loop system, a network of trenches is cut by a trencher or backhoe and from one to four pipes are laid horizontally at least four feet deep. The pipes are pressure tested, connected to the heat pump inside the home via the trenches, then backfilled. The most common designs make use of two pipes: one at six-feet deep and one at four-feet deep in a narrow trench; or two pipes placed five-feet deep in a two-foot-wide trench. The amount of piping necessary depends on the heat pump's rated capacity and is determined by the installer.

Another style of horizontal loop is called a slinky. In this system, a coil of pipe, looking somewhat like a coiled slinky, is laid in a wide trench and stretched out so that the coils just overlap. These systems can be installed in smaller lots than can conventional systems.

In a vertical ground-loop system, multiple boreholes are drilled at least 10 feet apart and from 100 to 200 feet deep. Two separate pipe lengths are connected with a U-bend to form a loop, placed in each borehole and pressure tested. The borehole is backfilled and sealed off at the surface. Vertical loops are tied together with a network of horizontal piping laid in trenches and then connected to the heat pump. The amount of piping and the number of boreholes required depends on the capacity of the heat pump and is determined by the installer.

The installation of a pond/lake loop depends on the availability of a nearby pond or lake and future development plans for the site. Pond loops are less expensive to install as the loop of pipe is simply immersed is at least 8 feet of water and trenched back to the house. The pond water transfers heat to and from the pipe coil. Under no circumstances should these loop coils be placed in a river or other body of water where fluctuating water levels or flood stage conditions could damage the pipe.

An open-loop system uses well water directly, instead of re-circulating a water/antifreeze mixture through a grid of pipes. Groundwater stays at a relatively constant temperature of between 40 and 70 degrees Fahrenheit depending on your location. Once it has circulated through the heat pump, the water is returned to the ground through one of several methods including recharge wells, drain fields, or the surface.

This option should be used only where an adequate amount of chemically pure groundwater is available. This is even more important if the well supplies both your home and heat pump. The amount of water necessary for the groundwater heat pump is listed by the manufacturer in gallons per minute (GPM). A good rule of thumb is three GPM per ton of heating and cooling. During extremely hot or cold weather, the well must be

able to handle the requirements of a heat pump running continuously.

The water return method must also be able to handle increased capacity during extreme weather conditions. A three-ton system, for example, may use as much as 12,000 gallons on a very old day. Drain fields are useful only in areas with soil conditions that will accept this large volume of water. Surface discharge is possible through irrigation, stock watering or to a pond or ditch, depending on local restrictions. A recharge well can be installed to return groundwater to the aquifer. This second well must have enough capacity to handle this same amount of water.

Geothermal heat pump technology has advanced steadily over the past 40 years. Units now boast COP's over 3.8 and EER's over 17. These systems give homeowners inexpensive air conditioning as well as heat that costs half as much as with any other fuel option.

A popular option is called a de-superheater, which consists of a circulating pump and loop that circulates water from the domestic water heater to the heat pump. The de-superheater then heats domestic hot water at heat pump efficiencies. In the summer, it provides free hot water by using waste heat from air conditioning.

Obviously, a heating system, that works this well, is not the cheapest alternative. However, after the total cost of installing a geothermal heat pump is compared to that of installing a quality furnace with air conditioning, an extra chimney flue, oil tanks or extra utility hookup, and carbon monoxide detectors, the cost difference is very small.