Geothermal Primer For Contractors

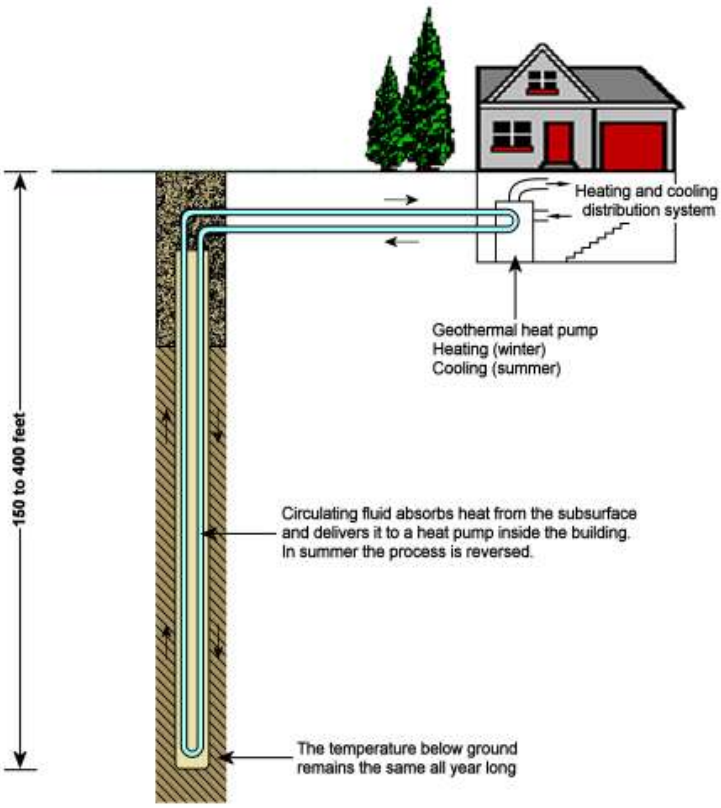
We are often asked by building owners whether geothermal heating and cooling is for them. While geothermal heating and cooling can often substantial savings for building owners over conventional systems, there are construction factors that should be considered before implementing geothermal.

There is often confusion of exactly what is geothermal. Geothermal can mean using hot waters that are naturally occurring below the earth's surface for either direct use heating or electrical power generation. Geothermal can also mean simply using the constant temperature of the earth's shallow temperatures (6 ft. to 1,500 ft. below ground surface) as a heat storage medium. This heat storage is also known as geoexchange. Heat pumps are used to heat or cool the building and the earth is used to store heat. The heat pumps are used to "exchange" the heat from or to the earth.

The three main geoexchange systems are the:

1. Closed Loop;
2. Open Loop; and
3. Standing Column Well.

In a closed loop system, a pump circulates a heat transfer fluid through a series of buried pipes in a closed loop: the fluid never leaves the system, but rather travels back and forth in a loop between the earth connection and the heat pump. The length of the ground loop is determined by the size of the heating and cooling loads of the building and the ground thermal properties. The loads are defined by the size of the building, type of construction, use of the building, duration of the heating and cooling seasons, and climate.



Closed-loop systems are environmentally benign. They are sealed so that no fluid is exchanged with the environment. The fluid often includes an antifreeze solution to protect the heat pump equipment. The high density polyethylene piping used in geoexchange systems is the same or higher grade of pipe used in cross country natural gas piping and often comes with a fifty year warranty.

The piping is installed either horizontally or vertically. The vertical bore configuration is a popular choice for systems of all sizes because of its efficient use of space. Each bore hole is four to six inches in diameter. A pipe is lowered to the bottom of the bore, makes a U-turn and returns to the top of the bore. The remaining space is filled with a grout to seal the hole from potential ground water penetration. Grout provides the means for thermal contact between the pipe and the surrounding earth. The header combines the flow through all the circuits before going to the building portion of the loop. The header can be installed outdoors in a valve pit or all of the circuits can be brought into the building before being combined. Six to twelve individual bores are typically connected together to form a circuit. The circuit connects to a header through a shut-off valve so a circuit can be isolated.

Open-Loop

Water is directly pumped out of the ground to a heat pump system. Water can be pumped from a water well, lake or pond. Easy access to groundwater, the amount of water available, and means to discharge the water are the main factors determining the feasibility of an open-loop system. Open water systems can provide the lowest initial cost when these factors are favorable.

Standing Column Well

A variation on an open-loop system is a standing column well that uses a few very deep wells (1,500 ft.) spaced about 100 to 300 feet apart. One 1,500 ft. well can often accommodate up to 40 tons of heating or cooling load. In a standing column well, water is pumped from the bottom of the well and re-injected at the top. As water moves along the length of the well, it exchanges heat with the surrounding earth and often circulates with ground water. The capacity of the well can be increased by bleeding off up to 10% of the extracted water. Bleeding of the well to induce flow of groundwater at more moderate temperatures into the well is a key feature of the system design.

Construction Considerations

The geoexchange system requires installation of the heat exchanger in the ground. In many instances ground conditions are not known prior to construction. The contractor should be aware of the potential impacts of these systems. The installation of the geoexhange system could impact schedule, site operations, or existing utilites.

Some key factors for each type of geoexchange system are discussed below.

Closed Loop Systems

For closed loop systems, the location of the loopfield can impede site operations and logistics. Some key considerations are:

- Soil disposal- the installation of the geoexchange loopfield system results in excess soils that may require disposal. If soils cannot be re-used on site, the soils must be disposed responsibly off site. Sometimes off-site disposal of soils can be costly.
- Environmental Conditions- Are the site soils or groundwater contaminated with hazardous materials. If so, geothermal may not be feasible at the site.
- Rock depth-If the depth to rock is greater than 50 ft., then steel casing may be required which can add costs to the project.

- Geothermal subcontractor experience-ensure experienced subcontractors are used to install the loopfield. Ensure the piping is properly installed, pressure tested, flushed and filled with the correct percentage of anti-freeze.
- Site Utilities-the loopfield location could impact existing utilities such as water, storm or waste water. Careful planning for the location of the loopfield should be made to minimize disruption to existing utilities.

Open Loop and Standing Column Well Systems

Open loop systems require upfront evaluation to determine water quality, disposal options and operational parameters. Groundwater may be an economical heat exchange resource if large quantities are available at a reasonable depth, along with an acceptable and economical means of disposal. Poor water quality might require the use of heat exchangers, and in some formations additional maintenance and aquifer reinjection might be expensive. These type systems may require extensive regulatory permitting depending on state requirements. These systems also involve well development and well testing. Water derived from well development and testing may require disposal. If the water cannot be disposed on site, then off-site disposal may be necessary. Additional costs should be reserved for water containment, testing and transportation and disposal.

Conclusion

Geothermal heating and cooling systems offer substantial savings over conventional fossil fuel systems, however the installation of these systems require upfront evaluation and feasibility analysis. The contractor should be aware of the types of geothermal systems and the impacts these systems have on the construction process.