Geothermal Heating Systems
Fact Sheet

Geothermal heat pumps use the relative constant temperature (6° - 13°C or 45° – 55°F) of the ground or water several feet below the earth's surface as a source of heating and cooling. The Earth stores heat from the Sun during the summer so this is a renewable energy source. Ground Source heat pumps transfer the heat from the ground into a building to provide space heating (up to 35°C), transfer heat away from the buildings to provide cooling and can provide domestic hot water. For every unit of electricity used to pump the heat, 3-4 units of heat are produced.

There are two basic types of geothermal systems. Both draw heat from the earth during the heating season and can also release heat to the earth when cooling is required. These are:

Open Loop Systems – These draw water through piping from a well and pump it through the heat exchanger in the building where heat is extracted and transferred to a refrigerant. The water is then returned to a drainage field, pond, stream or another well. The heat exchanger is basically a refrigeration system and consists of a Compressor, Condenser, Expansion Valve and Evaporator.

Closed Loop Systems – In this type of system, the liquid (often antifreeze) is circulated through piping buried in the ground. The ambient ground temperature heats the water/antifreeze liquid in the pipes. This water is then pumped to the heat exchanger inside the building. The closed loop piping can be installed in a vertical position, a straight horizontal or a spiral horizontal loop. The length of loop required varies with soil type, loop configuration and system capacity. Horizontal trenches 6' to 8' cost less than a vertical loop system bored 150' – 200' deep. The closed loops are used more frequently as they do not use much surface area. Double tubes going into the ground are used instead of single tubes as they deliver 30% more heat.

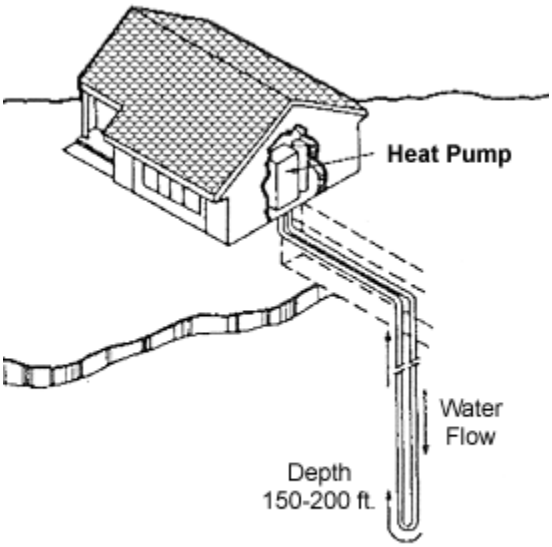
Process Description:

First a hole is drilled into the ground. This makes up a large part of the installation cost. If the soil is loose then it retains less heat but is easier to drill. Gas pockets may be encountered when drilling. Two PVC pipes about 1" to 2" in diameter, are run down into the hole and back out of it. The tubes are filled with a water and polypropylene glycol mixture to prevent it from freezing. The earth warms up the liquid inside the tubes to various temperatures depending on geographical location. For example in Alberta this temperature is about 6°C. The liquid is pumped down into the ground and then back up into the building where it passes through a heat exchanger which has a stainless steel plate through which the two ground liquid tubes run. There are two more holes in the stainless steel plate through which two lines filled with gas refrigerant run. Their temperature is -2 to -4°C. The heat from the ground liquid tubes is transferred into the steel which then warms up the gas.

The "warmed" refrigerant vapour enters the compressor in a saturated state. The heat of compression causes the vapour to become superheated when it is compressed. The superheated vapor travels through the condenser where it is condensed into a saturated liquid. The condensation process occurs at essentially a constant temperature. Then the liquid passes through an Expansion valve where it undergoes an abrupt decrease in pressure without loosing any heat. This warm, low pressure liquid is then released in a building heating system such as an in floor/radiant baseboard heating system where it will release its heat into the building. The liquid refrigerant then passes through the Evaporator where it is turned back into a vapour and the process begins again.

The main hazards are:

1) Retrofitting the buildings – usual construction hazards including electrical hazards.
2) Methane gas – Pockets may be encountered when drilling vertical holes. Sleeves around the closed loop are used so that the gas does not hit the heat exchanger.
3) The existence of water lines for the in floor heating.
4) The refrigerants used in the heat exchange can be toxic although alternatives are available. The refrigerant gas R22 which has toxic properties is being replaced by R407c which does not. R407c does not affect the ozone.



Vertical Loop System