Properties of Refrigerants

All Heat Pumps use a vapor compression cycle (refrigeration cycle) to utilize the properties of refrigerants to move heat from one location to another. Refrigerants are compounds, that have special thermal properties, which circulate through the Heat Pump. (See Bulletin: How does a Geothermal Heat Pump Work?).

The refrigeration cycle is difficult to understand without knowing a little about phase changes of a substance, like water. Let us say we are going to make ice cubes. We place a tray of water in the freezer. Energy (heat) is released by the water as it cools, one unit of energy for every one-degree drop in the ice cube tray. If the temperature of the water is 33\(^\circ\)C, one unit of energy is released by the water and it becomes 32\(^\circ\)C water. To change 32\(^\circ\)C water into 32\(^\circ\)C ice, however, about 120 units of energy must be released. Changing liquid water to ice is a phase change.

Water can illustrate another common phase change, liquid to steam (vapor). Water must adsorb about 1,000 units of energy to go from 212\(^\circ\)F water to 212\(^\circ\)F steam or vapor (See Diagram 1).

Refrigerants “boil” at much lower temperatures than water, depending on the pressure maintained by the refrigeration device (such as a Heat Pump) and the type of refrigerant. The refrigerant in most kitchen refrigerators vaporizes at 20\(^\circ\)F. This allows the refrigerant to adsorb heat and cool the refrigerator compartment.

KEY POINT: It is not the change in temperature of the refrigerant that is important, it is the phase change of the refrigerant. 30\(^\circ\)F to 50\(^\circ\)F water circulating from the earth can not heat your home or business, but it can enable the refrigerant to phase change, absorbing a great deal of energy, allowing the Heat Pump to heat the space.

Continued on Page 2
The unique characteristic of a Geothermal Heat Pump, compared to conventional refrigeration appliances, is the refrigeration process can be reversed. This is discussed in more detail (See bulletin: How does a Heat Pump work?) As it relates to the refrigerant circulating through the Heat Pump, many units of heat are released by the vapor, useable heat for making the home or business comfortable or providing for the domestic hot water needs.

As illustrated (see Diagram 2), 212° Steam (vapor) releases 1,000 units of energy to change back to 212° Water. Remember only one unit of energy is released if the temperature of the water is lowered to 211°.

The phase change properties of water are an appropriate way to show the important concept of absorption and release of energy. We are familiar with freezing and boiling points of water. A refrigerant is able to accomplish this phenomenon at more useful temperatures and do so much more efficiently. The phase changes of the refrigerant are the “magic” of Geothermal Heat Pumps. The refrigerants give them the ability to move the stored energy from the earth in the winter and remove heat from the space and transfer it to the ground in the summer.

New refrigerants are being developed to improve efficiency and eliminate the impact on the ozone layer. Geothermal Heat Pump manufacturers’ are already re-engineering and supplying equipment free of ozone depleting compounds.

If you have further questions on this GeoTech Bulletin please contact us toll-free