Understanding a Ground Source Heat Pump

The basic purpose of this project are the fundamental principals in physics and general knowledge in the HVAC industry in understanding how a heat pump works. We will examine some elementary dynamics in the construction of the heat pump and its purpose.

A ground source heat pump system (GSHPS) uses the following components within its framework: 1. the exterior heat exchanger source called the loop field or water source 2. The mechanical components of the actual heat pump. 3. HVAC feed and returns system.

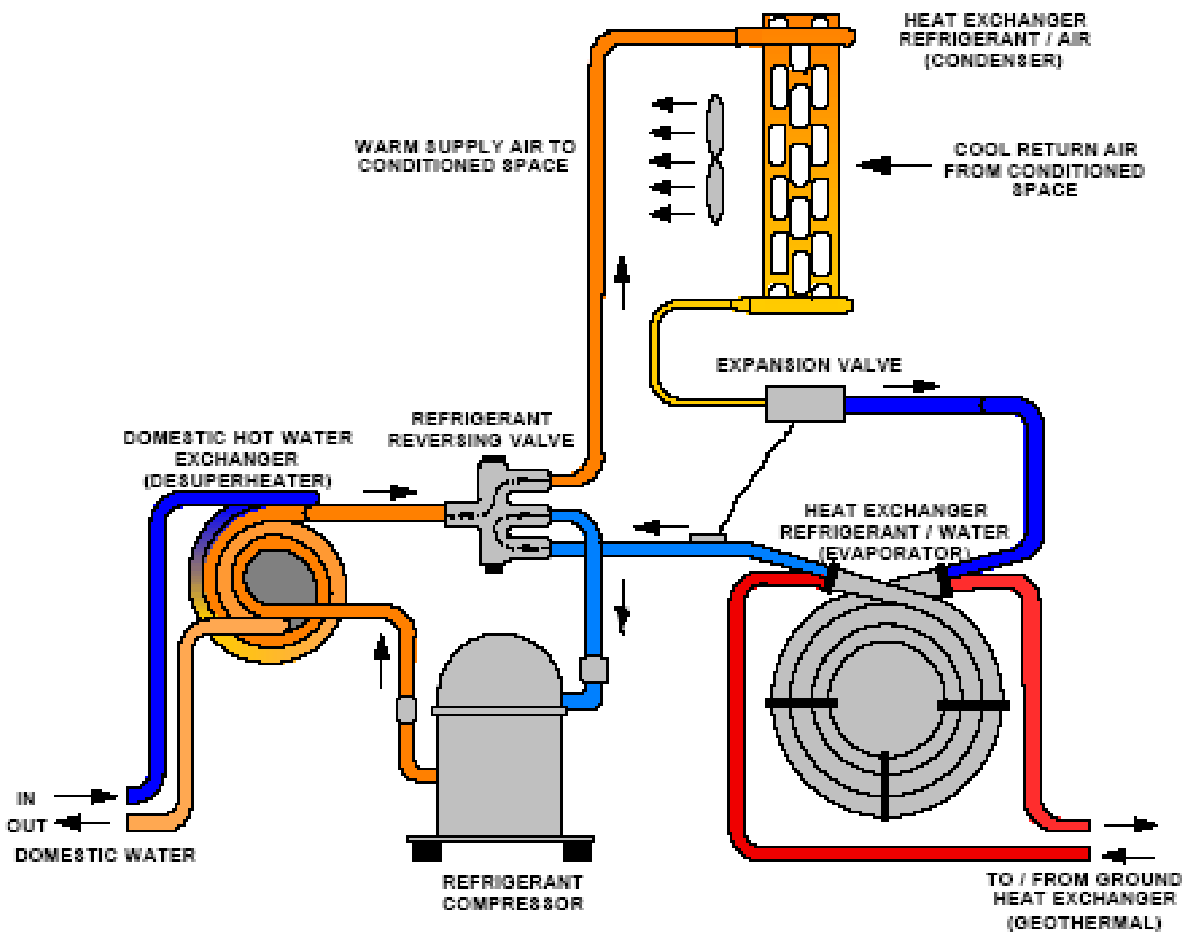

Figure 1a. GHP in the heating cycle (source: Oklahoma State University).

We will examine ONLY the actual GHP (geothermal heat pump). As the above diagram shows the internal components of a heat pump (similar in some respects to refrigerator or air conditioner), they are basically simple systems that comprise of 1st the heat exchanger refrigerant/water evaporator, 2nd refrigerant compressor, 3rd Optional domestic hot water exchanger, 4th refrigerant reversing valve, 5th heat exchanger and condenser, and 6th expansion valve.

The basic principals in operating a heat pump (in this case, it will be in the heating cycle) start with the heat gained from the loop fields of the ground heat exchanger (geothermal). The water (generally from 30°-52°F, depending on the system or season) with 17% propylene glycol is pumped to the evaporator in a closed system with a refrigerant at low temperatures whereby it changes state from liquid to vapor. (The ground water and refrigerant are independent of each other-they exchange thermal properties within the “exchanger”)Water absorbs a lot more heat when it changes phases than when it is warmed within a phase. A pound of water absorbs 970 BTU as it evaporates at 212°F. So the low pressure liquid refrigerant evaporates at about 32°F within this water heat exchanger (item 1 in diagram) and absorbs heat from the water with the propylene glycol. With 75 psi, Freon 22 changes state from liquid to vapor at 32°F.

Next the compressor functions to raise the pressure from 75PSI to 265 PSI so that heat can be released in the condenser. The compressor adds some heat to this fluid also. The compressor warms the Freon 22 gas to120°F with its increase in pressure to 265 PSI. Raise the pressure, and the properties remain the same, EXCEPT a phase change happens with higher temperatures. These are convenient temperatures and pressures for absorbing heat in the GSHP, thus warming the buildings. Higher pressure= higher temperatures.

The warm vapor (at this point may also go to the domestic hot water super heater system) then goes to the heat exchanger (where duct applications are done) where it gives off its heat (similar to those fins you see on your hot water baseboard heaters in your home) whereby it then condenses back to a liquid. The Freon 22 (or other) passes through the expansion valve whereby the pressure is reduced back to 75 PSI to start the cycle again.

The Reversing Valve is for changing the heat pump from heating to cooling mode. That is all that is needed. The chief cornerstone in designing a GSHPS is to give the EVAPORATOR as much heat as you can. This means plenty of water in open loop system and loops or bore in closed loop. If you reduce the amount of water or loops, the evaporator will ice or run cold, the condenser will be cooler and the heat pump will need to run longer to warm the buildings. However, over sizing these systems (especially in the cooling modes-greater than 25%) spells a whole host of problems. Proper design is key for electrical efficiency operation and proper load calculations. A 2.1 GPM for feeding the GSHP in ideal to balance electrical efficiencies between the well water pump and the GSHP. Why “floor” the gas pedal when “cruise” control is better?

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REFERENCES:

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