GEOTHERMAL HEAT PUMPS
- TRENDS AND COMPARISONS -

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Heat pumps are used where geothermal water or ground temperatures are only slightly above normal, generally 50 to 90ºF. Conventional geothermal heating (and cooling) systems are not economically efficient at these temperatures. Heat pumps, at these temperatures, can provide space heating and cooling, and with a desuperheater, domestic hot water. Two basic heat pump systems are available, air-source and water- or ground-source.

Water- and ground-coupled heat pumps, referred to as geothermal heat pumps (GHP), have several advantages over air-source heat pumps. These are: (1) they consume about 33% less annual energy, (2) they tap the earth or groundwater, a more stable energy source than air, (3) they do not require supplemental heat during extreme high or low outside temperatures, (4) they use less refrigerant (freon), and (5) they have a simpler design and consequently less maintenance.

The main disadvantage is the higher initial capital cost, being about 33% more expensive than air-source units. This is due to the extra expense and effort to burying heat exchangers in the earth or providing a well for the energy source. However, once installed, the annual cost is less over the life of the system, resulting in a net savings. The savings is due to the coefficient of performance (COP) averaging around 3 for GHP as compared to 2 for air-source heat pumps.

Types of Geothermal Heat Pump Systems

Two major types exist: earth-coupled or water-source. The earth-coupled uses a buried earth coil with circulating fluid in a closed loop of horizontal or vertical pipes to transfer thermal energy to and from the earth. The water-source uses a well or an open pond to provide an energy source or sink. Earth-coupled systems have been used in northern Europe for many years, but were not used on a commercial scale in the U.S. until 1980. Earth coupling is used where insufficient well water is available; where the quality of well water is a problem; where drilling and casing of wells are expensive, or where disposal of well water is restricted.

In the horizontal mode of the earth-coupled system, pipes are buried in trenches spaced a minimum of 5 feet apart and from 4 to 6 feet deep. This allows for minimum thermal interference between pipes; however, this system is affected by solar radiation. Solar radiation will affect the earth to a depth of about 30 feet, causing a cycling of soil temperatures, that lags in time and decreases with depth due to the insulating properties of the soil (Figure 1); however, the temperature is much more stable than for air-source units. Moist soil will have greater temperature swings than dry soil. The loops can be placed in a double layer as shown in Figure 2. Vertical installation (Figure 3) of the coils are used where land space is limited or trenching would disturb the surface landscape, and drilling costs are reasonable. Holes are drilled approximately 150 feet deep and 15 to 20 feet apart.