Achieving Energy Independence using Geothermal Heat Pumps

Executive Thoughts

Inside the Mind of One Engineering Group

Brian Campbell P.E.
Chief Engineering Officer

Brian Campbell, P.E, One Engineering Group Lead Engineer, recently attended the Accredited Installer Workshop and Technical Conference and Expo by the International Ground Source Heat Pump Association. As we explore this new technology, One Engineering is taking a proactive exploration of this new technology to help clients better understand the design and installation of these systems.

The chant "Drill baby drill" echoed through the Republican convention center in September as delegates voiced their enthusiastic support for opening offshore oil and gas drilling to help achieve energy independence. Separately, T. Boone Pickens has launched a massive grass roots campaign for his plan (aptly named "The Picken's Plan") to replace 22% of our imported oil by replacing natural gas electric generation with wind, and using the natural gas to replace diesel transportation fuel.

In contrast to the efforts to find and extract oil and reallocate natural gas use, another form of drilling can be used to exploit a renewable resource which is available to everyone. The earth collects and stores heat from the sun. This energy is available through a technology called ground source heat pump. Other terms which are used to describe this technology are "geothermal heat pumps", "earth-coupled heat pumps", and "geoexchange heat pumps". This technology uses the earth as a heat source/heat sink in contrast to an air-source heat pump.

A Higher Efficiency System

The temperature of the earth at a depth of 20 feet below the surface is constant, and is approximately equal to the average annual air temperature (68 F in DFW). Deeper than about 200 feet depth, the temperature gradually increases due to the heat flux from the earth's core. Since the earth's temperature at these depths is constant, it provides an attractive heat source / heat sink for a heat pump, resulting in a higher efficiency system than an air source heat pump. In contrast, an air source heat pump works hardest and is the least efficient during extreme heat or cold.

The heat pump unit consists of a compressor, coolant-to-air-coil, expansion/metering device, reversing valve, coolant-to-water heat exchanger and a circulating pump. During the winter, the coolant-to-water heat exchanger removes heat from the circulating fluid which returns to the ground at a cooler temperature. This cycle is reversed in the summer, and the coolant-to-water heat exchanger transfers heat from the conditioned space to the circulating fluid, which is returned to the earth at a warmer temperature. Entering circulating fluid temperatures for heat pumps typically are in the range 50 F to 95 F and flow rates of 3 gallons per minute per nominal ton of capacity.

If you have an Executive Thought of your own, please send it to us. We'll post your thoughts on our site to share with our clients and your peers.

Designing a Loop

In order to extract heat from the earth in the winter and reject heat to the earth in summer, it is necessary to design and construct an open loop or closed loop device to accomplish this heat transfer. Examples of open loops are ponds and water wells, in which water is drawn from the pond or well and pumped through the coolant-to-water heat exchanger and then returned to the pond or to a disposal well. In a closed loop system, a closed loop circuit of pipe is installed either in the ground or in a pond and a water/antifreeze solution is circulated.

The ground heat exchanger may either be a series of horizontal loops installed by trenching, or a series of vertical loops installed in wells. Design methodologies exist for both configurations. The "Best" configuration is the one that produces the desired entering water temperatures for the least cost. Both horizontal and vertical ground loops use high-density polyethylene pipe in the 1" to 1-1/2" diameter range. Ground loops for heat pumps over 2 tons are typically designed in a parallel configuration.

A horizontal loop is placed from 4 feet to 6 feet below the ground surface. Depending on the cost of trenching with a backhoe or trencher, two or more pipe loops may be placed in the same trench. A vertical loop consists of a factory assembled u-tube with the designated length. A 4" to 5" diameter hole is drilled and the loop installed. The hole is then grouted with a bentonite or bentonite/sand grout from the bottom of the hole to the top. This is the connection to the "Drill baby drill" approach on a local level help achieve energy independence.

Lastly, the loops are connected to supply and return headers which are then routed into the building and connected to the heat pump unit. The system is then completely filled with water and purged to rid it of all deleterious matter and air. Lastly it is pressurized to 30 to 40 psi, and a system performance check is run to verify that the system is performing as designed.

The Payback

The efficiency advantage afforded by this technology over traditional air source heat pumps, or air conditioning with electric or gas furnace systems comes with a price tag, namely the initial cost to install the ground heat exchanger. The payback period to recover this cost, based on expected energy savings of 40% to 60%, runs about 5 years. The recently enacted H.R. 1424, the Emergency Economic Stabilization Act of 2008, included a tax rebate of $2,000 for residential systems, and 10% investment tax credit and 5 year depreciation for commercial systems. These incentives are in place for 8 years.

A wealth of additional information may be found on the Internet, starting at the link:

http://en.wikipedia.org/wiki/Ground_source_heat_pump .

Learn more about One Engineering Group by contacting us today