Warmfloor
THE TOTAL RADIANT HEATING SOLUTION

FACT SHEET

CLOSED LOOP GROUND SOURCE HEAT PUMPS

Concept
The concept is simple. Energy is gathered from the ground by burying thermoplastic underground loops. Energy is transferred from the ground to the water flowing in the loops. This is then passed through the heat pump and transferred to the indoor distribution system for heating purposes and possible hot water provision. It is possible that during summer the system can be reversed to provide cooling, and the earth then acts as a "sink" to absorb the heat removed.

The trench temperature remains relatively constant all year round at a one metre depth. Alternatively energy can be collected from a bore, irrigation ditch, river, lake or the sea.

The principle is the same with the water from a lake passing through the heat pump and then after a certain amount of the energy has been removed the water is then reintroduced back into the lake.

This concept is consistent as water temperatures have little variation.

Benefits
More uniform year round earth and water temperatures ensure that ground source heat pumps (GSHP) will operate with higher efficiency than conventional air-source heat pumps and fossil fuelled equipment (gas & diesel boilers).
In heating mode GSHP installations can operate with higher heating capacities at low ambient temperatures and typically have a heating seasonal performance factor (HSPF) 20 to 30% higher than equivalent air-source systems.
Similar performance advantages are experienced for systems operating in the cooling mode. Typical performance measurements on ground source heat pump installations that provide space heating and domestic hot water using conventional equipment indicate average SPFs of 3. However more efficient systems can achieve HSPF2 greater than 5 by using state of the art components with optimized ground coils that provide heat to low temperature distribution systems in low energy buildings.

Lower Operating Costs
Higher efficiency levels lead to energy savings and lower operating costs for heating and cooling. For an electrical driven GSHP operating in heating mode typical energy costs are between 50-70% less than for electrical resistance heating, depending on climate conditions, and at least 25% less than for an air-source heat pump.

Compared to other sources of heating, potential savings are dependant on local costs of natural gas and oil, corresponding furnace efficiencies, etc.

TOTAL COMFORT
CENTRAL HEATING SYSTEMS

Reduced Maintenance

Because all parts of the GSHP are located either indoors or underground, the system is totally sheltered from weather and any vandalism, and little maintenance is required apart from routine servicing.

Temperatures underground are more stable than air temperatures, enabling systems generally to operate with lower compressor pressure ratios and less thermal and mechanical stress. Relatively high ground source temperatures prevent any evaporator coil frosting problems at the heat pump, and defrost cycling is therefore avoided.

With protection from the environment and less strenuous operating conditions GSHP systems have high reliability, and life expectancies are typically 20 to 25 years.

Lower CO2 Emissions

By reducing the primary energy consumption required for heating and cooling, heat pumps have the potential to reduce the quantity of CO2 produced by the combustion of fossil fuels and thus to reduce global warming. GSHPs can reduce emissions of greenhouse gases by two thirds or more compared with conventional heating and cooling systems. However the CO2 emissions from an electrically driven GSHP are directly related to fuel used for power generation and the efficiency of the power plant, and the net effect is therefore region specific. For example in New Zealand where electricity is generated primary from hydroelectric sources a GSHP used for residential heating purposes would produce less than 5000kg of CO2 over 20 years (including the direct effect from refrigerant releases), whereas a high efficiency gas furnace would emit 97,500 kg of CO2 (plus distribution network transmission losses) over the same frame.

Improved Aesthetics

With no outside equipment above ground level the nuisance noise from external fans is eliminated. For commercial buildings the appearance is improved by no longer needing any rooftop equipment and by fewer external penetrations of the building envelope.

Technology

GSHPs are an established technology with about 500,000 units currently installed worldwide and an estimated 45, 0000 new units being added annually. However there are no new statistics on what proportion of these are ground-coupled heat pump units.

The GSHP system is comprised of the ground collector heat exchanger, the heat pump, and the indoor heating distribution system.

Heat transfer to or from the ground coil is driven by the temperature difference between the ground and the circulating fluid. (Mostly water) Ground temperatures near the surface vary considerably depending on the time of the year, but at lower depths (typically 1 metre) these temperature swings are reduced. Other factors affecting the heat transfer are ground thermal properties, primarily the thermal conductivity and the thermal capacity of the soil. Thermal conductivity of soil remains relatively constant above a specific threshold called the critical moisture content (CMC). However, below the CMC the conductivity drops rapidly and may lead to serious degradation in performance of the ground source heat exchanger. Such problems are avoided in applications where the water table remains high and cooling loads are moderate. Underground water has a significant impact on heat transfer, since heat is also transferred by convection to moving water channels.

Some rules of thumb are available for estimating typical heat extraction rates. Horizontal heat exchangers suggest a range between 38-59 W/m for circuits. However, the wide variations depend on many variables, and are suitable only to assist in preliminary feasibility explorations.

The underground circuits should be connected in parallel. This arrangement leads to reduced pumping power, and material costs are also lower since pipe diameters are usually less for most piping runs. The length of piping in each circuit must be designed to ensure that equal flows are obtained.

The piping material selected for the ground heat exchanger affects the service life, maintenance costs, pumping power, capital cost and heat pump performance.

It is important there-for that the size, strength, material be well suited to the application. High density polyethylene or polybutylene are industry standards and typical pipe sizes are used between 20 mm and 40 mm in diameter.

Installation

Careful installation of the ground coil is necessary for efficient operation of the system, and the most important consideration is to ensure that continuous and reliable transfer is maintained between earth and coil. For installation of ground collectors, standard construction equipment such as backhoes or chain trenchers are usually sufficient to excavate the trenches required. The trenches must be at least a minimum of 1 metre deep and 150 mm wide. **See schematics attached.**

It is recommended that the pipes are laid on a bed of sand in the trench, and then covered with 15cm layer of sand before backfilling with removed soil. The installation should then be watered and compacted to minimize settlement. In the case of heat exchanger piping laid at multiple depths the same technique is required when installing each layer of pipe.

Indirect systems need the circulation of water either from a bore, stream or lake.

The energy is extracted and reintroduced back into its source. This is reliant on constant temperature requirements. Some water sources can vary, so this needs to be taken into consideration when calculating the load required for heating etc.

Applications
GSHP`s can be used for space heating, underfloor heating and to cool in the summer months on both accounts.

The GSHP can also be used for domestic hot water pre-heat. Because regulations require that domestic hot water be stored at a certain temperature, it will probably require a need for a back up energy source such as solar or gas etc.

The main market for GSHP`s is in the new lower energy housing where high insulation levels result in lower heating demands. Space heating temperatures can be reduced in forced air applications as well as underfloor hydronic water systems. The later only being able to be installed in new buildings applications.

The retro-fit market has much greater potential with the GSHP`s with space heating and can be readily installed in parallel with existing heating systems. Existing underfloor water heating can be re powered by GSHP`s systems.

Cooling again is seen as a plus in the above.

Commercial applications such as schools, hospitals, motels etc can be heated and cooled by GSHP`s providing substantial savings with regard to running costs. This market sector has been growing in recent years and ***Warmfloor Heating Systems Limited*** have undertaken to become heavily involved in the promotion and uptake of GSHP technology for both commercial and residential heating and cooling.

Warmfloor Heating Systems Ltd
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