GROUND SOURCE COOLING AND HEATING

Description of technology

Ground cooling and heating systems make use of the difference between the ground or groundwater temperature and the desired space or process temperature to transfer heat between the building or process to be heated or cooled and the ground. Where heat is required at a high temperature, the heat extracted from the ground can be upgraded in a heat pump system. Using the ground as a thermal energy source or sink has advantages over air in that ground temperature is much less variable than air temperatures. In the UK, at ground depth below 10 m the ground temperature remains approximately constant at around 10 °C.

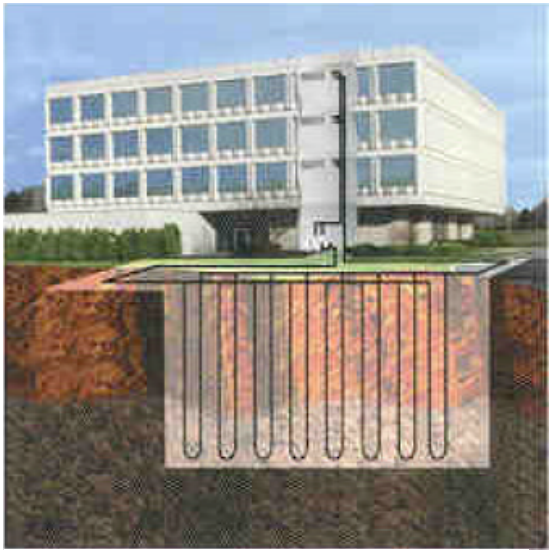

Figure 1. Closed loop ground heat exchange system (CDH Energy)

Ground heat exchange systems consist of two main subsystems. The ground loop and the thermal energy distribution system. There are two basic types of loops: closed and open. In open loop systems ground water is abstracted from an aquifer through one borehole, passes through the heat exchanger and then is discharged to the same aquifer through a second borehole some distance away. In the UK abstraction and discharge of groundwater requires a licence from the Environment Agency. In closed loop vertical systems, water or antifreeze (brine) is circulated through a U-tube in a borehole or a series of boreholes spaced uniformly in a grid. In closed loop horizontal systems the fluid is circulated in a pipework laid horizontally in a trench and exchanges heat indirectly with the ground.

State of Development

Ground heat exchange systems have been successfully and extensively used worldwide for many years. Most applications have been in North America, Northern Europe and Japan for space heating in the domestic sector in conjunction with heat pumps. There have also been successful applications in the commercial sector in schools, hotels and office buildings. Ground heat exchange systems have been less successful where cooling was the predominant load.

Applications in the food sector

There are a very small number of application examples of ground heat exchange systems in the food sector worldwide. An example in the UK is in the Saindsbury's millennium store in Greenwich where two boreholes are used to provide water supply for heat rejection from the refrigeration systems and cooling to the sales area. The system is reported to be performing satisfactorily but no performance data have been published in the open literature. Installation of more systems is currently being considered by a number of food retailers.

Barriers to uptake of the technology

The main barriers to uptake of ground heat exchange systems are:

- High capital cost involved with the drilling of boreholes where surface water is not available.
- Environmental legislation and the requirement of a licence for the use of open systems.
- Insufficient experience and performance data from applications in the food industry to provide confidence in the application of the technology.

Key drivers to encourage uptake

The main drivers to encourage uptake of the technology in the food sector are:

- Legislation that imposes limits on the energy intensity of food manufacturing and retail operations.
- Relaxation of legislation in the use and disposal of groundwater.
- Subsidies to reduce the capital expenditure of systems particularly borehole drilling.
- Further increases in fossil fuel prices.

Research and development needs

To increase the attractiveness and application of ground heat exchange systems in the food sector research and development work is required on:

- The design and integration of ground heat exchange systems with the other heating and cooling processes in the retail food store or food factory.
- Design of systems to achieve thermal balance in the ground to avoid long-term deterioration in performance.
- System optimisation to maximise heat exchange with the ground and reduce pumping power.