Water Source Heat Pumps

In the past few months, we’ve looked at Ground Source Heat Pumps (GSHP’s, popular with UK selfbuilders), Air Source Heat Pumps (ASHP’s, popular with the commercial sector), and Exhaust Air Heat Pumps (so far little used in the UK, but popular in Sweden, for example). There is another possible source of heat, an excellent source for a fortunate few: water. Only a few sites offer the opportunity, but when suitable water is available, a water source heat pump can be very effective.

A simple application is possible where there is access to a large pond. The collector is similar to that for a GSHP, viz, a closed loop of pipe with ‘brine’ circulating inside. But instead of being buried underground, the pipe is laid at the bottom of the pond, held in place by weights.

Another opportunity occurs when there is an aquifer under the plot at not too great a depth. (An aquifer is made up of permeable rock, or other material, saturated with water – eg, saturated sandstone, chalk, sand or gravel. A ‘Water borehole prognosis’ can be obtained from the British Geological Survey. See Further Info.)

The collector is an ‘open loop’ with two pipes to the aquifer, forming a source and a sink. Water is drawn up the source pipe to the heat pump where heat is extracted from it. Then the water, now colder, is returned to the aquifer by means of the sink pipe. (The boreholes for the source and sink need to be more than 15 m apart). Permission from the Environment Agency is required.

The temperature of groundwater is usually in the range, 6ºC – 12ºC. The source water is continually replaced, so the use of the heat pump does not lower the source temperature – unlike a GSHP which gradually lowers the surrounding ground temperature.

Another possible source of heat is the water in a river. If permission for extraction is forthcoming, this can make a good source.

When they work well, Water Source Heat Pumps can be very effective, especially for a big output. In practice, though, it has been found that some open loop systems have problems with the pipes and filters becoming blocked by debris or ice, and the trend is towards using closed loop collectors instead.

The Black Forest trials

In the Black Forest trials mentioned in my February article, the average Coefficient of Performance (COP) for the Ground Water Heat Pumps was 3.2. This was just below the results for the Ground Source Heat Pumps, which had an average COP of 3.4.

In these two-year trials, COP’s were found not just for the heat pumps themselves but also for the whole system. (For example, for a GSHP system, the system COP would take into account the electricity used by the pump that circulated the brine around the ground collector.)

The table below shows a brief summary of the results. The 'Best COP' column gives an indication of what is possible – eg, 4.4 for the best Ground Source Heat Pump system.
<table>
<thead>
<tr>
<th>Heat pump</th>
<th>Average COP</th>
<th>Best COP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ground Source Heat Pumps</td>
<td>3.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Ground Water Heat Pumps</td>
<td>3.2</td>
<td>2.9</td>
</tr>
<tr>
<td>Air Source Heat Pumps</td>
<td>2.8</td>
<td>2.4</td>
</tr>
<tr>
<td>Mini Heat Pumps for DHW</td>
<td>–</td>
<td>2.0</td>
</tr>
</tbody>
</table>

**Coefficient of Performance (COP) of heat pumps and their systems**

**Heat from the sea?**

Very few readers will have a building plot adjacent to the sea, but it’s worth mentioning the huge potential for extracting heat from the sea – after all, as the oceans are supposed to be getting warmer, making the sea a trifle colder might be environmentally benign!

An early application of heat pumps was for the heating of boats and ships. For housing, the potential would best be tapped on a collective basis, rather than by individuals. The Swedes were doing it twenty years ago, the Dutch ten years ago. And in the UK? – Well, there was a proposal for a scheme in Orkney but it seems to have come to nothing. Britain is surrounded by the sea. Shouldn’t we be showing the world how to tap into this vast store of renewable heat?

**Heat from collected rainwater?**

The building materials conglomerate, Hanson, produce Aquaflow slabs for making permeable paving. The slabs allow rainwater falling on a driveway or patio to drain through the surface rather than running off it. They are a key component in Hanson’s Thermapave system, which gains two greenie points simultaneously:

- **Harvesting water**
  Underneath the Aquaflow slabs, a waterproof membrane contains a deep layer of stones, with voids between the stones. This ‘tank’ collects the rain falling on the slabs, and the rainwater can be used for flushing toilets, etc.

- **Harvesting heat**
  At the bottom of the collection tank are the slinky coils of a GSHP system. This enables heat to be extracted from the water in the tank (which in turn gains some heat from the ground beneath it).

The Thermapave system forms part of the Hanson EcoHouse at the BRE Innovation Park near Watford. (See Further Info.)

**Waste Water Heat Pump?**

Last month we looked at Exhaust Air Heat Pumps, and saw that for the low carbon house of the near future the aim must be to allow as little heat as possible to escape. Even the heat in the stale air that is expelled during the course of ventilation can be recycled by an HRV unit and/or an Exhaust Air Heat Pump.
At present, though, there is a source of heat which is completely wasted – the warm water which goes down a plughole (ie, the waste water from baths, showers, basins, sinks, and washing machines).

In the first wave of eco building, in the Seventies and early Eighties, a few enthusiasts did attempt to utilise this heat. But though eco building is now becoming mainstream, recovering heat from waste water has so far been ignored. I expect the concept will be revived again, and within a few years there will be Waste Water Heat Pumps commercially available.

If so, it will be advantageous if waste water outlets are fairly close together in the house so that the waste pipes can drain to a central Waste Water Heat Pump. It always used to be considered good design practice to keep wet rooms close together for the sake of easy drainage (eg, bathroom above the kitchen). With the recent proliferation of ensuites for every bedroom, that ideal seems to have been abandoned – but perhaps its time will come again. So keep wet rooms clustered together so that their wastes can be connected easily to a Waste Water Heat Pump – at some time in the future! An immediate benefit, anyway, will be short pipe runs, which ensure that less hot water is wasted whenever a hot tap is used.

For saving the heat from individual wastes, especially shower wastes, see Further Info.

Combining heat pumps with other heat sources

We have become accustomed to heating systems with just one heat source, viz, a gas or oil boiler. When these boilers are installed they are usually oversized and more than capable of supplying all the heat required for both space heating and Domestic Hot Water. That is unlikely to be the case with a heat pump.

In previous articles, we have seen that for GSHP’s and ASHP’s:

• Heat pumps may be deliberately undersized to reduce capital costs. Also, for heat pumps without inverter technology, undersizing reduces inefficient on/off cycling.

• For maximum COP’s, heat pumps may heat water only to 35ºC – 45ºC. So supplementary heating may be required to heat DHW up to 60ºC.

The supplementary heating that is required might be totally independent of the main heating system, eg, a separate wood or pellet stove. Or the supplementary heating might be integrated into the system, most simply by electrical resistance heating, but alternatively by a second boiler.

Valency

‘Monovalent’ and ‘bivalent’ are a couple of jargon words used about heat pump systems. (‘Valentia’ is the Latin for ‘strong’.) A monovalent system has the heat pump as the sole source of heat. A bivalent system has another heating appliance (eg, a gas or pellet boiler) integrated into the system to supplement the heat pump.

Adding another heat source doesn’t sound difficult, but there are potential pitfalls in getting two ‘boilers’ to coordinate their activities.

Beware!
A friend of mine possessed a heating system with a gas boiler and solar panels, ie, it already had two heat sources. Being eco-concerned, he wanted to add a Ground Source Heat Pump – a third heat source. He engaged a small, specialist company to install the GSHP. This was about four years ago, when there was not much experience in the UK of GSHP’s. The heat pump was imported from Sweden, the boreholes drilled, and the pump fitted to the existing system. All seemed to be working well, and my friend paid for the installation. But it soon became apparent that the system didn’t work properly. In the following months, the company made various attempts to correct the situation, but their installers didn’t have the necessary expertise.

Eventually, my exasperated friend sent the company a letter threatening to sue. The company promptly declared itself bankrupt, and soon after that, the same people were trading in the same business under a different name. (My friend did eventually find a company that was able to get the system working, but of course he lost both money and time.)

I think there are two lessons to be learnt from this tale. The first is the specific one that integrating different heat sources into one heating system is more complicated than might at first be thought. So do try to engage a company which has the required expertise and experience.

The other is a more general warning: Beware of companies going bankrupt – a not uncommon event in the building trade.

**Geothermal Heat Pumps?**

Another term that is occasionally applied to heat pumps is ‘geothermal’. From the Greek, ‘geothermal’ means ‘earth heat’, and the term is probably best reserved for heat coming from deep underground (eg, as hot springs), not to heat near the surface derived from solar energy. Because the earth’s crust forms a good insulator, the amount of heat coming to the surface from the hot core within is only about 0.1 watts per square metre. Using this figure, about 0.88 kWh of geothermal energy reaches a square metre of the surface in a year. \(0.88 = 0.1 \times 24 \times 365 \div 1000.\) This is minute compared to the 1,000 kWh, or so, that a square metre of ground in the UK receives annually from solar radiation. So let’s stick with ‘Ground Source Heat Pumps’, not ‘Geothermal Heat Pumps’.

**A rise in VAT please!**

There is a budget due in April and I am hoping the Chancellor will take the opportunity to increase the VAT rate for domestic gas and electricity. At present, these fuels have a preferential status and only attract the reduced VAT rate of 5% (cf, the standard rate of 17.5% for nearly everything else). Since we are supposed to be trying to cut down on carbon emissions, ‘subsidising’ these carbon-intense fuels in this way is stupid. (The Government needs to increase tax revenue to reduce its borrowing. And the ‘fuel poor’ are helped by Government programmes such as Warm Front and the winter fuel allowance.)

Since calling for a tax increase is unlikely to be popular, perhaps I should point out to readers that higher prices for gas and electricity might be of financial benefit to them! Houses built in the near future will have to be much more fuel efficient than the present housing stock. That must add to the attraction of a newly built house and
make it more valuable. The higher the price of fuels, the higher will be the premium resulting from the low fuel requirements of a new selfbuild.

But changing the VAT rate on domestic gas and electricity will adversely affect lots of voters. Realistically, I expect that we will have to wait for a post-election budget before this simple way for the government to both raise revenue and reduce carbon emissions comes about.

Next month: Cooling with heat pumps, and other HP topics.

FURTHER INFO:

**British Geological Survey (BGS)**
Download reports:
Water borehole prognosis (£352), Ground Source Heat Pumps basic (£53).
www.bgs.ac.uk.

**Thermapave system**
Like most of the ‘British’ manufacturers of building materials, Hanson is now foreign owned:

**BRE Innovation Park**
www.bre.co.uk.

*Local recovery of heat in waste water:*
Dutch company:
www.hei-tech.nl/english.htm.

American product:

For the improvised recycling of both heat and water from a bath:
www.theyellowhouse.org.uk/themes/heatwat.html.

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