Heat pumps in hot water

Christian Hadley, renewables product manager for Dimplex, outlines the main points to be considered when specifying a cylinder for heat pumps

Modern properties are increasingly having unvented cylinders installed to provide mains-pressure hot water with high flow rates.

Using a heat pump can be an efficient way of generating all the domestic hot water if the unvented cylinder and heat pump are closely matched.

It is a widely-held misconception that heat pumps are only suitable for space heating. However, heat pumps also have the ability to provide plentiful hot water, either as the sole water heating appliance or, if preferred, in conjunction with another heat source such as solar or a fossil-fuelled boiler.

Before designing a hot-water system, it is important to understand that there are a number of differences between a cylinder designed to operate with heat pumps, and a standard cylinder that would be used with oil or gas systems.

FLOW TEMPERATURE

With a heat pump, efficiency or coefficient of performance (CoP) is much higher at low flow temperatures – below those expected with a gas- or oil-fired system.

This reduction in flow temperature has a knock-on effect on the coil size, storage temperature and storage volume.

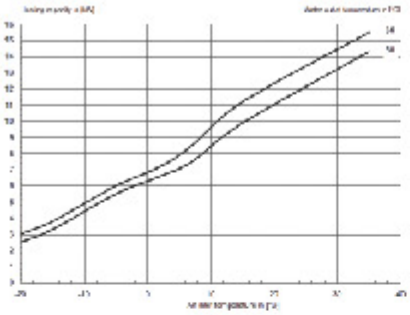

Figure 1: Attainable cylinder temperatures at 65ºc flow temperature for a 230-litre cylinder

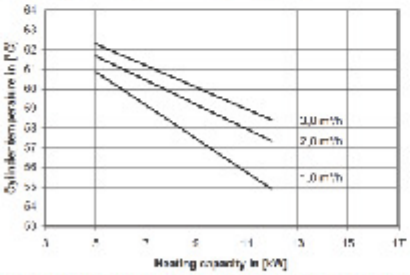

Figure 2: The output of a typical heat pump increases with a higher source temperature which has a counter-intuitive effect on the cylinder temperature

COIL SIZE

To counteract the low temperature gradient between the primary water going though the coil and the desired cylinder temperature, it is imperative to use a coil or other heat transfer mechanism with a large surface area to speed up the rate of heat transfer.

Typically, a heat pump cylinder coil would be 2.5 times bigger than a standard cylinder coil of the same storage capacity.

TEMPERATURE

Most heat pump cylinders store water at 45°c rather than 60°c, because the lower flow temperature increases the system efficiency.

Heat pump cylinders are frequently designed to store the water at the temperature that will be used. Heating the cylinder to 60°c and then mixing the water back down to 45°c decreases system performance unnecessarily.

VOLUME

In a standard system, a 100-litre cylinder with water stored at 60°c produces 150 litres of water when mixed down to a usable temperature of 43°c.

To offer a comparable amount of hot water, a heat pump cylinder that stores water at 45°c will have to be approximately 50% larger than the current cylinder.

Figure 1 shows that even if the flow temperature from the heat pump is constant at 65°c, the attainable cylinder temperature can be varied significantly by changing the flow rate and kW output of the heat pump. While all unvented cylinders have similar characteristics, coil sizes and flow rates in a domestic gas or oil system are not as critical because of the higher flow temperature.

For a heat pump system to maximise the system efficiency, the attainable cylinder temperature needs to be considered carefully.

It is notable that a heat pump's output increases with increasing source temperature.

For example, Figure 2 shows how an air source heat pump has a higher output when the external air temperature rises. Looking at Figure 1, it is clear that increasing the kW output decreases the attainable cylinder temperature.

This effect is counter-intuitive, but important to understand if the exact storage temperature of the cylinder is considered to be critical.

INSULATION

For a heat pump cylinder, levels of insulation are particularly important when the customer is interested in system efficiency.

Higher insulation levels ensure that the heat loss from the cylinder is decreased, which in turn means that system running costs and carbon emissions are lower.

Having a good level of insulation is critical to minimise heat loss – particularly if the cylinder is heated using a heat pump with off-peak electricity.

If this is the case, the water might not be used until late in the afternoon which means good insulation is required to stop the temperature falling and prevent energy being wasted.

A 300-litre heat pump cylinder

LEGIONELLA

Where there is a requirement to pasteurise against legionella, water temperature can be raised in a number of ways.

A high-temperature heat pump capable of flow temperatures above 65°c can be programmed to bring the cylinder up to 60°c for the desired amount of time.

If the heat pump can't reach these higher temperatures, a direct electric immersion heater can be used to finish off the sterilisation process. This is very cost effective, and the immersion can either be controlled by the heat pump or through a separate standalone timer.

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