

Technical Fact Sheet – Heat Pumps with Hydronic Fan Coils.



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Heat pumps are devices that use ambient heat from natural sources, such as the air, ground, or water, to provide cooling, heating, and hot water for buildings. They are highly energy-efficient, as they produce more heat than they consume electricity. Heat pumps can also reduce greenhouse gas emissions, energy costs, facilitate decarbonisation when compared to conventional heating systems that use fossil fuels.

There are two established means of measuring efficiency of a heat pump, these are the coefficient of performance (COP). This is the ratio of heat output to electricity input at that moment in time and the seasonal coefficient of performance (SCOP). Seasonal efficiency is a way of measuring the true energy efficiency of a heat pump over an entire year and gives a more realistic indication of the energy efficiency and environmental impact of a system.



Figure 1. Air to Water Heat Pump

The COP of a heat pump depends on the temperature difference between the source and the sink, also known as the delta T (ΔT). The smaller the ΔT , the higher the COP, and the lower the energy consumption. Conversely, the larger the ΔT , the lower the COP, and the higher the energy consumption.

Low temperature hot water (LTHW), is a common heating medium for heat pumps. The flow temperature of LTHW is typically 50°C to 30°C with a ΔT of 5 to 10K depending upon the technology used. This relatively small ΔT , means that the heat pump can operate at a high COP and consume less energy. With the move away from gas boilers, many heat pump manufacturers are busy developing high temperature heat pumps to achieve water temperatures $\geq 70^{\circ}\text{C}$ by using alternative refrigerants such as Propane (R-290) Ammonia (R-717), Carbon Dioxide (R-744) and Opteon XL20 (R454C).

According to the ΔT Conversion table, a heat pump with a ΔT of 5K can have a COP of 4.5, which means that it can produce 4.5 units of heat for every unit of electricity. A heat pump with a ΔT of 10K, on the other hand, can have a COP of 3.5. Therefore, a heat pump with a ΔT of 5K can reduce the energy consumption by about 22% compared to a heat pump with a ΔT of 10K.

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There are different types of heat pumps that can suit different applications and environments.

- Air source heat pumps, which extract heat from the outside air.
- Ground source heat pumps, which extract heat from the ground or Ambient loop.
- Water source heat pumps, which extract heat from rivers and lakes and bore holes.
- Hybrid heat pumps, which combine heat pumps with other heating systems i.e. gas boiler / electric heater / heat network.

Heat pumps are increasingly being used in Offices, Hotels, Apartments and Homes in the pursuit of Net Zero, but they require an emitter to efficiently distribute Heating and Cooling to the Space.

4 pipe Hydronic or Chilled water fan coil units (FCUs) are Heating and Cooling emitters that use a water medium from a central chiller plant and / or a heat pump to provide internal temperature control and dehumidification for buildings. They consist of a fan, a filter and a coil that contains the water. The fan typically draws air over the coil, heating or cooling it and removing moisture, and then distributes the conditioned air to the desired space. Typically the LTHW flow temperature is between 50 to 40°C from a heat pump with a reduced ΔT . FCU's either utilise a Mono-block coil with both cooling and heating sections within a single coil or have separate Cooling and Heating coils. The conventional heating section has traditionally been sufficient when using a Gas boiler as the LTHW source at say 81 to 60°C. The FCU manufacture may have to use supplementary heating coils, special Heat Pump coils or larger heating sections to ensure that the unit can deliver the design heating output without increasing the unit size, supply air volume or coil pressure drop.

Other options to 4 pipe FCU systems:

2 pipe changeover – These systems utilise a single reverse cycle heat pump that delivers LTHW in the winter and Chilled Water (ChW) in the Summer. The change over occurs either at a set date or external air temperature. The fan coil control strategy will have to react to the changeover via a universal reset or a pipe sensor that will operate the Fan coil in heating mode if it detects a higher pipe temperature compared to the room set point and the opposite if the pipe temperature is lower. A single valve and actuator are used. Supplementary electric heating can also be installed within the unit if there is a possibility of heating requirement during the cooling period.

6 way valves – This system is very popular on continental Europe and is being promoted by various valve manufactures. The valve has 6 ports, ChW flow and return, LTHW flow and return and FCU coil flow and return. The single valve and actuator move through Heating / bypass and Cooling zones. The advantage is fewer component and the use a single coil that can reduce over sizing of FCU's in heating mode.

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FCU Types

- Concealed ceiling FCUs, which are hidden above the ceiling.
- Exposed Ceiling FCUs, which are fixed to the slab with no ceiling.



- Wall mounted FCUs, which are installed on the wall of a room.
- Cassette FCUs, which are installed in the ceiling of a room.

Fan coils are the obvious choice to partner with heat pumps because they offer several advantages, such as:

- Flexibility, as can be installed in various positions and locations, depending on the design and layout of the space.
- They are energy-efficient and can operate with low flow temperatures, which are suitable for heat pump systems.
- Fan Coils provide both heating and cooling for different zones, which can reduce the overall energy consumption and Embodied Carbon
- They are quiet and have low noise levels, which can create a comfortable and productive working environment.
- Easy to maintain with simple long-life components, such as fans, a filter, a coil and condensate connection

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We will look at typical applications.

New Offices

Due to Building regulations and the desire to limit the use of fossil fuels, Heat pumps are being specified for new office indoor climate systems.

Fan coils have always been a staple solution for new offices, giving a flexible, tried and tested system that combined with smart controls can meet the highest BREEAM, WELL and NABERS requirements.

Many offices are designed with exposed services leading to a modern open environment. FCU manufactures have designed units specifically to be exposed with flush cases, painted finished and acoustic treatment where needed. New designs incorporating cassette type units and multiroom fan coils are also being designed into office spaces.

Office Refurbishment

With existing office stock aging, a solution to improve energy efficiency is to replace the existing gas boilers with heat pumps. The installed FCU's may need checking that they are suitable to meet the existing heating loads with the new lower Heat Pump LTHW flow and return temperatures. This may mean re-commissioning the LTHW flow rates and air volumes. If the units are unable to meet the demands, supplementary coils may be a solution or worst case replacing the FCU's with new more efficient models.



Below is an example of the reduction in heat output when using various LTHW Plant.

LTHW Plant	LTHW Flow and Return Temp °C	Maximum Heat Output of a Typical Fan Coil Unit @ 200 l/s
Gas Boiler	82 - 71	4.90 kW
Condensing Gas Boiler	70 - 50	3.55 kW
Heat Pump	45 - 40	2.36 kW

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Hotels

Hoteliers are keen to remove refrigerant gasses from within their properties and therefore Heat Pumps and Fan coils are the obvious answer, with compact horizontal FCU's mounted above the bathroom / lobby or vertical wall mounted units under the window. Chilled water fan coils are quite and economical to run. 2 pipe changeover with electric heating is also a very good option for hotels

Residential

Heat pump technology has made a big impact on the residential market, with ambient loop systems and standard heat pumps proving Heating, cooling and DHW. More apartments require cooling to either mitigate over heating (Part O building regs) or to meet market expectations. Fan coils are the ideal solution to provide both heating and cooling from a single system. Cooling only FCU's can also be used in conjunction with radiator or underfloor heating systems. In apartment ambient loop heat pumps also have the advantage of being reverse cycle allowing the unit to provide both LTHW and CHW on a 2 pipe change over system.



New developments

4 pipe Heat Pump delivering simultaneous heating and cooling.

Low to ZERO GWP (Global Warming Potential) Natural ref. CO₂, Ammonia, R454C

Cascading systems utilising units with different refrigerants.

High temp to low temp producing higher LTHW (over 60°C).

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