Underfloor heating is an established space heating technology that is becoming an ever more popular choice with designers, installers and building occupiers. The rise in popularity is owing to its optimal thermal comfort credentials and suitability with low-temperature, decarbonised heat sources such as heat pumps.

However, the choice for underfloor heating is not always as simple as it first might seem owing to the more complex embedded nature of the heating system. This CPD article considers wet underfloor heating systems that consist of low-temperature heating pipes that are laid into a floor construction and focuses on the key topics of human comfort, practicalities, system components and suitability for use with heat pumps.

As the name suggests, underfloor heating is a floor-based heating system that warms the floor surface to a temperature between 26°C to 29°C (depending upon the floor covering type). Heat is transmitted into the space using radiation heat transfer and typically provides air temperatures of 20°C to 24°C (depending on the room type and use).

As the entire floor acts as a heat emitter there are no cold spots (provided that pipes are evenly distributed) and wall space is freed up where typically radiators or fan convectors would have been provided. Human comfort is well suited to underfloor heating as a warm floor surface and the radiant effect mimic the same heat transfer of the sun to heating surfaces and releasing heat. There are further air quality benefits in that the absence of air circulation, dust and dryness associated with traditional heating systems is avoided which greatly benefits allergy sufferers.

In a “wet” underfloor heating system hot water flows through plastic or composite pipes built in the floor usually formed into loops. To fit various floor constructions, different installation options are available and the heat output of the system is dictated by the spacing between pipes and the number of loops in the floor as well as flow and return temperatures. The peak temperature is typically 35-45°C flow and 25-35°C return which are reduced as external temperature increases using the practice of weather compensation.

Underfloor heating pipes are routed back to a central manifold, usually one per floor or footprint zone, which is connected to the heating system. Considered at design stage

Underfloor heating is best suited to new builds with modern Building Regulations and standards where the underfloor heating components can be considered at the design stage and carefully planned and included into the complete building and M&E designs. The installation of underfloor heating systems will therefore be carried out much earlier in the construction programme as floor construction factors much earlier on the installation programme. Timing therefore is of the essence and early M&E design and installation is needed as compared with a traditional heating system installation programme.

Refurbishment projects, however, are also possible but require more consideration particularly when considering floor levels, existing fabric, spatial requirements and output. Floor levels require particular consideration as floor levels may require raising owing to the addition of floor insulation, pipes and floor coverings such as screeds—this could be a major issue and ceiling levels and door operation will require further consideration. The thermal performance of the existing fabric may require to be upgraded to match the output ability of the underfloor heating system (maximum 100W/...
m² under BS EN 1264 but often below 50W/m² on most projects). Alternatively, additional emitters can be introduced to the space but this is not ideal. Finally, additional space may be required to accommodate the connections between the floor pipe system and the heating system and the formation of cupboards to locate underfloor heating manifolds and equipment.

**Thermal response time**

An important practicality for users to consider is the thermal response time of the underfloor heating system. It is important to understand that underfloor heating systems have a time delay between when the heat is ‘charged’ into the floor construction and when it is released. The higher the thermal mass of the floor, for example, as with a concrete screeded floor, the longer the time delay will be. While this is not an issue it must be understood and the system controls are set up to respond accordingly i.e. switched on and off earlier or indeed operated with a continuous, but reduced, set-back temperature and most importantly that they also weather compensated.

While most underfloor heating systems are installed without problems caution should be given to damaging the pipes during installation. This could lead to leaks and also to the ingress of dirt into open ends of pipes causing blockages. Both issues can be troublesome once the screed has been poured so practices such as pressure testing and flushing are important to be carried out at the appropriate stage of the programme. The key system components for underfloor heating installation are: insulation, pipes and clips, screed, manifolds, and controls.

Insulation plays the all-important role of preventing heat loss into the ground and surrounding walls and ensuring that the heat is radiated into the space. A floor and perimeter insulation base is installed that is also capable of receiving clips to hold the pipework system down during the screed process. The type and thickness of insulation varies and is highly dependent on the floor structure, Building Regulations and other design standards such as PassivHaus. In most general cases a 50mm polysyrene insulation board with pipes attached is laid on a subfloor with extra insulation around the perimeter of the room, then a screed of 65mm to 95mm is poured over. However, there are many variants that include floating floor (overlay systems), low-profile systems, structural floor panels, diffusion plates and sprung floors.

There are a number of different pipe types that could be used for an underfloor heating system, one of which is PEX and AL-PEX. Another type is PERT and AL-PERT. PEX and AL-PEX piping is a coextruded crosslinked, polyethylene composite pressure pipe with a welded aluminium tube reinforcement between the inner and outer layers. PERT and AL-PERT pipes are made with an inner layer of raised temperature polyethylene (PERT) and another outer layer of polyethylene on top of the aluminium layer. PEX and AL-PEX are preferred in underfloor heating, due to easier installation and higher temperature resistance.

The use of clips is highly dependent on the insulation type. Extruded polysyrene insulation has channels pre-cut into it with factory-fitted aluminium heat diffusers and a polythene film over the top surface.

"As the entire floor area acts as a heat emitter there should be no cold spots in a room"

**Underfloor Heating Pros**

- Ideal thermal comfort for building occupants - feels natural like the sun’s heat.
- Reduced air circulation and dust transfer – This is better for people who suffer from allergens.
- More space and design freedom - Most modern radiators take up space on walls, hence the flexibility of the design accompanied with heated floors.
- Energy efficient heating – Less energy is required due to the lower temperature output and where heat pumps are used benefits from high CoPs.
- Reduced maintenance - As compared with fan coil solutions as there are fewer moving parts and therefore less servicing is required.

**Underfloor Heating Cons**

- Programme time – Earlier M&E involvement is required on projects.
- Warm up times - An underfloor heating system will take longer to heat a room, so it is vital to have the controls appropriately set up.
- Floor height issue – Installing a UFH system may increase floor height depending on design.
- Testing and Commissioning - A robust regime is needed that includes pressure testing, sealing of open pipe ends, air bleeding and leakage protection.
- Cost - it can be costly to have the system installed in a retrofit scenario.
- Output limitation – Some refurbishment projects can struggle with output temperatures and may require thermal improvement.
Hot water cylinders should regularly purge the water at 60°C however in order to prevent scalding and hot water should be cooled to 43°C this is usually achieved using blending or mixing valves that mix hot and cold water. This can be achieved with the operation of either a high temperature heat pump, additional electrical immersion heaters or using a hybrid system.

Clearly the choice of heating system using heat pumps and underfloor heating systems should not be without consideration to domestic hot water production and legionella management.

The heat pump cycle comprises:
- **evaporation** - the refrigerant passes through a heat exchanger where it evaporates absorbing heat from the source;
- **compression** - the heated refrigerant is then compressed to a higher pressure using an electrically driven compressor;
- **condensation** - the compressed refrigerant passes through another heat exchanger and condenses, changing back to a liquid and releasing heat in the process; and
- **expansion** – the liquid refrigerant passes through an expansion device lowering its pressure prior to returning to the evaporator to repeat the cycle.

The majority of heat pumps installed in the UK are monoblock type systems. This is where all the refrigerant gases are hermetically sealed within the outdoor unit. The outdoor unit is either floor or wall mounted. Heating flow and return water pipework connections are made between the outdoor unit and an indoor thermal store or heating and hot water cylinder. From this store/ cylinder hot water is piped to the underfloor heating manifolds.

Electricity consumption is much less in heat pumps than with other forms of direct electric heating.

It is for these reasons that electrically powered heat pumps are now considered to be arguably the optimal heat source option for an underfloor heating system.

**Careful choice of heat pumps**
The use of heat pumps for a complete heating and hot water solution needs careful consideration as domestic hot water temperatures require higher temperatures. An important aspect of UK regulations controls the temperature of stored hot water that is required to reach a sterilisation temperature of 60°C to kill legionella. Legionella bacteria causes legionnaires’ disease which is a potentially fatal type of pneumonia, contracted by inhaling airborne water droplets containing viable Legionella bacteria from, for example, spray taps and showers.

While the Health and Safety Executive consider the risks from hot systems as low risk (due to the regular water flow and tank refill) care is still required to negate any risks.

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Questions

1) When will the UK government’s future homes standard be looking to phase out gas-powered central heating?
- □ 2022
- □ 2023
- □ 2025
- □ 2030

2) Which of the following affects underfloor heating heat output?
- □ Insulation thickness
- □ Pipe spacing
- □ Flow rate temperatures
- □ All of the above

3) Why is underfloor heating believed to be comfortable?
- □ As it warms your head like the sun
- □ As it warms using radiation heat transfer like the sun
- □ As it warms the air causing convection currents in the air
- □ As it warms using conduction heat transfer like the sea

4) According to this CPD Article an air-source heat pump coupled with a floor heating system can be:
- □ 400 per cent efficient
- □ 100 per cent efficient
- □ 300 per cent efficient
- □ None of the above

5) What is the temperature range of a heat source used with underfloor heating?
- □ 35-45°C
- □ 45-55°C
- □ 55-65°C
- □ 65-75°C

6) Which of the following is considered an underfloor heating testing and commissioning issue?
- □ Clogging
- □ Leaks
- □ Trapped air
- □ All of the above

7) Which of the following is an advantage to underfloor heating systems?
- □ Is cheaper to install than all other solutions
- □ Has a faster response time
- □ Is classed as decarbonised when used with heat pumps
- □ None of the above

8) Which of the following is an aspect to consider when insulating underfloor heating systems?
- □ Type of insulation
- □ Amount of insulation used
- □ Floor structure
- □ All of the above

9) Which is not a component of an underfloor heating system?
- □ Fan coil
- □ Pipework
- □ Air vent
- □ Manifold

10) Why is consideration towards domestic hot water production necessary when specifying underfloor heating with heat pumps?
- □ No consideration is needed as hot water is needed at 43°C at taps
- □ As legionella control requires higher temperatures to be generated
- □ Provided the heat pump is reverse cycle this is not an issue
- □ Only a consideration when extreme external temperatures occur

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