THE CONTINUING PROFESSIONAL DEVELOPMENT PROGRAMME

Fundamentals CPD

Heating under your feet

Paul Bennett, managing director of BSSEC

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).

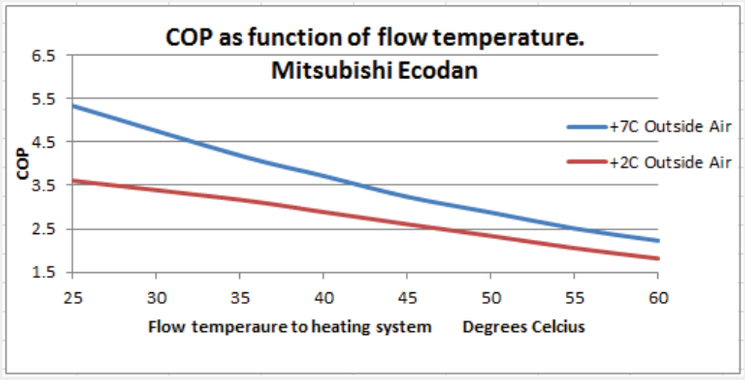
As the entire floor acts as a heat emitter there are no cold spots (provided that pipes are evenly distributed) and wall space is freed up where typically radiators or fan convectors would have been provided.

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.

Fig 1. Coefficient of Performance improves with lower flow temperatures and higher outside air temperatures.



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

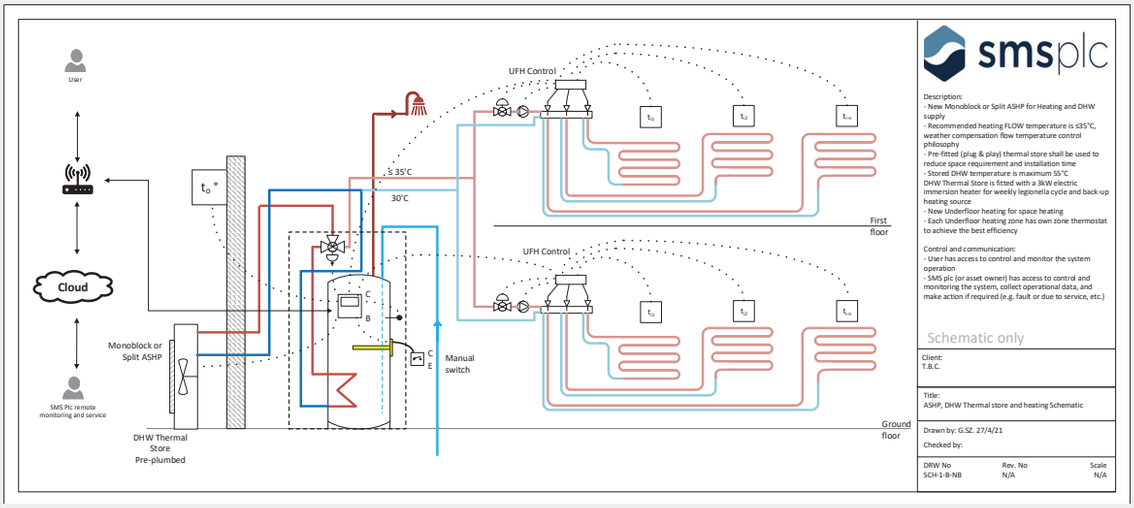
Considered at design stage

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/

For details on how to obtain your **Energy Institute CPD Certificate**, see ENTRY FORM and details on page 24

Fig. 2. Typical schematic diagram with a monoblock air source heat pump and underfloor heating system.



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 polystyrene 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 raised temperature polyethylene on top of the aluminium layer. PEX and AL-PEX are preferred in underfloor heating, due to easier installation and higher temperature resistance.

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

The use of clips is highly dependent on the insulation type. Extruded polystyrene insulation has channels pre-cut into it with factory-fitted aluminium heat diffusers and a polythene film over the top surface. Installing pipes with this type of insulation does not require any clips. Expanded polystyrene is another type of insulation that requires the use of U-shaped clips in order to secure and position pipes. Rigid boards are one of the commonly used insulations, which comes pre-fitted with clips that allow installers to fit pipes into with applied pressure.

The manifold makes the connection between the underfloor heating system and the heat source and forms a flow and return mini 'header'.

The manifolds are usually located in zones on a footprint and each port on the manifold serves a room or, where rooms are large, all the ways can serve a single room or sub-zones within the single room. Each way is provided with an isolation valve, air vent and drain valve on one header and a two port control valve and isolation valve on the other.

The two port control valve is typically connected to the control system and a thermostat is provided into each zone (or sub-zone) in order to limit flow rates and control output temperatures. The system pump is typically included in the heat source installation although some designs include a pump at each manifold.

The government is looking to decarbonise heat and in its 'future homes standard' it has decided on a move away from gas central heating systems and towards decarbonised solutions that include electric heat pumps in new build homes from 2025.

Electricity is seen as decarbonised as the national grid is in turn becoming decarbonised through renewables (wind and photovoltaics) and the increased use of energy storage systems. By 2050 the National Grid is hoping to be fully decarbonised.

Electric heat pumps use a refrigerant cycle to transfer heat from a source such as air, ground or water to the medium to be heated, in this case the water in 'wet' heating systems.

Underfloor Heating Pros	Underfloor Heating Cons
Ideal thermal comfort for building occupants - feels natural like the sun's heat.	Programme time – Earlier M&E involvement is required on projects.
Reduced air circulation and dust transfer – This is better for people who suffer from allergens.	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.
More space and design freedom - Most modern radiators take up space on walls, hence the flexibility of the design accompanied with heated floors.	Floor height Issue – Installing a UFH system may increase floor height depending on design.
Energy efficient heating – Less energy is required due to the lower temperature output and where heat pumps are used benefits from high CoPs.	Testing and Commissioning - A robust regime is needed that includes pressure testing, sealing of open pipe ends, air bleeding and leakage protection.
Reduced maintenance - As compared with fan coil solutions as there are fewer moving parts and therefore less servicing is required.	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.

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 hermitically 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.

The optimal heat output for a heat pump is 45°C and below which is ideal as these are the same operating temperatures of an underfloor heating system. At these temperatures heat pumps have an operating efficiency which typically averages 300 per cent (also termed as the Coefficient of Performance (CoP) with a corresponding figure of 3) thereby reducing their running costs.

Electricity consumption is much less in heat pumps as 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.

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.

ACKNOWLEDGEMENTS

- Steve Richmond, Head of Marketing & Technical - Building Solutions, REHAU Ltd, Hill Court, Walford, Ross-on-Wye, Herefordshire, HR9 5QN D: +44 (0)1989 762642 M:+44 (0)7921 405948 E: steve.richmond@rehau.com
- Max Halliwell, Communications Manager, Mitsubishi Electric Heating & Ventilation Systems, Mitsubishi Electric Europe B.V. Travellers Lane, Hatfield Herts, AL10 8XB. D: +44 (0)1707 276100, M: +44 (0)7917 426382, E: Max.Halliwell@meuk.mee.com
- Sam Hunt, Principal Energy Consultant, SMS PLC, Prennau House, Copse Walk, Cardiff Gate Business Park, Cardiff, CF23 8XH. D +44 (0) 2920 739 500 M: +44 (0)7813 304671 E: Sam.Hunt@sms-plc.com

CPD SERIES 19 / Module 03
Underfloor Heating

ENTRY FORM

Please mark your answers below by placing a cross in the box. Don't forget that some questions might have more than one correct answer. You may find it helpful to mark the answers in pencil first before filling in the final answers in ink. Once you have completed the answer sheet, return it to the address below. Photocopies are acceptable.

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 if 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

Please complete your details below in block capitals.

Name..... (Mr. Mrs, Ms).....

Business .....

Business Address .....

.....

.....

.....Post Code .....

email address.....

Tel No. .....

Completed answers should be mailed to:
The Education Department, Energy in Buildings & Industry, P.O. Box 825, Guildford, GU4 8WQ.
Or scan and e-mail to: editor@eibi.co.uk.
All modules will then be supplied to the Energy Institute for marking

Produced in Association with
energy institute

"Energy in Buildings and Industry and the Energy Institute are delighted to have teamed up to bring you this Continuing Professional Development initiative"
MARK THROWER Managing Editor

How to obtain a CPD accreditation from the Energy Institute

This is the third module in the nineteenth series and focuses on **Underfloor Heating**. It is accompanied by a set of multiple-choice questions.

To qualify for a CPD certificate readers must submit at least eight of the ten sets of questions from this series of modules to EiBI for the Energy Institute to mark. Anyone achieving at least eight out of ten correct answers on eight separate articles qualifies for an Energy Institute CPD certificate. This can be obtained, on successful completion of the course and notification by the Energy Institute, **FREE OF CHARGE** for both Energy Institute members and non-members.

The articles, written by a qualified member of the Energy Institute, will appeal to those new to energy management and those with more experience of the subject.

Modules from the past 18 series can be obtained free of charge. Send your request to editor@eibi.co.uk. Alternatively, they can be downloaded from the EiBI website: www.eibi.co.uk

SERIES 19 JUNE 2021 - MAY 2022

1. Electric Vehicles
2. Refrigeration
3. **Underfloor Heating**
4. Combined Heat & Power*
5. Humidification*
6. Smart Buildings*
7. Photovoltaics & Batteries*
8. Air Handling*
9. Variable Speed Drives*
10. Boilers & Burners*

** Only available to download after publication date*

CPD Fundamentals THE CONTINUING PROFESSIONAL DEVELOPMENT PROGRAMME

Terms: in submitting your completed answers you are indicating consent to EiBI's holding and processing the personal data you have provided to us, in accordance with legal bases set out under data protection law. Further to this, EiBI will share your details with the Energy Institute (EI) with whom this CPD series is run in contractual partnership. The EI will process your details for the purposes of marking your answers and issuing your CPD certificate. Your details will be kept securely at all times and in a manner complaint with all relevant data protection laws. For full details on the EI's privacy policy please visit www.energyinst.org/privacy.

To hear more from the EI subscribe to our mailing list: visit https://myprofile.energyinst.org/EmailPreferences/Subscribe