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CHOOSING YOUR FLOOR COVERING TO MAXIMISE YOUR UNDERFLOOR HEATING EFFICIENCY

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CHOOSING YOUR FLOOR COVERING TO MAXIMISE YOUR UNDERFLOOR HEATING EFFICIENCY

When considering underfloor heating, homeowners often have questions about the type of floor coverings that can be used or work well. Typically, these questions include:

- What is the best floor covering for underfloor heating?
- Can you use carpet with underfloor heating?
- Can you use underfloor heating with wooden floors?
- How long will it take to warm up a room with underfloor heating?

In summary, any type of flooring can work well with warm water underfloor heating UFH, however there are points that need to be considered. It is important that the floor covering is discussed with the supplier and/or installer at an early stage, alongside other factors such as room size, levels of insulation and glazed areas so that these considerations can be factored into the design. Electric underfloor heating is also available, but this is not covered in this article.

There are some golden rules to follow to ensure you gain the maximum benefits UFH has to offer. The first consideration when it comes to different floor finishes is the thermal conductivity of the flooring material, and its effect on the UFH system design.

1.
INTRODUCTION – DIFFERENT HEATING SYSTEMS AND HOW THEY WORK

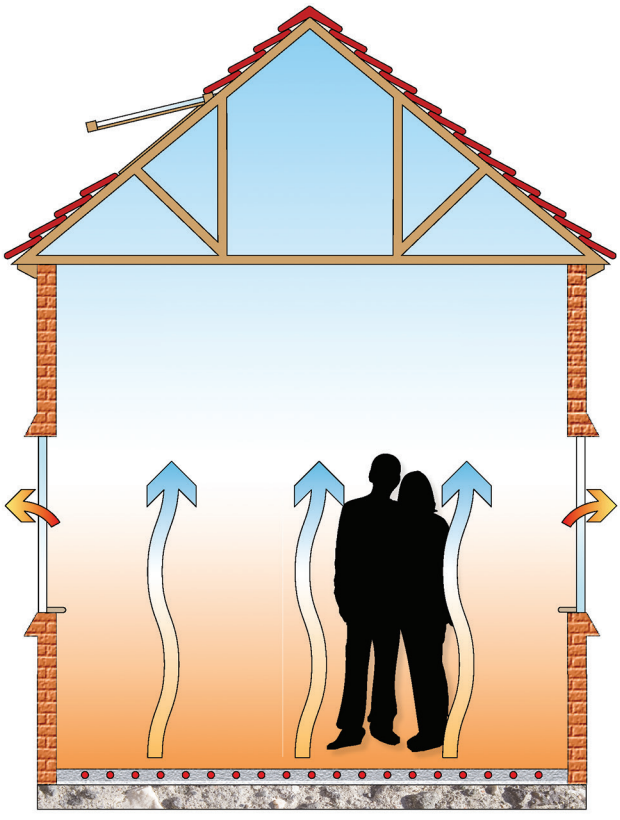
Traditional radiators predominantly transfer (or radiate) heat by convection, heating the air in a room as it circulates past the radiator. By comparison, UFH provides a radiant heat from the floor surface to the area above. An electric fire provides radiant heat but the application is very different: a small heater that gets very hot, versus a very large heater (your floor) that is only just warm to the touch.

For the floor to provide this gentle heat to the room there are a couple of stages to go through. In simple terms, a UFH system pumps warm water through pipes which are laid within the floor. Traditionally, the floor is solid - concrete or screed - but developments in technology mean that suspended baton-type floor decks of varying types are also widely used. Heat is transferred from the pipe into the floor structure, then from the floor structure into the floor finish. The surface of the floor then gently radiates the heat into the room.

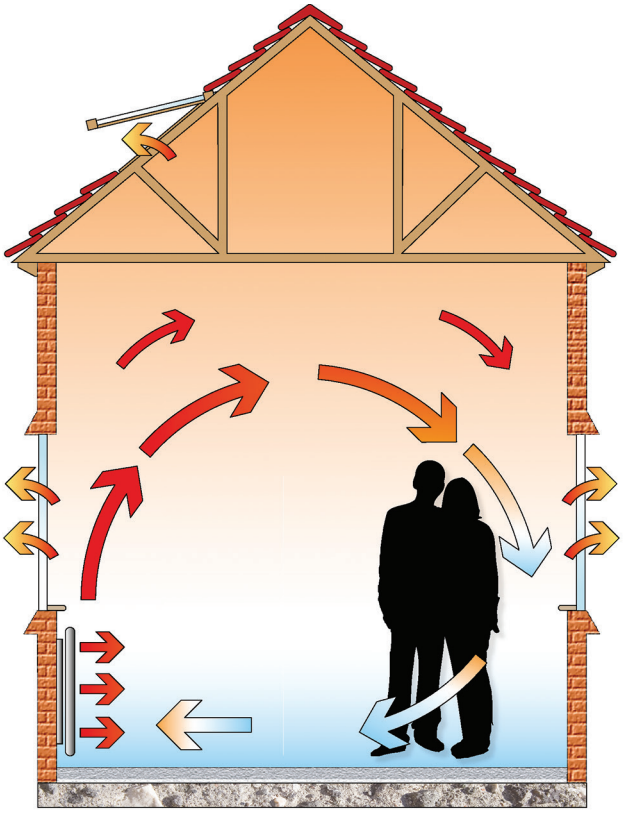
Heat always flows from warmer to colder areas. The transfer of heat through a solid material is known as conduction.

The heat transfer between the warm pipe and the floor surface (i.e. through solid materials) is therefore conduction. The thermal conductivity (the ease with which heat flows through the material) of both the floor and what is put over it affect the transfer rate of the heat to the surface. So in UFH applications this heat transfer, or thermal conductivity, becomes an important factor in the selection of materials and the design of the system.

As an initial guide, harder floor coverings such as ceramic tiles, slate or stone give a higher thermal conductivity, due to lower thermal resistance, than softer coverings such as carpet.



UNDERFLOOR HEATING



CONVENTIONAL RADIATORS

2. THERMAL PROPERTIES OF MATERIALS

Thermal conductivity – A technical definition

Thermal conductivity is a measure of the ability of a material to conduct heat. It refers to the rate of heat transfer that occurs per unit of length of the material (thickness) at a temperature differential of one degree Kelvin. It is measured in Watts per meter-Kelvin (W/(m·K). From this definition, it follows that heat is conducted better by materials with high thermal conductivity. This measurement is usually used to characterise a conductor of heat such as copper or aluminium.

Thermal resistance

Thermal resistance is a measure of a material's ability to resist conductive heat flow, per unit area, and for a temperature differential of one degree Kelvin. It is measured in (m^2K)/W, this measurement is defined as the R-value. The higher the R-value the less heat transfer will occur through the material, and the better it is at reducing heat losses. This measurement is usually used to characterise an insulator such as wall or loft insulation.

Tog Values

The term tog, widely used in English-speaking countries, is derived from the slang word for clothes (togs) and it is used as a measure of thermal resistance. It is used typically in the textile industry, most commonly seen in the rating of duvets. The basic unit of insulation coefficient is the R SI, which is equal to 1 m^2K/W. One tog is a tenth of one R SI, therefore a tog is 0.1 m^2K/W.

The standard launched in the 1940s by The Shirley Institute. The Shirley Togmeter is the standard apparatus for rating thermal resistance of textiles, commonly known as the Tog Test. This apparatus, described in BS 4745, measures a sample of textile, either between two metal plates (for underclothing) or between a metal plate and free air (for outer layers). Typically, materials with tog values lower than 2.5 togs are used as floor coverings in underfloor heating systems.

Here are some examples of different materials:

Material Type	Thermal conductivity k-Value	Thermal resistance R-Value	Tog Value
	W/(m·K)	m^2K/W	tog
15mm Stone Tiles	3.5	0.004	0.04
22mm Chipboard	0.14	0.157	1.57
Plywood (16mm")	0.14	0.114	1.14
30mm EPS	0.037	0.833	8.33
Fiberglass (20mm)	0.037	0.541	5.41
Fiberglass (25mm)	0.037	0.676	6.76
Fiberglass (40mm)	0.037	0.811	8.11
100mm Fibreglass	0.037	2.7	27
100mm PIR (Polyisocyanurate)	0.022	4.55	45.5

3.
IMPACTS OF FLOOR COVERINGS ON UNDERFLOOR HEATING SYSTEM DESIGN

The typical operating temperature of a UFH system is 27°C (depending upon target room temperature and the heat loss in each room). Floor coverings, such as carpets and tiles, act as thermal insulation materials meaning that they oppose the heat transfer from the warm water in the piping system.

The use of carpeted flooring, which has higher thermal resistance, will result in slightly longer times to heat up a space. On the other hand, once the space is heated, it will stay warmer for a longer time, due the thermal inertia of air. The Carpet Foundation carried out some research in conjunction with the BEAMA Underfloor Heating group and this proved conclusively that most carpets can be used over underfloor heating systems without impairing the performance of the system. The research showed that any carpet/underlay with a combined thermal resistance of less than 2.5 tog allows underfloor systems to operate efficiently.

What is the impact of flooring materials on heat output?

The required heat output of a UFH system is dependent on the heat loss from the room, ventilation, exposed heated floor area, pipe spacing, air temperature required and floor temperature. Heat output is influenced by changing any of these factors. The choice of flooring affects the heat output of the system based on the thermal conductivity of the material. In addition, certain floor finishes may have an upper temperature restriction, limiting the maximum heat output. It's usually the easiest factor to change as others, such as the room size, heat loss, air changes or comfort air temperature, are fixed for a specific space once the system is installed. The design should therefore account for the flooring type, as it can be adapted by changing other factors prior to installation, such as pipe spacing.

It is important to ensure that the heat output from the floor is greater than the heat loss figure of the room. A two-degree difference in the floor temperature makes a great difference in heat output. So, if your chosen flooring can only be heated to 27°C, and this does not give you the heat output you need, you may benefit from changing to a floor finish that can be heated to 29°C to give more heat output. You may also consider changing the flooring type to one that is more conductive, or improving other factors that can have an impact, such as insulation levels. This needs to be incorporated into the design of the system.

4. TYPES OF FLOOR COVERINGS

Natural Stone and Ceramics

This high-density material is the best floor material to use with UFH, allowing the heat from the pipework to easily flow to the rest of the room, with excellent heat transfer properties.

Increasing the thickness of the tile will have little effect on the heat output, but it will slightly increase the heat up time.

With stone (which includes slate) and ceramic tiles, it is always advisable to use a de-coupling membrane and flexible adhesive to reduce the potential for any hairline expansion cracks.

Carpets and Underlays

As previously mentioned, most carpets are suitable for use with UFH as long as the total tog of all materials, including any underlays, does not exceed 2.5 tog.

Choice of Underlay

There is a balance to be sought in the choice of underlay. The underlay used should allow adequate heat to pass through the floor covering into the room space above, whilst also giving the carpet adequate support to enhance the carpet's performance over its lifetime.

Underlays with a tog rating of around 1 tog, and designed specifically for use with underfloor heating are available on the market.

The tog value of the underlay needs to be added to the tog value of the carpet to get the overall tog rating.

Wood and Laminates

Wooden flooring, in the form of engineered timber, is an excellent choice for UFH, as its structural stability allows it to perform well with fluctuating temperatures.

Solid hardwoods and soft woods also transfer heat well but care should be taken when specifying the board width and thickness, as these can warp under temperature. It is important to check the manufacturer's recommended maximum floor surface temperature to ensure that the solid wood is suitable for use with underfloor heating. Most manufacturers give a maximum temperature, which is more than adequate in the majority of situations. In some circumstances, manufacturers will allow higher temperatures without compromising warranties. It is always worth checking with the flooring supplier. For any sensitive floor coverings, or where a system with a high heat output is being installed, a floor temperature sensor should be fitted to limit the maximum temperature of the floor.

- **Engineered timber** – Timber can be laid directly over the underfloor heating as a 'floating floor' or nailed into battens or joists. Unless installed over a screeded slab, engineered boards of less than 20mm thickness should be supported and fixed to an additional decking material to lend suitable structural support.
- **Parquet** – Also suitable for use with underfloor heating, these floor blocks should be continuously glued onto the screed or timber deck for good heat transfer. A floor temperature sensor should always be fitted.
- **Solid hardwood** – It is always best to use a kiln-dried timber with minimum moisture content, store it in a dry place before installation and fit a floor temperature sensor to reduce the chance of the timber overheating.

- **Soft woods** – Most soft woods can be used with UFH but it is not recommended for use with any high heat output systems as it can cause them to warp under temperature. A floor temperature sensor should always be fitted.

Linoleum and Vinyl Flooring

Linoleum (lino) and vinyl floorings perform very well with UFH systems, as long as some simple precautions are observed.

It is important to check the manufacturer's recommended maximum floor surface temperature to ensure that the covering is suitable for use with underfloor heating. Most manufacturers state 27°C, which is more than adequate in the majority of situations. In some circumstances, manufacturers will allow higher temperatures without compromising warranties. It is always worth checking with the flooring supplier. For any sensitive floor coverings, or where a system with a high heat output is being installed, a floor temperature sensor should be fitted to limit the maximum temperature of the floor.

- **Linoleum** – Lino is a very good option as it is cost-effective, easy to install, made from natural materials and sits happily over UFH.
- **Vinyl** – Vinyl works well with UFH as the heat can easily permeate the thin layer. However, as most vinyls should not be heated to above 26°C, the floor temperature should be restricted. Care should be taken in the design of systems in rooms with high heat losses, such as conservatories, as it may not be possible to sufficiently heat the room with a restricted floor temperature limit.
- **LVT** – A luxury vinyl which is practical and highly versatile, LVT is a popular choice of floor covering. To avoid any discolouration or damage, the floor temperature should be limited to 27°C.

Polished screed & synthetic resins

Due to their tough and durable finish, the use of polished screeds and synthetic resins in domestic properties is becoming more common. As screed, by nature, is very conductive it is well suited for use with UFH. By pairing the two together it also takes away the 'cold touch' associated with choosing a hard floor covering.

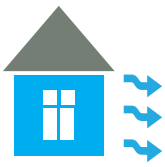
5.
UNDERFLOOR HEATING SUPPLIERS CHECKLISTS

A supplier will normally design an underfloor heating system based on certain parameters, such as:

1.

Desired room temperature

2.



Heat loss of the room

3.

Floor covering

4.

Insulation below the floor

5.

Make up of proposed floor construction

The supplier would normally supply you with certain parameters based on the above and following the British Standard, BS1264. These parameters are listed below.

1. **Required flow and return temperature**
2. **Expected calculated heat output.**
3. **Pipe spacing**
4. **Most suitable UFH system, based on the subfloor type and the finished floor system chosen.**

Members of the BEAMA Under Floor Heating Trade Association all subscribe to these parameters and will be able to provide you with advice along these lines when specifying a suitable system to accommodate the desired floor covering. A BEAMA member will also be able to provide system design data such as the number of zones, the heated area, pipe length and spacing and flow rate and temperature.

6. CONCLUSION

The output of the UFH system depends on a series of factors of which the floor covering is perhaps the most visual and open to discussion with the client.

Different floor coverings have different thermal characteristics and this is a key factor in a UFH design to enable consideration of any temperature limits of the chosen covering.

The floor covering type should be considered at an early stage in the design process as it is almost always possible to adjust the UFH parameters or other elements of the build to accommodate the floor covering of choice if this is discussed early enough.

BEAMA UFH members ascribe to design standards which accommodate these needs. An early discussion with a UFH supplier that is a BEAMA UFH member can give peace of mind when making these key decisions.

A full list of BEAMA UFH members can be found on the BEAMA website.

Go to http://www.beama.org.uk/member-directory.html?q=
and select Underfloor Heating to find out more.

MORE INFORMATION

For more information about BEAMA, the Ask for Underfloor campaign and underfloor heating, please visit www.askforunderfloor.co.uk.

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