Expert Article
Radiant Cooling in Offices

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A drop in productivity due to heat? No, thanks!

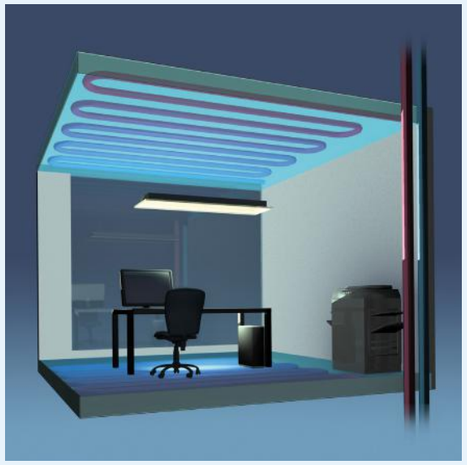
Whether too hot or too cold, temperatures perceived as unpleasant have a negative effect on productivity. On hot summer days, the temperatures inside office complexes can soon shoot up. This makes it all the more important to consider increased cooling requirements during the planning phase and thus ensure pleasant temperatures on a long-term basis. There are various ways to achieve the sought-after cooling, with radiant cooling representing an exceptionally convenient and energy-efficient solution.

Temperature influences well-being and workplace productivity

Large sections of glazing – but also people, lighting and electric devices such as computers and printers – increase the internal and external cooling loads of commercial properties. The heat they emit causes the temperature inside the building to rise. Even external shading cannot prevent the ambient temperature from frequently exceeding the comfort threshold of 26°C in central European climate zones. What's more, the number of hot days and tropical nights is increasing as a result of climate change. During such periods, buildings hardly cool down overnight. In addition, today's energy efficiency standards mean that buildings are increasingly well insulated, with modern building shells keeping the heat inside. While this ensures cosiness in winter, it also results in high temperatures in summer.

The need to act is especially great in office buildings. Studies – carried out by the World Green Building Council and others – indicate that ambient temperature has a considerable influence on well-being and workplace productivity. Heat represents the greater problem: if it's too cool, productivity drops by four per cent; if it's too warm, however, productivity falls by six per cent. The significance of this becomes apparent when you consider that personnel costs account for 90 per cent of operating costs. As such, any investment that boosts productivity will soon pay off.

If building owners and planners opt for building cooling as a result, radiant cooling systems constitute the first choice. They are not only exceptionally energy-efficient and can be easily combined with renewable energies, but are also perceived as extremely pleasant. Unlike air circulation-based cooling systems, radiant cooling does not produce draughts or irritating noises.



Thermally active building systems discharge the day's heating loads during the night, thus effectively preventing the build-up of heat.

Choosing the right system

When it comes to radiant cooling systems, various options are available: from thermally activated building systems (TABS) with pipes in the middle layer of concrete (e.g. Uponor Contec) and near-surface thermal-active building activation with pipes very close to the ceiling soffit positioned beneath the lower reinforcement layer (e.g. Uponor Contec ON or the high-performance version Uponor Contec ON HL) through to active ceiling panels and suspended cooling ceilings such as Uponor Thermatop M. What constitutes the right choice depends on the client's needs. The first step in this regard is to answer the following questions.

1. What level of comfort needs to be achieved?

The higher the comfort requirements, the faster the system needs to be able to respond. A conventional TABS is able to prevent temperatures in excess of the comfort threshold. With active ceiling panels or suspended cooling ceilings, the desired room temperature can be achieved to a high precision.

2. What cooling output is required?

The higher the required output, the closer the system needs to be to the space concerned. TABS delivers 40–60 W/m2, whereas near-surface systems can reach up to 70 W/m2 and suspended cooling ceilings up to 100 W/m2 or more – depending on the temperature difference selected. Although it is theoretically possible to achieve higher output levels with TABS using lower supply temperatures, the (desired) inertia of the system must always be taken into account: if the concrete has been cooled considerably due to low supply temperatures, it may be necessary to counteract this by heating more intensively when the weather changes – and this would just be a waste of energy. Here, system dynamics are far more important than the maximum nominal values achievable. Otherwise we can consider a longer operation time of TABS up to 24h a day which increases the overall cooling capacity.

3. What heating output needs to be achieved?

The same argument once again applies, just with smaller output values.

4. Should it be possible to control the cooling on a room-by-room basis?

If so, then sole TABS is no longer an option. For TABS it is beneficial to set up a zoning e. g. on the basis of building direction. Today´s standard also do not necessarily require a single room control for cooling. Whereas fast reacting systems should be equipped with a single room control in order to use their potential. Depending on the circumstances, a variety of options are feasible: Fast reacting stand-alone systems or suitable system combinations.

5. Which combination of systems is advisable?

An option that offers great advantages is the use of TABS for the building core together with a near-surface system at the edge of the facade. The latter can respond quickly to changes in loads (sunlight). The temperature can also be regulated on a single-room basis. If mechanical ventilation/air-conditioning is included in the building concept it is advisable to think about a combination with a radiant system. The radiant cooling surfaces can cover the major sensible load. A dedicated outdoor air system (DOAS) can then focus on covering the latent load, fresh air requirement & minor sensible load. The so called Hybrid system (radiant + DOAS) brings enormous advantages in respect to energy efficiency, thermal comfort and operational cost savings. The chiller for the radiant system can operate with high temperature cooling respectively renewable energy sources can be used. The air volume to be conditioned can be reduced substantial which reduces the need for air recirculation or allows a 100% fresh air option. This enables the most hygienic concept and best air quality you can think of.

6. What special factors need to be considered in terms of interior design and use?

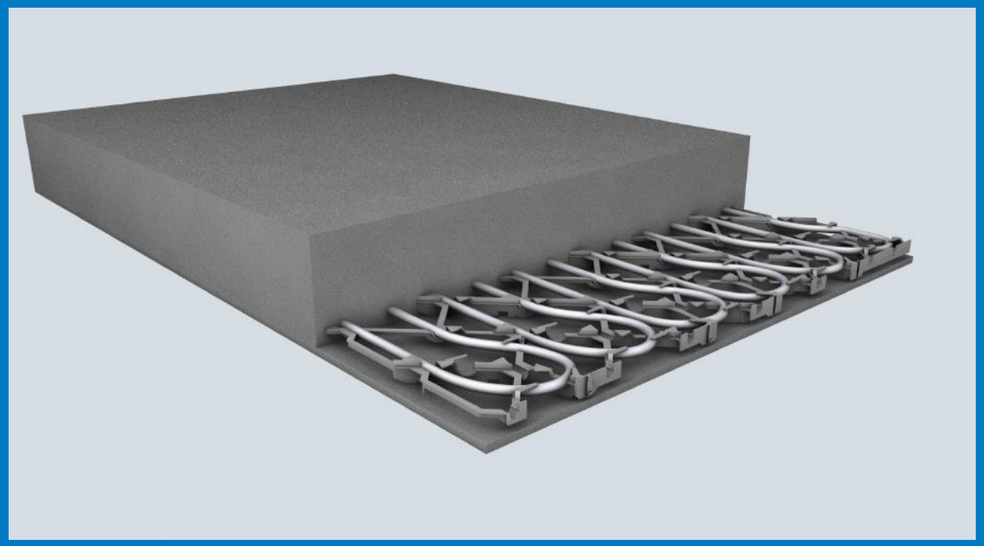
The decision may be influenced by factors such as the depth of the room, the proximity of workstations to windows, solar gain, the shading of windows, the proportion of window area and acoustic requirements. Acoustic requirements in particular, which are usually met by means of a suspended ceiling, have to be reconciled with TABS. Possible solutions can be suspended (slats) acoustic baffles or a combination of acoustically effective ceiling panels.

Harnessing the building mass: thermally active building systems

Thermally active building systems utilise the building's available storage mass. The idea is simple: continuous loading and unloading of the active concrete ceilings between storeys. The heat generated on hot summer days chiefly warms the concrete in the ceilings during the day and the heat stored in this way is discharged via integrated pipes in the night, meaning that comfortable temperatures can once again be maintained on the following day. In this way, the unwanted build-up of heat during spells of good weather can be prevented effectively.

If planners and building owners opt for a thermally active building system, factory-assembled modules of pipes can be positioned centrally in the concrete ceiling during construction using the hook lifting method. This guarantees not only a consistent installation distance, but also speedy and therefore cost-effective progress of construction work.

Thermally active building systems are built into the concrete ceiling. Prefabricated pipe modules are suspended from the upper reinforcement of the concrete ceiling and then encased in concret.



Contec ON is a near-surface version of TABS and is ideal for use in buildings with higher cooling and heating demands.

The Uponor Contec system includes a high-pressure cross-linked polyethylene pipe (PEX-A pipe), made using the Engel process, that has proved its mettle millions of times. The plastic used is robust and particularly well suited for the harsh environment of a building site, as it is shape-retentive and resistant to stress cracks. This is vital when it comes to the sustainable installation of the thermally active building system, as the pipe sets are moulded directly into the concrete ceiling. In other words, they are fixed in place. Depending on the building system used – along with the corresponding insulation and requirements in terms of heating/cooling loads – the thermally active building system (Contec) can be used as a stand-alone, monovalent cooling system. In terms of heating mode, the thermally active building system will mainly only serve the basic loads on account of the system's inertia

Alongside the conventional Contec as thermally active building system, Uponor also offers Contec ON – a near-surface system for use in buildings with higher cooling and heating loads or higher expectations of comfort. As the system is installed just a few millimetres below the raw concrete ceiling, it delivers increased heating/cooling output. An additional benefit is that the system can be controlled more quickly and effectively. As such, Contec ON can also be used as a monovalent heating system. During installation, the prefabricated Contec ON modules are used as a base for the lower reinforcement, meaning that contractors can lay the reinforcement directly on the modules. The Contec and Contec ON modules are reliably and permanently connected to the distribution and manifold pipes using precisely calibrated Uponor pressing machine made available for the systems.

Fast, simple, flexible: the Thermatop M cooling ceiling system

The seamless and modular Thermatop M cooling ceiling system from Uponor boasts a wide range of design and application possibilities. The design of the water-based system is flexible, can be tailored to challenging room geometries and offers freedom in terms of interior design. The clear separation of trade disciplines, the high proportion of active surface area, the finely tuned control components and the ability to quickly install individual modules in a standard plasterboard substructure make the planning and installation of Thermatop M exceptionally straightforward. The individual elements comprise prefabricated meanders made of multi-layer composite pipe and held in place with mounting rails. The mounting rails come with spring clips that enable fast, tool-free installation on the CD profiles of the ceiling substructure without any need to move the substructure at the construction site – the installer simply hangs the elements between the CD profiles. The plasterboard contractor then simply covers the ceiling in the same way as with ceilings that are built without cooling elements.

As the choice of plasterboard influences both acoustics and room temperature, all experts involved should agree on the specifications in advance: perforated board absorbs sound, whereas thermal plasterboard influences cooling output. Perforated plasterboard exhibits different sound absorption properties depending on the perforated pattern concerned; the highest levels of sound absorption are achieved by boards with between 10 and 20 per cent perforation. Once the ceiling has been panelled, the plasterboard contractor works on it in the usual way.

› The seamless and modular Thermatop M cooling ceiling system offers creative freedom: the design of the water-based system is flexible and can be tailored to challenging room arrangements.

› The individual modules can be quickly incorporated into a conventional plasterboard substructure, making installation of Thermatop M exceptionally straightforward.

Holmer Deecke
Director International Engineering at Uponor

Customised advice and comprehensive service

Each construction project is different and should be treated as such. Full-service providers such as Uponor therefore not only offer a technical solution, but also provide support at every stage of a project with an extensive array of services, from feasibility analysis and preliminary planning to implementation planning and after-sales support.

Alongside planning software, extensive BIM data and the provision of tender documents, this also includes personalised advice. Whatever option building owners and planners choose, building cooling ensures pleasant temperatures inside office complexes all year round, thus contributing to the well-being of workers and boosting productivity. Against the backdrop of climate change, it therefore represents a key investment in the future. Whatever option building owners and planners choose, building cooling ensures pleasant temperatures inside office complexes all year round, thus contributing to the well-being of workers and boosting productivity. Against the backdrop of climate change, it therefore represents a key investment in the future.

Meeting peak loads

If the output of Contec and/or Contec ON is not sufficient to meet peak loads – such as in rooms with higher demands (e.g. meeting rooms) or with specific architectural requirements (e.g. glazed corner rooms) – cooling peaks can be met by means of (additional) active ceiling panels. These can be connected to the Contec TS thermal socket from Uponor using an adapter, with the socket fitted flush to the ceiling. With its corrosion-proof housing, it is mounted directly on the ceiling formwork and is set in concrete together with the pipe sets of the thermally active building system. Another benefit comes courtesy of the factory-installed, built-in valve insert, which enables automatic closing of the thermal socket. When combined with the adapter, this eliminates the time-consuming process of emptying the entire system in the case of subsequent deployment of peak load elements such as heating/cooling panels. The thermal socket can be incorporated within two-, three-, or four-pipe systems using pipe widths in dimensions ranging from 14 x 2.0 mm to 20 x 2.3 mm, meaning that the installed peak load element can be utilised with different supply temperatures that are usually lower than those of Contec and Contec ON, thereby optimally utilising its capacity.

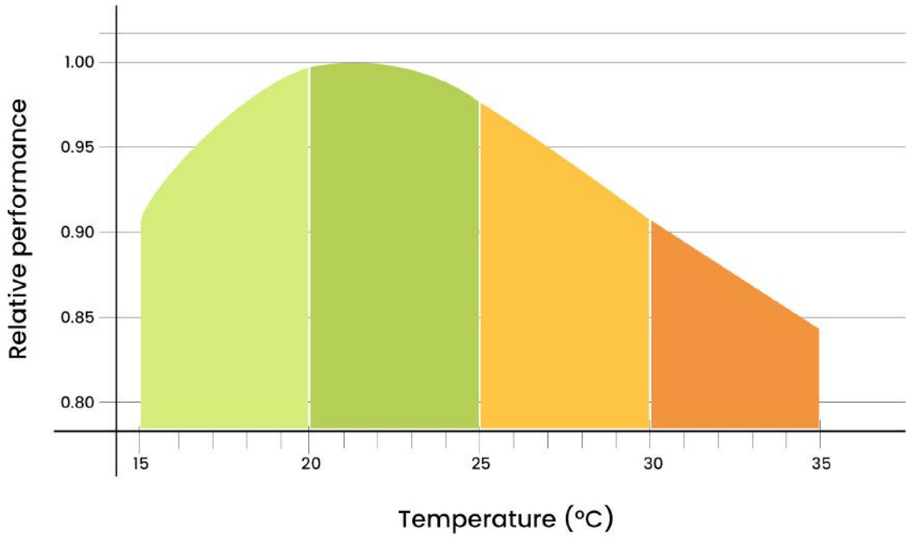
Work productivity

Creating a comfortable environment in commercial structures is a critical design consideration. Comfortable employees are more productive and comfortable customers are more relaxed, contributing to the success of a business.

The indoor environment in office buildings directly affects both sick leave and work performance. The direct and indirect cost of a deteriorated office indoor climate can easily be as high as the costs for heating, cooling and ventilation.

The working environment is naturally affected by many factors including room temperature, air quality, ventilation, acoustics, daylight etc. Ventilation is always required to ensure an adequate indoor air quality, but in combination with a radiant heating and cooling system, the ventilation system can be optimized (sized smaller) to exclusively provide a good quality of the indoor air. Reduced ventilation requirements means of course cost savings, as plant, fan and duct sizes are reduced, but furthermore it means that the ventilation air can be supplied to the rooms at higher temperatures resulting in better indoor environment. With reduced air flow volumes you also avoid cold draughts and circulation of dust and allergens, which are typical in traditional air conditioning systems. Radiant cooling is also silent – no noise from fans or blowers. Embedded water based heating and cooling systems like TABS are named radiant systems because the major part of the energy exchange with the environment takes place via radiation. When correctly designed, the system maintains uniform temperatures over the different room surfaces – this means no radiation asymmetry and an ideal thermal environment!

Low quality and deteriorated thermal comfort due to inappropriate conditioning systems means that initially saved investment costs will quickly be outweighed through illness-related absence and low staff productivity.



Source: Rehva Guide Book no 6., Seppänen et. al 2006

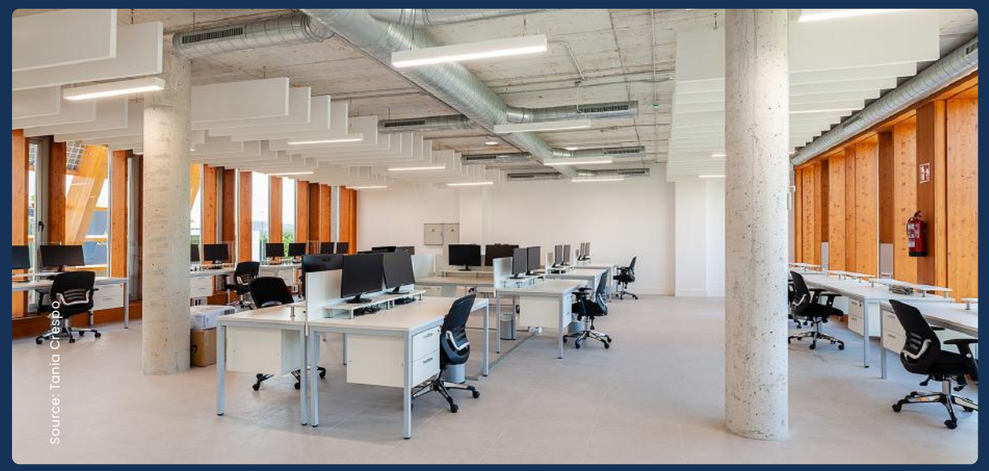
Relative performance as a function of temperature Source.

Zero emissions, maximum comfort

Greenspace PCTG in Asturias, Spain, is the first net-zero-energy office building in the region and one of the few of its kind in the whole country. An impressive achievement made possible by a combination of highly efficient active energy and passive systems. Spanish architects EMASE Arquitecturina worked with engineering firm SvR Ingenieros to create a sustainable, environmentally friendly design. It uses solar panels to keep solar loads out of the building on the one hand and to generate more energy than the building consumes on the other hand. In order to minimise the building's energy use, the project partners decided to include Uponor thermally active building systems (TABS) for heating and cooling.

The full case study can be read here: *https://www.uponor.com/en-en/r/greenspace-pctg*

Source: Uponor



Source: Tania Crespo

Moving
> Forward

Uponor is a leading international provider of solutions that move water for buildings and infrastructure. We're rethinking water for future generations with our safe drinking water delivery systems, energy-efficient radiant heating and cooling systems, and reliable infrastructure solutions. With a commitment to sustainability and a passion for innovation, we're developing new technologies and systems that build confidence and enrich people's lives.

That's moving forward.
And that's what Uponor is all about.

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