

Uponor solutions for cooling systems

Uponor Europe East and International International Sales Unit

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Most of people are happy at their work,



but there a lot of factors causing dissatisfaction:



Often the cause for dissatisfaction are too high temperatures in summer



If people feel too hot, 70% of them are dissatisfied ...



PMV: Predicted Mean Value PPD: Predicted Percentage of Dissatisfied

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... which directly influences their labour efficiency



Labour productivity as a function of operative (room) temperature

nach Hasse, Ehrisman, Lehmann, Sazakii und Mackwoth



Recommended room temperatures are:

Table 20 Design values for the operative temperature in office buildings					
Situation	Typical range (°C)	Default value for design (°C)			
Wintertime with heating	θ ₀ = 19 to 24	$\Theta_0 = 21^{-1}$			
Summertime with cooling	θ ₀ = 23 to 26	$\Theta_0 = 26^{-2}$			
 At design conditions for wintertime. Minimum temperature during the day. At design conditions for summertime. Maximum temperature during the day. 					

Except where agreed otherwise, the specified operative temperature shall apply to a location in the centre of the room at a height of 0,6 m above the floor.

EN 13 779

Airing of buildings – Performance requirements for air conditioning units

Cooling demand Factors, influence on cooling demand ⇒ Heat losses through walls and windows	ponor				
Factors, influence on cooling demand ⇒ Heat losses through walls and windows					
\Rightarrow Heat losses through walls and windows	Factors, influence on cooling demand				
_					
⇒ Heat emission of employees: ~ 6W/m (10m ² per person in the office)	2				
$\Rightarrow Heat emission from lightning: 10-12 W (400-500 lux)$	/m²				
⇒ Heat emission from electrical equipment: ~ 18 W/ (medium technical level, 10m ² per person in the office)	/m²				
⇒ solar irradiation: up to 3 W/m ²	130				



Cooling demand

Heating and cooling demand in office buildings (ADAM)





Cooling demand

Most office buildings do not have a heating, but a cooling problem





Cooling demand

Some areas have to be cooled more...



Uponor Cooling Solutions Cooling demand

Do you know the room planning of the future for...

> single offices?

> open-plan offices?

> conference rooms?

> open-plan offices with meeting room?

> single offices with public area?

> others?

It's better to have additional connections available for further cooling equipment



Solutions

You can solve cooling problems this way....







Solutions

... or use Uponor solutions for cooling systems:

Slab Heating and Cooling	Ceiling Cooling	Wall Cooling	Floor Cooling
Concrete core activation Thermally active surfaces	Capillary system	Capillary system Uponor panel 2	Uponor classic Uponor panel 1 Uponor panel 3 Capillary System
Basic cooling load Maximum energy efficiency Fast reaction surface	Maximum cooling output Fast reaction surface Ideal for renovation	High cooling output Fast reaction surface Ideal for renovation	Low cooling output Ideal for floor tempering As double system with UFH



Pipe material

Uponor offers highest pipe quality, made from different materials and completed with fittings tested for connections to manifolds, supply lines etc.



Approvals from 80 national and international institutes like

- ABS Europe Ltd.
- CSTB
- DIN CERTCO
- DVGW
- KIWA N.V.

Constant product quality as per ISO 9001 and 14001





Pipe material

MLC - material characteristics



Pipe material PE-RT according to German DIN 16833

Pipe material

MLC - advantages

- No incrustation
- Corrosion resistant
- Low thermally expansion
- Absolutely oxygen diffusion t
- Low weight
- High form stability
- Bending flexibility





Excellent long run behaviour



Pipe material

MLC pipes for:





Slab Cooling

Wall cooling



Floor cooling



Uponor Cooling Solutions Pipe material

PE-Xa - material characteristics



Standard pipe structure.



Cross-linked pipe structure.



Cross linked Polyethene PE-Xa

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Continuously ongoing longterm test run for more than 30 years

Uponor Cooling Solutions Pipe material

PE-Xa - material characteristics



No incrustation

Corrosion and abrasion resistant

High chemical resistance

Oxygen diffusion tight

Thermal memory effect

Bending flexibility

Low weight

High crack resistant at low temperatures

Excellent long-run behaviour



Pipe material

PE-Xa pipes for:



Slab cooling



Wall cooling



Floor cooling



Pipe material:

Pipe material

Pipe dimension:4,3Max operating temperature60

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Max. operating pressure



PP-R, type 3

Original height "only" 6 mm



Capillary system – material characteristics

Note:

The pipe material is not oxygen diffusion-tight!

The capillary system is to be installed with a heat exchanger only

Pipe material

Capillary system – advantages



Large active pipe surface

 \Rightarrow maximum cooling output

Surface temperature close to medium temperature

⇒ Fast reaction on cooling demand

Minimum height

 \Rightarrow Ideal for renovation



Pipe material

Capillary system for:

Ceiling cooling



Wall cooling



Capillary system can also be used for floor cooling

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SHAC - concrete core activation

Basics



Pipes are integrated in the slabs, usable for different kinds of slab constructions

\Rightarrow largely maintenance free

The thermal mass of concrete slabs absorbs cold air during night-time and utilises it during heat loads at daytime

⇒ Enables thermally comfortable room temperatures

Reduces the air change rate required for hygienic reasons

⇒ air conditioning system can be designed for room air quality only

Minimum difference for supply/return temperature

⇒ renewable energy sources can be used



SHAC - concrete core activation

Basics



Uponor Cooling Solutions Uponor **SHAC - concrete core activation Cooling output, medium temperatures** 0 0 0 0 0 0 0 0 0 0 0 0 00 $t_{supply} = 16^{\circ}C$ t_{return} = 19°C $q_K \approx 40 W/m^2$ $t_{room} = 26^{\circ}C$ 26°C Pipe Uponor PE-Xa 25 x 2,3 Spacing 150 mm q_K≈ 5 ... 20 **Cooling output depends** on ceiling construction W/m^2

Uponor Cooling Solutions SHAC - core concrete activation

Installation of pre-fabricated modules





Uponor SHAC modules are prefabricated according to drawings ...

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SHAC - concrete core activation

Installation of pre-fabricated modules



... delivered in time to the building site and installed according to building plan



Uponor Cooling Solutions SHAC - concrete core activation Installation of pre-manufactured elements



 simple and timesaving installation during slab construction

- good logistic and coordination between the required trades
- higher preparation costs

Uponor Cooling Solutions SHAC - concrete core activation

Onsite manufacturing of modules



Uponor SHAC modules can also be fabricated onsite, by fixing the Uponor PE-Xa pipe with plastic cable ties on steel meshes

Uponor Cooling Solutions SHAC - concrete core activation

Onsite manufacturing of modules



• efficient if there are many standard elements

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• operative reaction on building process

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SHAC - concrete core activation

Installation from the coil



- installation direct from the coil on the slab steel meshes
- no preparation costs
- monitoring required!





Uponor Cooling Solutions SHAC – thermally active surfaces

Fast reaction and peak load covered



Especially edging zones need faster response on external factors like solar irradiation and higher cooling output for peak load compensation.

Uponor contec ON modules are pipe registers installed close to the surface with high cooling output and low reaction time.



Uponor Cooling Solutions SHAC – thermally active surfaces

Manufacturing and installation



Uponor contec modules can be prefabricated industrially and are easy to install




SHAC – thermally active surfaces

Combination with concrete core activation



The best performance can be reached by combining

-concrete core activation for basic loads

and

- thermally active surfaces for covering peak loads



Cooling demand

Do you know the room planning of the future for...

> single offices?

> open-plan offices?

> conference rooms?

> open-plan offices with meeting room?

> single offices with public area?

> others?

With the thermal socket Uponor TS you are on the safe side and have a perfect solution for additional connections for further cooling equipment.



SHAC – thermal socket Uponor TS

Uponor TS included in cooling system layout



Uponor Cooling Solutions SHAC – thermal socket Uponor TS

Different kinds of connections for cooling elements for the future











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Capillary system

Minimum pipe diameter – maximum active surface

"Classic" System UPONOR slim Capillar System



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Capillary system

Components



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Capillary system

Installation



For wet and dry ceiling constructions ...



Capillary system

Installation





... walls and roof slopes ...



Capillary system

Installation



and floor cooling.

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Capillary system

Oxygen diffusion



Uponor capillary pipes made from PP-R are not diffusion tight.

The cooling system is to be connected to other components (e.g. chillers) with a heat exchanger.

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Capillary system

Fast reaction system



start

1 minute

Extremely short reaction time due to high active pipe surface and thin covering of the capillary mats





Capillary system

Cooling output



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Floor cooling

Overview systems



Uponor Cooling Solutions Floor cooling



Uponor screed system with steel mesh, components





Diffusion tight Uponor pipes fixed on reinforcement meshes - easy to install and adapt to layout



Floor cooling

Uponor screed system with steel mesh, installation





- Load distribution layer (Typically screed min 65mm)
 PE-Xa S Fixing clip Anti-corrosive mesh
 Insulation Separation Film

Floor cooling

Uponor panel type 1, components





Diffusion tight Uponor pipes dimension 14 - 17 mm fixed on special foil elements, pipes are damage-protected

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Floor cooling

Uponor panel type 1, installation





1-screed2-panel type 13-edging stripe4- Uponor pipe

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Floor cooling

Uponor panel type 3, components





Small diffusion-tight Uponor PE-Xa pipes 9.9 x 1.1 mm fixed on special foil elements

Can be installed on "old" floor screed, ideal for renovation

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Floor cooling

Uponor panel type 3, installation



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Floor cooling

Cooling output



Floor covering and pipe spacing has a direct influence on cooling output

Pipe PE-Xa 20 x2.3 T_{supply} =16°C T_{return} =19°C T_{room} =26°C Pipe covering 45mm screed



Floor cooling

Cooling output



Uponor Cooling Solutions Floor cooling

uponor



Floor cooling can be effectively used to compensate solar irradiation in combination with air conditioning systems for hygienic and dehumidification reasons

Heat load by direkt sunshine on the tiles up to 130 W/m²



Wall cooling

Uponor panel type 2, components





Diffusion tight Uponor pipes dimension 14 mm with special insulation and heat emission plates

Uponor Cooling Solutions Wall cooling

Uponor panel type 2, installation



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Wall cooling

Cooling output





Possibilities and limitations

Cooling output different solutions



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Possibilities and limitations

Dew point



condensation temperatur in °C (dew point)

		Relative humidity in %											
		35	40	45	50	55	60	65	70	75	80	85	90
oom temperatur in °C	20	9	9	9	10	11	12	13	14	15	16	17	18
	21	9	9	3	10	12	13	14	15	16	17	18	19
	22	9	9	10	11	12	13	14	15	17	18	19	20
	23	9	9	10	11	12	14	15	17	18	19	20	21
	24	9	10	11	12	13	15	17	18	19	20	21	22
	25	9	10	12	13	14	16	18	19	20	21	22	23
	26	9	10	12	14	16	18	19	20	21	22	23	24
	27	10	12	14	15	17	19	20	21	22	23	24	25
	28	10	12	14	16	18	20	21	22	23	24	25	25
	29	11	13	15	18	19	20	22	23	24	25	25	25
Ľ.	30	12	14	17	19	20	21	23	24	25	25	25	25

The minimum supply temperature must not be less than the dew point temperature for design relative humidity!

Uponor Cooling Solutions Possibilities and limitations Air conditioning Best cooling output at max Q_{cooling} maximum difference between cooling surface and room temperature requires minimum medium min t_{supply} temperature in pipe system, this means low dew point min t_{cond}. temperature. Only possible with low room **min** φ

humidity (normally 50-60%)

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Air condition

Uponor cooling solutions are not air-conditioning systems and can not be used for controlling humidity in buildings,

but

the air change rate in rooms can be reduced to minimum value required for hygienic reasons,

this

reduces costs for air conditioning channels, equipment and maintenance.

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Control system

Control system for zone control by reference room





Control system

Control system for individual room control





Energy efficiency

Basics



Relative high medium temperature and minimum temperature difference between supply and return allows the use of regenerative energy sources like ground water or soil energy

Energy efficiency

Heat pumps







Energy efficiency

Heat pumps –electrical power for pump required only



Uponor Cooling Solutions Energy efficiency

Basics

Components for thermal utilisation of the ground



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Energy efficiency

Earth collectors





Uponor PE-Xa pipes prior to installation

Laying and connecting of a ground cooling system below the foundation
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Cost efficiency

Investments, operation & maintenance costs

- smaller air conditioning units and channels (reduced air change rate on minimum value required for hygienic reasons)
- lower construction costs due to reduced ceiling heights
- lower running costs for pumps and air conditioning equipment
- higher efficiency of the air conditioning equipment due to higher cold water temperature
- using air conditioning equipment in off-peak time for cooling load of slabs
- utilisation of renewable energy sources
- maintenance free system

and

> more comfortable room climate





Uponor Cooling Solutions Project Airport Bangkok The project



500.000 m² terminal area (440 x 110 m), the largest terminal in the world

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Length of the concourses to the gates~3.5 km



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Project Airport Bangkok

The task

➔ To reach a room temperature of 24°C and a relative air humidity of 50-60% for 24h/day



nder the conditions of

an outdoor temperature of up to 34°C

High outdoor relative humidity

Solar irradiation up to 1000 W/m²

The solution



Combined system of

- floor cooling to compensate solar irradiation and to keep the floor surface temperature comfortable
- air conditioning system with variable flow rate for dehumidification and air exchange

together with special architectural and construction material solutions

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The solution



150.000m² floor area (approx. 20 pitches) cooled with Uponor system to compensate solar irradiation and keep the floor temperature constant

tsupply 13°C

treturn 19°C

cooling output 70-80 W/m²

The solution



The air displacement system with a fresh air temperature of 18°C assures a relative air humidity of 55-60%

Air exchange rate is reduced to minimum value required for hygienic reasons

1.8 m high air diffuser

03/2007

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Dew point control



The manifolds for the Uponor UFC system are installed in the air diffusers, which allows for lower supply temperatures

(dew point temperature for 18°C and 55-60% relative humidity is 10°C, cooling water supply temperature is 13°C)





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The result





Air conditioning is limited to a layer of 2.5m over floor surface

Under the roof the inside temperature is close to the outside temperature which reduces thermal transmission to minimum

The floor cooling system assures steady temperature layers in the building

The result

Only the combination of air conditioning with floor cooling assures steady temperature layers in the building.

Without floor cooling the surface temperature would be > 30°C and the air conditioning system would have to be scaled much larger.



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