Edition: 5.2014

aquatherm orange system

Industrial surface heating

Technical Information on floor constructions in commercial and industrial construction

aquatherm

state of the pipe

PREFACE

Dear customers and partners,

thank you for your interest in our family enterprise. For a long time the classification of enterprises as a family has rather been hidden than actively marketed. Only in recent years family enterprises experience a comeback. From employee perspective, they are generally a flat hierarchy, provide independent and responsible work under a cooperative management style, but above all they are considered safe employers who commit permanently to their employees.

By definition, family enterprises are distinguished primarily by the unity of ownership and management in the hands of a family; this criterion the aquatherm group still meets after the transition from the first to the second generation (pictured above).

Our self-image of a family enterprise, however, clearly exceeds this description. Our claim describes a proactive organization that bases in the responsible contact in everyday life, that challenges encouraging, thereby accompanies developments in a promoting way and sets on a personal influenced by nearby corporate culture. If these business properties meet determined people that daily inspire through initiative, diligence and passion, until we speak of a living family enterprise, until we speak with pride of the aquatherm family.

We look forward to presenting you on the following pages some insight into our colorful, slightly green-tinted aquatherm world!

Christof Rosenberg
Managing Director

Dirk Rosenberg
Managing Director

Maik Rosenberg
Managing Director

Gerhard Rosenberg
President of the Advisory Board

1973
Founding of aquatherm by Gerhard Rosenberg
1978
Transfer to the first factory in Biggen / D-Attendorn
1985
Completion of factory 1 in Biggen / D-Attendorn
1992
Founding of the branch in Radeberg near D-Dresden
1996
Founding of the metal processing company aquatherm metal, D-Attendorn
1998
Founding of a subsidiary in Carrara / Italy
1999
Completion of the main site in D-Attendorn as one complex (Factories 1+2, Production and Store, Laboratory and Training Centre)
2001
Completion of the extension Factory 2 in D-Attendorn
2001
Opening of the new training centre in D-Radeberg
2002
Completion of the logistics centre in D-Attendorn
2003
Completion of rebuilding and finishing of the training centre in D-Attendorn
2003
30 year celebration of the company aquatherm
2005
Adding of 2 storeys on the administration building
2005/06
Completion of the 4-storey hall on the premises in Attendorn
Basement: Store
Ground floor: Assembly / Packing
1st Floor: Laboratory and Technical department
2 nd Floor: Special manifold construction
2008
Aquisition of the former storehouse of the forwarding agent Kost, which also accomodates the room of the plant maintenace.
2009
Opening of the new expertise centre for technical application.
2013
40 year celebration of the company aquatherm

SYSTEM DESCRIPTION

Surface heating systems were previously used mainly in residential construction. New findings, particularly the thermal behavior and the temperature level of this type of heating, form the basis for the application in commercial and industrial construction.

Surface heating provide free interior design. Radiators or other heating units are not in the way and thus do not disturb the general workflow (e.g. forklift traffic).

For large ceiling heights it is especially important to make the distribution of the desired room temperature optimally and economically. Heat accumulation under the ceiling must be avoided. This requirement is met by a large-area heating on the hall floor with al low vertical temperature profile.

aquatherm industrial surface heating is designed as a hot water heating with plastic pipes (PE-RT-pipes) integrated in the floor construction.

Industrial surface heating systems are used in:

- Production halls
- Market halls
- Exhibition halls
- Assembly halls
- Maintenance hangars
- Aircraft hangars
- Logistic centers
- Warehouses
- High bay warehouses
- Distribution centers

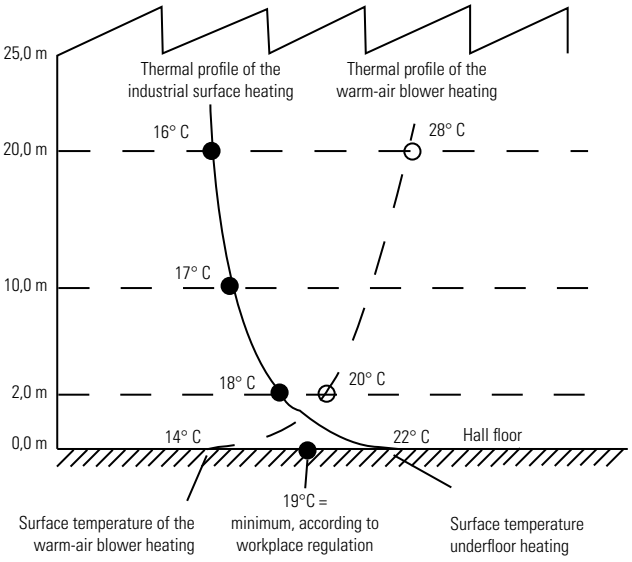
Surface heating systems find application also as freeze protection for cold stores.

The advantages of the aquatherm industrial surface heating

- Uniform temperature profile
- Low air velocity
- No maintenance costs
- Low temperatures
- Fast return of investment
- The lifetime of the heating pipes correspond to the lifetime of the building

Energy efficiency: Systems with temperatures near to the ambient room temperature have the highest energy efficiency. For the operation of heat pumps and the use of waste heat large-scale transfer surfaces are required to work with low flow temperatures. Only the industrial surface is applicable to these criteria.

Comparison of the systems:



The commercial and industrial surface heating meets the requirements of the Workplace/- Directive without the partly required support measures (e.g. floor grates against cold feet) of other types of heating in an advantageous manner.

Excerpt from the workplace regulation:

V§6 Room temperatures
(1) In places of work during working hours a room temperature conductive to health of the worker, considering the working methods and the physical demands of the workers must be available. Sentence 1 shall also apply to areas of working places in warehouses, machinery and adjoining rooms.
(2) It must be ensured that the workers are not exposed to unhealthful temperatures by heating facilities.

Explanatory note to paragraph 2
In the choice, design and arrangement of the heating must be regarded that workers are not exposed to harmful thermal effects.
This is possible e.g. with warm-air blowers, radiant heaters or other heat-emitting devices which were directly directed to the workplace.

Workplace Directive 8/1 Chapter 2.2
Adequate protection against heat dissipation is also given, if the surface temperature of the floor of not less than 18 °C is guaranteed, e.g. by heating systems or further suitable operational facilities.

PIPE MATERIAL

Heating pipes of polyethylene (PE-RT)

aquatherm orange system floor heating pipes of the material polyethylene (PE-RT) have a unique molecular structure with controlled side chain distribution, which ensures with high flexibility for excellent stress crack stability and very good long-term internal pressure behavior.

Designation:

aquatherm orange system underfloor heating pipe --- Art.-No. 90026 --- 16 x 2,0 mm --- oxygen tight --- DIN 16833 --- production date/time --- machine-no. --- meter-marking – Made in Germany

In addition every coil is printed continuously with the number of meters. A package insert containing the identification data is added to every coil.

Surplus material:

Surplus pipe lengths can be applied with the tested and approved aquatherm grey pipe connection technique for radiator connections. For more information about "Surplus material for underfloor heating pipes" please contact our information service on telephone number ++49 2722-950111 or ask directly for our aquatherm grey pipe catalog, order-no. E 70000.

aquatherm orange system underfloor heating pipes made of polyethylene (PE-RT)		
Art.-No.	**Nominal size**	**Length of coil**
90026	16 x 2,0 mm	250 m
90036	16 x 2,0 mm	500 m
90028	20 x 2,0 mm	250 m
90038	20 x 2,0 mm	500 m

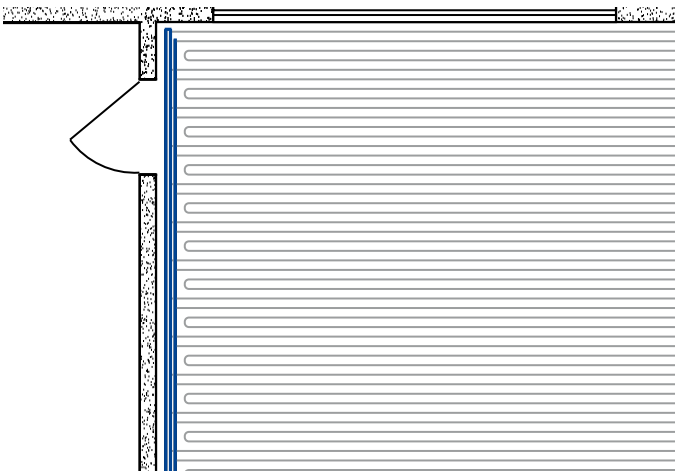
PLANNING REGULATIONS

Heating systems are subject to a variety of DIN standards, instructions, laws and regulations. This applies to the systems components and to the processing and planning.

- Heating system regulation
- Energy saving regulation
- Workplace guidelines
- Local regulations and decrees
- DIN 1045 Concrete and reinforced concrete
- DIN 1055 Load assumption for buildings
- DIN 1961 VOB B. and C.
- DIN 4102 Fire protection
- DIN 4108 Thermal Protection
- DIN EN 12831 Methods for calculation of nominal heat load
- DIN EN 1264
- DIN 4726 Pipes made of plastic
- DIN 4751 Safety equipment of hot water heating
- DIN EN 13163 Factory-made products made of expanded polystyrene (EPS)
- DIN 17174 Foam glass as insulating material
- DIN 18195 Waterproofing of building
- DIN 18202 Tolerances
- DIN 18331 Concrete and reinforced concrete works
- DIN 18336 Waterproofing
- DIN 18353 Screed works
- DIN 18380 Heating and processing water
- DIN 18560 T7 screeds in building industry (industrial screeds)

PIPE ROUTING PLAN ACCORDING TO TICHELMANN-PRINCIPLE

The weld-in saddle technique, developed by aquatherm, allows the connection of the heating pipes to a continuous manifold in the “reverse return” principle (Tichelmann).



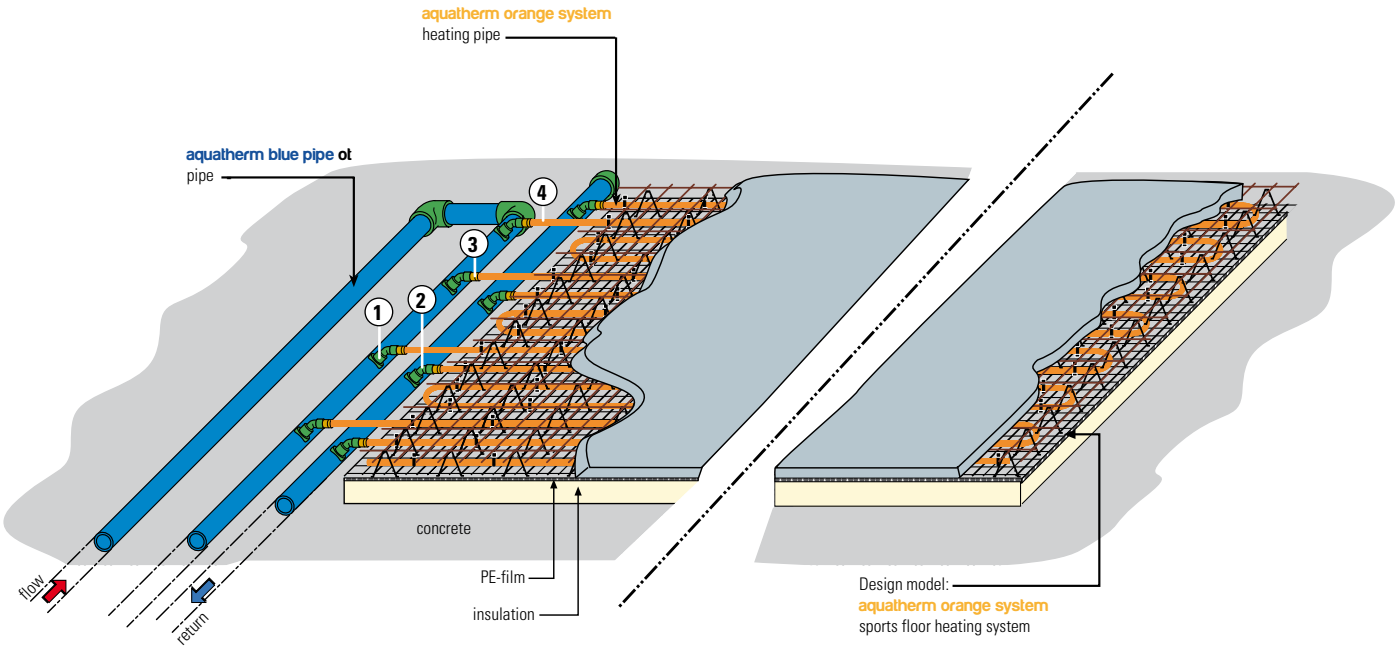
Pipe routing plan with weld-in saddle

DESIGN

In this connection method the distribution pipes are made of aquatherm blue pipes and weld-in saddles.

The distance of the saddles is determined by the laying distance of the heating pipes. For the connection of the diffusion-tight heating pipes the aquatherm grey pipe transition adapter are used. These allow an optimal connection of the aquatherm green pipe system with the aquatherm grey pipe system (sliding sleeve technology).

1. aquatherm green pipe weld-in saddle
2. aquatherm green pipe elbow 45°
3. aquatherm grey pipe transition adapter
4. heating pipe



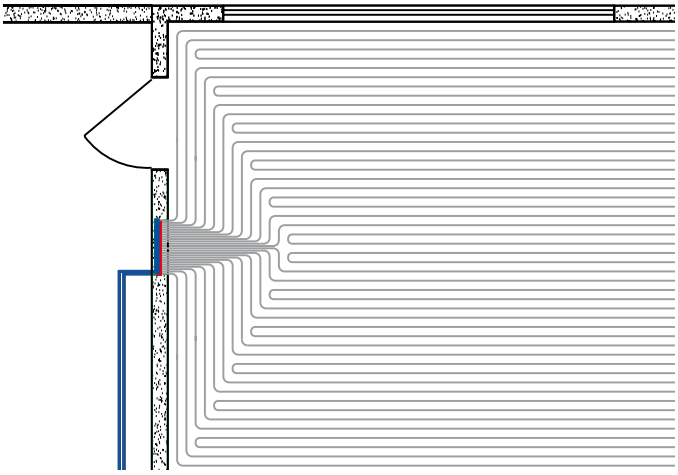
PIPE ROUTING IN INDUSTRIAL FLOORS ACCORDING TO TICHELMANN-TECHNOLOGY

PIPE ROUTING PLAN WITH HEATING CIRCUIT MANIFOLDS

The heating pipes of the aquatherm orange system industrial floor heating can be installed in the transverse or longitudinal direction in the construction of the reinforcement.

The connection of the heating pipes is made by heating circuit manifolds, which are equipped with flow and return valves. Thus an individual adjustment of each circuit is possible. In hydraulically same heating circuits the control of all connected circuits via a central zone control is possible.

The connection with heating circuit manifolds is made as in the area of the underfloor heating installation. A maximum of 20 heating circuits are connected to a manifold.



AQUATHERM ORANGE SYSTEM – INDUSTRIAL MANIFOLD

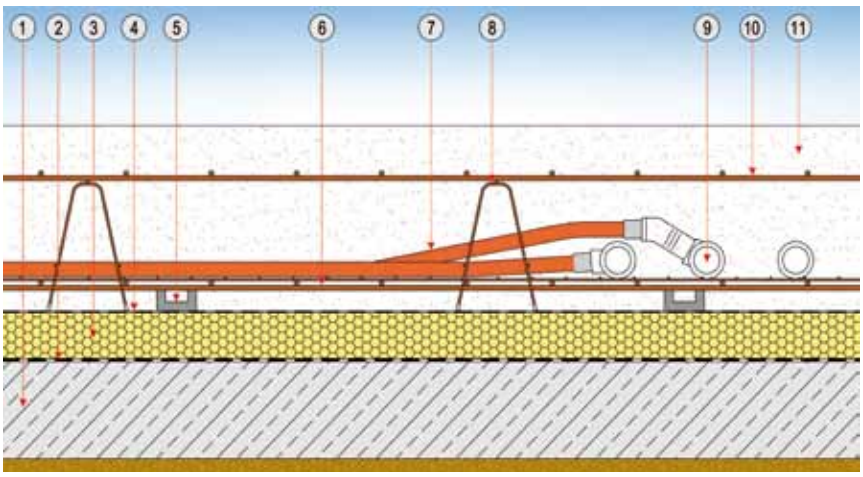
Made of high quality brass pipe MS 63 with:

- flat sealing connection
- end caps
- filling valves
- flow ball valves with connection for Euro cone, return valves with barrier
- connection for Euro cone and pre-adjustable flow regulation
- sound insulated and galvanized brackets
- staggered arrangement between flow and return

Compression fittings must be ordered separately.
Ball valve set must be ordered separately.

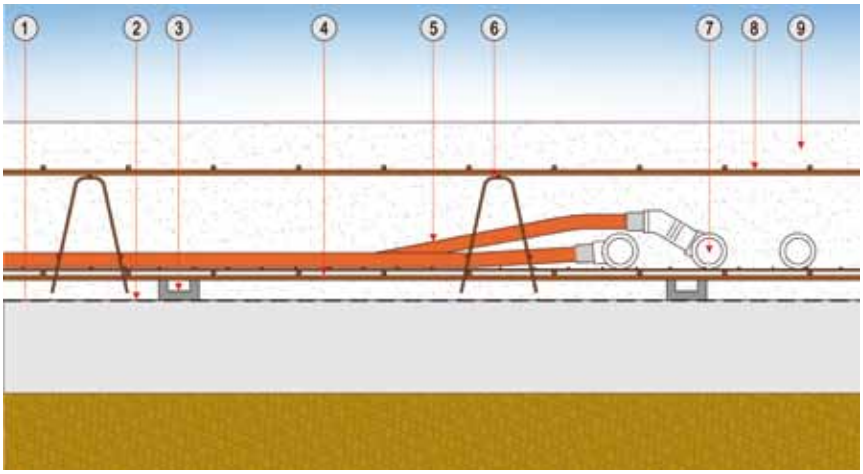
Art.-No.	Dimension	Packing Unit
99937	2-fold Length: 520 mm	1 Piece
99938	3-fold Length: 620 mm	1 Piece
99939	4-fold Length: 720 mm	1 Piece
99940	5-fold Length: 820 mm	1 Piece
99941	6-fold Length: 920 mm	1 Piece
99942	7-fold Length: 1020 mm	1 Piece
99943	8-fold Length: 1120 mm	1 Piece
99944	9-fold Length: 1220	1 Piece
99945	10-fold Length: 1320 mm	1 Piece
99946	11-fold Length: 1220 mm	1 Piece
99947	12-fold Length: 1520 mm	1 Piece
99948	13-fold Length: 1620 mm	1 Piece
99949	14-fold Length: 1720 mm	1 Piece
99950	15-fold Length: 1820 mm	1 Piece
99951	16-fold Length: 1920 mm	1 Piece
99952	17-fold Length: 2020 mm	1 Piece
99953	18-fold Length: 2120 mm	1 Piece
99954	19-fold Length: 2220 mm	1 Piece
99955	20-fold Length: 2320 mm	1 Piece

CONSTRUCTION VARIATIONS



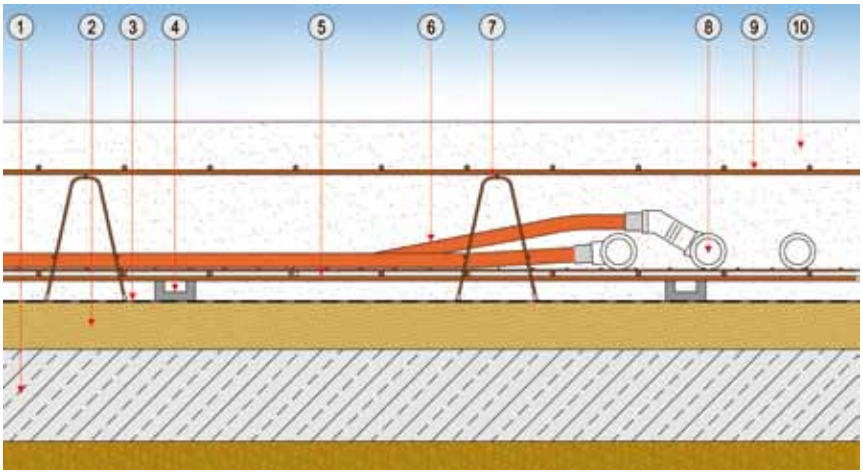
System design industrial space heating with Tichelmann manifold

1) subsoil
2) waterproofing of building DIN 18195
3) thermal insulation according to EneV
4) PE-film (possibly)
5) reinforcement carrier
6) lower reinforcement
7) aquatherm orange system heating pipe
8) spacer
9) aquatherm orange system Tichelmann manifold
10) upper reinforcement
11) concrete



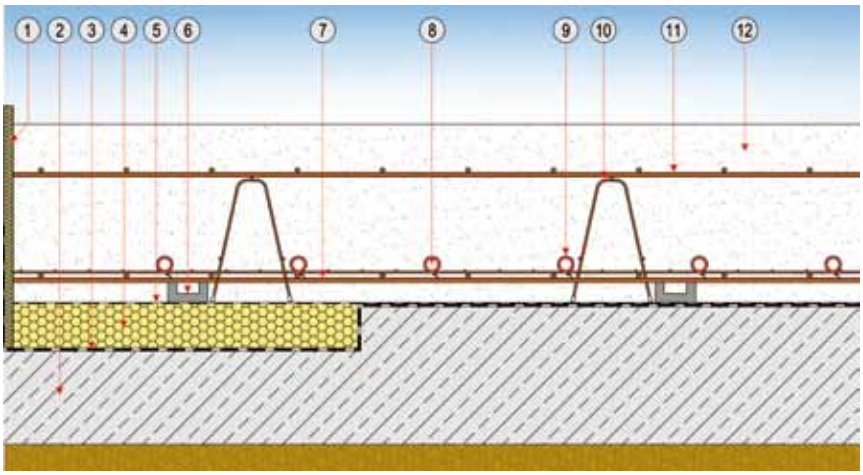
System design industrial space heating with Tichelmann manifold / without waterproofing of building

1) subsoil
2) PE-film (possibly)
3) reinforcement carrier
4) lower reinforcement
5) aquatherm orange system heating pipe
6) spacer
7) aquatherm orange system Tichelmann manifold
8) upper reinforcement
9) concrete



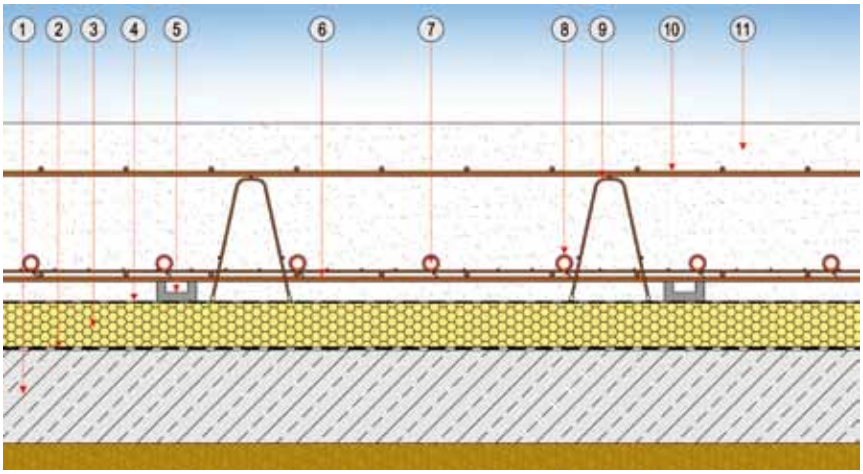
System design industrial space heating with Tichelmann manifold / with carrier layer

1) subsoil
2) Tragschicht
3) PE-film (possibly)
4) reinforcement carrier
5) lower reinforcement
6) aquatherm orange system heating pipe
7) spacer
8) aquatherm orange system Tichelmann manifold
9) upper reinforcement
10) concrete



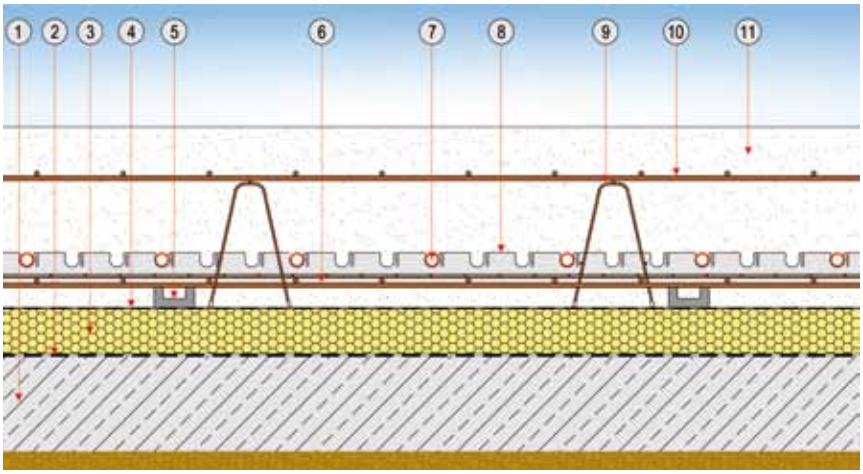
System design industrial space heating with cable ties / with edge insulation

1) aquatherm orange system edge insulation
2) subsoil
3) waterproofing of building DIN 18195
4) thermal insulation according to EneV (edge insulation)
5) PE-film (possibly)
6) reinforcement carrier
7) lower reinforcement
8) aquatherm orange system heating pipe
9) aquatherm orange system cable ties
10) spacer
11) upper reinforcement
12) concrete



System design industrial space heating with cable ties

1) subsoil
2) waterproofing of building DIN 18195
3) thermal insulation according to EneV (edge insulation)
4) PE-film (possibly)
5) reinforcement carrier
6) lower reinforcement
7) aquatherm orange system heating pipe
8) aquatherm orange system cable tie
9) spacer
10) upper reinforcement
11) concrete



System design industrial space heating with spring rail

1) subsoil
2) waterproofing of building DIN 18195
3) thermal insulation according to EneV (edge insulation)
4) PE-film (possibly)
5) reinforcement carrier
6) lower reinforcement
7) aquatherm orange system heating pipe
8) aquatherm orange system spring rail
9) spacer
10) upper reinforcement
11) concrete

DIFFERENT TYPES OF CONCRETE

Reinforced concrete:

The most common variant for industrial space heating is reinforced concrete. Reinforced concrete plates are provided with top and bottom reinforcements. Both layers of reinforcements are constructed from steel meshes, whose strength and execution are designed by a structural engineer.

Special spacers separate both layers in height and distance apart.

Steel fiber reinforced concrete (SFRC):

In this type of concrete there is no mesh reinforcement. The concrete is mixed with steel fibers as adding. The amount added depends on the required quality of the concrete. The fibers are evenly distributed in the concrete, and thus improve the flexural, compressive and tensile strength of the concrete. Type and design are determined by the structural engineer.

Finally the surface is treated by trowel.

Vacuum concrete:

Vacuum concrete is defined as a process in which a vacuum with a vacuum pump and suction mats is generated after concreting. By this a part of the water, which is not required for the hydration, is removed from the fresh concrete. Denser and more wear-resistant surfaces arise. In addition through this process a higher strength is reached very early and thus an earlier use of the surface is possible.

Roller compacted concrete (RCC):

RCC is installed in a very stiff consistency and compacted with rollers. This type of concrete is not suitable for the aquatherm orange system industrial space heating due to the driveways of these heavy vehicles.

Joint arrangement:

The type and arrangement of joints is independent of the industrial space heating and needs to be defined and determined by the structural engineer in general. The size of the field is dependent on various factors.

The heating circuits of the aquatherm orange system industrial space heating must be adapted to the field sizes. With the exception of dummy joints, these joints may be crossed only by connection supplies. In the cross-over area the connection supplies must be provided with pipe sleeves of 1.0 m length.

THERMAL INSULATION

Thermal insulation requirements according to EnEV 2009:
EnEV regulates the requirements for structural thermal insulation of non-residential buildings in & 4 paragraph 2:

- To be constructed non-residential buildings shall be designed so that the maximum values of the mean heat transfer coefficient of the heat transfer enclosing surface of annex 2, table 2, are not exceeded.
- The heat transfer coefficient for rooms adjacent to ground is to be calculated by the factor 0.5.
- In calculating the average of the floor panels adjoining the ground, the surfaces, which are more than 5 m from the outer edge of the building may be disregarded. Thus there is no thermal insulation requirement for these areas.

Line	**Component**	**Maximum values of the heat transfer coefficients based on the average value of the respective components**	
		Zones with room nominal temperature in case of heating ≥ 19 °C	**Zones with room nominal temperature in case of heating from 12 to < 19 ° C**
1	Opaque outer components, if not in components of line 3 and 4	U = 0,35 W/(m² x K)	U = 0,50 W/(m² x K)
2	Transparant components, if not in components of line 3 and 4	U = 1,90 W/(m² x K)	U = 2,80 W/(m² x K)
3	Curtain wall	U = 1,90 W/(m² x K)	U = 3,00 W/(m² x K)
4	Glass roofs, window strips and dome lights	U = 3,10 W/(m² x K)	U = 3,10 W/(m² x K)

Calculating the average of the thermal transmission coefficient

In the calculation of the average of each component, the components have to be considered in proportion to their area ratio. The thermal transmission coefficient of components against unheated rooms or soil are calculated in addition by the factor 0.5. In the calculation of the average of the adjacent to the ground floor slab, the surfaces, which are more than 5 m from the outer edge of the building, may be disregarded. The calculation is carried out separately for zones with different target room temperatures when heating.

Generally thermal insulation of industrial surface heating is laid as perimeter insulation (i.e. adjacent to ground). Depending on the static load there is the choice between extruder foam and foam glass plates. Insulation material for perimeter insulation must be impervious to moisture and suitable for load occurring.

In calculating the U-value, according to DIN 4108, only layers up to the waterproofing may be included. Only when presenting a building approval for the selected building material, the insulation value of the perimeter insulation is included in the calculation of the U-value for the total construction.

CONCRETING

The ready-mixed concrete is transported by concrete pumps to the installation site. A distinction is made between on-site and ready-mixed concrete:

- Site concrete is prepared right at the construction site
- Ready-mixed concrete is pre-mixed in the concrete plant and driven by transport vehicles to the installation site

The concrete is placed in ready-mixed consistency via transport hoses, distributed, levelled and compacted.

Consistency of the concrete:
(WZ-factor 0/5 - 0/6 at minimum 320 kg concrete/m³)

CONCRETE JOINTS

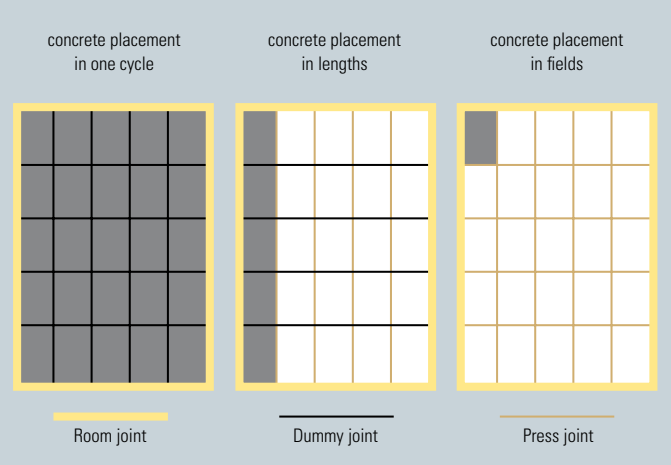
Generally type and extend of concrete joints are determined by the building designer. It is distinguished between:

- Movement joints
- Dummy joints
- Construction joints (press joints)

Movement joints (expansion joints) separate the concrete slab in whole strength. The width of the movement joints depends on the operating instructions and the surface area of the concrete slab.
Dummy joints ensure the controlled crack by a predetermined cross-sectional weakening in the concrete. The cut is sawed in the upper third of the slab (width 3 mm, depth about 1/3 of the total thickness). Depending on the condition of the concrete the saw cut is made between 12 and 48 hours after the concrete placement. If the joint is closed later, a later recut will be required. The joint closure is effected by means of joint profile (rubber profile)or potting.
Construction joints separate the adjacent fields that are concreted in intervals. For this suitable profile sheets are used.

Joint arrangement:

The joint planning is generally carried out by the structural engineer and is independent of the industrial space heating due to its low temperatures in the heating level.
The type, location and field sizes of the joints are depending on the room geometry, substructure, columns, pillars, concrete placement , etc.
The joint plans of the structural engineer must be considered in relation to the heating circuit planning and connection pipes. Joints may only be crossed by connection pipes and shall be provided with pipe sleeves.
Jointless industrial concrete up to 20.000 m² is possible under certain circumstances. (Source: GVG, Oldenburg)



Forklifts and floor vehicles produce a high abrasion on the concrete surfaces. A wear layer offers a stable surface with low abrasion. Depending on the specific application mastic asphalt screeds, magnesia screeds or cement-bonded hard aggregate floor screed can be applied.
Possible joints must be taken with the surface layer.
The type of surface wear layer is always determined by the building designer. Less stressed surfaces need no wear layer.

Preparation of construction joints by means of vertically adjustable seam joints

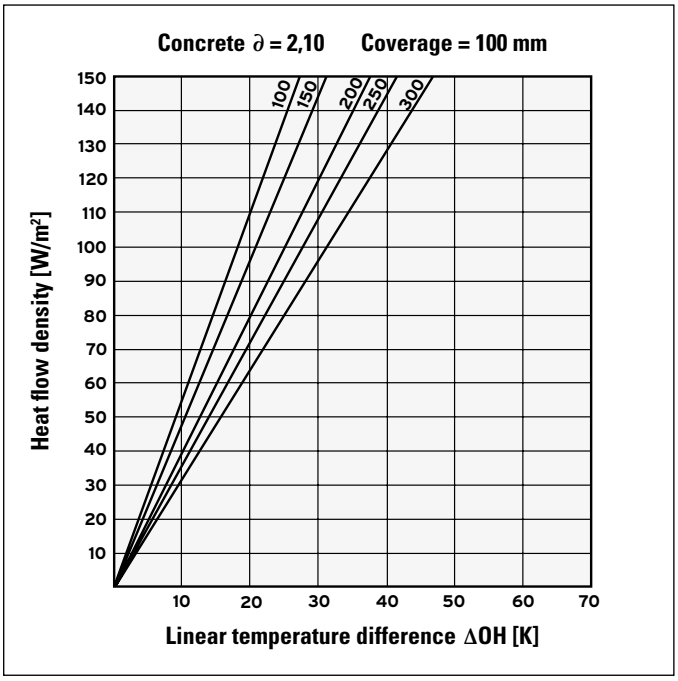
The surface is treated with a trowel

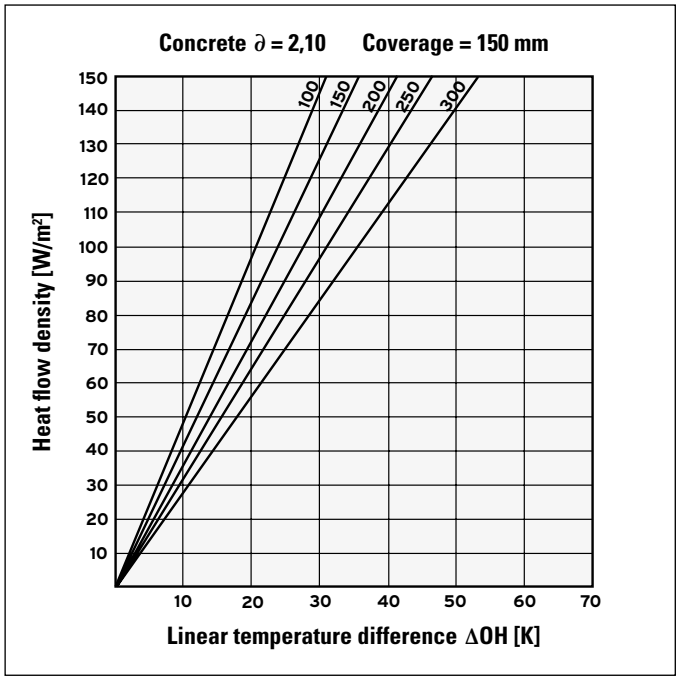
PLANNING AND DESIGN

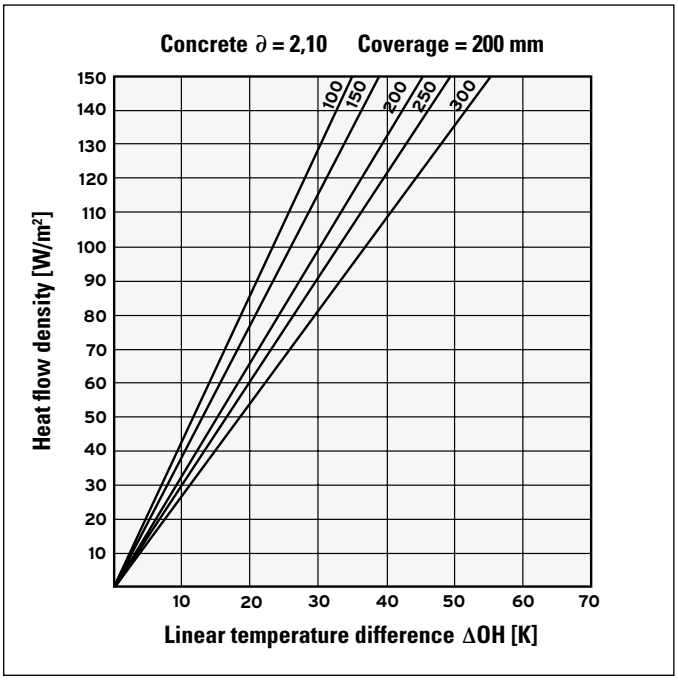
Compared to the normal residential building other conditions in the industrial halls have to be considered. In convective heating systems the room temperature is to be set 1 to 4 K higher depending on the ceiling height, as the room temperature increases with the height. With surface heating the temperature difference is nearly the same, since most of the heat output is provided via radiation. The following parameter should be considered when designing the aquatherm orange system industrial space heating:

- Heating load according to DIN EN 12831
- Heat flow density of the underfloor heating q (W/m²)
- Concrete covering (see diagram)
- Spacing
- Linear temperature difference
- Floor excess temperature

PERFORMANCE DATA







LAYING OF AQUATHERM ORANGE SYSTEM INDUSTRIAL SURFACE HEATING

AQUATHERM INDUSTRIAL SURFACE HEATING (FUNCTIONAL HEATING)

- Even industrial space heating is to be heated after the concrete and wear layer placement (Functional heating)
- The earliest possible start of heating depends on the quality and thickness of the concrete and must be agreed with the concrete layer/structural engineer. The wait time is usually 28 days.
- The functional heating is simply a function test according to VOB DIN 18380 and is not a “curing heating”.
- The functional heating is carried out as follows

- Heating start after release of the concrete surface
- Flow temperature 5 K above concrete surface temperature through the construction management
- Daily increase of flow temperature of 5 K up to the designed flow temperature
- Keeping of designed flow temperature for 24 hours
- Daily lowering of the flow temperature by 10 K

- The functional heating must be documented and submitted to the construction management
- In case of frost appropriate measures must be considered

SELECTION OF AQUATHERM REFERENCES

H&R Federn, Finnentrop, Germany

Tracto-Technik, Oedingen, Germany

REFERENCES AQUATHERM INDUSTRIAL SURFACE HEATING

1) Fa. Gebr. Bruse, Attendorn (1.600 m²)
2) Fa. Brüser, Finnentrop-Heggen (1.800 m²)
3) Fa. Bürger, Eslohe (300 m²)
4) Fa. Damm, Attendorn
5) Fa. Dornseifer, Wenden-Hünsborn
6) Fitnesscenter, Eslohe (300 m²)
7) Fa. HJE, Lennestadt-Theten (3.600 m²)
8) Fa. Kramer, Meinerzhagen – Krummenerl (2.200 m²)
9) Fa. Ohm & Hähner, Drolshagen (5.175 m²)
10) Fa. Cramer, Hagen (1.750 m²)
11) Fa. Mennekes, Kirchhundem (2.185 m²)
12) Fa.Promedia, Siegen (2.000 m²)
13) Fa. Rohlje, Olpe (750 m²)
14) Tracto-Technik, Lennestadt-Oedingen (2.500 m²)
15) Tracto-Technik, Lennestadt-Saalhausen (4.500 m²)
16) Tracto-Technik, Lennestadt-Langenei (1.300 m²)
17) Feuerwehrgerätehaus, Lennestadt-Grevenbrück (550.- m²)
18) Fa. Arens, Attendorn (3.450 m²)
19) Fa. SDT-IMO Turk, Halver (12.500 m²)
20) Fa. Westmark, Lennestadt-Elspe (1.150 m²)
21) Fa. H & R Federn, Lennestadt (3.200 m²)
22) Sauerland-Pyramiden, Lennestadt-Meggen
23) Fa. Schauerte, Lennestadt-Grevenbrück (2.500 m²)
24) Fa. Auto-Frey, Attendorn (500 m²)
25) Fa. Opel-Voss, Schmallenberg (3.000 m²)
26) Fa. Hydrophon, Kirchhundem Welschen-Ennest (1.750 m²)
27) Fa. Hydrophon, Kirchhundem Rahrbach (1.100 m²)
28) Fa. LKW Dolle, Lennestadt-Grevenbrück (1.000 m²)
29) Fa. VIA-Lasertechnik, Kirchhundem Würdinghausen (400 m²)
30) Fa. Elektro-Patt, Kirchhundem-Heinsberg (200.- m²)
31) Fa. Opel-Stracke, Meinerzhagen (900 m²)
32) Fa. Rad-Sport Thaler, Gevelsberg (1.200 m²)
33) Fa. B & B Metalltechnik, Lennestadt-Theten (800 m²)
34) Fa. Rudolf Eckel, Federntechnik, Lennestadt-Theten (1.000 m²)
35) Fa. Schreinerei Hömberg, Lennestadt-Theten (300 m²)
36) Fa. Plugge-Autotechnik, Attendorn
37) Fa. Olbrich, Eslohe
38) Feuerwehrgerätehaus, Neheim-Hüsten (450 m²)
39) Fa. Achenbach, Siegen (1.150 m²)
40) Elektro-Kaya, Kirchhundem (400 m²)
41) Fa. Sommer, Lennestadt-Grevenbrück (1.250 m²)
42) Fa. Pfitzer, Meschede (2.120 m²)
43) Fa. Birkenbeul, Hamm/Sieg (2.030 m²)
44) Fa. Steinhauer, Windeck (1.015 m²)
45) Fa. Weiper, Windeck (750 m²)
46) Fa. Elektro-Conze, Wissen (1.450 m²)
47) Fa. Wocklum-Chemie, Balve (3.500 m²)

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