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Ploskovni sistemi za gretje in hlajenje z vodo - 2. del: Talno gretje - Preskusne metode za doloļ evanje oddaje toplote talnega gretja z raļ unsko metodo in preskuġanjem

Water based surface embedded heating and cooling systems - Part 2: Floor heating: Prove methods for the determination of the thermal output of floor heating systems using calculation and test methods

Raumflächenintegrierte Heiz- und Kühlsysteme mit Wasserdurchströmung - Teil 2: Fußbodenheizung: Prüfverfahren für die Bestimmung der Wärmeleistung von Fußbodenheizsystemen unter Benutzung von Berechnungsmethoden und experimentellen Methoden

Systemes de refroidissement et de chauffage intégrés a circulation d'eau - Partie 2: Chauffage par le sol: Méthodes éprouvées pour la détermination de la puissance thermique des systemes de chauffage par le sol, par calcul et a l'aide de méthodes d'essai

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91.140.10	Sistemi centralnega ogrevanja	Central heating systems

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English Version

Water based surface embedded heating and cooling systems - Part 2: Floor heating: Prove methods for the determination of the thermal output using calculation and test methods

Systèmes de surfaces chauffantes et rafraîchissantes hydrauliques intégrées - Partie 2 : Chauffage par le sol: Méthodes de démonstration pour la détermination de l'émission thermique utilisant des méthodes par le calcul et à l'aide de méthodes d'essai

Raumflächenintegrierte Heiz- und Kühlsysteme mit Wasserdurchströmung - Teil 2: Fußbodenheizung: Prüfverfahren für die Bestimmung der Wärmeleistung von Fußbodenheizsystemen unter Benutzung von Berechnungsmethoden und experimentellen Methoden

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents

Foreword

This document (EN 1264-2:2008) has been prepared by Technical Committee CEN/TC 130 "Space heating appliances without integral heat sources", the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2009, and conflicting national standards shall be withdrawn at the latest by April 2009.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document will supersede EN 1264-2:1997.

This European Standard, *Water based surface embedded heating and cooling systems,* consists of the following parts:

— Part 1: Definitions and symbols;

— Part 2: Floor heating: Prove methods for the determination of the thermal output using calculation and test methods;

— Part 3: Dimensioning;

— Part 4: Installation;

— Part 5: Heating and cooling surfaces embedded in floors, ceilings and walls — Determination of the thermal output.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This European Standard is based on the realisation that in the field of commercial trade, the thermal output of heating and cooling systems represents the basis of rating. In order to be able to evaluate and compare different heating and/or cooling systems, it is, therefore, necessary to refer to values determined using one single, unambiguously defined method. The basis for doing so are the prove methods for the determination of the thermal output of floor heating systems specified in Part 2 of this European Standard. In analogy to the European Standard EN 442-2 (Radiators and convectors — Part 2: Test methods and rating), these prove methods provide characteristic partial load curves under defined boundary conditions as well as the characteristic output of the system represented by the standard thermal output together with the associated standard temperature difference between the heating medium and the room temperature.

1 Scope

This European Standard specifies the boundary conditions and the prove methods for the determination of the thermal output of hot water floor heating systems as a function of the temperature difference between the heating medium and the room temperature.

This standard shall be applied to commercial trade and practical engineering if proved and certifiable values of the thermal output shall be used.

This European Standard applies to heating and cooling systems embedded into the enclosure surfaces of the room to be heated or to be cooled. This Part of this European Standard applies to hot water floor heating systems. Applying of Part 5 of this European Standard requires the prior use of this Part of this European Standard. Part 5 of this European Standard deals with the conversion of the thermal output of floor heating systems determined in Part 2 into the thermal output of heating surfaces embedded in walls and ceilings as well as into the thermal output of cooling surfaces embedded in floors, walls and ceilings.

The thermal output is proved by a calculation method (Clause 6) and by a test method (Clause 9). The calculation method is applicable to systems corresponding to the definitions in EN 1264-1 (type A, type B, type C, type D). For systems not corresponding to these definitions, the test method shall be used. The calculation method and the test method are consistent with each other and provide correlating and adequate prove results.

The prove results, expressed depending on further parameters, are the standard specific thermal output and the associated standard temperature difference between the heating medium and the room temperature as well as fields of characteristic curves showing the relationship between the specific thermal output and the temperature difference between the heating medium and the room.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1264-1:1997, *Floor heating — Systems and components — Part 1: Definitions and symbols*

prEN 1264-3:2007, *Water based surface embedded heating and cooling systems — Part 3: Dimensioning*

3 Definitions and symbols

For the purposes of this document, the terms and definitions given in EN 1264-1:1997 apply.

4 Thermal boundary conditions

A floor heating surface with a given average surface temperature exchanges the same thermal output in any room with the same indoor room temperature (standard indoor room temperature ϑ_i). It is, therefore, possible to give a basic characteristic curve of the relationship between specific thermal output and average surface temperature that is independent of the heating system and applicable to all floor heating surfaces (including those having peripheral areas with greater heat emissions) (see Figure A.1).

In contrast, every floor heating system has its own maximum permissible specific thermal output, the limit specific thermal output, q_G. This output is calculated for an ambient (standard) indoor room temperature

ϑ_i = 20 °C. The other condition is the maximum surface temperature $\vartheta_{F,\,max}$ = 29 °C[1)] at temperature drop between supply and return of the heating medium σ = 0 K. The maximum specific thermal output for the peripheral area will be achieved at a maximum surface temperature $\vartheta_{F,\,max}$ = 35 °C[2)] and σ = 0 K.

For the calculation and for the test procedure, the centre of the heating surface is used as the reference point for $\vartheta_{F,\,max}$, regardless of system type.

The average surface temperature $\vartheta_{F,\,m}$, determining the specific thermal output (see basic characteristic curve) is linked with the maximum surface temperature. In this context, $\vartheta_{F,\,m} < \vartheta_{F,\,max}$ always applies.

The achievable value $\vartheta_{F,\,m}$ depends on both the floor heating system and the operating conditions (temperature drop $\sigma = \vartheta_V - \vartheta_R$, downward thermal output q_u and heat resistance of the floor covering $R_{\lambda,\,B}$).

The calculation of the specific thermal output is based on the following conditions:

— The heat transfer at the floor surface occurs in accordance with the basic characteristic curve.

— The temperature drop of the heating medium σ = 0; the extent to which the characteristic curve depends on the temperature drop, is covered by using the logarithmically determined temperature difference between the heating medium and the room $\Delta\vartheta_H$ [3] (see Equation (1)).

— Turbulent pipe flow: m_H/d_i > 4 000 kg/(h · m).

— There is no lateral heat flow.

— The heat-conducting layer of the floor heating system is thermally decoupled by thermal insulation from the structural base of the building.

NOTE The aforementioned last condition does not concern the test procedure of Clause 9.

5 Documents for testing

The system supplier's documents are taken as the basis for the determination of the thermal output. The following documents shall be provided:

— Installation drawing (section) of the floor heating system, covering two pipe spacing, including the peripheral area and giving information on the materials used (if necessary, the test results regarding the heat conductivity values of the materials shall be provided).

— Technical documentation of the system.

This information shall contain any details necessary for the calculation of the construction customary on site. It shall be submitted to the installer in the same form.

With a member of the testing body present, a demonstration surface of approximately 2 m × 2 m is constructed to represent the actual construction used on site.

1) National regulations may limit this temperature to a lower value

2) Some floor covering materials may require lower temperatures

6 Calculation of the specific thermal output (characteristic curves and limit curves)

6.1 General approach (see [2], [4])

The specific thermal output q at the surface of a floor is determined by the following parameters:

— Pipe spacing T;

— Thickness s_u and heat conductivity λ_E of the layer above the pipe;

— Heat conduction resistance $R_{\lambda, B}$ of the floor covering;

— Pipe external diameter $D = d_a$, including the sheathing ($D = d_M$) if necessary and the heat conductivity of the pipe λ_R or the sheathing λ_M. In case of pipes having non-circular cross sections, the equivalent diameter of a circular pipe having the same circumference shall be used in the calculation (the screed covering shall not be changed). Thickness and heat conductivity of permanently mounted diffusion barrier layers with a thickness up to 0,3 mm need not be considered in the calculation. In this case, $D = d_a$ shall be used;

— Heat diffusion devices having the characteristic value K_{WL} in accordance with 6.3;

— Contact between the pipes and the heat diffusion devices or the screed, characterised by the factor a_K.

The specific thermal output is proportional to $(\Delta\vartheta_H)^n$, where the temperature difference between the heating medium and the room temperature is:

$$\Delta\vartheta_H = \frac{\vartheta_V - \vartheta_R}{\ln \dfrac{\vartheta_V - \vartheta_i}{\vartheta_R - \vartheta_i}} \qquad (1)$$

and where experimental and theoretical investigations of the exponent n have shown that:

$$1{,}0 < n < 1{,}05 \qquad (2)$$

Within the limits of the achievable accuracy,

$$n = 1$$

is used.

The specific thermal output is calculated using Equation (3).

$$q = B \cdot \prod_i (a_i^{m_i}) \cdot \Delta\vartheta_H \qquad (3)$$

where

B is a system-dependent coefficient, in W/(m^2 · K);

$\prod_i (a_i^{m_i})$ is a power product linking the parameters of the floor construction with one another (see 6.2, 6.3 and 6.4).

A distinction shall be made between systems, where the pipes are installed inside or below the screed or wood floors, and systems with surface elements (plane section systems). For usual constructions, Equation (3) applies directly. For systems with additional devices for heat distribution, for air filled hollow sections or for other components influencing the heat distribution, the thermal output is determined experimentally in accordance with Clause 9.

6.2 Systems with pipes installed inside the screed (type A and type C)

For these systems (see Figure A.2), the characteristic curves are calculated in accordance with Equation (4a).

$$q = B \cdot a_B \cdot a_T^{m_T} \cdot a_u^{m_u} \cdot a_D^{m_D} \cdot \Delta\vartheta_H \tag{4a}$$

The power product given before the temperature difference $\Delta\vartheta_H$ is called the equivalent heat transmission coefficient K_H, which leads to the following abbreviated form of the expression:

$$q = K_H \cdot \Delta\vartheta_H \tag{4b}$$

where

B = B_0 = 6,7 W/(m^2 · K) for a pipe heat conductivity $\lambda_R = \lambda_{R,0}$ = 0,35 W/(m^2 · K) and a pipe wall thickness $s_R = s_{R,0} = (d_a - d_i)/2$ = 0,002 m.

For other materials with different heat conductivities or for different pipe wall thicknesses, or for sheathed pipes, B shall be calculated in accordance with 6.6.

For a heating screed with reduced moisture addition, λ_E = 1,2 W/(m^2 · K) shall be used. This value is also applicable to heating screeds. If a different value is used, its validity shall be checked.

a_B is the floor covering factor in accordance with the following equation:

$$a_B = \frac{\frac{1}{\alpha} + \frac{s_{u,0}}{\lambda_{u,0}}}{\frac{1}{\alpha} + \frac{s_{u,0}}{\lambda_E} + R_{\lambda,B}} \tag{5}$$

where

α = 10,8 W/(m^2 · K);

$\lambda_{u,0}$ = 1 W/(m · K);

$s_{u,0}$ = 0,045 m;

$R_{\lambda,B}$ is the heat conduction resistance of the floor covering, in m^2 · K/W;

λ_E is the heat conductivity of the screed, in W/(m · K);

a_T is a spacing factor in accordance with Table A.1; $a_T = f(R_{\lambda,B})$;

a_u is a covering factor in accordance with Table A.2; $a_u = f(T, R_{\lambda,B})$;

a_D is the pipe external diameter factor in accordance with Table A.3; $a_D = f(T, R_{\lambda,B})$.

$$m_T = 1 - \frac{T}{0{,}075} \quad \text{applies where } 0{,}050 \text{ m} \leq T \leq 0{,}375 \text{ m} \tag{6}$$

$$m_u = 100(0{,}045 - s_u) \quad \text{applies where } s_u \geq 0{,}010 \text{ m} \tag{7}$$

$$m_D = 250(D - 0{,}020) \quad \text{applies where } 0{,}008 \text{ m} \leq D \leq 0{,}030 \text{ m} \tag{8}$$

In Equations (6), (7) and (8)

T is the pipe spacing;

D is the external diameter of the pipe, including sheathing, where applicable;

s_u is the thickness of the screed covering above the pipe.

For a pipe spacing $T > 0{,}375$ m, the specific thermal output is approximately calculated using

$$q = q_{0,375} \frac{0{,}375}{T} \tag{9}$$

where

$q_{0,375}$ is the specific thermal output, calculated for a spacing $T = 0{,}375$ m.

For coverings above the pipe $s_u \leq 0{,}065$ m as well as for coverings above the pipe $0{,}065 \text{ m} < s_u \leq s_u^*$ (for s_u^* see below), Equation (4a) applies directly. The value of s_u^* depends on the pipe spacing as follows:

For a spacing $T \leq 0{,}200$ m, $s_u^* = 0{,}100$ m applies.

For a spacing $T > 0{,}200$, $s_u^* = 0{,}5\,T$ applies. In this relation, always the actual spacing T shall be used, even if the calculation is done in accordance with Equation (9).

For coverings above the pipe $s_u > s_u^*$, Equation (4b) shall be used. In this case, the equivalent heat transmission coefficient shall be determined in accordance with the following equation:

$$K_H = \frac{1}{\dfrac{1}{K_{H,\,s_u = s_u^*}} + \dfrac{s_u - s_u^*}{\lambda_E}} \tag{10}$$

In Equation (10), $K_{H,\,s_u = s_u^*}$ is the power product from Equation (4a), calculated for a covering s_u^* above the pipe.

The limit curves are calculated in accordance with 6.5.

6.3 Systems with pipes installed below the screed or timber floor (type B)

For these systems (see Figure A.3), the variable thickness s_u of the weight bearing layer and its variable heat conductivity λ_E are covered by the factor a_u. The pipe diameter has no effect. However, the contact between the heating pipe and the heat diffusion device or any other heat distribution device is an important parameter. In this case, the characteristic curve is calculated as follows:

$$q = B \cdot a_B \cdot a_T^{m_T} \cdot a_u \cdot a_{WL} \cdot a_K \cdot \Delta\vartheta_H \quad (11)$$

where

B = B_0 = 6,5 W/(m^2 · K) under the conditions given for Equations (4a) and (4b);

a_T is the pipe spacing factor in accordance with Table A.6; $a_T = f(s_u/\lambda_E)$;

m_T see Equation (6);

a_u is the covering factor, which is calculated in accordance with the following equation:

$$a_u = \frac{\frac{1}{\alpha} + \frac{s_{u,0}}{\lambda_{u,0}}}{\frac{1}{\alpha} + \frac{s_u}{\lambda_E}} \quad (12)$$

where

α = 10,8 W/(m^2 · K);

$\lambda_{u,0}$ = 1 W/(m · K);

$s_{u,0}$ = 0,045 m;

a_{WL} is the heat conduction factor (see Tables A.8); $a_{WL} = f(K_{WL}, T, D)$.

The following applies to the characteristic value K_{WL}:

$$K_{WL} = \frac{s_{WL} \cdot \lambda_{WL} + b_u \cdot s_u \cdot \lambda_E}{0{,}125} \quad (13)$$

where

b_u = $f(T)$ shall be taken from Table A.7;

$s_{WL} \cdot \lambda_{WL}$ is the product of the thickness and the heat conductivity of the heat diffusion device;

$s_u \cdot \lambda_E$ is the product of the thickness and the heat conductivity of the screed or timber covering.

If the width L of the heat diffusion device is smaller than the pipe spacing T, the value $a_{WL,\,L=T}$ determined in accordance with Tables A.8, shall be corrected as follows:

$$a_{WL} = a_{WL,\,L=T} - (a_{WL,\,L=T} - a_{WL,\,L=0})[1 - 3{,}2(L/T) + 3{,}4\,(L/T)^2 - 1{,}2(L/T)^3] \quad (14)$$

The heat conduction factors $a_{WL,\,L=T}$ and $a_{WL,\,L=0}$ shall be taken from Tables A.8a to A.8f. For $L = T$, the tables with K_{WL} in accordance with Equation (13) apply directly, for $L = 0$, the tables apply with K_{WL} determined in accordance with Equation (13) with $s_{WL} = 0$.

a_K is the correction factor for the contact in accordance with Table A.9; $a_K = f(T)$.

The correction factor for the contact a_K covers additional heat transmission resistances due to cases where there is only spot or line contact between the heating pipe and the heat diffusion device. These resistances depend on the manufacturing tolerances of the pipes and heat conduction devices as well as on the care taken in installing them, and are, therefore, subject to fluctuations in individual cases. For this reason, Table A.9 gives a calculated average value for a_K.

a_B is the floor covering factor:

$$a_B = \frac{1}{1 + B \cdot a_u \cdot a_T^{m_T} \cdot a_{WL} \cdot a_K \cdot R_{\lambda,B} \cdot f(T)} \quad (15)$$

with $f(T) = 1 + 0{,}44\sqrt{T}$

The limit curves are calculated in accordance with 6.5.

6.4 Systems with surface elements (plane section systems, type D)

For floors covered with surface elements (see Figure A.4), the following equation applies:

$$q = B \cdot a_B \cdot a_T^{m_T} \cdot a_u \cdot \Delta\vartheta_H \quad (16)$$

where

B = B_0 = 6,5 W/(m^2 · K) and

$a_T^{m_T}$ = 1,06;

a_u is the covering factor in accordance with Equation (12);

a_B is the floor covering factor:

$$a_B = \frac{1}{1 + B \cdot a_u \cdot a_T^{m_T} \cdot R_{\lambda,B}} \quad (17)$$

6.5 Limits of the specific thermal output

The procedure for the determination of the limits of the specific thermal output is shown in principle within Figure A.5.

The limit curve (see Figure A.5) gives the relationship between the specific thermal output and the temperature difference between the heating medium and the room for cases where the maximum permissible difference between surface temperature and indoor room temperature (9 K or 15 K respectively) is achieved.

The limit curve is calculated using the following expression in form of a product:

$$q_G = \varphi \cdot B_G \cdot \left[\frac{\Delta\theta_H}{\varphi}\right]^{n_G} \quad (18)$$

where