SLOVENSKI STANDARD
SIST EN 12939:2001

01-september-2001

Toplotne znaļilnosti gradbenih materialov in proizvodov - Ugotavljanje toplotne upornosti s ģļiteno ploģļno napravo in z napravo z merilniki gostote toplotnega toka - Izdelki velike debeline z visoko ali srednje visoko toplotno upornostjo

Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Thick products of high and medium thermal resistance

Wärmetechnisches Verhalten von Baustoffen und Bauprodukten - Bestimmung des Wärmedurchlasswiderstandes nach dem Verfahren mit dem Plattengerät und dem Wärmestrommessplatten-Gerät - Dicke Produkte mit hohem und mittlerem Wärmedurchlasswiderstand

Performance thermique des matériaux et produits pour le bâtiment - Détermination de la résistance thermique par la méthode de la plaque chaude gardée et la méthode fluxmétrique
- Produits épais de haute et moyenne résistance thermique

Ta slovenski standard je istoveten z: **EN 12939:2000**

ICS:

91.100.60	Materiali za toplotno in zvoļno izolacijo	Thermal and sound insulating materials

SIST EN 12939:2001 **en**

EUROPEAN STANDARD
NORME EUROPÉENNE
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English version

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This European Standard was approved by CEN on 18 October 2000.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 89 "Thermal performance of buildings and building components", the secretariat of which is held by SIS.

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of an identical text or by endorsement, at the latest by May 2001, and conflicting national standards shall be withdrawn at the latest by May 2001.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

The annexes A and B are normative. The annexes C and D are informative.

Introduction

This standard is intended to complement EN 12667. It addresses specific problems when testing, according to European product standards, thick high and medium thermal resistance specimens with a heat flow meter or guarded hot plate.

In this standard the references to ISO 8301:1991 and ISO 8302:1991 are limited to some experimental procedures and to the error analysis. The guarded hot plate and heat flow meter methods are described in EN 12667; assessment procedures are described in EN 1946-2:1999 and EN 1946-3:1999.

A CEN Report CR xxx, The use of interpolating equations in relation to measurements on thick specimens, (under preparation) supplies additional information on the use of interpolating functions to predict the thickness effect.

Among existing apparatus for steady state thermal testing, guarded hot plate apparatus and heat flow meter apparatus can be operated up to specimen thicknesses of 100 mm to 150 mm if the accuracy has to be kept within 2 % (and possibly 1 %), while the accuracy of guarded and calibrated hot box apparatus, which can test thicker specimens, is not as good as that of the previously mentioned two test apparatus.

As the thickness of many insulating products exceeds 100 mm to 150 mm, there is a need for a testing procedure that will supply enough information to predict the thermal performance of insulation products at their actual thicknesses. Different options are offered in this standard; the most appropriate one may be indicated in product standards.

When the thickness effect is relevant, i.e. when the thermal resistance of a thick product cannot be calculated as the sum of the thermal resistances of slices cut from the product, some material parameters are determined for use in interpolating equations. The procedure to determine these parameters is split into preliminary and routine measurements and evaluations, see C.1.

Background information and additional information on the use of interpolating equations is to be found in CR xxx.

1 Scope

This standard gives the procedures to determine the thermal resistance of products the thicknesses of which exceed the maximum thickness for guarded hot plate or heat flow meter apparatus. In any case most of the procedures described in this standard require apparatus that allows tests on specimens up to 100 mm thick.

This standard gives guidelines to assess the relevance of the thickness effect, i.e. to establish whether the thermal resistance of a thick product can or cannot be calculated as the sum of the thermal resistances of slices cut from the product, these guidelines complement the indications given in ISO 8302:1991 on the guarded hot plate apparatus.

This standard describes testing conditions which prevent the onset of convection. which could take place in some products under the considered temperature differences and thicknesses.

2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 1946-2:1999	Thermal performance of building products and components - Specific criteria for the assessment of laboratories measuring heat transfer properties – Part 2: Measurements by guarded hot plate method
EN 1946-3:1999	Thermal performance of building products and components - Specific criteria for the assessment of laboratories measuring heat transfer properties – Part 3: Measurements by heat flow meter method
EN 12667:-[1)]	Thermal performance of building materials and products - Determination of thermal resistance by means of guarded hot plate and heat flow meter methods - Products of high and medium thermal resistance
EN ISO 7345	Thermal insulation - Physical quantities and definitions (ISO 7345:1987)
EN ISO 9288	Thermal insulation - Heat transfer by radiation - Physical quantities and definitions (ISO 9288:1989)
ISO 8301:1991	Thermal insulation - Determination of steady-state thermal resistance and related properties - Heat flow meter apparatus
ISO 8302:1991	Thermal insulation - Determination of steady-state thermal resistance and related properties - Guarded hot plate apparatus

[1] To be published

3 Definitions, symbols and units

3.1 Terms and definitions

For the purposes of this standard the terms and definitions given in EN ISO 7345 and EN ISO 9288 apply.

NOTE EN ISO 9288 defines spectral directional extinction, absorption and scattering coefficients and the spectral directional albedo only, while this standard makes use of total hemispherical coefficients, which can be obtained by the previous ones by appropriate integrations.

3.2 Symbols and units

Symbol	Quantity	Unit
A	conduction parameter	W/(m·K)
B	solid conduction parameter	m^3/kg
C	radiation parameter	$W·m^2/(kg·K)$
E	extinction parameter for combined conduction and radiation	m^{-1}
F	complement to unity of the "two flux model" albedo	
L	thickness effect parameter	
R	thermal resistance	$m^2·K/W$
R_0, R_{01}, R_{02}	extrapolated thermal resistance at zero thickness	$m^2·K/W$
T	thermodynamic temperature	K
$\mathcal{T}$	transfer factor d/R (of a specimen)	W/(m·K)
Z	emissivity parameter	
d	thickness	m
d_b	mean bead or grain diameter	m
d_∞	thickness beyond which thermal resistance becomes linear	m
e	edge temperature ratio	
h_r	radiative heat transfer surface coefficient	$W/(m^2·K)$
q	density of heat flow rate	W/m^2
q_r	density of radiative heat flow rate	W/m^2
q_t	total density of heat flow rate	W/m^2
t	time	s
β'_*	mass extinction parameter	m^2/kg

Symbol	Quantity	Unit
ε	emissivity	
λ	thermal conductivity	W/(m·K)
λ_a	thermal conductivity of air	W/(m·K)
λ_g	thermal conductivity of gas	W/(m·K)
λ_r	radiativity (of a material)	W/(m·K)
λ_{cd}	combined gaseous and solid thermal conductivity (of a material)	W/(m·K)
λ_t	thermal transmissivity (of a material) $\Delta d/\Delta R$	W/(m·K)
θ	Celsius temperature	°C
ρ	density	kg/m³
ρ_s	density of the solid matrix	kg/m³
σ_n	Stefan-Boltzmann constant	W/(m²·K⁴)
ω^*	two-flux model albedo	

4 Instrumentation

4.1 General

The apparatus used for the measurements shall be a guarded hot plate or heat flow meter conforming with the requirements of EN 12667. This standard gives neither relevant design criteria and proven performance checks nor the determination of apparatus emissivity; these, as well as specific apparatus requirements applicable to the procedures described in this standard, are to be found either in EN 1946-2:1999 or EN 1946-3:1999, according to the apparatus used. Only those apparatus requirements affecting specimen sizes and tolerances are given in this standard.

When it is not explicitly stated otherwise, guarded hot plate apparatus requirements are assumed to be applicable also to heat flow meter apparatus.

Some recommended sizes and tolerances are supplied in this standard. In 4.2 and 4.3 requirements for common testing conditions are specified. More information is given in annex A.

4.2 Maximum specimen thickness

The maximum specimen thickness should be according to EN 12667, see limit values in its table A.1 for some common apparatus sizes. See also annex A of this standard for more information concerning low density specimens.

4.3 Minimum specimen thickness, flatness tolerances

The procedures described in this standard may require measurements at the minimum allowed specimen thickness (which depends upon apparatus parameters and testing conditions). The requirements of A.3.3 of EN 12667 shall be met, extending them for a thermal resistance of the specimen as low as 0,3 $m^2 \cdot K/W$. The following two testing conditions shall be considered in relation to this standard for both guarded hot plate and heat flow meter apparatus:

a) Tests on non rigid specimens achieving a good contact with the apparatus and whose thermal resistance is greater than or equal to 0,3 $m^2 \cdot K/W$, e.g. mineral wool boards or elastomeric cellular boards. In this case the departures from a true plane result in an error in the measurement of specimen thickness. This error shall be less than 0,5 % (see table A.1 of EN 12667). For detailed information see annex A of this standard.

b) Tests on rigid specimens having a thermal resistance greater than or equal to 0,3 $m^2 \cdot K/W$, e.g. polystyrene or rigid polyurethane boards. In this case the departures from a true plane are the source of contact resistances; these shall be less than 0,5 % of the specimen thermal resistance (see table A.2 of EN 12667).

This standard does not cover special testing techniques (use of contact sheets) to be applied when the thermal resistance of the specimen is less than 0,3 $m^2 \cdot K/W$.

5 Procedures

5.1 General

Specimen preparation and handling shall be in accordance with EN 12667. Specific specimen preparation should be found in the appropriate product standard referencing the procedures described in this standard.

5.2 Introductory considerations

The thermal resistance R of a specimen of low density insulating materials may be written as follows:

$$R = R_0 + d/\lambda_t \qquad (1)$$

(where R_0 is the extrapolated thermal resistance at zero thickness) and the transfer factor $\mathcal{T}$ is defined as follows:

$$\mathcal{T} = \lambda_t \frac{1}{1 + \frac{\lambda_t}{d} R_0} \qquad (2)$$

NOTE 1 For the derivation of equations (1) and (2) and their graphical representation see CR xxx.

The procedures described in this standard can be grouped as follows:

1) preliminary procedures to assess whether the thickness effect is relevant;

2a) procedures applicable when the thickness effect is not relevant;

2b) procedures applicable when the thickness effect is relevant.

The procedures described apply to products having thicknesses exceeding d_∞, with the exception of the use of tables 3 and 4, which also include thicknesses below d_∞. The procedures further assume that products are sufficiently homogeneous, such that no individual value of measured thermal resistance will deviate by more than 0,7 % from the interpolating straight line. When these conditions are not satisfied or when there is a need to keep the number of measurements to a minimum, annex C should be consulted for guidance. A flow-chart showing testing options is given in figure 1.

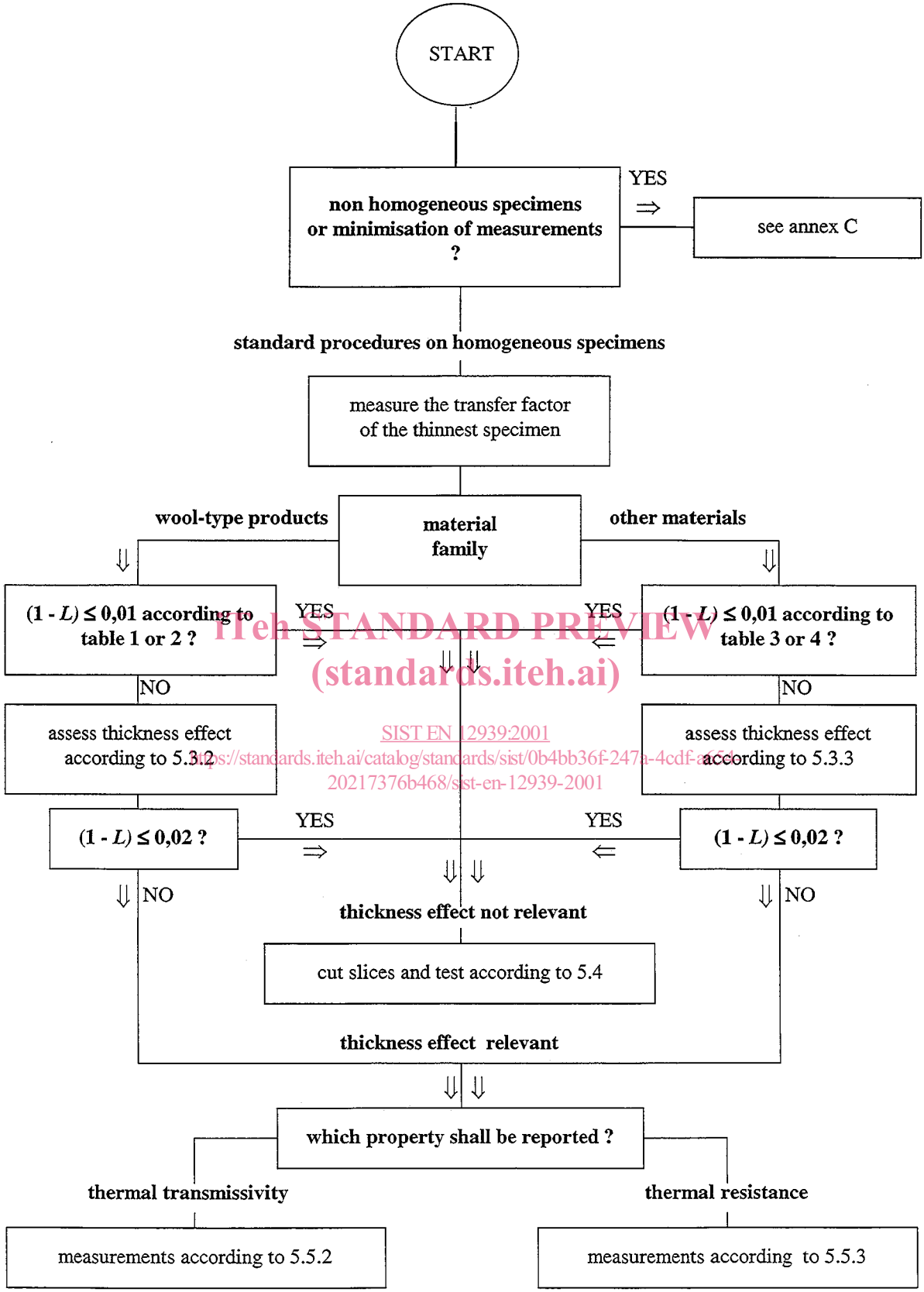

Figure 1 - Procedures to test thick specimens

NOTE 2 Due to the different mechanism of the radiation extinction, the procedures of this standard are differentiated by material families.

NOTE 3 The large amount of work required by the experimental procedures to assess the relevance of the thickness effect suggests they should be reduced to the absolute minimum needed. A thorough understanding of the influence of material parameters and their evaluation allows routines to be developed that require far less experimental work even though far more sophisticated. For this purpose some theoretical calculations based on just one measured value of the thermal resistance of a specimen are supplied in C.2.

NOTE 4 Even though this standard gives procedures to determine product thermal resistance at thicknesses that exceed guarded hot plate or heat flow meter capabilities, those applicable to materials exhibiting a relevant thickness effect can equally be applied to materials produced in thicknesses falling within apparatus capabilities, to allow the interpolation of product thermal resistances from measurements at few product thicknesses only.

NOTE 5 Specific procedures are described for products that have density gradients along the thickness, see C.3.2.1.2 for mineral wool, or have the density increasing quite sharply towards both product surfaces (skin products), see C.3.2.2.3 for cellular-plastic skin-products. Nevertheless, even for these products, the preliminary procedures of 5.3 apply.

All the procedures intended to characterise specimens having a thickness exceeding apparatus capabilities require a preliminary evaluation of the relevance of the thickness effect, i.e. how far from unity is the ratio $L = \overline{\lambda}/\lambda_t$ between the transfer factor and thermal transmissivity.

NOTE 6 The difference $(1 - L)$ may be of greater interest than L because $(1 - L)$ is zero when the thickness effect has no relevance.

5.3 The relevance of the thickness effect

5.3.1 General

If $(1 - L) = R_0/R \leq 0{,}02$, the thickness effect is not relevant for the product considered and the procedure of 5.4 shall be used. Otherwise elementary material-dependent procedures are given in 5.3.2 and 5.3.3 for routine and control purposes.

NOTE 1 The range of thicknesses of the products made of one material should be considered: if the largest product thickness is lower than the maximum allowed specimen thickness for the apparatus to be used and the relevance of the specimen thickness is to be assessed, the procedure in 3.4.2 of ISO 8302:1991 can be used.

NOTE 2 The simplest assessment of the relevance of the thickness effect is for materials containing air within their solid matrix, because tables or a graph can be used, see e.g. C.2.2.1.

5.3.2 Procedure for wool-type products

Measure the transfer factor of the product of the smallest thickness.

a) If, according to the data of table 1 for mineral wool or table 2 for wood wool, $(1 - L) \leq 0{,}01$, the thickness effect may be considered not relevant.

b) If $(1 - L) > 0{,}01$ according to table 1 for mineral wool or table 2 for wood wool, assess the relevance of the thickness effect as follows: