SLOVENSKI STANDARD
oSIST prEN 673:2023

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Steklo v gradbeništvu - Določanje toplotne prehodnosti (vrednost U) - Računska metoda

Glass in building - Determination of thermal transmittance (U value) - Calculation method

Glas im Bauwesen - Bestimmung des Wärmedurchgangskoeffizienten (U-Wert) - Berechnungsverfahren

Verre dans la construction - Détermination du coefficient de transmission thermique, U - Méthode de calcul

Ta slovenski standard je istoveten z: **prEN 673**

ICS:

81.040.20 Steklo v gradbeništvu Glass in building

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EUROPEAN STANDARD

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ICS

Will supersede EN 673:2011

English Version

Glass in building - Determination of thermal transmittance (U value) - Calculation method

Verre dans la construction - Détermination du coefficient de transmission thermique, U - Méthode de calcul

Glas im Bauwesen - Bestimmung des Wärmedurchgangskoeffizienten (U-Wert) - Berechnungsverfahren

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 129.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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European foreword

This document (prEN 673:2022) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 673:2011.

This edition is a combined revision of EN 673: 2011 and ISO 10292: 1994

In comparison with the previous edition, the following technical modifications have been made:

— update of references to normal and corrected emissivity for consistency with EN 12898: 2019;

— changes to some of the gas properties;

— introduction of a linear approximation for determining gas properties at different temperatures;

— provision of more details on heat transfer coefficients for glazing at angles other than vertical;

— additional clarification provided on the iteration procedure for glazing with more than one gas space.

1 Scope

This document specifies a calculation method to determine the thermal transmittance of glazing with flat and parallel surfaces.

This document applies to uncoated glass (including glass with structured surfaces, e.g. patterned glass), coated glass and materials not transparent in the far infrared which is the case for soda lime glass products, borosilicate glass, glass ceramic, alkaline earth silicate glass and alumino silicate glass. It applies also to multiple glazing comprising such glasses and/or materials. It does not apply to multiple glazing which include in the gas space sheets or foils that are far infrared transparent.

The procedure specified in this European Standard determines the *U* value (thermal transmittance) in the central area of glazing.

The edge effects due to the thermal bridge through the spacer of a sealed glazing unit or through the window frame are not included. Furthermore, energy transfer due to solar radiation is not taken into account. The effects of Georgian and other bars are excluded from the scope of this Standard.

The Standard for the calculation of the overall *U* value of windows, doors and shutters [1] gives normative reference to the *U* value calculated for the glazing components according to this standard.

For the purpose of product comparison, a vertical position of the glazing is specified. In addition, *U* values are calculated using the same procedure for other purposes, in particular for predicting:

— heat loss through glazing;

— conduction heat gains in summer;

— condensation on glazing surfaces;

— the effect of the absorbed solar radiation in determining the solar factor [2].

Reference should be made to [3], [4] and [5] or other European Standards dealing with heat loss calculations for the application of glazing *U* values determined by this standard.

A procedure for the determination of emissivity is given in EN 12898:2019.

The rules have been made as simple as possible consistent with accuracy.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 674:2011, *Glass in building - Determination of thermal transmittance (U value) - Guarded hot plate method*

EN 675:2011, *Glass in building - Determination of thermal transmittance (U value) - Heat flow meter method*

EN 12898:2019, *Glass in building - Determination of the emissivity*

EN ISO 10456:2007,[1] *Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values - Technical Corrigendum 1 (ISO 10456:2007/Cor 1:2009)*

[1] Impacted by EN ISO 10456:2007/AC:2009.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
thermal transmittance
***U* value**
parameter of glazing which characterizes the heat transfer through the central part of the glazing, i.e. without edge effects, and states the steady-state density of heat transfer rate per temperature difference between the environmental temperatures on each side

Note 1 to entry: The *U* value is given in watts per square metre Kelvin [W/(m²·K)]

3.2
declared value
U value obtained under standardized boundary conditions (see Clause 8)

4 Symbols, dimensionless numbers and subscripts

4.1 Symbols

A	constant	-
c	specific heat capacity of gas	J/(kg·K)
d	nominal thickness of material layer (glass or alternative glazing material)	m
F	volume fraction	-
h	— heat transfer coefficient	W/(m² ·K)
	— also thermal conductance	W/(m² ·K)
M	number of material layers	-
n	Exponent	-
N	number of spaces	-
r	thermal resistivity of glass (glazing material)	m·K/W
P	gas property	-
*R*n	normal reflectance (perpendicular to the surface)	-
s	width of gas space	m
T	absolute temperature	K
U	thermal transmittance	W/(m² ·K)
Δ*T*	temperature difference	K
ε	corrected emissivity	-

ε_n	normal emissivity (perpendicular to the surface)	-
ρ	gas density	Kg/m^3
σ	Stefan-Boltzmann's constant 5,67 × 10-8	$W/(m^2 \cdot K^4)$
μ	dynamic viscosity of gas	kg/(m·s)
λ	thermal conductivity of gas in space	W/(m·K)
ϑ	temperature on the Celsius scale	°C

4.2 Dimensionless Numbers

Gr	Grashof number
Nu	Nusselt number
Pr	Prandtl number

4.3 Subscripts

c	convection
e	external
i	internal
j	j^{th} material layer
k	k^{th} space
g	gas
m	mean
n	normal
r	radiation
s	space
t	total
1;2	first, second etc.

5 Basic formulae

5.1 General

The method of this standard is based on a calculation according to the following principles.

5.2 *U* value

The *U* value is given by:

$$\frac{1}{U} = \frac{1}{h_e} + \frac{1}{h_t} + \frac{1}{h_i} \qquad (1)$$

where

h_e and h_i are the external and internal heat transfer coefficients;

h_t is the total thermal conductance of the glazing.

$$\frac{1}{h_t} = \sum_1^N \frac{1}{h_s} + \sum_1^M d_j \cdot r_j \qquad (2)$$

where

h_S is the thermal conductance of each gas space;

N is the number of spaces;

d_j is the thickness of each material layer;

r_j is the thermal resistivity of each material (thermal resistivity of soda lime glass = 1,0 m·K/W);

M is the number of material layers.

$$h_{s,k} = h_{r,k} + h_{g,k} \qquad (3)$$

where

$h_{s,k}$ is the heat transfer of the kth space;

$h_{r,k}$ is the internal radiative heat transfer coefficient;

$h_{g,k}$ is the *U* value of gas of the kth space.

The thermal resistivity of components other than glass (e.g. interlayers in laminated glass) may be taken into account in determining the *U* value. Data on thermal conductivity of components other than glass should be obtained from the supplier or a default value taken from EN ISO 10456. In instances where the effects are not considered significant or important, a simplified approach may be taken, i.e. ignoring the effects of components other than glass.

NOTE In the absence of measured data from the manufacturer, a generic value for the thermal conductivity of the interlayer can be taken from the document *Glass in Building — Folio Interlayers for the Manufacturing of Laminated Glass — Product standard* (in preparation by CEN/TC129/WG3).

5.3 Internal radiative heat transfer coefficient h_r

The internal radiative heat transfer coefficient is given by:

$$h_r = 4\sigma \left(\frac{1}{\varepsilon_{1,k}} + \frac{1}{\varepsilon_{2,k}} - 1 \right)^{-1} T_{m,k}^3 \qquad (4)$$

where:

σ is the Stefan-Boltzmann's constant;

$T_{m,k}$ is the mean absolute temperature of the gas space;

$\varepsilon_{1,k}$ and $\varepsilon_{2,k}$ are the corrected emissivities at $T_{m,k}$.

5.4 Gas conductance h_g

5.4.1 General

The gas conductance is given by:

$$h_{g,k} = Nu \frac{\lambda_k}{S_k} \tag{5}$$

where:

s_k is the width of the space;

λ_k is the thermal conductivity;

Nu is the Nusselt number.

$$Nu = A \cdot (Gr \cdot Pr)^n \tag{6}$$

where:

A is a constant

Gr is the Grashof number

Pr is the Prandtl number

n is an exponent

$$Gr = \frac{9{,}81 \cdot s^3 \cdot \Delta T \cdot \rho^2}{T_m \cdot \mu^2} \tag{7}$$

$$Pr = \frac{\mu \cdot c}{\lambda} \tag{8}$$

where:

ΔT is the temperature difference between glass surfaces bounding the gas space;

ρ is the density;

μ is the dynamic viscosity;

c is the specific heat capacity;

T_m is the mean temperature.

The Nusselt number is calculated from Formula (6).

If *Nu* is less than 1, then the value unity is used for *Nu* in Formula (5).

5.4.2 Vertical glazing

For vertical glazing:

A is 0,035

n is 0,38

5.4.3 Horizontal and angled glazing

For horizontal or angled glazing and upward heat flow the heat transfer by convection is enhanced.

This effect shall be considered by substituting the following values of A and n in Formula (6).

Horizontal spaces	$A = 0,16$	$n = 0,28$
Space at 45°	$A = 0,10$	$n = 0,31$

For intermediate angles linear interpolation is satisfactory, however, the linear interpolation shall be between the two nearest points.

When the direction of heat flow is downward the convection shall be considered suppressed for practical cases and $Nu = 1$ is substituted in Formula (5).

6 Basic material properties

6.1 Emissivity

The corrected emissivities ε of the surfaces bounding the enclosed spaces are required to calculate the internal radiative heat transfer coefficient h_r in Formula (4).

For uncoated soda lime glass surfaces or for soda lime glass surfaces with coatings which have no effect on the emissivity, the normal emissivity to be used is 0,89. The corrected emissivity shall be determined from the normal emissivity in accordance with EN 12898: 2019, Clause 6.2.

With reasonable confidence the same value may be used for uncoated borosilicate glass, alkaline earth silicate glass, alumino silicate glass and glass ceramics.

For other coated surfaces the normal emissivity ε_n shall be determined with an infrared spectrometer in accordance with EN 12898:2019. The corrected emissivity shall be determined from the normal emissivity in accordance with EN 12898:2019, Clause 6.2.

Two different definitions of emissivity should be theoretically used to describe radiation exchange between:

a) glass surfaces facing each other in glazing;

b) a glass surface facing a room.

However, in practice numerical differences are found to be negligibly small. Thus corrected emissivity describes both types of heat exchange with a sufficient approximation.

NOTE For laminated glass and laminated safety glass where a low emissivity coating is in direct contact with an interlayer, the effect of the low emissivity coating is negated, in terms of U value.

The normal emissivity shall be truncated at three decimal places and then rounded to two decimal places. For the determination of the U value in accordance with this Standard, the correct emissivity shall not be rounded. Examples of normal emissivity truncated at three decimal places and then rounded to two decimal places are given in Table 1.