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

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

Glas im Bauwesen - Bestimmung des U-Wertes (Wärmedurchgangskoeffizient) - Berechnungsverfahren

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

Ta slovenski standard je istoveten z: **EN 673:2011**

ICS:

81.040.20	Steklo v gradbeništvu	Glass in building

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EUROPEAN STANDARD

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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 U-Werts (Wärmedurchgangskoeffizient) - Berechnungsverfahren

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Foreword

This document (EN 673:2011) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by August 2011, and conflicting national standards shall be withdrawn at the latest by August 2011.

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This document supersedes EN 673:1997.

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Introduction

CEN/TC 129/WG9 "Light and energy transmission, thermal insulation" prepared a working draft based on the document ISO/DIS 10292, "Thermal insulation of glazing: Calculation rules for determining the steady state U value of double or multiple glazing", document that was prepared by ISO/TC 160, "Glass in building". This was published in 1997 as EN 673.

This edition is a revision of EN 673:1997. The main change in this edition is that the internal and external heat transfer coefficients have been amended slightly to avoid any ambiguities. The original annex on the determination of emissivity has been removed and reference is made to EN 12898. Other changes include the incorporation of amendments A1 and A2 to EN 673:1997 and general improvements to the text to aid understanding.

1 Scope

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

This European Standard 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 and glass ceramic. 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[1)] (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 European Standard.

The standard for the calculation of the overall U value of windows, doors and shutters (see EN ISO 10077-1 [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 (see Bibliography, [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.

1) In some countries the symbol *k* has been used hitherto.

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

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 674, *Glass in building — Determination of thermal transmittance (U value) — Guarded hot plate method*

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

EN 12898, *Glass in building — Determination of the emissivity*

3 Terms and definitions

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

3.1
***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 The U value is given in watts per square metre Kelvin [W/(m^2·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	thickness of material layer (glass or alternative glazing material)	m
F	volume fraction	-
h	- heat transfer coefficient	W/(m^2·K)
	- also thermal conductance	W/(m^2·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	-
s	width of gas space	m
T	absolute temperature	K
U	thermal transmittance	W/(m^2·K)
ΔT	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 x 10^{-8}	W/(m^2·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	jth material layer
k	kth 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:

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

where

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

h_t is the total thermal conductance of the glazing,

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

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.

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

where

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

$h_{r,k}$ is the radiation conductance;

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

NOTE The thermal resistivity of components other than glass (e.g. interlayers in laminated glass) may be taken into account in determining the U value. For the purpose of this standard, thermal conductivity values used for glass in building should be obtained from the table of generally accepted values in the relevant product standard (e.g. EN 572-1 for basic soda lime silicate glass). 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.

5.3 Radiation conductance h_r

The radiation conductance is given by:

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

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 of the surfaces bounding the enclosed space between the panes at $T_{m,k}$.

5.4 Gas conductance h_g

5.4.1 General

The gas conductance is given by:

$$h_{g,k} = Nu \frac{\lambda_k}{s_k} \quad (5)$$

where

s_k is the width of the k^{th} space;

λ_k is the thermal conductivity of the k^{th} gas;

Nu is the Nusselt number.

$$Nu = A \cdot (Gr \cdot Pr)^n \quad (6)$$

where

A is a constant;

Gr is the Grashof number;

Pr is the Prandtl number;

n is an exponent.

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

$$Pr = \frac{\mu c}{\lambda} \quad (8)$$

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 Equation (6).

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

6 Basic material properties

6.1 Emissivity

The corrected emissivities ε of the surfaces bounding the enclosed spaces are required to calculate the radiation conductance h_r in Equation (4).

For uncoated soda lime glass surfaces or for soda lime glass surfaces with coatings which have no effect on the emissivity, the corrected emissivity to be used is 0,837.

NOTE 1 With reasonable confidence the same value may be used for uncoated borosilicate glass.

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