SLOVENSKI STANDARD
SIST EN 410:1999

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Steklo v stavbah - Doloļevanje svetlobnih in sonļnih karakteristik stekla

Glass in building - Determination of luminous and solar characteristics of glazing

Glas im Bauwesen - Bestimmung der lichttechnischen und strahlungsphysikalischen Kenngrößen von Verglasungen

Verre dans la construction - Détermination des caractéristiques lumineuses et solaires des vitrages

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ICS:

81.040.20 Steklo v gradbeništvu Glass in building

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English version

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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 Central Secretariat has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 129 "Glass in building", the secretariat of which is held by IBN.

CEN/TC 129/WG 9, "Light and energy transmission, thermal insulation", prepared a working draft based on the document ISO/DIS 9050, "Glass in building - Determination of light transmittance, solar direct transmittance, total solar energy transmittance and ultraviolet transmittance and related glazing factors", prepared by ISO/TC 160, "Glass in Building".

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of an identical text or by endorsement, at the latest by October 1998, and conflicting national standards shall be withdrawn at the latest by October 1998.

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.

1 Scope

This European Standard specifies methods of determining the luminous and solar characteristics of glazing in buildings. These characteristic can serve as a basis for lighting, heating and cooling calculations of rooms and permit comparison between different types of glazing.

This European Standard applies both to conventional glazing and to absorbing or reflecting solar-control glazing, used as vertical or horizontal glazed apertures. The appropriate formulae for single, double and triple glazing are given.

This European Standard is accordingly applicable to all transparent materials except those which show significant transmission in the wavelength region (5 to 50) µm of ambient temperature radiation, such as certain plastic materials.

Materials with light-scattering properties for incident radiation are dealt with as conventional transparent materials subject to certain conditions (see 4.2).

2 Normative references

This European standard, as appropriate incorporates by dated or undated references, 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 revision of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 673	Glass in building - Determination of thermal transmittance (*U* value) - Calculation method
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
prEN 1098	Glass in building - Measuring method for the determination of the thermal transmittance of multiple glazing (*U* Value) - Calibrated and guarded hot box method
prEN 12898	Glass in building - Determination of the emissivity

3 Symbols

Sym.	Deutsch/German/Allemand	Englisch/English/Anglais	Französisch/French/Français
D_{65}	Normlichtart D_{65}	standard illuminant D_{65}	illuminant normalisé D_{65}
UV	ultravioletter Strahlungsbereich	ultraviolet radiation	rayonnement ultraviolet
τ_{UV}	ultravioletter Transmissionsgrad	ultraviolet transmittance	facteur de transmission de l'ultraviolet
$\tau(\lambda)$	spektraler Transmissionsgrad	spectral transmittance	facteur de transmission spectrale
$\rho(\lambda)$	spektraler Reflexionsgrad	spectral reflectance	facteur de réflexion spectrale
τ_V	Lichtransmissionsgrad	light transmittance	facteur de transmission lumineuse
ρ_V	Lichtreflexionsgrad	light reflectance	facteur de réflexion lumineuse
τ_e	direkter Strahlungstransmissionsgrad	solar direct transmittance	facteur de transmission directe de l'énergie solaire
ρ_e	direkter Strahlungsreflexionsgrad	solar direct reflectance	facteur de réflexion directe de l'énergie solaire
g	Gesamtenergiedurchlaßgrad	total solar energy transmittance (solar factor)	facteur de transmission totale de l'énergie solaire ou facteur solaire
R_a	allgemeiner Farbwiedergabeindex	general colour rendering index	indice général de rendu des couleurs
D_λ	relative spektrale Verteilung der Normlichtart D_{65}	relative spectral distribution of illuminant D_{65}	répartition spectrale relative de l'illuminant normalisé D_{65}
$V(\lambda)$	spektraler Hellempfindlichkeitsgrad	spectral luminous efficiency	efficacité lumineuse relative spectrale
α_e	direkter Strahlungsabsorptionsgrad	solar direct absorptance	facteur d'absorption directe de l'énergie solaire
ϕ_e	Strahlungsleistung (Strahlungsfluß)	incident solar radiant flux	flux énergétique solaire incident

Sym.	Deutsch/German/Allemand	Englisch/English/Anglais	Französisch/French/Français
q_i	sekundärer Wärmeabgabegrad nach innen	secondary internal heat transfer factor	facteur de réémission thermique vers l'intérieur
q_e	sekundärer Wärmeabgabegrad nach außen	secondary external heat transfer factor	facteur de réémission thermique vers l'extérieur
S_λ	relative spektrale Verteilung der Sonnenstrahlung	relative spectral distribution of solar radiation	répartition spectrale relative du rayonnement solaire
h_e	Wärmeübergangskoeffizient nach außen	external heat transfer coefficient	coefficient d'échange thermique extérieur
h_i	Wärmeübergangskoeffizient nach innen	internal heat transfer coefficient	coefficient d'échange thermique intérieur
ε	korrigierter Emissionsgrad	corrected emissivity	émissivité corrigée
Λ	Wärmedurchlaßkoeffizient	thermal conductance	conductance thermique
λ	Wellenlänge	wavelength	longueur d'onde
$\Delta\lambda$	Wellenlängenintervall	wavelength interval	intervalle de longueur d'onde
U_λ	relative spektrale Verteilung der UV-Strahlung der Sonne	relative spectral distribution of UV in solar radiation	répartition spectrale relative du rayonnement ultraviolet solaire

4 Determination of characteristics

4.1 General

The characteristics are determined for quasi-parallel, near normal radiation incidence (see C.1) using the radiation distribution of illuminant D_{65} (see table 1), solar radiation in accordance with table 2 and ultraviolet (UV) radiation in accordance with table 3.

The characteristics are as follows:

- the spectral transmittance $\tau(\lambda)$ and the spectral reflectance $\rho(\lambda)$ in the wavelength range from (300 to 2500) nm;
- the light transmittance τ_v and the light reflectance ρ_v for illuminant D_{65};
- the solar direct transmittance τ_e and the solar direct reflectance ρ_e ;
- the total solar energy transmittance (solar factor) g ;
- the UV-transmittance τ_{UV};
- the general colour rendering index R_a.

To characterize glazing, the principal parameters are τ_v and g; the other parameters are optional to provide additional information.

If the value of a given characteristic is required for different glass thicknesses (in the case of uncoated glass) or for the same coating applied to different substrates, it can be obtained by calculation (in accordance with annex A).

4.2 Light transmittance

The light transmittance τ_v of the glazing is calculated using the following formula:

$$\tau_v = \frac{\sum_{\lambda=380\ \mathrm{nm}}^{780\ \mathrm{nm}} D_\lambda \tau(\lambda) V(\lambda) \Delta\lambda}{\sum_{\lambda=380\ \mathrm{nm}}^{780\ \mathrm{nm}} D_\lambda V(\lambda) \Delta\lambda} \qquad \text{...(1)}$$

where:

D_λ is the relative spectral distribution of illuminant D_{65} (see C.2);

$\tau(\lambda)$ is the spectral transmittance of the glazing;

$V(\lambda)$ is the spectral luminous efficiency for photopic vision defining the standard observer for photometry (see C.2);

$\Delta\lambda$ is the wavelength interval.

Table 1 indicates the values for $D_\lambda V(\lambda)\Delta\lambda$ for wavelength intervals of 10 nm. The table has been drawn up in such a way that $\Sigma D_\lambda V(\lambda)\Delta\lambda = 1$.

In the case of multiple glazing, the spectral transmittances $\tau(\lambda)$ are calculated from the spectral transmittances and reflectances of the individual components as follows :

For double glazing:

$$\tau(\lambda) = \frac{\tau_1(\lambda)\tau_2(\lambda)}{1-\rho'_1(\lambda)\rho_2(\lambda)} \qquad \text{...(2)}$$

where:

$\tau_1(\lambda)$ is the spectral transmittance of the outer pane;

$\tau_2(\lambda)$ is the spectral transmittance of the second pane;

$\rho'_1(\lambda)$ is the spectral reflectance of the outer pane, measured in the direction opposite to the incident radiation;

$\rho_2(\lambda)$ is the spectral reflectance of the second pane, measured in the direction of the incident radiation.

For triple glazing:

$$\tau(\lambda) = \frac{\tau_1(\lambda)\tau_2(\lambda)\tau_3(\lambda)}{[1-\rho'_1(\lambda)\rho_2(\lambda)].[1-\rho'_2(\lambda)\rho_3(\lambda)] - \tau_2^2(\lambda)\rho'_1(\lambda)\rho_3(\lambda)} \quad ...(3)$$

where:

$\tau_1(\lambda)$ $\tau_2(\lambda)$, $\rho'_1(\lambda)$ and $\rho_2(\lambda)$ are as explained in formula (2);

$\tau_3(\lambda)$ is the spectral transmittance of the third pane;

$\rho'_2(\lambda)$ is the spectral reflectance of the second pane, measured in the direction opposite to the incident radiation;

$\rho_3(\lambda)$ is the spectral reflectance of the third pane, measured in the direction of the incident radiation.

For glazing with more than three components, formulae similar to (2) and (3) are found to calculate $\tau(\lambda)$ of such glazing from the spectral coefficients of the individual components. As an example, glazing composed of five components may be treated as follows:

a) first consider the first three components as triple glazing and calculate the spectral characteristics of this combination;

b) next, run the same procedure for the next two components as double glazing;

c) then calculate $\tau(\lambda)$ for the five component glazing, considering it as double glazing consisting of the preceding triple and double glazing.

The use of an integrating sphere is necessary when light scattering materials are tested. In this case the size of the sphere and its aperture shall be large enough to collect all possible scattered light and to obtain fair average values when surface patterns are irregularly distributed.

4.3 Light reflectance

The light reflectance of the glazing ρ_v is calculated using the following formula:

$$\rho_v = \frac{\sum_{\lambda=380\text{ nm}}^{780\text{ nm}} D_\lambda \rho(\lambda) V(\lambda) \Delta\lambda}{\sum_{\lambda=380\text{ nm}}^{780\text{ nm}} D_\lambda V(\lambda) \Delta\lambda} \quad \text{...(4)}$$

where:

D_λ, $V(\lambda)$ and $\Delta\lambda$ are as explained in 4.2;

$\rho(\lambda)$ is the spectral reflectance of the glazing.

In the case of multiple glazing, the spectral reflectance $\rho(\lambda)$ is calculated from the spectral transmittances and the spectral reflectances of the individual components as follows.

For double glazing:

$$\rho(\lambda) = \rho_1(\lambda) + \frac{\tau_1^2(\lambda)\rho_2(\lambda)}{1-\rho_1'(\lambda)\rho_2(\lambda)} \quad \text{...(5)}$$

where:

$\tau_1(\lambda)$, $\rho_2(\lambda)$ and $\rho_1'(\lambda)$ are as explained in 4.2;

$\rho_1(\lambda)$ is the spectral reflectance of the outer pane, measured in the direction of incident radiation.

For triple glazing:

$$\rho(\lambda) = \rho_1(\lambda) + \frac{\tau_1^2(\lambda)\rho_2(\lambda)\left[1-\rho_2^{'}(\lambda)\rho_3(\lambda)\right] + \tau_1^2(\lambda)\tau_2^2(\lambda)\rho_3(\lambda)}{\left[1-\rho_1^{'}(\lambda)\rho_2(\lambda)\right].\left[1-\rho_2^{'}(\lambda)\rho_3(\lambda)\right] - \tau_2^2(\lambda)\rho_1^{'}(\lambda)\rho_3(\lambda)} \quad ...(6)$$

where:

$\rho_3(\lambda)$ is the spectral reflectance of the third pane, measured in the direction of the incident radiation;

τ_1, τ_2, ρ_1, ρ_2, $\rho_1^{'}$ and $\rho_2^{'}$ are as defined in 4.2 and 4.3.

For glazing with more than three elements the same method as described in 4.2 is used.

4.4 Total solar energy transmittance (solar factor)

4.4.1 Calculation

The total solar energy transmittance g is calculated as the sum of the solar direct transmittance τ_e and the secondary heat transfer factor q_i of the glazing towards the inside (see 4.4.3 and 4.4.6), the latter resulting from heat transfer by convection and longwave IR-radiation of that part of the incident solar radiation which has been absorbed by the glazing:

$$g = \tau_e + q_i \quad ...(7)$$

4.4.2 Division of incident solar radiant flux

The incident solar radiant flux ϕ_e is divided into the following three parts (see figure 1):

a) the transmitted part, $\tau_e\phi_e$;

b) the reflected part, $\rho_e\phi_e$;

c) the absorbed part, $\alpha_e\phi_e$;

where:

τ_e is the solar direct transmittance (see 4.4.3);

ρ_e is the solar direct reflectance (see 4.4.4);

α_e is the solar direct absorptance (see 4.4.5).