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Steklo v gradbeništvu - Določanje emisivnosti

Glass in building - Determination of the emissivity

Glas im Bauwesen - Bestimmung des Emissionsgrades

Verre dans la construction - Détermination de l'émissivité

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Glass in building - Determination of the emissivity

Verre dans la construction - Détermination de l'émissivité

Glas im Bauwesen - Bestimmung des Emissionsgrades

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European foreword

This document (EN 12898:2019) 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of an identical text or by endorsement, at the latest by September 2019, and conflicting national standards shall be withdrawn at the latest by September 2019.

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

This document supersedes EN 12898:2001.

The main changes compared to the previous edition are the following:

— introduction of a method to determine the emissivity using Fourier Transform Infrared (FTIR) spectrophotometers where the spectral range is limited;

— provision of a new method for the calculation of corrected emissivity; and

— clarification of rounding rules for normal emissivity.

In this version, the procedures covering transmittance and diffuse reflectance measurements and calculation of total normal transmittance have been moved to an informative annex (Annex C).

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

1 Scope

This document specifies a procedure for determining the emissivity at room temperature of the surfaces of glass and coated glass.

The emissivity is necessary for taking into account heat transfer by radiation from surfaces at the standard temperature of 283 K in the determination of the U value and of the total solar transmittance of glazing according to [1] to [4].

The procedure, being based on spectrophotometric regular reflectance measurements at near normal incidence on materials that are non-transparent in the infrared region, is not applicable to glazing components with at least one of the following characteristics:

a) with rough or structured surfaces where the incident radiation is diffusely reflected;

b) with curved surfaces where the incident radiation is regularly reflected at angles unsuitable to reach the detector while using regular reflectance accessories;

c) infrared transparent.

However, it can be applied with caution to any glazing component provided its surfaces are flat and non-diffusing (see 3.1.6) and it is non-transparent in the infrared region (see 3.1.7).

Although transmittance measurements are included in this document, they are only necessary to check if the sample is non-transparent in the infrared region in the context of this document (see 3.1.7). If the sample is transparent in the infrared region, this document is not applicable.

The previous version of this document was based on the use of reflectance measurements using double beam dispersive infrared spectrophotometers capable of measuring over almost the entire spectral range of a black body at the standard reference temperature and determining the emissivity by the 30 ordinate method [6]. This version takes account of Fourier Transform Infrared (FTIR) spectrophotometers where the spectral range is limited. It describes a method whereby spectrophotometers can be used to determine emissivity if they are able to measure up to the 24th ordinate point and if they satisfy a noise criterion for this spectral range. It allows the inclusion of data from the 25th ordinate point up to the 30th ordinate point. A new informative annex (Annex D) describing the principles of absolute reflection accessories has been added to this version. These accessories are intended to be used by qualified personnel.

As FTIR spectrophotometers are single beam instruments as opposed to dispersive spectrophotometers which are double beam instruments (and thus able to correct for instrument drift), a procedure was developed by the European funded project, THERMES, to correct for drift. This procedure is described in [10] and [16]. Other categories of ordinate errors using FTIR spectrophotometers are discussed in [14].

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviations

3.1 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 http://www.electropedia.org/

• ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
infrared
5 µm to 50 µm spectral range

3.1.2
emissivity
ratio of the energy emitted by a given surface at a given temperature to that of a perfect emitter (black body with normal and corrected emissivity = 1,0) at the same temperature

Note 1 to entry: Two different definitions of emissivity should theoretically be used to describe radiation exchange between:

a) glass surfaces facing each other in multiple glazing (effective emissivity);

b) a glass surface facing a room (hemispherical emissivity).

However, in practice numerical differences were found to be negligibly small (see [5]). Thus, corrected emissivity is used to describe both types of heat exchange with a close approximation.

3.1.3
specular reflectance
regular reflectance
reflectance according to the laws of geometrical optics, without the diffuse component

Note 1 to entry: The measurement arrangement should be such that the instrument beam reaches the detector after being specularly reflected on the surface of the sample (reference mirror) at an angle of incidence ≤ 10°.

3.1.4
diffuse reflectance
reflectance not containing any regular component, due to rough surfaces and/or transparent materials containing inhomogeneous particles

3.1.5
total reflectance
sum of regular and diffuse reflectance

3.1.6
non-diffusing glazing component
glazing component with a diffuse reflectance ≤ 0,05, measured at the near infrared wavelength of 2 µm (see Annex C)

Note 1 to entry: The purpose of this measurement is to ensure that the sample is non-diffusing in the measurement range. Most integrating spheres sold with visible/near infrared spectrophotometers have a port designed to measure diffuse reflectance. Diffuse reflectance measurements in the infrared range are difficult to perform.

3.1.7
glazing component non-transparent in the infrared region
glazing component with a total normal transmittance ≤ 0,05 at 283 K, measured spectrophotometrically

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

ε	total corrected emissivity at 283 K
ε_n	total normal emissivity at 283 K
E	reading of the spectrophotometer with the sample placed on the sample support of the reflectance accessory
E_0	the instrument reading without placing anything on the sample support
E_{st}	the instrument reading with the reference mirror replacing the sample
R_n	total normal reflectance at 283 K
$R_n(\lambda_i)$	spectral normal reflectance at wavelength λ_i
$R_{n,st}$	spectral normal reflectance of the reference mirror
$T_n(\lambda_i)$	spectral normal transmittance at wavelength λ_i
T_n	total normal transmittance at 283 K
N	number of measurement points to determine total normal reflectance

4 Brief outline of the procedure to determine corrected emissivity

The procedure for determining the corrected emissivity of coated glass surfaces includes the following steps:

a) the spectral regular reflectance of a glazing component non-transparent in the infrared region at near normal incidence, $R_n(\lambda_i)$, shall be determined with an infrared spectrophotometer in the range (5 to 50) µm (see Clause 5);

b) total normal reflectance at 283 K, R_n, shall be calculated using the integration procedure specified in 5.4 from the corresponding spectral reflectance values measured according to step a);

c) total normal emissivity, ε_n, shall be calculated from the total normal reflectance as specified in Clause 6;

d) the corresponding corrected emissivity, ε, shall be determined from the normal emissivity in accordance with Formula (6).

NOTE 1 The corrected emissivity, calculated from the normal emissivity with the help of a multiplicative correction factor, takes into account the effect of the angular distribution of emissivity in the heat transfer calculations of glazing according to [1] to [4].

NOTE 2 Both the normal and the corrected emissivity are total emissivities at 283 K, i.e. they are integrated over the relevant spectral range using as a weighting function Planck's radiation function for a black body at 283 K (see [6]).

For uncoated soda lime silicate glass surfaces or for soda lime silicate glass surfaces with coatings which have no effects on the emissivity, the normal emissivity to be used in the calculations specified in [1] to [4] shall be 0,89 (see [7]). For all other glazing materials or components it shall be measured.

NOTE 3 With reasonable confidence ε_n = 0,89 can be used for uncoated borosilicate glass, glass ceramics, alkaline earth silicate glass and alumino silicate glass (see [7]).

NOTE 4 For temperatures included in the range 253 K to 313 K emissivity is not strongly dependent on the temperature (see [7] and [8]).

5 Spectral normal reflectance measurements and calculations

5.1 Sample preparation

Samples shall be of a size suitable for being inserted into the sample compartment or placed on the reflectance accessory. In doing so, care shall be taken to ensure that the portion of the coated surface probed by the instrument beam is free of damage or any surface contamination. The procedures recommended by the producer for storing the samples and cleaning their surfaces shall be followed.

The sample shall be supported in a suitable way to ensure that the measuring spot during transmittance and reflectance measurements falls on a flat part.

5.2 Spectral normal reflectance measurements

5.2.1 General

The spectral regular reflectance curve of the sample at near normal incidence between 5 µm and 50 µm shall be determined with an infrared spectrophotometer equipped with a specular reflectance accessory at near normal incidence.

5.2.2 Test apparatus

The following equipment shall be used for the measurements:

— a spectrophotometer covering the spectral range 5 µm to 50 µm. Alternatively, a spectrophotometer that covers the spectral range from 5 µm to a wavelength less than 50 µm can be used as long as it is capable of measuring up to the 24th point (23,3 µm) and satisfying the noise criterion (see 5.4.3) for all points up to the 24th point inclusive;

— a reference mirror (free of surface scratches and contamination, see [6], [8] and [9]) whose spectral regular reflectance at near normal incidence Rn,st (λ) shall be traceable to a standard material from a metrological laboratory [15];

— a specular reflectance accessory consisting of a suitable array of mirrors and a sample support. When the accessory is placed in the sample compartment of the spectrophotometer and the sample (or reference mirror) placed on the sample support, the instrument beam reaches the detector after being specularly reflected on the surface of the sample (reference mirror) at an angle of incidence ≤ 10°.

As an alternative, Annex D provides a method for determining absolute reflectance by comparing the energy of the beam reflected from the sample to that of the incident beam. However, these accessories can be difficult to align and should be used with caution.

5.2.3 Measurement

The spectral regular reflectance curve of the sample at near normal incidence shall be determined with the relative method. The following measurements are required to determine the spectral normal reflectance of the sample R_n (λ_i) at each wavelength λ_i reported in Table A.1 of Annex A:

— E the instrument reading with the sample placed on the sample support of the reflectance accessory;

— E_{st} the instrument reading with the standard reference mirror replacing the sample;

— E_0 the instrument reading without placing anything on the sample support.

These wavelengths are selected at the centre of equal energy wavelength intervals of Planck's radiation function at 283° K [6].

Measurements shall be taken at each wavelength λ_i reported in Table A.1 over the wavelength range for which the spectrophotometer is capable.

At each wavelength λ_i the sample normal reflectance R_n (λ_i) shall be calculated as follows:

$$R_n(\lambda_i) = \frac{E(\lambda_i) - E_0(\lambda_i)}{E_{st}(\lambda_i) - E_0(\lambda_i)} \cdot R_{n,st}(\lambda_i) \quad (1)$$

with $R_{n,st}$ (λ_i) = spectral normal reflectance of the reference mirror at the wavelength λ_i.

5.2.4 Accuracy

The accuracy is estimated to be of the order of ± 0,01, expressed as absolute uncertainty of regular reflectance (see [6]).

NOTE In Annex B, information on procedures to improve the measurement accuracy is given.

5.3 Interpolation

If the spectra are measured at fixed wavelength or wavenumber intervals, then the reflectance and, if necessary, transmittance values corresponding to the wavelength intervals detailed in Table A.1 shall be linearly interpolated from the neighbouring wavelength points of the spectrum.

5.4 Determination of normal reflectance

5.4.1 General

The spectrophotometer shall be capable of measuring normal reflectance up to the 24th point (i.e. 23,3 µm) as detailed in Table A.1 and in accordance to the noise criterion described in 5.4.3. Thus, a minimum of the first 24 points shall be used in Formula 2. In addition, points 25 through 30 can be included, provided that they satisfy the noise criterion in a consecutive order. For example, if the 27th point satisfies the noise criterion, it should only be used in the calculations if both the 25th and 26th points also satisfy the noise criterion.

NOTE 24 is considered to be the minimum number of points needed to capture an acceptable amount of the black body curve while acknowledging the current measurement capability (see [17]).