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Glass in building — Determination of steady-state U values (thermal transmittance) of multiple glazing — Guarded hot plate method

Verre dans la construction — Détermination du coefficient de transmission thermique U, en régime stationnaire des vitrages multiples — Méthode de la plaque chaude gardée

Reference number
ISO 10291:1994(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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Glass in building — Determination of steady-state U values (thermal transmittance) of multiple glazing — Guarded hot plate method

1 Scope

This International Standard specifies a measuring method used to determine the coefficient of thermal transmittance, the *U*-value, of multiple glazing with flat and parallel surfaces, including cast and figured rolled glass.

It applies to multiple glazing with outer panes which are not transparent to far-infrared radiation, which is the case for normal window glass. However internal elements may be far-infrared transparent.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 8302:1991, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus.*

ISO 10292:1994, *Glass in building — Calculation of steady-state U values (thermal transmittance) of multiple glazing.*

3 General

This International Standard makes possible the determination of the coefficient of thermal transmittance, the *U*-value, in the central area of the multiple glazing. Edge effects, due to the thermal bridge through the spacer of a sealed glazing unit or through the frame are not included. Neither is energy transfer due to solar radiation taken into account.

The determination of the coefficient of thermal transmittance is performed for conditions which will correspond to the average situation for glazing in practice. In this way a fair comparison between different products becomes possible.

4 Basic equations and units

The coefficient of thermal transmittance, the *U*-value, of glazing characterizes the heat transfer through the central part of the glazing, i.e. without edge effects, and defines the steady-state density of heat transfer per unit of time, per surface area unit and per temperature difference between the ambient temperatures on each side. The *U*-value is given in watts per square metre kelvin [$W/(m^2 \cdot K)$].

The U-value depends on the thermal resistance of the multiple glazing and the external and internal surface heat transfer coefficients according to the following relation:

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

where

R is the thermal resistance of the multiple glazing, in square metres kelvin per watt $(m^2 \cdot K/W)$;

h_e is the external surface heat transfer coefficient, in watts per square metre kelvin $[W/(m^2 \cdot K)]$;

h_i is the internal surface heat transfer coefficient, in watts per square metre kelvin $[W/(m^2 \cdot K)]$.

In accordance with this International Standard, the thermal resistance of multiple glazing is measured using the guarded hot plate method. The U-value is then derived from equation (1).

5 Brief outline of measuring method

The thermal resistance of the multiple glazing is determined by means of the guarded hot plate method laid down in ISO 8302, respecting its detailed recommendations.

Within this context further requirements are necessary. The sizes of the test specimens and the performance of the measurements are laid down to meet special requirements for measuring multiple glazings (see clauses 6 to 9).

6 Test apparatus

The measurement equipment is a two-specimen apparatus. Figure 1 gives a general outline of this apparatus including some requirements specific to the measurement of multiple glazings.

Two nearly identical square specimens are placed either side of a heating unit. The thermal flux flows through the specimens to the cooling units.

The heating unit consists of a separate central metering section, where the unidirectional constant heat flux can be established surrounded by a guard section separated by a narrow gap. The metering section measures 500 mm × 500 mm. The cooling units have surface dimensions at least as large as those of the heating unit, including the guard heater.

The specimens shall be of such a size as to cover the heating unit surface completely. Additional edge insulation and/or auxiliary guard sections are required as stated in ISO 8302.

7 Specimen dimensions

The specimens shall be square and preferably be 800 mm × 800 mm. The maximum range is from 750 mm × 750 mm to 850 mm × 850 mm.

The two specimens needed for measurement shall be as nearly identical as possible. The difference in thickness between the two specimens, measured at the edges, shall not be more than 2 %.

The specimen surfaces shall be parallel. This is also required for specimens with a textured surface (cast glass, figured rolled giass).

8 Preparation of specimens

The sum of bowing or dishing of the outer panes in the central area of the specimens shall not exceed 0,5 mm. The check of bowing or dishing effects shall be carried out after cooling the specimens until isothermal equilibrium is reached at 10 °C, and by measuring immediately before the specimens are positioned in the measurement apparatus.

In the case of too high a bowing, a correction of the thickness of the specimens in the central area may be made by a corresponding pressure reduction. In the case of too high a dishing, a correction by insertion of air is only allowed if the needed correction does not exceed 0,5 mm.

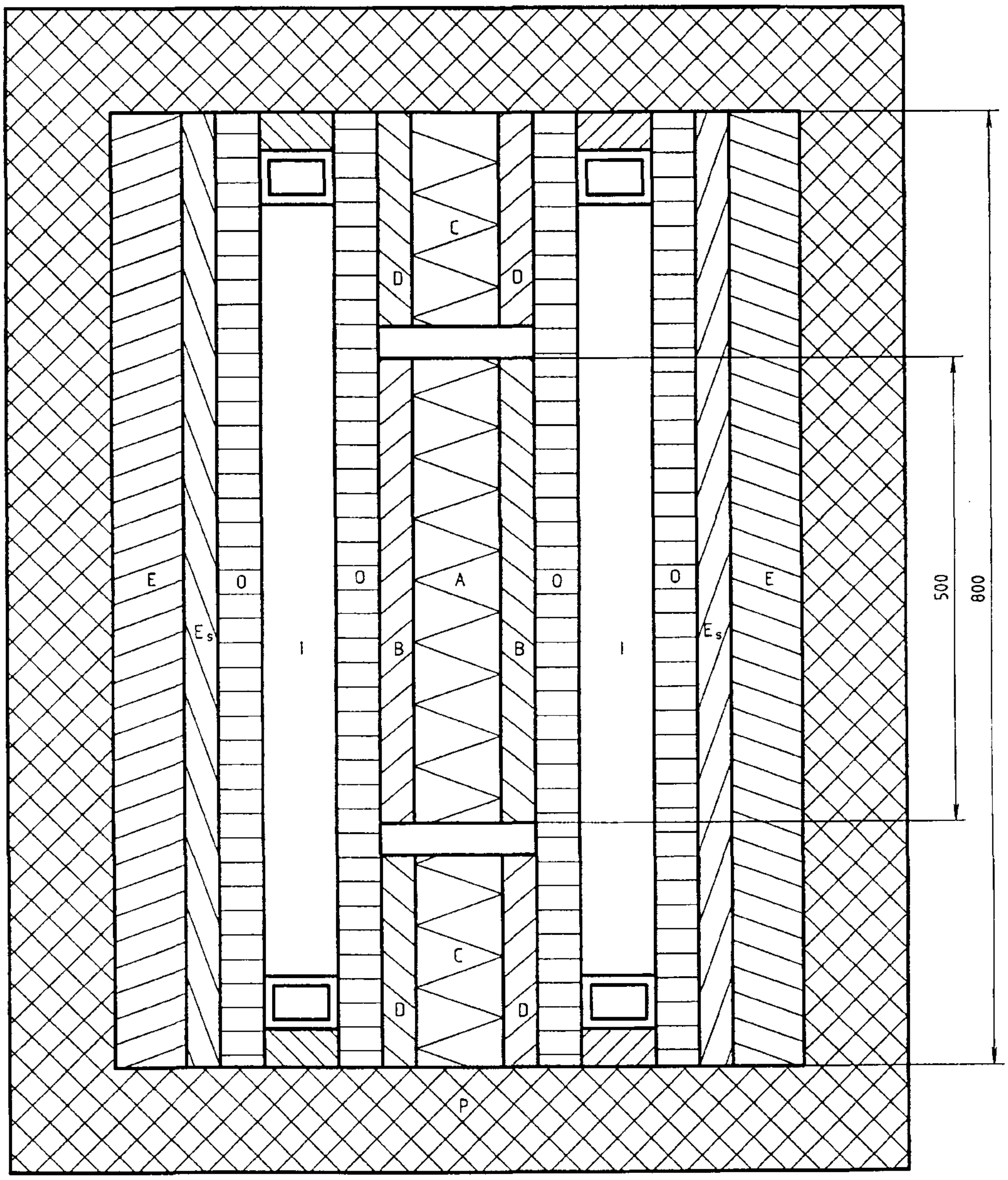
9 Measurements

The measurements are usually made with the specimens vertical.

To ensure sufficient contact between the specimens and the adjacent surface plates, pieces of natural rubber sponge about 3 mm thick are used.

Measurements are performed at a mean temperature for each specimen of (10 ± 0,5) °C. The mean temperature difference between the hot and cold specimen surfaces is (15 ± 1) °C.

Dimensions in millimetres



A	Metering area heater	Metering section of heating unit
B	Metering area surface plates	
C	Guard section	Guard section of heating unit
D	Guard surface plates	
E	Cooling units	
E_s	Cooling unit surface plates	
I	Specimens	
O	Rubber sponge	
P	Insulating material	

Figure 1 — Measuring equipment outline

10 Calculation and expression of results

10.1 Thermal resistance of multiple glazing

The thermal resistance, R, in square metres kelvin per watt $\left(\mathrm{m^2 \cdot K/W}\right)$, is calculated with the following equation:

$$R = \frac{2A(T_1 - T_2)}{\Phi} \qquad \ldots (2)$$

where

A is the metering area, in square metres;

T_1 is the average specimen hot side temperature, in kelvins;

T_2 is the average specimen cold side temperature, in kelvins;

Φ is the average power supplied to the central section of the heating unit, in watts.

10.2 Coefficient of thermal transmittance

The coefficient of thermal transmittance, U, is calculated according to equation (1).

For normal multiple glazing, i.e. glazing without a low-emissivity coating on the outer surface, the following values for the surface heat transfer coefficients are used:

— internal surface heat transfer coefficient: $h_i = 8\ \mathrm{W/\left(m^2 \cdot K\right)}$

— external surface heat transfer coefficient: $h_e = 23\ \mathrm{W/\left(m^2 \cdot K\right)}$

NOTE 1 The reciprocal values of h_e and h_i, expressed to two significant decimals, are as follows:

$1/h_e = 0{,}04\ \mathrm{m^2 \cdot K/W}$ and $1/h_i = 0{,}13\ \mathrm{m^2 \cdot K/W}$

For multiple glazing with a low-emissivity coating facing inward, h_i, in watts per square metre kelvin, is modified according to the following equation:

$$h_i = 3{,}6 + 4{,}4 \frac{\varepsilon}{0{,}837}$$

where ε is the corrected emissivity of the surface for room temperature radiation ($\varepsilon = 0{,}837$ for window glass). The corrected emissivity is determined as in ISO 10292.

NOTE 2 Values for ε lower than 0,837 (due to low-emissivity coatings) should only be taken into account if water condensation on the coated surface can be excluded.

Improvements of the U-value due to external-facing coated surfaces should not be taken into account.

If other values of h_e and h_i are used to meet special conditions, these values shall be indicated in the test report.

11 Test report

The test report shall indicate the following elements:

a) identification of specimens:

- — length, in millimetres,
- — width, in millimetres,
- — thickness measured at the edges, in millimetres,
- — thickness of the glass panes, in millimetres,
- — thickness of gas space measured at the edges, in millimetres,
- — type of gas filling,
- — position of any IR-reflecting coating(s),
- — bowing or dishing, in millimetres;

b) cross-section of the specimen: a figure shall show the structure of the specimen (position and thickness of glass panes, position and thickness of gas spaces, type of gas filling, position of internal foils, position of IR-reflecting coatings, etc.);

c) measurement results:

- — mean surface temperature on the hot side of the specimens, in kelvins,
- — mean surface temperature on the cold side of the specimens, in kelvins,

— mean temperature difference between the hot and cold sides of the specimens, in kelvins,

— mean temperature of the specimens, in kelvins,

— thermal resistance, in square metres kelvin per watt (to three significant figures),

— h_i and h_e, in watts per square metre kelvin, if non-standardized values have been used,

— U-value, in watts per square metre kelvin (to one decimal place).

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Descriptors: construction materials, thermal insulation, glass, plate glass, glazing, multiple glazing, thermodynamic properties, heat transfer, tests, determination, thermal resistance, thermal measurement.

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