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Glass in buildings — Insulating glass —

Part 1: Durability of edge seals by climate tests

Verre dans la construction — Verre isolant —

Partie 1: Résistance des fermetures de côté par essais climatiques

Reference number
ISO 20492-1:2008(E)

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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

ISO 20492-1 was prepared by Technical Committee ISO/TC 160, *Glass in building*, Subcommittee SC 1, *Product considerations*.

ISO 20492 consists of the following parts, under the general title *Glass in buildings — Insulating glass*:

— *Part 1: Durability of edge seals by climate tests*

— *Part 2: Chemical fogging tests*

— *Part 3: Gas concentration and gas leakage*

— *Part 4: Test methods for the physical attributes of edge seals*

Introduction

This part of ISO 20492 consists of a series of procedures for testing the performance of pre-assembled, permanently sealed insulating glass units or insulating glass units with capillary tubes that have been intentionally left open. This part of ISO 20492 is intended to help ensure that

— energy savings are made, as the U-value and solar factor (solar-heat gain coefficient) do not change significantly;

— health is preserved, because sound-reduction and vision do not change significantly;

— safety is provided, because mechanical resistance does not change significantly.

This part of ISO 20492 also covers additional characteristics that are important to the trade and includes the marking of the product (i.e., the CE marking or markings of other regulatory groups).

It is necessary to consider distinct markets for insulating glass. As within each market there are technical differences with respect to rebate sizes, vision lines and methods of application, two approaches are included in this part of ISO 20492. Approach 1 addresses requirements for markets such as North America. Approach 2 addresses requirements for markets such as Europe. Each approach includes separate test methods and specifications pertaining to minimum requirements for the durability of edge seals as determined by climate tests.

This part of ISO 20492 does not cover physical requirements of sealed-glass insulating units such as appearance, thermo-physical properties, heat and light transmission and glass displacement.

The main intended uses of the insulating glass units are installations in buildings and construction, such as in windows, doors, curtain walling, skylights, roofs and partitions where protection against direct ultraviolet radiation exists at the edges.

NOTE In cases where there is no protection against direct ultraviolet radiation at the edges, such as structural-sealant glazing systems, it is still necessary to review factors such as sealant longevity when exposed to long term ultraviolet light and the structural properties of the sealant for these applications. For more information on the requirements for structural-sealant glazing applications, reference can be made to ASTM C1369 [1], ASTM C1249 [2] and ASTM C1265 [3].

The test methods in this part of ISO 20492 are intended to provide a means for testing the performance of the sealing system and construction of sealed, insulating glass units.

Sealed, insulating glass units tested in accordance with these method are not intended for long-term immersion in water.

The options for testing apply only to sealed, insulating glass units that are constructed with glass.

The methods of this part of ISO 20492 might not be applicable in certain cases, such as for insulating glass units containing spandrel glass or absorptive coatings, as these products can experience field temperatures that exceed the temperature limitations of the sealant.

Glass in buildings — Insulating glass —

Part 1:
Durability of edge seals by climate tests

1 Scope

This part of ISO 20492 establishes two methods for testing the durability of edge seals of insulating glass units by means of climate tests. The two methods are designated as Approach 1 for markets such as North America and Approach 2 for markets such as Europe.

This part of ISO 20492 is applicable to pre-assembled, permanently sealed, insulating glass units with one or two airspaces, and with capillary tubes that are intentionally left open to equalize pressure inside the unit with the surrounding atmosphere.

This part of ISO 20492 is not applicable to sealed, insulating glass units that contain a spandrel glass coating.

This part of ISO 20492 does not apply to insulating glass (IG) units whose function is decorative only.

2 Normative references

The following reference documents are indispensable for the application of this document. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 760, *Determination of water — Karl Fischer method (General method)*

EN 572-1, *Glass in building — Basic soda lime silicate glass products — Definitions and general physical and mechanical properties*

EN 572-2, *Glass in building — Basic soda lime silicate glass products — Float glass*

EN 1279-1, *Glass in building — Insulating glass units — Part 1: Generalities, dimensional tolerances and rules for the system description*

ASTM E546, *Standard Test Method for Frost Dew Point of Sealed Insulating Glass Units*

ASTM E631, *Standard Terminology of Building Constructions*

ASTM C1036, *Standard Specification for Flat Glass*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1279-1, ASTM E631 and the following apply.

3.1
standard laboratory conditions
ambient temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %

3.2
standard moisture-adsorption capacity
capacity of a desiccant material to adsorb a quantity of moisture under controlled limit environmental conditions

3.3
controlled limit environmental conditions
environment temperature of 10 °C with a dew-point temperature of – 5 °C, giving a relative humidity of 32,8 %

3.4
moisture penetration index
amount of drying capacity consumed after standardized ageing conditions

3.5
accuracy
accuracy of the test method itself within statistical confidence limits of 99 %

3.6
frost/dew point
temperature at which water, organic vapour or other chemicals begin to appear on the interior glass surface of a sealed, insulating glass unit

3.7
sealed, insulating glass unit
pre-assembled unit consisting of panes of glass that are sealed at the edges and separated by dehydrated space(s), intended for use in buildings

NOTE The unit is normally used for windows, window walls, picture windows, sliding doors, patio doors, or other types of fenestration.

4 Symbols and abbreviated terms

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

I moisture penetration index (can be expressed in decimal or in percentage terms)

I_{av} average value of the moisture penetration index, I, based on five measurements

m_c mass of dish plus desiccant plus water adsorbed from 32 % r.h. air

m_f mass of dish plus desiccant plus water initially adsorbed plus water adsorbed when subjected to the climate conditions in the chamber

m_i mass of dish plus desiccant plus water initially adsorbed

M_m mass of desiccant in mixtures with non-desiccant material

m_r mass of dish plus desiccant plus water adsorbed in equilibrium with a defined reference level of relative humidity of air, or dish plus dried desiccant at high temperatures

M_t total mass of desiccant when, for the purpose of testing, in a mixture with non-desiccant material, the non-desiccant material is replaced by the same volume of desiccant

m_o mass of dish when empty, clean and dry

R ratio between the masses of desiccant M_m and M_t

r.h. relative humidity

T_c standard moisture adsorption capacity of desiccant

$T_{c,av}$ average standard moisture adsorption capacity of desiccant, T_c, obtained over two measurements

T_f final moisture content of desiccant

$T_{f,u}$ uncorrected final moisture content of desiccant

T_i initial moisture content of desiccant

$T_{i,av}$ average initial moisture content of desiccant, T_i, obtained over four measurements

$T_{i,u}$ uncorrected initial moisture content of desiccant

Θ temperature of test specimens in test chamber

Θ_c temperature of the central test specimen in test chamber during constant temperature phase

Θ_h high temperature of the central test specimen in the test chamber during the high humidity/temperature cycling phase

Θ_l low temperature of the central test specimen in the test chamber during the high humidity/temperature cycling phase

Θ_s temperature of the central test specimen in the test chamber as the cycle moves between high temperature and low temperature and vice versa

5 Requirements

5.1 Approach 1 — Final frost/dew point

The six test specimens that complete the weather cycle and high-humidity phases of the test in 6.1 shall be unbroken and without deposits in the airspaces.

The final frost/dew points of all airspaces shall be -40 °C or colder when measured in accordance with ASTM E546 or equivalent.

5.2 Approach 2 — Moisture-penetration index

The following values shall be verified on test specimens that are submitted to the climate test.

— The average moisture penetration index, I_{av}, over the five test specimens shall not exceed 0,20.

— The average moisture penetration index, I_{av}, shall be the average over five test specimens. Where a test specimen is broken, a spare test specimen shall be used instead.

NOTE Breakage of the glass in a test specimen does not constitute failure of the test specimen.

— The specimen with the highest moisture penetration index, I, shall have an index value that does not exceed 0,25.

6 Test methods

6.1 Approach 1

6.1.1 Principle

The frost/dew point of the test specimens is measured and the test specimens are then pre-conditioned for a specified time in a high-humidity chamber with constant high temperature and high humidity. The test specimens are then placed in a weather-cycling chamber where temperature, UV and moisture are varied to specified parameters for a specified number of cycles. After cycling, the test specimens are then returned to the high-humidity chamber for final conditioning. After final conditioning, the test specimens are evaluated for the final frost/dew point.

6.1.2 Test specimens

Each test specimen shall measure (355 ± 6) mm wide by (505 ± 6) mm high and shall be composed of two or three panes of clear, tinted or coated annealed, heat-strengthened, tempered or laminated glass.

The double-glazed test specimens shall be fabricated with at least one pane of clear, uncoated glass. The triple-glazed test samples shall be fabricated with at least one outer pane of clear, uncoated glass. The other outer pane shall be fabricated with a glass that allows easy viewing of the frost/dew point.

For double-glazed test specimens, the glass and airspace thicknesses of the test specimens shall be 4 mm glass with 12 mm airspace, or 5 mm glass with 6 mm airspace.

For triple-glazed test specimens, 4 mm glass with 6 mm airspaces shall be used.

The tolerances of glass thickness shall be in accordance with ASTM C1036.

The airspace tolerances shall be ± 0,8 mm.

A minimum of six double-glazed test specimens shall be submitted for testing.

NOTE 1 However, it is recommended to submit an additional three test specimens in case of breakage.

Triple-glazed, sealed, insulating glass units that have a plastic film as the intermediate airspace divider shall be acceptable as test specimens.

NOTE 2 The overall sealed, insulating glass unit thickness has some limits. Testing laboratories are usually able to accommodate 30 mm overall thickness. If thicker sealed, insulating glass units are being tested, it is necessary to contact the testing laboratory prior to manufacturing to ascertain their capabilities for testing thicker units.

Each test specimen shall be permanently and legibly marked with the designation of the manufacturer, the date of fabrication (month or quarter and year) and orientation intended in the field (for units constructed with coated glass).

During all stages of exposure and storage, the test specimens shall be held in a vertical position, with equal support to all panes and no compression loading.

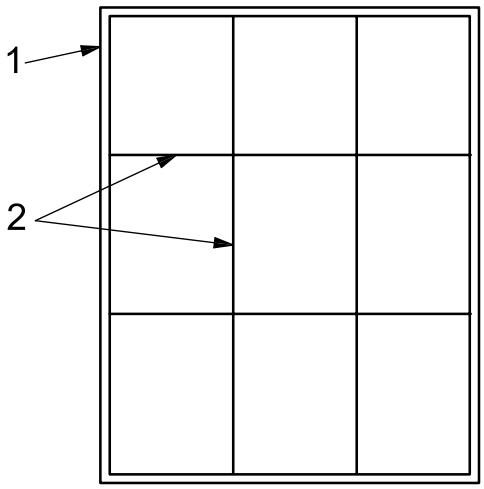
The selection of sealed, insulating, glass units for testing shall be made at random, except for sealed, insulating, glass units that have been damaged in transit. Damaged sealed, insulating, glass units shall not be tested.

Test specimens representing units that are gas-filled shall be fabricated using the same hole-sealing and gas-filling techniques as those used for manufacturing. For example, if a gas-filling plug is used in manufacturing the sealed insulating glass unit, then it should also be used in manufacturing the test specimens.

It is not necessary for the submitted test specimens to be filled with gas provided that the gas is classified as inert. Test specimens that represent sealed, insulating, glass units that are normally filled with an inert gas during manufacture may be submitted air-filled for testing, as long as the test specimens have been manufactured with the same techniques as the sealed, insulating, glass units.

The test specimens representing sealed-glass insulating units that include tubes intended to be left open shall be fabricated with one tube. This tube shall be left open during testing. Test specimens representing sealed, insulating glass units that include tubes intended to be closed off after shipping shall be fabricated with one tube. The exterior end of this tube shall be closed prior to testing.

For test specimens representing sealed-glass insulating units that include internal components in the airspace, the grid formed by these components shall divide the test specimen into nine equal areas (3×3; see Figure 1).



Key

1 insulating glass spacer/edge seal

2 internal grids

Figure 1 — Test specimen with internal grids

Measures shall be taken to ensure that there is a clear view of the interior glass surface for the detection of frost.

NOTE 3 Stains or scum that cannot be removed through cleaning are allowed to remain on the exterior glass surface of the specimen after the accelerated weathering test. To counteract this, for example, place a mask of plastic tape 50 mm by 50 mm (or larger) on the central region of both exterior glass surfaces before exposing the test specimen to weathering conditions. Remove the mask for frost/dew point measurement.

The sealed insulating glass units should be sealed a minimum of 4 weeks from the date of manufacture to allow for stabilization before testing.

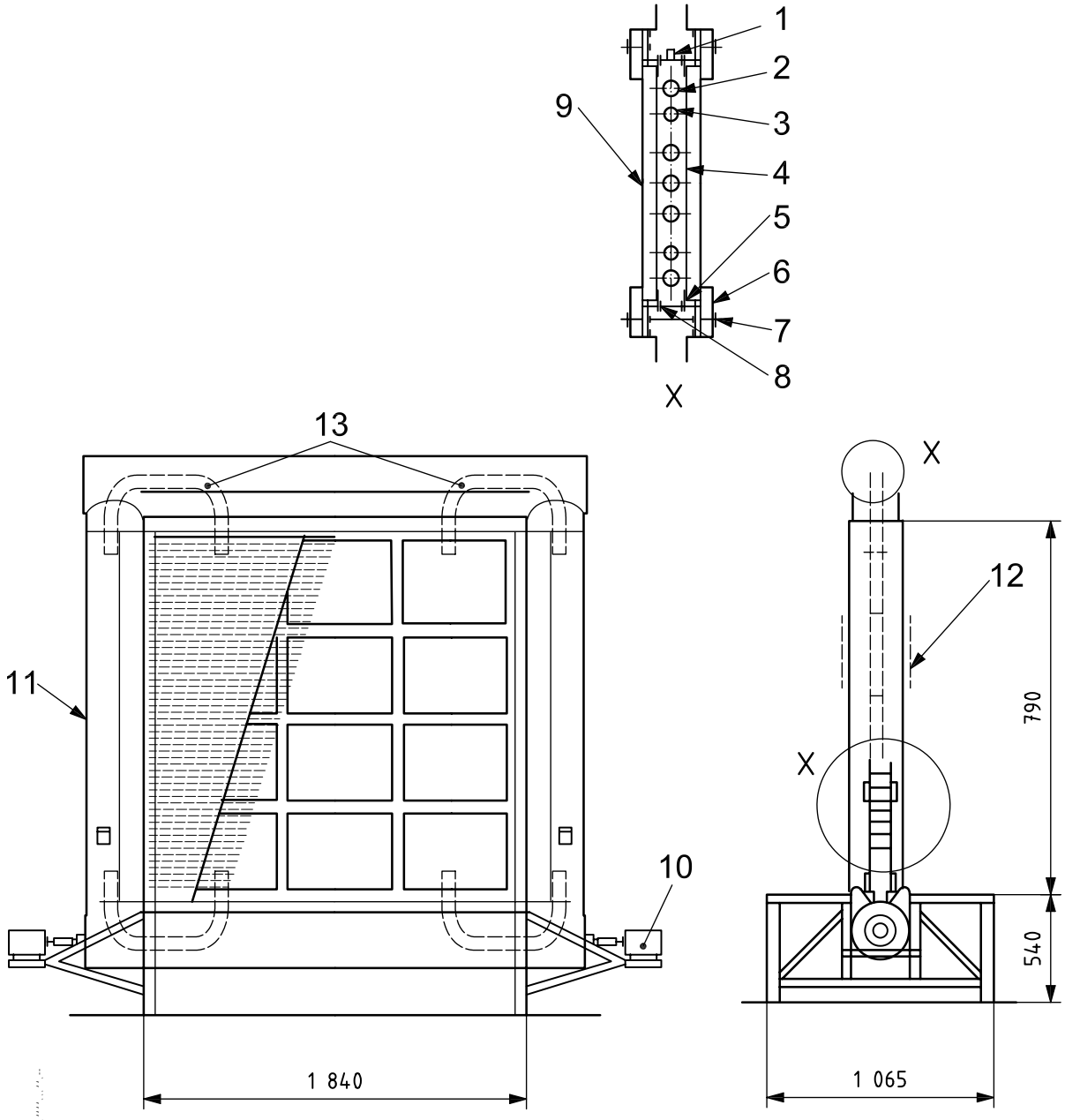
Breakage of only two test specimens as a result of testing shall be permitted throughout the test. If more than two test specimens are broken during the test, the relevant set of test specimens shall fail the test. Breakage due to laboratory handling is not considered as test breakage. Units broken due to laboratory handling shall be replaced and tested from the beginning.

6.1.3 Apparatus

6.1.3.1 High-humidity test chamber, capable of maintaining (60 ± 3) °C and 95 % ± 5 % r.h. The high-humidity test chamber shall be protected from overheating with protective devices, including one or more temperature sensors and a continuous temperature-recording device placed in an area in the chamber that monitors the average temperature inside the chamber.

6.1.3.2 Weather-cycle test chamber, capable of providing the required test conditions specified in 6.1.4.6 to 6.1.4.16. (see Figures 2 to 4). Modifications to the weather-cycle test chamber shall be acceptable as long as the required test conditions indicated in 6.1.4.2 are met. The chamber shall be protected from overheating and from overcooling with protective devices. It shall be equipped with one or more temperature sensors and a continuous temperature-recording device placed in an area that monitors the average temperature inside the chamber.

Dimensions in millimetres

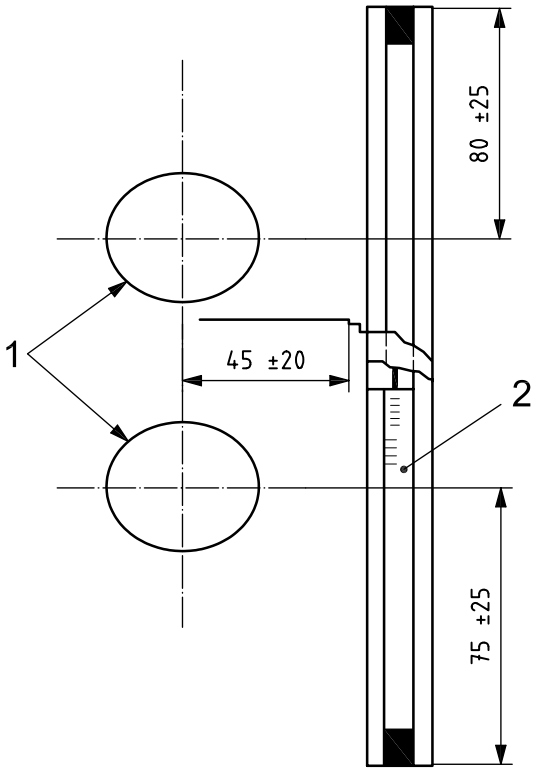


Key

1 fog or mist spray
2 cooling coil
3 fluorescent black light lamp F72T12BL/HO
4 heating coil
5 rubber pad
6 polystyrene insulation
7 rubber washer
8 clamping device
9 test specimen
10 fan motor
11 air duct
12 insulation
13 air flow

Figure 2 — Typical weather-cycle test chamber (Approach 1)

Dimensions in millimetres



Key

1 fluorescent black light lamps F72T12BL/HO

2 test specimen

Figure 3 — Location of fluorescent black-light lamp relative to the test specimen

NOTE The weather-cycle test apparatus is a modification of the device developed by the Institute for Research in Construction (IRC) of the National Research Council of Canada. One modification is to expose each test specimen to two black light lamps.

DANGER — Light from the ultraviolet sources used in this test method is harmful, especially to the eyes. Appropriate protective measures should be implemented as prescribed by the light source manufacturer.

6.1.3.3 **Ultraviolet light source**, consisting of two fluorescent black-light lamps, type F72T12BL/HO, for each test specimen (see Figure 2). Each lamp shall be replaced when its ultraviolet light intensity falls below 10 W/m^2 (1 000 µW/cm^2) when measured with a long-wave ultraviolet meter that is in direct contact with the lamp.

6.1.4 Procedure

6.1.4.1 In accordance with ASTM E546 or equivalent, determine the initial frost/dew point of all airspaces on all test specimens that have been submitted.

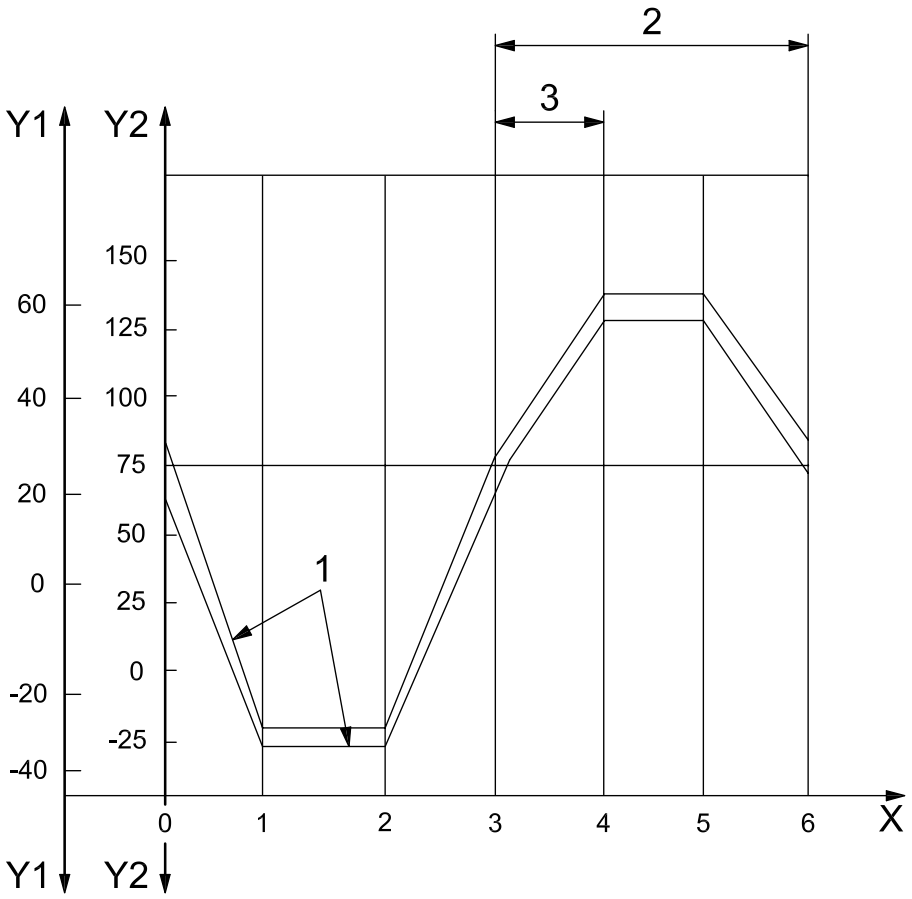
6.1.4.2 Place six test specimens in the high-humidity test chamber and arrange the test specimens so that each specimen has at least 6 mm (1/4 in) clearance all around.

6.1.4.3 Expose the six test specimens in the high-humidity test chamber to a temperature of (60 ± 3) °C and 95 % ± 5 % r.h.

6.1.4.4 After 14 days, remove the test specimens. Allow the temperature of the test specimens to equilibrate to (23 ± 3) °C for at least 24 h.

6.1.4.5 Determine the frost/dew point in accordance with ASTM E546 or equivalent. For triple-glazed, sealed, insulating glass units, determine the frost/dew point for all airspaces. If liquid appears, record the temperature of its appearance.

6.1.4.6 Place the six test specimens inside the weather-cycle chamber (see Figure 2), taking care that no stress is induced in the test specimens by the method of fastening. The test specimens shall be oriented in the weather-cycle chamber so that the glass surface that experiences weather changes in field exposure is the same that faces the changes in the chamber. The other side of glass surface of each specimen shall be exposed to room temperature [(23 ± 3) °C].



NOTE This figure represents the ideal cycle described in 6.1.4.2. Any temperature variation within the tolerance zone shown is acceptable.

Key

X time, expressed in hours
Y1 temperature, expressed in degrees Celsius
Y2 temperature, expressed in degrees Fahrenheit
1 temperature of the chamber
2 exposure to ultraviolet light
3 fog or mist spray

Figure 4 — Schematic drawing of each cycle for weather-cycle test chamber

6.1.4.7 Decrease the temperature inside the weather-cycling chamber from (23 ± 3) °C to (– 29 ± 3) °C over a period of (60 ± 5) min.

6.1.4.8 Maintain the temperature inside the weather cycling chamber at (– 29 ± 3) °C for (60 ± 5) min.

6.1.4.9 Increase the temperature inside the weather cycling chamber to (23 ± 3) °C over a period of (60 ± 5) min.

6.1.4.10 Switch on the ultraviolet light source, and over a period of (60 ± 5) min increase the temperature in the weather cycling chamber to (60 ± 3) °C.

6.1.4.11 At the beginning of this same 60 min period, turn on the water or mist supply to the weather-cycling chamber. Ensure that the interior of the chamber around the test specimens reaches a minimum of 90 % r.h. within this (60 ± 5) min time period. Turn off the water or mist supply after (60 ± 5) min.

6.1.4.12 Maintain the temperature in the weather-cycling chamber at (60 ± 3) °C, and continue ultraviolet exposure for a period of (60 ± 5) min.

6.1.4.13 Over a period of (60 ± 5) min, decrease the temperature inside the weather-cycling chamber from (60 ± 3) °C to room temperature, and continue the test specimens' exposure to the ultraviolet light source. At the end of this period of (60 ± 5) min, turn off ultraviolet light source.

6.1.4.14 Repeat 6.1.4.7 to 6.1.4.13, 252 times (cycles) over a period of 63 days. Each cycle shall be 6 h ± 5 min (see Figure 4). Remove the test specimens from the weather-cycling chamber and allow the test specimens to equilibrate to a temperature of (23 ± 3) °C for at least 24 h.

6.1.4.15 Determine the frost/dew point of the test specimens in accordance with ASTM E546 or equivalent. For triple-glazed, sealed, insulating glass units, determine the frost/dew point for all airspaces. If liquid appears, record the occurrence.

6.1.4.16 Repeat the steps outlined in 6.1.4.1 to 6.1.4.4, except continue the exposure time indicated in 6.1.4.4 for 28 days instead of 14 days.

6.1.4.17 Determine the final frost/dew point in accordance with ASTM E546 or equivalent. For triple-glazed, sealed, insulating glass units, determine the frost/dew point for all airspaces. If liquid appears, record the occurrence. Final frost/dew points shall be determined at least 24 h after the test, but no later than 7 days after the test.

6.2 Approach 2

6.2.1 Principle

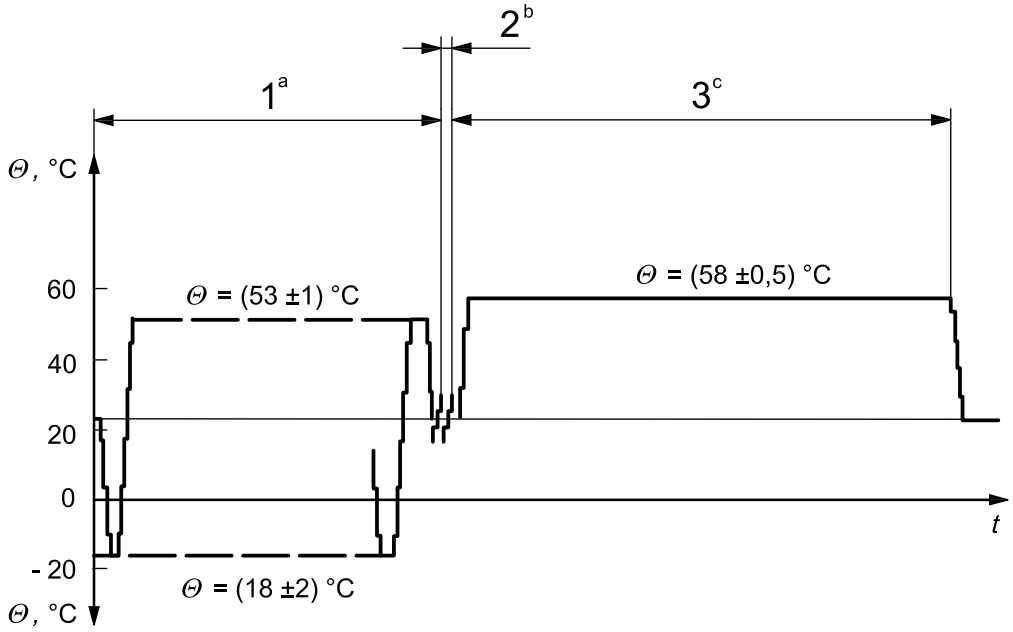
Sets of sealed, insulating glass units are exposed to a climate test. The initial and final dew point and the initial and final moisture content, as applicable to the specific insulating-glass system being tested, are measured and the moisture penetration index is calculated.

6.2.2 Apparatus

6.2.2.1 **Weather cycling chamber**, capable of providing the following required test conditions.

The climate condition in the chamber(s) shall include two parts, with the first part consisting of 56 temperature cycles of 12 h from – 18 °C to + 53 °C with rates of temperature change of 14 °C/h, followed by a second part consisting of a constant temperature of + 58 °C for seven weeks. High humidity shall be as described.

The exact specifications of the temperature, humidity and time and their tolerances shall be in accordance with Figures 5 and 6.



Key

1 56 temperature cycles of 12 h (four weeks' total duration)

2 interval of 2 h to 4 h for moving test pieces, if necessary

3 (1 176 ± 4) h (seven weeks' total duration) at a constant temperature and a relative humidity of r.h. ⩾ 95 %

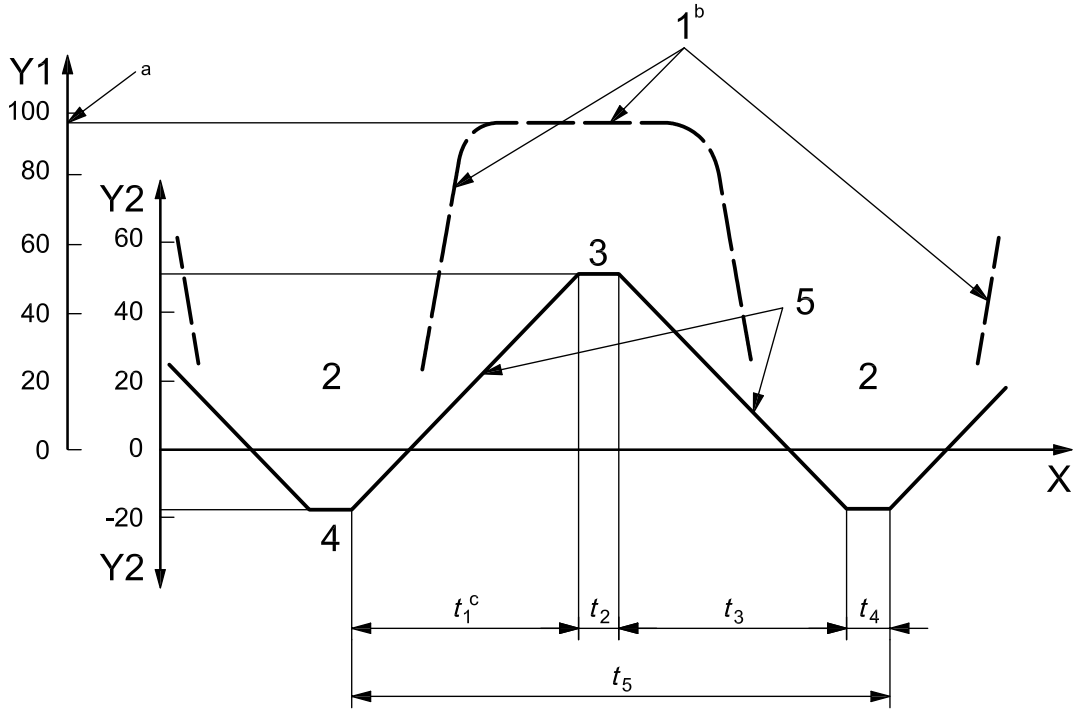
Θ glass temperature

a Temperature cycles start with the cooling segment.

b The two parts of the process, items 1 and 3, may be carried out in a single chamber or in two separate chambers. If two chambers are used, allow up to 4 h for moving the test specimens from one to the other for the second period.

c Condensation on test specimen is allowed.

Figure 5 — Overview of climate conditions in chamber of the centrally located test specimen



Key

X time, expressed in hours
Y1 relative humidity, expressed in percent
Y2 temperature, expressed in degrees Celsius
1 relative humidity during temperature cycle
2 relative humidity interrupted during the cold part of the cycle
3 high temperature, Θ_h, for the centrally located test specimen during the cycle, equal to (53,0 ± 1,0) °C
4 low temperature, Θ_l, for the centrally located test specimen during the cycle, equal to (18,0 ± 1,0) °C
5 temperature, Θ_s, of the centrally located test specimen during the cycle during a temperature change of (14 ± 2) °C/h

a Maximum value of ⩾ 95 %.
b Condensation on test specimen from time to time is allowed.
c Time intervals: t_1 = 5 h ± 1 min; t_2 = 1 h ± 1 min; t_3 = 5 h ± 1 min; t_4 = 1 h ± 1 min; t_5 = 12 h ± 1 min (total cycle time).

Figure 6 — Temperature/time and humidity/time relations in cycling stage

The temperatures and temperature tolerances indicated in Figures 5 and 6 shall be valid for the glass of the unit that is centrally located in the chamber(s). The temperature of that centrally located test specimen shall be recorded continuously. The relative humidity and air temperature, measured at the most suitable location in the test chamber(s) shall also be recorded continuously. Any deviations in temperature and in relative humidity shall be noted in the test report.

The glass temperatures of the other test specimens in the chamber shall be the following:

a) during cycling:

high temperature: (Θ_h ± 1,0) °C,

low temperature: (Θ_l ± 2,0) °C,

changing temperature: (Θ_s ± 2,0) °C for a rate of temperature change of (14 ± 2) °C/h;

b) during constant temperature: ($\Theta_c \pm 0{,}5$) °C.

In order to maximize uniform climate conditions throughout the chamber(s), the distance between the vertically placed test specimens shall not be less than 15 mm.

6.2.3 Test specimens

A set of sealed, insulating glass units shall consist of 15 test pieces. The test specimens shall be representative of the system description (see EN 1279-1) and shall consist of two panes of 4 mm clear float glass manufactured in accordance with EN 572-1 and EN 572-2. The length of each pane shall be (502 ± 2) mm, and the width (352 ± 2) mm. The gap between the panes shall be 12 mm ± 1 mm, or if a 12 mm gap cannot be made by the manufacturer, a gap shall be made between the panes that is as near to 12 mm as possible.

The cavity is preferably air filled, but other gases may also be used.

Construction details of the edges and corners of the test specimens shall correspond to the edge and corner details in sealed insulating glass units that are supplied to the market.

When the system description contains curved, sealed, insulating glass units with a bending radius $\leqslant$ 1 m, the test pieces shall be curved as described in EN 1279-1.

When the system provides a mixture of desiccant and non-desiccant material that is incapable of resisting 1 000 °C, ISO 760 (Karl Fischer method) shall be used for determining the moisture contents (after verifying the method for applicability), or the non-desiccant material shall be replaced by the same volume of desiccant.

When the system provides a mixture of desiccant and non-desiccant material that is incapable of withstanding 220 °C, the non-desiccant material shall be replaced by the same volume of desiccant.

6.2.4 Procedure

6.2.4.1 Condition 15 test specimens for a minimum of two weeks at standard laboratory conditions.

6.2.4.2 Measure the initial dew point temperatures of all 15 test specimens in accordance with 7.1.2, These shall be within a range of ± 10 °C of the maximum dew-point temperature as stated in, or derived from, information in the manufacturer's product/type description. Dew-point temperature measurements that are less than – 60 °C shall be considered and recorded as – 60 °C.

6.2.4.3 Rank the test specimens in order of dew-point value, commencing with the highest dew point value as number 1 and ending with the lowest dew point as number 15. Number units with dew point values below – 60 °C at random. The sealed, insulating glass units shall be selected in accordance with Table 1.

Table 1 — Designation of insulating glass units in climate tests

Unit number	Designated units
7, 8, 9 and 10	Measurement of initial moisture content of desiccant, T_i
4, 5, 6,11 and 12	Climate testing and measurement of final moisture content of desiccant, T_f
2, 3, 13 and 14	Spare units to replace broken units for measurement of final moisture content of desiccant, T_f, (after climate testing)
1 and 15	Rejection or measurement of standard moisture adsorption capacity of desiccant, T_c, as required

6.2.4.4 When starting the climate test, measure the initial moisture content, T_i, of the desiccant (if any) on the four selected test specimens (see Table 1), in accordance with 7.2. For sealed insulating glass units without desiccant, determine an equivalent value for initial moisture content, T_i, in accordance with 7.2.4. using the dew-point temperature from 6.2.4.2.

6.2.4.5 Calculate the average initial moisture content of the desiccant from Equation (1):

$$T_{1,\mathrm{av}} = \sum_{n=1}^{4} \frac{T_{\mathrm{i},n}}{4} \tag{1}$$

6.2.4.6 Submit the five selected test specimens (see Table 1) to the climate conditions in accordance with 6.2.2 and run through the required number of cycles.

NOTE For reasons of time saving and cost aspects of this test, the manufacturer or his agent can decide whether to submit the spare units to climate conditions from the beginning or only when a unit under climate conditions breaks.

6.2.4.7 After cycling the five test specimens, store them for a minimum of two weeks under standard laboratory conditions.

Measure the final moisture content, T_{f}, of the desiccant (if any) of the five test specimens in accordance with 7.2.

6.2.4.8 When the amount of desiccant in the test specimen differs from the sealed insulating glass units on the market, the final moisture content, T_{f}, shall be corrected using Equation (2):

$$k = \frac{Q_{\mathrm{desiccant\_as\_per\_system\_description}}}{Q_{\mathrm{desiccant\_unit\_in\_test}}} \tag{2}$$

where Q is the amount of desiccant, expressed as either mass (in grams) or as volume (cubic centimetres).

When there are technical reasons that the quantity of desiccant in the test pieces cannot be representative of the system description, the test may be performed with a different quantity, however test results should be corrected in order to obtain a true value.

6.2.4.9 For units without desiccant, measure the final dew-point temperatures of the five test specimens in accordance with 7.1.2. Using these dew-point temperatures, determine an equivalent value for T_{f} for each specimen in accordance with 7.2.4.

6.2.4.10 Establish the standard moisture adsorption capacity, T_{c}, in accordance with Annex D.

6.2.4.11 If a measurement of T_{c} is required in Annex D, use the measured values of the two specimens to calculate $T_{\mathrm{c,av}}$ from Equation (3):

$$T_{\mathrm{c,av}} = \sum_{n=1}^{2} \frac{T_{\mathrm{c},n}}{2} \tag{3}$$

6.2.4.12 Calculate the moisture penetration index, I, expressed as a fraction or as a percentage, of each of the five selected or designated test specimens subjected to the climate conditions, as given in Equations (4) and (5), respectively:

$$I = \frac{T_{\mathrm{f}} - T_{\mathrm{i,av}}}{T_{\mathrm{c,av}} - T_{\mathrm{i,av}}} \tag{4}$$

$$I = 100\,\frac{T_{\mathrm{f}} - T_{\mathrm{i,av}}}{T_{\mathrm{c,av}} - T_{\mathrm{i,av}}} \tag{5}$$

6.2.4.13 Calculate the average moisture penetration index from Equation (6):

$$I_{\mathrm{av}} = \sum_{n=1}^{5} \frac{I_{\mathrm{n}}}{5} \tag{6}$$

6.2.4.14 Ensure that the manufacturers of sealed, insulating glass units are aware of the accuracy of the climate test, using the results from proficiency testing.

NOTE A proficiency test involving 10 laboratories, using Approach 2 in this International Standard, demonstrated that an accuracy, as defined in 3.5, of $\pm$ 0,10 can be achieved when the moisture penetration index, I, is expressed as a ratio, or $\pm$ 10 % absolute can be achieved when I is expressed as a percentage.

7 Methods of measurement

7.1 Measurement of frost/dew point temperature

7.1.1 For Approach 1, the measurement method described in ASTM E546 shall be used to determine the frost/dew point. Any visible deposit in the airspace shall be observed and recorded.

7.1.2 For Approach 2, any measurement method that is applicable shall be checked against the reference method in Annex A.

7.2 Measurement of moisture content for Approach 2

7.2.1 General

Use the moisture-content measurement method, of those described in 7.2.2, 7.2.3 or 7.2.4, that corresponds to the appropriate insulating glass design: bulk desiccant, incorporated in sealant desiccant or no desiccant. Ensure that moisture content values from different measurement methods are not mixed.

NOTE Although the final moisture penetration index, I, is independent of the method used, the moisture content values are not.

7.2.2 Moisture content of desiccant in bulk

When the desiccant in the test specimens is loose and not incorporated into a sealant, use the method in Annex B to measure the initial moisture content, T_{i}, or the final moisture content, T_{f}.

7.2.3 Moisture content of desiccant incorporated in organic spacer

When the desiccant in the test specimens is incorporated in an organic spacer, use the method in Annex C to measure the initial moisture content, T_{i}, or the final moisture content, T_{f}. Prepare and collect four samples of organic spacer material containing desiccant; one from each side in accordance with C.4.2.3, of each test specimen.

NOTE The method determines directly the moisture contents, T_{i} and T_{f}.

7.2.4 Moisture content in insulating glass units without desiccant

When the dew point temperature is measured in accordance with 7.1.2, determine the corresponding water vapour partial pressure using Table 2. Designate the value obtained as T_{i} in the case of initial moisture content, and T_{f} in the case of the final moisture content.

The value of the water vapour partial pressure obtained for the controlled limit environmental conditions defined in 3.3 shall be designated T_{c}, and is equal to 402 Pa (dew point – 5 °C).

Table 2 — The water vapour partial pressure as function of the temperature

Dew point °C	Partial water vapour pressure Pa	Dew point °C	Partial water vapour pressure Pa	Dew point °C	Partial water vapour pressure Pa	Dew point °C	Partial water vapour pressure Pa
20	2 335	– 1	563	– 21	94	– 41	11,5
19	2 201	– 2	518	– 22	85	– 42	10,3
18	2 055	– 3	476	– 23	77	– 43	9,12
17	1 935	– 4	438	– 24	70	– 44	8,13
16	1 814	– 5	402	– 25	64	– 45	7,21
15	1 694	– 6	369	– 26	57,4	– 46	6,40
14	1 601	– 7	343	– 27	51,9	– 47	5,68
13	1 494	– 8	310	– 28	46,8	– 48	5,04
12	1 401	– 9	284	– 29	42,3	– 49	4,46
11	1 307	– 10	260	– 30	38,1	– 50	3,94
10	1 227	– 11	238	– 31	34,3	– 51	3,48
9	1 147	– 12	218	– 32	30,9	– 52	3,07
8	1 067	– 13	199	– 33	27,8	– 53	2,70
7	1 001	– 14	182	– 34	25,0	– 54	2,37
6	934	– 15	166	– 35	22,4	– 55	2,09
5	876	– 16	151	– 36	20,1	– 56	1,84
4	814	– 17	138	– 37	18,0	– 57	1,61
3	760	– 18	125	– 38	16,1	– 58	1,41
2	707	– 19	114	– 39	14,4	– 59	1,24
1	656	– 20	104	– 40	12,9	– 60	1,08
0	610						

8 Test report

8.1 Approach 1

The test report shall contain the following items:

a) reference to this part of ISO 20492;

b) dimensions of the test specimen (width by height) and overall thickness;

c) type and thickness of glass;

d) glass coatings and surface locations if applicable;

e) airspace thickness;

f) description of the spacer composition(s) and configuration;

g) description of the corner construction, including the type and number of corner keys;

h) desiccant type and quantity, if provided;

i) presence and type of tube, if applicable;

j) presence and composition (if known) of muntin bars;

k) sealant type(s) and dimensions, if provided;

l) manufacturer and manufactured date (month or quarter, if known, and year);

m) date testing was started;

n) glass breakage, if observed;

o) final frost/dew point of each unit after testing according to 6.1.4.3;

p) any visible deposit(s) in the airspace.

8.2 Approach 2

The test report shall evaluate the test in detail and shall include the summary shown in Figure 7:

Name of test house, its address and logo.

Summary of report nº ..... Date .....

Insulating glass units — Moisture penetration results in accordance with ISO 20492–1, Approach 2

For details, see the test report

Company: Name: .....

Address: .....

.....

.....

.....

.....

Plant: Name: .....

Address: .....

.....

.....

.....

.....

System description, file number: .....

Product name: .....

System conforms:	YES	NO	(Delete whichever is not applicable)

NOTE *Comparisons of moisture penetration indices of different insulating glass unit system are meaningless.*

.....

Name and signature

Figure 7 — Example summary of test report

Annex A
(normative)

Reference method for frost/dew point temperature measurement

A.1 Principle

A cooling cell is placed against a test specimen. Crushed solid carbon dioxide and ethanol are introduced into the cell to cool the glass surface of the test specimen. When dew or frost forms on the glass surface of the specimen, the temperature of the ethanol solution is read with a thermometer. This temperature, taken at the time that the frost/dew first forms, is the frost/dew point temperature.

This method serves as the reference method for Approach 2 for those test methods that are normally used by test houses. Comparisons of methods are carried out by taking test specimens as defined by 6.2.3, which should be placed vertically on their shorter edge.

NOTE 1 The method described here does not purport to measure the dew point temperature exactly. In fact, the deviation from the exact dew point temperature is not known precisely; however the maximum deviation is estimated at 5 °C. But the method is adopted for its reliability, its reproducibility and its simplicity.

NOTE 2 The dew point is characterized by the appearance of a water deposit on the glass. During dew- point temperature measurement, the condensed moisture on the glass surface needed for observation is subtracted from the free moisture so that the measured dew point temperature deviates towards lower values from the real one. The smaller the unit and the lower the dew point, the lesser is the amount of moisture and, consequently, the greater is the deviation of the measured dew point temperature from the real one. For units with standard dimensions, dew point temperatures below – 60 °C deviate too much, but the amount of moisture in the gap is so low that those dew point temperatures can be taken as equal to – 60 °C.

A.2 Reagents and materials

A.2.1 **Ethanol**, for cooling.

A.2.2 **Crushed solid carbon dioxide**, for cooling.

A.3 Apparatus

A.3.1 **Cooling cell**, in accordance with Figure A.1.

A.3.2 **Alcohol thermometer**, with a range of at least from ± 30 °C to – 0 °C, and with a precision of ± 1 °C.

A.4 Procedure

A.4.1 Carry out the measurement at standard laboratory conditions in accordance with 3.1.

A.4.2 Press the cooling cell to the cleaned glass surface in the centre of the sealed insulating glass unit with a few drops of ethanol between the glass and the mirror surfaces for optimal conductivity.

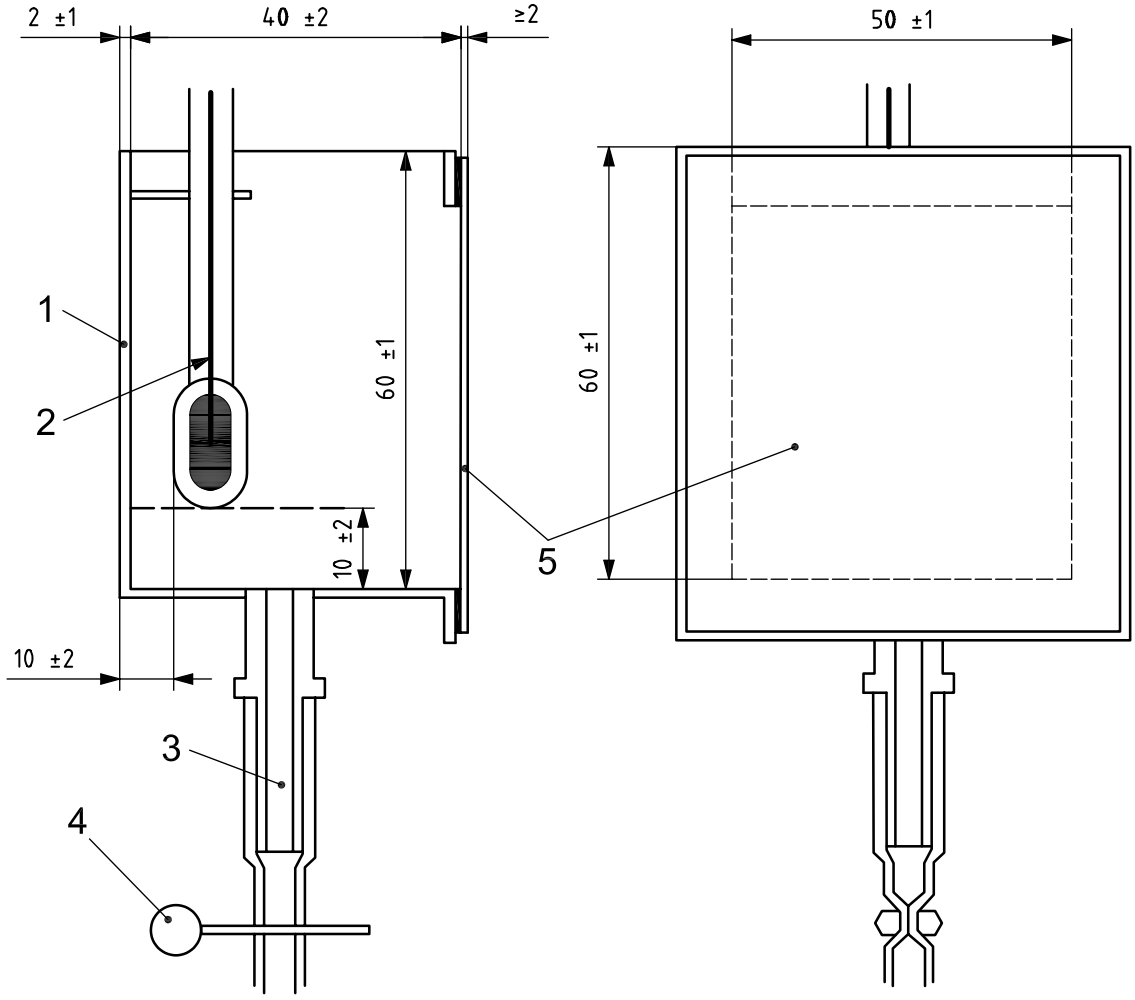
A.4.3 Position the thermometer in the cooling cell. Fill the cooling cell with ethanol up to a height of 30 mm to 35 mm.

A.4.4 Introduce the crushed solid carbon dioxide gradually into the ethanol. Ensure that the cooling rate from approximately 20 °C over the dew point is not more than 2 °C/min.

A.4.5 Observe continuously the internal glass surface immediately in front of the mirror. As soon as condensation appears, read and record the cooling liquid temperature as indicated by the thermometer.

NOTE This temperature is the frost/dew point temperature.

Dimensions in millimetres



Key

1 inox steel
2 alcohol thermometer, ± 1 °C
3 outlet
4 spring or screw, clip or tap
5 glass mirror, silver coating and protective painting at back face

Figure A.1 — Dew-point cooling cell and thermometer

Annex B
(normative)

Moisture content measurement according to the 950 °C drying method

B.1 Principle

The desiccant is removed from the spacer of a test specimen and then placed in a furnace to burn off any moisture. The difference in mass before and after conditioning in the furnace is the moisture content.

NOTE This method is appropriate for Approach 2 only, and is only applicable for evaluating desiccant in bulk.

B.2 Apparatus

B.2.1 Furnace, capable of maintaining a temperature of 950 °C.

B.2.2 Balance, accurate to ± 0,001 g.

B.2.3 Porcelain dish and lid, as illustrated in Figure B.1.

Dimensions in millimetres

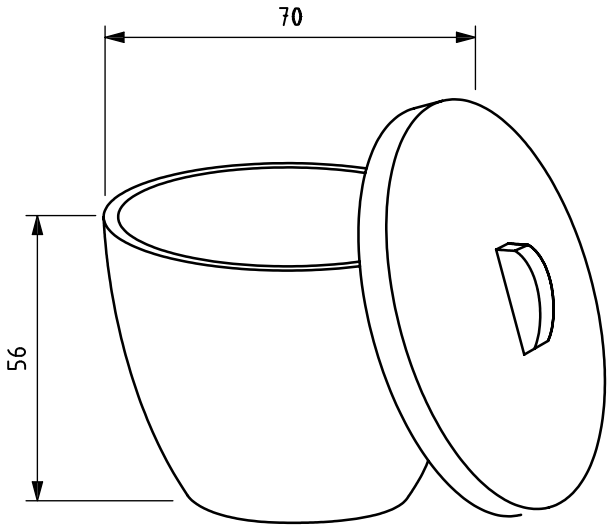


Figure B.1 — Illustration of a porcelain dish with lid

B.3 Procedure

B.3.1 Preparatory work

B.3.1.1 Room conditions shall be standard in accordance with 3.1. Precautions shall be taken to minimize dust. The room should be closed so that traffic through the room is prevented.

B.3.1.2 Clean a dish and lid by washing in distilled water and dry to constant mass by heating in an oven at 120 °C. Cool to room temperature before weighing. Weigh the dish without the lid. Designate the value of the mass obtained as m_o. Apply this procedure to all dishes at the beginning of all series of weighing.

B.3.2 Determining initial and final moisture content

B.3.2.1 Remove the desiccant in accordance with either a) or b) as follows.

a) The first recommended procedure for removing desiccant is as follows. Operations 1) to 3) should be done within 5 min. Operations 4) to 9) should be done within 3 min.

   1) Cut through the seal using a sharp knife.

   2) Remove one pane of glass. Repeat for the second pane of glass.

   3) Separate the spacer parts when possible.

   4) Saw the spacer parts in half through in the centre.

   5) Bend the spacer parts by hand over the dish and put desiccant in the dish.

   6) Retain 20 g to 30 g of the total amount where possible, after mixing if necessary.

   7) Avoid splinters from spacer in the desiccant.

   8) Place the lid on the dish. Transfer to weighing room.

   9) Weigh the dish and desiccant without the lid (m_i for T_i determination, m_f for T_f determination).

b) The second recommended procedure for removing desiccant is as follows. Operations 1) to 3) should be done within 5 min. Operations 4) to 8) should be done within 3 min.

   1) Remove the seal from over the number of millimetres sufficient for a template to be placed at approximately 60 mm from the corner.

   2) Place the template containing a hole with a diameter of 10 mm on the edge of the insulating glass.

   3) Drill a hole with the same diameter as the template hole in the back of the spacer. Ensure the top of the drill is shaped in order to prevent twisting. Avoid drilling through the inner wall of the spacer into the insulating glass unit.

   4) Place the desiccant in the dish. Discard the first 3 g to 5 g of desiccant, in order to prevent contamination from other materials.

   5) Retain 20 g to 30 g of the total amount where possible, after mixing if necessary.

   6) Avoid splinters from the spacer, and other materials, in the desiccant.

   7) Place the lid on the dish. Transfer from the work area to the weighing room.

   8) Weigh the dish and desiccant without the lid (m_i for T_i determination, m_f for T_f determination).

B.3.2.2 Place the lid on the dish and transfer to furnace. Ensure that additional dust does not enter the dish, and ensure that no desiccant is lost from the dish.

B.3.2.3 Remove the lid and place the dish containing desiccant in the furnace. Heat furnace from room temperature to 950 °C in (60 ± 20) min. Keep the temperature at (950 ± 50) °C for a further (120 ± 5) min.

NOTE The temperature of 950 °C applies to zeolites, silica-gels and mixtures. The advantage of this temperature is that, after drying, the desiccant is no longer active and, consequently, the possibilities for error are reduced.

B.3.2.4 Take out the dish containing the desiccant, place the lid on the dish, and place the dish in a desiccator for cooling to room temperature. Weigh the dish and the desiccant without the lid and designate this value as m_r.

B.3.2.5 Calculate the moisture contents as follows.

The initial moisture content, T_i, expressed as a fraction or as a percent, is calculated as given in Equation (B.1) or (B.2), respectively:

$$T_i = \frac{m_i - m_r}{m_r - m_0} \tag{B.1}$$

$$T_i = 100\frac{m_i - m_r}{m_r - m_0} \tag{B.2}$$

The final moisture content, T_f, expressed as a fraction or as a percent, is calculated as given in Equation (B.3) or (B.4), respectively:

$$T_f = \frac{m_f - m_r}{m_r - m_0} \tag{B.3}$$

$$T_f = 100\frac{m_f - m_r}{m_r - m_0} \tag{B.4}$$

B.3.2.6 When, for a mixture of desiccant with non-desiccant material, the non-desiccant material is replaced by desiccant, calculate the ratio, R, between the mass of desiccant in the mixture, M_m, and the total mass of desiccant when the non-desiccant material is replaced by the same volume of desiccant, M_t,as given in Equation (B.5):

$$R = \frac{M_m}{M_t} \tag{B5}$$

Designate the values obtained by Equations (B.1) and (B.2) as $T_{i,u}$ and that from Equations (B.3) and (B.4) as $T_{f,u}$. Calculate the corrected initial and final moisture contents, T_i and T_f, by multiplying $T_{i,u}$ and $T_{f,u}$ by the ratio R as given in Equations (B.6) and (B.7):

$$T_i = RT_{i,u} \tag{B.6}$$

$$T_f = RT_{f,u} \tag{B.7}$$

B.3.3 Determining the standard moisture adsorption capacity

B.3.3.1 Remove 20 g to 30 g of desiccant from the rejected insulating glass units in accordance with B.3.2.1. Do not weigh the dish at this point. If the desiccant is taken from a drum or bulk container, place it on a dish prepared according to B.3.2.

B.3.3.2 Prepare and maintain a relative humidity of 32 % in a desiccator as follows.

a) Prepare a saturated salt solution of calcium chloride crystals ($CaCl_2 \cdot 6H_2O$) in water at (23 ± 2) °C by adding the crystals until no more dissolve.

b) Check to ensure that at least one crystal remains undissolved in the solution throughout the full test period.

c) Place the saturated solution in the bottom of the desiccator and close. Allow the solution to equilibrate for 24 h.

NOTE The created environment with the calcium chloride solution simulates the controlled limit environmental conditions defined in 3.3.

B.3.3.3 Humidify the desiccant to equilibrium adsorption at the limit environment conditions.

a) Place the dish containing desiccant, with the lid removed, approximately 20 mm above the solution, and support it in such a way that a free flow of conditioned air can take place and secure the desiccant container so that it cannot come into contact with the solution.

b) Reclose the assembly and leave for four weeks. Check frequently throughout the test period to ensure that at least one crystal remains undissolved.

c) After four weeks, weigh the dish with desiccant within 30 s. Return the dish to the desiccator and leave for a further week.

d) Remove the dish from the desiccator and reweigh the dish and desiccant within 30 s. If two successive values do not agree to within 0,005 g, return the dish and desiccant to the desiccator to stand over the saturated calcium chloride solution for further weekly intervals until constant mass is achieved.

e) Designate the value of the mass as m_c.

B.3.3.4 Place the lid on the dish and transfer to the furnace. Ensure that additional dust does not enter the dish, and that desiccant is not lost from the dish.

B.3.3.5 Remove the lid and place the dish containing the desiccant in the furnace. Heat the furnace from room temperature to 950 °C over a period of (60 ± 20) min. Maintain the temperature at (950 ± 50) °C for a further (120 ± 5) min.

B.3.3.6 Take out the dish containing the desiccant, place the lid on the dish, and place the dish in a desiccator for cooling to room temperature. Weigh the dish and desiccant without the lid and designate this value as m_r.

B.3.3.7 Calculate the standard moisture adsorption capacity, T_c, as a fraction or as a percentage, as given in Equation (B.8) or (B.9):

$$T_c = \frac{m_c - m_r}{m_r - m_0} \quad \text{(B.8)}$$

$$T_c = 100\frac{m_c - m_r}{m_r - m_0} \quad \text{(B.9)}$$

Annex C
(normative)

Moisture content measurement by the Karl Fischer method

C.1 Principle

Samples of sealant containing the desiccant are cut out from the edge seals of a test specimen. Using the Karl Fischer method, these sealant samples are first weighed and then dried in a Karl Fischer (KF) tube furnace. A drying curve is established by removing the sample and weighing it at prescribed intervals. Moisture content is determined with the aid of a KF calculator by entering the mass loss of the sealant samples.

NOTE 1 This method is based on ISO 760. The method is applicable for desiccant incorporated in organic seal material.

NOTE 2 A proficiency test involving three laboratories, with zeolite in bulk and zeolite incorporated in polyisobuthylene and/or in butyl, using the detailed method below, has demonstrated that an accuracy comparable with those when the 950 °C drying method of Annex B is used, can be achieved. For other types of desiccant or other types of matrix containing desiccant, it is necessary to verify the applicability.

C.2 Reagents and materials

C.2.1 **Nitrogen**, $N_2 + Ar > 99{,}995$ %, $H_2O < 5$ µl/l, $O_2 < 2$ µl/l.

C.2.2 **Sodium tartrate** ($[CHOHCOONa]_2 \cdot 2H_2O$) or **sodium citrate** ($C_6H_5K_3O_7 \cdot H_2O$).

C.2.3 **KF reagents** and **KF solvents**, as specified in ISO 760.

The following reagent-solvent combinations may be used:

— KF reagent n° 34805 with KF solvent n° 34914;

— KF reagent n° 34801 with KF solvent n° 34800.

C.3 Apparatus

C.3.1 **Balance**, accurate to ± 0,001 g.

C.3.2 KF apparatus, as specified in ISO 760, including the following:

— KF titrimeter;

— KF burette;

— KF tube furnace;

— KF calculator.

The length of the connection between KF tube furnace and KF titrimeter should be ⩽ 200 mm.

C.4 Procedure

C.4.1 Preparatory work

C.4.1.1 Heat up the KF tube furnace to (200 ± 5) °C. Maintain a nitrogen flow of (200 ± 20) ml/min for (60 ± 1) min.

C.4.1.2 Measure the drift (caused by connections that are not perfectly tight). Maintain the nitrogen flow of (200 ± 20) ml/min and maintain the KF tube furnace temperature at (200 ± 5) °C. Record the drying curve for 10 min at a 1 min interval.

C.4.1.3 Place (0,2 ± 0,02) g of sodium tartrate or (0,5 ± 0,05) g of sodium citrate in the KF tube furnace. Maintain the nitrogen flow of (200 ± 20) ml/min, and maintain the KF tube furnace temperature at (150 ± 5) °C. Record drying curve during 60 min with a 5 min interval.

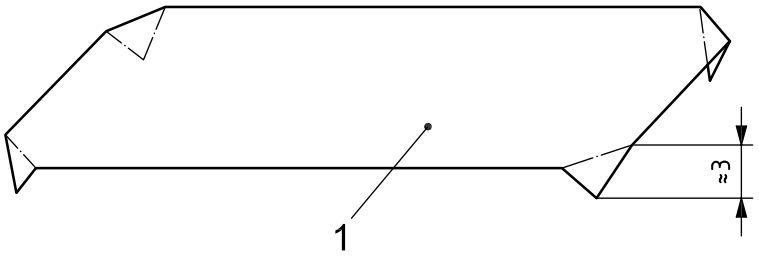
C.4.1.4 Calibrate on the basis of the results from C.4.1.2 and C.4.1.3.

C.4.2 Determining the initial and final moisture content

C.4.2.1 Room conditions shall be standard in accordance with 3.1. Precautions shall be taken to minimize dust. The room shall be closed so that traffic through the room is prevented.

C.4.2.2 Prepare a net in accordance with Figure C.1. Weigh the net. Designate the mass obtained as m_0.

Dimensions in millimetres



Key

1 net with folded corners

Figure C.1 — Example of a net

C.4.2.3 Open the insulating glass unit and select from the centres of the sides' cross-sections a quantity of sealant containing desiccant of approximately $b \times c \times d = 0{,}5\ \text{cm}^3$ with a mass of approximately 0,5 g, in accordance with Figures C.2 and C.3. In the case of insulating glass unit systems where an impermeable moisture penetration barrier is present, samples may be taken as illustrated in Figures C.2 and C.4.

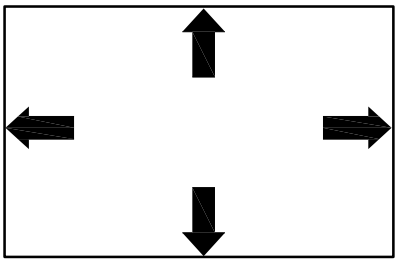
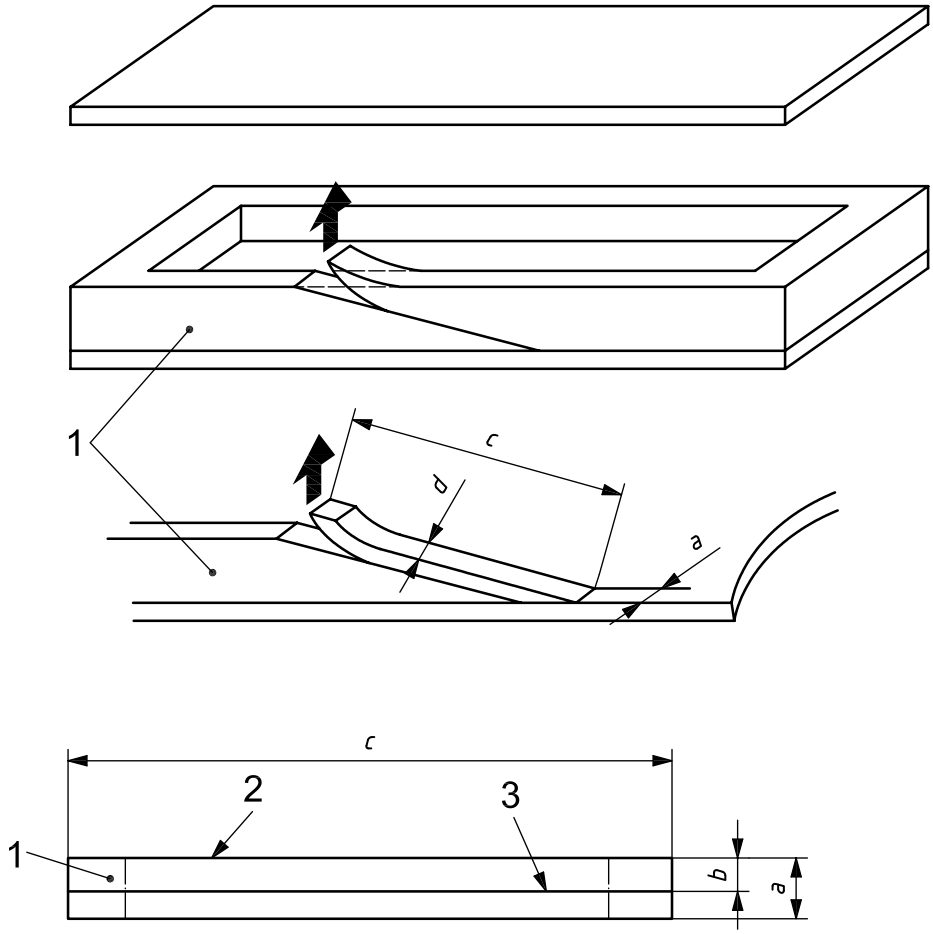


Figure C.2 — Illustration of the locations in an insulating glass unit whence to take the samples of organic material incorporating desiccant



Key

1 desiccant incorporated in sealant
2 sealant facing cavity of insulating glass unit
3 separation cut of inner part sealant over complete length, c
a thickness of sealant
b (a/2) mm ± 0,5 mm with a maximum of (3,5 ± 0,5) mm
c length of the material taken over the full width of the cavity
d height of the material taken

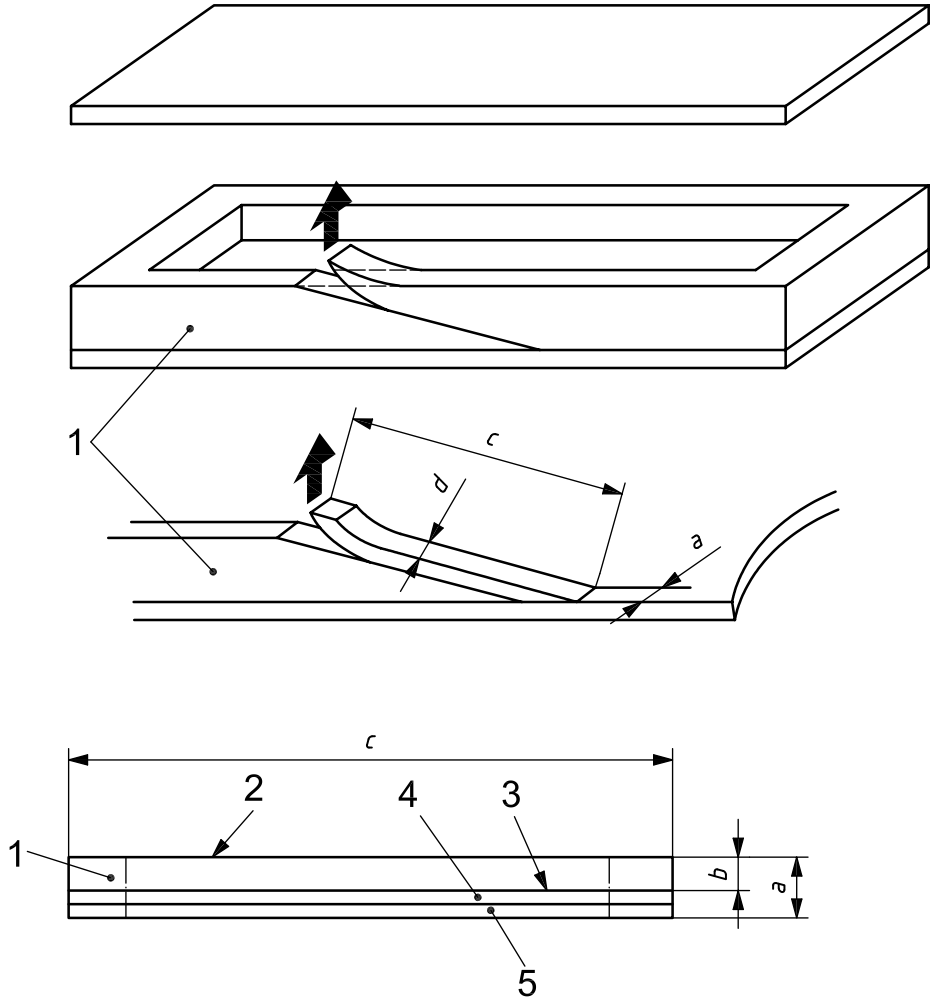
Figure C.3 — Illustration of how to take the samples of organic material incorporating desiccant

C.4.2.4 Place all samples on the net as illustrated in Figure C.5. Avoid materials other than the sealant containing desiccant.

C.4.2.5 Weigh the net with the samples. Designate the obtained values as m_i when initial moisture content is measured and as m_f when final moisture content is measured.

C.4.2.6 Place the net with the organic material in a shuttle. Place the shuttle into the KF tube furnace, which is stabilized at (200 ± 5) °C. Take no longer than 15 min from selecting samples to placing the shuttle with the sample into the KF tube furnace. Store spare samples in a small, tight and dry container.

All measurements should be performed within four days.



Key

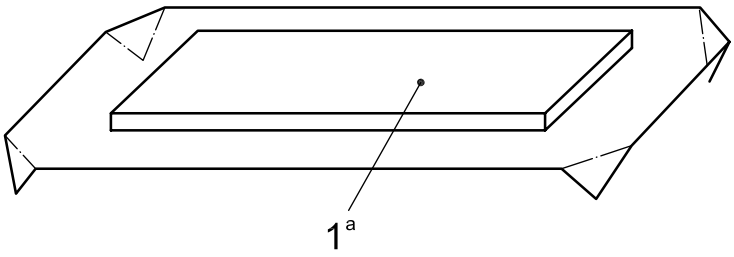
1 desiccant incorporated in sealant
2 sealant facing cavity of insulating glass unit
3 separation of inner part sealant from the moisture vapour barrier
4 impermeable moisture penetration barrier
5 sealant with or without desiccant
a thickness of sealant
b (a/2) mm ± 0,5 mm with a maximum of (3,5 ± 0,5) mm
c length of the material taken over the full width of the cavity
d height of the material taken

Figure C.4 — Illustration of how to take the samples of organic material incorporating desiccant with an impermeable barrier for water penetration

C.4.2.7 Maintain the nitrogen flow of (200 ± 20) ml/min, and the KF tube furnace temperature at (200 ± 5) °C during (150 ± 1) min. Record the drying curve with a 15 min interval.

C.4.2.8 Enter the appropriate value, m_i minus m_o or m_f minus m_o, in the KF calculator. Determine the moisture content, T_i, or T_f, using the calculator.

C.4.2.9 Repeat C.4.2.1 through C.4.2.8 for each insulating glass test specimen.



Key

1 desiccant in the organic matrix, pressed into a film approximately 1 mm thick

a A strip 40 mm × 10 mm is cut out from the film.

Figure C.5 — Example of desiccant sample placed on the net

C.4.3 Determining the standard moisture adsorption capacity

C.4.3.1 Take a quantity of sealant containing desiccant from a drum, or remove it from insulating glass units as indicated in C.4.2.3. Prepare four samples, each of approximately 2 g; place them on weighed nets that have a mass designated as $m_{o,m}$.

C.4.3.2 Prepare and maintain a relative humidity of 31 % at 55 °C in a chamber as follows.

a) Prepare a saturated salt solution of magnesium chloride ($MgCl_2 \cdot 6H_2O$) crystals in water at (55 ± 1) °C.

b) Check to ensure that at least one crystal is undissolved in the solution throughout the full test period.

c) Place the saturated solution in the bottom of the chamber and close. Allow the saturated solution to equilibrate for at least 24 h.

NOTE The created environment with the magnesium chloride solution simulates the controlled limit environmental conditions defined in 3.3.

C.4.3.3 Humidify the samples to standard maximum adsorption rate as follows.

a) Place a net with sample approximately 20 mm above the solution and support it in such a way that a free flow of conditioned air can take place. Avoid contact of the net and sample with the solution.

b) Maintain exposure for 21 weeks.

c) Check frequently throughout the full test period that at least one crystal remains undissolved. Maintain the chamber temperature at (55 ± 1) °C.

d) Weigh the samples at three-week intervals.

e) Plot the measured masses against exposure time period.

f) Observe when the curves level out, at which point the equilibrium adsorption condition has been reached. Designate the equilibrium masses as $m_{c,m}$.

g) If equilibrium is not obvious after 21 weeks exposure, continue the proceedings. Repeat weighings at further three weekly intervals until two successive values agree to within 0,000 2 g.

C.4.3.4 Place the net with organic material in a shuttle. Place the shuttle into the KF tube furnace that is stabilized at (200 ± 5) °C, taking no more than 3 min.

C.4.3.5 Maintain the nitrogen flow of (200 ± 20) ml/min, and the KF tube furnace temperature at (200 ± 5) °C for (150 ± 1) min. Record the drying curve every 15 min.

C.4.3.6 Enter the appropriate value, $m_{c,m}$ minus $m_{o,m}$, into the KF calculator. Determine the moisture content, $T_{c,m}$, using the calculator.

C.4.3.7 Calculate the moisture content, T_c, of the unit in accordance with Equation (C.1):

$$T_c = \sum_{m=1}^{4} \frac{T_{c,m}}{4} \quad \text{(C.1)}$$

Annex D
(normative)

Establishing the standard moisture adsorption capacity of desiccants

D.1 General

D.1.1 Moisture-adsorption capacity of desiccant can be established using one of three methods:

a) publications or reports in accordance with D.2;

b) generally accepted values for desiccant in bulk as outlined in D3;

c) measurement of desiccant samples from test specimens.

D.1.2 If measurement of the moisture-adsorption capacity is required in D.1.1, perform the following on the two rejected test specimens noted in Tables 1 and 15.

a) For desiccant in bulk, determine T_c in accordance with Annex B.

b) For desiccant incorporated in sealant, determine T_c in accordance with Annex C.

It is recommended that a laboratory independent of production performs the measurement.

D.2 Published or reported standard moisture adsorption capacity requirements

D.2.1 When the appropriate standard moisture-adsorption capacity is published or reported, it shall conform to at least one of D.2.2, D.2.3, or D.2.4. It is recommended that the publications or reports be issued by a laboratory independent of production.

D.2.2 Publication or report shall not be older than nine months when the desiccant manufacturer declares to operate a production control.

D.2.3 Publication or report not shall not be older than 30 months when

— the manufacturer operates a third-party surveillance system in accordance with an ISO 9001 [7] or ISO 9002 [8] quality-assurance system, and

— the quality procedures refer to relevant clauses of this International Standard.

D.2.4 Publication or report from the desiccant manufacturer shall not be older than 30 months when

— the manufacturer operates a third-party surveillance system in accordance with a ISO 9001 or ISO 9002 quality assurance system,

— the quality procedures refer to relevant clauses of this International Standard, and

— the method of measurement is verified.

D.3 Generally accepted values for desiccant in bulk

The generally accepted values for desiccant in bulk listed in Table D.1 may be used instead of repeated measurements, under the condition that the average moisture penetration index, I_{av}, of the test specimens used in this International Standard is $< 0{,}16$ when expressed as a fraction, or $I_{av} < 16$ % when expressed as a percentage.

NOTE When $0{,}16 \leqslant I_{av} \leqslant 0{,}24$ ($16\ \% \leqslant I_{av} \leqslant 24\ \%$), and when no publication or report in accordance with D.2 is available on the desiccant concerned, a measurement of the standard moisture adsorption capacity by an independent laboratory is recommended.

Table D.1 — Generally accepted values for the standard water vapour adsorption capacity, T_c

Desiccant in bulk	T_c for 950 °C drying method application
Zeolite 3 A	0,20 or 20 %
Zeolite 4 A	0,20 or 20 %
Zeolite 10 A	0,20 or 20 %
Silica-gel micropores	0,25 or 25 %
Silica-gel macropores	0,12 or 12 %

Bibliography

[1] ASTM C1369*, Standard Specification for Secondary Edge Sealants for Structurally Glazed Insulating Glass Units*

[2] ASTM C1249, *Standard Guide for Secondary Seal for Sealed Insulating Glass Units for Structural Sealant Glazing Applications*

[3] ASTM C1265, *Standard Test Method for Determining the Tensile Properties of an Insulating Glass Edge Seal for Structural Glazing Applications*

[4] ISO 20492-2, *Glass in buildings — Insulating glass — Part 2: Chemical fogging tests*

[5] ISO 20492-3, *Glass in buildings — Insulating glass — Part 3: Gas concentration and gas leakage*

[6] ISO 20492-4, *Glass in buildings — Insulating glass — Part 4: Test methods for the physical attributes of edge seals*

[7] ISO 9001, *Quality management systems — Requirements*

[8] ISO 9002, *Quality systems — Model for quality assurance in production, installation and servicing*

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