British Standard

BRITISH STANDARD

BS EN
1279-2:2002

Glass in building — Insulating glass units —

Part 2: Long term test method and requirements for moisture penetration

The European Standard EN 1279-2:2002 has the status of a British Standard

ICS 81.040.20

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 1279-2:2002.

The UK participation in its preparation was entrusted by Technical Committee B/520, Glass and glazing in building, to Subcommittee B/520/2, Insulating glass products, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Building and Civil Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 8 January 2003

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 29 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 41079 X

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 1279-2

November 2002

ICS 81.040.20

English version

Glass in building - Insulating glass units - Part 2: Long term test method and requirements for moisture penetration

Verre dans la construction - Vitrage isolant préfabriqué scellé - Partie 2: Méthode d'essai de longue durée et exigences en matière de pénétration d'humidité

Glas im Bauwesen - Mehrscheiben-Isolierglas - Teil 2: Langzeitprüfverfahren und Anforderungen bezüglich Feuchtigkeitsaufnahme

This European Standard was approved by CEN on 5 September 2002.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1279-2:2002 E

Contents

Foreword

This document (EN 1279-2:2002) has been prepared by Technical Committee CEN/TC 129 "Glass in building", the secretariat of which is held by IBN.

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 May 2003, and conflicting national standards shall be withdrawn at the latest by May 2003.

The described testing is part of type evaluation of insulating glass units.

This European Standard "*Glass in Building - Insulating glass units*" consists of the following Parts:

– *Part 1: Generalities, dimensional tolerances and rules for the system description.*

– *Part 2: Long term test method and requirements for moisture penetration.*

– *Part 3: Long term test method and requirements for gas leakage rate and for gas concentration tolerances.*

– *Part 4: Methods of test for the physical attributes of edge seals.*

– *Part 5: Evaluation of Conformity.*

– *Part 6: Factory production control and periodic tests.*

The annexes A to D are normative.

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, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This European Standard specifies requirements for moisture penetration and the long term test method for insulating glass units and ensures by means of an adequate evaluation of conformity to this standard that over time:

– energy savings are made because the *U*-value and solar factor 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.

It covers additional characteristics that are of importance for trade. Marking conditions are included.

For glass products with electrical wiring or connections for e.g. alarm or heating purposes, this standard covers only wiring subject for electrical potential difference to earth less than 50 V a.c. or less than 75 V d.c.

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

NOTE 1 In cases where there is no protection against direct ultraviolet radiation at the edges, such as structural sealant glazing systems, additional European technical specifications should be followed.

NOTE 2 Units where the nature is only artistic are not part of this standard.

This Part of this standard, which is inextricably bound up with the other Parts of this standard, covers the moisture penetration by testing as one means of verifying whether a product made in accordance with its system description conforms with the relevant aspect of the definition on insulating glass units.

2 Normative references

This European Standard incorporates, by dated or undated reference, 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 revisions of any of these publications apply to this European Standard only when incorporated by amendment or revision. For undated references, the latest edition of the publication referred to applies (including amendments).

EN 572-1, *Glass in Building - Basic soda lime silicate glass products - Part 1: Definitions and general physical and mechanical properties.*

EN 572-2, *Glass in Building - Basic soda lime silicate glass products - Part 2: Float glass.*

prEN 1279-1:1998, *Glass in Building - Insulating glass units - Part 1: Generalities, dimensional tolerances and rules for the system description.*

EN 1279-3, *Glass in Building - Insulating glass units - Part 3: Long term test method and requirements for gas leakage rate and for gas concentration tolerances.*

EN 1279-4, *Glass in Building - Insulating glass units - Part 4: Methods of test for the physical attributes of edge seals.*

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

3 Terms and definitions, abbreviations and symbols

3.1 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in prEN 1279-1:1998 together with the following apply.

3.1.1
standard laboratory conditions
ambient temperature of (23 ± 2) °C and a relative humidity of (50 ± 5) %

3.1.2
standard moisture adsorption capacity
capacity of a desiccant material to adsorb a quantity of moisture under controlled limit environment conditions

3.1.3
controlled limit environment conditions
environment temperature 10 °C with a dew point temperature of - 5 °C, giving a relative humidity of 32,8 %

3.1.4
moisture penetration index
amount of drying capacity consumed after standardised ageing conditions

3.1.5
accuracy
precision of the test method itself within confidence limits of 99 %

3.2 Abbreviations

r.h. relative humidity

3.3 Symbols

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

I_{av} Average value of the moisture penetration indices I, obtained over five measurements;

m_o Mass of dish when empty, clean and dry;

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

m_f Mass of dish plus desiccant plus water initially adsorbed plus water adsorbed when subjected to the climate conditions in the cabinet;

m_i Mass of dish plus desiccant plus water initially adsorbed;

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_m Mass of desiccant in mixtures with non-desiccant material;

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;

R Ratio between the masses of desiccant M_m and M_t ;

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 cabinet;

Θ_c Temperature of the central test specimen in test cabinet during constant temperature phase;

Θ_h High temperature of the central test specimen in the test cabinet during the high humidity/temperature cycling phase;

Θ_l Low temperature of the central test specimen in the test cabinet during the high humidity/temperature cycling phase;

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

4 Requirements

4.1 Moisture penetration index

Insulating glass units shall fulfil their functions during an economically reasonable working life. Therefore the following values are verified on test specimens submitted to the climate test described in this Part of the standard:

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

Although breakage of the glass does not constitute failure, the average moisture penetration index I_{av} shall be the average over not less than, and no more than, five units. Spare units shall be used instead of the broken test specimens.

The unit with the highest moisture penetration index shall have an index value I not exceeding 0,25.

4.2 Edge seal strength

For the requirements on edge seal strength, refer to EN 1279-4.

4.3 Gas leakage rate

When the system description includes gas-filled insulating glass units, for additional testing and requirements on gas leakage rate, refer to EN 1279-3.

5 Method of test

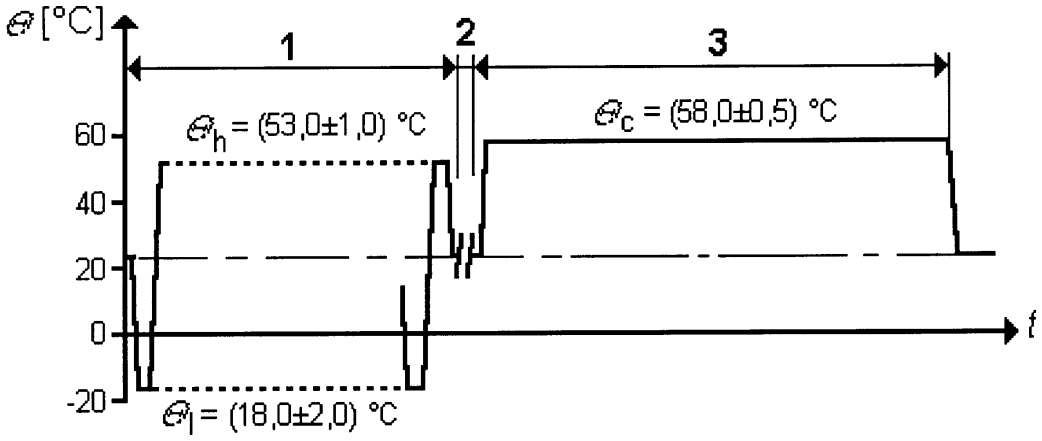
5.1 Principle

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

5.2 Climate conditions in cabinet

The high humidity/temperature test procedure consists of two parts. The climate condition in the cabinet comprises as a first part 56 temperature cycles of 12 h from -18 °C to +53 °C with slopes of 14 °C/h, followed by a second part comprising 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, are given in Figures 1 and 2.



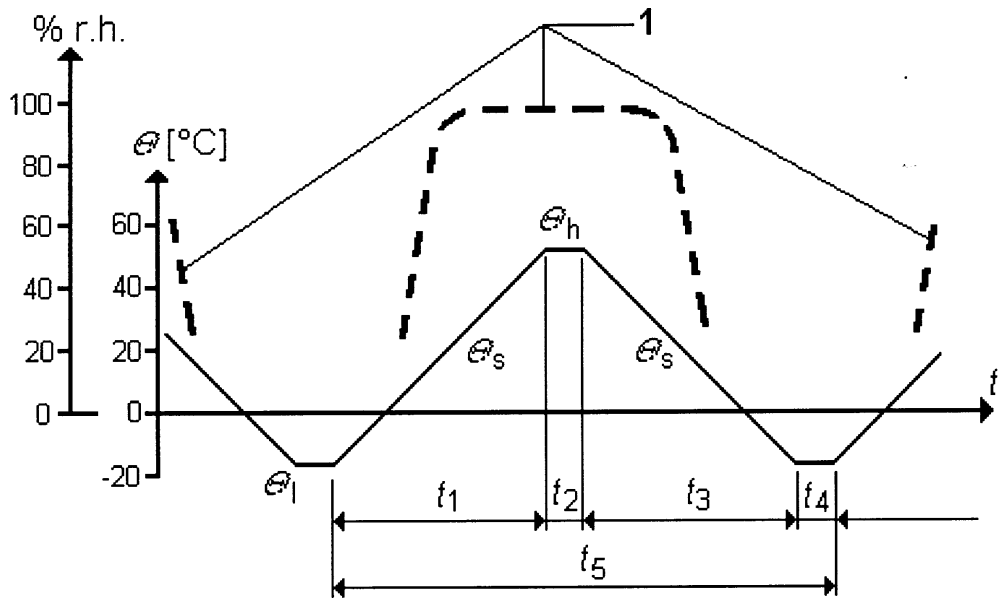
Key

1 56 temperature cycles of 12 h (is four weeks)

2 Interval of 2 h to 4 h for moving test pieces from one cabinet to a second cabinet when two cabinets are used

3 (1176 ± 4) h (seven weeks) constant temperature and a relative humidity of r.h. ≥ 95 %. Condensation on test specimen is allowed

Figure 1 — Overview of climate conditions in cabinet. ϑ is the glass temperature of the centrally located test specimen - Temperature cycles start with the cooling part



Key

1 Relative humidity during temperature cycle. Top value of r.h. ≥ 95 %. During the cold part of the cycle, the high humidity is interrupted. Condensation on test specimen from time to time is allowed.

– Time intervals: t_1 = 5 h, t_2 = 1 h, t_3 = 5 h, t_4 = 1 h, t_5 = total cycle time 12 h ;

– Tolerance on time intervals: less than 1 min;

– Temperatures of the centrally located test specimen during cycle:

  – Θ_h = (53,0 ± 1,0) °C (high temperature);

  – Θ_l = (-18,0 ± 1,0) °C (low temperature);

  – Θ_s = (14 ± 2) °C/h (slopes).

Figure 2 — Temperature/time and humidity/time relations in cycling stage

NOTE The two parts of the process can be carried out in a single cabinet or in two separate cabinets. If two cabinets are used allow up to 4 h for moving the test specimens from one to the other for the second period.

The indicated temperatures and temperature tolerances in Figures 1 and 2 are valid for the glass of that unit which is centrally located in the cabinet(s). The temperature of that centrally located test specimen shall be recorded continuously. Also the relative humidity and air temperature, measured at the most suitable location in the test cabinet(s) shall be recorded continuously. Any deviations in temperature and in relative humidity will be noted in the test report.

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

– during cycling: • high temperature $\Theta = (\Theta_h \pm 1{,}0)$ °C;

  • low temperature $\Theta = (\Theta_l \pm 2{,}0)$ °C;

- slopes $\Theta = (\Theta_S \pm 2{,}0)$ °C/h;

– during constant temperature: $\Theta = (\Theta_C \pm 0{,}5)$ °C.

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

5.3 Number, description and selection of the test specimens

A set of insulating glass units consists of 15 test pieces. The test specimens shall be representative of the system description (see prEN 1279-1) and shall consist of two panes of 4 mm clear float glass in accordance with EN 572-1 and EN 572-2. The length shall be (502 ± 2) mm and the width (352 ± 2) mm. The gap shall be 12 mm, or if not manufactured, a gap 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 shall correspond to the edge and corner details in units supplied to the market.

When the system description contains curved insulating glass units with a bending radius equal to or less than 1 m, the test pieces shall be curved as described in prEN 1279-1.

When the system provides a mixture of desiccant with a non-desiccant material, incapable of resisting 1 000 °C, the 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 with a non-desiccant material, incapable of withstanding 220 °C, the non-desiccant material shall be replaced by the same volume of desiccant.

Following reception, condition 15 test specimens for two weeks minimum at standard laboratory conditions. The initial dew point temperatures of the test specimens, measured in accordance with 6.1, shall be within a range of 10 K from the maximum dew point temperature as stated in, or to be derived from, information in the manufacturer's product/type description. Dew point temperatures less than -60 °C should be considered as -60 °C.

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. Select the units as indicated in Table 1.

Table 1 — Designation of insulating glass units in climate tests

Unit number	**Designate units for:**
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

5.4 Procedure

When starting the climate test, measure the initial moisture content (T_i) of the desiccant (if any) on the four selected test specimens, in accordance with 6.2. Submit the five selected test specimens to the climate conditions, in accordance with 5.2. For units without desiccant, measure the initial dew point temperature of the test specimens in accordance with 6.1. This dew point temperature enables an equivalent value for T_i to be found in accordance with 6.2.3.

NOTE 1 For reasons of time saving and cost aspects of this test, the manufacturer or his agent may decide whether the spare units shall be submitted to climate conditions from the beginning, or only when a unit under climate conditions breaks.

NOTE 2 In order to be able to determine the requirement for the periodic test on moisture penetration, it is recommended that parallel with this procedure the periodic moisture penetration test in accordance with EN 1279-6 is carried out.

Store the units 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 6.2. When the amount of desiccant in the test unit differs from the units placed on the market, the final moisture content T_f shall be corrected by the multiplier

$$k = \frac{Q_{desiccant\_as\_per\_system\_description}}{Q_{desiccant\_unit\_in\_test}} \qquad (1)$$

where

Q is amount of desiccant in weight or in volume.

NOTE 3 When there are technical reasons that the quantity of desiccant in the test pieces cannot be representative of the system description, the test can be performed with a different quantity, however test results have to be corrected in order to obtain a true *I*-value.

For units without desiccant, measure the final dew point temperature of the test specimens in accordance with 6.1. This dew point temperature enables an equivalent value for T_f to be found in accordance with 6.2.4.

Establish the standard moisture adsorption capacity (T_c) according to annex D. If necessary, measure the standard moisture adsorption capacity of the desiccant on the rejected units in accordance with 6.2. In the case of units without desiccant, find T_c in accordance with 6.2.4.

Calculate the average initial moisture content of the desiccant from the following equation:

$$T_{1,av} = \sum_{n=1}^{4} \frac{T_{i,n}}{4} \qquad (2)$$

When applicable, calculate the average standard moisture adsorption capacity of desiccant from the following equation:

$$T_{c,av} = \sum_{n=1}^{2} \frac{T_{c,n}}{2} \qquad (3)$$

Calculate the moisture penetration index, in fractions or in percentage, of each of the five selected or designated test specimens subjected to the climate conditions, from the following equation:

$$I = \frac{T_f - T_{i,av}}{T_{c,av} - T_{i,av}} \quad \text{or} \quad I = 100\frac{T_f - T_{i,av}}{T_{c,av} - T_{i,av}} \quad \text{in \%} \qquad (4)$$

Calculate the average moisture penetration index from the following equation:

$$I_{av} = \sum_{n=1}^{5} \frac{I_n}{5} \quad (5)$$

Insulating glass unit manufacturers should be aware of the accuracy of the test as evidenced by results from proficiency testing. A proficiency test involving 10 laboratories, using the method detailed in this standard, has demonstrated that an accuracy, as defined in 3.1.4, better than ± 0,10 when the moisture penetration index *I* is expressed as a ratio, or ± 10 % absolute when *I* is expressed as a percentage, can be achieved.

6 Methods of measurement

6.1 Measurement of dew point temperature

Any method is applicable when checked against the reference method given in annex A.

6.2 Measurement of moisture content

6.2.1 General

Moisture content values from different methods shall not be mixed.

NOTE There are three methods available for the moisture content measurements (T_i, T_f and T_C):

– the 950 °C drying method: applicable for desiccant in bulk;

– the Karl Fischer method: applicable for desiccant incorporated in organic sealing material;

– the partial pressure method: applicable for units without desiccant.

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

6.2.2 Moisture content of desiccant in bulk

Weigh an empty dish. Prepare and collect desiccant from each designated unit:

– for the initial moisture content T_i, according to B.3;

– for the final moisture content T_f, according to B.3;

– for the standard moisture capacity T_C, according to B.4.

Weigh the dish and desiccant. Dry desiccant according to B.2 and B.3. After cooling, weigh dish and desiccant. Calculate the moisture contents:

– initial moisture content: according to equation (B.1);

– final moisture content: according to equation (B.2) and eventual corrected value according to equation (B.4);

– standard moisture adsorption capacity: according to equation (B.5).

6.2.3 Moisture content of desiccant incorporated in organic spacer

Prepare and collect organic spacer material containing desiccant, four samples, one from each side according to C.3, of each designated unit:

– for the initial moisture content T_i according to C.3;

– for the final moisture content T_f according to C.3;

– for the standard moisture capacity T_C according to C.4.

Weigh the samples. Determine the moisture contents by applying the Karl Fischer method according to annex C.

NOTE The method gives directly the moisture contents: T_i, T_f or T_C.

6.2.4 Moisture content in insulating glass units without desiccant

When dew point temperature is measured in accordance with 6.1, find in Table 2 the corresponding water vapour partial pressure. The value obtained is designated T_i in case of initial moisture content, T_f in case of the final moisture content.

The value of the water vapour partial pressure obtained for the limit environment conditions defined in 3.1.3, is 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						

7 Test report

The test report shall evaluate the test in detail and shall include the following summary:

Name of test house, its address and logo.

Summary of report n°..... Date .....

Insulating glass units - Moisture penetration results according to prEN 1279-2

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

Annex A
(normative)

Reference method for dew point temperature measurement

A.1 General

The method serves as the reference one for those methods normally used by test houses. Comparisons of methods are carried out by taking test specimens as defined by 5.3, which shall be placed vertically on their shorter edge.

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.

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 from the real one to lower values. 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 of the 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 Apparatus and materials

– Cooling cell, in accordance with Figure A.1;

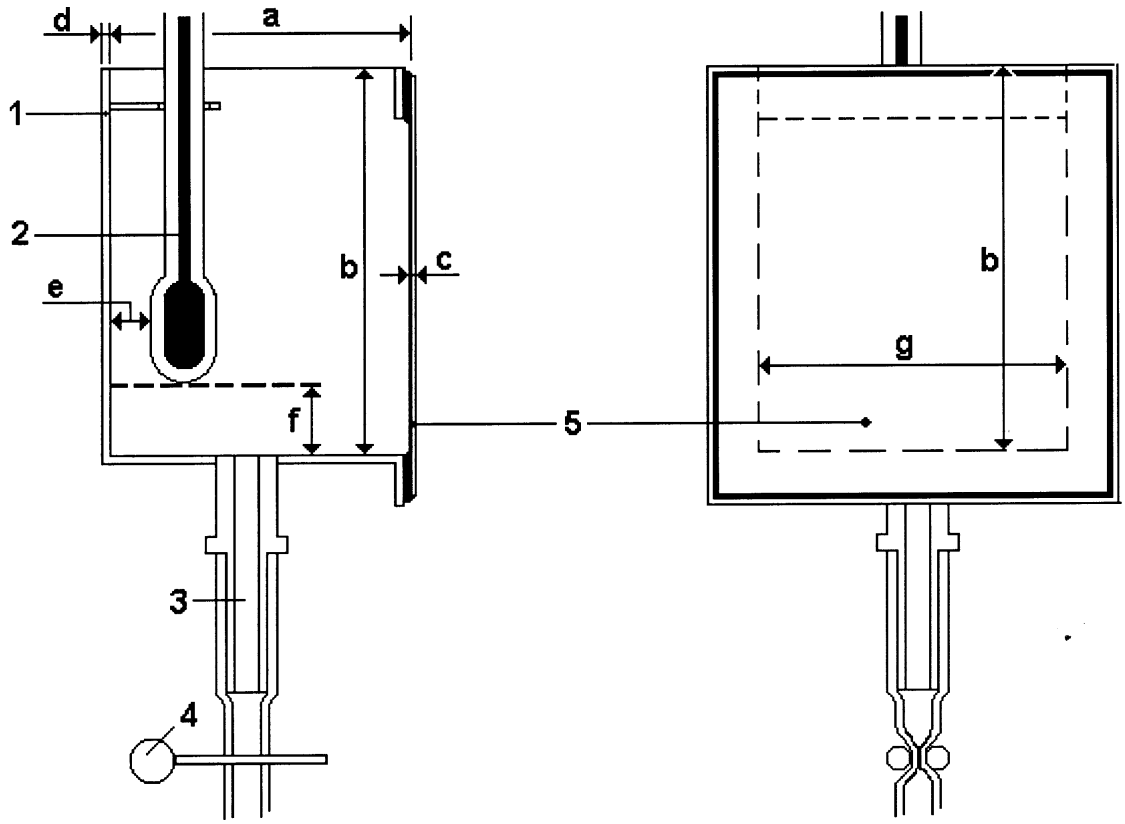
– Ethanol, for cooling;

– Crushed solid carbon dioxide, for cooling;

– Alcohol thermometer with a range of at least from +30 °C to -70 °C, and with a limit deviation of ± 1 °C.

A.3 Procedure

Carry out the measurement at standard laboratory conditions according to 3.1.1. Press the cooling cell to the cleaned glass surface in the centre of the unit with a few drops of ethanol between the glass and the mirror surfaces for optimal conductivity. Position the thermometer in the cooling cell. Fill the cooling cell with ethanol up to a height of 30 mm to 35 mm. Introduce the crushed solid carbon dioxide gradually into the ethanol. The cooling rate from approximately 20 K over the dew point, shall be not more than 2 K/min. 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. That temperature is the dew point temperature.



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

a = (40 ± 2) mm

b = (60 ± 1) mm

c is the maximum 2 mm including painting

d = (2 ± 0,1) mm

e = (10 ± 2) mm

f = (10 ± 2) mm

g = (50 ± 1) mm

Figure A.1 — Dew point cooling cell and thermometer

Annex B
(normative)

Moisture content measurement according to the 950 °C drying method

B.1 Applicability

The measurement method is applicable for desiccant in bulk.

B.2 Apparatus, materials and preparatory work

B.2.1 Room conditions shall be standard in accordance with 3.1.1. Precautions shall be taken to minimize dust. The room should be a closed one so that traffic through the room is prevented.

B.2.2 Balance accuracy shall be at least ± 0,001 g.

B.2.3 Recommended dish and lid: a porcelain one as e.g. illustrated in Figure B.1.

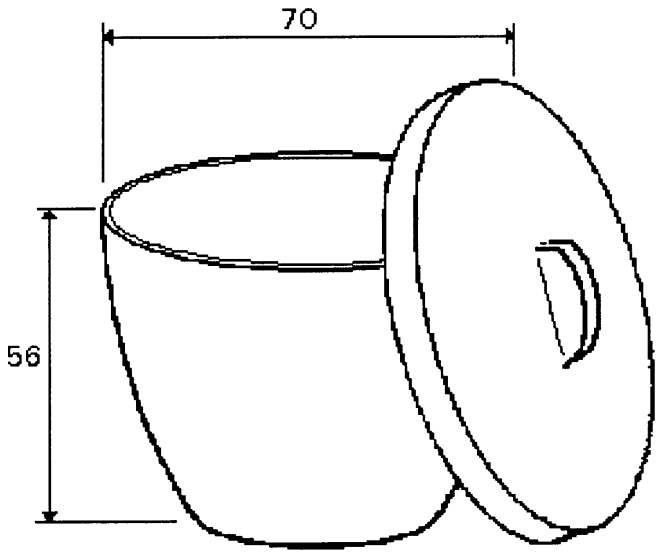


Figure B.1 — Illustration of a dish with lid. Dimensions in mm

B.2.4 Clean and dry a dish and lid, by washing in distilled water and drying to constant weight 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 m_o. Apply this procedure to all dishes at the beginning of all series of weighing.

B.3 Initial and final moisture content

B.3.1 Remove the desiccant according to either a) or b) as follows:

a) recommended procedure for removing desiccant, 1st alternative;

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 half through in the centre;
5) bend the spacer parts by hand over the dish and put desiccant in the dish;
6) retain 20 to 30 g from 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).

Operations 1) to 3) should be done within 5 min.

Operations 4) to 9) should be done within 3 min.

b) recommended procedure for removing desiccant, 2nd alternative:

1) remove the seal over a 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 to 30 g from 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) eigh the dish and desiccant without the lid (m_i for T_i determination, m_f for T_f determination).

Operations 1) to 3) should be done within 5 min.

Operations 4) to 8) should be done within 3 min.

B.3.2 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.3.3 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.3.4 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 (m_r).

B.3.5 Calculate the moisture contents in fractions or in percentages:

– initial moisture content:

$$T_i = \frac{m_i - m_r}{m_r - m_0} \quad \text{or} \quad T_i = 100\frac{m_i - m_r}{m_r - m_0} \qquad \text{in \%} \qquad \text{(B.1)}$$

– final moisture content:

$$T_f = \frac{m_f - m_r}{m_r - m_0} \quad \text{or} \quad T_f = 100\frac{m_f - m_r}{m_r - m_0} \qquad \text{in \%} \qquad \text{(B.2)}$$

B.3.6 In the case of a mixture of desiccant with non-desiccant material, and that 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).

This ratio is:

$$R = \frac{M_m}{M_t} \qquad \text{(B.3)}$$

The values obtained by expressions B.1 and B.2 are designated $T_{i,U}$ and $T_{f,U}$. Calculate the corrected initial and final moisture contents (T_i and T_f) by multiplying $T_{i,U}$ and $T_{f,U}$ with the ratio R:

$$T_i = RT_{i,u} \qquad \text{(B.4)}$$

and

$$T_f = RT_{f,u} \qquad \text{(B.5)}$$

B.4 Standard moisture adsorption capacity

B.4.1 Remove 20 g to 30 g desiccant from the rejected units in accordance with B.2.4. Do not weigh the dish at this point. If the desiccant is taken from a drum, place it on a dish prepared according to B.2.4.

B.4.2 Prepare and maintain a relative humidity of 32 % in a desiccator by means of:

– 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;

– check if at least one crystal remains undissolved in the solution throughout the full test period;

– place the saturated solution in the bottom of the desiccator and close. Allow to come to equilibrium for 24 h.

NOTE The created environment with the Calcium Chloride solution simulates the limit environment conditions defined in 3.1.3.

B.4.3 Humidify the desiccant to equilibrium adsorption at limit environment conditions:

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

– reclose the assembly and leave for four weeks. Check frequently throughout the test period to ensure that at least one crystal remains undissolved;

– after four weeks weigh the dish with desiccant within 30 s. Return to desiccator and leave for a further week;

– reweigh the dish and desiccant quickly. If two successive values do not agree to within 0,005 g, return the dish and desiccant to desiccator to stand over saturated Calcium Chloride solution for further weekly intervals until constant mass is achieved.

B.4.4 Designate the value of the constant mass m_c.

B.4.5 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.4.6 Remove the lid and place the dish containing desiccant in the furnace. Heat the furnace from room temperature to 950 °C in (60 ± 20) min. Keep the temperature at (950 ± 50) °C for a further (120 ± 5) min.

B.4.7 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 (m_r).

B.4.8 Calculate the standard moisture adsorption capacity in fractions or in percentages:

$$T_c = \frac{m_c - m_r}{m_r - m_0} \quad \text{or} \quad T_c = 100\frac{m_c - m_r}{m_r - m_0} \qquad \text{in \%} \tag{B.6}$$

Annex C
(normative)

Moisture content measurement according to the Karl Fischer method

C.1 Applicability

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

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 the applicability shall be verified.

C.2 Apparatus, materials and preparatory work

C.2.1 Room conditions shall be standard in accordance with 3.1.1. Precautions shall be taken to minimize dust. The room shall be a closed one so that traffic through the room is prevented.

C.2.2 Balance accuracy shall be at least ± 0,000 1 g.

C.2.3 The measurement method needs the following Karl Fischer (KF) apparatus and KF materials:

– KF titrimeter;

– KF reagent;

– KF solvent;

– KF burette;

– KF tube furnace;

– KF calculator;

and additionally nitrogen (N_2+Ar>99,995 %, H_2O<5 × 10^{-6} volume, O_2<2 × 10^{-6} volume) and Sodium Tartrate ($[CHOHCOONa]_2 \cdot 2H_2O$) or Sodium Citrate ($C_6H_5K_3O_7 \cdot H_2O$).

NOTE 1 The length of the connection between KF tube furnace and KF titrimeter should be equal or less than 200 mm.

NOTE 2 The following combinations of reagent and solvent can be used:

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

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

C.2.4 Prior to placing samples in the KF tube furnace, carry out the following preparatory work:

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

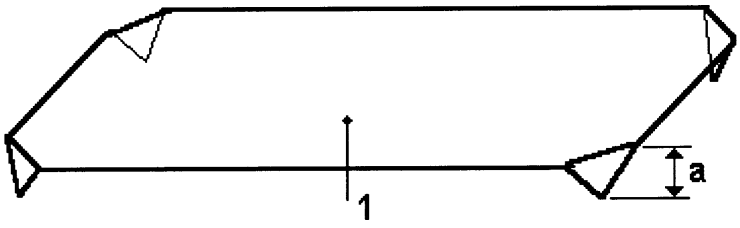
b) Measure the drift (caused by connections which are not perfectly tight). Maintain the nitrogen flow of (200 ± 20) ml/min, and maintain the KF tube furnace temperature at (200 ± 5) °C. Record drying curve during 10 min with a 1 min interval.

c) 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.

d) Calibrate on the basis of the results from b) and c).

C.3 Initial and final moisture content

C.3.1 Prepare a net in accordance of Figure C.1. Weigh the net. Designate the value of the mass obtained mo.



Key

1 Net with folded corners

a Aapproximately 3 mm

Figure C.1 — Example of net

C.3.2 Open the insulating glass unit and select from the centres of the sides cross sections of approximately 0,5 g sealant containing desiccant, in accordance with Figures C.2 and C.3.

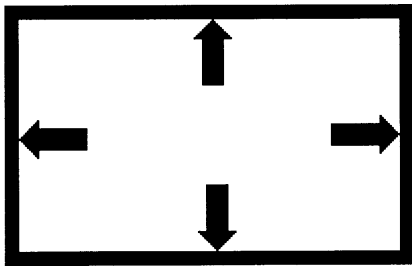
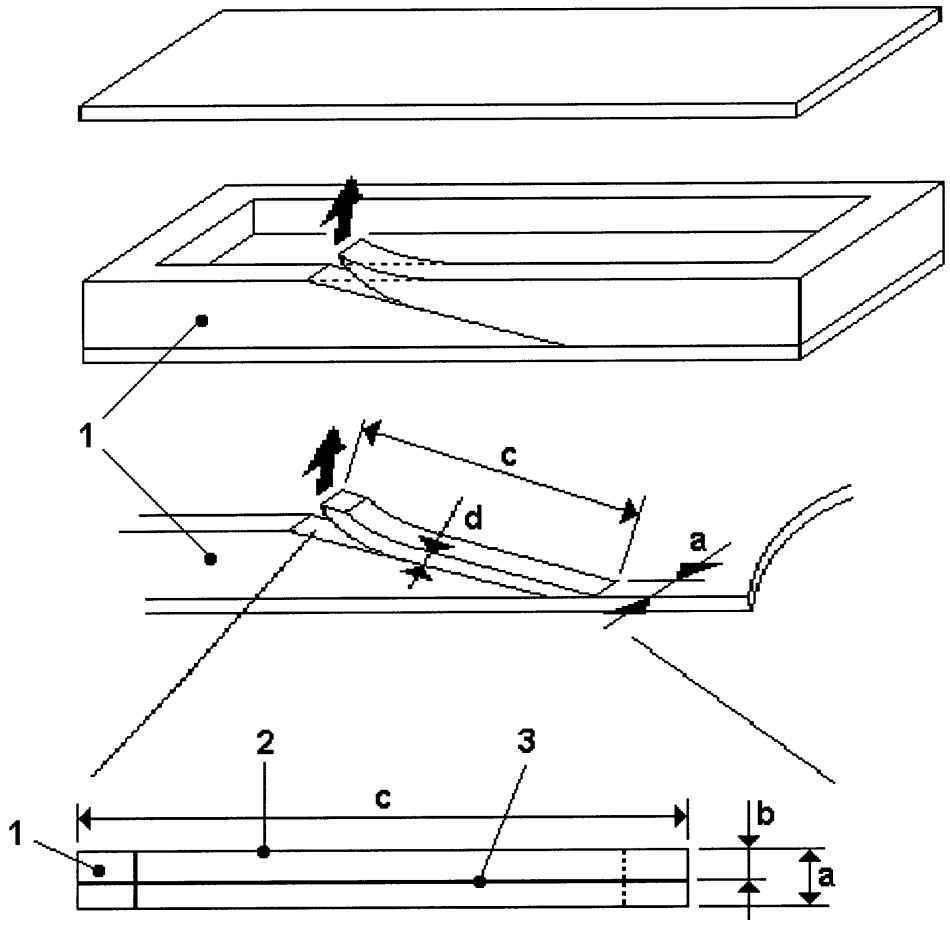


Figure C.2 — Illustration from where in an insulating glass unit to take the samples of organic material incorporating desiccant



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

b is the half of width a ± 0,5 mm with a maximum of (3,5 ± 0,5) mm

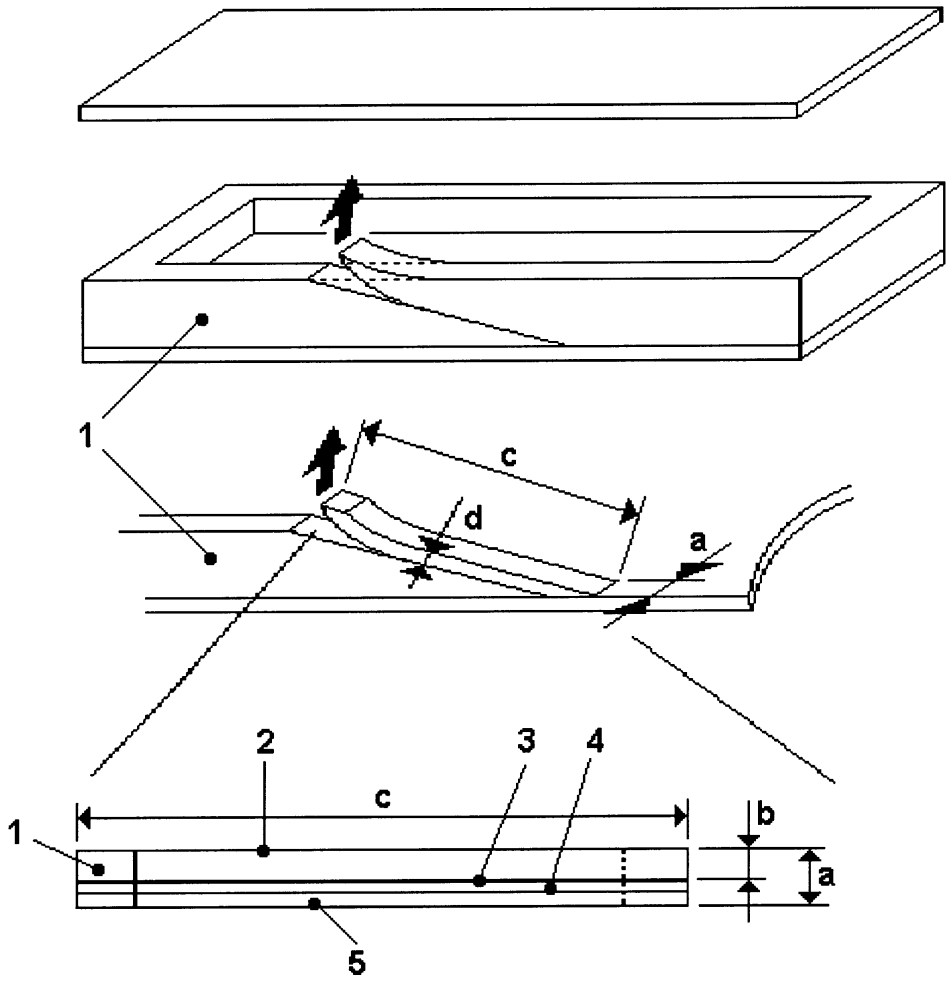
Figure C.3 — Illustration of how to take the samples of organic material incorporating desiccant

Quantity (b·c·d) shall be approximately 0,5 cm³, so that the mass is approximately 0,5 g.

In the case of insulating glass unit systems where an impermeable moisture penetration barrier is present, samples can be taken as illustrated in Figures C.2 and C.4.

Avoid materials other than the sealant containing desiccant. Place all samples, which shall be mixed on the net as illustrated in Figure C.5. Weigh the nets with the samples. Designate the obtained values m_i when initial moisture content is measured, and m_f when final moisture content is measured. Place net with 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.

NOTE 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

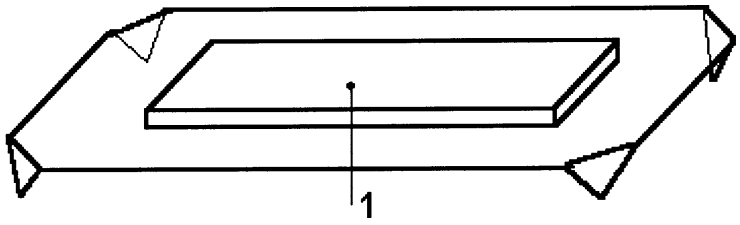
c is the length of the material taken over the full width of the cavity.

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

Quantity (b·c·d) shall be approximately 0,5 cm^3, so that the mass is approximately 0,5 g.

C.3.3 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.3.4 Enter the appropriate value (m_i -m_o) or (m_f -m_o) in the KF calculator. Read the moisture content T_i, or T_f, from the calculator.



Key

1 Desiccant in organic matrix, pressed into film of approximately 1 mm thick.

From film, a strip of 40 mm x 10 mm is cut out.

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

C.4 Standard moisture adsorption capacity

C.4.1 Take a quantity of sealant containing desiccant from a drum, or remove it from insulating glass units as indicated in C.3.2. Prepare four samples, each of approximately 2 g, place them on nets which have a mass $m_{o,m}$.

C.4.2 Prepare and maintain a relative humidity of 31 % at 55 °C in a cabinet as follows:

– Prepare a saturated salt solution of Magnesium Chloride ($MgCl_2 \cdot 6H_2O$) crystals in water at (55 ± 1) °C;

– Check if at least one crystal is undissolved in the solution throughout the full test period;

– Place the saturated solution in the bottom of the cabinet and close. Allow to come to equilibrium for at least 24 h.

NOTE The created environment with the Magnesium Chloride solution simulates the limit environment conditions defined in 3.1.3

C.4.3 Humidify the samples to standard maximum adsorption rate as follows:

– place the nets with sample approximately 20 mm above the solution and support in such a way that free flow of conditioned air can take place. Avoid contact between the net and sample with the solution;

– maintain exposure for 21 weeks;

– check frequently throughout the full test period that at least one crystal remains undissolved. Maintain the cabinet temperature at (55 ± 1) °C;

– weigh the samples at three week intervals;

– plot the measured masses against exposure time period;

– observe when the curves level out, at which point the equilibrium adsorption condition has been reached. Designate the equilibrium values $m_{c,m}$;

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

C.4.4 Place the net with organic material in a shuttle. Place the shuttle into the KF tube furnace, which is stabilized at (200 ± 5) °C, taking no more than 3 min.

C.4.5 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.4.6 Enter the appropriate value ($m_{c,m}$ -$m_{o,m}$) in the KF calculator. Read the moisture content $T_{c,m}$ from the calculator.

C.4.7 Calculate the moisture content, T_c, of the unit in accordance with the following equation:

$$T_c = \sum_{m=1}^{4} \frac{T_{c,m}}{4} \qquad \text{(C.3)}$$

Annex D
(normative)

Establishing the standard moisture adsorption capacity of desiccants

D.1 General

For the standard moisture adsorption capacity, two measurements methods are available:

– the 950 °C drying method: suitable for desiccant in bulk, shall be measured according B.4;

– the Karl Fischer method: suitable for desiccant incorporated in organic sealing material, shall be measured according to C.4.

When the appropriate standard moisture adsorption capacity is published or reported according to D.2, it may be used instead of a repeated measurement.

Generally accepted values for desiccant in bulk according to D.3 may also be used instead of repeated measurements under the condition that the average moisture penetration index I_{av} is less than 0,16 when expressed in fraction, or I_{av} less than 16 % when expressed in percentage.

NOTE When $0{,}16 \leq I_{av} \leq 0{,}24$ ($16\ \% \leq I_{av} \leq 24\ \%$), 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.

When the generally accepted value according D.3 is either not available or inapplicable, and when there is no publication or report in accordance with D.2, the standard moisture adsorption capacity shall be measured when an insulating glass unit is subject for the climate test.

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

D.2 Appropriate information

Publication or report not older than nine month when:

– the desiccant manufacturer declares to operate a production control.

NOTE It is recommended that the report is issued by a laboratory independent of production.

Publication or report not older that 30 month when:

– the manufacturer operates a third party surveillance system in accordance with an EN ISO 9001 Quality assurance system (see Bibliography [1] and [2]); and

– the quality procedures refer to relevant clauses of this standard.

NOTE It is recommended that the report is issued by a laboratory independent of production.

Publication or report from the desiccant manufacturer not older than 30 month when:

– the manufacturer operates a third party surveillance system in accordance with an EN ISO 9001 Quality assurance system; and

– the quality procedures refer to relevant clauses of this standard;

– and the method of measurement is verified.

NOTE It is recommended that the report is issued by a laboratory independent of the desiccant production.

D.3 Generally accepted values for desiccant in bulk

Instead of repeatedly measuring the standard moisture adsorption capacity, the generally accepted values from Table D.1 may be used.

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 %

D.4 Desiccant manufacturing

For the purposes of this Part of the standard, it is permissible for the desiccant manufacturer to determine the amount of desiccant for control purposes in his factory, provided that he has established a relationship between his method and the requirements of this standard.

Bibliography

[1] EN 1279-6, *Glass in Building - Insulating glass units - Part 6 Factory production control and periodic tests.*

[2] EN ISO 9001, *Quality management systems - Requirements (ISO 9001:2000).*

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL