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ISO 18097

Second edition
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Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature

Produits isolants thermiques pour l'équipement du bâtiment et les installations industrielles — Détermination de la température maximale de service

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 88, *Thermal insulating materials and products*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 18097:2013), which has been technically revised.

The main changes are as follows:

— EN 14706:2012 and ISO 18097:2013 have been merged into one document;

— editorial revisions.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature

1 Scope

This document specifies the equipment and procedures for determining the maximum service temperature of flat insulation products. It is applicable to thermal insulating products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5725-2:2019, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 7884-1, *Glass — Viscosity and viscometric fixed points — Part 1: Principles for determining viscosity and viscometric fixed points*

ISO 7884-7, *Glass — Viscosity and viscometric fixed points — Part 7: Determination of annealing point and strain point by beam bending*

ISO 16544, *Thermal insulating products for building applications — Conditioning to moisture equilibrium under specified temperature and humidity conditions*

ISO 29466, *Thermal insulating products for building applications — Determination of thickness*

ISO 29768, *Thermal insulating products for building applications — Determination of linear dimensions of test specimens*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
maximum service temperature
highest temperature at which the thermal insulation product, when installed at the recommended thickness in a given application, continues to function within specified limits of performance

Note 1 to entry: The required performance may be in the areas of dimensional stability, thermal properties and mechanical properties as well as changes in appearance and resistance against creation of hazards such as internal self-heating (see Annexes A and C and possible requirements in the relevant product standard).

Note 2 to entry: In the present test procedure, which is used as a reference, the test specimen is exposed to a temperature difference going from ambient to the maximum service temperature. This may not reflect the actual application conditions when products are exposed to different temperatures on the two main faces, e.g. in multilayer systems or for faced products where the facing may limit the maximum service temperature.

[SOURCE: ISO 9229:2020, 3.6.9.1, modified — Notes 1 and 2 to entry have been added.]

4 Principle

The thickness, length and width shall be measured after one-sided heat treatment for a specified time period, at the maximum service temperature, achieved using a specified rate of temperature increase. The thickness of the test specimen is measured during heat treatment, and the length and width only after cooling to ambient temperature.

NOTE The procedure can be an iterative process.

Additional requirements for assessing the maximum service temperature of specific materials are described in Annexes A to D or the relevant product standard or any other international technical specification.

5 Apparatus

A general arrangement of the apparatus is indicated in Figure 1 and comprises:

5.1 Flat square or circular hot plate, with a uniform temperature distribution in the measuring zone on the hot face and a heat flux perpendicular to the face of the hot plate. The deviation from flatness of the hot plate shall not exceed 1 mm in the measuring zone at ambient temperature.

The hot plate shall be capable of being controlled to within ±2 % of a predetermined temperature or ±10 °C, whichever is smaller.

The hot plate shall be capable of being heated at 50 °C/h and/or 300 °C/h.

If a small size equipment (e.g. Ø 100 mm) is used, the free movement of the test specimen during the test is critical and shall be controlled strictly.

5.2 Edge insulation, with a gap as small as possible (e.g. ≤ 1 mm/100 mm test specimen size) which permits free movement during the test of the test specimen and of the pressure plate.

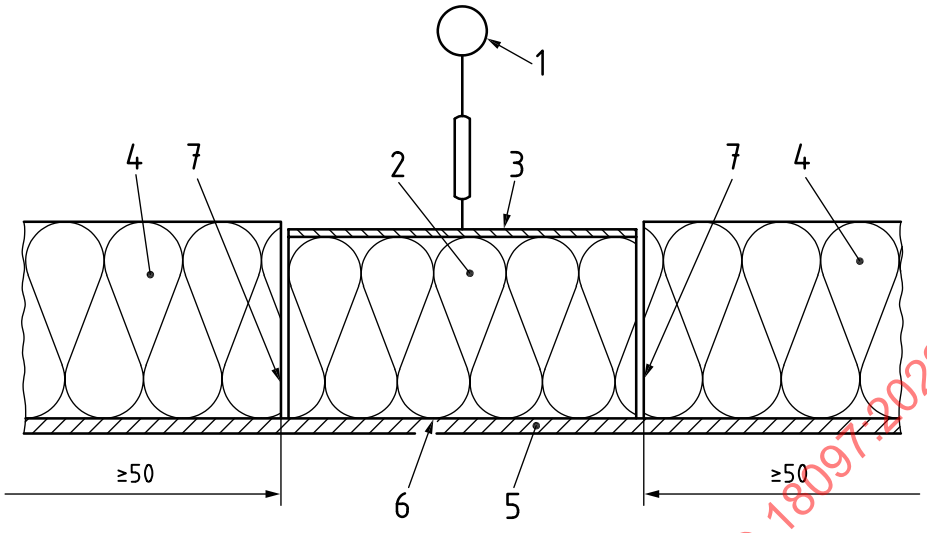
5.3 Square or circular pressure plate, with the same dimensions as the test specimen exerting the required load on the test specimen.

5.4 Device, e.g. electromechanical for measuring the thickness of the test specimen during the test to the nearest 0,1 mm.

When determining the thickness of the test specimen, the thermal movement of the apparatus (e.g. quartz rod) shall be taken into account up to the maximum service temperature.

5.5 Temperature sensors (e.g. thermocouples), capable of recording the hot plate temperature to the nearest ±1 % in centigrade but not less than ±1 °C, which are placed within grooves on the hot plate.

Dimensions in millimetres



Key

1	device for measuring thickness, e.g. electromechanical device	5	hot plate
2	test specimen	6	thermocouple
3	pressure plate	7	small gap
4	edge insulation		

Figure 1 — Example of an apparatus for determining maximum service temperature

6 Test specimens

6.1 Dimensions of test specimens

6.1.1 Length and width

Test specimens shall be cut as squares or cylinders (as appropriate) and the cross-section dimensions shall be as follows:

100 mm × 100 mm (or diameter 100 mm); or

150 mm × 150 mm (or diameter 150 mm); or

200 mm × 200 mm (or diameter 200 mm); or

300 mm × 300 mm (or diameter 300 mm).

The length and width or diameter shall be as specified in the relevant product standard or in Annexes A to D.

6.1.2 Thickness

The thickness shall be (100 ± 5) mm prepared by slicing if needed.

NOTE 1 In the absence of a product standard or any other international technical specification, the dimensions can be agreed between parties.

NOTE 2 Testing can be performed on multilayer systems to simulate the conditions existing in the application.

6.2 Number of test specimens

The number of test specimens shall be as specified in the relevant product standard. If the number is not specified, then at least three test specimens shall be used.

NOTE In the absence of a product standard or any other international technical specification the number of test specimens can be agreed between parties.

6.3 Conditioning of test specimens

The test specimens shall be stored for at least 6 h at (23 ± 5) °C. In case of dispute, they shall be stored at (23 ± 2) °C and (50 ± 5) % relative humidity for the time specified in the relevant product standard or at least 24 h.

In tropical climates, different conditioning and testing conditions can be relevant. In this case, the conditions shall be (27 ± 5) °C and (65 ± 5) % relative humidity.

7 Procedure

7.1 Test conditions

The initial temperature of the test specimen and the hot plate shall be (23 ± 5) °C.

In tropical climates, different conditioning and testing conditions can be relevant. In this case the initial temperature of the test specimen and the hot plate shall be (27 ± 5) °C.

7.2 Test procedure

Measure the length and width of the test specimen, l_1, b_1, (or diameter) in accordance with ISO 29768, read to the nearest 0,5 mm.

Measure the thickness of the test specimen, d_0, in accordance with ISO 29466 using the load specified in the relevant product standard.

Install the test specimen in the apparatus ensuring contact between the test specimen and the hot plate.

Load the test specimen with a pressure of 500 Pa and record the thickness, d_1, to the nearest 0,1 mm.

NOTE For polyethylene foam and flexible elastomeric foam products, see Annex D.

Heat the test specimen using a temperature rate of increase of 50 °C/h or 300 °C/h, as specified in the relevant product standard or Annexes A to D.

Maintain the temperature of the hot side, at the expected maximum service temperature, for 72 h within ±2 % of this temperature or ±10 °C, whichever is smaller.

Record the thickness continuously during the test and at the end of the 72 h period, d_2, to the nearest 0,1 mm.

Cool the test specimen in the equipment to a temperature of < 35 °C and remeasure the thickness, d_3, to the nearest 0,1 mm, unless otherwise specified in the relevant product standard or Annexes A to D.

Take the test specimen from the apparatus and remeasure the length, l_2, and the width, b_2, (or diameter) of the test specimen as before, to the nearest 0,5 mm.

In the case of non-rectangular edges, this shall be taken into account when measuring l_2 and b_2 (or diameter).

Examine the test specimen visually and note any changes caused by the test.

If the relevant product standard or Annexes A to D specifies additional requirements, the observations and/or tests shall be performed accordingly.

Repeat the test procedure for the other test specimens.

8 Calculation and expression of results

8.1 Thickness deformation versus time

The curves thickness deformation versus time and temperature versus time recorded during testing shall be given. An example is shown in Figure 2.

8.2 Dimensional changes

Calculate the dimensional changes of thickness, $\Delta\varepsilon_d$, length, $\Delta\varepsilon_l$, and width, $\Delta\varepsilon_b$, in percentage, using the following equations:

$$\Delta\varepsilon_d = 100 \times \frac{d_{2(or3)} - d1}{d1} \quad (1)$$

$$\Delta\varepsilon_l = 100 \times \frac{l_2 - l_1}{l_1} \quad (2)$$

$$\Delta\varepsilon_b = 100 \times \frac{b_2 - b_1}{b_1} \quad (3)$$

where

d_1 is the measured thickness installed before heating, in millimetres;

d_2 is the measured thickness installed after the 72 h at constant temperature, in millimetres;

d_3 is the measured thickness after cooling down to a temperature of < 35 °C, in millimetres;

l_1, b_1 are the measured length and width before heating, in millimetres;

l_2, b_2 are the measured length and width after the 72 h at constant temperature and after cooling down, in millimetres.

In case of circular test specimens, the diameter/diameter change is calculated instead of length and width. Formula (2) can be used by inserting diameter instead of length.

If the dimensional change in thickness is larger by using d_3 instead of d_2 in Formula (1), this thickness shall be used in the calculation of the test result.

Calculate the test result as the mean values of dimensional changes, $\overline{\Delta\varepsilon_d}$, $\overline{\Delta\varepsilon_l}$, $\overline{\Delta\varepsilon_b}$, as a percentage rounded to the nearest 0,5 % from the test results of the individual test specimens.

If the change in the mean value (test result) for any of the dimensions exceeds the value specified in the relevant product standard, the test shall be repeated at a lower temperature until the dimensional changes are smaller than or equal to the specified value. This temperature is then considered as the maximum service temperature (see Figure 3), providing that the requirements given in 8.3 and 8.4 are also fulfilled.

The steps in centigrade for the indication of the maximum service temperature shall be as specified in the relevant product standard or in Annexes A to D. If the steps are not specified, the maximum service

temperature shall be declared in steps of not less than 5 °C for temperatures up to 100 °C and in steps of not less than 10 °C for temperatures above 100 °C.

NOTE It is possible that results will not be comparable for a product tested at different thicknesses and/or different loads.

8.3 Additional tests and/or observations

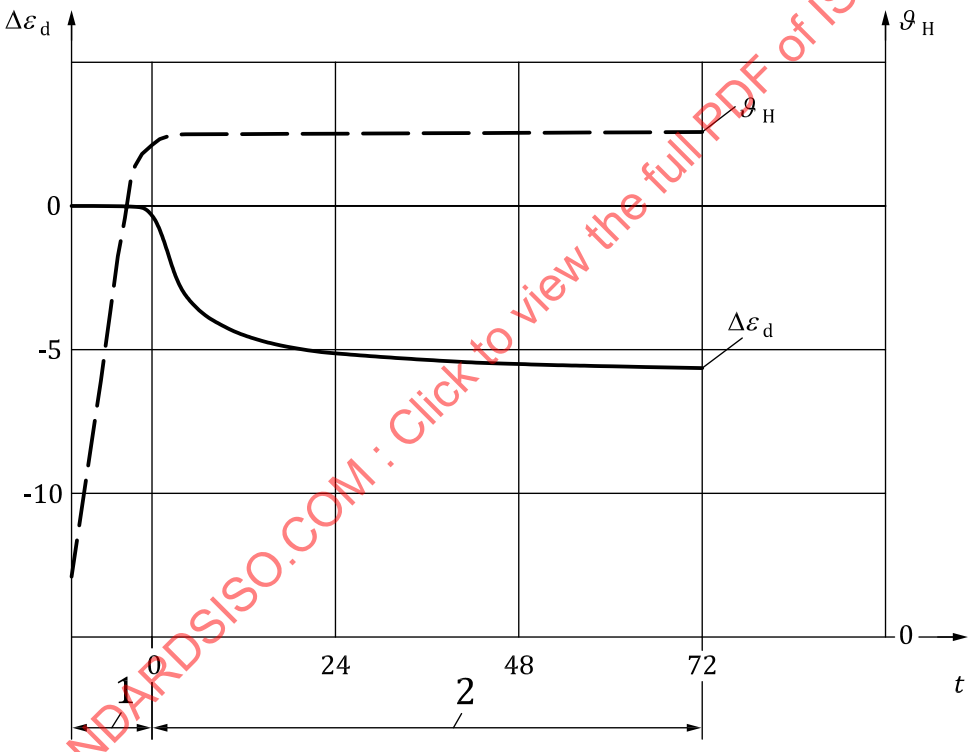
The result of the visual examination shall be noted.

If a relevant annex (see Annexes A to D) and/or the relevant product standard specifies additional requirements, the calculations and/or observations shall be noted accordingly.

8.4 Internal self-heating

Evidence of internal self-heating is found when the test specimen temperature at any time during the test exceeds the temperature of the hot plate.

The test procedure is described in the relevant Annexes A to D.



Key

1 period of heating
2 period of testing
$\Delta\varepsilon_d$ change in thickness in percentage
ϑ_H temperature of the hot plate in °C
t time in hours

Figure 2 — Example of hot plate temperature and thickness change versus time curves

Key

1 maximum change of thickness according to the relevant product standard in percentage

2 maximum service temperature in °C

$\Delta\varepsilon_d$ change in thickness in percentage

ϑ_H temperature of the hot plate in °C

Figure 3 — Example of determination of the maximum service temperature (after 72 h)

9 Accuracy of measurement

An interlaboratory test was performed with ten pieces of equipment from seven laboratories. Two products were tested.

The results, analysed according to ISO 5725-2:2019, are given in Table 1.

Table 1 — Relative change of thickness at a chosen temperature (equipment verification in comparative testing)

Temperature levels used °C	**340 and 690** °C
Estimate of repeatability standard deviation s_r	0,1 %
95 % repeatability limit	0,4 %
Estimate of reproducibility standard deviation s_R	0,3 %
95 % reproducibility limit	0,9 %

All values given in Table 1 are expressed in percentage of the test specimen thickness.

The above-mentioned terms shall be applied as described in ISO 5725-2:2019.

Bias cannot be determined in this test method as there is not any accepted reference material for it.

NOTE The choice of products was made to get a wide range of temperatures and also test a worst-case situation (for the most complicated test specimen preparation, see Figure A.1).

10 Test report

The test report shall include the following information:

a) reference to this document, i.e. ISO 18097:2022;

b) product identification

   1) product name, factory, manufacturer or supplier;

   2) production code number;

   3) type of product;

   4) packaging;

   5) form in which the product arrived at the laboratory;

   6) other information as appropriate, e.g. nominal dimensions, nominal density;

c) test procedure

   1) pre-test history and sampling, e.g. who sampled and where;

   2) conditioning;

   3) conditioning and testing conditions in tropical climates, if applicable;

   4) if any deviation from Clauses 6 and 7;

   5) date of testing;

   6) dimensions and number of test specimens;

   7) chosen temperature increase rate;

   8) general information relating to the test;

   9) events which can have affected the results;

Information about the apparatus and identity of the technician should be available in the laboratory but it need not be recorded in the report.

d) results

   1) all individual curve deformations and temperature versus time;

   2) all individual values and the mean values of the dimensional changes. Note whether dimensional changes are shrinkage or expansion;

   3) all individual values and the mean value of the maximum service temperature;

   4) note the visual evaluation;

   5) additional results as specified in Annexes A to D or the relevant product standard or any other international technical specification.

Annex A
(normative)

Modifications of and additions to the general test method for mineral wool products

A.1 General

For mineral wool products, the test method described in this document shall be modified in accordance with the following clauses.

A.2 Test specimens

A.2.1 Conditioning of test specimens

For wired mats, the wire and the stitching are removed before testing. Any existing profile on the surface of boards shall be cut off. Facings are not removed.

A.2.2 Dimensions of test specimens

Test specimens may be prepared by slicing or layering to obtain the thickness (d_0) of (100 ± 5) mm (necessary for thicknesses (d_0) other than 100 mm to obtain the thickness of 100 mm under the load specified in the relevant product standard). If slicing, the density of the test specimen shall be as for the unsliced test specimen.

A.3 Procedure

A.3.1 Test conditions

The test shall be started at an initial temperature of the test specimen and the hot plate between 20 °C and 50 °C. In case of dispute the test shall be started at (23 ± 5) °C, in tropical climates (27 ± 5) °C.

The test load shall be 500 Pa. If necessary, the test load shall be reduced stepwise to 250 Pa or 100 Pa to ensure that the thickness (d_1) is at least 95 % of the thickness (d_0) and the load used shall be declared.

For special applications, different test loads may be agreed between parties and shall be declared. The thickness (d_1) shall be measured under the agreed load.

A.3.2 Test procedure

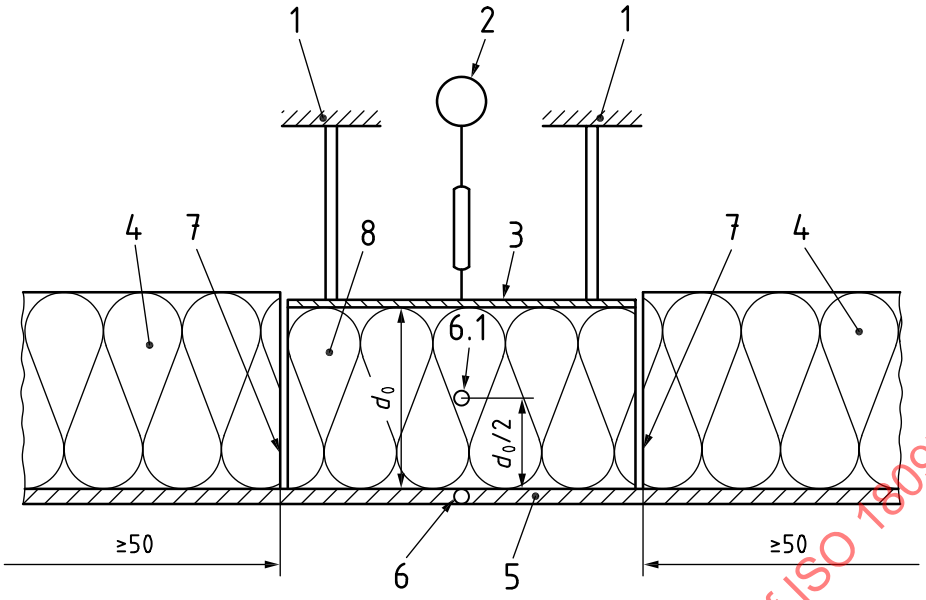
Measure dimensional changes in thickness only.

For wired mats, where d_1 is larger than the thickness d_0, the test specimen shall be compressed to thickness d_0 by using the equipment shown in Figure A.1. In this way, any expansion in the thickness during testing is avoided.

Heat the test specimen using a temperature rate of increase of 300 °C/h.

The thickness, d_3, after cooling the test specimen down to a temperature of less than 35 °C need not be measured.

Dimensions in millimetres



Key

1	height adjustable clamps to install the thickness d_0	6	thermocouple
2	device for measuring the thickness	6.1	additional thermocouple for testing for internal self-heating (A.5)
3	pressure plate (500 Pa)	7	small gap
4	edge insulation	8	test specimen
5	heated plate	d_0	thickness of the test specimen

Figure A.1 — Example of an apparatus for determining maximum service temperature for wired mats

A.4 Additional tests and/or observations

After the measurement of d_2 and cooling down, remove the test specimen, cut the test specimen vertically through the centre and examine visually the cut edges to establish if the fibrous structure has deteriorated. If cavities have been formed or if the test specimen has visually collapsed, then this shall be reported as evidence of failure.

If failure occurs, the test shall be repeated at a lower temperature.

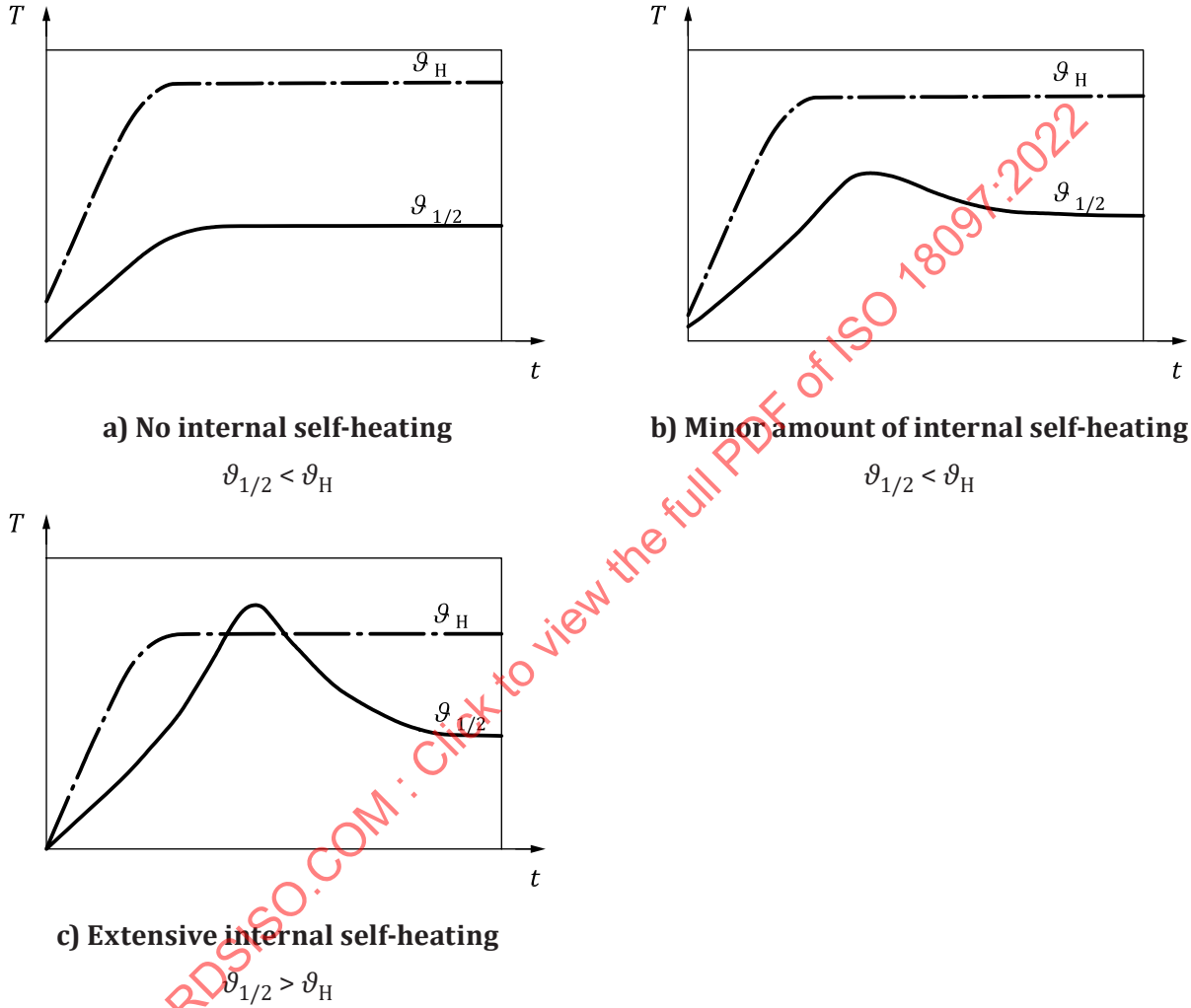
NOTE Any organic binder present is likely to have been removed from parts of the test specimen that have exceeded about 250 °C. This in itself does not impair the thermal performance of the product and is not a cause of failure in the test.

A.5 Test for internal self-heating

If required, the test for internal self-heating has to be carried out. For that purpose, an additional thermocouple shall be installed at half the thickness of the test specimen (see Figure A.1, key 6.1). The temperature $\vartheta_{1/2}$, in the middle of the thickness of the test specimen below the device for measuring the thickness, during the test of the maximum service temperature should not exceed the temperature of the heated plate ϑ_H. The appraisal of the test results is carried out according to Figure A.2 a) to c).

The test has failed if $\vartheta_{1/2} > \vartheta_H$ [Figure A.2 c) extensive internal self-heating]. If failure occurs, the test shall be repeated at a lower temperature.

NOTE Ideally, the thermocouple should be moved to the centre along the isotherm at the 50 % thickness level. If the thermocouple is placed at the 50 % level directly vertically from the centre of the top of the test specimen a deviation of up to 20 °C can be found. This difference between vertically and horizontally placing is normally not critical as the aim is only to determine a possible exothermic reaction. In case of dispute, the thermocouple should be moved to the centre along the isotherm at the 50 % thickness level.



a) No internal self-heating

$\vartheta_{1/2} < \vartheta_H$

b) Minor amount of internal self-heating

$\vartheta_{1/2} < \vartheta_H$

c) Extensive internal self-heating

$\vartheta_{1/2} > \vartheta_H$

Key

T temperature in °C

t time

Figure A.2 — Typical temperature profiles during the test for the internal self-heating versus time

Annex B
(normative)

Modifications of and additions to the general test method for cellular glass products

B.1 General

For cellular glass products, the test method described in this document shall be modified in accordance with the following clauses.

B.2 Apparatus

The edge insulation shall be at least 100 mm wide.

B.3 Test specimens

B.3.1 Conditioning of test specimens

Facings are not removed.

B.3.2 Dimensions of test specimens

The test specimens shall have dimensions of 150 mm × 150 mm.

B.4 Test procedure

Heat the test specimens using a temperature rate of increase of 50 °C/h.

B.5 Additional tests and/or observations

B.5.1 Observations

After the measurement of d_2 and cooling down to a temperature lower than 35 °C, remove the test specimen and examine it visually. If cavities have been formed or if the test specimen has visually collapsed, then this shall be reported as evidence of failure.

If failure occurs the test shall be repeated at a lower temperature.

NOTE Discoloration is a normal phenomenon at temperatures in excess of 250 °C. This in itself does not impair the thermal performance of the product and is not a cause of failure in the test.

B.5.2 Additional tests

Determine the strain point of the glass in accordance with ISO 7884-1 and ISO 7884-7.

Annex C
(normative)

Modifications of and additions to the general test method for phenolic foam products

C.1 General

For phenolic foam products, the test method described in this document shall be modified in accordance with the following clauses.

C.2 Test specimens

C.2.1 Dimensions of test specimens

The test specimens shall be square with dimensions of 100 mm × 100 mm.

C.2.2 Conditioning of test specimens

The test specimens shall be conditioned in accordance with ISO 16544 at (70 ± 2) °C and then at (23 ± 2) °C and (50 ± 5) % relative humidity prior to test.

C.3 Test procedure

During the test, the test specimens shall be heated at a temperature rate of 50 °C/h up to the manufacturer's claimed maximum service temperature.

C.4 Additional tests and/or observations

If required, the test for internal self-heating has to be carried out. For that purpose, an additional thermocouple shall be installed at half the thickness of the test specimen (see Figure A.1, key 6.1). The temperature $\vartheta_{1/2}$, in the middle of the thickness of the test specimen below the device for measuring the thickness, during the test of the maximum service temperature should not exceed the temperature of the heated plate ϑ_H. The appraisal of the test results is carried out according to Figure C.1 a) to c). The test has failed if $\vartheta_{1/2} > \vartheta_H$ [Figure C.1 c) extensive internal self-heating]. If failure occurs, the test shall be repeated at a lower temperature.

Ideally, the thermocouple should be moved to the centre along the isotherm at the 50 % thickness level. If the thermocouple is placed at the 50 % level directly vertically from the centre of the top of the test specimen, a deviation of up to 20 °C can be found. This difference between vertically and horizontally placing is normally not critical as the aim is only to determine a possible exothermic reaction. In case of dispute, the thermocouple should be moved to the centre along the isotherm at the 50 % thickness level.