BS ISO 18097:2013

BSI Standards Publication

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

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**National foreword**

This British Standard is the UK implementation of ISO 18097:2013.

The UK participation in its preparation was entrusted to Technical Committee B/540/8, Mirror committee for ISO/TC 163 - Thermal Performance and Energy use in the built Environment.

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

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BS ISO 18097:2013

INTERNATIONAL STANDARD

**ISO 18097**

First 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*

Reference number
ISO 18097:2013(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 18097 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*.

ISO 18097 includes the original EN 14706 prepared by Technical Committee CEN/TC 88, *Thermal insulating materials and products.* However, the following have been modified to reflect conditions for tropical countries:

6.3 “Conditioning of test specimens”;

7.1 “Test conditions”;

Clause 10 “Test report.”

# Introduction

This International Standard is one of a series of existing European Standards on test methods for products used to insulate building equipment and industrial installations which comprises the following group of International Standards:

| ISO standard | Title | Respective EN standard |
|---|---|---|
| ISO 12623 | *Thermal insulating products for building equipment and industrial installations — Determination of short-term water absorption by partial immersion of preformed pipe insulation* | EN 13472 |
| ISO 12624 | *Thermal insulation products for building equipment and industrial installations — Determination of trace quantities of water soluble chloride, fluoride, silicate, sodium ions and pH* | EN 13468 |
| ISO 12628 | *Thermal insulating products for building equipment and industrial installations — Determination of dimensions, squareness and linearity of preformed pipe insulation* | EN 13467 |
| ISO 12629 | *Thermal insulating products for building equipment and industrial installations — Determination of water vapour transmission properties of preformed pipe insulation* | EN 13469 |
| ISO 18096 | *Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature for preformed pipe insulation* | EN 14707 |
| ISO 18097 | *Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature* | EN 14706 |
| ISO 18098 | *Thermal insulating products for building equipment and industrial installations — Determination of the apparent density of preformed pipe insulation* | EN 13470 |
| ISO 18099 | *Thermal insulating products for building equipment and industrial installations — Determination of the coefficient of thermal expansion* | EN 13471 |

A further series of existing European Standards on test methods was adopted by ISO. This “package” of standards comprises the following group of interrelated standards:

| ISO standard | Title | Respective EN standard |
|---|---|---|
| ISO 12344 | *Thermal insulating products for building applications — Determination of bending behaviour* | EN 12089 |
| ISO 12968 | *Thermal insulation products for building applications — Determination of the pull-off resistance of external thermal insulation composite systems (ETICS) (foam block test)* | EN 13495 |
| ISO 29465 | *Thermal insulating products for building applications — Determination of length and width* | EN 822 |
| ISO 29466 | *Thermal insulating products for building applications — Determination of thickness* | EN 823 |

| | | |
|---|---|---|
| ISO 29467 | *Thermal insulating products for building applications — Determination of squareness* | EN 824 |
| ISO 29468 | *Thermal insulating products for building applications — Determination of flatness* | EN 825 |
| ISO 29469 | *Thermal insulating products for building applications — Determination of compression behaviour* | EN 826 |
| ISO 29470 | *Thermal insulating products for building applications — Determination of the apparent density* | EN 1602 |
| ISO 29471 | *Thermal insulating products for building applications — Determination of dimensional stability under constant normal laboratory conditions (23 degrees C/50 % relative humidity)* | EN 1603 |
| ISO 29472 | *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions* | EN 1604 |
| ISO 29764 | *Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions* | EN 1605 |
| ISO 29765 | *Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces* | EN 1607 |
| ISO 29766 | *Thermal insulating products for building applications — Determination of tensile strength parallel to faces* | EN 1608 |
| ISO 29767 | *Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion* | EN 1609 |
| ISO 29768 | *Thermal insulating products for building applications — Determination of linear dimensions of test specimens* | EN 12085 |
| ISO 29769 | *Thermal insulating products for building applications — Determination of behaviour under point load* | EN 12430 |
| ISO 29770 | *Thermal insulating products for building applications — Determination of thickness for floating-floor insulating products* | EN 12431 |
| ISO 29771 | *Thermal insulating materials for building applications — Determination of organic content* | EN 13820 |
| ISO 29803 | *Thermal insulation products for building applications — Determination of the resistance to impact of external thermal insulation composite systems (ETICS)* | EN 13497 |
| ISO 29804 | *Thermal insulation products for building applications — Determination of the tensile bond strength of the adhesive and of the base coat to the thermal insulation material* | EN 13494 |
| ISO 29805 | *Thermal insulation products for building applications — Determination of the mechanical properties of glass fibre meshes* | EN 13496 |
| ISO 16534 | *Thermal insulating products for building applications — Determination of compressive creep* | EN 1606 |
| ISO 16535 | *Thermal insulating products for building applications — Determination of long-term water absorption by immersion* | EN 12087 |

| | | |
|---|---|---|
| ISO 16536 | *Thermal insulating products for building applications — Determination of long-term water absorption by diffusion* | EN 12088 |
| ISO 16537 | *Thermal insulating products for building applications — Determination of shear behaviour* | EN 12090 |
| ISO 16544 | *Thermal insulating products for building applications — Conditioning to moisture equilibrium under specified temperature and humidity conditions* | EN 12429 |
| ISO 16545 | *Thermal insulating products for building applications — Determination of behaviour under cyclic loading* | EN 13793 |
| ISO 16546 | *Thermal insulating products for building applications — Determination of freeze-thaw resistance* | EN 12091 |

The Application of Agreement on technical cooperation between ISO and CEN (Vienna Agreement), Modes 1, 2, 4, and 5, was not approved by CEN/TC 88 and the necessity not seen by its stakeholders.

This International Standard is one of a series of standards which specify test methods for determining dimensions and properties of thermal insulating materials and products. The original EN 14706 supports a series of product standards for thermal insulating materials and products which derive from the Council Directive of 21 December 1988 on the approximation of laws, regulations, and administrative provisions of the Member States relating to construction products (Directive 89/106/EEC) through the consideration of the essential requirements.

This International Standard contains the following four normative annexes:

Annex A — Modifications of and additions to the general test method for mineral wool products;

Annex B — Modifications of and additions to the general test method for cellular glass products;

Annex C — Modifications of and additions to the general test method for phenolic foam products;

Annex D — Modifications of and additions to the general test method for polyethylene foam (PEF) and flexible elastomeric foam (FEF) products.

This International Standard has been prepared for products used to insulate building equipment and industrial installations, but it may also be applied to products used in other areas.

A similar standard is available for testing of preformed pipe insulation: ISO 18096:—[1)], *Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature for preformed pipe insulation*.

1) To be published.

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

## 1 Scope

This International Standard 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, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5725-2:1994, *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.

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

[SOURCE: ISO 9229:2007, definition 2.6.9.1]

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.

## 4 Principle

Measure thickness, length, and width 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 may be an iterative process.

Additional requirements for assessing the maximum service temperature of specific materials are described in normative annexes to this International Standard 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 will permit free movement during the test of the test specimen and of the pressure plate.

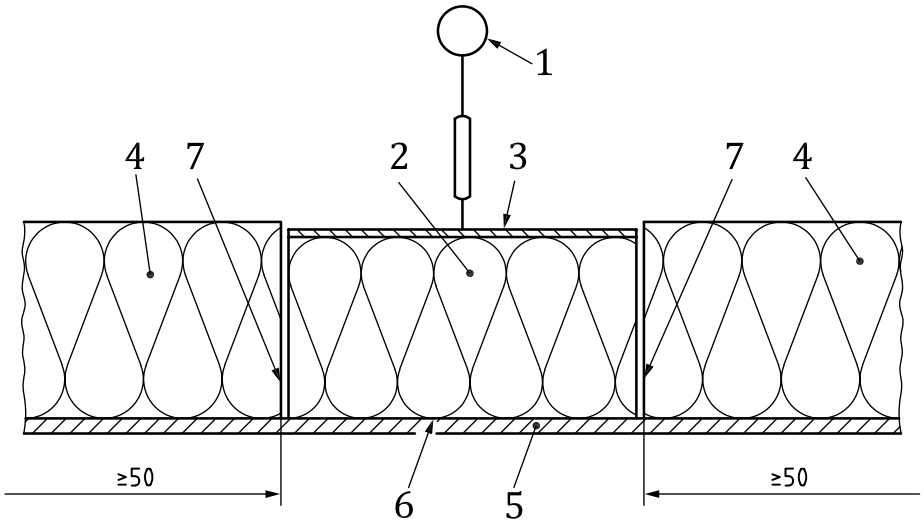
**5.3 Square or circular pressure plate**, with the same dimensions as the test specimen exerting the required load on the test specimen.

**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

**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).

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

The length and width or diameter shall be as specified in the relevant product standard or in annexes to this International Standard.

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

NOTE 2 Testing may 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 may 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 (RH) for the time specified in the relevant product standard or at least 24 h.

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

## 7 Procedure

### 7.1 Test conditions

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

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

### 7.2 Test procedure

Measure the length, $l_1$, and width, $b_1$, (or the diameter) of the test specimen 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 annex of this International Standard.

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 annex of this International Standard.

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 annex of this International Standard 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 formulae:

$$\Delta_{\varepsilon d} = 100\ x\ \frac{d_{2(or3)} - d_1}{d_1} \tag{1}$$

$$\Delta\varepsilon_l = 100 \times \frac{l_2 - l_1}{l_1} \tag{2}$$

$$\Delta\varepsilon_b = 100 \times \frac{b_2 - b_1}{b_1} \tag{3}$$

where

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

$d_2$ is the measured thickness installed after the 72-h period 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 period 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, $\overline{\Delta\varepsilon_d}$, $\overline{\Delta\varepsilon_l}$, and $\overline{\Delta\varepsilon_b}$, 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 annex to this International Standard. 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 Results may not be comparable for a product tested at different thicknesses and/or different loads.

## 8.3 Additional tests and/or observations

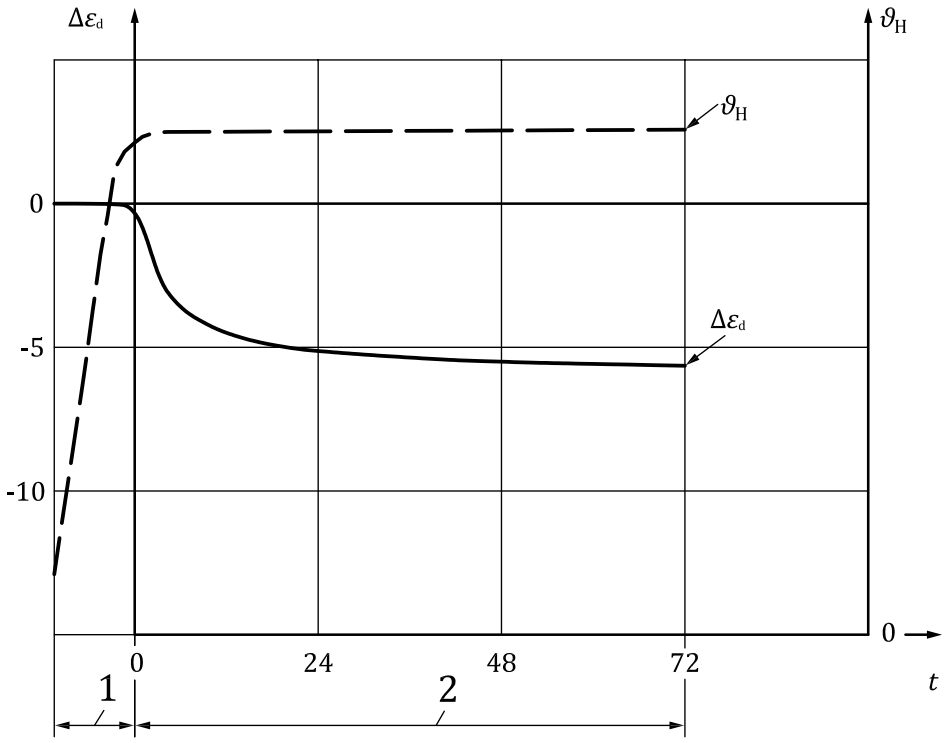
The result of the visual examination shall be noted.

If a relevant annex of this International Standard 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 of this International Standard.




**Key**

1 period of heating

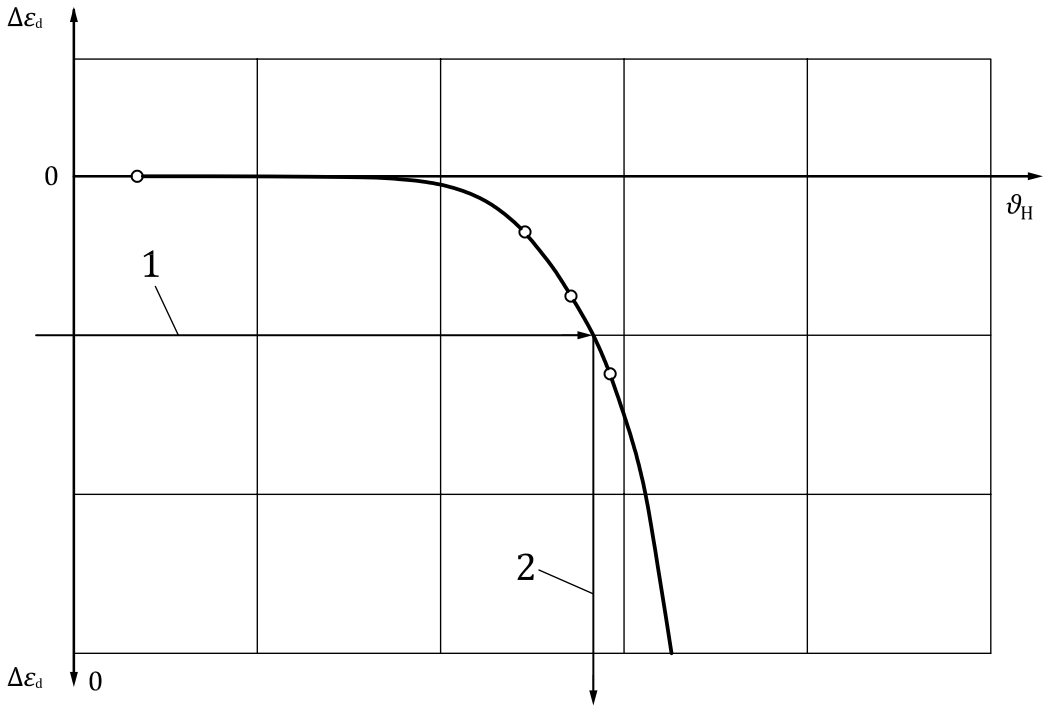
2 period of testing

$\Delta\varepsilon_d$ change in thickness in percentage

$\vartheta_H$ temperature of the hot plate in centigrade

$t$ time in hours

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




**Key**

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

2 maximum service temperature in centigrade

$\Delta\varepsilon_d$ change in thickness in percentage

$\vartheta_H$ temperature of the hot plate in centigrade

**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 5725-2:1994, 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 variance, $s_r$<br>95 % repeatability limit | 0,1 %<br>0,4 % |
| Estimate of reproducibility variance, $s_R$<br>95 % reproducibility limit | 0,3 %<br>0,9 % |

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

The above mentioned terms are applied as described in ISO 5725-2:1994.

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 (the most complicated test specimen preparation, see Figure A.1).

## 10 Test report

The test report shall include the following information:

a) a reference to this International Standard (i.e. ISO 18097:2013);

b) product identification:

product name, factory, manufacturer, or supplier;

production code number;

type of product;

packaging;

form in which the product arrived at the laboratory;

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

c) test procedure:

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

conditioning;

conditioning and testing conditions in tropical countries, if applicable;

any deviation from Clauses 6 and 7;

date of testing;

dimensions and number of test specimens;

chosen temperature increase rate;

general information relating to the test;

events which may have affected the results;

NOTE 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:

all individual curves of deformation and temperature versus time;

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

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

note the visual evaluation;

additional results as specified in the annexes of this International Standard 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 Introduction

For mineral wool products, the test method described in this International Standard 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 has to 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 EN 14303). 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.

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

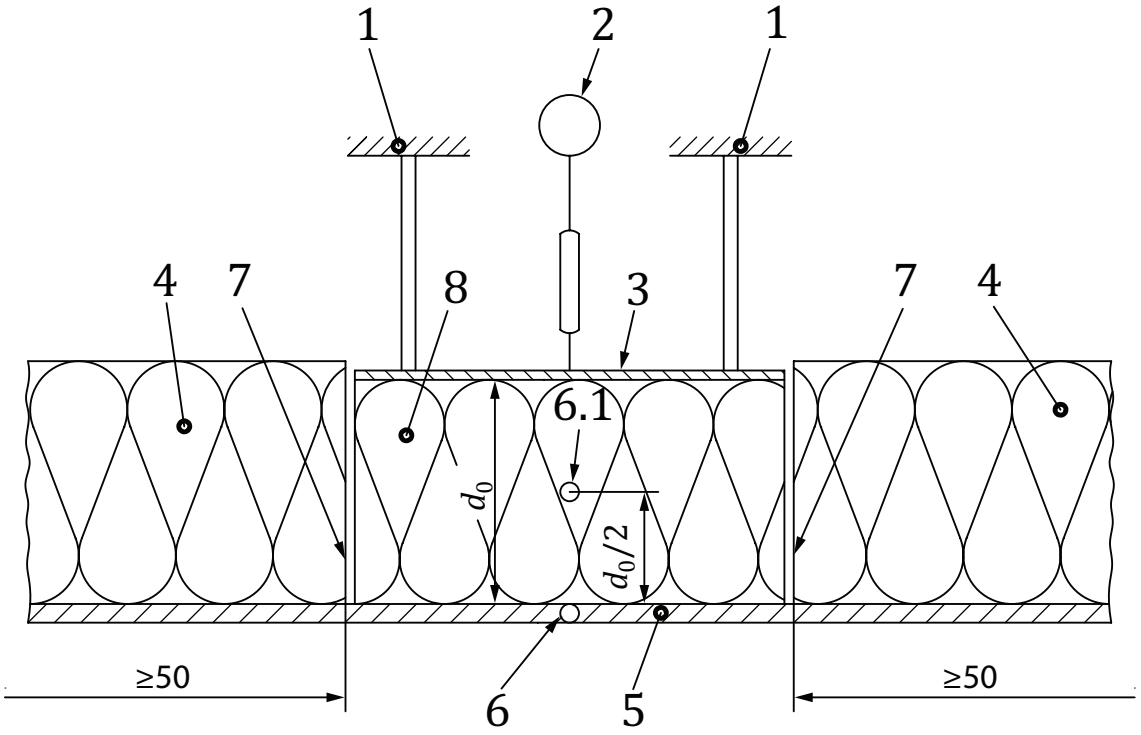
Measure dimensional changes in thickness only.

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, $d_0$
2 device for measuring the thickness
3 pressure plate (500 Pa)
4 edge insulation
5 heated plate
6 thermocouple
6.1 additional thermocouple for testing for internal self-heating (A.5)
7 small gap
8 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.

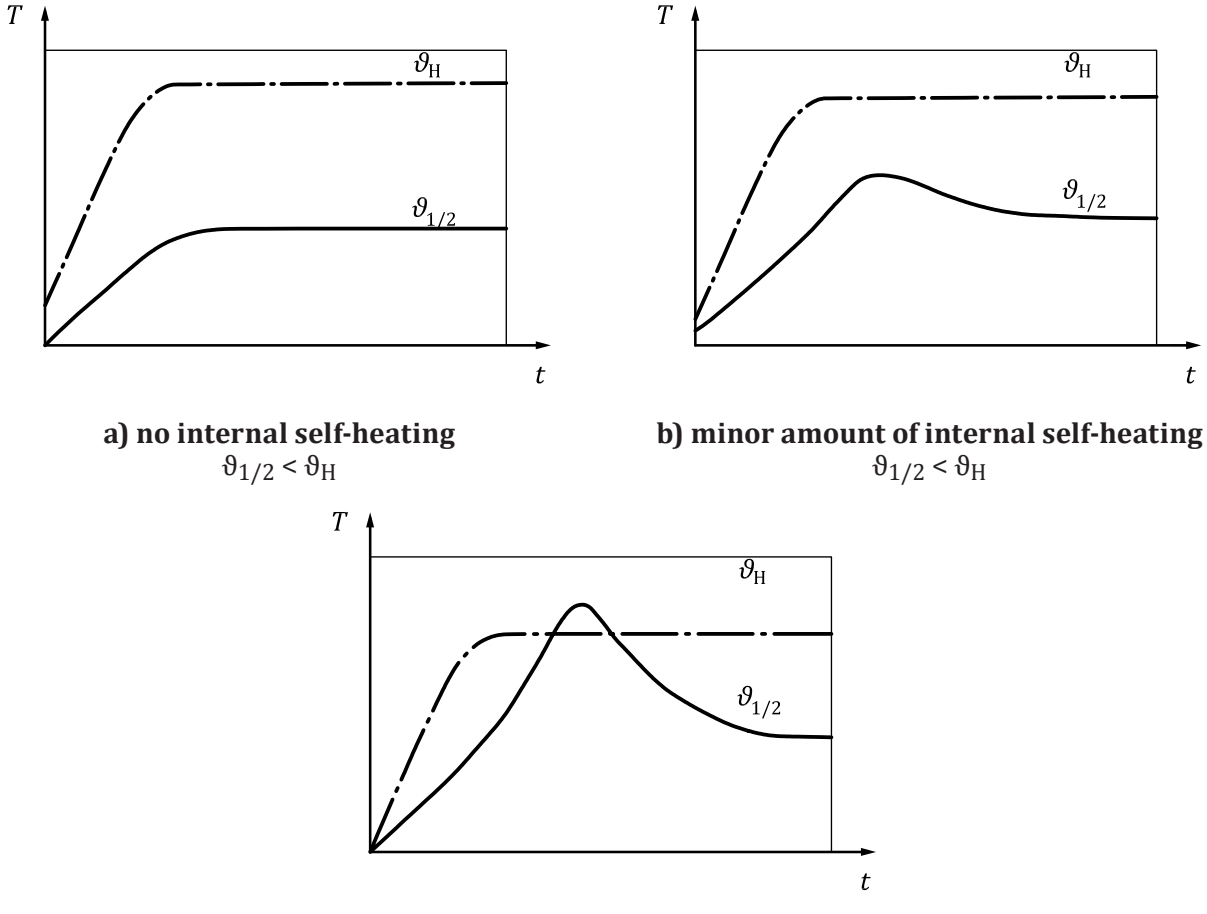
If failure occurs, the test shall be repeated at a lower temperature.

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 has to 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, $\vartheta_H$. 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)]. 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 may be found. This difference between vertical and horizontal placement 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**

1 temperature in centigrade
2 time
*T* temperature in centigrade
*t* time

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

# Annex B
(normative)

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

## B.1 Introduction

For cellular glass products, the test method described in this International Standard 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 Introduction

For phenolic foam products, the test method described in this International Standard 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) % RH prior to the test.

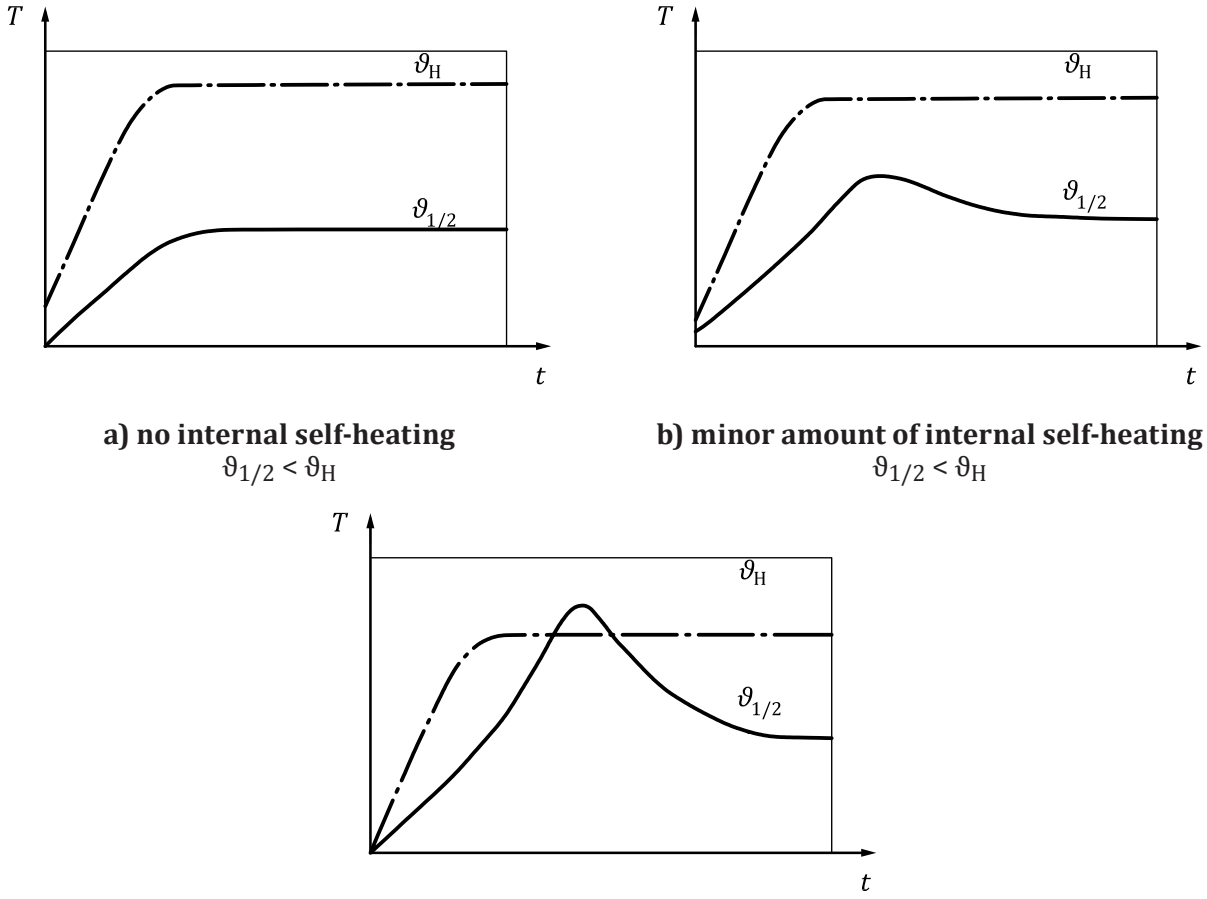
## C.3 Test procedure

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 has to 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, $\vartheta_H$. 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)]. 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 may be found. This difference between vertical and horizontal placement 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**

1 temperature in centigrade
2 time
*T* temperature in centigrade
*t* time

NOTE Discolouration/change of colour does not impair the thermal performance of the product and is not a cause of failure in the test.

**Figure C.1 — Typical temperature profiles during the test for internal self-heating versus time**

# Annex D
(normative)

# Modifications of and additions to the general test method for polyethylene foam (PEF) and flexible elastomeric foam (FEF) products

## D.1 Introduction

For polyethylene foam and flexible elastomeric foam products, the test method described in this International Standard shall be modified in accordance with the following clauses.

## D.2 Apparatus

The edge insulation shall be at least 20 mm wide. The gap of the insulation shall be as small as possible, e.g. ≤ 3 mm.

## D.3 Dimensions of the test specimens

The test specimen shall be square with dimensions 100 mm × 100 mm or, alternatively, 200 mm × 200 mm.

The largest product thickness shall be tested. Multilayered products may be used for thickness up to 100 mm.

## D.4 Test procedure

Measure the dimensional changes in thickness only.

The thickness shall be measured with $d_0$ being the initial thickness measured according to ISO 29466 and $d_1$ being the thickness taken at ambient temperature 24 h after the pressure plate has been applied to flatten the surface. $d_2$ is the thickness as stated in 7.2 of this International Standard. $d_3$ shall not be measured.

In case there is not a perfect thermal contact to the hot plate, glue the test specimen directly onto the hot plate or, alternatively, to a flat and stable metal plate using a suitable adhesive. Lay the test specimen on the heating plate with the metal plate face down. Make sure that the metal plate is in perfect thermal contact with the hot plate. Load the test specimen with a flat and stable metallic pressure plate exerting a load of 50 Pa for FEF and 250 Pa for PEF.

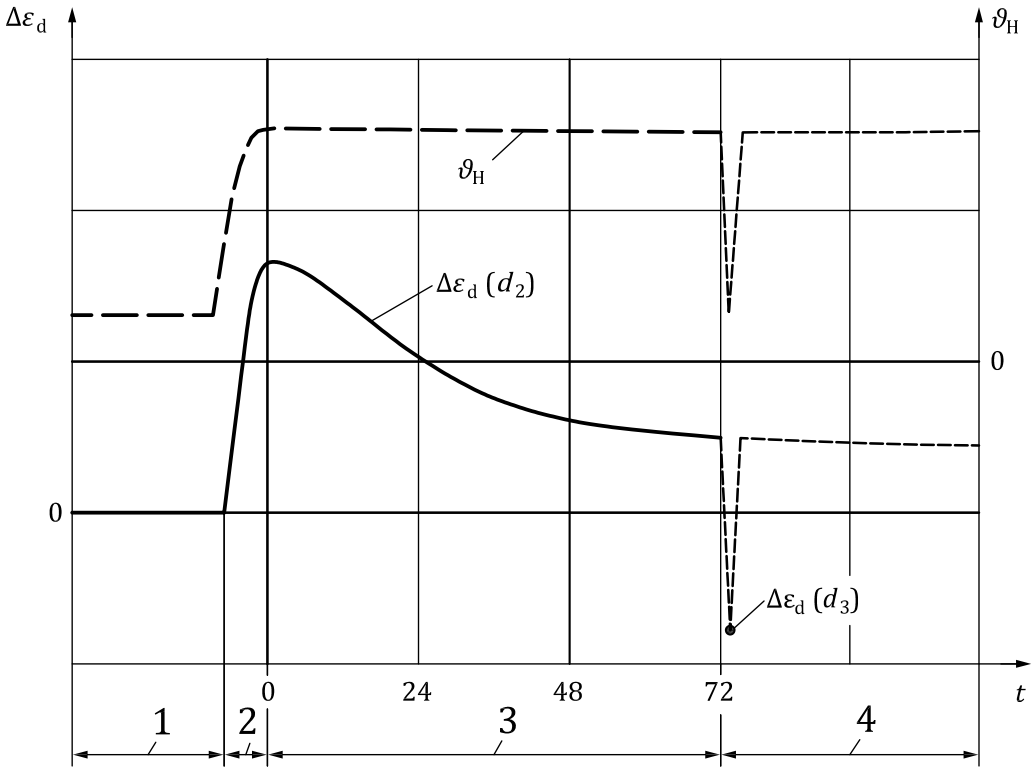
Leave the test specimen for 24 h at ambient temperature to ensure that small initial surface unevenness is flattened out. Measure $d_1$.

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

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 (at least after 0, 0,5, 1, 6, 24, 48, 72 h).

NOTE Because of the thermal expansion of the entrapped cell gas when heating the foam from the start to the expected maximum service temperature (gas law), the thickness of the test specimen may initially increase (typical curve, see Figure D.1).




**Key**

1 ambient conditions, load installed
2 period of heating
3 period of testing
4 extra period of cooling down and heating up (exemplary only)
$\Delta\varepsilon_d$ change of thickness in percentage
$\vartheta_H$ temperature of the hot plate in centigrade
$t$ time in hours

**Figure D.1 — Typical example of temperature and thickness deformation versus time curves**

## D.5 Calculation and expression of results

Calculate the dimensional changes using Formula (1) of Clause 8 of this International Standard.

NOTE The wall thickness, $d_3$, at room temperature is not of interest for this kind of product because the reduction in temperature causes a reduction of the pressure inside the cells, which leads to a reversible reduction in wall thickness. Heating up again leads to a similar thickness as before under temperature load.

# Bibliography

[1] ISO 9229, *Thermal insulation — Vocabulary*

[2] EN 14303, *Thermal insulation products for building equipment and industrial installations — Factory made mineral wool (MW) products — Specification*

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