INTERNATIONAL STANDARD

ISO 18096

Second edition
2022-08

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

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

Reference number
ISO 18096:2022(E)

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Published in Switzerland

Contents

Page

Foreword

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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).

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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 18096:2013), which has been technically revised.

The main changes are as follows:

— EN 14707:2012 and ISO 18096:2013 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 for preformed pipe insulation

1 Scope

This document specifies the equipment and procedures for determining the maximum service temperature for preformed pipe insulation. 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 12628, *Thermal insulating products for building equipment and industrial installations — Determination of dimensions, squareness and linearity of preformed pipe insulation*

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

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 and requirements in the relevant product standard).

Note 2 to entry: The test procedure in this document, 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 multi-layer 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 and length 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 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 C or the relevant product standard or any other international technical specification.

5 Apparatus

A general arrangement of the apparatus is indicated in Figures 1 and 2 and is comprised of:

5.1 Hot pipe, with a uniform temperature distribution in the measuring zone on the hot surface and a heat flux perpendicular to the surface of the pipe within the measuring zone (two pipes are required, with diameters that fulfil the requirements of 6.1). The hot pipe shall be linear to within ±1 mm in the measuring zone at ambient temperature.

The hot pipe shall be capable of being controlled to within ±2 % of a predetermined temperature or ±10 °C whichever is smaller over the central 60 % of the total pipe length.

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

5.2 End insulation, with a gap as small as possible between end insulation and guard piece of the test specimen (e.g. ≤ 3 mm) which permits free movement during the test of the test specimen.

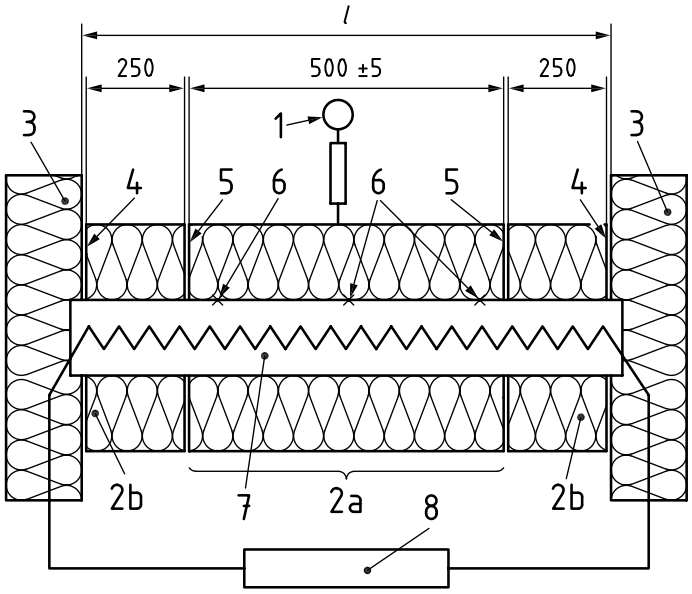
5.3 Temperature sensors (e.g. thermocouples), capable of recording the hot surface temperature of the test pipe to the nearest ±1 % in centigrade but not less than ±1 °C, which are placed within grooves on the hot pipe.

5.4 Flexible metal foil, three pieces (e.g. brass), capable of exerting a uniform pressure of 500 Pa on the upper surface of the test specimen along its testing length of (500 ± 5) mm and the two end guards, length (250 ± 5) mm. The pressure shall be calculated using the area, e.g. the test length of 500 mm times the diameter of the hot pipe.

5.5 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.

Dimensions in millimetres

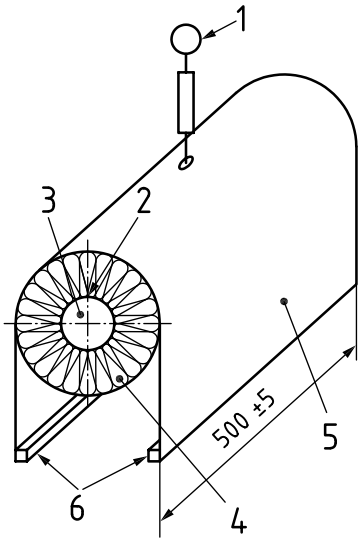


Key

1	device for measuring thickness, e. g. electromechanical device	5	circumferential joints
2a	test length of the test specimen	6	thermocouples
2b	test specimen end guard	7	hot pipe
3	end insulation	8	power supply and temperature control
4	small gap	*l*	length of the hot pipe between the end insulation

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

Dimensions in millimetres



Key

1	device for measuring thickness, e.g. electromechanical device	4	test specimen
2	thermocouple	5	flexible metal foil
3	hot pipe	6	weights for loading

Figure 2 — Example of an apparatus for determining maximum service temperature — Test specimen loading arrangement

6 Test specimens

6.1 Dimensions of test specimens

Length: The test specimen, length (1 000 ± 10) mm, shall be cut at right angles to its length to give two end guards, length each (250 ± 5) mm, and a test length of (500 ± 5) mm.

Thickness: The thickness shall be 100 mm or the largest thickness below 100 mm available.

Inside diameter: Two sizes shall be tested, in the range 22 mm to 220 mm.

The dimensions shall be as specified in the relevant product standard or in Annexes A to C.

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 multi-layer systems to simulate the conditions existing in the application.

If the pipe insulation is cut from a homogeneous, isotropic flat product, then the maximum service temperature can be obtained from tests carried out on the flat product with similar properties according to ISO 18097.

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 one test specimen for each size 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 (RH) 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) % RH.

7 Procedure

7.1 Test conditions

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

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

7.2 Test procedure

Measure the length, the inside diameter and the thickness of the test specimen, l_0, D_i, d_0, in accordance with ISO 12628 to the nearest 0,5 mm.

Install the test specimen (the two guards and the test length of the test specimen) on the hot pipe and ensure contact on the upper part of the hot pipe between the test specimen and the hot surface. Avoid any longitudinal gaps and any gaps between the end guards and the test length of the test specimen. The installation practice shall duplicate the practice, if required in the product standard.

In cases where gaps of more than 2 mm develop between the end guards and the test length during the test, action should be taken to close the gap without disturbing the measurement.

Place the two pieces of flexible metal foil over the two end guards, length (250 ± 5) mm, and exert a pressure of 500 Pa (see 5.4).

Place the third flexible metal foil, length (500 ± 5) mm, over the test specimen test length and exert a pressure of 500 Pa (see 5.4).

For polyethylene foam and flexible elastomeric foam products, see Annex B.

Measure the thickness of the test specimen, d_1, to the nearest 0,1 mm.

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 in Annexes A to C.

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 in Annexes A to C.

Observe the presence of any longitudinal gaps and any gaps between the end guards and the test length of the test specimen and measure their width to the nearest 0,1 mm.

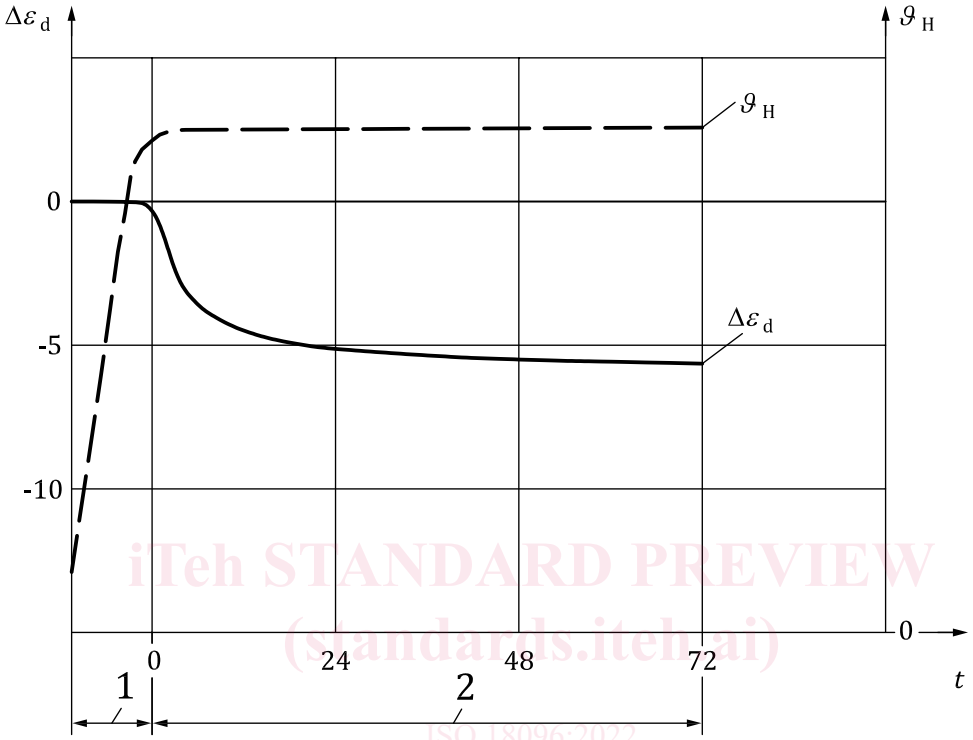
Examine the test specimen visually and note any changes caused by the test.

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

8 Calculation and expression of results

8.1 Thickness deformation versus time

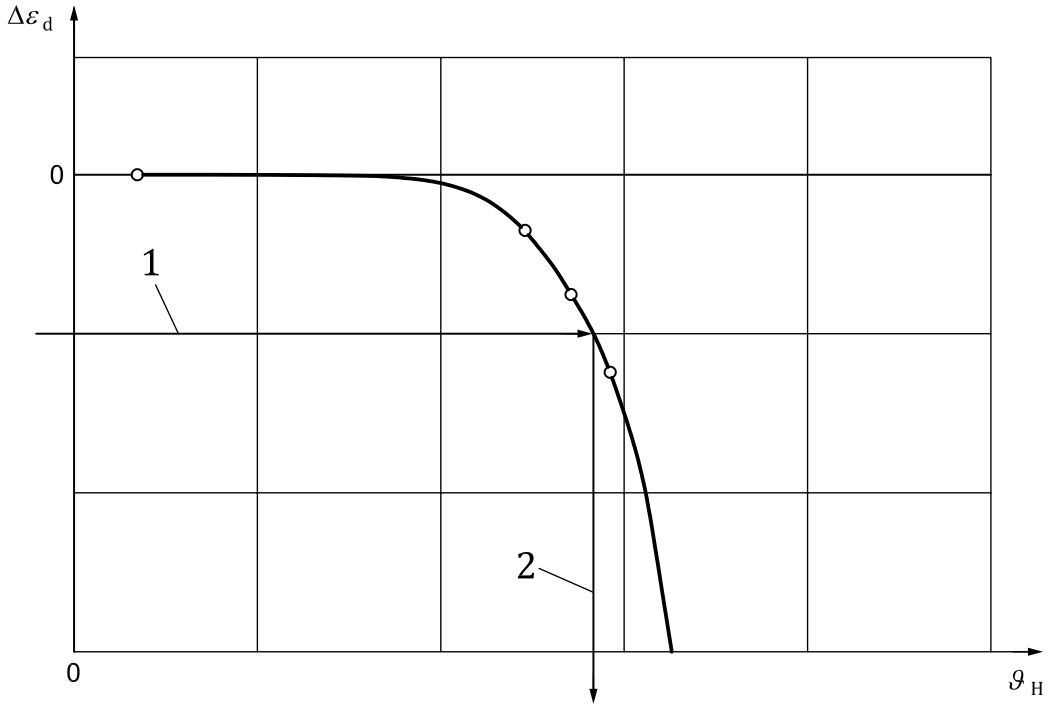
The curve thickness deformation versus time and relative thickness change versus applied temperature recorded during testing shall be given. Examples are shown in Figure 3 and Figure 4.



Key

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

Figure 3 — Example of hot pipe 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 °C

$\Delta\varepsilon_d$ change in thickness in percentage

ϑ_H temperature of the hot pipe in °C

Figure 4 — Example of determination of the maximum service temperature (after 72 h)

Calculate the thickness change, $\Delta\varepsilon_d$, in percentage, using Formula (1):

$$\Delta\varepsilon_d = 100 \times \frac{d_{2(or3)} - d_1}{d_1} \quad (1)$$

where

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

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

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

If the 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 value of the thickness change, $\overline{\Delta\varepsilon_d}$, in percentage rounded to the nearest 0,5 % from the test results of the individual test specimens.

If the change in the mean thickness exceeds the value specified in the relevant product standard, the test shall be repeated at a lower temperature until the thickness change is smaller than or equal to the specified value. This temperature is then considered as the maximum service temperature (see Figure 4), provided that the requirements given in 8.2 and 8.3 are also fulfilled.