INTERNATIONAL STANDARD

ISO 16546

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Thermal insulating products for building applications — Determination of freeze-thaw resistance

Produits isolants thermiques destinés aux applications du bâtiment — Détermination de la résistance aux effets du gel-dégel

Reference number
ISO 16546:2012(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 16546 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 16546 includes the original EN 12091 prepared by Technical Committee CEN/TC 88 “Thermal insulating materials and products”, with the following clauses modified to reflect the conditions for tropical countries:

— Clause 6.4: Conditioning of test specimens;

— Clause 10: Test report.

Introduction

ISO 16546 is one of a series of existing European Standards on test methods which were adopted by ISO. This group of International Standards comprises the following group of interrelated standards:

ISO	Title	Respective EN standard
12344	Thermal insulating products for building applications — Determination of bending behaviour	EN 12089
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
29465	Thermal insulating products for building applications — Determination of length and width	EN 822
29466	Thermal insulating products for building applications — Determination of thickness	EN 823
29467	Thermal insulating products for building applications — Determination of squareness	EN 824
29468	Thermal insulating products for building applications — Determination of flatness	EN 825
29469	Thermal insulating products for building applications — Determination of compression behaviour	EN 826
29470	Thermal insulating products for building applications — Determination of the apparent density	EN 1602
29471	Thermal insulating products for building applications — Determination of dimensional stability under constant normal laboratory conditions (23 degrees C/50 % relative humidity)	EN 1603
29472	Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions	EN 1604
29764	Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions	EN 1605
29765	Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces	EN 1607
29766	Thermal insulating products for building applications — Determination of tensile strength parallel to faces	EN 1608
29767	Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion	EN 1609
29768	Thermal insulating products for building applications — Determination of linear dimensions of test specimens	EN 12085
29769	Thermal insulating products for building applications — Determination of behaviour under point load	EN 12430
29770	Thermal insulating products for building applications — Determination of thickness for floating-floor insulating products	EN 12431

29771	Thermal insulating materials for building applications — Determination of organic content	EN 13820
29803	Thermal insulation products for building applications — Determination of the resistance to impact of external thermal insulation composite systems (ETICS)	EN 13497
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
29805	Thermal insulation products for building applications — Determination of the mechanical properties of glass fibre meshes	EN 13496
16534	Thermal insulating products for building applications — Determination of compressive creep	EN 1606
16535	Thermal insulating products for building applications — Determination of long-term water absorption by immersion	EN 12087
16536	Thermal insulating products for building applications — Determination of long-term water absorption by diffusion	EN 12088
16537	Thermal insulating products for building applications — Determination of shear behaviour	EN 12090
16546	Thermal insulating products for building applications — Determination of freeze-thaw resistance	EN 12091
16544	Thermal insulating products for building applications — Conditioning to moisture equilibrium under specified temperature and humidity conditions	EN 12429
16545	Thermal insulating products for building applications — Determination of behaviour under cyclic loading	EN 13793

A further group of existing European Standards on test methods for products used to insulate building equipment and industrial installations comprises the following group of interrelated International Standards:

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 insulating 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

Thermal insulating products for building applications — Determination of freeze-thaw resistance

1 Scope

This International Standard specifies the equipment and procedures for determining the effects of successive cycling from dry conditions at −20 °C to wet conditions at 20 °C on the mechanical properties and moisture content of the product. It is applicable to thermal insulating products.

It is intended to simulate freeze–thaw effects on thermal insulating products which are frequently exposed to water and low temperature conditions, e.g. inverted roofs and unprotected ground insulation.

This test method is not recommended for all thermal insulating products. If relevant, the product standards will state for which products this International Standard is applicable.

2 Normative references

The following referenced documents are indispensable for the application 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 29469, *Thermal insulating products for building applications — Determination of compression behaviour*

ISO 16535 (EN 12087), *Thermal insulating products for building applications — Determination of long-term water absorption by immersion*

ISO 16536 (EN 12088), *Thermal insulating products for building applications — Determination of long-term water absorption by diffusion*

3 Definitions

For the purposes of this document, the following definition applies:

3.1
freeze-thaw resistance
ability of a product to withstand repeated wetting followed by freezing conditions, quantified by water absorption and change in compression behaviour

4 Principle

The freeze-thaw resistance is determined as the change in the amount of water absorbed and the change in compression strength or stress of a test specimen which is subjected to 300 successive cycles from dry conditions at −20 °C to wet conditions at 20 °C. Testing is carried out in conjunction with either one of the following long-term water absorption tests:

a) Water absorption by diffusion, according to ISO 16536 (EN 12088);

b) Water absorption by total immersion, according to ISO 16535 (EN 12087).

The chosen long-term water absorption test a) and/or b) is given in the relevant product standard in accordance with the application. Freezing takes place in the air; thawing in the water.

5 Apparatus

5.1 Cold chamber, with a constant temperature of (–20 ± 2) °C.

5.2 Water tank, with a constant water temperature of (20 ± 2) °C, equipped with a device for keeping the test specimen in position.

NOTE Normally no accelerated thermal exchange is provided, e.g. fan assistance in the cold chamber or turbulent water circulation in the watertank.

5.3 Balance, which permits a reading to 0,1 g.

5.4 Compression testing machine, including measuring devices, according to ISO 29469.

6 Test specimens

The freeze-thaw test shall be made on the same test specimens, referred to as set A, which have been used for the determination of long-term water absorption by diffusion, according to ISO 16536 (EN 12088), or by total immersion, according to ISO 16535 (EN 12087).

6.1 Dimensions of test specimens

The thickness of the test specimens shall be the original product thickness.

The test specimens for set A shall be squares with squarely cut edges having sides of (500 ± 1) mm or (200 ± 1) mm depending on the chosen water absorption test.

6.2 Number of test specimens

The number of test specimens for set A is determined by the requirement that two sets of test specimens for the compression test (set B1 and B2) can be prepared from set A.

The number and dimensions of test specimens for each set B1 and B2 for the compression test shall be as specified in the relevant product standard or any other technical specification. In the absence of such a specification, the number and dimensions of test specimens shall be as defined in ISO 29469.

6.3 Preparation of test specimens

If possible, the test specimens shall be cut so that they do not include original product edges.

Cutting of the test specimens shall be by methods that do not change the original structure of the product. Any skins, facings and/or coatings shall be retained.

6.4 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 for a minimum of 6 h.

In tropical countries, different conditioning and testing conditions may be relevant. In this case, the conditions shall be (27 ± 5) °C and (65 ± 5) % RH, and be stated clearly in the test report.

7 Procedure

Carry out the freeze-thaw test in accordance with the procedure indicated in Figure 1. All test specimens shall be taken from the same sample.

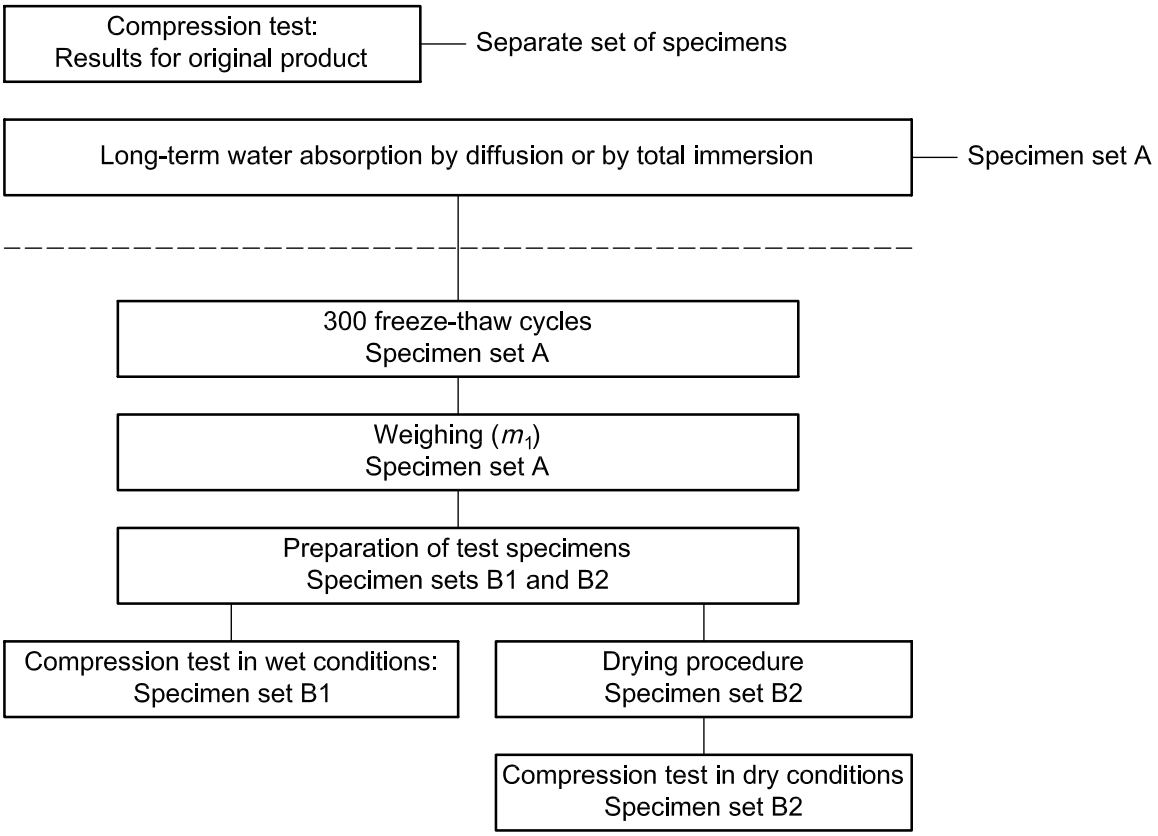


Figure 1 — Flow chart for the test procedure

Determine the compression behaviour of the original product, in accordance with ISO 29469 (σ_m or σ_{10}).

Determine the long-term water absorption of the test specimens using either ISO 16536 (EN 12088) or ISO 16535 (EN 12087).

Record m_0, the mass of test specimens at the end of the diffusion test ($m_0 = m_D$) or the total immersion test ($m_0 = m_{28}$).

Place the test specimens in the cold chamber and maintain the temperature at (−20 ± 2) °C for 1 h. Remove the test specimens from the cold chamber and immerse them in water. Maintain the temperature at (20 ± 2) °C for 1 h.

Continue the test for 300 cycles (see Figure 2).

When there are breaks longer than 1 h, e.g. during the night or the weekend, the test specimens shall be left in the cold chamber.

Determine the mass m_1, of each of the test specimens (set A) to the nearest 0,1 g after completion of all cycles.

Examine the test specimens visually for defects, e.g. cracks, blisters.

Prepare the test specimens for set B1 and set B2.

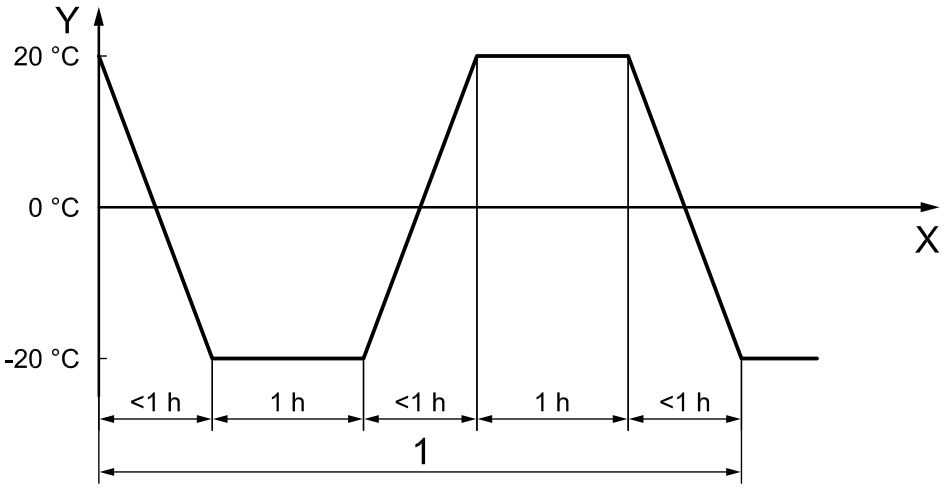
Determine the compression behaviour of the test specimens, in accordance with ISO 29469, from set B1 (compression behaviour in wet conditions, $\sigma_{m,wet}$ or $\sigma_{10,wet}$) within 24 h of the last freeze-thaw cycle.

Dry the test specimens from set B2 in a ventilated drying chamber for the time and temperature specified in the relevant product standard or any other European technical specification. In the absence of such a specification, the test specimens shall be dried until reaching constant mass. For the purpose of this test, the constant mass is considered to have been reached when the change in mass between two subsequent weighings with a 24 h interval is lower than 0,5 % of the total mass at a minimum drying temperature of 40 °C.

NOTE Commonly used drying conditions are 105 °C for 24 h, 70 °C for 4 days or 40 °C for 7 days.

Determine the compression behaviour of the test specimens, in accordance with ISO 29469, from set B2 (compression behaviour in dry conditions, $\sigma_{m,dry}$ or $\sigma_{10,dry}$).

The freeze-thaw test is ideally carried out immediately after the test for long-term water absorption. In the event that this is not possible, the wet test specimens should be wrapped in polyethylene film and stored in ambient laboratory conditions.



Key

X time

Y temperature

Figure 2 — Test cycle duration

8 Calculation and expression of results

8.1 Water absorption

The test results, W_m or W_v, shall be the mean values of the individual values.

Calculate the water absorption for each test specimen, W_m or W_v, in percent by mass or in percent by volume using Equation (1) or (2):

$$W_m = \frac{m_1 - m_0}{m_0} \times 100 \quad (1)$$

$$W_V = \frac{m_1 - m_0}{V \times \rho_W} \times 100 \quad (2)$$

where

m_1 is the mass of the test specimen after 300 freeze–thaw cycles, in g;

m_0 is the mass of the test specimen at the end of the water absorption by diffusion or by total immersion, in g;

V is the volume of the test specimen, in cm^3;

ρ_W is the density of water, assumed to be 1 g/cm3.

W_m shall be rounded to the nearest 0,1 percent by mass.

W_v shall be rounded to the nearest 0,1 volume percent.

8.2 Changes in the compression behaviour

Calculate the mean change in the compression behaviour based on the test result for each condition, $\Delta\sigma_{wet}$ and $\Delta\sigma_{dry}$, in percentages using Equation (3) or (4) and Equation (5) or (6):

$$\Delta\sigma_{wet} = \frac{\sigma_{m,wet}}{\sigma_m} \times 100 \quad (3)$$

$$\Delta\sigma_{wet} = \frac{\sigma_{10,wet}}{\sigma_{10}} \times 100 \quad (4)$$

or

$$\Delta\sigma_{dry} = \frac{\sigma_{m,dry}}{\sigma_m} \times 100 \quad (5)$$

$$\Delta\sigma_{dry} = \frac{\sigma_{10,dry}}{\sigma_{10}} \times 100 \quad (6)$$

where

$\sigma_{m,wet}$ is the compressive strength of the test specimen in wet conditions, in kPa;

$\sigma_{10,wet}$ is the compressive stress of the test specimen at 10 % relative deformation in wet conditions, in kPa;

$\sigma_{m,dry}$ is the compressive strength of the test specimen in dry conditions, in kPa;

$\sigma_{10,dry}$ is the compressive stress of the test specimen at 10 % relative deformation in dry conditions, in kPa;

σ_m is the compressive strength of the original product, in kPa;

σ_{10} is the compressive stress at 10 % relative deformation of the original product, in kPa.

The result shall be expressed to two significant figures.

9 Accuracy of measurement

NOTE It has not been possible to include a statement on the accuracy of measurement in this edition of this International Standard, but it is intended to include such a statement when this International Standard is next revised.

10 Test report

The test report shall include the following information:

a) Reference to this International Standard, i.e. ISO 16546:2012;

b) Product identification

1) product name, factory, manufacturer or supplier;

2) production code number;

3) type of product;

4) packaging;

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

6) presence of facing or coating;

7) other information as appropriate, e.g. nominal thickness, nominal density;

c) Test procedure

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

2) conditioning;

3) if any deviation from Clauses 6 and 7;

4) date of testing;

5) conditioning conditions in tropical countries, if applicable;

6) general information relating to the test:

i) long-term water absorption method used;

ii) temperature;

iii) relative humidity;

iv) duration;

v) dimensions of test specimens;

vi) number of cycles;

7) events which may 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 values and the mean values;

2) any visual observations after the freeze-thaw cycles, e.g.cracks.

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