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Thermal insulating products for building equipment and industrial installations — Determination of water vapour transmission properties of preformed pipe insulation

Produits isolants thermiques pour les équipements de bâtiments et les installations industrielles — Détermination des propriétés de transmission de la vapeur d'eau des coquilles isolantes préformées

Reference number
ISO 12629:2022(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.

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 12629:2011), which has been technically revised.

The main changes are as follows:

— EN 13469:2012 and ISO 12629:2011 have been merged into one document;

— technical revision of Clause 3, Terms, definitions, symbols and subscripts, 6.3, Number of test specimens, Clause 7, Procedure and Clause 8, Calculation and expression of results;

— Annex A has been deleted;

— 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 water vapour transmission properties of preformed pipe insulation

1 Scope

This document specifies the equipment and procedure for determining the water vapour transmission properties in the steady state under specified test conditions for test specimens of preformed pipe insulation. It is applicable to thermal insulating products.

It is intended to be used for homogeneous materials (see NOTE below) and for products which can have integral skins or adhered facings of some different material.

NOTE A material is considered to be homogeneous in terms of mass distribution if its density is approximately the same throughout, i.e. if the measured density values are close to its mean density.

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 9346, *Hygrothermal performance of buildings and building materials — Physical quantities for mass transfer — Vocabulary*

ISO 12628, *Thermal insulating products for building equipment and industrial installations — Determination of dimensions, squareness and linearity of preformed pipe insulation*

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

3 Terms, definitions, symbols, units and subscripts

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9346 and the following 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/

3.1.1
water vapour flow rate
G
quantity of water vapour transmitted through the surface of the test specimen in mass divided by time

3.1.2
density of water vapour flow rate
g
mass of water vapour transferred through the specimen per area and per time under specified conditions of temperature, humidity and thickness

3.1.3
water vapour permeance
W
quotient of water vapour transmission rate of the test specimen and the water vapour pressure difference per area between the test specimen faces during the test

3.1.4
water vapour resistance
Z
inverse of *water vapour permeance* (3.1.3) (1/*W*)

3.1.5
water vapour permeability
δ
product of the permeance and the thickness of the test specimen ($\delta = W \cdot d$)

Note 1 to entry: The water vapour permeability of a homogeneous product is a property of the material. It is the quantity of water vapour transmitted per unit of time through a unit area of the product per unit of vapour pressure difference between its faces for a unit thickness.

3.1.6
water vapour resistance factor
μ
quotient of the *water vapour permeability* (3.1.5) of air and the water vapour permeability of the material or the homogeneous product concerned

Note 1 to entry: It indicates the relative magnitude of the *water vapour resistance* (3.1.4) of the product and that of an equally thick layer of stationary air at the same temperature.

3.2 Symbols and units

The symbols and units are given in Table 1.

Table 1 — Symbols and units

Symbol	Quantity	Unit
A	area of specimen	m^2
G	water vapour flow rate through specimen	kg/s
R_v	gas constant for water vapour = 462	N·m/(kg·K)
T	thermodynamic temperature	K
W	water vapour permeance with respect to partial vapour pressure	kg/(m^2·s·Pa)
Z	water vapour resistance with respect to partial vapour pressure	m^2·s·Pa/kg
d	mean thickness of specimen	m
g	density of water vapour flow rate	kg/(m^2·s)
l	length of the test specimen	m
m	mass of specimen	kg
p	barometric pressure	hPa
p_0	standard barometric pressure = 1 013,25	hPa
p_s	water vapour saturation pressure	hPa
t	time	s
Δp	water vapour pressure difference across specimen	Pa
δ	water vapour permeability of the specimen	kg/(m·s·Pa)
δ_a	water vapour permeability of air	kg/(m·s·Pa)

Table 1 *(continued)*

Symbol	Quantity	Unit
μ	water vapour resistance factor	—
ϑ	celsius temperature	°C
φ	relative humidity (RH)	—

NOTE The above units are in accordance with ISO 9346; a conversion table to other units commonly used in permeability measurements is given in ISO 12572:2016, Annex J.

3.3 Subscripts

The subscripts are given in Table 2.

Table 2 — Subscripts

Subscript	Denoting
1, 2	time steps, index
a	air
i	inside
o	outside

4 Principle

A desiccant filled "dry cup" made from a preformed pipe insulation test specimen is placed in a test atmosphere whose temperature and humidity are controlled. Because of the difference between the partial water vapour pressures in the test assembly and in the test atmosphere water vapour flows through the test specimen, periodic weighings of the assembly are made to determine the rate of water vapour transmission when the steady state is reached.

The water vapour transmission rate and permeance values are specific to the test specimen (i.e. the product) thickness tested. For homogeneous products, the water vapour permeability is a property of the material.

If the pipe insulation is cut from a flat product, then the water vapour transmission properties can be obtained from tests carried out on the flat product with similar properties according to ISO 12572.

5 Apparatus

5.1 Chamber, capable of being maintained within a temperature of (23 ± 1) °C and a relative humidity (RH) of (50 ± 3) %.

NOTE In order to maintain the required conditions throughout the chamber, it can be necessary to use air circulation with an air speed between 0,02 m/s to 0,3 m/s.

5.2 Desiccant, anhydrous calcium chloride ($CaCl_2$) with particle size 2 mm to 15 mm (RH 0 %) or any other desiccant that gives the same results.

5.3 Analytical balance, capable of weighing the test assembly to an accuracy of ±1 mg or better. If larger test assemblies are used, the weighing accuracy may be determined with respect to the total weight and the required accuracy of the test results.

5.4 Measuring instruments, capable of determining linear dimensions and thicknesses in accordance with the requirements of ISO 29768 or ISO 12628, whichever is relevant.

5.5 Aluminium foil, water vapour diffusion tight (at least 50 µm thick) protected with a polymer film on the face in contact with the calcium chloride ($CaCl_2$).

5.6 Adhesive, suitable to make a water-vapour-tight joint between the aluminium foil and the test specimen (see relevant product standard).

NOTE Any combination of foil or sealant and adhesive which provides comparable results can be used.

6 Test specimens

6.1 General

The test specimens shall be representative of the product and shall include any natural surface skins or adhered facings of different materials.

Pipe insulation pieces (half sections or segments) shall be placed together using an appropriate sealant or adhesive to form a full-size pipe insulation test specimen.

NOTE For faced or coated products with a water vapour diffusion resistance factor $\mu \leq 3$, for the core material, the permeability can be determined from measurements made on the facing/coating itself, after separation from the product. For pipe insulations with large dimensions, test specimen of the facing or coating can be cut out and tested according to ISO 12572.

6.2 Dimensions of the test specimen

Cut the test specimens to a minimum length of (100 ± 1) mm; for outside diameters greater than 100 mm the length shall be at least 150 mm. The cut surfaces shall be as flat as possible, equally formed and perpendicular to the vertical axis of the test specimen.

The thickness of the test specimen shall be the thickness of the product.

6.3 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 five test specimens shall be used.

In addition to the specified test specimens, one test specimen, “dummy”, identical to the others but not filled with desiccant shall be prepared. This “dummy” shall be included in the test procedure. Its weight changes during the test procedure are not caused by water vapour diffusion, but by, e.g. gas or humidity evaporation/absorption or air pressure variations.

NOTE 1 In the absence of a product standard or any other technical specification, the method of selection of the test specimens can be agreed between parties.

The weight changes of the test specimens shall be corrected by the weight changes of the dummy.

NOTE 2 Information on the use of a "dummy" test specimen can be found in Reference [4].

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) % RH for the time stated in the relevant product standard.

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 and shall be stated clearly in the test report.

7 Procedure

7.1 Test conditions

Select the desired test environment from the conditions given in Table 3.

Table 3 — Test conditions

Set	Condition °C - % relative humidity (RH)	Tolerances				
		Temperature °C	Relative humidity (RH)[a] %			
			Dry state		Wet state	
			Set point	Tolerance	Set point	Tolerance
A	23 – 0/50	23 ± 1	0	+5	50	±5
B	23 – 0/85	23 ± 1	0	+5	85	±5
C	23 – 50/93	23 ± 1	50	±5	93	±5
D	38 – 0/93	38 ± 1	0	+5	93	±3
E	23 – 50/100	23 ± 1	50	±5	100	

NOTE 1 ”Dry” tests (condition A) give information about the performance of materials at low humidities when moisture transfer is dominated by vapour diffusion. ”Wet” tests (condition C) give guidance about the performance of materials under high humidity conditions. At higher humidities, the material pores start to fill with water; this increases the transport of liquid water and reduces vapour transport. Tests in this area therefore give some information about liquid water transport within materials. This is discussed further in ISO 15148.

NOTE 2 Condition E is used for low resistance specimens.

[a] Saturated salt solutions, which regulate the RH in the specimens at some value less than 100 %, are used because, with many materials, there is a danger of condensation occurring on the underside of the sample, which disrupts the vapour flow. In the case of very low resistance, the vapour flow rates are so high that a) condensation is unlikely and b) the saturated salt solution will possibly not remain in equilibrium for the duration of the test. In this case, that distilled water should be used.

Other sets of temperature and RH may be agreed between the parties when needed for special application conditions.

EXAMPLE 1 This is an example of desiccants which produce the specified air relative humidities at 23 °C.

Desiccants

Calcium chloride, $CaCl_2$ - particle size < 3 mm 0 %

Magnesium perchlorate, $Mg(ClO_4)_2$ 0 %

Phosphorus pentoxide, P_20_5 0 %

Silicagel 0 %

EXAMPLE 2 This is an example of saturated aqueous solutions which produce the specified air relative humidities at 23 °C.

Aqueous solutions

Sodium dichromate, $Na_2Cr_20_7 \cdot 2H_20$ 52 %

Magnesium nitrate, $Mg(NO_3)_2$ 53 %

Potassium chloride, KCl 85 %

Ammonium dihydrogen phosphate, $NH_4H_2PO_4$	93 %
Potassium nitrate, KNO_3	94 %

Further details of suitable solutions can be found in ISO 12571:2013[1)], Annexes A and B.

Regular checks shall be made, especially during long tests, to ensure that saturated solutions remain as a mixture of liquid with a large amount of undissolved substance.

It is presupposed that all chemical substances are handled with care and in accordance with relevant safety regulations.

7.2 Preparation of specimen and test assembly

Bond the test specimen to the aluminium foil (see 5.5), at one end, to achieve a water-vapour-tight joint.

Place sufficient desiccant within the test specimen.

The quantity of desiccant shall not be greater than 2/3 of the enclosed volume.

Close the open end of the test specimen as in the first paragraph.

Bubbles under the foil should be avoided, and the bond between the foil and the test specimen should be such that any attempt to separate the foil from the test specimen breaks the test specimen rather than the bond.

In case of products with a low water vapour transmission rate, the borderline between the foil and the test specimen may be sealed in addition with a sealant (e.g. wax) in such a way that the reduction in free surface is not significant.

Immerse the test specimens in the test chamber (see Figure 1) under the specified test conditions. Avoid contact between the test specimens.

Condition the test specimens in the test chamber for a period between 1 h and 24 h.

7.3 Test procedure

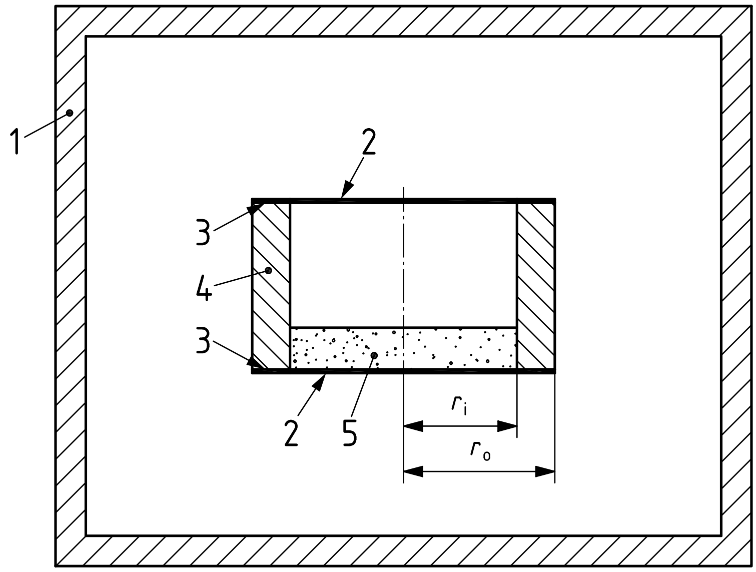
Weigh the test specimens at regular intervals. The weighing shall be carried out under the same conditions that exist in the test chamber. If the weighing is made outside of the chamber, care shall be taken that the duration of time outside of the chamber does not affect the result. The weight changes of the test specimens shall be corrected by the weight changes of the dummy.

In order to avoid contamination of the test specimen, gloves should be used while handling the test specimen.

Repeat the weighings until five successive determinations of "change in mass per unit time" are constant to within ±5 % of the mean value for the test specimen (see 8.1). Repeat the procedure for the remaining test specimens.

Plot a curve of change in mass against time to help recognize the condition of constant change (steady state).

1) Cancelled and replaced by ISO 12571:2021.



Key

1	test chamber	r_i	inside radius
2	aluminium foil	r_o	outside radius
3	adhesive		
4	test specimen		
5	desiccant		

Figure 1 — Example of test assembly

8 Calculation and expression of results

8.1 Water vapour flow rate

Calculate for each test specimen for the selected time interval, the water vapour flow rate, $\Delta\dot{m}_{12}$, using Formula (1):

$$\Delta\dot{m}_{12} = \frac{m_2 - m_1}{t_2 - t_1} \tag{1}$$

where

$\Delta\dot{m}_{12}$	is the change of mass per time for a single determination, in kg/s;
m_1	is the mass of the test assembly at time t_1, in milligrams;
m_2	is the mass of the test assembly at time t_2, in milligrams;
t_1 and t_2	are successive times of weighings, in seconds.

G is the mean of five successive determinations of $\Delta\dot{m}_{12}$ for each test specimen.

The final value of G is obtained when each of the last five successive determinations of $\Delta\dot{m}_{12}$ is within ±5 % of G.