INTERNATIONAL STANDARD

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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 des bâtiments et les installations industrielles — Détermination des propriétés de transmission de la vapeur d'eau des coquilles isolantes préformées

Reference number
ISO 12629:2011(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 12629 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 12629 includes the original EN 13469 prepared by Technical Committee CEN/TC 88 *Thermal insulating materials and products*. However,

— Subclause 6.4, “conditioning of test specimen”,

— Clause 10, “test report”

have been modified to reflect conditions for tropical countries.

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 13469 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 constructive products (Directive 89/106/EEC) through the consideration of the essential requirements.

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 is comprised of 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 — 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

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	Title	Respective EN standard
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	Title	Respective EN standard
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

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.

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

1 Scope

This International Standard 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 may 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 approximatively the same throughout, i.e. if the measured density values are close to its mean density.

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 in accordance with EN 12086.

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 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*

EN 12086, *Thermal insulating products for building applications — Determination of water vapour transmission properties*

3 Terms and definitions

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

3.1
water vapour flow rate
G
quantity of water vapour transmitted through the surface of the test specimen in unit time

3.2
water vapour transmission rate
g
quantity of water vapour transmitted through unit area in unit time under specified conditions of temperature, humidity and thickness

3.3
water vapour permeance
W
quotient of water vapour transmission rate of the test specimen and the water vapour pressure difference between the test specimen faces during the test

3.4
water vapour resistance
Z
inverse of water vapour permeance ($1/W$)

3.5
water vapour permeability
δ
product of the permeance and the thickness of the test specimen ($\delta = W \times d$)

NOTE 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.

3.6
water vapour diffusion resistance factor
μ
quotient of the water vapour permeability of air and the water vapour permeability of the material or the homogeneous product concerned

NOTE It indicates the relative magnitude of the water vapour resistance of the product and that of an equally thick layer of stationary air at the same temperature.

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.

For products with a low water vapour transmission rate, special consideration has to be taken into account (see Annex A).

5 Apparatus

5.1 Chamber, capable of being maintained within a temperature of (23 ± 1) °C and an RH (relative humidity) 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 $\mu \leqslant 3$, 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 EN 12086.

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.

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

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 countries, 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

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 to maintain “zero” percent RH throughout the test.

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) at (23 ± 1) °C and (50 ± 3) % RH. Avoid contact between the test specimens.

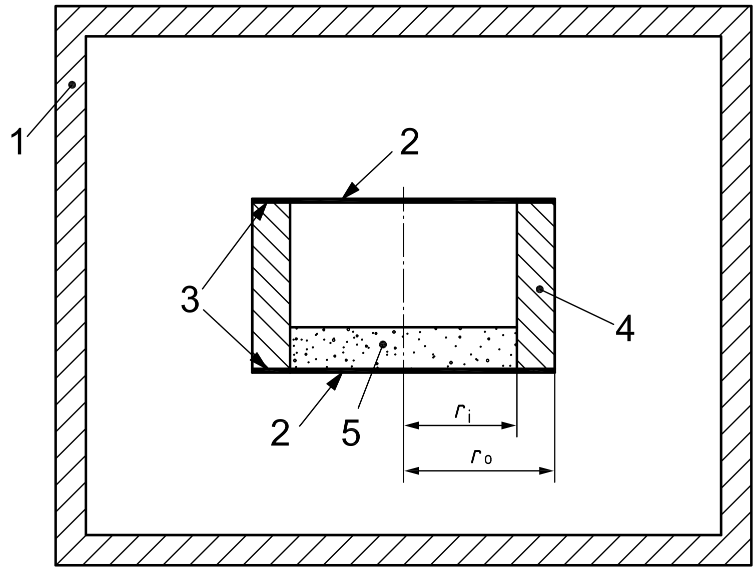
Condition the test specimens in the test chamber for a period between 1 h and 24 h.

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.

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).



Key

1 test chamber
2 aluminium foil
3 adhesive
4 test specimen
5 desiccant

r_i inside radius
r_o outside radius

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, G_{12}, in milligrams per hour using the equation:

$$G_{12} = \frac{m_2 - m_1}{t_2 - t_1} \tag{1}$$

where

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 hours.

Calculate G, the mean of five successive determinations of G_{12}, in milligrams per hour, for each test specimen.

The test stops when each of the five successive determinations of G_{12} is within ±5 % of G.

8.2 Water vapour transmission rate

Calculate the water vapour transmission rate, g, in milligrams per square metre per hour using the equation:

$$g = \frac{G}{A} \tag{2}$$

where

A is the calculated exposed area of the test specimen, in square metres, calculated using the equation:

$$A = \frac{2 \times \pi \times l \times \left(r_o - r_i\right)}{\ln \frac{r_o}{r_i}} \tag{3}$$

where

l is the length of the test specimen, in metres;

r_o is the outside radius, in metres;

r_i is the inside radius, in metres.

8.3 Water vapour permeance

Calculate the water vapour permeance, W, in milligrams per square metre per hour per Pascal using the equation:

$$W = \frac{G}{A \times \Delta p} \tag{4}$$

where

Δp is the water vapour pressure difference, in Pascal, and has the value of 1 400 Pascal at the test condition 23-0/50 according to EN 12086.

8.4 Water vapour resistance

Calculate the water vapour resistance, Z, in square metres times hours times Pascal per milligram using the equation:

$$Z = \frac{1}{W} \tag{5}$$

8.5 Water vapour permeability

Calculate the water vapour permeability, δ, in milligrams per metre per hour per Pascal using the equation:

$$\delta = W \times d \tag{6}$$

where

d is the test specimen thickness, in metres.

8.6 Water vapour diffusion resistance factor

8.6.1 General

Calculate the water vapour diffusion resistance factor, μ, dimensionless using the equation:

$$\mu = \frac{\delta_{\text{air}}}{\delta} \tag{7}$$

where

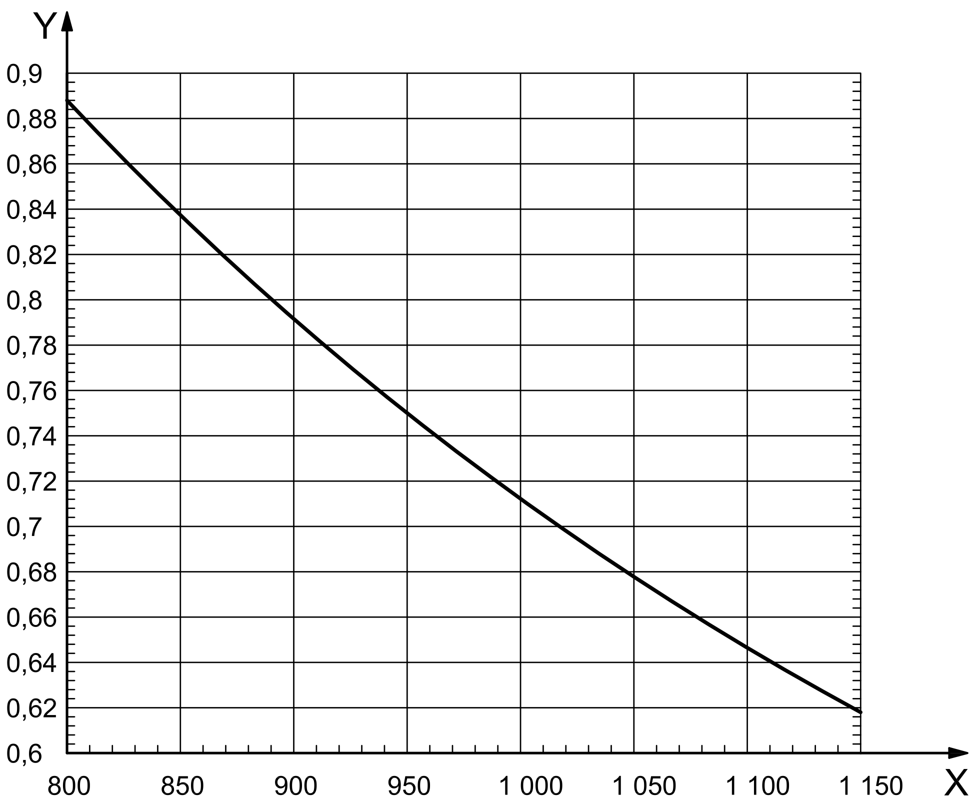
δ is the water vapour permeability of the test specimen;

δ_{air} is the water vapour permeability of air (depending on the mean barometric pressure during the test; see Figure 2).

NOTE Since the water vapour permeability of air and the material are assumed to depend equally on the barometric pressure, their quotient, the factor μ, can be considered independent from the barometric pressure. When calculating water vapour transmission rate at different locations, the actual barometric pressure can be taken into account using the equation:

$$g = \frac{\Delta p}{(\mu \times d)} \times \delta_{\text{air}} \tag{8}$$

8.6.2 Calculation of δ_{air}



Key

Y δ_{air} in mg/(m h Pa)

X barometric pressure in hPa

Figure 2 — Water vapour permeability in air at 23 °C

The calculation can also be made by using the formula of Schirmer:

$$\delta_{air} = \frac{D}{R_D \times T} \tag{9}$$

$$\delta_{air} = \frac{0{,}083}{R_D \times T} \times \frac{p_o}{p} \times \left(\frac{T}{273}\right)^{1{,}81} \tag{10}$$

where

D is the water vapour diffusion coefficient, in square metres per hour;

R_D is the gas constant of water vapour: 462×10^{-6} Nm/(mg K);

T is the test temperature, in Kelvin;

p is the mean barometric pressure during the test, in hecto Pascal;

p_o is the normal barometric pressure: 1 013,25 hPa.

8.6.3 Calculation of δ

$$\delta = d \times \frac{G}{\Delta p \times A} \tag{11}$$

where

d is the thickness of the test specimen, in metres;

G is the water vapour flow rate, in milligrams per hour;

A is the area, in square metres;

Δp is the water vapour pressure difference between inside and outside of the test specimen, in Pascal.

a) Water vapour flow rate

$$G = \frac{\Delta m}{\Delta t} \tag{12}$$

where

Δm is the weight difference in milligrams between two readings;

Δt is the measuring time, in hours.

b) Water vapour pressure difference

$$\Delta p = \left(p_{s1} \times \varphi_1\right) - \left(p_{s2} \times \varphi_2\right) \tag{13}$$

where

p_{s1} is the water vapour saturation pressure in the test chamber, in Pascal;

φ_1 is the RH in the test chamber, expressed as a decimal;

p_{s2} is the water vapour saturation pressure in the test assembly — above the desiccant, in Pascal;

φ_2 is the RH in the test assembly — above the desiccant, expressed as a decimal.

If calcium chloride is used as desiccant, an RH of 0 % is assumed, in which case, φ_2 is equal to zero.

Therefore $\Delta p = p_{s1} - \varphi_1$

A good approximation for p_s is:

$$p_s = a \times \left(b + \frac{T - 273,15}{100} \right)^n \tag{15}$$

where

a is 288,68 Pa;

b is 1,098;

n is 8,02;

T is the temperature, in Kelvin.

8.6.4 Calculation of μ

Calculate the μ value from the following equation:

$$\mu = \frac{1}{\left(r_o - r_i\right)} \times \frac{0,083}{R_D \times T} \times \frac{p_o}{p} \times \left(\frac{T}{273,15}\right)^{1,81} \times \frac{\Delta t}{\Delta m} \times \frac{2 \times \pi \times l \times \left(r_o - r_i\right)}{\ln \frac{r_o}{r_i}} \times 288,68 \times \left(1,098 + \frac{\left(T - 273,15\right)}{100}\right)^{8,02} \times \varphi_1 \tag{16}$$

9 Accuracy of measurement

NOTE It has not been possible to include a statement on the accuracy of the method 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;

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) 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) deviation from Clauses 6 and 7 if applicable, including, for example, testing of the facing alone;

4) date of testing;

5) conditioning and testing conditions in tropical countries, if applicable;

6) dimensions and number of test specimens;

7) general information relating to the test;

8) 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) the water vapour transmission property (water vapour diffusion factor, permeance or permeability) including the direction of the water vapour flow relative to the facings, if the two facings are different, for which the results have been calculated. If desirable, all three properties may be reported, where appropriate;

2) all individual test results;

3) arithmetic mean of the individual test results.

Annex A
(informative)

Correction for air pressure variations during testing

For products with low water vapour transmission rates, large day-to-day pressure variations may affect the results. It may, therefore, be necessary to take into account the buoyancy effect by including the change in weight of a test specimen, without a desiccant, in the calculation. Detailed information regarding this problem is available in Hansen and Lund [1].

Bibliography

[1] HANSEN, K. K. and LUND, H.B. Cup Method for Determination of Water Vapour Transmission Properties of Building Materials. Sources of Uncertainty in the Method. Proceedings of the 2nd Symposium “Building Physics in Nordic Countries”, 20-22 August 1990, Trondheim, Norway, TAPIR Publishers, 1990

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