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BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN 13469:2012. It supersedes BS EN 13469:2001 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/540, Energy performance of materials components and buildings.

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

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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 l'équipement du bâtiment et les installations industrielles - Détermination des propriétés de transmission de la vapeur d'eau des coquilles isolantes préformées

Wärmedämmstoffe für die Haustechnik und für betriebstechnische Anlagen - Bestimmung der Wasserdampfdurchlässigkeit von vorgeformten Rohrdämmstoffen

This European Standard was approved by CEN on 24 August 2012.

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Foreword

This document (EN 13469:2012) has been prepared by Technical Committee CEN/TC 88 “Thermal insulating materials and products”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2013, and conflicting national standards shall be withdrawn at the latest by April 2013.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13469:2001.

The following main technical changes have been implemented in this new edition of EN 13469:

a) the content of Annex A "Correction for air pressure variations during test" has been included in the main part of the standard and the annex has been deleted;

b) the document has been editorially updated.

This European Standard is one of a series of standards which specify test methods for determining dimensions and properties of thermal insulating materials and products. It 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 European 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.

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1 Scope

This European 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) 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 approximately 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 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.

EN 12085, *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*

EN 13467, *Thermal insulating products for building equipment and industrial installations — Determination of dimensions, squareness and linearity of preformed pipe insulation*

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
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

Note 1 to entry: Water vapour permeability is a product of the permeance and the thickness of the test specimen ($\delta = W \times d$). It is a property of the material of a homogeneous product.

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 which 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.

5 Apparatus

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

In order to maintain the required conditions throughout the chamber, it may 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 (relative humidity 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 EN 12085 or EN 13467, 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 water vapour tight joint between the aluminium foil and the test specimen (see relevant product standard).

Any combination of foil or sealant and adhesive, which provides comparable results, may 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.

For faced and/or coated products with a water vapour diffusion resistance index $\mu \leq 3$, for the core material, the permeability may be determined from measurements made on the facing/coating itself, after separation from the product. For pipe insulations with large dimensions, test specimens of the facing and/or coating may 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.

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.

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

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

In the absence of a product standard or any other European Technical Specification, the method of selection of the test specimens may 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) % relative humidity for the time stated in the relevant product standard.

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 relative humidity throughout the test.

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

Prepare also one test specimen, “dummy”, identical to the others but not filled with desiccant.

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) % relative humidity. Avoid contact between the test specimens.

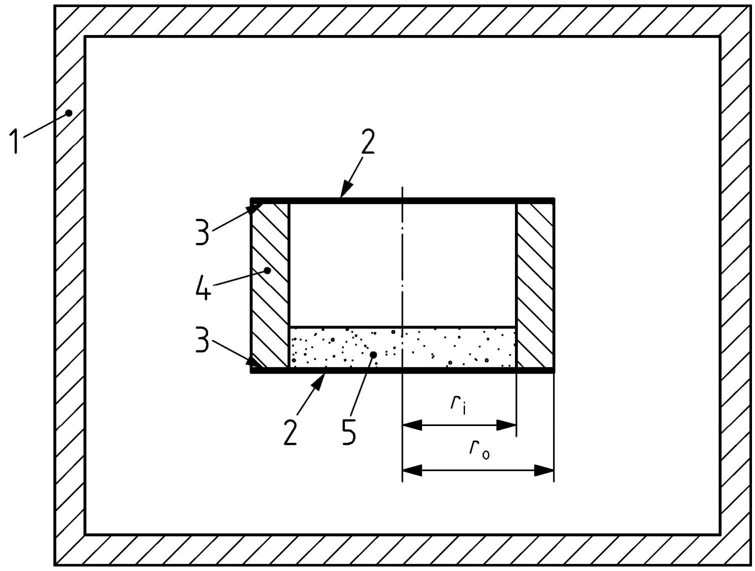
Condition the test specimens in the test chamber for a period between 1 h and 24 h.

Weigh the test specimens at regular intervals. The weighing shall be carried out under the same conditions as exist in the test chamber. If the weighing is made outside the chamber, care shall be taken that the duration of time outside 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 recognise 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 formula:

$$G_{12} = \frac{m_2 - m_1}{t_2 - t_1} \quad (1)$$

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 formula:

$$g = \frac{G}{A} \quad (2)$$

where

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

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

where

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

r_o is the outside radius, in metres;

r_i is the inner 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 formula:

$$W = \frac{G}{A \times \Delta p} \quad (4)$$

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 Pascals per milligrams using the formula:

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

8.5 Water vapour permeability

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

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

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 formula:

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

where

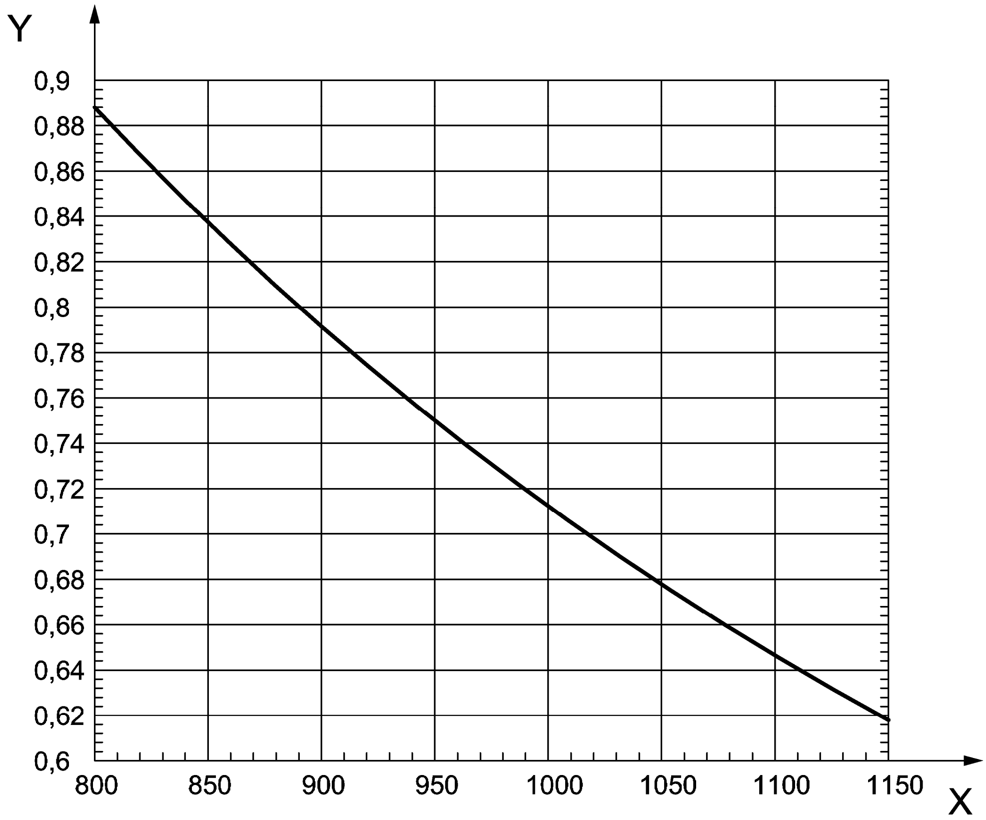
δ is the water vapour permeability of the test specimen;

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

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 may be taken into account using the formula:

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

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*:

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

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

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 hectopascalS;
- 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 pascals.

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:

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

where

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

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

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

φ_2 is the relative humidity in the test assembly – above the desiccant, expressed as a decimal.

If calcium chloride is used as desiccant, a relative humidity of 0 % is assumed. In which case φ_2 is equal to zero.

Therefore $\Delta p = p_{s1} \times \varphi_1$. (14)

A good approximation for p_s is:

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

where

a = 288,68 Pa;

b = 1,098;

n = 8,02;

T is the temperature, in Kelvin.

8.6.4 Calculation of μ

Calculate the μ value from the following formula:

$$\mu = \frac{1}{(r_o - r_i)} \times \frac{0{,}083}{R_D \times T} \times \frac{p_0}{p} \times \left(\frac{T}{273{,}15} \right)^{1{,}81} \times \frac{\Delta t}{\Delta m} x$$

$$\frac{2 \times \pi \times l \times (r_o - r_i)}{ln \frac{r_o}{r_i}} \times 288{,}68 \times \left(1{,}098 + \frac{(T - 273{,}15)}{100} \right)^{8{,}02} \times \varphi_1 \qquad (16)$$

9 Accuracy of measurement

NOTE 1 It has not been possible to include a statement on the accuracy of the method in this edition of the standard, but it is intended to include such a statement when the standard is next revised.

NOTE 2 EN ISO 12572 [2] gives some general guidance on the accuracy of testing.

10 Test report

The test report shall include the following information:

a) reference to this European Standard (EN 13469);

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) if any deviation from Clauses 6 and 7 including e.g. testing of the facing alone;

4) date of testing;

5) dimensions and number of test specimens;

6) general information relating to the test;

7) 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:

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.

Bibliography

[1] EN ISO 12572 *Hygrothermal performance of building materials and products — Determination of water vapour transmission properties* (ISO 12572)

[2] 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, editor Jan Vincent Thue, TAPIR Publishers, 1990

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