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Thermal insulating products for building applications — Determination of water vapour transmission properties

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National foreword

This British Standard is the UK implementation of EN 12086:2013. It supersedes BS EN 12086:1997, which is withdrawn.

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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 applications - Determination of water vapour transmission properties

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Wärmedämmstoffe für das Bauwesen - Bestimmung der Wasserdampfdurchlässigkeit

This European Standard was approved by CEN on 15 December 2012.

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Foreword

This document (EN 12086:2013) 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of an identical text or by endorsement, at the latest by September 2013, and conflicting national standards shall be withdrawn at the latest by September 2013.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 12086:1997.

The revision of this standard contains no major changes, only minor corrections and clarifications of an editorial nature.

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 drafted for applications in buildings but it may also be used in other areas where it is relevant.

This European test standard is one of the following group of inter-related standards on test methods for determining dimensions and properties of thermal insulation materials and products, all of which fall within the scope of CEN/TC 88:

— EN 822, *Thermal insulating products for building applications — Determination of length and width*

— EN 823, *Thermal insulating products for building applications — Determination of thickness*

— EN 824, *Thermal insulating products for building applications — Determination of squareness*

— EN 825, *Thermal insulating products for building applications — Determination of flatness*

— EN 826, *Thermal insulating products for building applications — Determination of compression behaviour*

— EN 1602, *Thermal insulating products for building applications — Determination of the apparent density*

— EN 1603, *Thermal insulating products for building applications — Determination of dimensional stability under constant normal laboratory conditions (23 °C/50 % relative humidity)*

— EN 1604, *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*

— EN 1605, *Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions*

— EN 1606, *Thermal insulating products for building applications — Determination of compressive creep*

- EN 1607, *Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces*
- EN 1608, *Thermal insulating products for building applications — Determination of tensile strength parallel to faces*
- EN 1609, *Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion*
- 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 12087, *Thermal insulating products for building applications — Determination of long-term water absorption by immersion*
- EN 12088, *Thermal insulating products for building applications — Determination of long-term water absorption by diffusion*
- EN 12089, *Thermal insulating products for building applications — Determination of bending behaviour*
- EN 12090, *Thermal insulating products for building applications — Determination of shear behaviour*
- EN 12091, *Thermal insulating products for building applications — Determination of freeze-thaw resistance*
- EN 12429, *Thermal insulating products for building applications — Conditioning to moisture equilibrium under specified temperature and humidity conditions*
- EN 12430, *Thermal insulating products for building applications — Determination of behaviour under point load*
- EN 12431, *Thermal insulating products for building applications — Determination of thickness for floating floor insulating products*
- EN 13793, *Thermal insulating products for building applications — Determination of behaviour under cyclic loading*
- EN 13820, *Thermal insulating materials for building applications — Determination of organic content*

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the equipment and procedures for determining the water vapour transmission rate, water vapour permeance and water vapour permeability of test specimens in the steady state under different sets of specified test conditions. It is applicable to thermal insulating products.

It is intended to be used for homogeneous materials and for products which may contain integral skins or facings of different material(s).

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

This test method is not normally used for determining the water vapour transmission properties of single, separate vapour barriers (of high diffusion resistance), such as prefabricated films, foils, membranes or sheets, due to the long duration of the test. For products with a vapour retarder or barrier with a water vapour diffusion equivalent air layer thickness $s_d \geq 1\ 000$ m (see 3.6) other test methods e.g. IR-detection can be used for measuring the single separate vapour retarder or barrier, provided that the results obtained are in the same range as the values measured in accordance with this standard.

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.

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*

3 Terms and definitions

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

3.1
water vapour transmission rate
g
quantity of water vapour transmitted through unit area in unit time under specified conditions of temperature, humidity and thickness

3.2
water vapour permeance
W
quotient of the water vapour transmission rate of the test specimen and the water vapour pressure difference between the two specimen faces during the test

3.3
water vapour resistance
Z
inverse of water vapour permeance

3.4
water vapour permeability
δ
product of the permeance and the thickness of the test specimen

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.

3.5
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; 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

3.6
water vapour diffusion equivalent air layer thickness

s_d

thickness of a motionless air layer which has the same water vapour resistance as the test specimen with the thickness d

Note 1 to entry: A conversion table and units for the above definitions are given in Annex A.

4 Principle

The test specimen is sealed to the open side of a test dish containing a desiccant or an aqueous saturated salt solution. The assembly is then 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 conducted to determine the rate of water vapour transmission when the steady state is reached.

5 Apparatus

5.1 Test dishes, preferably of circular shape and which are (corrosion) resistant to any desiccant or to the salt solution which they may be required to contain and impermeable to water or water vapour.

These dishes are typically made of glass or metal. The size of the dishes depends on the size of the test specimen to be tested. The difference in size between the upper exposed area (A_1) and the lower exposed area (A_2) of the test specimen shall be less than 3 % (see examples in Annex B).

Some types of test dish are unsuitable for use with certain materials. This should be stated in the relevant product standard or any other European Technical Specification.

5.2 Measuring instruments, capable of determining linear dimensions in accordance with EN 12085.

5.3 Template (with edge tapered to facilitate removal after use) with a shape and size corresponding to that of the test dish to duplicate the exposed area of the specimen.

The template shall have an area that is at least 90 % of the test specimen's surface in order to limit the edge effect due to non-linear vapour flow (see Annex C).

5.4 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.

5.5 Chamber, capable of being maintained within ± 3 % of the required relative humidity and within ± 1 °C of the required temperature.

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

If a non-injection type humidity chamber is used, saturated salt solutions may then be used.

5.6 **Sealant**, unaffected by test conditions. The following are examples of suitable sealants:

5.6.1 Mixture of 90 % micro crystalline wax and 10 % of plasticiser (e.g. low molecular weight polyisobutylene).

5.6.2 60 % micro crystalline wax with 40 % refined crystalline paraffin.

6 Test specimens

6.1 Dimensions of test specimens

6.1.1 Shape and fit

The test specimens shall be representative of the product and shall include any natural surface skins or facings of different material(s).

If it is intended to measure the permeability of the core material, all skins and facings shall be removed and the test specimens shall have a thickness of at least 20 mm.

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.

The test specimens shall be cut to correspond to the dimensions of the chosen test assembly (see examples in Annex B).

6.1.2 Thickness of test specimens

The thickness of the test specimen shall be the thickness of the product. If this exceeds 100 mm, the specimen thickness may be reduced by cutting.

6.1.3 Exposed area

The exposed area A of the test specimen (arithmetic mean of the upper and lower exposed areas) shall be at least 50 cm^2. The diameter of circular test specimens or the equivalent diameter of rectangular test specimens (calculated from the area) shall be at least twice the test specimen thickness.

6.2 Number of test specimens

A minimum of five test specimens shall be tested. If the test specimen area is $>$ 500 cm^2, a minimum of three test specimens shall be tested.

If the test specimens have been cut, all pieces shall be tested.

If the product to be tested is suspected of being anisotropic, the test specimens shall be cut such that the parallel faces are normal to the direction of vapour flow of the product in its application.

If the product is faced with natural skins or adhered facing which are different for the two sides, the test specimens shall be tested with the vapour flow in the same direction as that in the intended use. If the direction of intended use relative to the facings is not known, a duplicate set of test specimens shall *be* prepared so that tests can be made and reported for each direction of vapour flow.

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 for the time specified in the relevant product standard with a minimum of 6 h.

7 Procedure

7.1 Test conditions

Select the test atmosphere from the three sets of conditions given in the table below:

Table 1 — Test conditions

Set	**Condition**	**Temperature in °C**	**Relative Humidity in %**	
			“dry state” [a]	humid state
A	23 - 0/50	23 ± 1	0	50 ± 3
B	23 - 0/85	23 ± 1	0	85 ± 3
C	23 - 50/93	23 ± 1	50 ± 3	93 ± 3

[a] A tolerance is not applied to the 0 % relative humidity condition because it is the condition deemed to be generated by the use of the desiccant.

For hygroscopic products the result depends on the set of conditions and it is recommended that both sets A and C should be used.

Other test conditions (temperature and relative humidity) can be agreed between the parties when needed to simulate special application conditions.

The following desiccants and saturated aqueous salt solutions may be used to produce the specified relative humidities at 23 °C; a large excess is necessary.

Desiccants

	relative humidity, in %
1) P_20_5 (phosphorus pentoxide):	0
2) $CaCl_2$ (calcium chloride), particle size: e.g. 2 mm to 8 mm:	0
3) $Mg(Cl0_4)_2$ (magnesium perchlorate):	0

Aqueous salt solutions (saturated salt solutions in contact with a large content of undissolved salt)

	relative humidity, in %
1) $Na_2Cr_20_7 . 2H_20$ (sodium dichromate):	52
2) KCl (potassium chloride):	85
3) $NH_4H_2PO_4$ (ammonium dihydrogen phosphate):	93
4) KNO_3 (potassium nitrate):	94

7.2 Test procedure

Monitor the test chamber to ensure that test conditions are kept constant.

Select a test assembly. Examples of suitable configurations are given in Annex B.

Prepare test specimens in accordance with 6.1.

Measure the thickness of the test specimen to the nearest 0,2 mm, or to an accuracy of 0,5 %, whichever is the smaller, in accordance with EN 12085.

Place the desiccant or the aqueous saturated salt solution at the bottom of each dish in a layer of appropriate thickness, with a minimum of 15 mm. Use melted wax to seal the test specimen to the open side of the dish. The air space between the desiccant and the test specimen shall be (15 ± 5) mm.

Condition the test assemblies in the test chamber for a period between 1 h and 24 h. Weigh the test assembly to the nearest milligram or in the case of larger assemblies with an accuracy depending on the total weight and the required accuracy of the test results.

Weigh the test assemblies at regular intervals of not less than 24 h. If the temperature of the room where the balance stands is within ± 2 °C of the nominal test temperature, then test assemblies can be weighed either inside or outside of the test chamber.

If the measurement is made outside the chamber return the test assemblies as soon as possible. Care shall be taken that the duration outside the chamber does not affect the result.

If the temperature of the balance is outside of the ± 2 °C range, then the test assemblies shall be weighed in the test atmosphere.

Continue weighing until five successive determinations of change in mass per unit time for each test specimen are constant within ± 5 % of the mean value for this test specimen (see 8.1). Plot a curve of change in mass against time to help recognise the condition of constant change (steady state).

8 Calculation and expression of results

8.1 Change in mass of test assembly

Calculate for each test specimen the change in mass for the selected time interval, $G_{1,2}$, in milligrams per hour using Formula (1):

$$G_{1,2} = \frac{m_2 - m_1}{t_2 - t_1} \quad (1)$$

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 $G_{1,2}$, in milligrams per hour, for each test specimen.

The final value of G is obtained when each of the last five successive determinations of $G_{1,2}$ is within ± 5 % of G.

8.2 Water vapour transmission rate

Calculate the water vapour transmission rate, g, in milligrams per square metre times hours using Formula (2):

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

where

A is the exposed area (arithmetic mean of the upper and lower exposed areas) of the test specimen, in square metres.

8.3 Water vapour permeance

Calculate the water vapour permeance, W, in milligrams per square metre times hours times pascals using Formula (3):

$$W = \frac{G}{A \times \Delta p} \tag{3}$$

where

Δp is the water vapour pressure difference in pascal and has one of the following values, depending on the set of test conditions (see 7.1, Table 1):

Test condition:	23-0/50	Δp = 1 400 Pa
	23-0/85	Δp = 2 390 Pa
	23-50/95	Δp = 1 210 Pa

8.4 Water vapour resistance

Calculate the water vapour resistance, Z, in square metres times hours times pascals per milligrams using Formula (4):

$$Z = \frac{1}{W} \tag{4}$$

8.5 Water vapour permeability

Calculate the water vapour permeability, δ, in milligrams per metre times hours times pascals using Formula (5):

$$\delta = W \times d \tag{5}$$

where

d is the test specimen thickness, in metres.

8.6 Water vapour diffusion resistance factor

Calculate the water vapour diffusion resistance factor, μ, dimensionless using the Formula (6):

$$\mu = \frac{\delta_{\text{air}}}{\delta} \tag{6}$$

where

δ_{air} is the water vapour permeability of air (depending on the mean barometric pressure during the test, see Figure 1).

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 Formula (7):

$$g = \frac{\Delta p}{(\mu \times d)} \times \delta_{\text{air}} \tag{7}$$

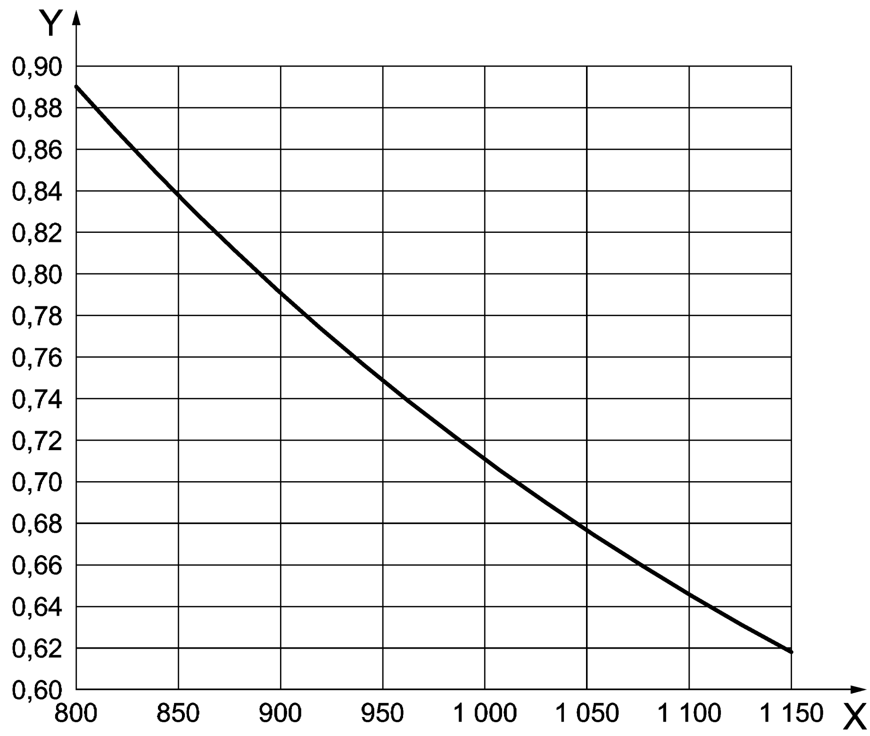


Figure 1 — Water vapour permeability in air at 23°C

The calculation can also be made by using Formulae (8a) or (8b) of *Schirmer:*

$$\delta_{\text{air}} = \frac{D}{R_D \times T} \tag{8a}$$

$$\delta_{\text{air}} = \frac{0{,}083}{R_D \times T} \times \frac{p_{\text{o}}}{p} \times \left(\frac{T}{273}\right)^{1{,}81} \tag{8b}$$

where

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

R_{D} is the gas constant of water vapour: 462×10^{-8} 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.

The barometric pressure can be measured with a barometer or ascertained from a meteorological service.

8.7 Water vapour diffusion equivalent air layer thickness

Calculate the water vapour diffusion equivalent air layer thickness, s_d, in metres using Formulae (9) or (10):

$$s_d = \mu \times d \quad (9)$$

$$s_d = \delta_{air} \times Z \quad (10)$$

where

d is the test specimen thickness, in metres.

9 Accuracy of measurement

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

For special cases, see informative Annex C.

10 Test report

The test report shall include the following information:

a) reference to this European 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 if necessary, e.g. nominal thickness, nominal density;

c) test procedure:

   1) pre-test history and sampling (e.g. who sampled and place of sampling);

   2) conditioning;

   3) deviation from Clauses 6 and 7, if any;

   4) date of testing;

   5) dimensions and number of test specimens;

   6) temperature and relative humidity gradient and the mean air pressure during the test;

   7) test configuration used;

   8) general information relating to the test;

9) 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 properties:

i) water vapour transmission rate, and/or

ii) water vapour permeance, and/or

iii) water vapour permeability, and/or

iv) water vapour diffusion resistance factor, and/or

v) water vapour diffusion equivalent air layer thickness and the direction of the vapour flow relative to the facings, if the two facings are different, for which the results have been calculated; all properties may be reported as appropriate;

2) all individual values and the mean values.

Annex A
(informative)

Conversion table for water vapour transmission units

Table A.1 — Conversion table for water vapour transmission units

A [a]	B	C [b]
Quantity in accordance with this European Standard	**Conversion factor**	**Quantity in accordance with ISO 9346**
water vapour transmission rate g [mg / (m^2 . h)]	2,778 . 10^{-10}	density of moisture flow rate g [kg / (m^2 . s)]
water vapour permeance W [mg / (m^2 . h . Pa)]	2,778 . 10^{-10}	moisture permeance W_p [kg / (m^2 . s . Pa)]
water vapour resistance Z [m^2 . h . Pa / mg]	3,60 . 10^9	moisture resistance Z_p [m^2 . s . Pa/kg]
water vapour permeability δ [mg / (m . h . Pa)]	2,778 . 10^{-10}	moisture permeability δ_p [kg / (m . s . Pa)]
water vapour diffusion resistance factor μ [-]	–	moisture resistance factor μ [-]
water vapour diffusion equivalent air layer thickness s_d [m]	–	– – –
change in mass per unit time G [mg / h]	2,778 . 10^{-10}	moisture flow rate G [kg/s]

[a] A = B x C
[b] C = A / B

EXAMPLE 1

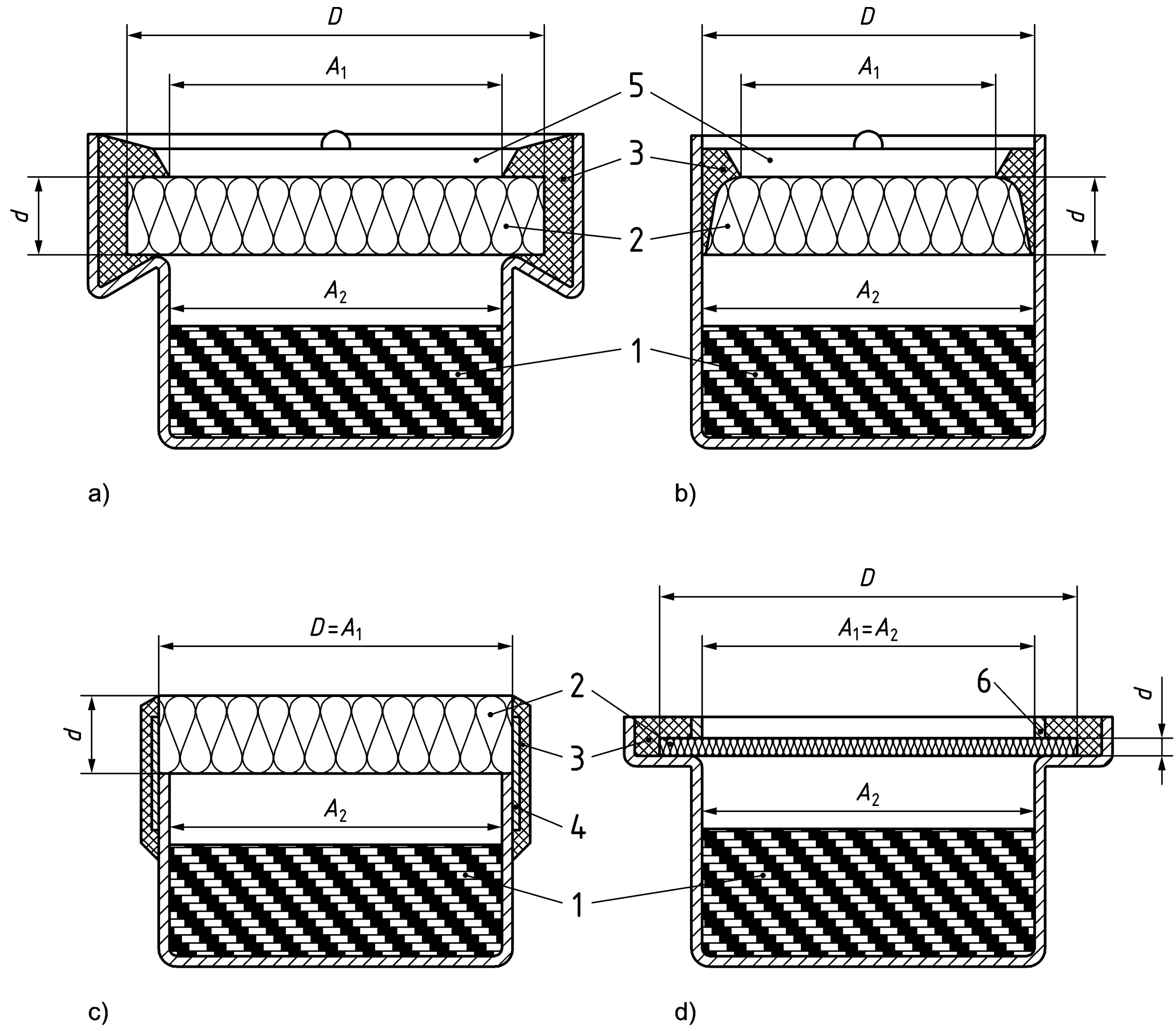
$$W_p = 1 \frac{mg}{m^2 \times h \times Pa} = 2{,}778 \times 10^{-10} \times \frac{kg}{m^2 \times s \times Pa}$$

EXAMPLE 2

$$\delta_p = 1 \frac{kg}{m \times s \times Pa} = \frac{1}{2{,}778 \times 10^{-10}} \times \frac{mg}{m \times h \times Pa}$$

Annex B
(informative)

Examples of test assemblies



1 desiccant/aqueous saturated salt solution
2 test specimen
3 sealant
4 tape
5 template
6 limiting ring

A_1 is the upper exposed area;
A_2 is the lower exposed area; the mean exposed area:
$A = (A_1 + A_2) / 2$
D is the area of the test specimen
d is the thickness of the test specimen

Figure B.1 — Examples of test assemblies

Annex C
(informative)

Information about correction procedures

C.1 General

The precision of this test with different sets of test conditions is not known because interlaboratory round robin data are not yet available on products with different thicknesses and vapour transmission properties.

With regard to the test specimen area and the upper and lower exposed areas, a correction might be necessary for thicker test specimens due to the "masked edge effect". A correction for air layer thickness inside the test dish and a correction for barometric pressure variations during the test might also be necessary.

C.2 Correction for "masked edge effect"

When the test specimen area is larger than the upper and lower exposed areas (see also Annex B), the overlay upon the ledge is a source of error, particularly for thick test specimens. In proportion to the exposed area, the overlay material results in an excess water vapour flow, which is a function of the test specimen thickness, ledge width, upper/lower exposed areas and possibly the product water vapour permeability. Detailed information regarding this problem is available for example in [2].

C.3 Correction for air layer thickness inside test dish

The water vapour resistance of the air space between the desiccant/salt solution and the test specimen may affect the results, especially for products with low water vapour resistance. Detailed information regarding this problem is available in the standards SIS 021582:1974 [3] and DIN 52 615:1987 [4].

C.4 Correction for air pressure variations during test

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 an aqueous saturated salt solution or dessicant, in the calculation. Detailed information regarding this problem is available in the bibliography [5].

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[1] ISO 9346, *Thermal insulation — Mass transfer — Physical quantities and definitions*

[2] Joy, F.A. and Wilson, H.G. Standardization of Dish Method for Measuring Water Vapour Transmission"; *International Symposium on Humidity and Moisture*, Vol. 4, 1963, pp.259-270.

[3] SIS 021582:1974, *Determination of water vapour transmission of building materials*

[4] DIN 52 615:1987, *Wärmeschutztechnische Prüfungen — Bestimmung der Wasserdampfdurchlässigkeit von Bau- und Dämmstoffen*

[5] 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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