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Hygrothermal performance of building materials and products — Determination of water vapour transmission properties

Performance hygrothermique des matériaux et produits pour le bâtiment — Détermination des propriétés de transmission de la vapeur d'eau

Reference number
ISO 12572:2001(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 12572 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 163, *Thermal insulation*, Subcommittee SC 1, *Test and measurement methods*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

Annexes A to G form a normative part of this International Standard. Annexes H and J are for information only.

Contents

Foreword

The text of EN ISO 12572:2001 has been prepared by Technical Committee CEN/TC 89 "Thermal performance of buildings and building components", the secretariat of which is held by SIS, in collaboration with Technical Committee ISO/TC 163 "Thermal insulation".

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of an identical text or by endorsement, at the latest by December 2001, and conflicting national standards shall be withdrawn at the latest by December 2001.

This standard is one of a series of standards which specify test methods for the thermal and moisture related properties of building materials and products.

The annexes A, B, C, D, E, F and G are normative.

The annexes H and J are informative.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This standard specifies a method based on cup tests for determining the water vapour permeance of building products and the water vapour permeability of building materials under isothermal conditions. Different sets of test conditions are specified.

The general principles are applicable to all hygroscopic and non hygroscopic building materials and products, including those with facings and integral skins. Annexes give details of test methods suitable for different material types. This standard is not applicable in the case of test specimens with water vapour diffusion-equivalent air layer thickness values less than 0,1 m, as a result of increasing uncertainty in the measurement results. If the measured water vapour diffusion-equivalent air layer thickness is greater than 1500 m the material can be considered impermeable.

The results obtained by this method are suitable for design purposes, production control and for inclusion in product specifications.

2 Normative reference

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

ISO 9346	*Thermal insulation - Mass transfer - Physical quantities and definitions*

3 Definitions, symbols and units

3.1 Terms and definitions

For the purposes of this standard, the terms and definitions given in ISO 9346 and the following apply.

3.1.1

density of water vapour flow rate

mass of water vapour transferred through the specimen per area and per time

3.1.2

homogeneous material

material with properties likely to affect the transmission of water vapour which do not vary on a macroscopic scale

3.1.3

water vapour permeance

density of water vapour flow rate divided by the water vapour pressure difference between the two specimen faces

3.1.4

water vapour resistance

reciprocal of water vapour permeance

3.1.5

water vapour permeability

product of the water vapour permeance and the thickness of a homogeneous specimen

> NOTE Water vapour permeability can only be calculated for specimens of a homogeneous material.

3.1.6

water vapour resistance factor

water vapour permeability of air divided by that of the material concerned

> NOTE The water vapour resistance factor indicates how much greater the resistance of the material is compared to an equally thick layer of stationary air at the same temperature.

3.1.7

water vapour diffusion-equivalent air layer thickness

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

3.2 Symbols and units

Symbol	Quantity	Unit
A	area of specimen	$\mathrm{m^2}$
G	water vapour flow rate through specimen	kg/s
R_v	gas constant for water vapour = 462	$\mathrm{N \cdot m/(kg \cdot K)}$
S	hydraulic diameter of specimen	m
T	thermodynamic temperature	K
W_p	water vapour permeance with respect to partial vapour pressure	$\mathrm{kg/(m^2 \cdot s \cdot Pa)}$
Z_p	water vapour resistance with respect to partial vapour pressure	$\mathrm{m^2 \cdot s \cdot Pa/kg}$
D	mean thickness of specimen	m
g	density of water vapour flow rate	$\mathrm{kg/(m^2 \cdot s)}$
l	diameter of circle or side of square specimen	m
m	mass of specimen and cup assembly	kg
p	barometric pressure	hPa
p_0	standard barometric pressure = 1013,25	hPa
s_d	water vapour diffusion-equivalent air layer thickness	m
t	time	s
Δp_v	water vapour pressure difference across specimen	Pa
δ_p	water vapour permeability with respect to partial vapour pressure	$\mathrm{kg/(m \cdot s \cdot Pa)}$
δ_a	water vapour permeability of air with respect to partial vapour pressure	$\mathrm{kg/(m \cdot s \cdot Pa)}$
μ	water vapour resistance factor	-
θ	Celsius temperature	°C
φ	relative humidity	-

NOTE The above units comply with ISO 9346; a conversion table to other units commonly used in permeability measurements is given in annex J.

3.3 Subscripts

Subscript	Denoting
I	interval
r	repeatability
a	air
c	corrected for air layer
f	film
j	joint
m	membrane
me	masked edge
s	specimen
t	total

4 Principle

The test specimen is sealed to the open side of a test cup containing either a desiccant (dry cup) or an aqueous saturated solution (wet cup). The assembly is then placed in a temperature and humidity controlled test chamber. Because of the different partial vapour pressure between the test cup and the chamber, a vapour flow occurs through permeable specimens. Periodic weighings of the assembly are made to determine the rate of water vapour transmission in the steady state.

5 Apparatus

a) Test cups resistant to corrosion from the desiccant or salt solutions they contain; typically cups are made of glass or metal.

The design of cups suitable for testing various different types of materials is described in annexes A to E.

> NOTE Circular cups can be easier to seal and transparent cups allow better control of salt solutions.

b) For certain cups and sealing methods (see annex A), a template, with shape and size corresponding to that of the test cup, is used when applying the sealant to give a sharply defined, reproducible test area. The template shall have an area of at least 90 % of the specimen to limit non-linear vapour flow.

c) Measuring instruments capable of determining specimen thickness with accuracy required in 7.2.

d) Analytical balance, capable of weighing the test assembly with the repeatability needed for the required accuracy. Wherever possible a balance of 0,001 g resolution shall be used. For heavy test assemblies a balance resolution of 0,01 g may be sufficient. See annex H for information linking the balance resolution to the duration of test.

> NOTE The factors that affect the necessary accuracy of measurement are discussed in annex H.

e) Constant temperature, constant humidity chamber, capable of being maintained within ± 3 % relative humidity around the set point relative humidity and ± 0,5 K around the set point temperature. In order to ensure uniform conditions throughout the chamber, the air shall be stirred so as to obtain velocities between 0,02 m/s and 0,3 m/s. If highly permeable materials are being tested, means should be provided to measure the air speed directly over the upper surface of the specimen - see annex G.

f) Suitable sensors and a logging system to continuously record the temperature, relative humidity and, if necessary, the barometric pressure within the test chamber. The sensors shall be calibrated at regular intervals.

g) Sealant, which is impermeable to water vapour, does not undergo physical or chemical changes during the test and does not cause physical or chemical changes to the specimen.

NOTE Examples of sealants suitable for specific materials, if necessary, are listed in the appropriate annex.

6 Test specimens

6.1 General principles for preparation of test specimens

The test specimens shall be representative of the product. If the product has natural skins or integral facings, these may be included in the test specimen, but they shall be removed if it is intended to measure the permeability of the core material. If the skins or facings are different on the two sides, specimens shall be tested with vapour flow in the direction of the intended use. If the direction of flow is not known, duplicate specimens shall be prepared and tests carried out for each direction of flow. Unless the product to be tested in isotropic, the test specimens shall be cut so that the parallel faces are normal to the direction of vapour flow of the product in use.

Specimen preparation shall not involve methods which damage the surface in ways which affect the flow of water vapour.

6.2 Dimensions of test specimens

6.2.1 Shape and fit

Test specimens shall be cut to correspond with the dimensions of the chosen test assembly - see annexes A to E.

6.2.2 Exposed area

The diameter of a circular specimen or the side of a square specimen shall be at least twice the specimen thickness. The exposed area (the arithmetic mean of the upper and lower free surface areas) shall be at least 0,005 m^2. The upper and lower free surface areas shall not differ by more than 3 % of the mean in the case of homogeneous materials, and by no more than 10 % in the case of other materials.

6.2.3 Thickness of test specimens.

Whenever possible, the thickness of the specimen shall be that of the product in use. In the case of homogeneous materials, if the thickness exceeds 100 mm, this may be reduced by cutting. In the case of non homogeneous materials, such as concrete containing aggregates, the thickness should be at least three times (and preferably five times) the largest particle size.

If a material contains macroscopic formed voids, the solid material should be tested and the resistance of the whole material calculated from the proportions of solid to air space assuming one dimensional vapour flow.

If it is necessary to test a product so thick that the available test cups do not have an area large enough to comply with 6.2.2, the product may, only as a last resort, be sliced. In this case, all slices shall be tested and the results reported.

NOTE This procedure may lead to significant inaccuracies, especially when wet cup tests are carried out on hygroscopic materials.

6.3 Number of test specimens

If the specimen area is less than 0,02 m^2, a minimum of five specimens shall be tested, otherwise a minimum of three specimens shall be tested.

6.4 Conditioning of test specimens

Before testing, the test specimens shall be stored at (23 ± 5) °C, (50 ± 5) % relative humidity for a period long enough for their weight to stabilise so that three successive daily determinations of their weight agree to within 5 %.

NOTE This period will vary from a few hours in the case of some insulating materials to 3 - 4 weeks or more for massive hygroscopic materials and products. Wet field specimens may be dried before conditioning using the methods specified in ISO 12570, *Hygrothermal performance of building materials and products - Determination of moisture content by drying at elevated temperature.*

A period of conditioning is not necessary in the case of plastic membranes.

7 Procedure

7.1 Test conditions

Select the desired test environment from the sets of conditions given in Table 1.

Table 1 - Test conditions

Set	Condition °C - % RH	Tolerances				
		Temperature °C	Relative humidity %			
			Dry state		Wet state	
			Set point	Tolerance	Set point	Tolerance
A	23 - 0/50	23 ± 0,5	0	+ 3	50	± 3
B	23 - 0/85	23 ± 0,5	0	+ 3	85	± 3
C	23 - 50/93	23 ± 0,5	50	± 3	93	± 3
D	38 - 0/93	38 ± 0,5	0	+ 3	93	± 3

NOTE 1 ‘Dry cup’ tests (condition A) give information about the performance of materials at low humidities when moisture transfer is dominated by vapour diffusion. ‘Wet cup’ 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, *Hygrothermal performance of building materials and products - Determination of water absorption coefficient by partial immersion*.

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

NOTE 2 The following are examples of desiccants and saturated aqueous solutions which produce the specified air relative humidities at 23 °C:

a) Desiccants

Calcium chloride, $CaCl_2$ - particle size < 3 mm	0 %
Magnesium perchlorate, $Mg(ClO_4)_2$)	0 %

b) Aqueous solutions

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 annexes A and B of ISO 12571, *Hygrothermal performance of building materials and products - Determination of hygroscopic sorption curves.*

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.

All chemical substances shall be handled with care and in accordance with relevant safety regulations.

7.2 Preparation of specimen and test assembly

Prepare test specimens to correspond to the test assembly used - see annexes A to E. Measure the thickness of specimens to the nearest 0,1 mm, or to an accuracy of ± 0,5 %, whichever is the more accurate. For rigid materials, measure the thickness of test specimens at four positions equally spaced around the circumference. Calculate the mean thickness of each test specimen. Record the procedure used to measure the effective thickness of compressible and loose-fill materials and of test specimens with irregular surfaces.

Place the desiccant or aqueous solution, with a minimum depth of 15 mm in the bottom of each cup. Seal the test specimen into the cup, using the appropriate technique specified in the relevant annex. The air space between the desiccant or saturated solution and the specimen shall be (15 ± 5) mm.

Prepare a test assembly using a cup and sealant system suitable for the type of material under test - see annexes A to E.

7.3 Test procedure

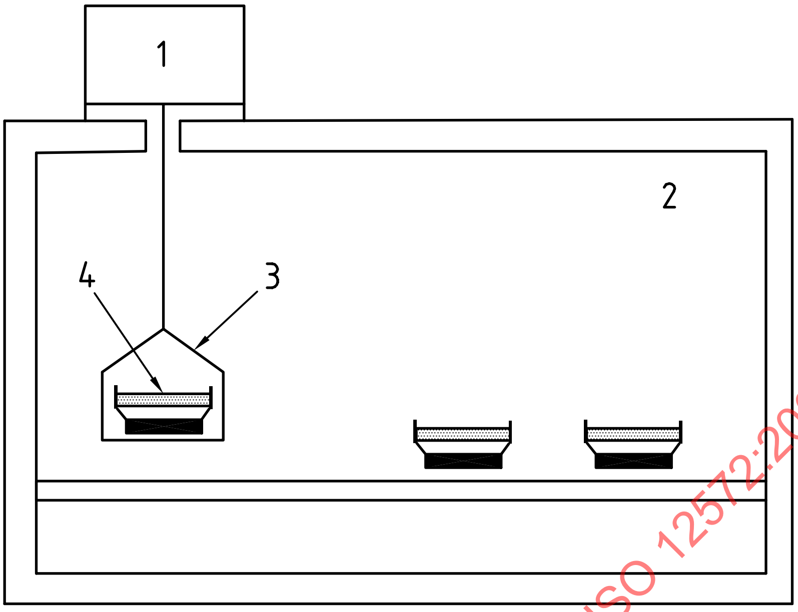
Place the test assemblies in the test chamber. Then weigh in turn each test assembly at time intervals selected according to the specimen characteristics and to the repeatability of the weighing procedure.

NOTE Annex H gives guidance on the ways of reaching the required accuracy.

Weighings shall be carried out in an environment with a temperature within ± 2 °C of the test condition, wherever possible within the test chamber. Figure 1 shows an arrangement for small chambers.

The temperature and relative humidity within the test chamber shall be recorded continuously with suitable sensors. The calibration of the sensors shall be checked regularly.

The barometric pressure at the testing laboratory shall be measured daily during the test or obtained from a closely adjacent meteorological station.



Key

1	Balance
2	Controlled environment test chamber with ‘glove box’ access door
3	Suspended weighing platform
4	Test assembly during weighing

Figure 1 - Example of an arrangement of balance and test assemblies for weighing procedures in a chamber

Continue weighings until five successive determinations of change in mass per weighing interval for each test specimen are constant within ± 5 % of the mean value for this specimen (or within ± 10 % for low permeance materials with $\mu > 750\ 000$) and until the change in weight of the cup assembly exceeds 100 times the repeatability of the weighing procedure.

Plot a curve of change in mass against time to facilitate recognition of the condition of constant mass change rate.

The test shall be terminated prematurely when:
i) in a dry cup test, the assembly has gained more that 1,5 g per 25 ml of desiccant in the cup;
ii) in a wet cup test, the weight loss is half the initial mass of the solution in the cup.

8 Calculation and expression of results

8.1 Mass change rate

For each set of successive weighings of the specimens, calculate the mass change rate, $\Delta\dot{m}_{12}$, using :

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

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 kg;
m_2	is the mass of the test assembly at time t_2, in kg;
t_1 and t_2	are the successive times of weighings, in s.

Calculate the regression line between mass and time, excluding the earlier, non-linear, stage of the test. The slope of this line is G, in kg/s.

NOTE If required, the standard error of the slope of the regression line (i.e. the standard error of the flow rate) can be found by standard statistical methods.

8.2 Density of water vapour flow rate

The density of water vapour flow rate, g, is given by:

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

where

A is the exposed area (arithmetic mean of the free upper and free lower surface areas) of the test specimen, in m^2.

If a cup and sealant system which includes a 'masked edge' (see annex A) has been used, values shall be corrected before being used to calculate further parameters - see annex F.

8.3 Water vapour permeance

The water vapour permeance, W, is given by :

$$W = \frac{G}{A \cdot \Delta p_v} \tag{3}$$

The value of Δp_v shall be calculated from the mean of the measured temperature and relative humidity over the course of the test.

NOTE For temperatures greater than 0 °C, the vapour pressure on either side of the specimen may be calculated from the temperature and relative humidity using (see reference [11] in the Bibliography):

$$p_{\text{sat}} = \varphi \cdot 610{,}5 \cdot \mathrm{e}^{\frac{17{,}269 \cdot \theta}{237{,}3+\theta}}$$

If highly permeable materials or thin membranes, with $s_d < 0{,}2$ m, are being tested, the resistance of the air gap between the base of the sample and the desiccant or saturated solution shall be taken into account in the calculation of W - see annex G.

8.4 Water vapour resistance

The water vapour resistance, Z, is the reciprocal of the water vapour permeance:

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

8.5 Water vapour permeability

The water vapour permeability, δ, is given by:

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

8.6 Water vapour resistance factor

The water vapour resistance factor, μ, is defined by the equation :

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

Equation (7), known as the Schirmer formula, is used to calculate δ_{a}, using the mean barometric pressure, p, over the test.

$$\delta_{\text{a}} = \frac{0{,}083 p_0}{R_{\text{v}} \cdot T \cdot p} \left(\frac{T}{273} \right)^{1{,}81} \tag{7}$$

Values of δ_{a} at 23 °C are shown in Figure 2.

The water vapour permeability of air and the material may be assumed to vary equally with the barometric pressure. The factor μ can therefore be considered independent of barometric pressure. When calculating the density of water vapour flow rate using the expression :

$$g = \frac{\Delta p \cdot \delta_{\text{a}}}{\mu \cdot d} \tag{8}$$

the value of δ_{a} shall correspond to the actual barometric pressure.

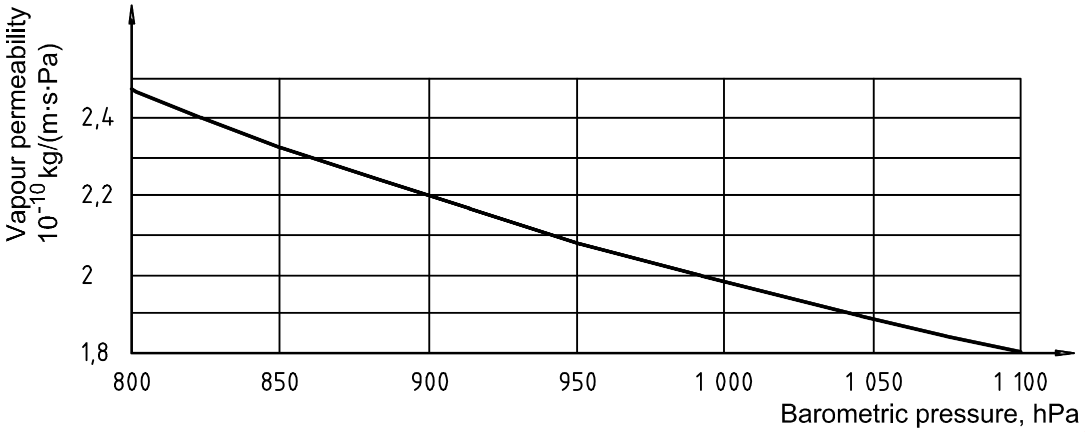


Figure 2 – Water vapour permeability of air as a function of barometric pressure at 23°C

8.7 Water vapour diffusion-equivalent air layer thickness

The water vapour diffusion-equivalent air layer thickness, s_d, is given by either:

$$s_d = \mu \cdot d \tag{9a}$$

or

$$s_d = \delta_a \cdot Z \tag{9b}$$

9 Accuracy of measurement

9.1 General

This clause and annex H discuss the factors that affect the accuracy of the result and give guidance how to improve it, if necessary.

> NOTE A number of ‘round-robin’ intercomparisons of measurements by different laboratories have been carried out - see references [6], [7] and [8] in the Bibliography for discussion of the results.

A number of factors affect the accuracy of the measured values.

9.2 Specimen area

The diameter of a circular test cup or the side of a square test cup shall be measured to an accuracy of ± 0,5 mm, giving a possible error in the area of a specimen of the minimum size specified in 6.2.2 (i.e. 0,005 m^2) of ± 0,5 %. This error will be less with larger specimens. For certain cup types it will be necessary to correct for the effect of a masked edge as specified in annex F.

9.3 Specimen thickness

If the permeance or resistance of a complete product is being measured, the accuracy is not affected by the thickness. However if the permeability of a material is needed, the accuracy with which the specimen thickness can be measured will directly effect the accuracy of the result. The thickness of a rigid specimen can be measured to better than 0,5 % with a micrometer.

NOTE The accuracy will be lower in the case of loose fill and similar materials.

9.4 Sealants

If an appropriate sealant is installed as specified in the annexes, errors caused by leakage can be much less than those from other sources. A faulty seal will result in a much higher flow rate through one of the test assemblies; that result shall be rejected before averages are taken over the samples.

9.5 Weighing precision

The influence of weighing uncertainty on the accuracy of the results depends on the size of the specimen and the time interval between successive weighings.

NOTE Information about the weighing repeatability needed to achieve a desired accuracy in relation to the specimen size and weighing interval is given in annex H.

9.6 Control of environmental conditions

The vapour pressure difference between the test cup and the environmental chamber is the driving potential for the whole test. The accuracy with which this difference is known consequently determines the accuracy of the measured values.

The vapour pressure within the cup is determined by the desiccant or saturated solution used. A suitable desiccant should give effectively zero vapour pressure. The relative humidity over saturated solutions is quoted to the nearest ± 0,5 % relative humidity in tables and this can be achieved if care is taken in their preparation.

The test conditions in Table 1 will result in a variation in vapour pressure difference across the test specimen of ± 10 % of the set point value.

Conditions within the environmental chamber shall be carefully monitored with accurately calibrated instruments to determine an accurate mean vapour pressure over the test.

NOTE Considerable care is needed in the measurement of conditions within the environmental chamber in order to obtain accurate permeability data.

9.7 Variations in barometric pressure during test

For products with low water vapour transmission rates, especially thin flexible membranes, large day-to-day pressure variations may affect the results. Account shall be taken of the buoyancy effect either by including the change of weight of a 'dummy' specimen, without an aqueous saturated solution or desiccant, or by extending the test over several weeks and selecting the measurements taken on the days with a similar barometric pressure for further analysis.

9.8 High permeance specimens

The measurement uncertainties discussed in 9.1 to 9.7 are too large to allow the properties of high permeance specimens (i.e. those with $s_d < 0{,}1$ m) to be measured with the methods specified in this standard.

10 Test report

The test report shall include the following :

a) reference to this standard;

b) product identification:
- product name, factory, manufacturer or supplier;
- type of product ;
- production code number or similar identifier;
- the form in which the product arrived at the laboratory, including facings, if any;
- the method of preparation of the specimen, including slicing where done, and details of any curing process, where necessary;
- other details of the product e.g. nominal thickness or nominal density;

c) test procedure:
- the mean air pressure and the temperature and relative humidity gradients across the specimen and the range of any deviations from the mean;
- test configuration used;
- conditioning of the specimen carried out;
- any deviation from this standard procedure and any incidents which may have influenced the results;
- the date of the test;
- information concerning the operator and the apparatus used, (it is mandatory that the information is available at the laboratory, but it should be included only if requested);

d) results:
- the water vapour transmission property (water vapour transmission rate, permeance, permeability or water vapour resistance) including the direction of the vapour flow relative to the facings for materials with two different facings, for which the results have been calculated;
- all corrections applied for a masked edge or variations in barometric pressure;
- the individual test results;
- the arithmetic mean of the individual test results.

Annex A (normative)
Methods suitable for self supporting materials

A.1 General

This annex applies to all materials which can be made into self-supporting specimens. That includes insulating materials and materials such as rendering or mortars which are made up and cured before test. For thermal insulation materials, 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.

A.2 Specimen preparation

Specimens of appropriate size shall be cut from board or masonry materials. Care shall be taken to ensure the vapour transfer properties of surfaces cut normal to the direction of moisture flow are not affected by the cutting process - for example, a skin may form on plastic foams during cutting.

Where materials such as mortars or renders have to be made up for testing, specimens of the required thickness, somewhat larger than the dimensions of the test cup shall be prepared and cured for 28 days before testing. Cement-based mortars shall be covered with a vapour barrier for three days; after this moist curing, the specimens shall be stored for the remaining 25 days at a temperature of (23 ± 5) °C and relative humidity of (50 ± 5) %. The specimens shall then be cut to the size of the test cup

A.3 Cup design

Examples of suitable cups are shown in Figure A.1.

A template is shown in Figures A.1 a) and b); it is essential that these are used with these types of cups to provide a well defined upper specimen surface area free of sealant. If the cups shown in Figures A.1 a) and b) are used, the specimen will have a 'masked edge'. It is necessary to correct for this in the calculation of the vapour flow rate - see annex F.

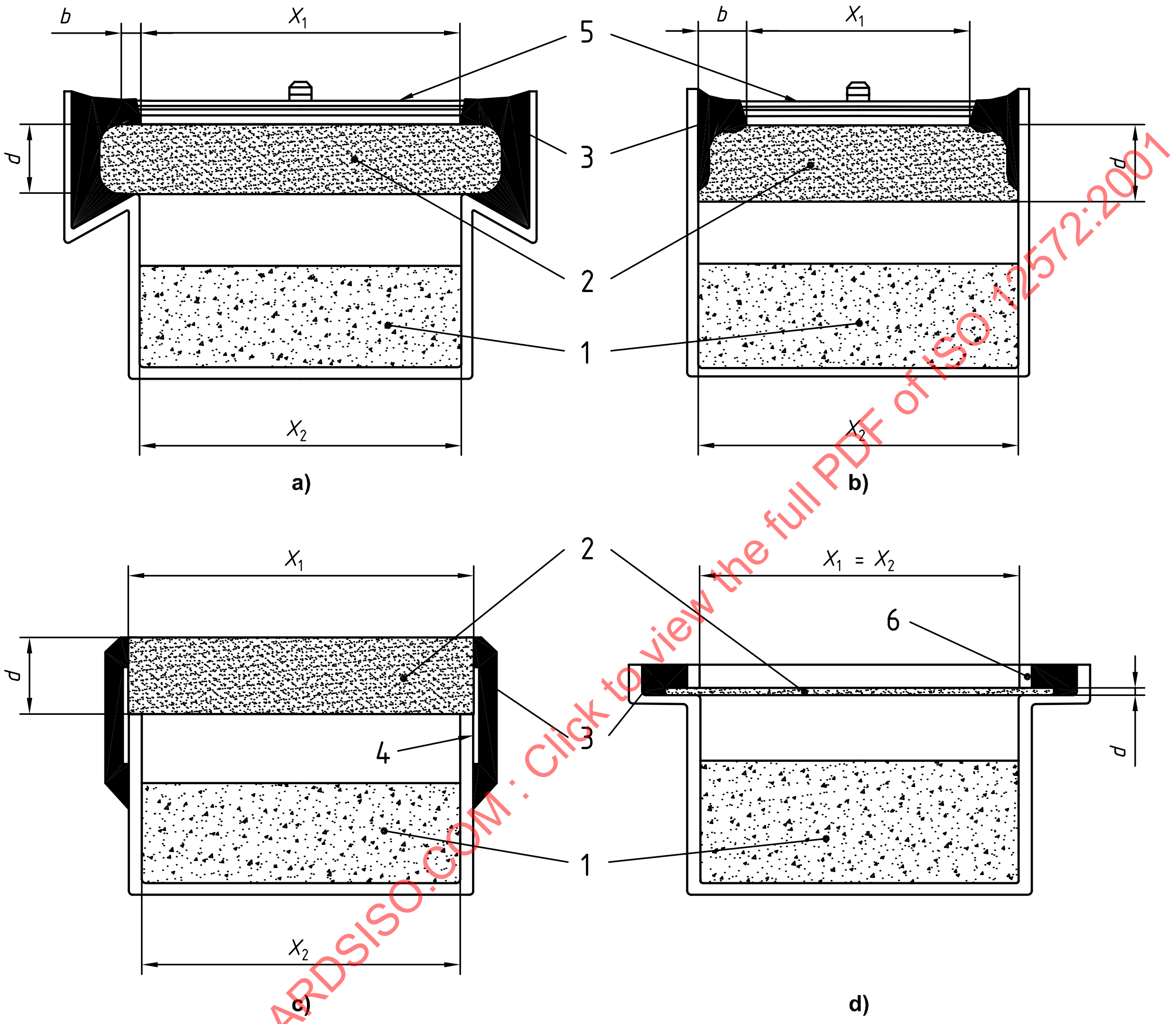
A.4 Sealants

Sealants should be easily handled, remain flexible and not crack over a long test and have good adhesion to the specimen. Molten sealants may penetrate far enough into porous materials to introduce errors into the effective area under test. The edge of these samples should be sealed with tape or an epoxy resin before sealing.

NOTE Examples of suitable sealants are : a) a mixture of 90 % micro crystalline wax and a 10 % of a plasticizer (e.g. a low molecular weight polyisobutylene); b) a mixture of 60 % micro crystalline wax with 40 % refined crystalline paraffin. See the Bibliography for further information.

A.5 Calculation and expression of results

The areas of the top and bottom of the specimen A_1 and A_2 shall be calculated from the dimensions X_1 and X_2 (the diameter of a circle or the side of a square) shown in Figure A.1. The procedures specified in clause 8 shall then be followed.



Key

1 Desiccant/aqueous saturated solution
2 Test specimen
3 Sealant
4 Tape
5 Template
6 Limiting ring

X_1	defines the upper exposed area
X_2	defines the lower exposed area
d	is the thickness of the test specimen
b	is the width of the masked edge (see annex F)

Figure A.1 - Examples of test assemblies

Annex B (normative)
Methods suitable for loose fills

B.1 General

This annex covers all materials that are used in powder or granular form, from which it is not possible to make a self supporting test specimen.

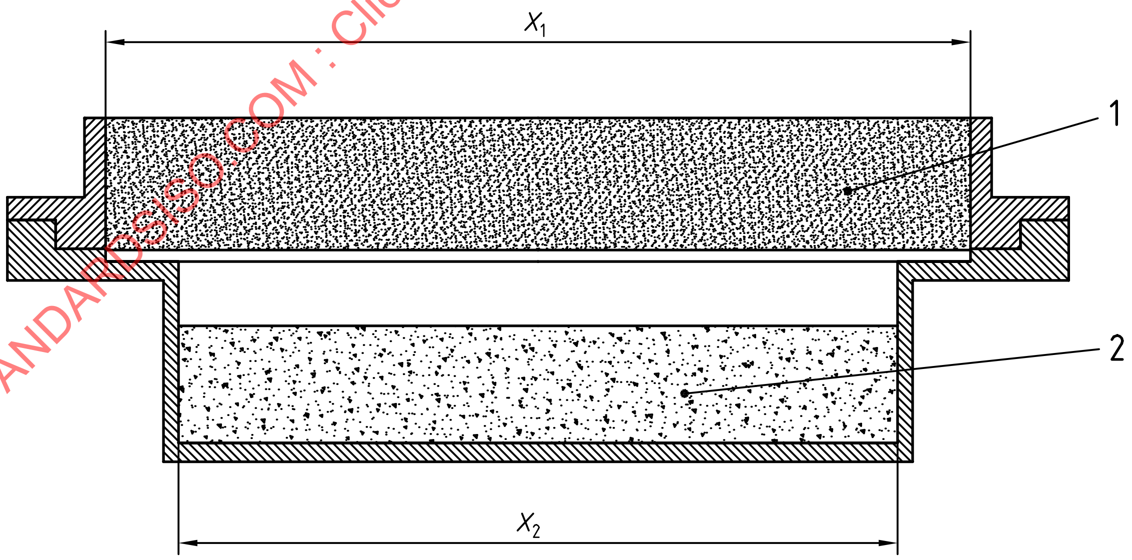
B.2 Sample selection

If the material to be tested contains a range of particle sizes, the samples tested shall be representative of the whole material in use.

B.3 Cup design

As shown in Figure B.1, the specimen is supported on a wire mesh or permeable membrane placed over the mouth of the cup. If a mesh is used, the open areas shall be as large as possible while completely supporting the specimen during the whole course of the test. If a membrane or grid with an open area small enough to affect the flow of vapour is used, the permeability of these shall also be tested without the fill in place. The specimen should have a thickness of at least 100 mm, to limit the uncertainties that will result from the difficulty of accurately measuring the thickness of this type of material. As it is not possible to seal this type of material, it shall overlap the edge of the test cup by at least 20 mm.

> NOTE As the permeability will be high, the errors that result from leakage at the edges will be of little consequence.



Key

1 Test specimen
2 Grid or membrane

Figure B.1 - Suitable cup for loose fill

B.4 Calculation and expression of results

If an open mesh grid is used to support the specimen, the results shall be calculated according to clause 8, with the effective area taken as the mean of the areas calculated from the dimensions X_1 and X_2 indicated in Figure B.1. If a membrane is used, the vapour resistance of the membrane alone Z_m and the membrane and specimen Z_t shall be calculated as in 8.1 to 8.4. The vapour resistance of the specimen alone is then given by $Z_s = Z_t - Z_m$. Z_s can then be used to calculate the other parameters in clause 8.

Annex C (normative)
Methods suitable for membranes and foils

C.1 General

This annex covers all flexible membranes, foils and sheet materials.

C.2 Specimen preparation

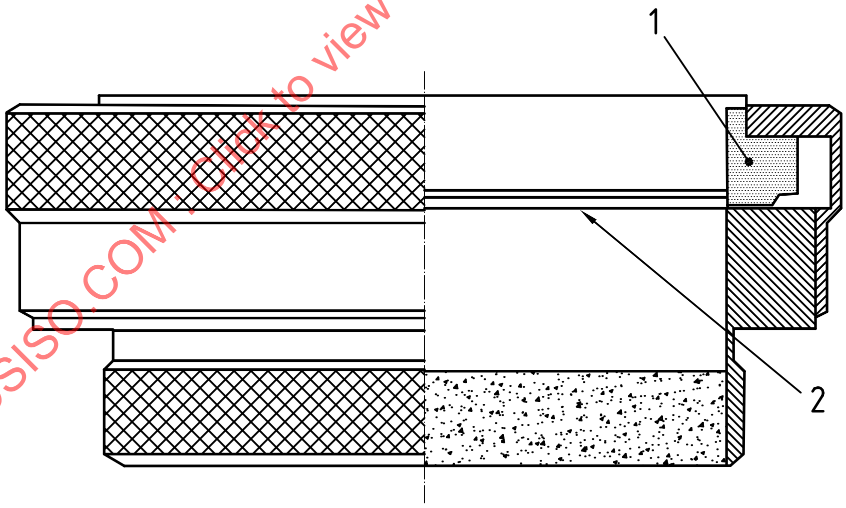
Specimens shall be cut to an appropriate size for the cup to be used.

C.3 Cup design

A recommended cup design using mechanical sealing is shown in Figure C.1. Sealing rings of an appropriate material can be included to improve the seal.

C.4 Calculation and expression of results

The equations in clause 8 shall be used to calculate the results of the test. For many materials covered by this annex, especially thin foils and membranes, it is not usual to measure the thickness and calculate the permeability; the permeance or resistance of the actual product in use is quoted.



Key
1 Sealing ring
2 Specimen

Figure C.1 - Cup suitable for membranes and foils

Annex D (normative)
Methods suitable for mastics and sealants

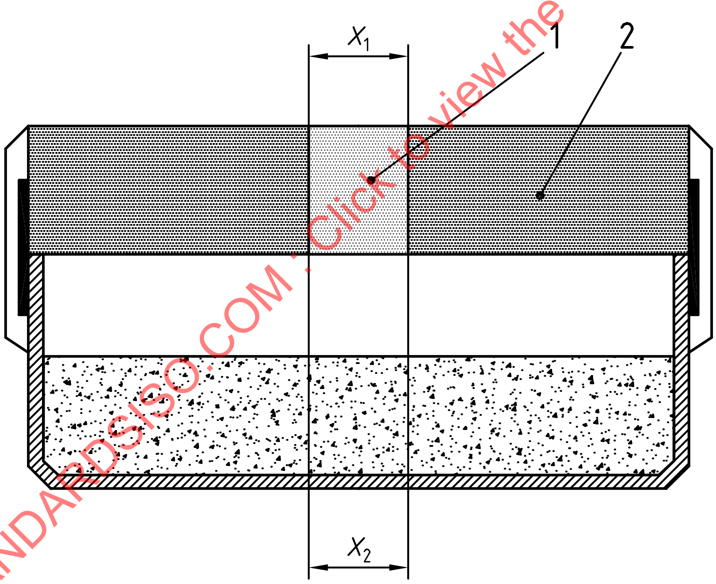
D.1 General

This annex covers materials, such as mastics or sealants, that are applied as highly viscous fluids, which set to a non rigid flexible matrix.

D.2 Specimen preparation

A permeable membrane, that does not react physically or chemically with the test material, shall be spread on a flat surface. The test material is then spread upon it to slightly more than the required thickness. Before hardening, a top plate, if necessary with an intermediate film to prevent sticking, is placed on top to achieve the required test thickness. After the specimens have cured, the top plate and film are removed and the specimen cut to the size of the test cup.

It may be difficult to achieve a uniform coating of some adhesives or sealants. In this case, a narrow slot of defined dimensions cut in a self supporting material with a known low permeance W_s, is filled with the sealant or mastic (see Figure D.1). This shall be tested as specified in annex A.



Key

1 Mastic sealant in slot
2 Low permeability material

Figure D.1 - Cup suitable for mastics and sealants

D.3 Cup design

If the specimen is supported by a membrane, a recommended cup design is shown in Figure B.1. If the specimen is filling a joint a recommended cup is shown in Figure D.1.

D.4 Calculation and expression of results

If a membrane has been used, the vapour resistance of the membrane alone Z_m and the membrane and specimen Z_t shall be calculated as in 8.1 to 8.4. The vapour resistance of the specimen alone is then given by:

$$Z_s = Z_t - Z_m \tag{D.1}$$

Z_s can then be used to calculate the other parameters as in clause 8.

If the method including a filled joint, shown in Figure D.1, has been used, the rate at which the weight of the cup changes is:

$$G = G_j + G_s \tag{D.2}$$

where G_j is due to the joint and G_s is due to the remaining specimen. If the respective areas are A_j and A_s, then

$$G_s = W_s \cdot A_s \cdot \Delta p \tag{D.3}$$

and

$$g_j = G_j / A_j \tag{D.4}$$

Therefore

$$g_j = (G - W_s \cdot A_s \cdot \Delta p) / A_j \tag{D.5}$$

The remaining parameters as specified in 8.3 to 8.7 can then be calculated from g_j and A_j.