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Hygrothermal performance of building materials and products — Determination of moisture content by drying at elevated temperature

Performance hygrothermique des matériaux et produits pour le bâtiment — Détermination du taux d'humidité par séchage à chaud

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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 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 12570 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...".

Annex A of this International Standard is for information only.

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Foreword

The text of EN ISO 12570:2000 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of an identical text or by endorsement, at the latest by September 2000, and conflicting national standards shall be withdrawn at the latest by December 2001.

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.

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.

Introduction

The moisture content of a material can be used for various purposes, such as

- part of a test method for the moisture related behaviour of the material;
- to characterize the material's state;
- to compare the actual moisture content with a critical or safe moisture content or to assess the moisture distribution.

The test specimens, number, size and preparation can be specified in the relevant product standards for the different types of materials.

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1 Scope

This standard, which is applicable to porous water permeable materials, specifies a general method for determining the free water content of building materials by drying at elevated temperature. The standard does not specify the method for sampling.

2 Normative references

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 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.

EN ISO 9346	Thermal insulation - Mass transfer - Physical quantities and definitions (ISO 9346)

3 Definitions, symbols and units

3.1 Definitions

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

3.1.1 moisture content mass by mass
mass of evaporable water divided by mass of dry material

3.1.2 moisture content volume by volume
volume of evaporable water divided by volume of dry material

3.1.3 moisture content mass by volume
mass of evaporable water divided by volume of dry material

3.1.4 dry density
mass per volume of dry material

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3.2 Symbols and units

Symbol	Quantity	Unit
m	mass of test specimen	kg
m_0	mass of dried test specimen	kg
u	moisture content mass by mass	kg/kg
V	volume of test specimen	m^3
ψ	moisture content volume by volume	m^3/m^3
w	moisture content mass by volume	kg/m^3
ρ_0	dry density	kg/m^3

4 Principle

The moisture content is calculated from the mass of the test specimen before drying and the mass after drying at elevated temperature.

5 Apparatus

The test apparatus shall include:

a) ventilated oven capable of maintaining the drying temperature with accuracy specified in table 1 and a relative humidity of less than 10 %: in warm, humid climates or at low drying temperatures it can be necessary to provide a supply of dried air to achieve this relative humidity;

b) scale or balance capable of weighing test specimens with an uncertainty not greater than 0,1 % of their mass;

c) metal rule or metal tape graduated in millimetres and permitting reading to an accuracy of 0,5 mm;

d) callipers, or any other instrument, capable of reading the dimensions of test specimens to an accuracy of 0,1 mm;

e) desiccator.

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6 Test specimens

6.1 Dimensions and number of test specimens

The dimensions and number of test specimens, chosen to be representative of the material, shall be specified.

NOTE These can be found in the relevant product standard or any other applicable document or agreement.

6.2 Preparation of test specimens

6.2.1 When test specimens have to be taken from larger elements, cutting and drilling shall not significantly influence the moisture content.

6.2.2 If the moisture content mass by volume, w, or volume by volume, ψ, is to be determined, the test specimen surfaces shall be clean and sufficiently plane to enable determination of the volume to the accuracy specified in 7.2 or 7.3 as relevant.

6.2.3 If the sampling is done in the field or when the drying cannot follow immediately after the cutting of the test specimens, the test specimens shall be packed in vapour-tight metal containers or wrapped in two layers of low permeability film or foil of vapour resistance at least 200 MNs/g or s_d at least 1000 m (e.g. polyethylene foil of minimum thickness 0,2 mm) and sealed in order to avoid any change in moisture content before drying. When sampling in rain or after immersion, dry the surface of the specimen with a wrung out damp sponge.

Care shall be taken to mark the sample to ensure subsequent identification.

7 Procedure

7.1 Test conditions

The laboratory temperature during the test shall be (23 ± 6) °C.

7.2 Procedure for test specimens weighed immediately after cutting from sample

Before drying, weigh the test specimens with an accuracy of 0,1 % of their mass. If the determination of the moisture content mass by volume or volume by volume is required, measure the dimensions of the test specimen with a metal rule or a calliper, with the accuracy stated in clause 5. The error in determining the volume of the test specimen shall not exceed 1 %.

Dry the specimens at the temperature specified in the relevant product standard to constant mass. If no temperature for drying is specified in any product standard, the value appropriate to the material type specified in table 1 shall be used.

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Table 1 - Drying temperatures

Material	Drying temperature °C
Materials which do not change the structure at 105 °C e.g. some mineral materials, wood	105 ± 2
Materials, in which changes in structure can occur between 70 °C and 105 °C e.g. some cellular plastics	70 ± 2
Materials, for which higher temperature can drive out water of crystallisation or affect blowing agents e.g. gypsum or some foams	40 ± 2

NOTE 1 It is important to choose the drying temperature carefully in order to limit a) any damage to the specimen; b) any change in mass due to diffusion of materials such as blowing agents in cellular plastics; c) any residual dimensional changes of the test specimens; and d) any damage to packaging that is included in the test.

Constant mass is reached if the change of mass between three consecutive weighings made 24 h apart is less than 0,1 % of the total mass.

NOTE 2 If the drying process is very slow, e.g. for thick specimens (larger than 0,1 m) or materials with low moisture diffusivity, the time needed to reach constant mass may be correspondingly longer. The interval between successive weighings can then be increased e.g. to two or three days.

NOTE 3 Cutting the specimens in smaller pieces reduces the time needed to reach constant mass.

Cool the test specimens in a desiccator and weigh them when they have reached 30 °C to 40 °C to the same accuracy as given above.

NOTE 4 Specimens are weighed before they have completely cooled to minimise re-absorption of moisture.

7.3 Procedure for test specimens, sealed vapour tight after cutting from sample

Before unpacking, weigh, without drying, the sealed test specimens with an accuracy of 0,1 % of their mass. Unpack the test specimens, and dry the test specimens and the packing materials (container or impermeable foils) separately as specified in 7.2.

If the determination of the moisture content mass by volume or volume by volume is required, before drying measure the dimensions of the test specimen with a metal rule or a calliper, with the accuracy stated in clause 5. The error in determining the volume of the test specimen shall not exceed 1 %.

Dry the specimens at the temperature specified in the relevant product standard to constant mass. If no temperature for drying is specified in any product standard, the value appropriate to the material type specified in table 1 shall be used.

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NOTE 1 It is important to choose the drying temperature carefully in order to limit a) any damage to the specimen; b) any change in mass due to diffusion of materials such as blowing agents in cellular plastics; c) any residual dimensional changes of the test specimens; and d) any damage to packaging that is included in the test.

After drying, weigh the test specimens and the packing separately before they have cooled down completely in the desiccator (30 °C to 40 °C) to avoid re-absorption of moisture.

Alternatively the following procedure with the same accuracy can be used:
-weigh the complete package, including the specimen;
-open the package and dry the test specimen together with the packing material;
-weigh the test specimen with the packing material after drying;
-separate the test specimen from the packing material and weigh the packing material.

NOTE 2 The alternative method is recommended for brittle materials, where material may be lost when unpacking.

8 Calculation and expression of results

8.1 Moisture content mass by mass

8.1.1 Test specimens weighed immediately after cutting from sample

The moisture content mass by mass, u, of a test specimen shall be calculated using the equation:

$$u = \frac{m - m_0}{m_0} \quad (1)$$

where:

m is the mass of the test specimen before drying;
m_0 is the mass of the test specimen after drying.

8.1.2 Test specimens sealed vapour tight after cutting from sample

The moisture content mass by mass, u, of a test specimen shall be calculated using the equation:

$$u = \frac{m - m_0 - m_p}{m_0} \quad (2)$$

where:

m is the mass of the test specimen and packing material before drying;
m_0 is the mass of the test specimen after drying;
m_p is the mass of the packing material after drying.

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8.2 Moisture content mass by volume

If the moisture content mass by volume, w, is required, it shall be calculated using the equation:

$$w = u \rho_0 \quad (3)$$

where:

u is the moisture content mass by mass;

ρ_0 is the density of the dry material determined according to 8.4.

8.3 Moisture content volume by volume

If the moisture content volume by volume, ψ, is required, it shall be calculated using the equation:

$$\psi = u \frac{\rho_0}{\rho_w} \quad (4)$$

where:

u is the moisture content mass by mass;

ρ_0 is the density of the dry material;

ρ_w is the density of water (ρ_w = 997,6 kg/m^3 at 23 °C).

NOTE The density of water at other temperatures (θ °C) can be determined from the empirical equation: $\rho_w = 999{,}90 + 0{,}5201\theta - 0{,}00759\ \theta^2 + 0{,}3871 \times 10^{-5}\ \theta^3$.

8.4 Dry density

The dry density ρ_0 shall be calculated using the equation:

$$\rho_0 = \frac{m_0}{V} \quad (5)$$

where:

m_0 is the mass of the dry test specimen;

V is the volume of the dry test specimen determined from linear dimensions.

NOTE 1 Methods for determining the dry density of materials may be found in annex A.

NOTE 2 The apparent density of irregular shaped test specimens can be determined by making linear measurements on right prism specimens cut from the original specimen.

8.5 Test result

The test result is the mean value of the individual values.

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