BRITISH STANDARD

BS EN
13471:2001

Thermal insulating products for building equipment and industrial installations — Determination of the coefficient of thermal expansion

The European Standard EN 13471:2001 has the status of a British Standard

ICS 91.120.10; 91.100.60

National foreword

This British Standard is the official English language version of EN 13471:2001. This British Standard, together with BS EN 13467:2001, BS EN 13468:2001, BS EN 13469:2001, BS EN 13470:2001 and BS EN 13472:2001, partially supersedes BS 2972:1989.

The UK participation in its preparation was entrusted by Technical Committee RHE/9, Thermal insulating materials, to Subcommittee RHE/9/4, Nomenclature and specifications, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

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This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 09 November 2001

Summary of pages

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 13471

September 2001

ICS 91.100.60

English version

Thermal insulating products for building equipment and industrial installations - Determination of the coefficient of thermal expansion

Produits isolants thermiques pour l'équipement du bâtiment et les installations industrielles - Détermination du coefficient de dilatation thermique

Wärmedämmstoffe für die Haustechnik und für betriebstechnische Anlagen - Bestimmung des Wärmeausdehnungskoeffizienten

This European Standard was approved by CEN on 18 August 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 13471:2001 E

Contents

Foreword

This European Standard 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 March 2002, and conflicting national standards shall be withdrawn at the latest by March 2002.

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.

No existing European Standard is superseded.

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 European Standard specifies the equipment and procedures for determining the coefficient of linear thermal expansion. The standard is applicable to thermal insulating products within the temperature range - 196 °C to 850 °C, subject to the possible temperature limitation of the test specimens. It shall not be used for products which during the test experience dimensional changes due to the loss of hydration water or which undergo other phase changes.

NOTE Because of its small dimensions the test specimen should be carefully selected to be representative of the product being tested.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publica-tions. 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).

EN 12085, *Thermal insulating products for building applications – Determination of linear dimensions of test specimens.*

3 Terms and definitions

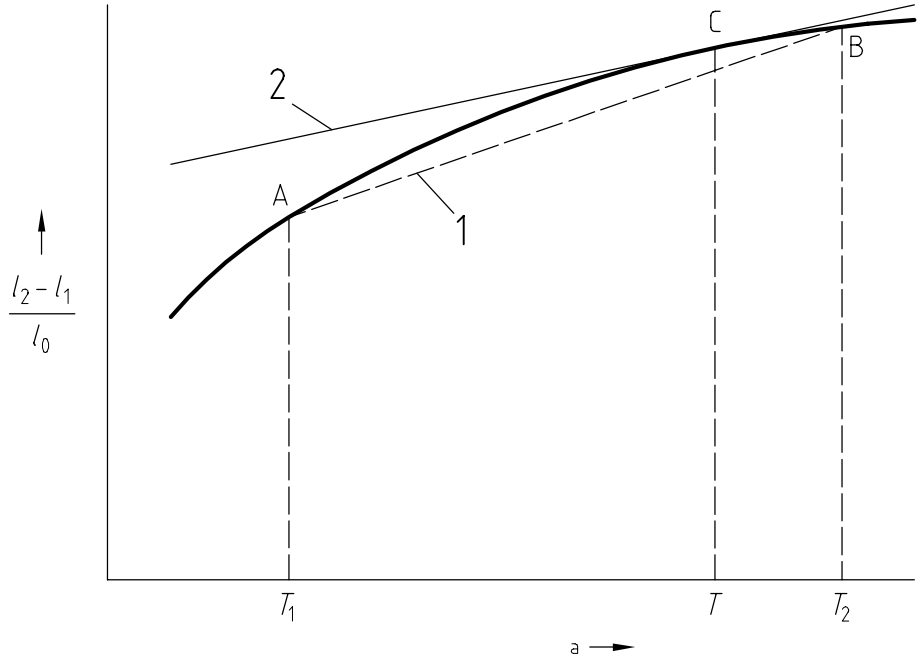
For the purpose of this European Standard, the following terms and definitions apply:

3.1
linear thermal expansion
reversible changes in the length of a product resulting from a change in temperature

3.2
mean coefficient of linear thermal expansion α_m between different temperatures
reversible change in length divided by the length at the reference temperature and the temperature difference between the test temperatures

3.3
coefficient of thermal expansion α_t at the temperature *T*
limit value of α_m as the higher temperature approaches the lower temperature (see Figure 1)

NOTE The definition of α_m and α_t assumes that the function giving the length variation in relation to the temperature variation is continuous. This excludes the use of the mean coefficient of linear thermal expansion α_m when the test specimen experiences physical change due to change of phase, eg. recrystallisation or loss of water of hydration. The curve giving the length variation as a function of the temperature variation can be reported but the mean coefficient of thermal expansion should not be calculated for parts of the curve which are not continuous.



Key
a Temperature

1 ----- The mean coefficient of thermal expansion between T1 and T2 is illustrated by the gradient of the dotted line between the points A and B

2 ___ The coefficient of thermal expansion at T is illustrated by the gradient of the tangent at point C

Figure 1 - The relative length variation as a function of temperature

4 Principle

The changes of a product's linear dimensions, as its temperature is changed, are measured and characterised. It shall be done in a continuous way when the full curve over a temperature range is needed or only at two specified temperatures if only a mean coefficient of linear thermal expansion between these temperatures is needed.

5 Apparatus

5.1 Dilatometer

Any dilatometer with appropriate dimensions and suitable for the temperature range (see Figure 2).

NOTE The usual dilatometers are of the tube or rod type, fabricated of high purity vitreous silica. Modern dilatometers incorporate the essential features described below.

5.2 Micrometer caliper

A caliper with micrometer indication permitting direct reading of the test specimen lengths at different temperatures. The accuracy of these measurements shall be such that consecutive measurements at the

same temperature are determined to $2 \times 10^{-4} \times l_0$ for the length and to $2 \times 10^{-5} \times l_0$ for the length variations.

5.3 Electrical furnace

For high temperatures, an electrical furnace, capable of maintaining the mean temperature of the test specimen to within ± 2 K of the desired test temperature and the maximum and minimum temperature of the test specimen to within ± 2 K.

The electrical furnace shall be capable of limiting the rate of temperature change to 1 °C/min during the change from one test temperature to another.

5.4 Test chamber

For low and cryogenic temperatures, a test chamber, capable of maintaining the mean temperature of the test specimen to within ± 1 K of the desired test temperature and the maximum and minimum temperature of the test specimen to within ± 1 K.

The test chamber shall be capable of limiting the rate of temperature change to 1 °C/min during the change from one test temperature to another.

5.5 Temperature - measuring instruments

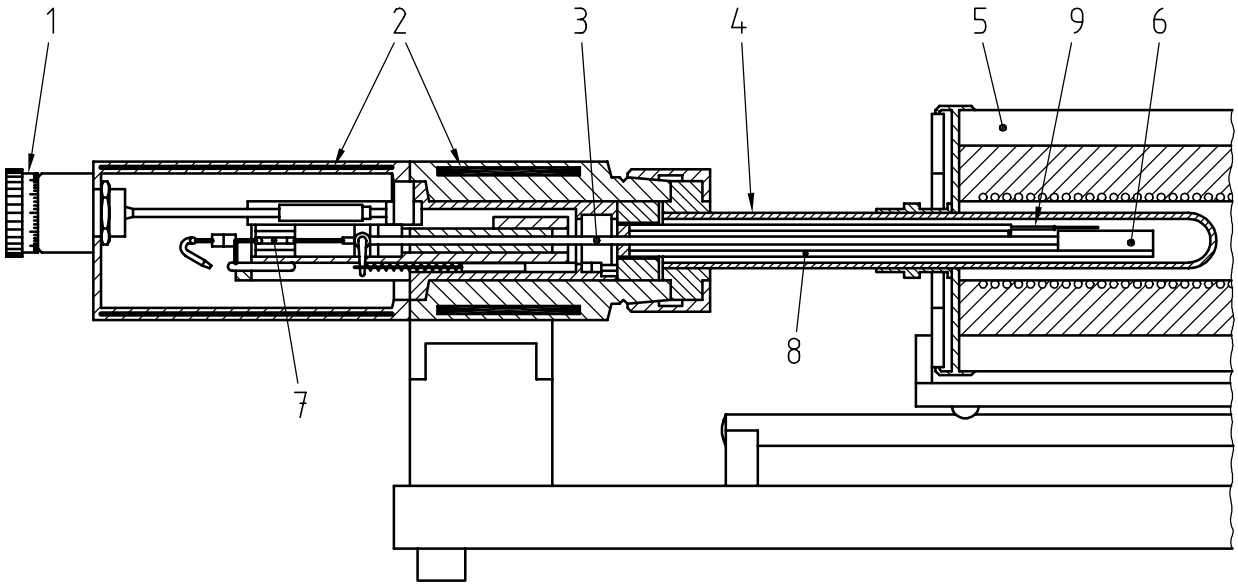
Calibrated thermocouples suitable for the temperature needed for the test with an accuracy of ± 0,5 K from -196 °C to + 200 °C, ± 1 K from 200 °C to 500 °C and ± 2 K from 500 °C to 850 °C.

The thermocouples are connected to a continous recording device. If only the mean coefficient of linear thermal expansion α_m between two temperatures is needed, the measurements shall only be carried out at these temperatures.

NOTE Devices which are normally used for the simultaneous recording of the length variation and the temperature, provide a curve of $\frac{\Delta l}{l_0}$ as a function of T_2 - T_1.

5.6 Equipment to prepare the test specimen

Suitable saw or thin walled steel tube to prepare the test specimen.



Key
1 Micrometer screw
2 Thermostat
3 Push-rod
4 Protective tube
5 Furnace
6 Test specimen
7 Linear variable differential transducer
8 Test specimen carrier
9 Thermocouple

Figure 2 - Typical example of a dilatometer

6 Test specimens

6.1 Dimensions of test specimens

The dimensions shall be appropriate for the dimensions of the dilatometer and suitable for the test material.

Dimensions of the test specimens shall be as specified in the relevant product standard.

NOTE 1 In the absence of a product standard the dimensions of test specimens may be agreed between parties.

NOTE 2 Typical test specimens have a length of (50 ± 1) mm with square cross section of (10 ± 1) mm or a diameter of (10 ± 1) mm. Smaller or larger dimensions are acceptable, but the user of the standard should be aware that too short test specimens give a loss of sensitivity while too long test specimens may be subjected to axial temperature differences or physical deformation such as creep or elastic strain rates.

The tolerance on parallelism and flatness between the two faces of the test specimen used for the length

determination shall not be more than 1 % of their linear dimension.

6.2 Preparation of test specimens

Any skins, facings and/or coatings shall be removed.

Test specimens shall be sawn or cut with a thin walled steel tube from the product in the direction in which the measurement of the coefficient of linear thermal expansion shall be made and in which the linear dimensions are to be recorded.

Special requirements for preparation such as annealing or drying under specified conditions shall be indicated where relevant in the product standard.

For anisotropic products the measurements shall be carried out both in the direction of the length and of the width.

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 two test specimens shall be used.

NOTE In the absence of a product standard or any other European technincal specification the number of test specimen 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 specified in the relevant product standard.

7 Procedure

7.1 Test conditions

The test shall be started at (23 ± 2) °C, due to the importance of accurate temperatures for this test method.

7.2 Test procedure

Clean the test specimen and install it in the dilatometer making sure that the end surfaces as well as the contact surfaces of the dilatometer are free of foreign particles.

Measure its length at (23 ± 2) °C which shall be considered as the reference temperature.

Place the thermocouples in representative manner ensuring good contact with the test specimen.

Insert the dilatometer assembly in the furnace or in the test chamber.

Heat or cool the system, making sure that the temperature gradient given in the relevant product standard is respected. If no information is available, do not exceed 3 K/min and 1 K/min for the last 50 °C interval.

Stabilize the temperature at temperature intervals not greater than 50 °C over a time sufficient to obtain homogeneous temperature within the test specimen. Usually 30 min is sufficient.

Measure the temperature and the test specimen length when constant temperature is recorded (± 2 K for high temperature and ± 1 K for low temperature). Record the length variation/temperature curves continuously, following the instructions specific to the instrument used.

Bring the temperature back to the reference value and remeasure the length.
If irreversible changes have occurred repeat the cycles until only reversible changes occur.

The result shall be calculated from the readings of the reversible changes.

8 Calculation and expression of results

Apply the corrections specific to the instrument used to the measured lengths, e.g. the correction for the expansion of the quartz support over the length of the test specimen.

Calculate the mean coefficient of linear thermal expansion, α_m, in $°C^{-1}$ between the temperatures T_1 and T_2 using the equation:

$$\alpha_m = \frac{1}{l_0} \times \frac{l_2 - l_1}{T_2 - T_1} \quad (1)$$

where:

l_0 is the length of the test specimen, in millimetres, at the reference temperature T_0, in degree Celcius;

l_1 is the length of the test specimen, in millimetres, at the temperature T_1, in degree Celcius;

l_2 is the length of the test specimen, in millimetres, at the temperature T_2, in degree Celcius.

If required, determine the coefficient of thermal expansion at the temperature T, α_t, as the tangent to the above curve.

9 Accuracy of measurement

NOTE 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.

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 as appropriate, e.g. nominal dimensions;

c) test procedure

1) pre-test history and sampling, e.g. who sampled and where;
2) waiting time before conditioning;
3) conditioning;
4) annealing, drying conditions;

5) presence of facings, the mass of the facing and the method of removal, if necessary;
6) presence of surface skins and the method of removal, if necessary;
7) if any deviation from clauses 6 and 7;
8) date of testing;
9) general information relating to the test;
10) 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

all individual values of the coefficient of thermal expansion in each temperature interval or at each temperature, mean value in the same temperature intervals or at the same temperatures.

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London
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