INTERNATIONAL STANDARD

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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

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18099 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 1, *Test and measurement methods*.

ISO 18099 includes the original EN 13471 prepared by Technical Committee CEN/TC 88, *Thermal insulating materials and products*.

However, modifications were made to the following to reflect conditions for tropical countries:

— 5.4 “Conditioning of test specimens”;

— 6.1 “Test conditions”; and

— Clause 9 “Test report”.

Introduction

This International Standard is one of a series of existing European Standards on test methods for products used to insulate building equipment and industrial installations which comprises the following group of International Standards:

ISO standard	Title	Respective EN standard
ISO 12623	*Thermal insulating products for building equipment and industrial installations — Determination of short-term water absorption by partial immersion of preformed pipe insulation*	EN 13472
ISO 12624	*Thermal insulation products — Determination of trace quantities of water soluble chloride, fluoride, silicate, sodium ions and pH*	EN 13468
ISO 12628	*Thermal insulating products for building equipment and industrial installations — Determination of dimensions, squareness and linearity of preformed pipe insulation*	EN 13467
ISO 12629	*Thermal insulating products for building equipment and industrial installations — Determination of water vapour transmission properties of preformed pipe insulation*	EN 13469
ISO 18096	*Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature for preformed pipe insulation*	EN 14707
ISO 18097	*Thermal insulating products for building equipment and industrial installations — Determination of maximum service temperature*	EN 14706
ISO 18098	*Thermal insulating products for building equipment and industrial installations — Determination of the apparent density of preformed pipe insulation*	EN 13470
ISO 18099	*Thermal insulating products for building equipment and industrial installations — Determination of the coefficient of thermal expansion*	EN 13471

A further series of existing European Standards on test methods was adopted by ISO. This "package" of standards comprises the following group of interrelated standards:

ISO standard	Title	Respective EN standard
ISO 12344	*Thermal insulating products for building applications — Determination of bending behaviour*	EN 12089
ISO 12968	*Thermal insulation products for building applications — Determination of the pull-off resistance of external thermal insulation composite systems (ETICS) (foam block test)*	EN 13495
ISO 29465	*Thermal insulating products for building applications — Determination of length and width*	EN 822
ISO 29466	*Thermal insulating products for building applications — Determination of thickness*	EN 823
ISO 29467	*Thermal insulating products for building applications — Determination of squareness*	EN 824
ISO 29468	*Thermal insulating products for building applications — Determination of flatness*	EN 825
ISO 29469	*Thermal insulating products for building applications — Determination of compression behaviour*	EN 826
ISO 29470	*Thermal insulating products for building applications — Determination of the apparent density*	EN 1602
ISO 29471	*Thermal insulating products for building applications — Determination of dimensional stability under constant normal laboratory conditions (23 degrees C/50 % relative humidity)*	EN 1603
ISO 29472	*Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*	EN 1604
ISO 29764	*Thermal insulating products for building applications — Determination of deformation under specified compressive load and temperature conditions*	EN 1605
ISO 29765	*Thermal insulating products for building applications — Determination of tensile strength perpendicular to faces*	EN 1607
ISO 29766	*Thermal insulating products for building applications — Determination of tensile strength parallel to faces*	EN 1608
ISO 29767	*Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion*	EN 1609
ISO 29768	*Thermal insulating products for building applications — Determination of linear dimensions of test specimens*	EN 12085
ISO 29769	*Thermal insulating products for building applications — Determination of behaviour under point load*	EN 12430
ISO 29770	*Thermal insulating products for building applications — Determination of thickness for floating-floor insulating products*	EN 12431
ISO 29771	*Thermal insulating materials for building applications — Determination of organic content*	EN 13820
ISO 29803	*Thermal insulation products for building applications — Determination of the resistance to impact of external thermal insulation composite systems (ETICS)*	EN 13497

The Application of Agreement on technical cooperation between ISO and CEN (Vienna Agreement), Modes 1, 2, 4, and 5, was not approved by CEN/TC 88 and the necessity not seen by its stakeholders.

This International Standard is one of a series of standards which specify test methods for determining dimensions and properties of thermal insulating materials and products. The original EN 13471 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 International 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.

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

1 Scope

This International Standard specifies the equipment and procedures for determining the coefficient of linear thermal expansion. It 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 is not applicable to products which experience dimensional changes during the test due to the loss of hydration water or which undergo other phase changes.

2 Terms and definitions

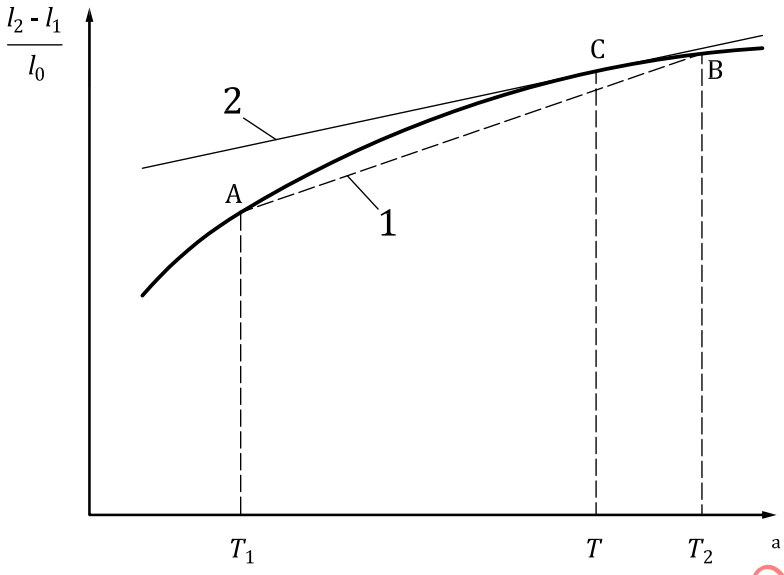
For the purposes of this document, the following terms and definitions apply.

2.1
linear thermal expansion
reversible changes in the length of a product resulting from a change in temperature

2.2
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

2.3
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 1 to entry: 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, e.g. 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 T_1 and T_2 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

3 Principle

The changes in 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.

4 Apparatus

4.1 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.

4.2 Micrometer calliper, a calliper 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.

4.3 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.

4.4 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.

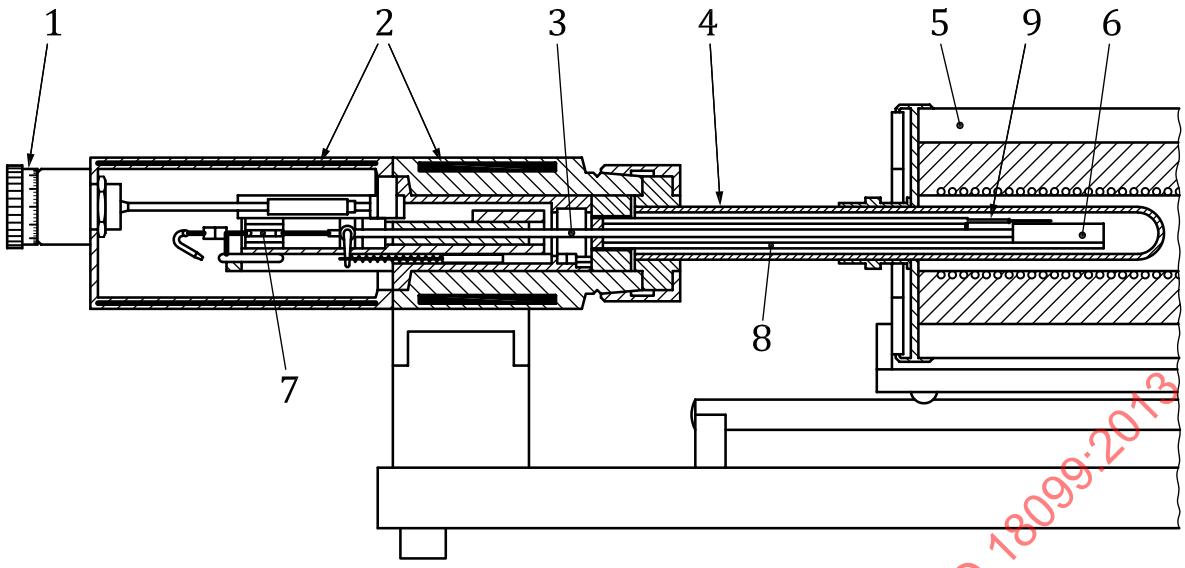
The test chamber shall be capable of limiting the rate of temperature change to 1 °C/min during the change from one test temperature to another.

4.5 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 continuous recording device. If only the mean coefficient of linear thermal expansion, $\alpha_{m,}$ 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.

4.6 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

5 Test specimens

5.1 Dimensions of test specimens

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

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 this International 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.

5.2 Preparation of test specimens

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