INTERNATIONAL STANDARD

ISO 8143

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Thermal insulation products for building equipment and industrial installations — Calcium silicate products

Produits isolants thermiques pour l'équipement du bâtiment et les installations industrielles — Produits en silicate de calcium

Reference number
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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 8143 was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 3, *Thermal insulation products*.

Thermal insulation products for building equipment and industrial installations — Calcium silicate products

1 Scope

This International Standard specifies the requirements for factory-made calcium silicate products which are used for thermal insulation of industrial installations and building equipment with an operating temperature of up to approximately +1 100 °C.

NOTE Calcium silicate products can be used at temperatures lower than 0 °C. For operating temperatures below 0 °C, special tests, regarding the suitability of the product in the intended application, are advised (e.g. liquefaction of oxygen). It is advisable to seek the advice of the manufacturer(s) in all cases.

The products are manufactured in the form of boards, pipe sections, segments and prefabricated ware.

This International Standard describes product characteristics and includes procedures for testing, evaluation of conformity, marking and labelling.

Products covered by this International Standard are also used in prefabricated thermal insulation systems and composite panels; the structural performance of systems incorporating these products is not covered.

This International Standard does not specify the required level or class of a given property required to be achieved by a product in order to demonstrate fitness for purpose in a particular application. The levels required for a given application can be found in regulations and invitations to tender.

This International Standard is not applicable to

a) products with a declared thermal conductivity greater than 0,6 W/(m·K) at 23 °C;

b) products intended to be used for the insulation of the building structure;

c) the acoustical aspects

   1) direct airborne sound insulation, and

   2) impact noise transmission index.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1182[1)], *Reaction to fire tests for products — Non-combustibility test*

1) To be published. (Revision of ISO 1182:2002)

ISO 1716[2)], *Reaction to fire tests for products — Determination of the heat of combustion (calorific value)*

ISO 2477, *Shaped insulating refractory products — Determination of permanent change in dimensions on heating*

ISO 8894-1, *Refractory materials — Determination of thermal conductivity — Part 1: Hot-wire method (cross-array)*

ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

ISO 8497, *Thermal insulation — Determination of steady-state thermal transmission properties of thermal insulation for circular pipes*

ISO 9229, *Thermal insulation — Vocabulary*

ISO 12576-1, *Thermal insulation — Insulating materials and products for buildings — Conformity control systems — Part 1: Factory-made products*

ISO 13787, *Thermal insulation products for building equipment and industrial installations — Determination of declared thermal conductivity*

ISO 21129, *Hygrothermal performance of building materials and products — Determination of water-vapour transmission properties — Box method*

ISO 29465, *Thermal insulating products for building applications — Determination of length and width*

ISO 29466, *Thermal insulating products for building applications — Determination of thickness*

ISO 29467, *Thermal insulating products for building applications — Determination of squareness*

ISO 29468, *Thermal insulating products for building applications — Determination of flatness*

ISO 29469:2008, *Thermal insulating products for building applications — Determination of compression behaviour*

ISO 29472, *Thermal insulating products for building applications — Determination of dimensional stability under specified temperature and humidity conditions*

ISO 29767, *Thermal insulating products for building applications — Determination of short-term water absorption by partial immersion*

EN 13467, *Thermal insulating products for building equipment and industrial installations — Determination of dimensions, squareness and linearity of preformed pipe insulation*

EN 13468, *Thermal insulating products for building equipment and industrial installations — Determination of trace quantities of water soluble chloride, fluoride, silicate, sodium ions and pH*

EN 13469:2002, *Thermal insulating products for building equipment and industrial installations — Determination of water vapour transmission properties of preformed pipe insulation*

EN 13472, *Thermal insulating products for building equipment and industrial installations — Determination of short term water absorption by partial immersion of preformed pipe insulation*

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2) To be published. (Revision of ISO 1716:2002)

3 Terms, definitions, symbols, units and abbreviated terms

3.1 Terms and definitions

For the purposes of this document the terms and definitions given in ISO 9229 and the following apply.

3.1.1
production line
equipment that produces products in a continuous process

NOTE For initial type test (ITT) and factory production control (FPC), each line is considered separately.

3.1.2
production unit
equipment that produces products in a discontinuous process

NOTE For ITT and FPC, units using the same process in one factory are considered together (as one production line).

3.1.3
minimum service temperature
lowest temperature to which a thermal insulation product may be exposed at a given thickness and at which it will continue to function within specified limits of performance

NOTE The required performance may be in the areas of dimensional stability, thermal properties and mechanical properties.

3.2 Symbols, units and abbreviated terms

3.2.1 Symbols and units

Symbol	Quantity	Unit
d	inside diameter of pipe section	mm
b	width	mm
t	thickness	mm
t_{dec}	declared thickness of the product	mm
S_{lin}	deviation from linearity	mm
l	length	mm
S_h	deviation from squareness of boards on length and width	mm/m
S_d	deviation from squareness of boards on thickness	mm
S_{max}	deviation from flatness	mm
$\Delta\varepsilon_b$	relative change in width	%
$\Delta\varepsilon_d$	relative change in thickness	%
$\Delta\varepsilon_l$	relative change in length	%
λ	thermal conductivity	W/(m·K)
λ_D	declared thermal conductivity	W/(m·K)
μ	water vapour diffusion resistance factor	—
σ_5	compressive stress at 5 % deformation	kPa
σ_m	compressive strength	kPa
S_p	deviation from squareness for pipe insulation	mm
ρ_a	apparent density	kg/m^3

3.2.2 Abbreviated terms for declared properties

Abbreviated term	Declared property
CS(Y)	declared level for compressive strength
CS(5)	declared level for compressive stress at 5 % deformation
Cl	declared level for chloride content
F	declared level for fluoride content
Na	declared level for sodium
K	declared level for potassium content
pH	declared level for pH
L	declared class for length tolerances
MU	declared value for water vapour diffusion resistance factor
P	declared value for flatness tolerances
S	declared class for squareness tolerances
ST (+)	declared level for maximum service temperature
ST (−)	declared level for minimum service temperature
T	declared class for thickness tolerances
W	declared class for width tolerances

3.2.3 Abbreviated terms

Abbreviated term	Meaning
CS	Calcium silicate
ITT	Initial type test
ML	Manufacturer's literature
FPC	Factory production control

4 Requirements

4.1 General

Product properties shall be assessed in accordance with Clause 5. To comply with this International Standard, products shall meet the requirements of 4.2, and the requirements of 4.3, as appropriate.

The test methods to be used for determination of each property are given in Table 4, which also shows the required test specimen dimensions and the minimum number of test specimens required to give one test result.

One test result for a product property is the average of the measured values on the number of test specimens given in Table 4.

For FPC, see Annex A.

4.2 For all applications

4.2.1 Thermal conductivity

The thermal conductivity values shall be declared by the manufacturer at reference mean temperatures covering the product service temperature range. The following conditions apply:

— the measured values shall be expressed with three significant figures;

— the declared conductivity curve shall be given as a limit curve, as defined in ISO 13787.

4.2.2 Dimensions and tolerances

4.2.2.1 Linear dimensions

The length, l, width, b, and thickness, t, of boards and the dimensions of pipe sections and prefabricated ware shall be declared. When determined, no test result shall deviate from the declared values by more than the tolerance given in Table 1.

Table 1 — Dimensional tolerances

Form of delivery	Length	Width	Thickness	Inside diameter
Board	± 3 mm or ± 0,6 %[a]	± 3 mm or ± 0,4 %[a]	$^{+3}_{-2}$ mm	
Pipe section or segment	± 3 mm or ± 0,6 %[a]		$^{+3}_{-2}$ mm	0 mm to +5 mm
[a] Whichever gives the greatest numerical tolerance.				

4.2.2.2 Squareness

The deviation from squareness of boards on length and width, S_b, shall not exceed 6 mm/m and the deviation from squareness of boards on thickness, S_d, shall not exceed 2 mm. For pipe sections and segments, the deviation from squareness, S_p, shall not exceed 3 mm.

4.2.2.3 Flatness

The deviation from flatness, S_{max}, shall not exceed 6 mm.

4.2.2.4 Pipe section linearity

The deviation from linearity, S_{lin}, shall not exceed 3 mm or 0,6 % on length, whichever gives the greatest numerical tolerance.

4.2.3 Dimensional stability

Standard atmospheres used for initial and final conditioning shall be chosen in accordance with 5.2.

The test shall be carried out after storage for 48 h at (23 ± 2) °C and (90 ± 5) % relative humidity. The relative changes in length, $\Delta\varepsilon_l$, width, $\Delta\varepsilon_b$, and thickness, $\Delta\varepsilon_d$, shall not exceed 1,0 %.

4.2.4 Fire properties

It is recommended that the fire properties with respect to reaction to fire be assessed according to the legislation in the individual territories in which the product is to be used.

4.2.5 Durability characteristics

4.2.5.1 General

The appropriate durability characteristics have been considered and are covered in 4.2.5.2, 4.2.5.3 and 4.2.5.4.

4.2.5.2 Durability of fire properties against ageing/degradation and high temperature

The fire properties in respect to reaction to fire performance of CS products does not change with time or when subjected to high temperature.

4.2.5.3 Durability of thermal resistance against ageing/degradation

The thermal conductivity of CS products does not change with time.

4.2.5.4 Durability of thermal resistance against high temperature

The thermal conductivity of CS products does not change with time at a high temperature.

4.3 For specific applications

4.3.1 General

If there is no requirement for a property, described in 4.3 for a product in use, then that property need not be determined and declared by the manufacturer.

If a property described in 4.3 is declared, it shall be determined in accordance with the test method shown in Table 4.

NOTE For information on additional properties, see Annex B.

4.3.2 Maximum service temperature

At the maximum service temperature, the relative changes in length, $\Delta\varepsilon_l$, and width, $\Delta\varepsilon_b$, shall not exceed 2 %. The maximum service temperature, ST (+), shall be declared in °C in levels with steps of 50 °C as given in the examples shown in Table 2.

Table 2 — Levels for maximum service temperature

Level	Requirement °C
ST (+) 650	650
ST (+) 800	800
ST (+) 1 000	1 000
ST (+) 1 100	1 100

4.3.3 Minimum service temperature

The minimum service temperature, ST (–), shall be declared in levels with steps of 50 °C.

At the minimum service temperature, ST (–), the relative changes in length, $\Delta\varepsilon_l$, and in width, $\Delta\varepsilon_b$, shall not exceed 2 %.

Minimum service temperature within the scope of this International Standard, but above 0 °C, need not be tested.

4.3.4 Compressive stress or strength

No test result shall be lower than the value, given in Table 3, for the declared level.

Table 3 — Levels for compressive stress at 5 % deformation or compressive strength

Level	Requirement kPa
CS (5\Y) 300	> 300
CS (5\Y) 500	> 500
CS (5\Y) 1 000	> 1 000
CS (5\Y) 1 500	> 1 500
CS (5\Y) 2 000	> 2 000
CS (5\Y) 3 000	> 3 000
CS (5\Y) 4 000	> 4 000
CS (5\Y) 5 000	> 5 000
CS (5\Y) 10 000	> 10 000

NOTE ISO 29469 is not applicable to pipe sections.

4.3.5 Trace quantities of water-soluble ions and the pH-value

Trace quantities of water-soluble ions and the pH-value shall be declared as levels in milligrams per kilogram of product and the pH-value as levels in steps of 0,5. For chloride and fluoride, no test result shall exceed the declared value. For sodium and potassium, no test result shall be below the declared value. For the pH-value, no test result shall deviate from the declared value by more than 1,0.

4.3.6 Water vapour diffusion resistance

Calcium silicate products are used for applications at high temperatures where high humidity and water adsorption are irrelevant. In exceptional cases, the water vapour diffusion resistance factor, μ, may be measured and declared.

4.3.7 Short-term water absorption by partial immersion

Calcium silicate products may absorb water under poor storage conditions. The product may be tested for short-term water absorption by partial immersion.

4.3.8 Release of dangerous substances

It is recommended that the release of dangerous substances be assessed according to the regulations and codes pertaining in the individual territories in which the product is to be used.

5 Test methods

5.1 Sampling

Flat test specimens shall be taken from the same sample and sufficient to cover the needed tests. Pipe section specimens shall be taken from a sample consisting of at least three full-sized sections.

If this is not possible, the properties of the product shall be measured on the boards from which the product is fabricated. In all cases, dimensions and, when relevant, squareness and flatness shall be measured on the finished product.

5.2 Conditioning

Test specimens are to be conditioned as specified in the relevant test standard. The surfaces of the test specimens shall be free of dust and water.

In cases of dispute or when obtaining comparative data on products, such as for databases, the test specimens shall be conditioned by storage at (23 ± 2) °C and (50 ± 10) % relative humidity, until constant mass is reached.

Constant mass is reached when the change of mass between three consecutive weighings made 24 h apart is less than 0,1 % of the total mass (see ISO 12570).

5.3 Testing

5.3.1 General

Table 4 gives the dimensions of the test specimens, the minimum number of test specimens required to get one test result and any specific conditions which are necessary.

In the case of pipe sections and prefabricated wares cut from boards, the properties shall be determined on the boards from which they are cut, except dimensions and, where relevant, linearity and squareness.

Table 4 — Test methods, test specimens and conditions

Dimensions in millimetres

Clause		Test method[a]		Test specimens		Specific conditions
No.	Title	Flat	Pipe section	Dimensions[b]	Minimum number to get one test result	
4.2.1	Thermal conductivity	ISO 8894-1 ISO 8302 ISO 8497		$\geqslant 300 \times 300 \times t$ $\geqslant 200 \times 100 \times t$ Full-sized	1 1 1	See Annex C
4.2.2.1	Linear dimensions Length and width Thickness Inside diameter	ISO 29465 ISO 29466	EN 13467 EN 13467 EN 13467	Full-sized Full-sized Full-sized	1 1 1	—
4.2.2.2	Squareness	ISO 29467	EN 13467	Full-sized	1	—
4.2.2.3	Flatness	ISO 29468	—	Full-sized	1	—
4.2.2.4	Pipe section linearity		EN 13467	Full-sized	1	—
4.2.3	Dimensional stability	ISO 29472	—	Full-sized $500 \times 500 \times t$ $250 \times 250 \times t$ $200 \times 200 \times t$	1 3 3 3	—
4.2.4	Fire properties	ISO 1182:2002	ISO 1716:2002	—	—	—
4.3.2	Maximum service temperature	ISO 2477	ISO 2477	$100 \times 100 \times t$	3	see 5.3.3
4.3.3	Minimum service temperature	See Annex D	—	—	—	—
4.3.4	Compressive stress or strength	ISO 29469	—	see ISO 29469:2008, 6.1	3	—
4.3.5	Trace quantities of water-soluble ions and the pH-value	EN 13468	—	—	3	20 g
4.3.6	Water vapour diffusion resistance	ISO 21129	EN 13469	see EN 13469:2002, 6.1 and 6.2	3	see EN 13469:2002, 6.1
4.3.7	Short-term water absorption by partial immersion	ISO 29767	 EN 13472	 $200 \times 200 \times t$	4 4	—
4.3.8	Release of dangerous substances[c]	—	—	—	—	—

[a] All test methods referenced in this table are normative.

[b] Full-sized product thickness, except for 4.2.3.

[c] Test methods are not yet available.

5.3.2 Thermal conductivity

The thermal conductivity values shall be determined by the manufacturer and verified in accordance with ISO 13787.

For flat specimens, thermal conductivity shall be based upon measurements carried out in accordance with ISO 8302 or, where necessary for reasons of practicability, ISO 8894-1 (when this method is calibrated against ISO 8302).

For cylindrical specimens, ISO 8497 shall be used.

The tests in accordance with ISO 8497 may be replaced by tests according to ISO 8894-1 or ISO 8302 provided that it has been demonstrated that the results are safe (higher) values.

The thermal conductivity shall be determined for the full temperature range for the product.

For factory production control, see Annex A.

The thermal conductivity shall be measured directly at the measured thickness. If this is not possible, it shall be determined by measurements on other thicknesses of the product, provided:

— the product is of similar chemical and physical characteristics and is produced on the same production unit;

— it can be demonstrated that the thermal conductivity, λ, does not vary more than 5 % over the range of thicknesses where the calculation is applied.

Where a product is manufactured in a range of thicknesses and the manufacturer chooses to characterize the entire range by declaring only one thermal conductivity, λ, the manufacturer shall declare the highest thermal conductivity of the range. In the case of pipe sections, measurements made on two internal diameters of pipe sections at the greatest and smallest insulation thickness for each of the diameters are deemed to be representative of the total product range.

NOTE 1 Suitable sizes are internal diameters of 48 mm and 194 mm.

The guarded hot plate method ISO 8302 or the hot wire methods ISO 8894-1 shall be deemed to be suitable methods for measurement of pipe sections having a diameter exceeding 500 mm. Flat slabs shall be prepared having the same thickness and density as the sections.

NOTE 2 For further guidance on the preparation of test specimens for thermal conductivity, see Annex C.

5.3.3 Maximum service temperature

5.3.3.1 The maximum service temperature shall be determined in accordance with ISO 2477, at the declared maximum service temperature with the exception that the minimum test temperature shall be 650 °C. Specimens for testing the maximum service temperature of pipe sections and segments may be cut from flat boards with the same composition and density as the pipe section or segment product.

5.3.3.2 The test specimens shall be square cut with a cross-section of 100 mm × 100 mm.

The thickness shall always be product thickness for all applications.

5.3.4 Minimum service temperature

The minimum service temperature, ST (–), shall be determined in accordance with Annex D.

5.3.5 Fire properties

Fire properties with respect to reaction to fire shall be determined in accordance with ISO 1182 and ISO 1716, if no national standard or regulation has been established.

6 Designation code

A designation code for the product shall be given by the manufacturer. The following shall be included except when there is no requirement for a property described in 4.3:

— The calcium silicate abbreviated term	CS
— This International Standard number	ISO 8143
— Maximum service temperature	ST (+) i
— Compressive stress at 5 % deformation or compressive strength	CS (5\Y) i
— Water-soluble chloride level	Cli
— Water-soluble fluoride level	Fi
— Water-soluble sodium level	Nai
— Water-soluble potassium level	Ki
— pH-value	pHi
— Water vapour diffusion resistance factor	Mui

where “i” shall be used to indicate the relevant class or level.

The designation code for a CS product is illustrated by the following example:

CS – ISO 8143 – ST (+) 1 050 – CS (5) 1 500

7 Evaluation of conformity

The manufacturer or its authorized representative shall be responsible for the conformity of its product with the requirements of this International Standard. The evaluation of conformity shall be carried out in accordance with ISO 12576-1 and shall be based on initial type testing (ITT) and factory production control (FPC) by the manufacturer, including product assessment and tests on samples taken at the factory.

ITT shall be carried out in accordance with ISO 12576-1 for all characteristics declared.

For ITT testing, the λ curve and the maximum and minimum temperature characteristics, only one test result is required using test specimens from four different production dates.

For the evaluation of the conformity of a λ curve over a product full service range, ISO 13787 is applicable.

FPC testing shall be made for the characteristics listed in Annex A, with no additional testing where the frequency is noted as ITT.

If a manufacturer decides to group its products, it shall be done in accordance with ISO 12576-1.

The minimum frequencies of tests in the factory production control shall be in accordance with Annex A. When indirect testing is used, the correlation to direct testing shall be established in accordance with ISO 12576-1.

The manufacturer or its authorized representative shall make available, in response to a request, a certificate or declaration of conformity as appropriate.

8 Marking and labelling

Products conforming to this International Standard shall be clearly marked, either on the product or on the label or on the packaging, with the following information:

— product name or other identifying characteristic;

— name or identifying mark and address of the manufacturer or its authorised representative;

— year of manufacture (the last two digits);

— shift or time of production and manufacturing plant or traceability code;

— reaction to fire class; specific test conditions shall be indicated with the marking by reference to manufacturer's literature, ML, where relevant;

— declared thermal conductivity: reference to manufacturer's literature, ML, showing thermal conductivity as a function of mean temperature, given as a table, curve or equation;

— declared thickness;

— designation code as given in Clause 6;

— type of facing, if any;

— declared length and declared width or inside diameter, as appropriate;

— number of pieces and area in the package, as appropriate.

Annex A
(normative)

Factory production control

Table A.1 — Minimum product testing frequencies

Subclause		Minimum testing frequency[a]
No.	**Title**	
4.2.1	Thermal conductivity — at the declared temperature range	 once per year[b]
4.2.2	Dimensions and tolerances — length and width — thickness — inside diameter	 once per production batch once per production batch once per production batch
4.2.2.2	Squareness	once per production batch
4.2.2.3	Flatness	once per production batch
4.2.2.4	Pipe section linearity	once per production batch
4.2.3	Dimensional stability	ITT[c] and once every 5 years
4.2.4	Fire properties	See 4.2.4
4.3.2	Maximum service temperature	once per production batch
4.3.3	Minimum service temperature	ITT[c] and once every 5 years
4.3.4	Compressive stress or strength	once per production batch
4.3.5	Trace quantities of water-soluble chloride, fluoride and the pH-value	ITT[c] and once every 5 years
4.3.6	Water vapour diffusion resistance factor	ITT[c] and once every 5 years
4.3.7	Short-term water absorption	ITT[c] and once every 5 years
4.3.8	Release of dangerous substances	See 4.3.8

[a] The minimum testing frequencies, expressed in test results, shall be understood as the minimum for continuous production for each production unit/line under stable conditions. In addition to the testing frequencies given above, testing of relevant properties of the product shall be repeated when changes or modifications are made which are likely to affect the conformity of the product. For ITT and FPC, units using the same process in one factory are considered together (as one production line).

For mechanical properties, the testing frequencies given are independent of the change of product. In addition the manufacturer shall establish internal rules for process adjustments related to these properties when changing the product.

[b] Testing once every two years is acceptable, if density is a declared property and the product and process have not changed.

[c] ITT, see ISO 12576-1.

Annex B
(informative)

Additional properties

B.1 General

The manufacturer can choose to give information on the following additional properties (see Table B.1).

This information, where appropriate for the product and the application, should be given as limiting values for each test result obtained from the referred test method, sampling and conditions as given in Table B.1

B.2 Coefficient of thermal expansion

Coefficient of thermal expansion, if voluntarily declared, shall be determined in accordance with EN 13471.

B.3 Apparent and true porosity

The apparent and true porosity of calcium silicate products, if voluntarily declared, shall be determined in accordance with EN 993-1.

B.4 Airflow resistance

Airflow resistance, if voluntarily declared, shall be determined in accordance with ISO 9053.

B.5 Creep in compression

Creep in compression, if voluntarily declared, shall be determined in accordance with EN 993-9.

B.6 Permeability to gases

Permeability to gases, if voluntarily declared, shall be determined in accordance with EN 993-4.

B.7 Acoustic properties

Acoustic properties, if voluntarily declared, shall be determined in accordance with ISO 11654.

B.8 Bending strength

Bending strength, if voluntarily declared, shall be determined in accordance with EN 12089. No test result should be less than the declared level, σ_m, chosen from the following values: 250 kPa, 500 kPa, 750 kPa, 1 000 kPa, 1 500 kPa, 2 000 kPa, 3 000 kPa, 4 000 kPa, 5 000 kPa and 10 000 kPa.

B.9 Density

Apparent density, ρ_a, is a useful identification parameter, but it should not be used as a basis for quality assessment of calcium silicate products. Apparent density of boards should be determined in accordance with ISO 29470. No mean value of a product should deviate by more than ± 10 % from the declared value given in the ML.

Apparent density of pipe sections not made from boards should be determined in accordance with EN 13470.

Density, if voluntarily declared, shall be determined as the quotient of mass after drying to constant mass at (105 ± 5) °C and the volume calculated from the specimen dimensions.

The measured density shall not deviate from the manufacturer's declared value by more than 10 %.

Table B.1 — Test methods, specimens and conditions

Dimensions in millimetres

Clause		Test method[a]	Test specimen		Specific conditions	Factory production control
No.	Title		Dimensions[b]	Number to get one test result		Minimum product testing frequencies[c]
B.2	Coefficient of thermal expansion	EN 13471	50 × 10 × 10 or diameter of 10	1	see 6.4 and 7.1 in EN 13471:2001	ITT and once every 5 years
B.3	Apparent and true porosity	EN 993-1				ITT and once every 5 years
B.4	Airflow resistance	ISO 9053				ITT and once every 5 years
B.5	Creep in compression	EN 993-9	cylinder 50 × 50	1		ITT and once every 5 years
B.6	Permeability to gases	EN 993-4				ITT and once every 5 years
B.7	Acoustic properties	ISO 11654				ITT and once every 5 years
B.8	Bending strength	EN 12089		3		ITT and once every 5 years
B.9	Density	ISO 29470		3		once per production batch

[a] All test methods referenced in this table are normative.

[b] Product thickness.

[c] Only relevant in case of declaration of the property.

Annex C
(informative)

Preparation of the test specimens to measure thermal conductivity

C.1 General

During the first heating of calcium silicate products, self-heating and cooling effects are possible. To avoid an influence of these effects, it is recommended to either use dead burnt specimens or choose measurement temperatures without such effects. Differential thermal analysis data or mass change data of the product can be helpful to find temperature ranges without heating and cooling effects.

When using ISO 8302, it is recommended, for maximum accuracy, that the temperature difference between the hot and the cold surface of the specimens is such that the temperature gradient in the specimen equals or exceeds 500 K/m with a minimum of 15 K.

When using ISO 8894-1, it is recommended, for maximum accuracy, that the temperature of the hot wire between the start and the end of the measurement varies by not more than 30 K.

C.2 Ageing

No ageing of the thermal resistance properties of calcium silicate products occurs.

Annex D
(informative)

Determination of the minimum service temperature

D.1 Principle

Determine the dimensional variation of the test specimen in contact with the coldest plate for the determination of the thermal conductivity by the guarded hot plate by measuring its length, width and thickness before the cooling down and after the apparatus has been returned to ambient temperature. Record the lowest temperature of the coldest plate during the measurement.

Alternative method: determine the dimensional variation of the test specimen by the determination of the thermal conductivity by the hot wire method, by measuring its length, width and thickness before the cooling down and after the apparatus has been returned to ambient temperature. Record the lowest temperature during the measurement.

NOTE In this test procedure, which is used as a reference, the test specimen is exposed to a temperature difference going from ambient to the minimum service temperature. This might not reflect the actual application conditions when products are exposed to different temperatures on the two main faces, such as in multi-layer systems.

The procedure may be an iterative process.

The two alternative methods described in this clause should be regarded as equivalent.

D.2 Apparatus

D.2.1 Guarded hot plate apparatus to measure the thermal conductivity, capable of functioning with a coldest plate as cold as the expected minimum service temperature of the test product.

The test specimen dimensions shall correspond to the requirements of this International Standard.

D.2.2 Hot wire apparatus to measure the thermal conductivity, capable of functioning as cold as the expected minimum service temperature of the test product.

D.2.3 Micrometer, permitting thickness reading to at least 0,05 mm.

D.2.4 Sliding calliper, permitting reading to an accuracy of at least 0,1 mm.

D.3 Test specimens

D.3.1 Dimensions of test specimens

The test specimens shall be square cut with dimensions corresponding to those foreseen for the used guarded hot plate method.

They shall not be less than 150 mm × 150 mm × 25 mm nor exceed 500 mm × 500 mm × 50 mm.

The length, width and thickness shall be as specified in this International Standard, complying with the requirements of this annex.

D.3.2 Number of test specimens

The minimum number of test specimens shall be as specified in this International Standard.

D.3.3 Conditioning of the test specimens

The test specimens shall be stored in the conditions foreseen for the thermal conductivity measurement. In the absence of such conditions, they shall be stored for at least 6 h at (23 ± 5) °C or, if necessary, for example in tropical locations, at (27 ± 5) °C. In the case of dispute or when obtaining comparative data, for example for databases, the test specimens shall be conditioned at (23 ± 2) °C and (50 ± 10) % relative humidity as specified in 5.2.

D.4 Procedure

D.4.1 Test conditions

The initial temperature for the test shall be the same as used for pre-conditioning.

D.4.2 Test procedure

Measure the length and width of the test specimen, in accordance with ISO 29768, read to the nearest 0,1 mm.

Measure the thickness of the test specimen, in accordance with ISO 29466, using the load specified in the relevant product standard, read to the nearest 0,05 mm.

Install the test specimen in the guarded hot plate apparatus, one plate of which shall be cooled down to the minimum service temperature during the thermal conductivity measurement.

Carry out the thermal conductivity measurements recording the lowest temperature of the coldest plate and the temperatures of the less cold plate at the same time.

After the measurements, usually consisting of several points, shut off the apparatus and wait until the apparatus is warmed up to ambient temperature.

Take the test specimen from the apparatus and remeasure its length and width, in accordance with ISO 29768, to the nearest 0,1 mm.

Remeasure the thickness of the specimen, in accordance with ISO 29466, using the load specified in the relevant product standard, read to the nearest 0,05 mm.

D.5 Calculation and expression of results

D.5.1 Dimensional changes

Calculate the dimensional changes of length, width and thickness, in percentage, using the following equations:

$$\Delta\varepsilon_l = 100 \times (l_2 - l_1)/l_1 \quad \text{(D.1)}$$

$$\Delta\varepsilon_b = 100 \times (b_2 - b_1)/b_1 \quad \text{(D.2)}$$

$$\Delta\varepsilon_d = 100 \times (t_2 - t_1)/t_1 \quad \text{(D.3)}$$

where

l_1, b_1 and t_1 are, respectively, the length, width and thickness of the test specimen before the measurement of thermal conductivity;

l_2, b_2 and t_2 are, respectively, the length, width and thickness of the test specimen after the measurement of thermal conductivity.

Calculate the mean value of dimensional changes, $\Delta\varepsilon_l$, $\Delta\varepsilon_b$ and $\Delta\varepsilon_d$ as a percentage rounded to the nearest 0,5 % of the individual results.

D.5.2 Additional tests and/or observations

The results of the visual examination of the test specimen shall be noted.

If the relevant clause of this annex or the relevant product standard specifies additional requirements, the calculations and/or observations shall be noted accordingly.

D.6 Accuracy of measurements

NOTE It has not been possible to include a statement on the accuracy of the method in this edition of this International Standard, but it is intended such a statement be included when this International Standard is next revised.

D.7 Test report

The test report shall include the following information:

a) reference to this International Standard, i.e. ISO 8143;

b) product identification:

   1) product name, factory, manufacturer or supplier,

   2) production code number,

   3) type of product,

   4) packaging,

   5) form in which the product arrived at the laboratory,

   6) other information as appropriate, e.g. nominal dimensions, nominal density;

c) test procedure:

   1) pre-test history and sampling, e.g. who sampled and where,

   2) conditioning,

   3) deviations from Clauses D.4 and D.5, if any,

   4) date of testing,

   5) dimensions and number of test specimens,

   6) chosen temperature increase rate,

7) general information relating to the test,

8) events which may have affected the results;

NOTE Information about the apparatus and identity of the technician can be made available in the laboratory, but need not be recorded in the test report.

d) results:

1) all individual values of dimensional changes and the temperatures at which they occurred,

2) mean values of the dimensional changes and the temperatures at which they occurred (it must be noted if the changes are expansion or shrinkage),

3) note of the result of the visual examination,

4) all individual values of the minimum service temperature,

5) mean value of the minimum service temperature,

6) additional results as specified in the relevant clauses of this annex or the relevant product standard or any other International Technical Specification.

Bibliography

[1] ISO 9053, *Acoustics — Materials for acoustical applications — Determination of airflow resistance*

[2] ISO 11654, *Acoustics — Sound absorbers for use in buildings — Rating of sound absorption*

[3] ISO 12570, *Hygrothermal performance of building materials and products — Determination of moisture content by drying at elevated temperature*

[4] ISO 29470, *Thermal insulating products for building applications — Determination of the apparent density*

[5] ISO 29768, *Thermal insulating products for building applications — Determination of linear dimensions of test specimens*

[6] ISO 29771, *Thermal insulating materials for building applications — Determination of organic content*

[7] EN 993-1, *Methods of test for dense shaped refractory products — Part 1: Determination of bulk density, apparent porosity and true porosity*

[8] EN 993-4, *Methods of test for dense shaped refractory products — Part 4: Determination of permeability to gases*

[9] EN 993-9, *Methods of testing dense shaped refractory products — Part 9: Determination of creep in compression*

[10] EN 12089, *Thermal insulating products for building applications — Determination of bending behaviour*

[11] EN 13470, *Thermal insulating products for building equipment and industrial installations — Determination of the apparent density of preformed pipe insulation*

[12] EN 13471:2001, *Thermal insulating products for building equipment and industrial installations — Determination of the coefficient of thermal expansion*

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