International Standard 4898

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

Cellular plastics — Specification for rigid cellular materials used in the thermal insulation of buildings

Plastiques alvéolaires — Spécifications des matériaux rigides utilisés dans l'isolation thermique des bâtiments

First edition — 1984-11-01

UDC 678.5/8 : 405.8 : 699.86 **Ref. No. ISO 4898-1984 (E)**

Descriptors : plastics, cellular plastics, specifications, physical properties, tests, dimensional tolerances, thermal insulation, buildings.

Price based on 6 pages

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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 4898 was prepared by Technical Committee ISO/TC 61, *Plastics*.

Printed in Switzerland

Cellular plastics — Specification for rigid materials used in the thermal insulation of buildings

1 Scope and field of application

This International Standard specifies requirements and methods of testing for rigid cellular plastics that are intended for use as thermal insulation in buildings. It covers rigid cellular plastics in the form of flat or profiled boards, with or without natural skins. They may also be faced or laminated with foil, plastic or metal films or sheets, mineral coatings, paper, cardboard or other materials.

This International Standard is not applicable to materials used for the thermal insulation of pipes and vessels, for impact sound absorption or for acoustical insulation.

This International Standard covers the following cellular materials used in the thermal insulation of buildings :

RC/PS Based on polystyrene;

RC/PUR Based on polyurethanes made with isocyanates (concerning isocyanurates, see 3.2).

NOTES

1 RC denotes rigid cellular material.

2 When other cellular plastic materials become commercially available, it is intended to add these materials to this International Standard.

The limiting quality values in this International Standard are for use only in the specification of materials between purchaser and supplier, and are not intended to be used for design purposes (see the annex).

Additional requirements for special applications may be added to those specified in this International Standard by agreement between purchaser and supplier.

2 References

ISO 291, *Plastics — Standard atmosphere for conditioning and testing.*

ISO 472, *Plastics — Vocabulary.*

ISO 844, *Cellular plastics — Compression test of rigid materials.*

ISO 845, *Cellular rubbers and plastics — Determination of apparent density.*

ISO 1040, *Modular co-ordination — Multimodules for horizontal co-ordinating dimensions.*

ISO 1209, *Rigid cellular plastics — Bending test.*

ISO 1663, *Cellular plastics — Determination of water vapour transmission rate of rigid materials.*

ISO 1923, *Rigid cellular plastics — Determination of linear dimensions.*

ISO 2581, *Plastics — Rigid cellular materials — Determination of "apparent" thermal conductivity by means of a heat-flow meter.*

ISO 2796, *Cellular plastics — Test for dimensional stability of rigid materials.*

ISO/TR 2799, *Cellular plastics — Determination of the temperature at which fixed permanent deformation of rigid materials occurs under compressive load.*

ISO 2896, *Rigid cellular plastics — Determination of water absorption.*

3 Definitions

For the purpose of this International Standard, the following definitions apply.

3.1 RC/PS : A rigid cellular plastic material that has been expanded from polystyrene or its copolymers. For the purpose of this International Standard, these materials are divided into two types :

RC/PS-M Board, expanded from expandable polystyrene beads, which is moulded to shape or cut from continuously or discontinuously produced block.

RC/PS-E Board produced by the continuous extrusion process, either with or without natural surface skins.

RC/PS-M and RC/PS-E used for thermal insulation purposes have a cellular structure consisting substantially of closed cells.

3.2 RC/PUR : A rigid cellular plastic material based on polyurethanes or urethane/isocyanurate polymers.[1)]

RC/PUR used for thermal insulation purposes has a cellular structure consisting substantially of closed cells.

4 Sizes and dimensional tolerance requirements

4.1 Board materials shall be supplied in dimensions agreed between purchaser and supplier, but preferably in accord with ISO 1040. Boards shall be essentially flat.

4.2 Dimensional tolerances for length, width and rectangularity shall conform to the following requirements :

Length or width	Tolerance on length or width (see note 1)	Rectangularity tolerances based on differences in diagonal measurements (see notes 2 and 3)
mm	mm	mm
less than 1 000	± 5	5
1 000 to 2 000 (incl.)	± 7,5	7
> 2 000 to 4 000 (incl.)	± 10	13
> 4 000	+ unlimited − 10	

NOTES

1 If more restricted tolerances are required, these shall be agreed between purchaser and supplier.

2 Tolerance categories for diagonal measurements are based on the board length (not width).

3 Rectangularity may also be determined by equivalent methods such as the use of a rectangular pattern.

4.3 Dimensional tolerances for thickness shall conform to the following requirements :

Thickness	Tolerance (see note 1)
mm	mm
less than 50	± 2
50 to 75 (incl.)	± 3
> 75 to 100 (incl.)	± 3 (see note 2)
> 100	To be agreed between purchaser and supplier

NOTES

1 If more restricted tolerances are required, these shall be agreed between purchaser and supplier.

2 For RC/PS-E with natural skins, the thickness tolerance for this thickness catergory shall be ± 4 mm.

5 Physical property requirements

5.1 Categories

Physical property requirements are organized into product categories to meet purchaser and supplier needs over a range of end-use applications.

Category I — Suitable for non-load-bearing applications such as wall and cavity insulations, vented roofs, cavity wall insulation and similar applications.

Category II — Suitable for limited load-bearing applications such as in built-up roofs, under floors and comparable applications, where elevated temperatures may be encountered and where compressive creep resistance is required.

Category III — Suitable for load-bearing applications such as in parking decks, floors of cold-storage areas and comparable applications requiring a higher level of compressive strength and compressive creep resistance.

5.2 Subcategories

Product property categories are further divided into subcategories (A, B, C) on the basis of thermal conductivity values (see the note). All thermal conductivity specification values given for the subcategories in tables 1 and 2 are maximum values.

NOTE — Thermal conductivity values given in tables 1 and 2 are to be used only as limiting quality values for specification of materials between purchaser and supplier. They are not to be used for design purposes (see the annex).

5.3 Limiting quality values

RC/PS materials shall conform to the limiting quality values for physical properties as specified in table 1.

RC/PUR materials shall conform to the limiting quality values for physical properties as specified in table 2.

5.4 Burning characteristics

It is recognized that there is a need to consider the burning characteristics of these materials in their intended application. Therefore, until such time as International Standards become available, individual national practice should be followed.

6 Sample

6.1 For density determination, ten (10) full size boards are required.

6.2 For all other physical property determinations and dimensional measurements, at least three (3) full size boards are required.

1) For definitions of **isocyanurate plastic**, **polyurethane** and **urethane plastic**, see ISO 472.

7 Aging and conditioning

7.1 Aging

7.1.1 There is no aging requirement for materials faced with impermeable, hole-free facing.

NOTE — For example, metal coverings of about 50 µm thickness have been found to fulfil this requirement.

7.1.2 All materials without impermeable, hole-free facing shall be aged at ambient conditions for a minimum of 28 days from the date of manufacture. Thermal conductivity test specimens are to be aged with all surfaces exposed to the ambient air.

7.2 Conditioning

Prior to dimensional measurements and physical property testing, the test specimens shall be conditioned, with all surfaces exposed, for a minimum of 48 h at 23 ± 2 °C and 45 % to 55 % relative humidity. This 48-hour conditioning period may be incorporated as the final two days of the 28-day aging period.

8 Test methods

8.1 Linear dimensions

The linear dimensions shall be measured according to ISO 1923 for each of three boards. If the material has a surface facing, lamination or a natural skin, the dimensions shall be determined without removing them.

A minimum of 5 measurements is to be taken for each dimension. Each single value must be within the tolerances specified in 4.2 and 4.3.

8.2 Density

Density measurement is optional for all materials in countries where a system of quality identification has been established.

Density shall be determined on each of 10 full-size boards according to ISO 845 and reported as the average of the ten determinations. The density of the lowest density board shall be no lower than 90 % of the ten-board average.

When the natural skin surface of the material forms an integral part of the product in its end-use, the surface skin shall not be removed prior to the determination of density. For those materials with surface facing, lamination or coating, the density is to be determined for the core material after removing such facing, lamination or coating.

8.3 Compressive strength

Compressive strength or the compressive stress at 10 % deformation or yield, whichever occurs first, shall be determined according to ISO 844. Specimens shall be tested with natural skin integral to the final product, surface facing, lamination or coating, unless surface irregularities require removal of such surfaces for uniform loading.

8.4 Thermal conductivity

Thermal conductivity shall be determined according to ISO 2581 or an absolute method[1] at a mean temperature of either 23 °C or 10 °C. Thermal conductivity values measured at one of these mean temperatures may be calculated for the other mean temperature on the basis of a documented thermal conductivity versus mean temperature relationship. In cases of dispute, the thermal conductivity shall be tested at the mean temperature for which the value is reported.

NOTE — These thermal conductivity values are to be used for specification purposes only (see the annex).

8.5 Dimensional stability/compressive creep properties at elevated temperature

8.5.1 Dimensional stability at 70 °C for 48 h shall be determined according to ISO 2796, except that the thickness of the test specimen shall be equal to the thickness of the board as sold. Surface skins or facings shall not be removed.

8.5.2 Compressive creep at 20 kPa and 80 °C for 48 h shall be determined according to ISO/TR 2799, except that the specimen dimensions shall be 50 ± 1 mm × 50 ± 1 mm × thickness of the board as sold. Surface skins or facings shall not be removed. If the product thickness is greater than 50 mm, the specimen shall be a cube with the side dimensions equal to the thickness.

The specimens shall be subjected to a load of 20 kPa in an atmosphere conforming to the requirements of ISO 291. After 48 h the test specimens shall be subjected to a temperature of 80 °C under the same load for an additional 48 h. The differences in compression between each of the two time periods shall be reported.

8.5.3 Compressive creep at 40 kPa and 70 °C for 7 days shall be determined according to ISO/TR 2799, except that the specimen dimensions shall be 50 ± 1 mm × 50 ± 1 mm × thickness of the board as sold. Surface skins or facings shall not be removed. If the product thickness is greater than 50 mm, the specimen shall be a cube with the side dimensions equal to the thickness. Except for the differences in load and temperature, the procedure is the same as in 8.5.2.

1) Method in preparation by ISO/TC 163.

8.6 Water vapour permeability

Water vapour permeability shall be determined according to ISO 1663 at one of the following test conditions :

a) 38 °C/0 to 88,5 % r.h.

b) 23 °C/0 to 50 % r.h.

8.7 Water absorption

Water absorption measurement is required only when direct contact with water is anticipated in the end-use application, i.e. perimeter insulation, inverted-roof-insulation and comparable applications. Water absorption shall be tested in accordance with ISO 2896 except that the specimen size shall be 150 mm by 150 mm square and preferably 75 mm in thickness. Products with natural skins or products sold with a thickness of less than 75 mm thickness shall be tested using specimens of thickness equal to that of the product.

8.8 Bending load

Bending load at break determined for RC/PS-M materials is a measure of the fusion quality of the expanded particles. This test is conducted in accordance with ISO 1209 except that the test specimen shall be 250 mm × 100 mm × 20 mm thickness and the testing span shall be 200 mm at a speed of 50 mm/min.

9 Test report

The test report shall include the following information :

a) reference to this International Standard;

b) product trade name and supplier; lot number and date of manufacture;

c) type of product (RC/PS-M, RC/PS-E, RC/PUR) and other description such as the presence and type of facings;

d) nominal size of product sold;

e) physical property requirement category and sub-category against which the product is being tested;

f) test conditions used if a choice of conditions is permitted (such as with thermal conductivity and water vapour permeability);

g) any deviation or additions to the requirements of this International Standard as agreed upon between purchaser and supplier;

h) complete listing of all test results and comparison with the requirements of this International Standard.

Table 1 — Properties of RC/PS types M and E used for thermal insulation of building

Properties	Unit	Category (5.1) and subcategory (5.2)					Test method
		I	II		III		
			A	B	A	B	C	
Density (min.)[1]	kg/m³	15	20	20	30	30	30	ISO 845
Compressive strength or compressive stress at 10 % deformation (min.)	kPa	50	100	100	150	150	150	ISO 844
Thermal conductivity (max.) 10 °C mean/28 days min.	mW/(m · K)	37	34	37	28	32	37	ISO 2581 or an absolute method
or 23 °C mean/28 days min.		39	36	39	29	34	39	
Dimensional change after 48 h at 70 °C (max.)	%	5	5	5	5	5	5	ISO 2796 as modified in 8.5.1
Compressive creep (max.) after 48 h at 80 °C under 20 kPa load	%	—	5	5	—	—	—	ISO/TR 2799 as modified in 8.5.2
Compressive creep (max.) after 7 days at 70 °C under 40 kPa load	%	—	—	—	5	5	5	ISO/TR 2799 as modified in 8.5.3
Water vapour permeability[2] 23 °C/0 to 50 % r.h.	ng/(Pa · s · m)	9,5 to 3,5	4,5 to 0,5		2,0 to 0,5		4,5 to 1,0	ISO 1663
Water absorption (max.)[3]	% (V/V)	6	4	4	2	2	2	ISO 2896 as modified in 8.7
Fusion quality (bending load at break)	N	15	25	25	35	35	35	ISO 1209 as modified in 8.8

1) Density is optional in a country that has established a system of quality identification.

2) A specific limiting value (maximum or minimum, depending on the application) may be selected by agreement between purchaser and supplier.

3) Values required only when direct contact with water is anticipated in the end-use application.

Table 2 — Properties of RC/PUR used for thermal insulation of buildings

Properties	Unit	Category (5.1) and subcategory (5.2)				Test method
		II		III		
		A	B	A	B	
Density (min.)[1]	kg/m^3	30	30	30	30	ISO 845
Compressive strength or compressive stress at 10 % deformation or yield, whichever occurs first (min.)	kPa	100	100	150	150	ISO 844
Thermal conductivity (max.) 10 °C mean/28 days min. or 23 °C mean/28 days min.	mW/(m · K)	22 24	27 29	22 24	27 29	ISO 2581 or an absolute method
Dimensional change after 48 h at 70 °C (max.)	%	5	5	5	5	ISO 2796 as modified in 8.5.1
Compressive creep (max.) after 48 h at 80 °C under 20 kPa load	%	5	5	—	—	ISO/TR 2799 as modified in 8.5.2
Compressive creep (max.) after 7 days at 70 °C under 40 kPa load	%	—	—	5	5	ISO/TR 2799 as modified in 8.5.3
Water vapour permeability[2] 23 °C/0 to 50 % r.h. 38 °C/0 to 88,5 % r.h.	ng/(Pa · m · s)	6,5 to 1,5 9 to 1,5		6,5 to 1,5 12 to 1,5		ISO 1663
Water absorption (max.)[3]	% (V/V)	4	4	3	3	ISO 2996 as modified in 8.7

1) Density is optional in a country that has established a system of quality identification.

2) A specific limiting value (maximum or minimum, depending on the application) may be selected by agreement between purchaser and supplier.

3) Values required only when direct contact with water is anticipated in the end-use application.

Annex

Effects of aging on the thermal conductivity of cellular materials

(This annex forms part of the Standard.)

The thermal conductivity of cellular plastic insulating materials is influenced by the composition and chemical nature of the material, its ratio of open and closed cells, its moisture content, the measurement temperature, and the composition of the gases in the cells. It is also well known that thermal conductivity may increase with time as the composition of the cell gases changes. It is possible to reduce or prevent this increase by use of thin surfacing materials which impede or stop the gaseous interchange.

Because of these and other reasons, for instance the method of installation in the building, the thermal conductivity values specified in tables 1 and 2 of this International Standard are not to be used for design purposes but only for specification of material between purchaser and supplier.

On the basis of more than 20 years of experience, reliable correlations between laboratory measurements on recently manufactured product and long term insulation performance in the field have been established. Using these correlations, various methods have been derived by which thermal conductivity of aged cellular plastics may be calculated from the laboratory test values (see the bibliography).

Bibliography

[1] BALL, G.W., HEALY, W.G. and PARTINGTON, J.B., *European Journal of Cellular Plastics*, Vol. 1, No. 1 (1978).

[2] BUTTLER, F. and RADLINSKY, J., Paper presented at 9th International Foamed Plastics Symposium, May 17, 1979 (Dusseldorf). Published in *Kunstoffe Fortschrittsberichte*, Vol. 4, *Schaumkunststoffe*, 1979, Carl Hanser Verlag München/Wien.

[3] ZEHENDNER, H., *Cellular polymers*, Vol. 1, p. 211 (1982).