BRITISH STANDARD

BS 5241-1: 1994

Rigid polyurethane (PUR) and polyisocyanurate (PIR) foam when dispensed or sprayed on a construction site —

Part 1: Specification for sprayed foam thermal insulation applied externally

Confirmed December 2009

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Plastics and Rubber Standards Policy Committee (PRM/-) to Technical Committee PRM/72, upon which the following bodies were represented:

Association of Building Component Manufacturers
Brick Development Association
British Board of Agrement
British Plastics Federation
British Rigid Urethane Foam Manufacturers' Association
Calcium Silicate Brick Association Limited
Cavity Foam Bureau
Department of the Environment (Building Research Establishment)
Department of the Environment (Construction Directorate)
Engineering Equipment and Materials Users' Association
European Phenolic Foam Association
Flat Roofing Contractors' Advisory Board
Ministry of Defence
National Federation of Roofing Contractors
National House-building Council
Polyethylene Foam Insulation Association
Royal Institute of British Architects

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

British Ceramic Research Ltd.
British Urethane Foam Contractors' Association (BUFCA)
Department of the Environment
RAPRA Technology Ltd.

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Contents

Foreword

This Part of BS 5241 has been prepared under the direction of the Plastics and Rubber Standards Policy Committee. It is revision of BS 5241-1:1989 which is withdrawn.

The 1989 revision of BS 5241:1975 resulted in the separation of the standard into two Parts to reflect trends in current technology.

In BS 5241-1:1989 the specific requirements of sprayed PUR and PIR foams applied externally were detailed, whereas Part 2 covered the requirements for applications where the foam is dispensed.

Also in BS 5241-1:1989 the advice to users was updated, a water absorption method added and the physical property requirements amended to take account of the revised test methods described in the latest revision of BS 4370.

This edition introduces technical changes but it does not reflect a full review or revision of the standard. A requirement has been included for the thermal conductivity of the foam to be designated by the manufacturer. It is envisaged that this standard will be replaced by a European Standard in due course and that the European Standard will be adopted in the BS EN series.

Attention is drawn to BS 7021, a code of practice for the thermal insulation of roofs externally by means of sprayed polyurethane (PUR) or polyisocyanurate (PIR) foam, which is published simultaneously.

WARNING. Adequate fire precautions should be taken when repairing any structure containing PUR or PIR foams. Do not use welding or flame cutting equipment. The attention of contractors and purchasers is drawn to the fact that this specification covers the foam only. In almost all cases, sprayed foam requires some surface treatment or covering in order to conform to the surface spread of flame rating appropriate to the final application (see Annex C and BS 7021), to provide protection from ultraviolet light and to confer weatherproofing.

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Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 6, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 5241 specifies the physical property and compositional requirements for externally sprayed polyurethane (PUR) and polyisocyanurate (PIR) foams used for the thermal insulation of external surfaces, e.g. roofs and storage tanks.

2 References

2.1 Normative references

This Part of BS 5241 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Part of BS 5241 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 5241 refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

3 Designation

For the purposes of this British Standard, the materials are divided into four types, as follows:

Type 1 polyurethane foams suitable for general use;

Type 2 polyurethane foams suitable for use where there is a requirement for greater resistance to compressive forces;

Type 3 polyisocyanurate foams suitable for general use;

Type 4 polyisocyanurate foams suitable for use where there is a requirement for greater resistance to compressive forces.

Types 1 and 2 differ principally from types 3 and 4 in their burning characteristics. Types 2 and 4 are specified where greater robustness is required e.g. in the insulation of roofs externally, where the slope of the roof is less than 45° (see **3.2** of BS 7021:1989).

The designation shall consist of a three component code comprising the following items, in the order presented:

a) the number and date of this British Standard i.e. BS 5241-1:1994;

b) a number indicating the foam type;

c) a double digit number to indicate the thermal conductivity selected in accordance with Table 1.

An example of the designation required for a type 4 foam with a thermal conductivity of 0.02 W/(m·K) is as follows:

BS 5241-1:1994/4/20.

Table 1 — Designation codes for thermal conductivity

Thermal conductivity (see **6.1**) W/(m·K)	**Code**
0.015	15
0.016	16
0.017	17
0.018	18
0.019	19
0.020	20
0.021	21
0.022	22
0.023	23
0.024	24
0.025	25
0.026	26
0.027	27
0.028	28
0.029	29
0.030	30
0.031	31
0.032	32

NOTE These values are 30 day values for quality control purposes. For corresponding long-term design values the manufacturer's advice should be sought (see Annex A).

4 Composition

The material shall be of rigid polyurethane (PUR) or polyisocyanurate (PIR) foam. A material indicated by (PUR) shall be substantially composed of urethane linkages and one indicated by (PIR) shall be substantially composed of isocyanurate linkages.

NOTE No requirement for odour is included as its assessment is largely subjective. However, it is recommended that the material should be free from objectionable odour.

5 Test specimens and sampling

Test specimens shall be prepared from samples trepanned from the foam during installation or, if trepanning is impracticable, special test samples shall be prepared by a suitable method. Suitable precautions shall be taken to ensure that the spaces left by extracting the samples are infilled without delay.

6 Physical properties

6.1 Thermal conductivity

Thermal conductivity shall be determined by either method 7A or 7B of BS 4370-2:1993 at a mean temperature of 10 °C (30 ± 2) days after manufacture. Materials shall be conditioned throughout this period at (23 ± 2) °C and (50 ± 5) % r.h.

NOTE See additional guidance in Annex A concerning the thermal conductivity 3 day values and design values.

6.2 Other properties

The materials shall conform to the requirements given in Table 2 when tested in accordance with the appropriate methods listed.

7 Marking

The containers or invoice shall be marked with at least the following information:

a) manufacturer's name or trademark;

b) product designation as given in clause **3**[1)];

c) manufacturer's description and/or product reference.

Table 2 — Physical properties

Physical property	Test requirement				Test method
	Type 1	Type 2	Type 3	Type 4	
Minimum compressive strength (in kPa) (see Annex A)	175	250	175	250	Method 3 of BS 4370-1:1988 applying the force in a direction normal to the major plane of the foam
Dimensional stability: maximum change (in %)					Method 5A or 5B of BS 4370-1:1988
Test conditions:					
24 h at – 15 ± 2 °C	1	1	1	1	
24 h at 100 ± 2 °C	2	2	2	2	
24 h at 125 ± 2 °C	—	—	2	2	
24 h at 70 ± 2 °C and 95 ± 5 % r.h.	3	3	3	3	
Closed cell content: minimum apparent volume (in %)	85	85	85	85	Method 10 of BS 4370-2:1993
Burning characteristics: extent of burning (in mm)	< 125	< 125	< 25	< 25	BS 4735:1974 (see note)
Maximum water vapour permeability at 38 °C and 88 % r.h. (in ng/Pa·s·m)	5.5	5.5	8.5	8.5	Method 8 of BS 4370-2:1993 condition a)
Maximum apparent water absorption by volume (in %)	6.5	6.5	6.5	6.5	Annex B

NOTE The small scale laboratory test described in BS 4735 is solely for assistance in monitoring consistency of production and is not for use as a means of assessing potential fire hazard of a material in use (see Annex C).

[1)] Marking BS 5241-1:1994 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

Annex A (informative) Notes for designers

Attention is drawn to the following points of specific relevance to rigid PUR and PIR foams.

a) Materials of minimum overall density 35 kg/m^3 are usually found to be suitable for roofs with slopes greater than or equal to 45° and storage tank sides (type 1 and type 3). Those of minimum overall density 48 kg/m^3 are usually suitable for applications in which there is a requirement for a greater robustness (type 2 and type 4), such as roofs, including flat roofs, with slopes of less than 45° and storage tank tops.

b) In addition to the 30 day maximum thermal conductivity value which forms the specification value for the purposes of this standard, two related maximum thermal conductivity values have practical importance, and should be obtained for the product from the manufacturer as follows.

1) *Design value of thermal conductivity*. This figure takes into account the limited diffusion of gases which can be used as a basis for user calculations. Generally this will be higher than or equal to the 30 day value.

2) *The 3 day value of thermal conductivity*. This value is often used in manufacturing control operations, to ensure the quality of product is regularly maintained. Generally it will be lower than or equal to the 30 day value.

c) It has been established that a negligible increase in thermal conductivity occurs within the density range of 28 kg/m^3 to 71 kg/m^3.

d) When the foam is applied externally it is essential that it is adequately protected. It is essential that reference is made to BS 7021:1989 for guidance on the insulation of roofs externally by means of sprayed rigid polyurethane (PUR) or polyisocyanurate (PIR) foam.

Annex B (normative) Method for determination of apparent water absorption

B.1 Principle

This method describes a procedure for determining the apparent water absorption of rigid cellular materials resulting from immersion in water under special conditions of depth and time.

The principle of the method is that the buoyant force of an object less dense than water when submerged is equal to the weight of water it displaces less the dry weight of the object. Water absorbed by the object reduces the buoyant force by reducing the volume of water replaced. The water absorption may be determined by measuring the change of buoyant force.

The method described is intended for quality control purposes and does not include corrections for the volume of water in the cut surface cells of the test specimen.

B.2 Apparatus and materials

B.2.1 *A balance*, capable of measurement to an accuracy of 0.01 g with provision for making submerged weighings.

B.2.2 *An underwater weighing jig*, constructed from a material not attacked by distilled water and large enough to contain one test specimen. A sinker is attached to the base of the jig, so that the combined weight of sinker and jig is sufficient to overcome the upthrust of the test specimen. The jig is also fitted with a means of suspending it from the balance and is constructed so that it traps no air when submerged.

B.2.3 *A mesh cage*, constructed from a material not attacked by distilled water and large enough to contain a minimum of three test specimens. The cage is weighted sufficiently to overcome the upthrust of the test specimens.

B.2.4 *An immersion tank*, capable of accommodating the mesh cage and underwater weighing jig and at least 150 mm in depth.

B.2.5 *De-aerated distilled water*

B.2.6 *Low permeability plastics film*

B.3 Test specimen

The test specimen shall be a rectangular block with length, width and thickness each (50 ± 1) mm. The test specimen shall be free from voids and blemishes, shall have the surface skin removed and shall be prepared with minimal deformation of the original cellular structure in such a way that only the surface layer of cells is opened.

NOTE Rough cutting on a band saw followed by trimming on a suitable slicing machine has been found satisfactory for the preparation of test specimens. Hot wire cutting should not be used.

B.4 Conditioning

The test specimens shall be conditioned for not less than 16 h at (23 ± 2) °C and (50 ± 5) % r.h. before testing.

The test shall be conducted at (23 ± 2) °C.

B.5 Procedure

Test a minimum of three test specimens. Determine the mean length, width and thickness of each test specimen as described in method 1 of BS 4370-1:1988 taking readings along the centre of each face. If the individual readings of length, width or thickness vary by more than 0.5 mm, reject the test specimen and prepare a new specimen.

Weigh the test specimen to the nearest 0.01 g in air (M_1).

Introduce de-aerated distilled water (**B.2.5**) at (23 ± 2) °C into the immersion tank (**B.2.4**) containing the under-water weighing jig (**B.2.2**). Immerse the test specimen in the water using the weighted mesh cage (**B.2.3**) and remove any air bubbles clinging to the specimen with a brush or by agitation. Add further water until the base of the test specimen is approximately 100 mm below the surface of the water. Cover the immersion tank with a low permeability plastics film (**B.2.6**) for a 7 day period.

After 7 days weigh the empty underwater weighing jig to the nearest 0.01 g in water (M_2).

Introduce the test specimen into the underwater weighing jig without removing the specimen from the water and weigh the jig and specimen to the nearest 0.01 g in water (M_3).

B.6 Calculation

Calculate the initial volume, V_o, of the test specimen (in cm^3) from the equation

$$V_o = lwt \times 10^{-3}$$

where

l is the mean length of the test specimen (in mm);

w is the mean width of the test specimen (in mm);

t is the mean thickness of the test specimen (in mm).

Calculate the water absorption, W_A, expressed as a percentage by volume, from the equation

$$W_A = \frac{(V_o\delta + M_3 - M_2 - M_1)\ 100}{V_o\delta}$$

where

δ is the density of water, which can be taken as 1 g/ml;

M_1 is the mass of the test specimen derived from the weight in air (in g);

M_2 is the mass of the jig derived from the weight in water (in g);

M_3 is the mass of the jig and test specimen derived from the weight in water (in g).

B.7 Test report

The report shall include the following:

a) identification of the material;

b) the number of test specimens used and the number of internal skins in each specimen;

c) the individual results for the apparent water absorption;

d) the mean value of the apparent water absorption to the nearest 0.5 %;

e) any deviations from this standard procedure;

f) date of test.

Annex C (informative) Burning properties of rigid polyurethane and polyisocyanurate foam and recommendations regarding their use

The fire performance of the finished structure or article which contains PUR or PIR foam is most relevant when considering the possible fire hazard associated with the foams.

These foams are organic material and hence are combustible. Care should be taken to avoid ignition, particularly since the burning rate of the foams, if exposed, can be significantly greater than that of wood.

The risk of ignition and fire growth association with PUR or PIR in building construction, industry, transport, etc. should be assessed in accordance with the recommendations of BS 6336 that is, consideration should be given to the design of the end product formed from or incorporating the foams and the risks to which they might be exposed. Recommendations on the provision of suitable protective measures, together with references to appropriate regulatory requirements are given in the British Standard specifications for the end product. In general, the performance of the latter is primarily controlled by the type of finish or facing used in conjunction with the foam and the way in which the composite is used.

This standard is concerned only with the specification of PUR and PIR foams as basic materials, formulated so that under certain well-defined conditions, their burning characteristics are reduced to a given level, assessed by testing to BS 4735.

Whilst treatment to this level can prevent sustained ignition of PUR and PIR by small energy sources such as a match or small burner flame, this is no longer true if the severity of the source is increased.

Once ignition has occurred, compliance with the limits specified in this standard ceases to be relevant and in fact any modification in formulation introduced to satisfy the requirement may adversely affect the levels of smoke and gaseous emissions generated in a “fully-developed” fire.

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List of references (see clause 2)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 4370, *Methods of test for rigid cellular materials.*

BS 4370-1:1988, *Methods 1 to 5.*

BS 4370-2:1993, *Methods 6 to 10.*

BS 4735:1974, *Laboratory method of test for assessment of the horizontal burning characteristics of specimens no larger than 150 mm × 50 mm × 13 mm (nominal) of cellular plastics and cellular rubber materials when subjected to a small flame.*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 6336:1982, *Guide to the development and presentation of fire tests and their use in hazard assessment.*

BS 7021:1989, *Code of practice for thermal insulation of roofs externally by means of sprayed polyurethane (PUR) or polyisocyanurate (PIR) foam.*

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