BRITISH STANDARD

BS 4840-2: 1994

Rigid polyurethane (PUR) foam in slab form —

Part 2: Specification for PUR foam for use in refrigerator cabinets, cold rooms and stores

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 Agrément
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 Industries 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)
RAPRA Technology Ltd.

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Contents

Foreword

This Part of BS 4840 has been prepared under the direction of the Plastics and Rubber Standards Policy Committee. It supersedes BS 4840-2:1985, which is withdrawn.

The 1985 revision of BS 4840:1973 resulted in the separation of the standard into two Parts to reflect more accurately the existing technology and use of rigid polyurethane (PUR) foam in slab form.

This edition introduces technical changes, but it does not reflect a full review or revision of the standard. 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.

Requirements have been included for thermal conductivity to be designated by the manufacturer.

Although this Part is intended primarily for quality assurance uses, guidance has been included for those involved in design work (Annex A).

This Part also contains guidelines (Annex B and Annex C) on burning properties and fire hazards. These guidelines are in accordance with the principles recommended in BS 6336:1982.

Attention is drawn to BS 2501:1992 and BS 2502:1979 which specify constructional requirements for commercial refrigeration cabinets, cold rooms and cold stores. Attention is also drawn to BS 3456-202.24:1990 which specifies requirements for domestic refrigeration appliances.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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 4840 specifies requirements for the composition, physical properties and dimensional tolerances of rigid polyurethane (PUR) foam in the form of slabs (blocks, boards and sheets) for the thermal insulation of refrigerator cabinets (domestic and commercial), cold rooms and cold stores.

2 References

2.1 Normative references

This Part of BS 4840 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriates 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 4840 only when incorporated in it by updating or revision.

2.2 Informative references

This Part of BS 4840 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 references should be made to the latest editions.

3 Designation

The material specified in this Part of BS 4840 is defined as type 2. 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 4840/2:1994;

b) a number indicating the foam type, i.e. 2;

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

An example of the designation for a type 2 foam with a thermal conductivity of 0.020 W/(m·K) is as follows:

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4 Composition and form

The slabs shall consist of rigid polyurethane (PUR) foam, shall be flat and shall have a uniform cellular structure.

NOTE No requirement for odour is included as its assessment is largely subjective. However, it is recommended that the material should be supplied free from objectionable odour. The slabs should also be supplied free from irregular surface skin.

Table 1 — Designation codes for thermal conductivity

Thermal conductivity[a] (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

[a] **CAUTION.** 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).

5 Sampling

In cases of doubt or dispute as to whether a consignment of slabs conforms to this standard, one slab shall be selected at random for test from each five hundred slabs of any consignment supplied, or from the total if this is less than five hundred. In the even of non-conformity of any slab to the requirements of this standard, two more slabs shall be tested from the same group of five hundred. If either of these fails, the consignment shall be considered not to conform to the requirements of this standard.

6 Physical properties

6.1 Thermal conductivity

Thermal conductivity shall be determined by either method 7A or method 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 guidance in Annex A concerning 3-day values and design values of thermal conductivity.

6.2 Other properties

The other physical properties shall conform to the requirements given in Table 2.

Table 2 — Physical property requirements

Physical property	Test requirement	Test method
Minimum compressive strength normal to the major plane of the slab, kPa	175	Method 3 of BS 4370-1:1988 Apply force normal to the major plane of the slab.
Dimensional stability: maximum mean linear change, % Test conditions: 24 h at (– 15 ± 2) °C 24 h at (100 ± 2) °C 24 h at (70 ± 2) °C and (95 ± 5) % r.h.	 1 2 3	Method 5A as described in **5.2** of BS 4370-1:1988 Cut the length and width of the test specimen parallel to the major plane of the slab.
Maximum water vapour permeability normal to the major plane of the slab, ng/(Pa s m)	5.5	Method 8 as described in clause **3** of BS 4370-2:1993 Carry out the test at (38 ± 0.5) °C and (88 ± 2) % r.h. on one face of the test specimen and at (38 ± 0.5) °C and 0 % r.h. on the other. Cut the cylindrical test specimens (25 ± 5) mm thick such that their plane faces are parallel to the major plane of the slab.
Maximum apparent water absorption by volume, %	6.5	Annex D
Minimum closed cell content apparent volume, %	85	Method 10 as described in clause **5** of BS 4370-2:1993
Burning characteristics[a]	Extent of burning not to exceed 125 mm	BS 4735:1974

[a] **CAUTION.** 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 the potential fire hazard of a material in use. (See Annex B and Annex C).

7 Dimensional tolerances

The permissible deviation of thickness shall be ± 1.5 mm.

Other dimensional tolerances shall conform to the requirements given in Table 3.

Table 3 — Dimensional tolerances for lengths, widths and diagonals

Lengths or widths mm	Permissible deviations of lengths or widths mm	Maximum difference between the longest diagonals of rectangular slabs mm
Up to and including 100	± 1	3
Over 100 up to and including 1 000	± 1.5	5
Over 1 000 up to and including 2 000	± 2.5	7
Over 2 000 up to and including 4 000	± 5	13
Over 4 000	± 10	25

8 Marking

The product, packages or invoice shall be marked with at least the following information:

a) manufacturer's name or trademark;

b) product designation in accordance with clause **3**[1)];

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

[1)] Marking BS 4840/2:1994 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) Guidance for designers

PUR slabstock foams of apparent densities 28 kg/m^3 to 35 kg/m^3 are normally suitable for refrigerator cabinets, cold rooms and stores.

The attention of designers is drawn specifically to the following points:

a) 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 value 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 that the quality of product is regularly maintained. Generally it will be lower than or equal to the 30-day value.

b) the need for water and moisture vapour barriers on the surfaces of the PUR foam;

c) the possibility of corrosion at the interface of PUR foam and metal surfaces in the presence of water vapour;

d) the possible deleterious effects, including odour, of some adhesives;

e) the fire performance of the complete structure, which is largely determined by the facings applied to the foam and the design of the component or structure (see Annex B); where Fire Regulations apply, these usually specify given ratings for Standard Fire Tests on specimens of the completed structure and should be considered at an early stage.

Annex B (informative) Burning properties of PUR foam and recommendations regarding its use

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

PUR foam is an organic material and hence is combustible. Care should be taken to avoid its ignition, particularly since the burning rate of the PUR foam, if exposed, can be significantly greater than that of wood.

The risk of ignition and fire growth associated with PUR foam in building construction, industry, transport, etc., should be assessed in accordance with the recommendations of BS 6336:1982, i.e. consideration should be given to the design of the end product formed from, or incorporating, the PUR foam and to the risks to which it might be exposed. Recommendations on the provision of suitable protective measures, together with references to appropriate regulatory requirements, are given in the British Standards for the end products. In general, the performance of the end product 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 foam as a basic material, formulated so that under certain well-defined conditions, its tendency to burn is reduced to a given level, when tested as described in BS 4735:1974.

Whilst formulation to this specification can prevent sustained ignition of PUR foam 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 the early ignition phase of the fire has passed, many other factors are involved in the development of the fire, and the requirement for extent of burning given in Table 2 ceases to be relevant; in fact, any modification in formulation introduced to satisfy the requirement may adversely affect the level of smoke generated in a fully-developed fire.

Care should be taken during the construction or repair of any structure or article which contains PUR foam. The use of heat sources such as welding torches in the vicinity of the foam should be avoided unless precise instructions are available on safety measures appropriate to the individual construction.

Annex C (informative) Guidance intended to minimize fire hazards

The following practices are recommended wherever PUR foam is manufactured, stored, fabricated or installed.

a) Maintain good housekeeping standards.

b) Observe stringent fire precautions, especially in respect of welding operations. Prohibition of smoking, except in designated areas, is advised.

c) Ensure that employees are fully aware of the potential fire hazards presented by these materials.

d) Consult the Health and Safety Executive for advice in respect of fire precautions during manufacture, storage and handling.

e) Maintain fire drill procedures in consultation with the Fire Authority.

f) Inform the Fire Authority of materials being used.

g) Install suitable fire protective systems as required by the situation, e.g. fire-segregated storage, automatic sprinkler system, fire detection system.

h) Ensure that the material is suitably installed with protective facings of materials that will give adequate protection against fire spread.

i) Observe the appropriate regulations in respect of fire performance of the finished structure.

j) Install suitable fire protection systems and observe fire precautions appropriate for the building structure and its intended uses.

k) Inform the Fire Authority if large quantities of PUR foam are used in the building structure.

Annex D (normative) Method for the determination of apparent water absorption

D.1 Principle

This method describes a procedure for determining the apparent water absorption of rigid cellular materials resulting from immersion in water under specified 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 displaced. 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.

D.2 Apparatus

D.2.1 *Balance,* capable of measurement to an accuracy of 0.01 g with provision for making submerged weighings.

D.2.2 *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.

D.2.3 *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.

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

D.2.5 *De-aerated distilled water*

D.2.6 *Low-permeability plastics film*

D.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, blemishes or skins and shall be prepared with a minimum of deformation of the original cellular structure so 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.

D.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.

D.5 Procedure

A minimum of three test specimens shall be tested. For each specimen determine the mean length, width and thickness of the 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 at (23 ± 2) °C into the immersion tank containing the underwater weighing jig. Immerse the test specimen in the water using the weighted mesh cage 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 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).

D.6 Calculation

Calculate the initial volume of the test specimen, V, in cubic centimetres, from the equation:

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

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, expressed as a percentage by volume, from the equation:

$$W = \frac{(V\delta + M_3 - M_2 - M_1) \times 100}{V\delta}$$

where

δ is the density of water, which is 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).

D.7 Test report

The report shall include the following:

a) the identification of the material;

b) the number of test specimens used;

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) the date of test.

blank

List of references (see clause 2)

Normative references

BSI standards publication
BRITISH STANDARD 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 standards publications
BRITISH STANDARD INSTITUTION, London

BS 2501:1992, *Specification for commercials refrigerated storage cabinets of the closed reach-in type.*
BS 2502:1979, *Specification for manufacturer of sectional cold rooms (walk-in type).*
BS 3456, *Specification for safety of household and similar electrical appliances.*
BS 3456-202, *Particular requirements.*
BS 3456-202.24:1990, *Refrigerators and food freezers.*
BS 4840, *Rigid polyurethane (PUR) foam in slab form.*
BS 4840-1:1985, *Specification for PUR foam for use in transport containers and insulated vehicle bodies.*
BS 6336:1982, *Guide to development and presentation of fire tests and their use in hazard assessment.*

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