Designation: C 240 – 97 (Reapproved 2003)

Standard Test Methods of Testing Cellular Glass Insulation Block[1]

This standard is issued under the fixed designation C 240; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 These test methods cover the testing of cellular glass insulation block for density, water absorption, compressive strength, flexural strength at ambient temperature; preparation for chemical analysis; and thermal conductivity measurements.

1.2 The values stated in SI are generally to be regarded as the standard. The SI dimensions are to be used for material supplied in metric sizes. The inch dimensions are to be used for material supplied in inch sizes.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 165 Test Method for Measuring Compressive Properties of Thermal Insulations[2]

C 168 Terminology Relating to Thermal Insulation[2]

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus[2]

C 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation[2]

C 303 Test Method for Dimensions and Density of Preformed Block and Broad-Type Thermal Insulation[2]

C 390 Practice for Sampling and Acceptance of Preformed Thermal Insulation Lots[2]

C 518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus[2]

C 871 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions[2]

D 226 Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing[3]

2.2 *ISO Standard:*

ISO 3951 Sampling Procedure and Charts for Inspection by Variables for Percent Nonconforming[4]

2.3 *Military Standard:*

MIL-I-24244 Specification Insulation Materials with Special Corrosion, Chloride, and Fluoride Requirements[5]

2.4 *Other Standard:*

NRC 1.36 Nonmetallic Thermal Insulation for Austenitic Stainless Steel[6]

3. Terminology

3.1 *Definitions*—Terminology C 168 shall be considered as applying to the terms considered in these test methods.

4. Significance and Use

4.1 From a general standpoint, these test methods outline the particular points which have to be taken into account when applying ASTM standard test methods to the case of cellular glass insulating block.

5. Test Methods

5.1 *General Sample Preparation*—All tests have to be run on dry specimens. In case of need, the sample must be unpacked and stored in a dry place in such a way that all surfaces are exposed to the ambient air for at least one day before testing.

5.2 *Density*—Determine the density in accordance with Test Method C 303. Preferably, the density shall be measured on a full block, 450 by 600 mm (18 by 24 in.) by full thickness.

5.2.1 It should be noted that density is interesting as such for calculation of insulated equipment load and because it has some influence on the other important properties of cellular glass. But it should not be considered in itself as a criterion for acceptance in the case of cellular glass.

5.3 *Water Absorption*:

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[1] These test methods are under the jurisdiction of ASTM Committee C16 on Thermal Insulation and are the direct responsibility of Subcommittee C16.32 on Mechanical Properties.

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[2] *Annual Book of ASTM Standards,* Vol 04.06.

[3] *Annual Book of ASTM Standards,* Vol 04.04.

[4] Available from American National Standards Institute, 25 W. 43nd St., 4th Floor, New York, NY 10036.

[5] Available from Standardization Documents Order Desk, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094.

[6] Available from Director of Regulatory Standards, US Atomic Energy Commission, Washington, DC 20545.

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5.3.1 *Scope*—This test method covers the determination of water absorption of cellular glass insulating blocks by measuring the amount of water retained as a result of complete immersion for a prescribed time interval. Surface blotting is used to correct for the water absorbed on the cut surface cells.

5.3.2 *Significance and Use*—This test method provides a means of measuring the water absorption of cellular glass insulating blocks under isothermal conditions as a result of direct immersion in liquid water. It is intended for use in product evaluation and quality control.

5.3.3 *Equipment and Materials*:

5.3.3.1 *Balance*, with about 1500 g capacity and at least 0.1 g sensitivity.

5.3.3.2 *Immersion Tank*, equipped with inert specimen supports and top surface weights such as stainless steel.

5.3.3.3 *Synthetic Sponge*, at least 100 by 180 by 40 mm (4 by 7 by 1.5 in.). Sponges found acceptable to use include cellulosic sponges and fine-pored absorbent synthetic plastic sponges.

5.3.3.4 *Test Room*, with temperature of 21 ± 3°C (70 ± 5°F) and relative humidity of 50 ± 10 %.

5.3.3.5 *Distilled Water*.

5.3.4 *Procedure*:

5.3.4.1 Carefully measure the thickness, width, and length to the nearest 1 mm of a cellular glass block, preferably 50 by 300 by 450 mm (2 by 12 by 18 in.) and calculate the volume and exposed surface area.

5.3.4.2 Weigh the specimen to the nearest 0.1 g (W_1), then submerge it horizontally under 25 mm (1 in.) of water maintained at 21 ± 3°C (70 ± 5°F). Inert top surface weights are required to keep it submerged. After submerging it for 2 h, set the specimen on end on a damp cotton bath towel to drain for 10 min. After the 10 min, remove the excess surface water by hand with a damp sponge for 1 min per large face and 1 min for the four sides. Wring out the sponge before and once in between for each face and pass at least two times on each surface. Blot each face of the specimen equally by compressing the sponge by at least 10 % of its thickness. Weigh the specimen immediately (W_2) to the nearest 0.1 g.

5.3.5 *Calculation of Results*—Calculate the weight of water absorbed ($W_2 - W_1$) and express it as a function of the exterior surface of the sample (g/cm ^{2}). Water absorption can also be expressed as a function of volume percent, absorbed water volume divided by specimen volume; or as a function of weight percent, weight of water absorbed ($W_2 - W_1$) divided by the dry specimen weight (W_1). Such ways of expressing the results should be strictly limited to direct comparison of results on specimens of identical sizes.

5.3.6 *Precision and Bias*—The precision as determined in inter-laboratory tests is given in Research Report RR C16-1007.[7] The repeatability or single-laboratory operator precision is ±0.00060 g/cm^2 or ±0.030 volume % (±1S). The reproducibility or multilaboratory operator precision is ±0.00071 g/cm^2 or ±0.035 volume %. Due to a lack of a standard, no statement can be made regarding bias.

[7] Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: C16 – 1007.

5.4 *Compressive Strength*—Determine the compressive strength in accordance with Test Method C 165 Procedure A, with the following test parameters and specimen preparation techniques:

5.4.1 Each of the two parallel bearing surfaces of the specimens shall be plane. If necessary, rub them on a suitable abrasive surface to produce the required flat surface.

5.4.2 The test specimens shall preferably be one half block 300 by 450 mm (12 by 18 in.) by nominal received thickness. Alternates include a quadrant 225 by 300 mm (9 by 12 in.) or a full block 450 by 600 mm (18 by 24 in.) by nominal received thickness. A quadrant specimen shall be taken from any one of four equal area quadrants of the preformed block. The minimum acceptable specimen size is 200 by 200 mm (8 by 8 in.). The report shall include the specimen size.

5.4.3 Cap both bearing surfaces of the specimens as follows: Coat one surface with molten Type III or Type IV asphalt (preheated to 177, + 28, − 14°C (350, + 50, − 25°F)), completely filling the surface cells with a small excess. Such a coating application rate is approximately 1.0 kg/m^2(0.20 lb/ft^2) ± 25%. Immediately press the hot coated block onto a precut piece of felt or paper laying on a flat surface. This is to prevent the asphalt surface from sticking to the compression platten during the test. A lightweight kraft paper is suitable, although traditionally a Type 1 roofing felt paper, commonly called a No. 15 asphalt felt, per Specification D 226 has been used.

NOTE 1—A hot asphalt capping is used to simulate field applied systems, which require a high load bearing insulation product, ranging from roof applications to cryogenic storage tank base applications. Uncapped material or different cappings will give different values.

Properly capped surfaces should be approximately plane and parallel. Set the specimens on edge, exposing both capped surfaces to room temperature for a minimum of 15 min to allow the asphalt to harden before testing.

5.4.4 The number of specimens to be tested and the sampling plan shall conform to Criteria C 390 where applicable. For the purpose of inspection by user's representative or independent third party, the number of specimens shall conform to ISO 3951 inspection level S-4, 10.0 % AQL using the S method.

5.4.5 Compress the specimen until failure. The deformation at failure will vary, depending on the thickness of insulation and the thickness of the capping materials. Record the loads at the failure point or definite yield point. The compressive strength is calculated from this load divided by the specimen cross sectional area in accordance with Test Method C 165.

5.4.6 The rate of loading will depend on the type of equipment used. With a hydraulic test machine use a constant load rate of 2200 N/s (500 lbf/s) for half block specimen. With a screw driven machine use a crosshead speed of 0.1 mm/min. (0.01 in./min.) per cm (in.) of specimen thickness, within a tolerance of ±25 %. Another alternate testing procedure is to reach failure within 30 to 90 s [nominal 16kPa/s (2.3 psi/s)].

5.4.7 Due to the sample preparation, with the inclusion of felts and asphalt, the method described in Test Method C 165 to determine compressive modulus of elasticity does not apply for cellular glass as a material by itself.

NOTE 2—It has been found extremely convenient to employ a partially

submerged roll (see Fig. 1) for applying the asphalt.

5.5 *Flexural Strength*—Determine flexural strength in accordance with Test Method C 203, Method I or Method II, Procedure A, preferably with a test specimen 25 mm thick by 100 mm wide by 300 mm long (1 in. thick by 4 in. wide by 12 in. long).

5.5.1 Measure the distance between the supports from center to center of the bearing bars.

5.5.2 The number of specimens to be tested and the sampling plan shall conform to Criteria C 390 where applicable. For the purpose of inspection by user's representative or independent third party, the minimum number of specimens shall conform to ISO 3951 inspection level S-3, 10.0 % AQL using the S method.

5.6 *Thermal Conductivity*—Determine the thermal conductivity in accordance with Test Method C 177 or Test Method C 518. In the case of cellular glass, the following points deserve special attention:

5.6.1 To achieve flatness and parallelism of the surface as required by Test Method C 177 or Test Method C 518, the following method is suggested:

5.6.1.1 By sawing from the original block, prepare a specimen with the required dimensions, its thickness being 2 or 3 mm greater than the final thickness should be.

5.6.1.2 Place the specimen on a flat metal plate slightly larger than the specimen itself and put two machined metal bars on the metal plate near two opposite sides of the specimen. Insert a uniform sheet of paper with a thickness about ¼ mm (0.01 in.) between the flat base plate and the metal bars but not under the sample. The metal bars are as thick as the final thickness of the specimen and machined so that their top and bottom surfaces are flat and parallel. Alternatively to machined bars, one can use cold-rolled steel bars. These bars generally are sufficiently flat and uniform in thickness.

5.6.1.3 Using a third straight metal bar long enough to lap metal bars on each side, carefully rub off the upper face of the specimen until the scraping bar just contacts the thickness bars.

5.6.1.4 Turn the specimen upside down and place it back on the flat metal plate and put the two metal bars on the metal plate near two opposite sides of the specimen, this time without the sheet of paper under each metal bar.

5.6.1.5 Repeat the rubbing operation described in 5.6.1.3.

5.6.1.6 If the specimens have to be shipped, provide adequate protection.

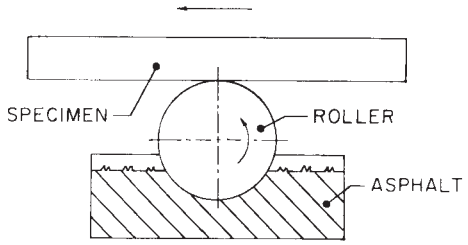

FIG. 1 Application of Hot Asphalt to Specimen Surfaces

5.6.2 Due to the rigid nature of the material and its open cell surface, it is preferable to have the thermocouples mounted on the surface of the plates and not adhered to the surface of the specimens.

5.6.3 For maximum accuracy, it is recommended that the temperature difference between the hot and cold surfaces of the specimens is such that the temperature gradient in the specimen equals or exceeds 900 K m^{-1}(40 F/in.). Avoid specimens made from several pieces of cellular glass. Joints are prohibited in the central measuring area and their number should be minimized in the guard area.

5.6.4 The number of specimens to be tested and the sampling plan shall conform to Criteria C 390 where applicable. For the purpose of inspection by user's representative or independent third party, the number of specimens shall conform to ISO 3951 inspection level S-3, 10.0 % AQL using the S method.

5.7 *Specimen Preparation for Chemical Analysis*—When specified in the purchase order or contract, the following chemical analysis results shall be furnished to the purchaser.

5.7.1 *Chemical Analysis for Leachable Chloride, (Fluoride), Silicate, and Sodium Ions*—Determine leachable chloride, (fluoride), silicate and sodium ions in accordance with Test Methods C 871, MIL-I-24244, or NRC 1.36, with the following exceptions or additions. The test specimen may be prepared for leaching by either of the following equivalent methods:

5.7.1.1 *Method A*—Break about 300 g of the sample into small size pieces about 13 mm (½ in.) or less. Comminute in a nominal 4-L (1-gal) mill one-third to one-half full of appropriate media for about 10 min. Screen out the − 200 + 325 mesh fraction of about 50 g, wash on the finer screen with 400 to 600 mL of cp methanol using a wash bottle, and dry on the screen to constant weight at 100 to 110°C (212 to 230°F). An appropriate grinding media is flint pebbles or alumina pebbles.

5.7.1.2 *Method B*—Break about 150 g of the sample into small size pieces about 13 mm (½ in.) or less. Comminute using either a manual or motorized mortar and pestle or a blender, and concurrently screen out the − 200 + 325 mesh fraction until about 50 g is accumulated. Wash the fraction on the finer screen with 400 to 600 mL of cp methanol, using a wash bottle, and dry on the screen to constant weight at 100 to 110°C (212 to 230°F).

NOTE 3—Alternatively, the sized fraction may be washed in a specially made small screen by dunking repeatedly into a container of methanol. In any case, the screens should be washed first with methanol.

5.7.2 All of the other chemical requirements of Test Methods C 871, MIL-I-24244, and NRC 1.36 are to be followed.

6. Report

6.1 The report shall include the following information:

6.1.1 Density, flexural strength and thermal conductivity shall be reported as designated in the appropriate method.

6.1.2 Water absorption, in g/cm^2.

6.1.3 Compressive strength in accordance with Test Method C 165, except that the dimensions of the test specimens shall also be recorded.

6.1.4 Chemical analysis results, if required, as specified in purchase order.

7. Keywords

7.1 breaking load; breaking strength; cellular materials; compressive strength; flexural strength; thermal insulating materials-glass; water absorption

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