IS 11239-9 (1988): Methods of Test for Rigid Cellular Thermal Insulation Materials, Part 9: Water Absorption [CHD 27: Thermal Insulation]

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Indian Standard

METHODS OF TEST FOR RIGID CELLULAR THERMAL INSULATION MATERIALS

PART 9 WATER ABSORPTION

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

 November 1988

Indian Standard

METHODS OF TEST FOR RIGID CELLULAR THERMAL INSULATION MATERIALS

PART 9 WATER ABSORPTION

0. FOREWORD

0.1 This Indian Standard (Part 9) was adopted by the Bureau of Indian Standards on 10 May 1988, after the draft finalized by the Thermal Insulation Materials Sectional Committee had been approved by the Chemical Division Council.

0.2 In the preparation of this standard, considerable assistance has been drawn from ISO 2896 'Determination of water absorption of rigid cellular plastics'.

0.3 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

*Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part 9) prescribes the method for determination of water absorption for rigid cellular thermal insulation materials.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 3069-1965* shall apply.

3. PRINCIPLE

3.1 Water absorption of rigid cellular thermal insulation materials is determined by measuring the change in the buoyant force resulting from immersion of a specimen under a 50 mm head of water for 7 days.

NOTE — Corrections are specified to take account of any change in volume of the specimen and also to correct for the volume of water in the cut surface cells of the specimen.

3.2 Water absorption may be expressed as a percentage by volume or as volume per unit surface area. The significance of these different values depends on both the material and its end use. Hence, results of the test are expressed in both the ways.

4. CONDITIONING

4.1 The test specimens shall be conditioned at 27 ± 2°C and 65 ± 5 percent relative humidity for at least 16 hours. The test shall be carried out at an ambient temperature of 27 ± 2°C immediately after conditioning.

*Glossary of terms, symbols and units relating to thermal insulation materials.

5. APPARATUS

5.1 Balance — Capable of weighing the test specimen to an accuracy of ±0·01 g.

5.2. Mesh Cage — Made of a stainless material not attacked by distilled water and large enough to contain the specimens. A sinker of approximately 125 g in mass (to compensate for the upthrust of the test specimens) shall be attached to the base of the cage. The cage shall be fitted with a means of suspending it from the balance (*see* Fig. 1).

5.3 Cylindrical Vessel — Approximately 3 litres in volume, approximately 120 mm in diameter and 240 mm in height.

5.4 Distilled Water — De-aerated.

5.5 Low-Permeability Plastic Film — For example, polyethylene.

6. SPECIMENS

6.1 The test specimens shall be in cubes of 50 ± 0·5 mm.

6.2 The distance between two faces shall not vary by more than 1 percent (tolerance of parallelism).

6.3 The test specimens shall be free from any moulding skin or facing.

NOTE — When the material supplied is less than 50 mm thick, thinner specimens can be used, provided that the specimen's thickness is not less than 15 mm. The thickness shall be stated in the test report.

7. NUMBER OF SPECIMENS

7.1 A set of three test specimens shall be tested.

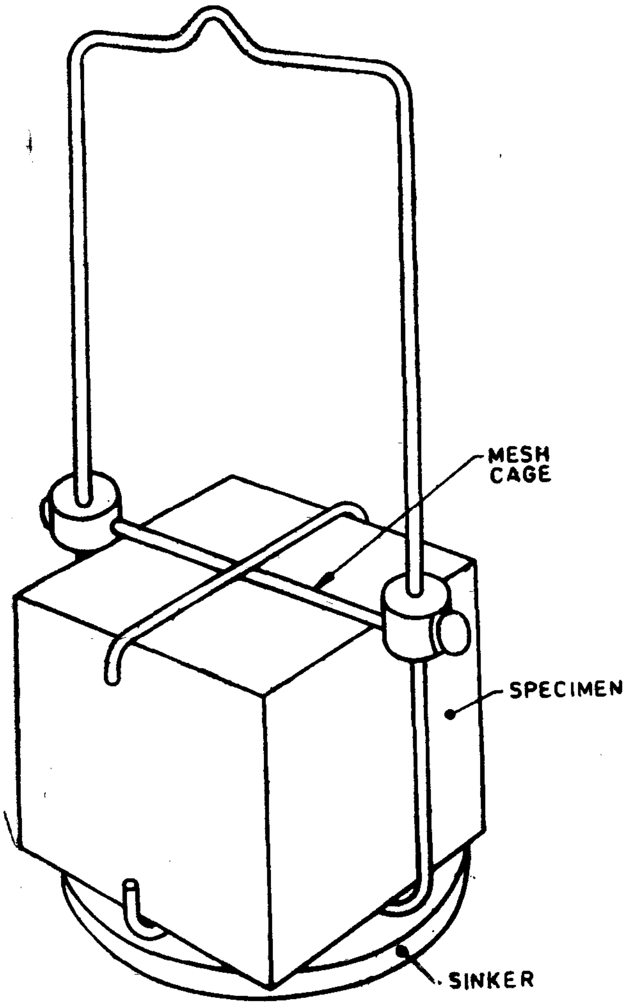


FIG. 1 SPECIMEN PLACED IN THE MESH CAGE

8. PROCEDURE

8.1 Fill the cylindrical vessel with de-aerated distilled water at room temperature maintained at 27 ± 2°C.

8.1.1 Weigh the specimen to the nearest 0·01 g (mass m_1). Before immersion in water, measure the dimensions of the specimen to an accuracy of ± 0·5 mm.

8.1.2 Immerse the assembled cage, remove any bubbles, attach it to the balance and determine the apparent mass (m_2) to the nearest 0·01 g.

8.1.3 Place the specimen in the cage, re-immerse the cage so that the distance between the surface of the water and the base of the specimen is approximately 100 mm. Remove obvious air bubbles from the specimen with a brush or by agitation.

8.1.4 After 7 days or otherwise agreed immersion period, determine the apparent mass (m_3) to the nearest 0·01 g of the submerged cage containing the specimen.

8.1.5 Between weighings, cover the cylindrical vessel with a low permeability plastic film.

8.2 After the immersion period, if the specimen shows no evidence of non-uniform deformation, proceed as follows.

8.2.1 Remove the specimen from the water and remeasure its dimension. The correction for uniform swelling of specimen, S_0 is:

$$S_0 = \frac{V_1 - V_0}{V_0}$$

where

V_0 = original volume of the specimen

$V_1 = \dfrac{d_1 \times l_1 \times b_1}{1\ 000}$

d_1 = specimen thickness in millimetres after immersion,

l_1 = specimen length in millimetres, after immersion, and

b_1 = specimen width in millimetres after immersion.

8.2.2 Correction for volume of water in the cut surface cells shall be done as under:

Determine the percentage of open cells as a function of the ratio of surface to volume of the specimen for at least three ratios obtained from the same original sample of material as the water absorption specimens (*see* Fig. 2).

From this graph, determine the correction factor, C for cut surface cells as follow:

Read off O_1=percentage open cells for ratio of surface to volume

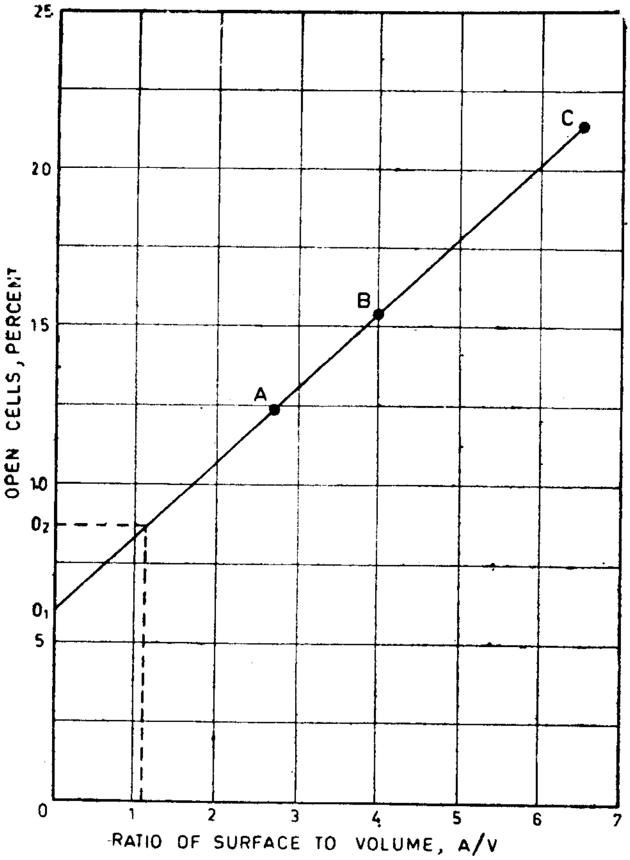
Read off O_2=percentage open cells for ratio of surface to volume of water absorption specimen=

$$\frac{A}{V_0} \text{ (see 9.1 and 9.2)} = \frac{O_2 - O_1}{100}$$

8.3 If the specimens show any evidence of non-uniform deformation, proceed as follows:

Obtain a cylindrical vessel similar to the one described in **5.3** but fitted with an over flow. Fill this vessel with water until it runs from the over flow. When the water level has stabilized, place a graduated receptacle of at least 150 cm³ capacity under the over flow. This receptacle must be capable of allowing the volume of water deposited in it to be measured to ±0·5 cm³ (this may be done by weighing).

Remove the specimen and cage from the original vessel. Allow to drain for approximately 2 min (until the surface water has drained). Carefully immerse the specimen and cage in the filled vessel and determine the volume of water displaced (V_2). Repeat this procedure with the empty cage to determine its volume (V_3).



'*A*' is the specimen total surface area in square centimetres and *V* is the specimen volume in cubic centimetres.

FIG. 2 PERCENTAGE OF OPEN CELLS AS A FUNCTION OF THE SURFACE TO VOLUME RATIO OF THE SPECIMEN

The combined swelling and surface correction factor is:

$$S_1 = \frac{V_2 - V_3 - V_0}{V_0}$$

where V_0 is the original volume of the specimen obtained in **9.1**.

9. CALCULATION

9.1 Calculate the original volume of the specimen :

$$V_0 = \frac{d \times l \times b}{1\ 000}$$

where

V_0 = original specimen volume in cubic centimetres;

d = original specimen thickness in millimetres;

l = original specimen length in millimetres; and

b = original specimen width in millimetres.

9.2 Calculate the surface area of the specimen

$$A = \frac{(l.b + l.d + b.d)}{50}$$

where A is the original surface area in square centimetres.

9.3 Calculate the water absorption, expressed as a percentage by volume (WA_V).

9.3.1 If the specimen has not deformed non-uniformly and the procedures in **8.2.2** were followed:

$$WA_V = m_3 + \frac{(l + S_0 - C) V_0 - (m_1 + m_2)}{V_0} \times 100$$

9.3.2 If the specimen deformed and the procedure in **8.3** was used:

$$WA_V = \frac{m_3 + (l + S_1) V_0 - (m_1 + m_2)}{V_0} \times 100$$

9.4 Calculate the water absorption per unit surface area (WA_A).

9.4.1 If the specimen has not deformed non-uniformly and the procedure in **8.2.1** was followed:

$$WA_A = \frac{m_3 + (l + S_0 - C) V_0 - (m_1 + m_2)}{A} \times 10^4 \text{ cm}^3/\text{m}^2$$

9.4.2 If the specimen deformed and the procedure in **8.3** was followed:

$$WA_A = \frac{m_3 + (l + S_1) V_0 - (m_1 + m_2)}{A} \times 10^4 \text{ cm}^3/\text{m}^2$$

10. TEST REPORT

10.1 The test report shall include the following:

a) description of the material including density;

b) the method of obtaining the test specimen·

c) the number of specimen used;

d) the individual results and mean expressed as a percentage by volume;

e) the individual results and mean expressed as volume per unit surface area;

f) the correction procedures used and their magnitude expressed as percentage by volume, that is:

$S_0 \times 100$
$S_1 \times 100$
$C \times 100$

g) the time of immersion;

h) if evaluated, a graph of absorption against times; and

j) any deviations from this standard or any observations relevant to the performance of the material.

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