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Rigid cellular plastics — Determination of water absorption

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FOREWORD

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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.

International Standard ISO 2896 was drawn up by Technical Committee ISO/TC 61, *Plastics*, and circulated to the Member Bodies in September 1972.

It has been approved by the Member Bodies of the following countries :

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The Member Body of the following country expressed disapproval of the document on technical grounds :

United Kingdom

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Rigid cellular plastics — Determination of water absorption

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard specifies a method for determining the water absorption of rigid cellular plastics by measuring the change in the buoyant force resulting from immersion of a specimen under a 50 mm head of water for 7 days. 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.

1.2 The method described is intended for quality control. If a full assessment of the water absorption characteristics of a material is required it is essential to determine this property over a range of immersion periods and obtain a graph of absorption against time.

1.3 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 ways.

2 REFERENCES

ISO/R 291, *Plastics — Standard atmospheres for conditioning and testing.*

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

3 PRINCIPLE

Determination of the water absorption by measurement of the variation of the upthrust of a specimen immersed in distilled water.

4 APPARATUS

4.1 Balance, accurate to 0,01 g.

4.2 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 figure 1 for an example.)

4.3 Cylindrical vessel, approximately 3 l in volume, approximately 120 mm in diameter and 240 mm in height.

4.4 Distilled water, de-aerated.

4.5 Low-permeability plastic film, for example polyethylene.

5 SPECIMENS

5.1 Dimensions

Specimens shall be cubes with edges of 50 ± 0,5 mm.

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

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

5.2 Preparation and conditioning

Free the specimens from any moulding skin, cut their faces with a mechanical saw, machine them, if necessary, without modifying the original structure of the product, and remove any dust.

Dry the specimens in a desiccator at room temperature until the results of two successive weighings, at intervals of at least 12 h, do not vary by more than 1 % of their mean.

Condition the specimens in one of the standard atmospheres defined in ISO/R 291.

5.3 Number of specimens

At least three specimens shall be tested.

6 PROCEDURE

6.1 Operate in a room where the temperature is maintained in accordance with ISO/R 291.

Fill the cylindrical vessel with de-aerated distilled water at room temperature.

Weigh the specimen to the nearest 0,01 g (mass m_1).

Before immersion in water, measure the dimensions of the specimen in accordance with ISO 1923.

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.

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.

After 7 days or other agreed immersion period (see 1.2), determine the apparent mass (m_3), to the nearest 0,01 g, of the submerged cage containing the specimen.

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

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

6.2.1 Remove the specimen from the water and remeasure its dimensions. The correction for uniform swelling of the specimen S_0 is

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

where

V_0 is the original volume of the specimen (see 7.1);

$$V_1 = \frac{d_1 \, l_1 \, b_1}{1\,000}$$

d_1 being the specimen thickness, in millimetres, after immersion;

l_1 being the specimen length, in millimetres, after immersion;

b_1 being the specimen width, in millimetres, after immersion.

6.2.2 For the correction for the volume of water in the cut surface cells, proceed as follows.

Using the method described in ISO . . .[1], determine the percentage of open cells as a function of the ratio of surface to volume of the specimen for at least three specimens obtained from the same original sample of material as the water absorption specimens (see figure 2).

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

Read off O_1 = Percentage open cells for ratio of surface to volume = 0.

Read off O_2 = Percentage open cells for ratio of surface to volume of water absorption specimen = $\frac{A}{V_0}$ (see 7.1 and 7.2).

$$C = \frac{O_2 - O_1}{100}$$

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

Obtain a cylindrical vessel similar to the one described in 4.3 but fitted with an overflow. Fill this vessel with water until it runs from the overflow. When the water level has stabilized, place a graduated receptacle of at least 150 cm^3 capacity under the overflow. This receptacle must be capable of allowing the volume of water deposited in it to be measured to ± 0,5 cm^3 (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).

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 7.1.

7 CALCULATION

7.1 Calculate the original volume of the specimen :

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

where

V_0 is the original specimen volume, in cubic centimetres;

d is the original specimen thickness, in millimetres;

l is the original specimen length, in millimetres;

b is the original specimen width, in millimetres.

7.2 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.

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

1) In preparation.

7.3.1 If the specimen has not deformed non-uniformly and the procedures in 6.2 were followed :

$$WA_V = \frac{m_3 + (1 + S_0 - C)\, V_0 - (m_1 + m_2)}{V_0} \times 100$$

7.3.2 If the specimen deformed and the procedure in 6.3 was used :

$$WA_V = \frac{m_3 + (1 + S_1)\, V_0 - (m_1 + m_2)}{V_0} \times 100$$

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

7.4.1 If the specimen has not deformed non-uniformly and the procedures in 6.2 were followed :

$$WA_A = \left[\frac{m_3 + (1 + S_0 - C)\, V_0 - (m_1 + m_2)}{A}\right] \times 10^4 \text{ cm}^3/\text{m}^2$$

7.4.2 If the specimen deformed and the procedure in 6.3 was followed :

$$WA_A = \left[\frac{m_3 + (1 + S_1)\, V_0 - (m_1 + m_2)}{A}\right] \times 10^4 \text{ cm}^3/\text{m}^2$$

8 TEST REPORT

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 specimens 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 a percentage by volume, i.e.

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

g) the times of immersion;

h) if evaluated, a graph of absorption against time;

i) any deviations from this International Standard or any observations relevant to the performance of the material.

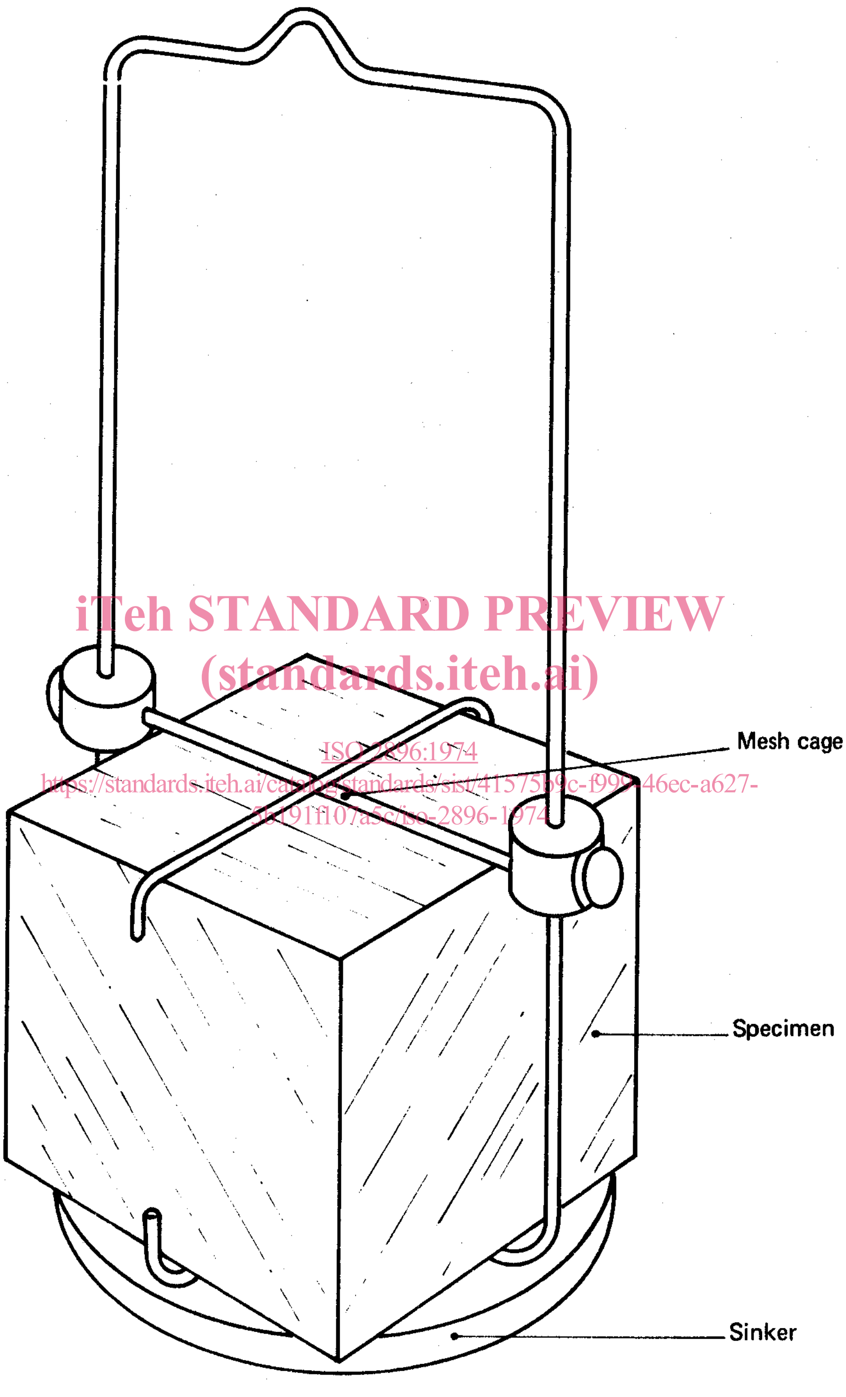

FIGURE 1 — **Specimen placed in the mesh cage**

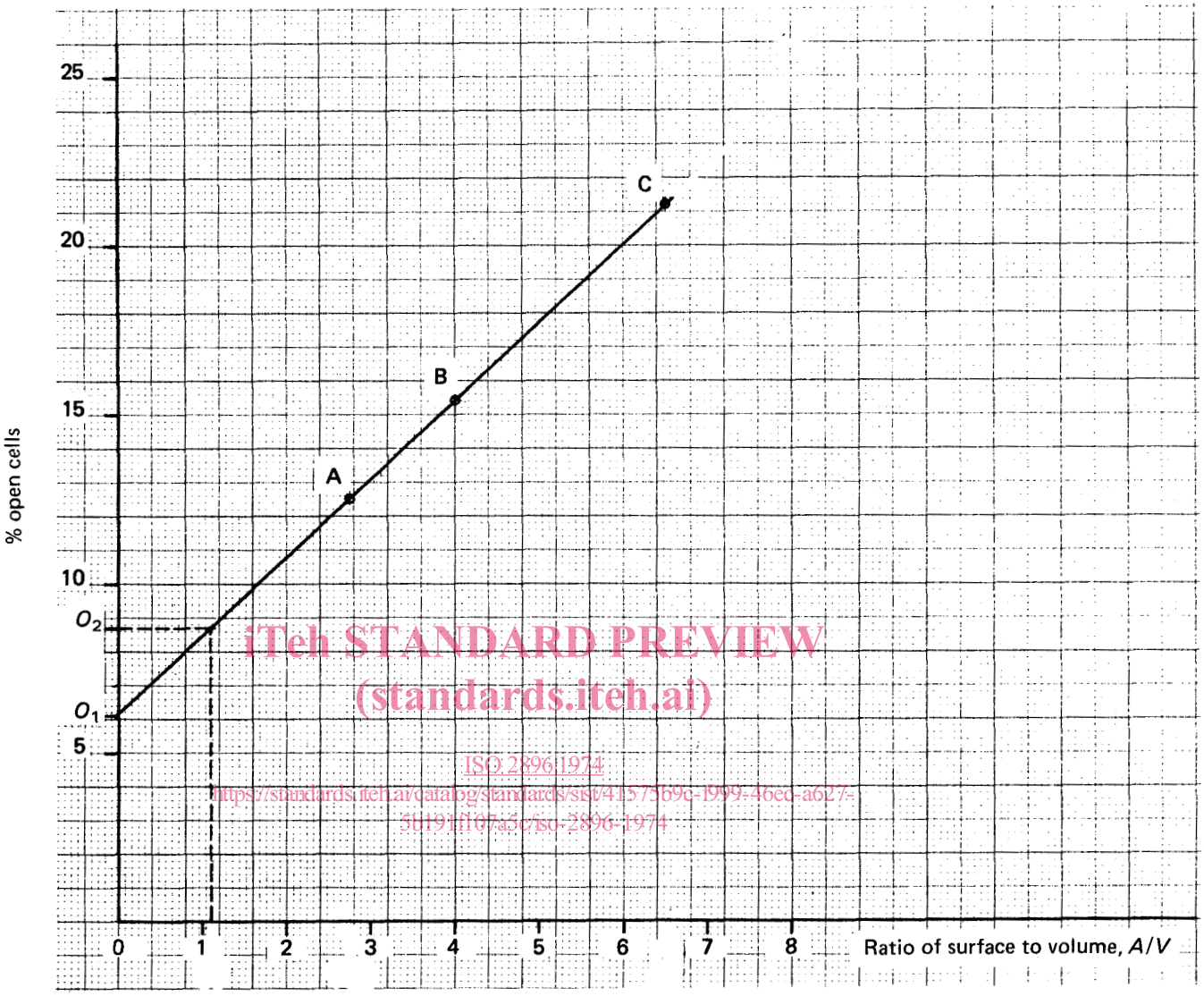

FIGURE 2 – **Percentage of open cells as a function of the surface to volume ratio of the specimen**
(A is the specimen total surface area in square centimetres; V is the specimen volume in cubic centimetres.)