International Standard 62

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Plastics — Determination of water absorption

Plastiques — Détermination de l'absorption d'eau

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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 62 was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in May 1978.

It has been approved by the member bodies of the following countries :

Australia	India	Romania
Austria	Iran	South Africa, Rep. of
Belgium	Israel	Spain
Bulgaria	Italy	Sweden
Canada	Japan	Switzerland
Czechoslovakia	Korea, Rep. of	Turkey
Finland	Mexico	United Kingdom
France	Netherlands	USA
Greece	New Zealand	USSR
Hungary	Poland	Yugoslavia

The member body of the following country expressed disapproval of the document on technical grounds :

Germany, F. R.

This International Standard cancels and replaces ISO Recommendations R 62-1958 and R 117-1959, of which it constitutes a technical revision.

Plastics — Determination of water absorption

0 Introduction

Under the action of water, a plastic may be subjected to two phenomena at more or less the same time :

— the absorption of water, sometimes accompanied by swelling;

— the extraction of any water-soluble constituents.

The action of the water may also result in changes in the dimensions and/or in the physical properties of the material.

The water absorption values of different plastics may be used for comparing their behaviour under moist conditions, but they do not represent the maximum amount of water that may be absorbed.

Comparison of the water absorption of various plastics is possible only if the test specimens are of identical dimensions and, as nearly as possible, in the same physical state.

Correspondence between the methods specified in this International Standard and the previous Recommendations ISO/R 62 and ISO/R 117 is indicated in the standard itself.

1 Scope and field of application

1.1 This International Standard specifies four conventional methods for the determination of the mass of water absorbed by a plastic test specimen of defined dimensions that is immersed in water for a specified time and at a specified temperature. Two of the methods are for use when it is desired to take account of the possible presence of water-soluble matter.

1.2 The four conventional methods specified are applicable to all plastics except cellular plastics and plastics that soften at the temperature of boiling water to an extent that causes them to lose their shape entirely. In the latter case, only tests at 23 °C are applicable.

1.3 The standard immersion periods are 24 h at 23 °C and 30 min at the boiling point of water, but provision is made for longer test durations, by agreement between the interested parties.

NOTE — Except for the variations in mass covered in this International Standard, the influence of water absorption on the properties of plastics should be determined in accordance with ISO 175.

2 References

ISO 175, *Plastics — Determination of the effects of liquid chemicals including water.*[1)]

ISO 293, *Plastics — Compression moulding test specimens of thermoplastic materials.*[2)]

ISO 294, *Plastics — Injection moulding test specimens of thermoplastic materials.*

ISO 295, *Plastics — Compression moulding test specimens of thermosetting materials.*

ISO 2508, *Unplasticized polyvinyl chloride (PVC) pipes — Determination of water absorption.*

ISO 2818, *Plastics — Preparation of test specimens by machining.*

3 Principle

Complete immersion of test specimens of the plastic material in water for a specified period of time and at a specified temperature. Determination of changes in the mass of the test specimens after immersion in water and if required after elimination of the water by drying.

The water absorption may be expressed in the following ways :

a) as the mass of water absorbed;

b) as the mass of water absorbed per unit of surface area;

1) At present at the stage of draft. (Revision of ISO/R 175 and ISO/R 462.)

2) At present at the stage of draft. (Revision of ISO 293-1974.)

c) as a percentage by mass of water absorbed with respect to the mass of the test specimen.

IMPORTANT NOTE — Comparisons between various plastics on the basis of this test are valid only if the test specimens are of identical dimensions and, as nearly as possible, in the same physical state (surface, internal stress, etc.).

4 Apparatus

4.1 Balance, with an accuracy of 1 mg.

4.2 Oven, capable of being controlled at 50 ± 2 °C or at any other agreed temperature (see clause 6, note 2).

4.3 Containers, containing distilled water, or water of equivalent purity, equipped with a means of heating and capable of being controlled at the temperature specified.

4.4 Desiccator.

4.5 Means of measuring dimensions of specimens, if required (see 7.2.1).

5 Test specimens

Three specimens shall be tested. They may be obtained directly by moulding or by machining. In the latter case, the cut surface shall be smooth and shall not show any trace of charring that may be due to the method of preparation.

5.1 Moulding material

The test specimen shall have a diameter of 50 ± 1 mm and a thickness of 3 ± 0,2 mm. It shall be moulded under the conditions given in the relevant specification for the material (or under the conditions prescribed by the supplier of the material).

NOTES

1 The general principles for preparing moulded test specimens are the subject of the following International Standards : ISO 293, ISO 294 and ISO 295.

2 In certain specific cases, a square test specimen of side 50 ± 1 mm and a thickness of 4 ± 0,2 mm may be used by agreement between the interested parties.

5.2 Extrusion compounds

The test specimen shall have a diameter of 50 ± 1 mm and a thickness of 3 ± 0,2 mm. It shall be cut from a sheet of this thickness, prepared under the conditions given in the relevant specification for the material (or under the conditions prescribed by the supplier of the material).

5.3 Sheet

The specimen shall be 50 ± 1 mm square and shall be machined from the sheet under test, for example in accordance with ISO 2818.

The thickness of the test specimen shall be the same as that of the sheet under test if the nominal thickness of the sheet is equal to or less than 25 mm.

If the nominal thickness is greater than 25 mm and in the absence of special provisions in the relevant specification, the thickness of the test specimen shall be reduced to 25 mm by machining on one surface only.

5.4 Tubes and rods

5.4.1 Tubes

When possible, reference shall be made to the relevant International Standards for the material under test.[1] In the absence of specific International Standards, the test specimen shall be a piece of tube, of length 50 ± 1 mm, obtained by cutting it at right angles to its longitudinal axis.

For tubes of outside diameter larger than 50 mm, a length of 50 ± 1 mm shall be cut and the test specimen prepared from this length by making a cut along each of two planes containing the longitudinal axis of the tube, so as to give a developed width of 50 ± 1 mm when measured on the outer surface.

5.4.2 Rods

For rods of diameter below or equal to 50 mm, the test specimen shall be a piece of the rod, of length 50 ± 1mm, obtained by cutting it at right angles to its longitudinal axis.

For rods of diameter greater than 50 mm, in the absence of any specification agreed between the interested parties, the test specimen shall be a 50 ± 1 mm length of the rod with its diameter reduced to 50 ± 1 mm by machining concentrically.

5.5 Profiles

In the absence of specific International Standards, a piece of the profile of length 50 ± 1 mm shall be cut and the test specimen shall be either :

a) this piece of the profile, or

b) this piece after machining so as to reduce one or more of the dimensions of the cross-section of the profile in such a way that the thickness in particular is as near as possible to 3 ± 0,2 mm. In this case, the dimensions to be obtained and the machining conditions shall be the subject of an agreement between the interested parties.

1) For example, for rigid unplasticized PVC pipes, see ISO 2508.

6 Procedure

NOTES

1 With certain materials it may be necessary to weigh the test specimens in a weighing vessel.

2 Other drying procedures than those described in 6.2 to 6.5 may be used by agreement between the interested parties.

6.1 General conditions

6.1.1 The volume of water used shall be at least 8 ml per square centimetre of the total surface of the test specimens, so as to avoid any extraction product becoming excessively concentrated in the water during the test.

6.1.2 In general, place each set of three test specimens in a separate container (4.3) with the specimens immersed completely in the water.

However, when several samples of the same composition have to be tested, it is permissible to place several sets of test specimens in the same container.

In no case shall any significant area of the surface of a test specimen come into contact with the surface of other test specimens, or with the walls of the container.

6.1.3 The times for immersion in the water are stated in 6.2 and 6.4. However, longer times may be used by agreement between the interested parties. In such cases the following precautions shall be taken :

— If testing in water at 23 °C, agitate the water at least once daily, for example by rotating the containers.

— If testing in boiling water, add boiling water from time to time, as required to maintain the volume.

6.2 Method 1 [Formerly procedure A in ISO/R 62-1958]

Dry three test specimens for 24 ± 1 h in the oven (4.2) controlled at 50 ± 2 °C, allow to cool to ambient temperature in the desiccator (4.4) and weigh each specimen to the nearest 1 mg (mass m_1). Then place the specimens in a container (4.3) containing distilled water, controlled at 23 °C with a tolerance of ± 0,5 °C or ± 2 °C according to the relevant specification. In the absence of a specification, the tolerance shall be ± 0,5 °C.

After immersion for 24 ± 1 h, take the specimens from the water and remove all surface water with a clean, dry cloth or with filter paper. Re-weigh the specimens to the nearest 1 mg within 1 min of taking them from the water (mass m_2).

6.3 Method 2 [Formerly procedure B in ISO/R 62-1958]

If it is desired to allow for the presence of water-soluble matter, dry the test specimens again for 24 ± 1 h in the oven (4.2), controlled at 50 ± 2 °C, after completion of method 1 (6.2). Allow the specimens to cool to ambient temperature in the desiccator (4.4) and reweigh to the nearest 1 mg (mass m_3).

6.4 Method 3 [Formerly procedure A in ISO/R 117-1959]

Dry three test specimens for 24 ± 1 h in the oven (4.2), controlled at 50 ± 2 °C, allow to cool to ambient temperature in the desiccator (4.4) and weigh each specimen to the nearest 1 mg (mass m_1). Place the specimens in a container (4.3) containing boiling distilled water.

After immersion for 30 ± 1 min, take the specimens from the boiling water and allow them to cool for 15 ± 1 min in distilled water at ambient temperature. Take the specimens from the water and remove all surface water with a clean, dry cloth or with filter paper. Re-weigh the specimens to the nearest 1 mg within 1 min of taking them from the water (mass m_2).

6.5 Method 4 [Formerly procedure B in ISO/R 117-1959]

If it is desired to allow for the presence of water-soluble matter dry the test specimens again for 24 ± 1 h in the oven (4.2), controlled at 50 ± 2 °C, after completion of method 3 (6.4). Allow the specimens to cool to ambient temperature in the desiccator (4.4) and re-weigh to the nearest 1 mg (mass m_3).

7 Expression of results

7.1 Standard way of expressing results (as the mass of water absorbed)

7.1.1 For methods 1 and 3, calculate for each test specimen the mass, in milligrams, of water absorbed, according to the formula

$$m_2 - m_1$$

where

m_1 is the mass, in milligrams, of the test specimen before immersion;

m_2 is the mass, in milligrams, of the test specimen after immersion.

7.1.2 For methods 2 and 4, calculate for each test specimen the mass, in milligrams, of water absorbed, according to the formula

$$m_2 - m_3$$

where

m_2 is as defined in 7.1.1;

m_3 is the mass, in milligrams, of the test specimen after immersion and drying.

7.1.3 For all four methods, express the result as the arithmetic mean of the three values obtained.

7.2 Other possible ways of expressing results

If the material specification so demands, or by agreement between the interested parties, the results may be expressed in one of the following ways.

7.2.1 As the mass of water absorbed per unit of surface area

Calculate for each test specimen the water absorption, in milligrams per square centimetre, by the following formulae, as appropriate :

$$\frac{m_2 - m_1}{A} \quad \text{or} \quad \frac{m_2 - m_3}{A}$$

where

m_1, m_2 and m_3 are as defined in 7.1.1 and 7.1.2;

A is the initial total surface area, in square centimetres, of the test specimen.

7.2.2 As a percentage by mass of water absorbed

Calculate for each test specimen the water absorption as a percentage by mass of the initial mass, by the following formulae, as appropriate :

$$\frac{m_2 - m_1}{m_1} \times 100 \quad \text{or} \quad \frac{m_2 - m_3}{m_1} \times 100$$

NOTE — If it is required to express the water absorption as a percentage of the mass of the test specimen after drying, use the formula

$$\frac{m_2 - m_3}{m_3} \times 100$$

where m_1, m_2 and m_3 are as defined in 7.1.1 and 7.1.2.

7.2.3 For the calculations described in 7.2.1 and 7.2.2, express the result as the arithmetic mean of the three values obtained.

8 Test report

The test report shall include the following particulars :

a) reference to this International Standard;

b) complete identification of the material or the product tested;

c) the type of test specimens used, the method of preparing them, their dimensions, their initial mass, and, if applicable, their initial surface area and their surface condition (for example whether machined or not);

d) the method (1, 2, 3 or 4) used and the immersion period if this is different from that specified in the method;

e) the water absorption calculated by one or more of the ways of expressing results given in clause 7;

NOTE — If the calculations described in 7.1 and 7.2 give a negative value for water absorption, this fact should be stated clearly in the test report.

f) any incidents likely to have affected the results.