INTERNATIONAL STANDARD

ISO 2577

Third edition
2007-12-15

Plastics — Thermosetting moulding materials — Determination of shrinkage

Plastiques — Matières à mouler thermodurcissables — Détermination du retrait

Reference number
ISO 2577:2007(E)

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Published in Switzerland

Foreword

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 2577 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 12, *Thermosetting materials*.

This third edition cancels and replaces the second edition (ISO 2577:1984), which has been technically revised.

Plastics — Thermosetting moulding materials — Determination of shrinkage

1 Scope

This International Standard specifies a method of determining the moulding shrinkage and the shrinkage after heat treatment of moulded test specimens of thermosetting moulding materials.

These characteristics are useful for the production control of thermosetting material and for checking uniformity of manufacture. Furthermore, knowledge of the initial shrinkage of thermosetting materials is important for the construction of moulds, and knowledge of post-shrinkage for establishing the suitability of the moulding material for the manufacture of moulded pieces with accurate dimensions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 10724-1, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 1: General principles and moulding of multipurpose test specimens*

ISO 10724-2, *Plastics — Injection moulding of test specimens of thermosetting powder moulding compounds (PMCs) — Part 2: Small plates*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
moulding shrinkage
difference in dimensions between a moulding and the mould cavity in which it was moulded, both the mould and the moulding being at normal temperature when measured

3.2
post-shrinkage
shrinkage of a plastic product after moulding, during post-treatment, storage or use

4 Apparatus

4.1 Mould, press, etc., suitable for moulding the test specimens specified in Clause 6. For compression moulding, a positive or a semi-positive mould with single or multiple cavities shall be used. For injection moulding, the type D2 ISO mould, giving 60 mm × 60 mm × 2 mm specimens, as specified in ISO 10724-2:1998, Clause 4, shall be used.

If required, marks may be engraved in the mould near opposite ends of the specimen to facilitate the accurate measurement of the length of the cavity and the specimens.

NOTE If multiple cavities are used with a positive mould, resulting variations in test specimen density may be sufficient to produce inconsistent shrinkage.

4.2 Equipment, suitable for measuring the lengths of the test specimen and the corresponding cavity of the mould to within 0,02 mm.

4.3 Oven (for post-shrinkage only).

5 Sampling

A representative sample shall be taken from the moulding material and be kept at room temperature in airtight containers, without any conditioning, until moulded into test specimens.

6 Test specimens

6.1 The test specimens shall be:

a) for compression moulding — bars of length 120 mm, width 15 mm and thickness 10 mm;

b) for injection moulding — flat square plates measuring approximately 60 mm × 60 mm × 2 mm.

6.2 The specimens shall be moulded to shape by compression or injection moulding using a mould with single or multiple cavities.

7 Procedure

7.1 If not already known, measure the lengths of the cavities (or the distances between the engraved marks in the mould) to the nearest 0,02 mm at a temperature of 23 °C ± 2 °C.

Record these measurements for use in the calculation of shrinkage.

From time to time, moulds should be checked for wear, etc. As an alternative to measuring directly the lengths of the cold moulds, the gauges for the moulds may be obtained very precisely by cold-moulding specimens from lead and measuring their lengths.

7.2 Mould at least two specimens from the sample to be tested, under the conditions given below:

a) For compression moulding:

Mould the specimens under the conditions of pressure, temperature, time, etc., specified in ISO 295 or in the relevant specification for the material.

b) For injection moulding:

Mould the specimens under the conditions specified in ISO 10724-2:1998, Clause 5, and ISO 10724-1.

In the case of fibrous materials that are to be injection-moulded as a plate, at least four specimens shall be tested.

7.3 After removal from the mould, allow the test specimens to cool to room temperature by placing them on a material with low thermal conductivity and under an appropriate load to avoid warping. Store them at a

temperature of 23 °C ± 2 °C and a relative humidity of 45 % to 55 % for between 16 h and 72 h, or for such shorter time as can be shown to give the same test results.

7.4 Before measuring the lengths of the test specimens, place them on a flat surface or against a straight edge in order to determine any warp or distortion. Any test specimen that has a warp exceeding 1 % of its length shall be discarded.

7.5 For the determination of moulding shrinkage, measure, to the nearest 0,02 mm, the lengths of bar specimens parallel to their major axis between opposite end faces or the distances between the gauge marks, at a temperature of 23 °C ± 2 °C. Measurement of plate specimens shall be made at distance of 20 mm from the corners, making two measurements in the same direction.

NOTE In order to measure the effect of orientation on the shrinkage of an injection-moulded specimen, shrinkages in two directions at right-angles (each of which is calculated from an average of two measurements in the same direction) are measured and calculated independently.

7.6 For the determination of post-shrinkage, place the test specimens, measured as described in 7.5, in an oven maintained at the temperature given below. Support the specimens to avoid deformation and in such a way that they are separated from each other.

The heating temperatures shall be:

80 °C ± 2 °C for urea-formaldehyde moulding materials;

110 °C ± 3 °C for all other thermosetting moulding materials.

The times of exposure shall be:

48 h ± 1 h for rapid determination;

168 h ± 2 h for normal determination.

Post-shrinkage depends strongly on the time of exposure. Therefore the exposure time shall be noted [see 8.2 and Clause 9, item f)] and shall be as specified in the specification for the material.

At the end of the heating period, remove the test specimens from the oven and allow them to cool in a standard atmosphere of 23 °C ± 2 °C and a relative humidity of 45 % to 55 % for at least 3 h.

After the cooling period, measure the test specimens again, at a temperature of 23 °C ± 2 °C, to the nearest 0,02 mm, as specified in 7.5.

8 Expression of results

8.1 The moulding shrinkage (MS) is given, as a percentage, by the equation:

$$MS = \frac{L_0 - L_1}{L_0} \times 100$$

where

L_0 is the length, in millimetres, of the dimension of the mould, determined as in 7.1;

L_1 is the length, in millimetres, of the corresponding dimension measured on the test specimen in accordance with 7.5.

NOTE When shrinkage is being determined using injection-moulded plates, L_0 and L_1 are each the average of two readings, measured in the same direction, taken 20 mm from the corners of the mould and the test specimen, respectively.

8.2 Post-shrinkage (PS) is given, as a percentage, by the equation:

$$PS_{48\,h} \text{ or } PS_{168\,h} = \frac{L_1 - L_2}{L_1} \times 100$$

where

L_1 is as defined in 8.1;

L_2 is the length, in millimetres, of the same dimension of the test specimen, measured after heat treatment for 48 h or 168 h in accordance with 7.6.

NOTE When post-shrinkage is being determined using injection-moulded plates, L_2 is the average of two readings, measured in the same direction, taken 20 mm from the corners of the test specimen.

9 Test report

The test report shall include the following particulars:

a) a reference to this International Standard;

b) the grade and designation of the moulding material;

c) the type of test specimen used (bar or plate);

d) the method of moulding the specimens (compression or injection) and the moulding conditions;

e) the number of test specimens discarded because of excessive warping;

f) the conditions of heat treatment for the determination of post-shrinkage;

g) the moulding shrinkage (MS) and the post-shrinkage ($PS_{48\,h}$ and/or $PS_{168\,h}$), as a percentage, including the individual values, the arithmetic mean and, for injection-moulded plates, the direction of measurement with respect to the direction of injection;

h) the dates of moulding the test specimens, measurement of moulding shrinkage, post-shrinkage heat treatment, and measurement of post-shrinkage.