INTERNATIONAL STANDARD

ISO 75-2

Second edition
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Plastics — Determination of temperature of deflection under load —

Part 2: Plastics and ebonite

Plastiques — Détermination de la température de fléchissement sous charge —

Partie 2: Plastiques et ébonite

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 75-2 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical properties.*

This second edition cancels and replaces the first edition (ISO 75-2:1993), which has been technically revised.

ISO 75 consists of the following parts, under the general title *Plastics — Determination of temperature of deflection under load*:

— *Part 1: General test method*

— *Part 2: Plastics and ebonite*

— *Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics*

Annex A forms a normative part of this part of ISO 75. Annex B is for information only.

Introduction

ISO 75-1:1993 and ISO 75-2:1993 described three methods (A, B and C) using different test loads and two specimen positions, edgewise and flatwise. For testing in the flatwise position, test specimens with dimensions 80 mm × 10 mm × 4 mm were required. These can be moulded directly or machined from the central section of the multipurpose test specimen (see ISO 3167). These "ISO bars" cannot be easily used in the edgewise position, because this would require both a reduction in span and an increase in test load by the same factor, and this may be impossible to achieve on existing instruments for edgewise testing. Specimens for testing in the edgewise position are less closely specified. Using the 80 mm × 10 mm × 4 mm ISO bar has the following advantages:

— Thermal expansion of the test specimen has less influence on the test result.

— Draft angles do not influence the test result. The specimen does not stand "on edge".

— The moulding parameters and the specimen dimensions are specified more closely.

This increases the comparability of the test results. Therefore, it was decided that the possibility of testing in the edgewise position would be deleted from the standard. In order to provide a sufficient transition period, in this edition the flatwise position is described as the preferred and recommended one, while testing in the edgewise position is optional and has been moved to a normative annex (in this part of ISO 75). This annex and all other references to edgewise testing will be deleted on occasion of the next revision of this document.

Earlier editions of this International Standard allowed methods other than using a heating bath for heating the test specimen, namely forced-circulation ovens or fluidized beds. None of these alternative methods is widely used and no proven instruments are commercially available. Furthermore, there is no general comparability between tests using different heating methods due to the differences in the heat transfer characteristics and the temperature control methods described in this standard.

Therefore only heating in heating baths is allowed in this edition.

In order to maintain consistency with ISO 10350-1:1998, T_f has been used as the symbol for temperature of deflection under load.

Plastics — Determination of temperature of deflection under load —

Part 2: Plastics and ebonite

1 Scope

This part of ISO 75 specifies three methods, using different values of constant flexural stress, that can be used for the determination of the temperature of deflection under load of plastics (including filled plastics and fibre-reinforced plastics in which the fibre length, prior to processing, is up to 7,5 mm) and ebonite:

— method A, using a flexural stress of 1,80 MPa;

— method B, using a flexural stress of 0,45 MPa;

— method C, using a flexural stress of 8,00 MPa.

The standard deflection Δs used to determine the temperature of deflection under load corresponds to a flexural-strain increase $\Delta\varepsilon_f$ defined in this part of ISO 75. The initial flexural strain due to the loading of the specimen at room temperature is neither specified nor measured in this part of ISO 75. The ratio of this flexural-strain difference to the initial flexural strain depends on the modulus of elasticity, at room temperature, of the material under test. This method is therefore only suitable for comparing the temperatures of deflection of materials with similar room-temperature elastic properties.

NOTE The methods give better reproducibility with amorphous plastics than with semi-crystalline ones. With some materials, it may be necessary to anneal the test specimens to obtain reliable results. Annealing procedures, if used, generally result in an increase in the temperature of deflection under load (see 6.6).

For additional information, see ISO 75-1:2004, clause 1.

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 75-1:2004, *Plastics — Determination of temperature of deflection under load — Part 1: General test method*

ISO 293, *Plastics — Compression moulding test specimens of thermoplastic materials*

ISO 294-1, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar test specimens*

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

ISO 3167, *Plastics — Multipurpose test specimens*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 75-1 apply.

NOTE Depending on the selected value of the flexural stress (see clause 1), the temperature of deflection under load (see definition 3.7 in ISO 75-1:2004) is designated as $T_{fx}0{,}45$, $T_{fx}1{,}8$ or $T_{fx}8{,}0$ (where x = f for flatwise testing and x = e for edgewise testing).

4 Principle

See ISO 75-1:2004, clause 4.

5 Apparatus

5.1 Means of producing a flexural stress

See ISO 75-1:2004, subclause 5.1.

The span (distance between the lines of contact between specimen and supports) shall be (64 ± 1) mm for testing in the preferred (flatwise) position. See annex A for testing in the edgewise position.

5.2 Heating equipment

See ISO 75-1:2004, subclause 5.2.

5.3 Weights

See ISO 75-1:2004, subclause 5.3.

5.4 Temperature-measuring instrument

See ISO 75-1:2004, subclause 5.4.

5.5 Deflection-measuring instrument

See ISO 75-1:2004, subclause 5.5.

6 Test specimens

6.1 General

See ISO 75-1:2004, subclause 6.1.

6.2 Shape and dimensions

See ISO 75-1:2004, subclause 6.2.

The preferred test-specimen dimensions are:

length l: (80 ± 2,0) mm;

width b: (10 ± 0,2) mm;

thickness h: (4 ± 0,2) mm.

See annex A for dimensions of test specimens for edgewise testing.

6.3 Specimen inspection

See ISO 75-1:2004, subclause 6.3.

6.4 Number of test specimens

See ISO 75-1:2004, subclause 6.4.

6.5 Test-specimen preparation

Test specimens shall be produced in accordance with ISO 293 (and ISO 2818, if applicable), or in accordance with ISO 294-1 or ISO 10724-1, or as agreed by the interested parties. The test results obtained on moulded test specimens depend on the moulding conditions used in their preparation. The moulding conditions shall be in accordance with the standard for the material concerned, or as agreed by the interested parties.

In the case of compression-moulded specimens, the thickness shall be in the direction of the moulding force. For materials in sheet form, the thickness of the test specimens (this dimension is usually the thickness of the sheet) shall be in the range 3 mm to 13 mm, preferably between 4 mm and 6 mm.

The specimen can be taken from the narrow central part of the multipurpose test specimen specified in ISO 3167.

6.6 Annealing

Discrepancies in test results due to variations in moulding conditions can be minimized by annealing the test specimens before testing them. Since different materials require different annealing conditions, annealing procedures shall be employed only if required by the materials standard or if agreed upon by the interested parties.

7 Conditioning

See ISO 75-1:2004, clause 7.

8 Procedure (flatwise testing)

8.1 Calculation of force to be applied

See ISO 75-1:2004, subclause 8.1.

The flexural stress produced shall be one of the following:

1,80 MPa (preferred value), in which case the method is designated method A;

0,45 MPa, in which case the method is designated method B;

8,00 MPa, in which case the method is designated method C.

8.2 Initial temperature of the heating equipment

See ISO 75-1:2004, subclause 8.2.

8.3 Measurement

See ISO 75-1:2004, subclause 8.3.

Apply the force required to produce one of the flexural stresses specified in 8.1 of this part of ISO 75.

Calculate the standard deflection Δs by means of equation (5) in ISO 75-1:2004, using a value of 0,2 % for the flexural-strain increase $\Delta \varepsilon_f$.

Record the temperature at which the initial deflection of the bar has increased by the standard deflection. This temperature is the temperature of deflection under load. If the individual results for amorphous plastics or ebonite differ by more than 2 °C, or those for semi-crystalline materials by more than 5 °C, repeat tests shall be carried out.

NOTE 1 Table 1 gives examples of standard deflections for the preferred dimensions of test specimens tested in the flatwise position. See annex A for testing in the edgewise position.

Table 1 — Standard deflections for different test-specimen heights for a 80 mm × 10 mm × 4 mm specimen tested in the flatwise position

Test-specimen height (thickness h of specimen) mm	**Standard deflection** mm
3,8	0,36
3,9	0,35
4,0	0,34
4,1	0,33
4,2	0,32

NOTE 2 The thicknesses in Table 1 reflect the acceptable variation in the test-specimen dimensions (see 6.2).

9 Expression of results

See ISO 75-1:2004, clause 9.

10 Precision

See Annex B.

11 Test report

See ISO 75-1:2004, clause 11.

The test report shall also include the following additional information:

l) the value of the standard deflection used.

In item i) of the test report, indicate the flexural stress used by means of the following designation system:

— for flatwise testing: T_{ff} 0,45 for method B, T_{ff} 1,8 for method A or T_{ff} 8,0 for method C;

— for edgewise testing: T_{fe} 0,45 for method B, T_{fe} 1,8 for method A or T_{fe} 8,0 for method C.

Annex A
(normative)

Testing in the edgewise position

A.1 General

Carrying out the test in the flatwise position with the smaller (80 mm x 10 mm x 4 mm) specimen is preferred to testing in the edgewise position because it gives a number of advantages which increase the comparability of the test results (see the Introduction).

A.2 Span between supports

The span L shall be (100 ± 1) mm.

A.3 Dimensions of test specimens

The dimensions of the test specimens shall be:

length l: (120 ± 10) mm;

width b: 9,8 mm to 15 mm;

thickness h: 3,0 mm to 4,2 mm.

A.4 Calculation of force to be applied

See ISO 75-1:2004, subclause 8.1, equation (2).

The flexural stress produced shall be one of the following:

1,80 MPa (preferred value), in which case the method is designated method A;

0,45 MPa, in which case the method is designated method B;

8,00 MPa, in which case the method is designated method C.

A.5 Initial temperature of the heating equipment

See ISO 75-1:2004, subclause 8.2.

A.6 Measurement

See ISO 75-1:2004, subclause 8.3.

Apply the force required to produce one of the flexural stresses specified in clause A.4.

Calculate the standard deflection Δs by means of equation (6) in ISO 75-1:2004, using a value of 0,2 % for the flexural-strain increase $\Delta\varepsilon_f$. Examples of standard deflections are given in Table A.1.

Note the temperature at which the initial deflection of the bar has increased by the standard deflection given in Table A.1. This temperature is the temperature of deflection under load. If the individual results for amorphous plastics or ebonite differ by more than 2 °C, or those for semi-crystalline materials by more than 5 °C, repeat tests shall be carried out.

Table A.1 — Standard deflection for different test-specimen heights for a 120 mm × (3,0 to 4,2) mm × (9,8 to 15,0) mm specimen tested in the edgewise position

Test-specimen height (width b of specimen) mm	**Standard deflection** mm
9,8 to 9,9	0,33
10,0 to 10,3	0,32
10,4 to 10,6	0,31
10,7 to 10,9	0,30
11,0 to 11,4	0,29
11,5 to 11,9	0,28
12,0 to 12,3	0,27
12,4 to 12,7	0,26
12,8 to 13,2	0,25
13,3 to 13,7	0,24
13,8 to 14,1	0,23
14,2 to 14,6	0,22
14,7 to 15,0	0,21

A.7 Expression of results

See ISO 75-1:2004, clause 9.

Annex B
(informative)

Precision

B.1 General

A round robin involving eight materials and ten laboratories was conducted in 1996 in accordance with ASTM E 691 to determine the precision of the method specified in this part of ISO 75.

B.2 Test materials

Designation No. of material	Type of material
1	PP 1
2	PP 2
3	ABS
4	POM 1
5	PBT
6	PET
7	POM 2
8	Composite

B.3 Summary of results

Eight materials were tested by ten laboratories. All test specimens were injection moulded by one laboratory. Each material was tested twice. PP 1 and PP 2 were tested at 0,45 MPa stress loading and the rest at 1,8 MPa stress loading, with the specimen in the flatwise position.

Not every laboratory tested every material. Only four laboratories tested material 8 and the data was therefore not included in the statistical calculation. Data from Lab 7 was significantly lower than data from the others and Lab 10 tested materials only once. Data from these two laboratories were therefore also excluded from the calculation.

Due to the limitations of the ASTM E 691 software, three separate precision statements were established. The results were combined and reported as one as shown in Table B.1.

Table B.1 — Precision data

Material	Number of labs	Loading MPa	Average result °C	s_r °C	s_R °C	r °C	R °C
PP 1	7	0,45	81,9	0,9	2,4	2,5	6,9
PP 2	7	0,45	115,2	1,0	3,4	2,9	9,7
ABS	8	1,8	79,3	0,3	0,7	0,9	2,0
POM 1	8	1,8	91,1	0,8	2,1	2,1	5,8
PBT	8	1,8	49,7	0,4	0,4	1,0	1,0
PET	8	1,8	65,4	0,1	1,0	0,4	2,8
POM 2	6	1,8	160,5	0,9	1,0	2,5	2,7

s_r is the within-laboratory standard deviation of the average.

s_R is the between-laboratories standard deviation of the average.

r is the repeatability limit (= 2,83 × s_r).

R is the reproducibility limit (= 2,83 × s_R).

B.4 Precision statement

The data in Table B.1 should not be rigorously applied to acceptance or rejection of material, as those data are specific to the round robin and may not be representative of other lots, conditions, materials or laboratories. Users of this test method should apply the principles of ASTM E 691 to generate data specific to their laboratory and materials, or between specific laboratories. The following principles would then be valid for such data.

Concept of repeatability r and reproducibility R. If s_r and s_R have been calculated from a large enough body of data, then test results can be judged as follows:

— *Repeatability r:* Two test results should be judged not equivalent if they differ by more than the r value for the material.

— *Reproducibility R:* Two test results should be judged not equivalent if they differ by more than the R value for the material.

Any judgment made in accordance with r and R would have an approximately 95 % probability of being correct.

Bibliography

[1] ISO 10350-1:1998, *Plastics — Acquisition and presentation of comparable single-point data — Part 1: Moulding materials*

[2] ASTM E 691 *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*

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