INTERNATIONAL STANDARD

ISO 75-2

Third 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

Reference number
ISO 75-2:2013(E)

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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 third edition cancels and replaces the second edition (ISO 75-2:2004), which has been technically revised. In particular, Clause 5 and Annex A have been updated.

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*

Introduction

The first editions of ISO 75-1 and this part of ISO 75 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 20753).

The previous (i.e. second) editions of ISO 75-1 and this part of ISO 75 specified the flatwise test position as preferred, while still allowing testing in the edgewise position with test conditions given in Annex A until the next revision of ISO 75-1 and this part of ISO 75, as agreed in ISO/TC 61/SC2/WG 5. Therefore, with this revision, the edgewise test position will be removed.

Technical development of testing instruments in recent years made instruments based on a fluidized bed or air ovens available. These are especially advantageous for use at temperatures at which the common silicone oil-based heat transfer fluids reach their limit of thermal stability. The fluidized bed and air oven methods of heat transfer are introduced in ISO 75-1.

An additional precision statement covering the new heating methods is introduced in this part of ISO 75.

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, which 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 increase 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 1 The methods give better reproducibility with amorphous plastics than with semi-crystalline ones. With some materials, it can 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).

NOTE 2 For additional information, see ISO 75-1:2013, Clause 1.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 293, *Plastics — Compression moulding of 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 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 20753, *Plastics — 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 75-1:2013)is designated as T_f 0,45, T_f 1,8 or T_f 8,0.

4 Principle

The principle is specified in ISO 75-1:2013, Clause 4.

5 Apparatus

5.1 Means of producing a flexural stress

This is specified in ISO 75-1:2013, 5.1.

The span (distance between the lines of contact between specimen and supports) shall be (64 ± 1) mm for testing.

5.2 Heating equipment

This is specified in ISO 75-1:2013, 5.2.

5.3 Weights

This is specified in ISO 75-1:2013 5.3.

5.4 Temperature-measuring instrument

This is specified in ISO 75-1:2013, 5.4.

5.5 Deflection-measuring instrument

This is specified in ISO 75-1:2013, 5.5.

6 Test specimens

6.1 General

This is specified in ISO 75-1:2013, 6.1.

6.2 Shape and dimensions

See ISO 75-1:2013, 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.

6.3 Specimen inspection

This is specified in ISO 75-1:2013, 6.3.

6.4 Number of test specimens

This is specified in ISO 75-1:2013, 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 may be taken from the narrow central part of the multipurpose test specimen specified in ISO 20753 (specimen type A1).

6.6 Annealing

Discrepancies in test results due to variations in moulding conditions may 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

This is specified in ISO 75-1:2013, Clause 7.

8 Procedure

8.1 Calculation of force to be applied

This is specified in ISO 75-1:2013, 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

This is specified in ISO 75-1:2013, 8.2.

8.3 Measurement

This is specified in ISO 75-1:2013, 8.3.

Apply the force required to produce one of the flexural stresses specified in 8.1.

Calculate the standard deflection, Δs, by means of Formula (4) in ISO 75-1:2013 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.

Table 1 — Standard deflections for different test-specimen heights for a 80 mm length × 10 mm width specimen tested

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

9 Expression of results

This is specified in ISO 75-1:2013, Clause 9.

10 Precision

See Annex A.

11 Test report

This is specified in ISO 75-1:2013, Clause 11.

The test report shall also include the following additional information:

l) the value of the standard deflection used.

In item h) of the test report, indicate the flexural stress used by means of the following designation system: $T_{f\ 0,45}$ for method B, $T_{f\ 1,8}$ for method A or $T_{f\ 8,0}$ for method C.

Annex A
(informative)

Precision

A.1 General

A.1.1 Round robin studies have been performed independently and separate from each other, using different heating methods. The heating methods were heat transfer by oil, by a fluidized bed and by air.

A.1.2 A round robin study involving eight materials and 10 laboratories was conducted in 1996 in accordance with ASTM E691 to determine the precision of the method specified in this part of ISO 75. In this study, oil was used as the heat transfer medium.

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 were therefore not included in the statistical calculation. Data from laboratory 7 were significantly lower than data from the others, and laboratory 10 tested materials only once. Data from these two laboratories were, therefore, also excluded from the calculation.

Due to the limitations of the ASTM E691 software, three separate precision statements were established. The results were combined and reported as one, as shown in Table A.1.

A.1.3 Tables A.2 to A.4 are based on a round robin test performed in 2009 involving three to six laboratories and seven to 11 materials. Three heating methods were used, being the standard method with oil as heat transfer medium, fluidized beds with aluminium oxide powder and air ovens. Test specimens were always prepared and distributed by one source. Each laboratory obtained and reported six individual test results for each material. The results reported were evaluated according to ISO 5725-2.

CAUTION — Due to the limited number of laboratories and materials, the following explanations of *r* and *R* (see A.1.4 to A.3) are only intended to present a meaningful way of considering the approximate precision of this test method. The data in Tables A.1 to A.4 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.

A.1.4 Concept of *r* and *R*:

a) repeatability: two test results obtained within one laboratory shall be judged not equivalent if they differ by more than the *r* value for that material. *r* is the interval representing the critical difference between two test results for the same material, obtained by the same operator using the same equipment in the same laboratory.

b) reproducibility: two test results obtained by different laboratories shall be judged not equivalent if they differ by more than the *R* value for that material. *R* is the interval representing the critical difference between two test results for the same material, obtained by different operators using different equipment in different laboratories.

The judgements in Tables A.1 to A.4 will have an approximately 95 % (0,95) probability of being correct.

A.2 Statistical properties

In Tables A.1 to A.4, the statistical properties used are:

s_r = within laboratory standard deviation

s_R = between laboratory standard deviation

r = 95 % repeatability limit = 2,8 s_r

R = 95 % reproducibility limit = 2,8 s_R

n_{Lab} = number of laboratories reporting results

A.3 Results using oil as heat transfer medium

Table A.1 — Heat transfer medium: oil (see A1.2)

Material	Number of lab., n_{Lab}	Flexural stress MPa	Average °C	s_r °C	s_R °C	r °C	R °C
PP 1	7	0,45	$T_{f\,0,45}$ = 81,9	0,9	2,4	2,5	6,9
PP 2	7	0,45	$T_{f\,0,45}$ = 115,2	1,0	3,4	2,9	9,7
ABS	8	1,8	$T_{f\,1,8}$ = 79,3	0,3	0,7	0,9	2,0
POM 1	8	1,8	$T_{f\,1,8}$ = 91,1	0,8	2,1	2,1	5,8
PBT	8	1,8	$T_{f\,1,8}$ = 49,7	0,4	0,4	1,0	1,0
PET	8	1,8	$T_{f\,1,8}$ = 65,4	0,1	1,0	0,4	2,8
POM 2	6	1,8	$T_{f\,1,8}$ = 160,5	0,9	1,0	2,5	2,7

A.4 Results using oil, fluidized bed and air as heat transfer medium

Table A.2 — Heat transfer medium: oil (see A.1.3)

		Heating rate, 120 °C/h				
Material	**Number of lab., n_{Lab}**	**Average $T_{f\,1,8}$** °C	s_r °C	s_R °C	r °C	R °C
PS	6	77,3	0,2	1,7	0,7	4,7
POM 1	5	97,9	1,1	3,3	3,1	9,2
PC	6	126,0	0,2	3,5	0,4	9,8
POM 2	6	161,4	0,4	0,9	1,1	2,6
PPE	6	187,1	0,2	1,9	0,7	5,4
PES	4	202,9	1,0	1,6	2,2	4,4
PPS	3	267,5	0,5	0,9	1,5	2,6

Table A.3 — Heat transfer: fluidized bed (see A.1.3)

Material		**Heating rate,** 120 °C/h				
	Number of lab., n_{Lab}	**Average $T_{f\,1,8}$** °C	s_r °C	s_R °C	r °C	R °C
PS	3	77,1	0,0	1,1	0,1	3,1
POM 1	3	107,6	1,8	3,1	5,0	8,8
PC	3	129,3	0,5	0,8	1,3	2,4
POM 2	3	162,0	0,1	0,4	0,3	1,1
PPE	3	189,5	1,0	1,0	2,9	2,9
PES	3	209,2	1,0	1,7	2,7	4,7
PPS	3	274,5	0,3	0,5	0,9	1,5
LCP 1	3	311,8	1,1	1,1	3,1	3,1
LCP 2	3	319,5	0,6	1,2	1,8	3,2
PEEK	3	319,7	1,7	1,7	4,8	4,8
LCP 4	3	368,4	0,2	1,9	0,6	5,4

Table A.4 — Heat transfer medium: air (see A.1.3)

Material	Number of lab., n_{Lab}	Heating rate, 120 K/h Average $T_{f\ 1,8}$ °C	s_r °C	s_R °C	r °C	R °C
PS	3	78,3	0,2	1,7	0,4	4,7
POM 1	3	101,7	2,0	4,3	5,7	12,0
PC	3	131,7	0,9	3,1	2,4	8,6
POM 2	3	169,4	0,1	0,8	0,2	2,2
PPE	3	193,6	0,1	3,1	0,4	8,6
PES	3	206,5	0,5	3,7	1,3	10,2
PPS	3	273,9	0,2	1,1	0,6	3,0
LCP 1	3	308,0	1,2	1,9	3,4	5,3
LCP 2	3	315,2	0,4	1,6	1,2	4,3
PEEK	3	301,1	2,1	5,0	6,0	14,1
LCP 4	3	363,5	1,4	1,6	4,1	4,5

Bibliography

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

[2] ASTM E691, *Standard Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method*

[3] ISO 5725, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

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