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Plastics — Determination of temperature of deflection under load —

Part 1: General test method

Plastiques — Détermination de la température de fléchissement sous charge —
Partie 1: Méthode d'essai générale

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 2, *Mechanical behavior*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 249, *Plastics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 75-1:2013), which has been technically revised. The main changes compared to the previous edition are as follows:

— specification for the temperature difference between the middle and the ends of the test specimens has been removed;

— specification for the position of the tip of the temperature sensor has been widened;

— editorial changes have been applied.

A list of all parts in the ISO 75 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Plastics — Determination of temperature of deflection under load —

Part 1: General test method

1 Scope

1.1 This document gives a general test method for the determination of the temperature of deflection under load (flexural stress under three-point loading) of plastics. Different types of test specimen and different constant loads are defined to suit different types of material.

1.2 ISO 75-2 gives specific requirements for plastics (including filled plastics and fibre-reinforced plastics in which the fibre length, prior to processing, is up to 7,5 mm) and ebonite, while ISO 75-3 gives specific requirements for high-strength thermosetting laminates and long-fibre-reinforced plastics in which the fibre length, prior to processing, is greater than 7,5 mm.

1.3 The methods specified are suitable for assessing the relative behaviour of different types of material at elevated temperature under load at a specified rate of temperature increase. The results obtained do not necessarily represent maximum applicable temperatures because, in practice, essential factors, such as time, loading conditions and nominal surface stress, can differ from the test conditions. True comparability of data can only be achieved for materials having the same room-temperature flexural modulus.

1.4 The methods specify preferred dimensions for the test specimens.

1.5 Data obtained using the test methods described are not intended to be used to predict actual end-use performance. The data are not intended for design analysis or prediction of the endurance of materials at elevated temperatures.

1.6 This method is commonly known as the heat deflection temperature or heat distortion temperature (HDT) test, although there is no official document using this designation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 75-2, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite*

ISO 75-3, *Plastics — Determination of temperature of deflection under load — Part 3: High-strength thermosetting laminates and long-fibre-reinforced plastics*

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

ISO 16012, *Plastics — Determination of linear dimensions of test specimens*

IEC 60584-1, *Thermocouples — Part 1: EMF specifications and tolerances*

IEC 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
flexural strain
ε_f
nominal fractional change in length of an element of the outer surface of the test specimen at midspan

Note 1 to entry: It is expressed as a dimensionless ratio or a percentage (%).

3.2
flexural strain increase
$\Delta\varepsilon_f$
specified increase in *flexural strain* (3.1) that takes place during heating

Note 1 to entry: It is expressed as a percentage (%).

3.3
deflection
s
distance over which the top or bottom surface of the test specimen at midspan deviates during flexure from its original position

Note 1 to entry: It is expressed in millimetres (mm).

3.4
standard deflection
Δs
increase in *deflection* (3.3) corresponding to the *flexural strain increase* (3.2), $\Delta\varepsilon_f$, at the surface of the test specimen, and which is specified in ISO 75-2 or ISO 75-3

Note 1 to entry: It is expressed in millimetres (mm). See Formula (4).

3.5
flexural stress
σ_f
nominal stress at the outer surface of the test specimen at midspan

Note 1 to entry: It is expressed in megapascals (MPa).

3.6
load
F
force, applied to the test specimen at midspan, which results in a defined *flexural stress* (3.5)

Note 1 to entry: It is expressed in newtons (N). See Formulae (1) to (3).

3.7
temperature of deflection under load
T_f
temperature at which the *deflection* (3.3) of the test specimen reaches the *standard deflection* (3.4) as the temperature is increased

Note 1 to entry: It is expressed in degrees Celsius (°C).

4 Principle

A standard test specimen is subjected to three-point bending under a constant load in the flatwise position to produce one of the flexural stresses given in the relevant part of ISO 75. The temperature is raised at a uniform rate, and the temperature at which the standard deflection, corresponding to the specified increase in flexural strain, occurs is measured.

5 Apparatus

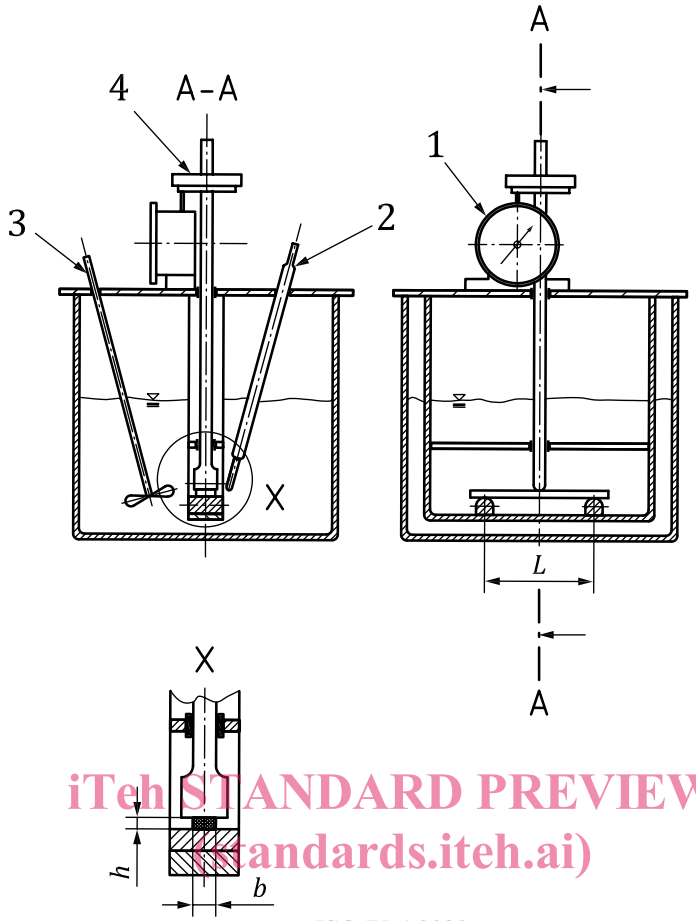
5.1 Means of producing a flexural stress

The apparatus shall be constructed essentially as shown in Figure 1. It consists of a rigid metal frame in which a rod shall move freely in the vertical direction. One end of the rod is fitted with a weight-carrying plate and the other end is equipped with a loading edge. The base of the frame is fitted with test-specimen supports. These supports and the vertical members of the frame are made of a material having the same coefficient of linear expansion as the rod.

The test-specimen supports consist of metal pieces that are cylindrical in the contact area and with their lines of contact with the specimen in a horizontal plane. The size of the span, i.e. of the distance between the contact lines, is given in ISO 75-2 or ISO 75-3. The supports are fitted to the base of the frame in such a way that the vertical force applied to the test specimen by the loading edge is midway (±1 mm) between them. The contact edges of the supports are parallel to the loading edge and at right angles to the length direction of the test specimen placed symmetrically across them. The contact edges of the supports and loading edge have a radius of (3,0 ± 0,2) mm and shall be longer than the width of the test specimen.

Unless vertical parts of the apparatus have the same coefficient of linear thermal expansion, the difference in change of length of these parts introduces an error in the reading of the apparent deflection of the test specimen. A blank test shall be made on each apparatus using a test specimen made of rigid material having a low coefficient of expansion and a thickness comparable to that of the specimen under test. The blank test shall cover the temperature ranges to be used in the actual determination, and a correction term shall be determined for each temperature. If the correction term is 0,01 mm or greater, its value and algebraic sign shall be recorded, and the term applied to each test result by adding it algebraically to the reading of the apparent deflection of the test specimen.

NOTE Invar and borosilicate glass have been found suitable as materials for the test specimen in the blank test.



Key

1 deflection measuring device
2 temperature measuring instrument
3 stirrer
4 weight
b width of test specimen
h thickness of test specimen
L span between supports

Figure 1 — Typical apparatus for determination of temperature of deflection under load

5.2 Heating equipment

The heating equipment shall be a heating bath containing a suitable liquid, a fluidized bed or an air oven. For heat transfer media other than gas (air) the test specimen shall be immersed to a depth of at least 50 mm. An efficient stirrer or means to fluidize a solid heat transfer medium shall be provided. If liquids are used for heat transfer, it shall be established that the liquid chosen is stable over the temperature range used and does not affect the material under test, for example causing it to swell or crack.

The method using a liquid heat transfer medium shall be considered a reference method in case of doubts or conflicts, if possible, in the temperature range under consideration.

The heating equipment shall be provided with a control unit so that the temperature can be raised at a uniform rate of (120 ± 10) °C/h.

The heating rate shall be verified periodically either by

— checking the automatic temperature reading, or

— manually checking the temperature at least every 6 min.

The requirement for the heating rate shall be considered satisfied if, over every 6 min interval during the test, the temperature change is (12 ± 1) °C.

NOTE 1 The apparatus can be designed to stop heating automatically when the standard deflection has been reached.

NOTE 2 Liquid paraffin, transformer oil, glycerol and silicone oils are suitable liquids, but others can be used. For fluidized beds, aluminium oxide powder has been found suitable.

5.3 Weights

A set of weights shall be provided so that the test specimen can be loaded to the required flexural stress, calculated as specified in 8.1.

5.4 Temperature-measuring instrument

Use a suitable temperature-measuring instrument of appropriate range and maximum error limit of ±1 °C.

Temperature-measuring instruments shall be calibrated at the depth of immersion particular to the apparatus in use. The temperature-sensing part of the instrument shall be located not farther than 12,5 mm from the point where the loading edge contacts the specimen. The temperature-sensing part of the instrument shall not touch the specimen or be in contact with any part of the frame.

Thermocouples shall comply with the requirements of IEC 60584-1. Resistance thermometers shall comply with the requirements of IEC 60751.

It is recommended that the heating bath is equipped with a separate temperature-measuring instrument at each test station, if there are several.

5.5 Deflection-measuring instrument

Use a calibrated dial gauge or any other indicating or recording device, including electric displacement sensing apparatus, to measure the deflection of the specimen at the point where the loading edge contacts the specimen. The deflection measuring device shall be readable to 0,01 mm.

In certain types of apparatus, the force, F_s, exerted by the dial gauge spring acts upwards and therefore reduces the downward force exerted by the weighted rod, while in other types, F_s acts downwards and augments those exerted by the weighted rod. In such cases, it is necessary to determine the magnitude and direction of F_s so as to be able to compensate for it as specified in 8.1. Since, in certain dial gauges, F_s varies considerably over the measurement range of the instrument, it shall be measured in that part of the range in which the instrument is to be used.

5.6 Micrometers and gauges

These are used to measure the width and thickness of the test specimens. They shall be accurate to 0,01 mm and conform to ISO 16012.