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Plastics and ebonite — Determination of temperature of deflection under load

Plastiques et ébonite — Détermination de la température de fléchissement sous charge

Reference number
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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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 75 was prepared by Technical Committee ISO/TC 61, *Plastics.*

This second edition cancels and replaces the first edition (ISO 75 : 1974), of which it constitutes a technical revision.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Plastics and ebonite — Determination of temperature of deflection under load

1 Scope and field of application

1.1 This International Standard specifies two methods for the determination of the temperature of deflection under load (bending stress) of plastics and ebonite:

- Method A, using a nominal surface stress of 1,80 MPa;
- Method B, using a nominal surface stress of 0,45 MPa.

1.2 The methods specified are only applicable to materials that are rigid at room temperature, and are suitable for assessing the behaviour of plastics and ebonite at elevated temperature under load at a specified rate of temperature increase. The results obtained do not necessarily represent maximum use temperatures, because in practice essential factors such as time, loading conditions and nominal surface stress may differ from the testing conditions.

1.3 The methods are more reproducible with amorphous plastics than with semi-crystalline ones and are not recommended for testing laminates. With some materials, it may be necessary to anneal the test specimens to obtain reliable results.

2 References

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

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

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

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

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

ISO 3167, *Plastics — Preparation and use of multipurpose test specimens.*

3 Principle

Determination of the temperature at which a specified deflection occurs when a standard test specimen of plastics or ebonite is subjected to bending stress producing one of the nominal surface stresses given in 1.1, when the temperature is raised at a uniform rate.

4 Apparatus

4.1 Means of application of bending stress.

The apparatus shall be constructed essentially as shown in the figure. It consists of a rigid metal frame in which a rod can move freely vertically. The rod is provided with a weight-carrying plate and a loading nose. The base of the frame is fitted with test specimen supports; these and the vertical members of the frame are made of metal having the same coefficient of linear expansion as the rod.

The test specimen supports consist of cylindrical-shaped metal pieces 100 ± 2 mm apart (see the figure), with their lines of contact in a horizontal plane, fitted to the base of the frame in such a way that the vertical force applied to the test specimen by the loading nose is midway between them. The edges of the supports are parallel to the loading nose and at right angles to the length direction of a test specimen placed symmetrically between them. The contact edges of the supports and the loading nose are rounded to a radius of 3,0 ± 0,2 mm and shall be longer than the thickness of the test specimen.

Unless vertical parts of the apparatus have the same coefficient of linear expansion, the differential change in the 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.[1] The temperature ranges to be used shall be covered and a correction term determined for each temperature. If the correction term is 0,010 mm or greater, its algebraic sign shall be noted and the term applied to each test by adding it algebraically to the reading of apparent deflection of the test specimen.

4.2 Heating bath, containing a suitable liquid in which the test specimen can be immersed to a depth of at least 50 mm.

1) Invar and borosilicate glass have been found suitable for this purpose.

An efficient stirrer shall be provided. The heating bath shall be equipped with a means of control so that the temperature can be raised at a uniform rate of 120 ± 10 K/h. This heating rate shall be considered to be met if over every 6 min interval during the test, the temperature change is 12 ± 1 K.

The apparatus may be arranged to shut off the heat automatically and sound an alarm when the specified deflection has been reached.

NOTES

1 Liquid paraffin, transformer oil, glycerol and silicone oils may be suitable liquid heat-transfer media, but other liquids may be used. In all cases, it shall be established that the liquid chosen is stable at the temperature used and does not affect the material under test, for example by swelling, softening or cracking. If no suitable liquid can be found for use as a heat-transfer medium, a fluidized bed may be used as a heat-transfer medium.

2 The results of the test may depend on the thermal conductivity of the heat-transfer medium.

4.3 Weights.

A set of weights shall be provided so that the test specimen can be loaded to the required nominal surface stress, calculated according to 7.1.

NOTE — It may be necessary to adjust these weights in 1 g increments.

4.4 Thermometer, mercury-in-glass of the partial-immersion type, or **other suitable temperature-measuring instrument,** of appropriate range and reading to 0,5 °C or less. Mercury-in-glass thermometers shall be calibrated for the depth of immersion required by 7.2.

4.5 Deflection-measuring instrument: a calibrated micrometer dial-gauge or other suitable measuring instrument to measure to 0,01 mm the deflection at the midpoint of the test specimen.

NOTES

1 In certain forms of construction of the apparatus, the force F_s of a dial-gauge spring is directed upward and therefore detracts from the downward force applied by the mass of the weighted rod, while in other forms, F_s acts downward and augments that applied 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 its effects accordingly (see 7.1).

2 Since in certain dial-gauges F_s varies considerably over the stroke, it should be measured in that part of the stroke which is to be used.

5 Test specimens

5.1 At least two test specimens shall be used to test each sample. For moulding materials the test specimens shall be a rectangular bar 120 ± 10 mm in length, between 3,0 and 4,2 mm in thickness (b), and between 9,8 and 15 mm in height (h). In case of compression moulded test specimens, the height shall be perpendicular to the direction of the moulding pressure. For materials in sheet form, the thickness of the test specimen (which dimension is ordinarily the thickness of the sheet) shall be in the range of 3 to 13 mm, preferably between 4 and 6 mm.

NOTE — The test results obtained on specimens approaching 13 mm thick may be 2 to 4 K above those obtained from thin test specimens because of poorer heat transfer.

5.2 The test results obtained on moulded test specimens depend on the moulding conditions used in their preparation. Moulding conditions shall be in accordance with the standard for the material or shall be agreed upon by the interested parties.

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

6 Conditioning

Unless otherwise required by the specification for the material being tested, the specimens shall be preconditioned and tested in accordance with ISO 291.

7 Procedure

7.1 Calculation of force to be applied

The force F to be applied to the test specimen is given, in newtons, by the equation

$$F = \frac{2\sigma b h^2}{3L}$$

where

σ is the maximum nominal surface stress in the test specimen, in megapascals (i.e. 1,80 when testing according to method A and 0,45 when testing according to method B);

b is the thickness of the test specimen, in millimetres;

h is the height of the test specimen, in millimetres;

L is the measured length of span between supports, in millimetres.

Measure dimensions b and h to the nearest 0,1 mm and dimension L to the nearest 0,5 mm.

The effect of the mass m_r of the rod that applies the testing force F shall be taken into account as contributing part of that force. If a spring-loaded component such as a dial gauge is used, the magnitude and direction of the force F_s exerted by its spring shall also be taken into account as a positive or negative contribution to the force F (see notes 1 and 2 of 4.5).

If required, the mass m_w of additional weight to be placed on the rod to produce the required total force F is given by the equation

$$F = 9{,}81\,(m_w + m_r) + F_s$$

and hence

$$m_w = \frac{F - F_s}{9{,}81} - m_r$$

where

m_w is the mass of the weight to be added, in kilograms;

F is the total force to be applied to the test specimen, in newtons;

m_r is the mass of the rod that applies the testing force, in kilograms;

F_s is the force exerted by any spring-loaded components involved, in newtons, and is a positive value if the thrust of the spring is towards the test specimen (downwards), or a negative value if the thrust of the spring is opposing the descent of the rod, or zero if no such component is involved.

The actual force applied shall be the calculated force F $\pm 2{,}5$ %.

7.2 Initial temperature of the heating bath

The thermometer bulb or sensitive part of the temperature-measuring instrument (4.4) shall be at the same level and as close as possible to the test specimen (within 10 mm), but not in contact with it. The temperature of the bath shall be 20 to 23 °C at the start of each test, unless previous tests have shown that, for the particular materials under test, no error is introduced by starting at other temperatures.

7.3 Method A

Place a test specimen on the supports so that the long axis of the specimen is perpendicular to the supports. Apply the calculated force (7.1) to give a nominal surface stress of 1,80 MPa on the test specimen. Allow the force to act for 5 min (see the note). Then make the zero reading or setting of the measuring device and start the heating. This waiting period may be omitted when testing materials that show no appreciable creep during the initial 5 min.

Raise the temperature of the bath at a uniform rate of 120 ± 10 K/h. Note the temperature at which the bar reaches the standard deflection corresponding to the height of the test specimen, as given in the table, as the temperature of deflection under load at 1,80 MPa nominal surface stress.

NOTE — The 5 min waiting period is provided to compensate partially for the creep exhibited by some materials at room temperature when subjected to the specified nominal surface stress. That part of the creep which occurs in the initial 5 min is usually a significant fraction of that which occurs in the first 30 min.

Table — Standard deflection *vs.* height of test specimen

Height of test specimen	Standard deflection
mm	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

7.4 Method B

Conduct the test exactly as for Method A, except that the force shall be that which gives a nominal surface stress of 0,45 MPa calculated using the formula given in 7.1. Note the temperature at which the specimen reaches the standard deflection corresponding to the height of the test specimen as given above, as the temperature of deflection under load at 0,45 MPa nominal surface stress.

7.5 Express the temperature of deflection under load of the material under test as the arithmetic mean of the temperatures of deflection under load of the specimens tested. If the individual results for amorphous plastics or ebonite differ by more than 2 K, or those for semicrystalline materials by more than 5 K, repeat tests shall be carried out.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) full identification of the material tested;

c) the method employed (A or B);

d) the dimensions of the test specimens used;

e) the method of preparation of the test specimens;

f) the immersion medium;

g) the conditioning and annealing procedures used, if any;

h) the temperature of the deflection under load, in degrees Celsius; if the individual results after 2 measurements differ more than the limits given in 7.5, all individual results shall be reported;

i) any peculiar characteristics of the test specimen noted during the test or after removal from the apparatus.

Dimensions in millimetres

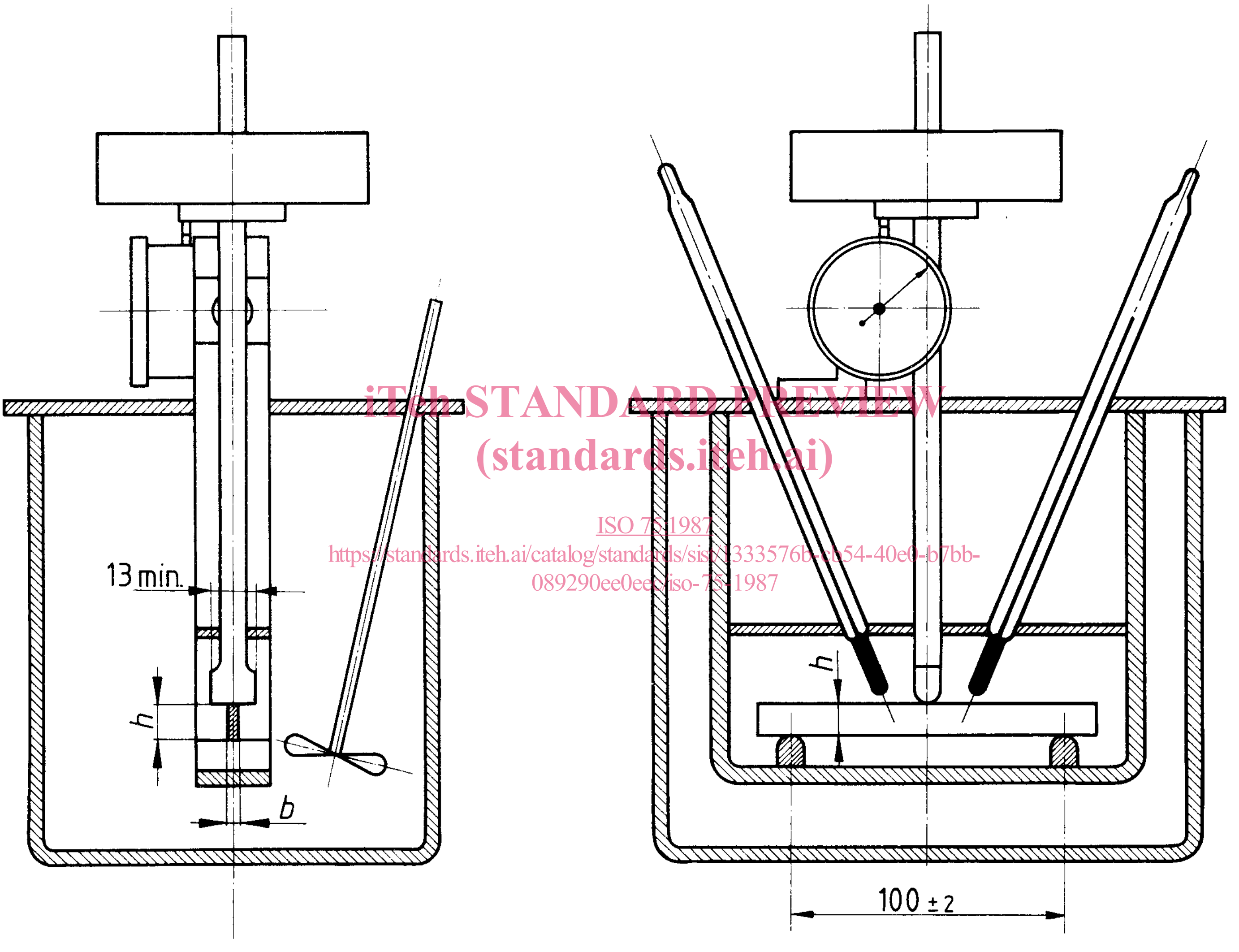

Figure — Typical apparatus for determination of temperature of deflection under load

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