INTERNATIONAL STANDARD

ISO 24999

First edition
2008-07-01

Flexible cellular polymeric materials — Determination of fatigue by a constant-strain procedure

Matériaux polymères alvéolaires souples — Détermination de la fatigue par un procédé de déformation constante

Reference number
ISO 24999:2008(E)

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Published in Switzerland

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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.

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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.

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ISO 24999 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products (other than hoses)*.

Flexible cellular polymeric materials — Determination of fatigue by a constant-strain procedure

WARNING — Persons using this International Standard should be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard specifies a method for determining the loss in thickness of flexible cellular materials when compressed repetitively to a fixed level of strain. It is particularly useful for quality control in the manufacture of flexible polymeric cellular materials.

Another procedure already exists as ISO 3385: this measures the fatigue characteristics of flexible polymeric cellular materials by constant-stress loading of the specimen rather than constant strain. It forms the basis of a material classification system in ISO 5999.

These two fatigue procedures are complementary to each other and can both be useful in the prediction of end-use performance.

The procedure and equipment used in this International Standard allow testing of a large number of test pieces at any one time, whereas ISO 3385 only allows testing of one test piece at a time under the compression device.

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 1923, *Cellular plastics and rubbers — Determination of linear dimensions*

3 Principle

Constant strain is repetitively applied to the whole surface of the test piece, then the final thickness of the test piece is measured.

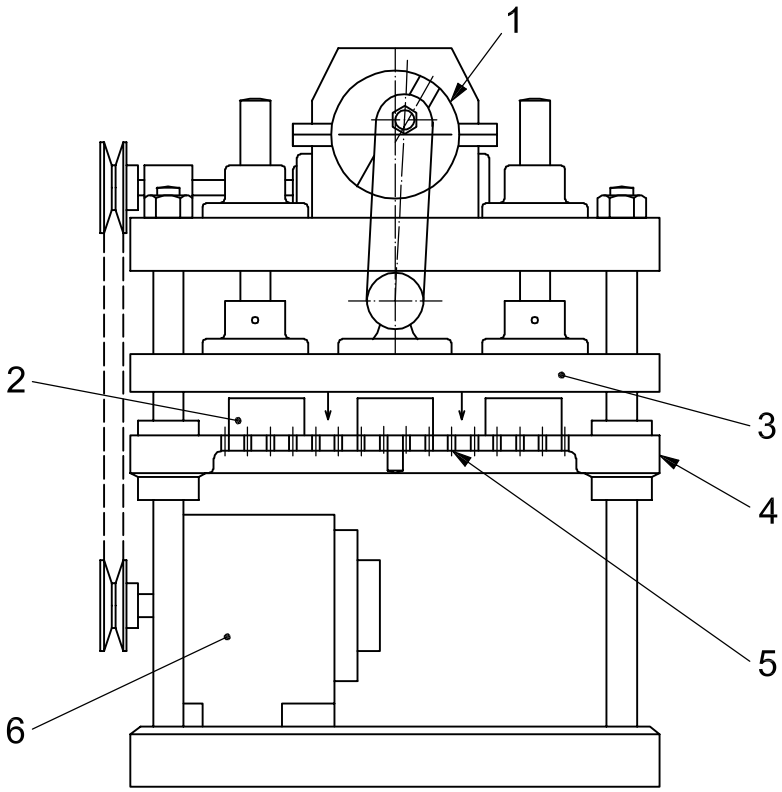
4 Apparatus

The test machine to be used shall be a compression type having the following structure and functions.

The machine shall have two square flat plates, operating in parallel, the sizes of which are at least 10 mm greater than the sides of the test piece. Either the upper or lower of the plates shall oscillate in the vertical direction to create compression of the test piece. The spacing between the plates shall be adjustable.

The lower plate shall be suitably vented with holes approximately 6 mm in diameter at approximately 20 mm pitch in order to allow air to escape from the test piece during compression.

A typical design of such a compression mechanism is shown in Figure 1.



Key

1 cam device
2 test piece
3 top plate
4 bottom plate
5 air-vent hole
6 motor

Figure 1 — An example of a constant-strain test machine

5 Test pieces

5.1 Shape and dimensions

Test pieces shall be in the form of a parallelepiped not less than 50 mm long and wide and not less than 20 mm thick.

Several test pieces of differing density and/or indentation hardness can be tested simultaneously, provided that individual thicknesses are within 3 mm of each other.

5.2 Samples showing orientation

If the products show an orientation of the cellular structure, the direction in which the pressure is to be applied shall be agreed upon between the interested parties. Normally, this will correspond to the direction of applied compression in the finished product.

5.3 Number

Three test pieces shall be tested.

5.4 Conditioning

Materials shall not be tested less than 72 h after manufacture unless it can be demonstrated that the mean results obtained at either 16 h or 48 h after manufacture do not differ by more than ± 10 % from those obtained after 72 h, in which case testing is permitted at 16 h or 48 h, respectively.

Prior to the test, the test pieces shall be conditioned, uncompressed and otherwise undistorted, for at least 16 h in one of the following atmospheres as given in ISO 23549:

— (23 ± 2) °C, (50 ± 5) % relative humidity;

— (27 ± 2) °C, (65 ± 5) % relative humidity.

This conditioning period can form the final part of or, in the case of testing 16 h after manufacture, the whole of the period following manufacture.

In the case of quality-control tests, test pieces can be taken a shorter time (down to a minimum of 12 h) after manufacture and testing carried out after conditioning for a shorter period (down to a minimum of 6 h) in one of the atmospheres specified above.

6 Procedure

Measure, in accordance with ISO 1923, the thickness, d_1, at the centre of each test piece to the nearest 0,1 mm without causing any deformation in the shape of the foam. After the measurement, place the test piece on the lower plate.

When several test pieces are to be tested simultaneously, ensure that they are sufficiently far apart for there to be no contact between them during compression.

Compress the test pieces for 80 000 cycles at a frequency of (60 ± 5) cycles per minute with the machine stroke adjusted to apply 50 % compression of the original thickness, d_1, to the thinnest of the test pieces. The compression plate shall be set to thickness d_1 for the decompression process. On completion of the test, remove the test pieces and allow them to recover for 30 min ± 5 min in the conditioning atmosphere (see 5.4) before re-measuring the thickness, d_2, at the same position as before, to the nearest 0,1 mm.

7 Expression of results

The percentage loss in thickness, Δd, is given by the equation:

$$\Delta d = 100 \times \frac{d_1 - d_2}{d_1}$$

where

d_1 is the original thickness, expressed in millimetres;

d_2 is the final thickness, expressed in millimetres.

Express the result as the median of the values obtained for the three test pieces.

8 Precision

See Annex A.

9 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) a description of the material tested;

c) the conditioning used;

d) the size and shape of the test pieces;

e) the predominant orientation of the cellular structure, if any;

f) the median percentage thickness loss after compression;

g) the date of the test.

Annex A
(informative)

Precision

A.1 General

The precision of the method specified in this International Standard was determined in an interlaboratory test programme (ITP) in accordance with ISO/TR 9272. The precision results as determined by this ITP should not be used for acceptance or rejection of any group of materials without documentation that the results of this precision evaluation are actually applicable to the particular group of materials tested.

A.2 Details

Seven laboratories participated in the ITP. Three types of flexible polyurethane foam of different densities were used. Two test pieces of each type of foam were prepared and the loss in thickness determined in accordance with the method specified in this International Standard. The interval for repeatability (within-laboratory precision) was 7 days.

A.3 Precision results

A.3.1 The precision results are given in Table A.1.

A.3.2 Repeatability: The repeatability, or local-domain precision, of this test method has been established as the values given in Table A.1 for each repeatability parameter listed in the table. Test results obtained in a particular laboratory (by the proper use of this International Standard) that differ by more than the tabulated values of r, in measurement units, and (r), in percent, should be considered suspect, i.e. to have come from different populations, and to suggest that some appropriate investigative action be taken.

A.3.3 Reproducibility: The reproducibility, or global-domain precision, for this test method has been established as the values given in Table A.1 for each reproducibility parameter listed in the table. The test results obtained in different laboratories (by the proper use of this International Standard) that differ by more than the tabulated values of R, in measurement units, and (R), in percent, should be considered suspect, i.e. to have come from different populations, and to suggest that some appropriate investigative action be taken.

Table A.1 — Precision results

Type of sample according to hardness	Mean loss in thickness	Within laboratory			Between laboratories		
	%	s_r	r	(r)	s_R	R	(R)
Soft [a]	5,71	0,105	0,297	5,201	0,406	1,15	20,140
Medium [b]	4,18	0,308	0,872	20,861	0,253	0,72	17,225
Hard [c]	1,55	0,154	0,434	28,000	0,185	0,52	33,548

[a] Low-hardness type (density 14 kg/m^3).

[b] Medium-hardness type (density 20 kg/m^3).

[c] High-hardness type (density 35 kg/m^3).

Bibliography

[1] ISO 3385, *Flexible cellular polymeric materials — Determination of fatigue by constant-load pounding*

[2] ISO 5999, *Flexible cellular polymeric materials — Polyurethane foam for load-bearing applications excluding carpet underlay — Specification*

[3] ISO/TR 9272, *Rubber and rubber products — Determination of precision for test method standards*

[4] ISO 23529, *Rubber — General procedures for preparing and conditioning test pieces for physical test methods*

ICS 83.100

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