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Cellular plastics — Polyethylene — Methods of test

Plastiques alvéolaires — Polyéthylène — Méthodes d'essai

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 7214 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 10, *Cellular plastics*.

This fourth edition cancels and replaces the third edition (ISO 7214:2007). Figure 1, which was dimensionally incorrect in the previous edition, has been replaced by Figure 2 from ISO 34-1:2010.

Cellular plastics — Polyethylene — Methods of test

1 Scope

1.1 This International Standard specifies methods for testing flexible and semi-rigid cellular plastics made from polyethylene. Cellular plastics containing copolymers of ethylene or blends of polymers with polyethylene may also be tested by the procedures of this International Standard provided these materials have characteristics similar to polyethylene as described in ISO 1872-1, or copolymers of ethylene as described in ISO 4613-1.

1.2 Mandatory tests suitable for characterization of cellular polyethylene, regardless of end use, are described in Clause 7. Optional tests for the determination of properties that are relevant to certain uses are described in Clause 8.

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 845:2006, *Cellular plastics and rubbers — Determination of apparent density*

ISO 1663, *Rigid cellular plastics — Determination of water vapour transmission properties*

ISO 1798, *Flexible cellular polymeric materials — Determination of tensile strength and elongation at break*

ISO 1856, *Flexible cellular polymeric materials — Determination of compression set*

ISO 1872-1, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 1: Designation system and basis for specifications*

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

ISO 2796, *Cellular plastics, rigid — Test for dimensional stability*

ISO 2896, *Rigid cellular plastics — Determination of water absorption*

ISO 3386-1, *Polymeric materials, cellular flexible — Determination of stress-strain characteristics in compression — Part 1: Low-density materials*

ISO 3582, *Flexible cellular polymeric materials — Laboratory assessment of horizontal burning characteristics of small specimens subjected to a small flame*

ISO 4613-1, *Plastics — Ethylene/vinyl acetate (E/VAC) moulding and extrusion materials — Part 1: Designation and specification*

ISO 4651, *Cellular rubbers and plastics — Determination of dynamic cushioning performance*

ISO 7850:1986, *Cellular plastics, rigid — Determination of compressive creep*

ISO 8301, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Heat flow meter apparatus*

ISO 8302, *Thermal insulation — Determination of steady-state thermal resistance and related properties — Guarded hot plate apparatus*

ISO 8497, *Thermal insulation — Determination of steady-state thermal transmission properties of thermal insulation for circular pipes*

ISO 9772, *Cellular plastics — Determination of horizontal burning characteristics of small specimens subjected to a small flame*

3 Test specimens

The specimens shall be cut so that the edges are clean and the sides are planar and normal to the surface. The specimens shall be cut from the sample so that a representative value is determined for each physical property investigated. With anisotropic samples, take specimens in the appropriate direction.

Clauses 7 and 8 outline the requirements for the number of specimens, their shape and their dimensions. Unless otherwise required by a specific test method, the surfaces of the specimens shall be the same as the surface of the material in normal use.

4 Conditioning

Unless otherwise specified in Clause 7 or 8, specimens shall be conditioned for a minimum of 24 h at

(23 ± 2) °C and (50 ± 10) % relative humidity,

or

(23 ± 5) °C and 50^{+20}_{-10} % relative humidity,

or

(27 ± 5) °C and 65^{+20}_{-10} % relative humidity.

NOTE Some materials may require up to 30 days ageing after manufacture for the physical properties to stabilize.

5 Atmosphere during test

Unless otherwise specified, testing shall be carried out under the following conditions:

(23 ± 2) °C and (50 ± 10) % relative humidity,

or

(23 ± 5) °C and 50^{+20}_{-10} % relative humidity,

or

(27 ± 5) °C and 65^{+20}_{-10} % relative humidity.

6 Measurement of dimensions

All measurements shall be taken in accordance with ISO 1923 unless the specimens are not planar over the area of measurement (e.g. because they have been cut from curved articles). With non-planar specimens, dimensions not exceeding 30 mm shall be measured using a hand-held dial gauge with a circular 20-mm-diameter foot. A maximum of 1 kPa pressure can be applied to the foot of the hand-held dial gauge, provided that the deformation of the specimen is less than the required accuracy of measurement.

7 Mandatory tests

7.1 Apparent density

Determine the apparent density in accordance with ISO 845.

For specimens that are 15 mm thick or less, the requirement for the minimum volume of the specimen specified in subclause 5.1 of ISO 845:2006 shall be amended to 15 cm^3.

A dial gauge with measuring surface of 10 cm^2, as specified in ISO 1923, shall be used for measurement of thicknesses not greater than 15 mm.

7.2 Compressive stress

Determine the compressive stress in accordance with ISO 3386-1.

Test specimens shall be a minimum of 10 mm thick. For thinner materials, stack individual specimens to attain the minimum 10 mm thickness.

The test shall be conducted in such a way that the rate of compression is (50 $\pm$ 10) % of the initial specimen thickness per minute.

Determine the compressive stress during the first compression.

Determine the compressive stress at 10 %, 25 % and 50 % deformation.

7.3 Compression set

Determine the compression set in accordance with ISO 1856.

Compress the specimen to a deformation of 25 % of its original thickness for 22 h.

Measure the thickness after a 30 min and a 24 h recovery period.

7.4 Tensile strength and elongation

Determine the tensile strength and elongation at break in accordance with ISO 1798.

The speed of the grip of the test machine shall be (500 $\pm$ 50) mm/min.

For materials manufactured at less than 10 mm thickness, test the material in the thickness supplied. For materials 10 mm thick or more, test the material at (10 $\pm$ 1) mm thickness.

7.5 Dimensional stability at elevated temperature

7.5.1 Method A

Determine the dimensional stability at elevated temperature in accordance with ISO 7850:1986, procedure A.

The specimen thickness shall be a minimum of 20 mm. For materials manufactured at 20 mm or greater thickness, test the material as manufactured. For materials manufactured at less than 20 mm thickness, stack specimens to provide the minimum 20 mm thickness required.

Determine the temperature at which the thickness changes by more than 5 % by carrying out the creep test (ISO 7850) for 7 days with an applied stress of 40 kPa, increasing the test temperature at 5 °C intervals until the thickness change during the test exceeds 5 %.

7.5.2 Method B

Determine the dimensional stability at elevated temperature in accordance with ISO 2796, using (70 ± 5) °C and (20 ± 1) h.

Specimens shall be (150 ± 5) mm × (150 ± 5) mm square and flat, with parallel upper and lower faces. The thickness shall be that of the material as manufactured.

It is recommended that both vertical and horizontal dimensional change be measured.

7.6 Water absorption

7.6.1 Method A — For specimens greater than 25 mm thick

Determine the water absorption in accordance with ISO 2896.

The specimen thickness shall be that of the material as manufactured.

7.6.2 Method B — For specimens not more than 25 mm thick

7.6.2.1 Specimens

For materials without skins:

Following the requirements of ISO 1923, cut out three specimens (100 ± 5) mm wide and (100 ± 5) mm long. The thickness shall be that of the material as manufactured.

For materials with a skin on one or both surfaces:

Following the requirements of ISO 1923, cut out three test samples (120 ± 5) mm long and (120 ± 5) mm wide, of the thickness of the material as manufactured, and mark on each a 100 mm square defining the test specimens.

7.6.2.2 Apparatus

7.6.2.2.1 Water tub and alcohol tub, large enough for the test specimens/test samples to be immersed at least 50 mm below the surface of the liquid.

7.6.2.2.2 Air-circulation drying oven, capable of maintaining a temperature of (60 ± 2) °C.

7.6.2.2.3 Balance, capable of measuring the mass of the specimens to within ±1 %.

7.6.2.3 Procedure

Immerse the test specimens/test samples (50 ± 5) mm beneath the surface of the water, using a piece of wire gauze to hold them under the surface, for (24 ± 0,5) h. Remove them from the water and immerse them in ethyl alcohol (concentration at least 95 %) for (5 ± 1) s.

For materials without skins, remove the specimens from the alcohol, air-dry at (60 ± 2) °C for (5 ± 0,5) min, and weigh immediately. Then dry at (60 ± 2) °C for (24 ± 0,5) h and weigh each specimen again.

For materials with a skin layer on one or both surfaces, remove the test samples from the alcohol and air dry at (60 ± 2) °C for (5 ± 0,5) min. Immediately cut out (100 ± 5) mm wide and (100 ± 5) mm long test specimens by cutting along the marked lines, and weigh them. Then dry at (60 ± 2) °C for (24 ± 0,5) h and weigh each specimen again.

7.6.2.4 Calculation

7.6.2.4.1 Calculate the water absorption Q_V (g/cm^3) or Q_S (g/cm^2) using the equation in 7.6.2.4.2 or 7.6.2.4.3, respectively.

7.6.2.4.2 For material without skins, use the following equation:

$$Q_V = (m_1 - m_2)/V$$

where

Q_V is the water absorption (g/cm^3);

m_1 is the mass of the test specimen immediately after drying at 60 °C for 5 min (g);

m_2 is the mass of the test specimen after drying at 60 °C for 24 h (g);

V is the volume of the test specimen (cm^3).

7.6.2.4.3 For material with skins on one or both surfaces, use the following equation:

$$Q_S = (m_1 - m_2)/2A$$

where

Q_S is the water absorption (g/cm^2);

m_1 is the mass of the test specimen immediately after cutting it out of the test sample (g);

m_2 is the mass of the test specimen after drying at 60 °C for 24 h (g);

A is the area of the test specimen (cm^2).

7.7 Burning characteristics

Determine the burning characteristics in accordance with ISO 3582 or ISO 9772.

NOTE Additional burning-characteristics testing may be required by regional or national codes and regulations.

8 Optional tests

8.1 Dynamic cushioning performance

Determine the dynamic cushioning performance in accordance with ISO 4651.

8.2 Compressive creep

The compressive creep shall be determined in accordance with ISO 7850:1986, procedure A.

Determine compressive creep curves at 23 °C and 40 °C, at ambient humidity, at intervals up to a maximum of 1 000 h elapsed time. Determine the compressive deflection at 0,1 h, 1 h, 24 h and 168 h intervals after the load has been applied.

Normally, the applied load shall be such that the initial compressive stress is one-tenth of the compressive stress at 10 % deformation (as determined in 7.2). A different stress may be used, however, if it is agreed that a different stress is likely to occur in practice.

The specimens shall be either square or cylindrical. The minimum area of each loaded face shall be 25 cm^2. The height of the specimen shall not exceed half the width or diameter of the loaded faces.

The preferred specimen size is (50 ± 1) mm long and (50 ± 1) mm wide, with a thickness of (25 ± 1) mm. The surfaces in the thickness dimension shall not deviate from parallel more than 1 mm.

8.3 Thermal conductivity

Determine the thermal conductivity in accordance with ISO 8301, ISO 8302 or ISO 8497 at a mean temperature of 10 °C, 23 °C or 40 °C.

8.4 Water-vapour transmission

Determine the water-vapour transmission rate, permeance and permeability in accordance with ISO 1663.

Specimens shall be of the same thickness as the manufactured material. Thin specimens can be supported on a thin-wire mesh.

8.5 Dynamic stiffness

Determine the dynamic stiffness in accordance with a national standard.

8.6 Cell count

Determine the cell count in accordance with Annex A.

8.7 Tear strength

8.7.1 Test specimen

The maximum thickness of the test specimen shall be 10 mm. For samples exceeding 10 mm in thickness, slice the material to give 10 mm thickness. Punch out the test specimen to the shape shown in Figure 1 with a punching die.

If the material is anisotropic, take test specimens in both the longitudinal and the lateral direction.

Dimensions in millimetres

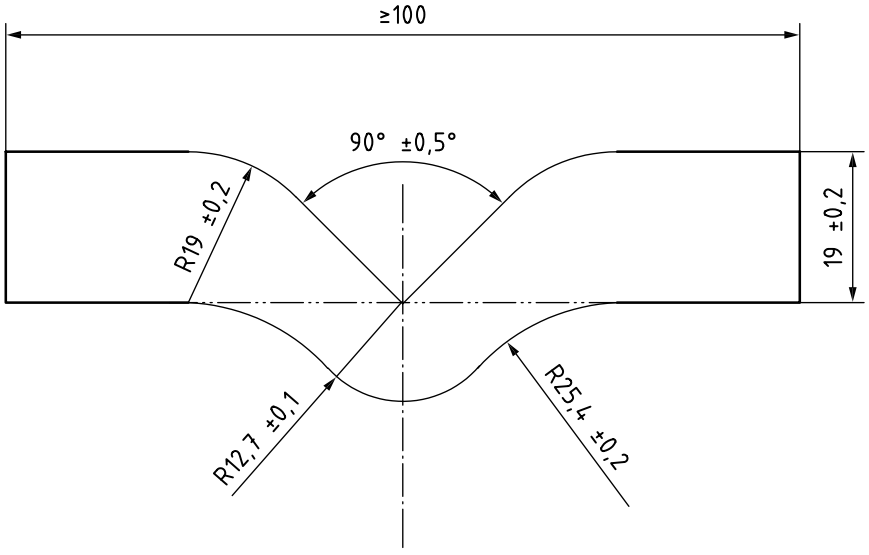


Figure 1 — Specimen for tear strength

8.7.2 Apparatus

Use the apparatus specified in ISO 1798.

8.7.3 Procedure

Measure the thickness of the test specimen at its centre in accordance with Clause 6. Attach the test specimen in the tester and pull the specimen at a rate of (500 ± 10) mm/min until it breaks. Measure the maximum load at the time of break.

8.7.4 Calculation

Calculate the tear strength T_t, in N/cm, using the following equation:

$$T_t = F/t$$

where

F is the load when the specimen breaks (N);

t is the thickness of the specimen (cm).

Round the result to two significant figures.

8.8 Permanent set after repeated compression

8.8.1 Test specimen

The test specimen shall be a rectangular parallelepiped of length (50 ± 5) mm, width (50 ± 5) mm and thickness (25 ± 2) mm, with parallel upper and lower faces and cut faces in periphery. With thin materials, stack specimens to a minimum thickness of 25 mm and glue them with (20 ± 2) g/m^2 of adhesive.

8.8.2 Apparatus

Use a repeated-compression tester which has two flat, parallel plates at least 10 mm wider than the faces of the test specimen, one of which is driven to make a vertical reciprocating motion in vertical to its amplitude and spacing of the two pieces of flat plates. Figure 2 shows an example of a repeated-compression tester.

8.8.3 Procedure

Measure the thickness of the test specimen at its centre in accordance with Clause 6. Put the specimen between the plates of the tester and compress the specimen 80 000 times without interruption to 25 % of its initial thickness at a rate of 60 times/min in one of the test atmospheres given in Clause 5.

Remove the test specimen and condition for 24 h in the same atmosphere. Measure the thickness of the specimen at the same location as it was measured before compression.

8.8.4 Calculation

Calculate the permanent set after repeated compression C_f, in percent, using the following equation:

$$C_f = \frac{t_0 - t_1}{t_0} \times 100$$

where

t_0 is the initial thickness of the specimen (mm);

t_1 is the thickness of the specimen after testing (mm).

9 Test report

The test report shall include the following information:

a) a reference to this International Standard;

b) all details necessary for complete identification of the product tested, including the manufacturer's lot number;

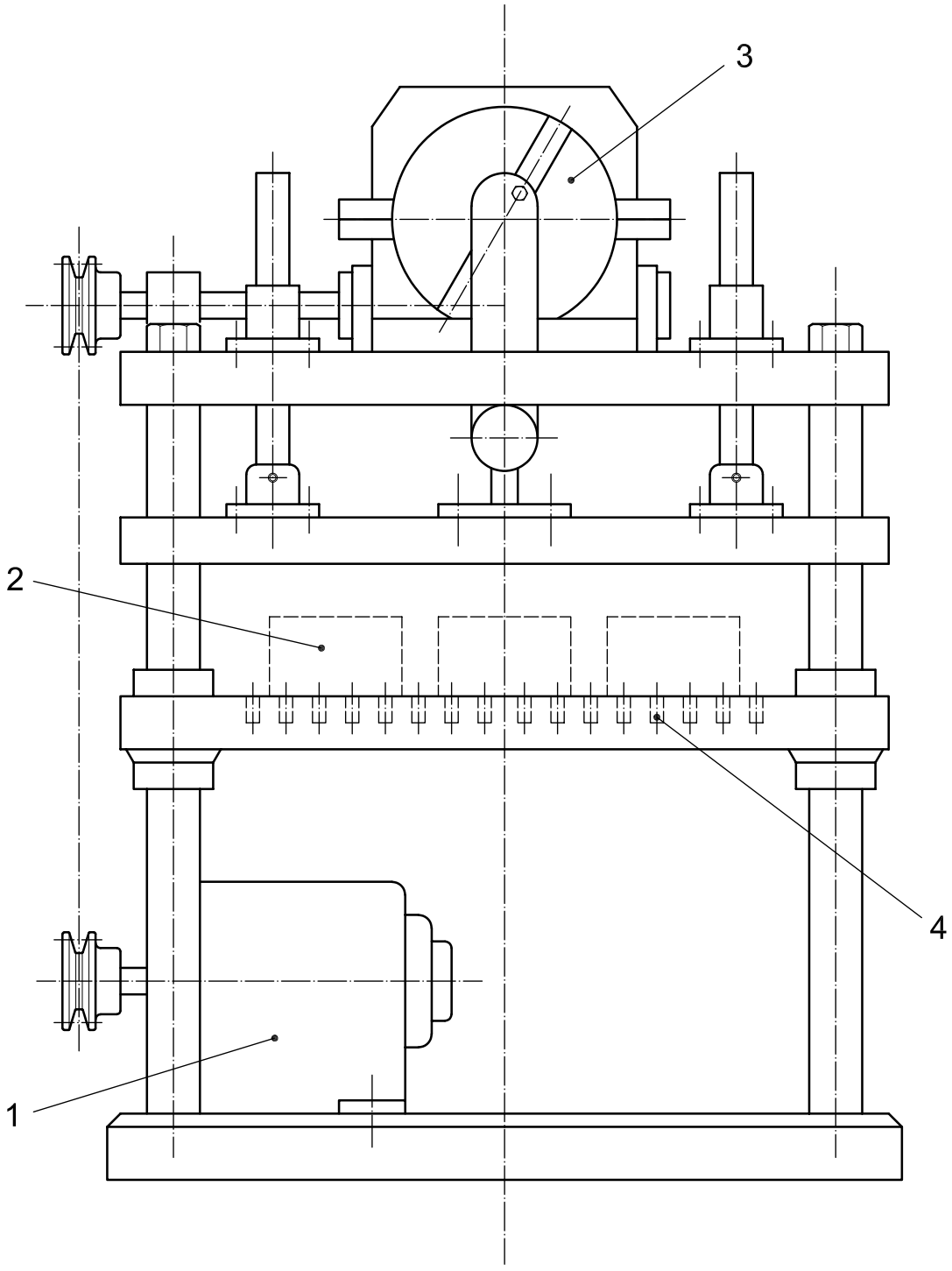
c) the dimensions of the test specimens;

d) the direction in which the force was applied in relation to any anisotropy;

e) the presence or absence of skins (or facings) on the test specimens and, if applicable, on which faces, and whether the material was homogeneous or laminated;

f) the individual test results and their arithmetic mean;

g) details of any deviation from the testing and conditioning procedures specified.



Key

1 motor
2 test specimen
3 cam mechanism
4 air vent (small hole)

Figure 2 — Repeated-compression tester

Annex A
(normative)

Cell count procedure

A.1 Scope

This annex specifies a method for determining the cell count of flexible and rigid cellular polyethylene. Cellular plastics containing copolymers of ethylene or blends of polymers with polyethylene may also be tested by this procedure, provided these materials have characteristics similar to polyethylene or copolymers of ethylene as described in ISO 1872-1.

A.2 Terms and definitions

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

A.2.1
cell count
number of cells per 25 mm in the cellular polyethylene under specified conditions

A.3 Apparatus

The apparatus shall consist of a magnifying device (of sufficient power to allow identification of each cell) with a scale, calibrated in millimetres, capable of measuring a length of 25 mm to an accuracy of at least ±0,1 mm. A 25 mm cloth-counting glass is suitable.

A × 10 magnifying device is suitable for a cell count of 40 or less.

A.4 Test specimens

A.4.1 Preparation

If the material shows a predominant direction of the cellular structure (orientation of the cells), the specimens shall be cut in such a way that both axes of the cells can be measured.

A.4.2 Shape and dimensions

The specimens shall be free of skin and have a plane surface large enough to accommodate the counting glass. A 50 mm × 50 mm × 3 mm specimen is recommended. Specimens shall be cut out with a sharp blade in such a manner that the cells are not damaged.

Specimen surfaces showing marked variation in the cellular structure from place to place shall not be measured unless specifically required.

A.4.3 Number of specimens

A.4.3.1 Five specimens shall be used.

A.4.3.2 If there is a noticeable difference in the cell count in specimens taken from different locations in the sample, the specimen location shall be as agreed upon by the interested parties.

A.5 Procedure

Lay the specimens on a flat horizontal surface, without strain. Place the counting device on the surface of each specimen in turn and count the actual number of cells against the counting edge of the glass.

Where there is marked anisotropy in the cell dimensions, a minimum of two counts shall be made. The directions shall be chosen such that the maximum and minimum dimensions of the cells are used to perform this test.

A.6 Precision

The precision of this test method is not known because interlaboratory data are not available. This method may not be suitable for use in specifications or in the event of disputed results as long as these data are not available.

A.7 Test report

The test report shall include the following information:

a) the direction(s) in which the cell count was made;

b) the average number of cells per 25 mm;

c) the power of the magnifying device;

d) any deviation from the testing and conditioning procedures specified.

ICS 83.100

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