INTERNATIONAL STANDARD

ISO 1872-2

Second edition
1997-04-01

Plastics — Polyethylene (PE) moulding and extrusion materials —

Part 2:
Preparation of test specimens and determination of properties

Plastiques — Polyéthylène (PE) pour moulage et extrusion —
Partie 2: Préparation des éprouvettes et détermination des propriétés

Reference number
ISO 1872-2:1997(E)

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.

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.

International Standard ISO 1872-2 was prepared by Technical Committee ISO/TC 61, *Plastics,* Subcommittee SC 9, *Thermoplastic materials.*

This second edition cancels and replaces the first edition (ISO 1872-2:1989) and includes the following changes:

— the text has been brought into accordance with the standard SC 9 frame text;

— the list of properties and test conditions has been revised in accordance with ISO 10350.

ISO 1872 consists of the following parts, under the general title *Plastics — Polyethylene (PE) moulding and extrusion materials*:

— *Part 1: Designation system and basis for specifications*

— *Part 2: Preparation of test specimens and determination of properties*

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Plastics — Polyethylene (PE) moulding and extrusion materials —

Part 2:
Preparation of test specimens and determination of properties

1 Scope

This part of ISO 1872 specifies the methods of preparation of test specimens and the test methods to be used in determining the properties of PE moulding and extrusion materials. Requirements for handling test material and for conditioning both the test material before moulding and the specimens before testing are given here.

Procedures and conditions for the preparation of test specimens and procedures for measuring properties of the materials from which these specimens are made are given. Properties and test methods which are suitable and necessary to characterize PE moulding and extrusion materials are listed.

The properties have been selected from the general test methods in ISO 10350. Other test methods in wide use for or of particular significance to these moulding and extrusion materials are also included in this part of ISO 1872, as are the designatory properties specified in part 1.

In order to obtain reproducible and comparable test results, it is necessary to use the methods of preparation and conditioning, the specimen dimensions and the test procedures specified herein. Values determined will not necessarily be identical to those obtained using specimens of different dimensions or prepared using different procedures.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 1872. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 1872 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 62:1980, *Plastics — Determination of water absorption.*

ISO 75-1:1993, *Plastics — Determination of temperature of deflection under load —Part 1: General test method.*

ISO 75-2:1993, *Plastics — Determination of temperature of deflection under load — Part 2: Plastics and ebonite.*

ISO 178:1993, *Plastics — Determination of flexural properties.*

ISO 179:1993, *Plastics — Determination of Charpy impact strength.*

ISO 291: —[1], *Plastics — Standard atmospheres for conditioning and testing.*

1) To be published. (Revision of ISO 291:1977)

ISO 293:1986, *Plastics — Compression moulding test specimens of thermoplastic materials.*

ISO 294-1:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 1: General principles, and moulding of multipurpose and bar specimens.*

ISO 294-3:1996, *Plastics — Injection moulding of test specimens of thermoplastic materials — Part 3: Plates.*

ISO 527-1:1993, *Plastics — Determination of tensile properties — Part 1: General principles.*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics.*

ISO 899-1:1993, *Plastics — Determination of creep behaviour — Part 1: Tensile creep.*

ISO 1133:1997, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.*

ISO 1183:1987, *Plastics — Methods for determining the density and relative density of non-cellular plastics.*

ISO 1210: —[2], *Plastics — Determination of the burning behaviour of horizontal and vertical specimens in contact with a small-flame ignition source.*

ISO 1628-3:1991, *Plastics — Determination of viscosity number and limiting viscosity number — Part 3: Polyethylenes and polypropylenes.*

ISO 1872-1:1993, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 1: Designation system and basis for specifications.*

ISO 2818:1994, *Plastics — Preparation of test specimens by machining.*

ISO 3146:1985, *Plastics — Determination of melting behaviour (melting temperature or melting range) of semi-crystalline polymers.*

ISO 3167:1993, *Plastics — Multipurpose test specimens.*

ISO 4589-2:1996, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test.*

ISO 6603-2:1989, *Plastics — Determination of multiaxial impact behaviour of rigid plastics — Part 2: Instrumented puncture test.*

ISO 8256:1990, *Plastics — Determination of tensile-impact strength.*

ISO 10350:1993, *Plastics — Acquisition and presentation of comparable single-point data.*

IEC 93:1980, *Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials.*

IEC 112:1979, *Method for determining the comparative and the proof tracking indices of solid insulating materials under moist conditions.*

IEC 243-1:1988, *Methods of test for electric strength of solid insulating materials — Part 1: Tests at power frequencies.*

IEC 250:1969, *Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including metre wavelengths.*

---

2) To be published. (Revision of ISO 1210:1992)

IEC 296:1982, *Specification for unused mineral insulating oils for transformers and swithchgear.*

ASTM D 1693:1995, *Test method for environmental stress-cracking of ethylene plastics.*

3 Preparation of test specimens

It is essential that specimens are always prepared by the same procedure (either injection moulding or compression moulding), using the same processing conditions.

The procedure to be used for each test method is indicated in tables 3 and 4 (M = injection moulding, Q = compression moulding).

3.1 Treatment of the material before moulding

Before processing, no pretreatment of the material sample is normally necessary.

3.2 Injection moulding

Injection moulding of test specimens is used for PE moulding materials having a melt mass-flow rate of ⩾ 1 g/10 min determined in accordance with ISO 1133 using set of conditions D (190 °C/2,16 kg).

Injection-moulded specimens shall be prepared in accordance with ISO 294-1 or ISO 294-3, using the conditions specified in table 1.

Table 1 — Conditions for injection moulding of test specimens

Material	Melt temperature °C	Mould temperature °C	Average injection velocity mm/s	Cooling time s	Total cycle time s
MFR ⩾ 1 g/10 min	210	40	100 ± 20	35 ± 5	40 ± 5

3.3 Compression moulding

Compression moulding is used for materials with a melt mass-flow rate of < 1 g/10 min determined in accordance with ISO 1133 using set of conditions D (190 °C/2,16 kg). In the case of thin sheet (< 2 mm), and, where individually prescribed in tables 3 and 4, compression moulding shall be used for all melt flow rates.

Compression-moulded sheets shall be prepared in accordance with ISO 293 using the conditions specified in table 2. The test specimens required for the determination of the properties shall be machined from the compression-moulded sheets in accordance with ISO 2818 or stamped.

Table 2 — Conditions for compression moulding of test specimens

Material	Moulding temperature °C	Average cooling rate °C/min	Demoulding temperature °C	Full pressure MPa	Full-pressure time min	Preheating pressure MPa	Preheating time min
All grades	180	15	⩽ 40	5/10[1)]	5 ± 1	Contact	5 to 15
1) Use 5 MPa for frame mould and 10 MPa for positive mould.							

A type 1 (frame) mould may be used, but it is necessary to start cooling whilst simultaneously applying the full pressure. This avoids the melt being pressed out of the frame and avoids sink marks.

For thicker sheet (≈ 4 mm), a type 2 (positive) mould has been found to work satisfactorily. The preheating time depends on the type of mould and the type of energy input (steam, electricity). For frame moulds, 5 min is usually sufficient but for positive moulds, due to the bigger mass, a preheating time of up to 15 min can be necessary, especially if electric heating is used.

4 Conditioning of test specimens

Test specimens shall be conditioned in accordance with ISO 291 for at least 40 h at 23 °C ± 2 °C and (50 ± 5) % relative humidity.

5 Determination of properties

In the determination of properties and the presentation of data, the standards, supplementary instructions and notes given in ISO 10350 shall be applied. All tests shall be carried out in the standard atmosphere of 23 °C ± 2 °C and (50 ± 5) % relative humidity unless specifically stated otherwise in tables 3 and 4.

Table 3 is compiled from ISO 10350, and the properties listed are those which are appropriate to polyethylene (PE) moulding and extrusion materials. These properties are those considered useful for comparisons of data generated for different thermoplastics.

Table 4 contains those properties, not found specifically in table 3, which are in wide use or of particular significance in the practical characterization of polyethylene (PE) moulding and extrusion materials.

Table 3 — General properties and test conditions (selected from ISO 10350)

Property	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation[1)]	Test conditions and supplementary instructions
Rheological properties					
Melt mass-flow rate Melt volume-flow rate	g/10 min cm^3/10 min	ISO 1133	Moulding compound	—	See conditions given in ISO 1872-1
Mechanical properties					
Tensile modulus	MPa	ISO 527-1, ISO 527-2	See ISO 3167	M/Q	Test speed 1 mm/min
Yield stress	MPa				Test speed 50 mm/min
Yield strain	%				Test speed 50 mm/min
Nominal strain at break	%				Test speed 50 mm/min
Stress at 50 % strain	MPa				Test speed 50 mm/min
Stress at break	Mpa				Test speed 5 mm/min. Only to be quoted if strain at break is < 10 %
Strain at break	%				
Tensile creep modulus	MPa	ISO 899-1	See ISO 3167	M/Q	At 1 h, At 1 000 h: Strain ⩽ 0,5 %
Flexural modulus	MPa	ISO 178	80 × 10 × 4	M/Q	Test speed 2 mm/min
Charpy notched impact strength	kJ/m^2	ISO 179	80 × 10 × 4 V-notch, r = 0,25	M/Q	Method 1eA (edgewise impact)
Tensile notched impact strength	kJ/m^2	ISO 8256	80 × 10 × 4 double V-notch, r = 1	M/Q	Only to be quoted if fracture cannot be obtained with notched Charpy test
Thermal properties					
Melting temperature	°C	ISO 3146	Moulding compound	—	Method C (DSC or DTA). Use 10 °C/min
Temperature of deflection under load	°C	ISO 75-1, ISO 75-2	110 × 10 × 4 edgewise or 80 × 10 × 4 flatwise	M/Q	0,45 MPa and 1,8 MPa
Coefficient of linear thermal expansion	$°C^{-1}$	TMA (see ISO 10350)	Prepared from ISO 3167	M/Q	Parallel, Normal: Quote the secant value over the temperature range 23 °C to 55 °C
Flammability	mm/min	ISO 1210	125 × 13 × 3	M/Q	Method A — linear burning rate of horizontal specimens
Ignitability	%	ISO 4589-2	80 × 10 × 4	M/Q	Procedure A — top surface ignition
Electrical properties					
Relative permittivity Dissipation factor	— —	IEC 250	⩾ 80 × ⩾ 80 × 1	Q	Frequency 100 Hz and 1 MHz (compensate for electrode edge effect)
Volume resistivity Surface resistivity	Ω·m Ω	IEC 93	⩾ 80 × ⩾ 80 × 1	Q	Voltage 100 V
Electric strength	kV/mm	IEC 243-1	⩾ 80 × ⩾ 80 × 1 ⩾ 80 × ⩾ 80 × 3	Q M/Q	Use 25 mm/75 mm coaxial-cylinder electrode configuration. Immerse in IEC 296 transformer oil. Use short time (rapid rise) test
Comparative tracking index	—	IEC 112	⩾ 15 × ⩾ 15 × 4	M/Q	Use solution A
Other properties					
Water absorption	%	ISO 62	50 × 50 × 3 or ∅ 50 × 3 disc	M/Q	24 h immersion in water at 23 °C
Density	kg/m^3	ISO 1183	—	M/Q	Test specimen to be taken from the centre of an injection-moulded specimen (see 3.2) or from a compression-moulded sheet (see 3.3) Not be used for specifications

1) M = Injection moulding
Q = Compression moulding

Table 4 — Additional properties and test conditions of particular utility to PE moulding and extrusion materials

Property	Unit	Standard	Specimen type (dimensions in mm)	Specimen preparation[1)]	Test conditions and supplementary instructions
Mechanical properties					
Total penetration energy	J	ISO 6603-2	60 × 60 × 2 or Ø 60 × 2 disc	M/Q	
Other properties					
Viscosity number	ml/g	ISO 1628-3	Moulding compound	—	
Stress-cracking[2)]	h	ASTM D 1693	38 × 13 × 3	Q	Determine the 50 % failure rate F_{50}

1) M = Injection moulding
Q = Compression moulding

2) The stress-cracking test gives a crude comparison of PE materials and is untypical of many applications. It is better to carry out performance tests related to specific applications by referring to the relevant product standards.

This page intentionally left blank