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Plastics — Ethylene/vinyl acetate copolymer (E/VAC) thermoplastics —

Part 2 :

Preparation of test specimens and determination of
properties

*Plastiques — Thermoplastiques à base de copolymères d'éthylène/acétate de vinyle
(E/VAC) —*

Partie 2 : Préparation des éprouvettes et détermination des caractéristiques



Reference number
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Foreword

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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 4613-2 was prepared by Technical Committee ISO/TC 61, *Plastics*.

ISO 4613 consists of the following parts, under the general title *Plastics — Ethylene/vinyl acetate copolymer (E/VAC) thermoplastics*:

Part 1: Designation

Part 2: Preparation of test specimens and determination of properties

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Plastics — Ethylene/vinyl acetate copolymer (E/VAC) thermoplastics —

Part 2 :

Preparation of test specimens and determination of properties

1 Scope

1.1 This part of ISO 4613 specifies procedures for moulding test specimens of ethylene/vinyl acetate (E/VAC) materials under specified moulding conditions and methods for measuring their properties.¹⁾

1.2 No figures are quoted for these properties. Those required for the designation of ethylene/vinyl acetate materials for moulding and extrusion are given in ISO 4613-1. Other properties are determined by the appropriate methods referred to in this part of ISO 4613 and values may be obtained from manufacturers' literature. Values should only be compared if the procedures described herein for preparing the test specimens and for determining the properties are followed.

1.3 The values determined in accordance with this part of ISO 4613 will not necessarily be identical to those obtained using specimens of different dimensions and/or prepared by different procedures. They may also be influenced by colorants and other additives. The values obtained for the properties of a moulding depend on the moulding compound, the shape, the test method and the state of anisotropy. The last-mentioned depends on the gating and the moulding conditions, for example temperature, pressure and injection rate. Any subsequent treatment must also be considered, for example conditioning or annealing.

1.4 The thermal history and the internal stresses of the specimens may strongly influence the thermal and mechanical properties and the resistance to environmental stress cracking, but exert less effect on the electrical properties, which depend mainly on the chemical composition of the moulding compound.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4613. 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 4613 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 : 1987, *Plastics and ebonite — Determination of temperature of deflection under load.*

ISO 175 : 1981, *Plastics — Determination of the effects of liquid chemicals, including water.*

ISO 178 : 1975, *Plastics — Determination of flexural properties of rigid plastics.*

ISO 179 : 1982, *Plastics — Determination of Charpy impact strength of rigid materials.*

ISO 180 : 1982, *Plastics — Determination of Izod impact strength of rigid materials.*

ISO 291 : 1977, *Plastics — Standard atmospheres for conditioning and testing.*

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

ISO 294 : 1975, *Plastics — Injection moulding test specimens of thermoplastic materials.*

ISO 306 : 1987, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature.*

ISO 458-1 : 1985, *Plastics — Determination of stiffness in torsion of flexible materials — Part 1: General method.*

ISO/R 527 : 1966, *Plastics — Determination of tensile properties.*

ISO 537 : 1980, *Plastics — Testing with the torsion pendulum.*

ISO 868 : 1985, *Plastics and ebonite — Determination of indentation hardness by means of a durometer (Shore hardness).*

1) Preferred methods and temperatures in this part of ISO 4613 will become mandatory at the next five-year revision.

ISO 899 : 1981, *Plastics — Determination of tensile creep.*

ISO 974 : 1980, *Plastics — Determination of the brittleness temperature by impact.*

ISO 1133 : 1981, *Plastics — Determination of the melt flow rate of thermoplastics.*

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

ISO 1628-3 : — ¹⁾, *Plastics — Determination of viscosity number and limiting viscosity number — Part 3: Polyethylenes and polypropylenes.*

ISO 2039-1 : 1987, *Plastics — Determination of hardness — Part 1: Ball indentation method.*

ISO 2039-2 : 1987, *Plastics — Determination of hardness — Part 2: Rockwell hardness.*

ISO 2556 : 1974, *Plastics — Determination of the gas transmission rate of films and thin sheets under atmospheric pressure — Manometric method.*

ISO 2818 : 1980, *Plastics — Preparation of test specimens by machining.*

ISO 4582 : 1980, *Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or artificial light.*

ISO 4600 : 1981, *Plastics — Determination of environmental stress cracking (ESC) — Ball or pin impression method.*

ISO 4607 : 1978, *Plastics — Methods of exposure to natural weathering.*

ISO 4613-1 : 1985, *Plastics — Ethylene/vinyl acetate copolymer (E/VAC) thermoplastics — Part 1: Designation.*

ISO 4892 : 1981, *Plastics — Methods of exposure to laboratory light sources.*

ISO 6252 : 1981, *Plastics — Determination of environmental stress cracking (ESC) — Constant tensile stress method.*

ISO 6602 : 1985, *Plastics — Determination of flexural creep by three-point loading.*

ISO 8985 : — ¹⁾, *Plastics — Ethylene/vinyl acetate copolymers — Determination of vinyl acetate content.*

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

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

IEC Publication 243 : 1967, *Recommended methods of test for electric strength of solid insulating materials at power frequencies.*

1) To be published.

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.*

3 Preparation of test specimens

Two methods of preparation of test specimens are described: compression moulding and injection moulding.

3.1 Compression moulding

Specimens shall be prepared either by stamping or by machining from a compression-moulded sheet (see ISO 2818). Full details of compression moulding of sheet are given in ISO 293, but for polyethylene materials the following additional points shall apply:

Mould: A simple three-plate frame mould as described in ISO 293 is satisfactory for producing small sheets from which test specimens may be cut.

Predrying: No drying is normally necessary.

Moulding temperature:

< 10 % vinyl acetate: 180 °C ± 5 K is preferred.

> 10 % vinyl acetate: 130 °C ± 5 K is preferred.

Other temperatures may have to be used because of the nature of the polymer, generally in the range 120 °C to 180 °C; they shall be reported.

Average cooling rate:

Method B — Standard rate:
15 K·min⁻¹ ± 5 K·min⁻¹

Method C — Quench cooling rate:
60 K·min⁻¹ ± 30 K·min⁻¹

Method D — Slow cooling rate:
5 K·h⁻¹ ± 0,5 K·h⁻¹

Method B is preferred but, if a different rate is used because of the requirements of the user, it shall be reported.

Moulding procedure: The contact pressure time shall be 5 min to 10 min and the full-pressure time 2 min to 5 min. The demoulding temperature shall be less than or equal to 40 °C.

3.2 Injection moulding

The properties of injection-moulded test specimens depend strongly on the equipment and conditions used. At present, because of the very wide range of polyethylene materials available, it is not yet possible to standardize an injection-moulding procedure. This does not exclude the manufacture and testing of injection-moulded specimens by agreement between interested parties following the operating conditions specified in ISO 294.

4 Determination of properties

Test specimens shall be conditioned in accordance with ISO 291, unless otherwise stated in the relevant standard, for at least 16 h at $23\text{ °C} \pm 2\text{ K}$ prior to test. The properties shall be determined using the specimens and methods referred to in table 1.

5 Test report

When properties are determined using test specimens prepared in accordance with ISO 293 and this part of ISO 4613, the following additional information shall be included in the test report:

- a) a reference to this part of ISO 4613;
- b) the form of the material tested (powder, granules, pellets, specimen from a moulded part);
- c) the injection-moulding conditions, equipment and type of mould used to prepare the test specimens;
- d) the moulding temperature;
- e) the average cooling rate;
- f) details of non-standard test conditions, when used.

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Table 1 — Test methods and conditions¹⁾

| Property | Units | Method | Specimen dimensions mm | Comments |
|---|--|-------------|---------------------------------|--|
| Mechanical properties | | | | |
| Tensile stress at yield ²⁾ | MPa | } ISO/R 527 | } Type 2 (thickness 2) | Speed D (100 mm/min ± 10 mm/min) Speed A (1 mm/min ± 0,5 mm/min) Test speed: 2 mm/min ± 0,5 mm/min |
| Tensile stress at break ²⁾ | MPa | | | |
| Tensile elongation at yield ²⁾ | % | | | |
| Tensile elongation at break ²⁾ | % | | | |
| Tensile elastic modulus ³⁾ | MPa | | | |
| Flexural modulus at 1 % strain | MPa | | | |
| Shear modulus and mechanical loss factor | MPa | | | |
| Tensile creep modulus ³⁾ | MPa | | | |
| Flexural creep modulus ³⁾ | MPa | | | |
| Torsional stiffness | MPa | | | |
| Izod impact resistance ⁴⁾ vs temperature | kJ/m ² | ISO 178 | 80 × 10 × 4 | Method ISO 180/1A Method ISO 179/1A |
| Charpy impact resistance ⁵⁾ vs temperature | kJ/m ² | ISO 537 | 60 × 10 × 1 | |
| Ball indentation hardness | N/mm ² | ISO 899 | ISO/R 527 type 2 (thickness 2) | |
| Rockwell hardness | | | 80 × 10 × 4 | |
| Shore A or D hardness | | | 80 × 10 × 4 | |
| | | | Minimum thickness 4 | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Thermal properties | | | | |
| Deflection temperature under load ⁶⁾ | °C | ISO 75 | 110 × 10 × 4 | Method B Method A (at 50 K/h) |
| Vicat softening temperature (VST) | °C | ISO 306 | 25 × 25 × 4 | |
| Brittleness temperature | °C | ISO 974 | 20 × 2,5 × 1,6 | |
| Electrical properties | | | | |
| Surface resistance | Ω | IEC 93 | | |
| Volume resistivity | Ω·cm | IEC 93 | | |
| Dielectric strength | kV/mm | IEC 243 | | |
| Relative permittivity | | IEC 250 | | |
| Dissipation factor | | IEC 250 | | |
| Comparative tracking index | | IEC 112 | | |
| Ageing properties | | | | |
| Natural weathering | | ISO 4607 | | |
| | | ISO 4582 | | |
| Artificial-light weathering | | ISO 4892 | | |
| | | ISO 4582 | | |
| Miscellaneous properties | | | | |
| Melt flow rate (MFR) | g/10 min | ISO 1133 | Test done on granules or powder | See also ISO 4613-1 |
| Density of moulded pieces | g/cm ³ | ISO 1183 | Pieces from ISO/R 527 specimen | |
| Water absorption | mg | ISO 62 | | |
| Gas transmission rate | cm ³ /(m ² ·d·atm) | ISO 2556 | | |
| Effect of liquid chemicals | | ISO 175 | | |
| Viscosity number | ml/g | ISO 1628-3 | Test done on granules or powder | |
| Vinyl acetate content | % | ISO 8985 | Test done on granules or powder | |
| Environmental stress cracking | | | | |
| — Ball or pin method | | ISO 4600 | 80 × 10 × 4 | |
| — Constant tensile stress method | h | ISO 6252 | 80 × 10 × 4 | |

1). Preferred specimens and conditions are given, but some alternatives are indicated in these footnotes. It is intended to make the preferred conditions mandatory at the next revision.

2). Speed D is preferred. Alternative speeds, for example 50 mm/min, may be used but shall be reported.

3). A graph of modulus against time at specified temperatures and stresses is recommended.

4). Method 180/1A is preferred. Method 180/4A is an alternative, but its use shall be reported.

5). Method 179/1A is preferred, with a distance between supports of 60 mm. Methods 179/1C and 2C are alternatives, but their use shall be reported.

6). 110 mm × 10 mm × 4 mm is the preferred size. A 110 mm × 12,7 mm × 4 mm specimen is an alternative, but its use shall be reported.