
**Notch tensile test to measure the
resistance to slow crack growth of
polyethylene materials for pipe and fitting
products (PENT)**

*Essai de traction d'une entaille pour mesurer la résistance à la
propagation lente de fissure des polyéthylènes pour tubes et raccords
(PENT)*

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[ISO 16241:2005](https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005)

<https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005>



PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 16241:2005

<https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005>

© ISO 2005

The reproduction of the terms and definitions contained in this International Standard is permitted in teaching manuals, instruction booklets, technical publications and journals for strictly educational or implementation purposes. The conditions for such reproduction are: that no modifications are made to the terms and definitions; that such reproduction is not permitted for dictionaries or similar publications offered for sale; and that this International Standard is referenced as the source document.

With the sole exceptions noted above, no other part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either ISO at the address below or ISO's member body in the country of the requester.

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

Published in Switzerland

Contents

Page

Foreword.....	iv
Introduction	v
1 Scope.....	1
2 Normative references	1
3 Terms and definitions.....	1
4 Principle	2
5 Apparatus	2
6 Test piece preparation.....	4
6.1 Test piece geometry	4
6.2 Test piece preparation.....	5
6.3 Test piece notching	5
6.4 Number of test pieces.....	6
7 Preconditioning.....	6
8 Procedure	6
8.1 Calculation of test mass.....	6
8.2 Loading the test piece	6
8.3 Checking temperature	7
8.4 Recording time to failure.....	7
8.5 Examination of failed test piece	7
9 Test report	7
Annex A (informative) Application of the test.....	8
Annex B (informative) Measurement of extension.....	9
Annex C (informative) Notch depth	10
Annex D (informative) Recommended minimum requirements for polyethylene.....	11
Annex E (informative) Precision	12
Bibliography	13

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 16241 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

ITEH STANDARD PREVIEW

(standards.iteh.ai)

ISO 16241:2005

<https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005>

Introduction

This test method is based on ASTM F 1473^[1], which was originally developed at the University of Pennsylvania. It has been used for assessing and comparing the resistance to slow crack growth of a wide range of polyethylene pipe compounds used primarily for gas applications in the USA and Europe. The test had been evaluated by ten laboratories in the USA prior to acceptance as an ASTM standard. Further work was then carried out by an *ad-hoc* group of ISO/TC 138/SC4, *Plastics pipes and fittings for the supply of gaseous fuels*, to evaluate and refine the procedure, involving six laboratories in Europe and the USA.

Resistance to slow crack growth is an important consideration for polyethylene materials used for pipeline applications and tests to assess this property are incorporated in pressure pipe system standards. The test is also applicable to polyethylene materials used for other pipeline applications as well as to other thermoplastics materials used for other applications. Although seen primarily as a materials test, it has been applied to assess the performance of test pieces cut from pipe and fitting products and butt fusion welds.

iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 16241:2005](https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005)

<https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005>

iTeh STANDARD PREVIEW
(standards.iteh.ai)

ISO 16241:2005

<https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005>

Notch tensile test to measure the resistance to slow crack growth of polyethylene materials for pipe and fitting products (PENT)

1 Scope

This International Standard specifies a method for determining the resistance to slow crack growth of polyethylene (PE) materials for pipes and fitting products.

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

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

ISO 1872-2, *Plastics — Polyethylene (PE) moulding and extrusion materials — Part 2: Preparation of test specimens and determination of properties*

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

3 Terms and definitions

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

3.1

brittle failure

failure with a fracture surface which exhibits no visible permanent material deformation, e.g. stretching, elongation or necking down

3.2

ductile failure

failure with a fracture surface which clearly exhibits permanent material deformation with stretching, elongation and necking down

3.3

slow crack growth

slow extension of a crack with time which is of a brittle appearance

3.4

remaining ligament

remaining cross section after notching and crack growth

4 Principle

To assess the resistance to slow crack growth of a material, a test piece is cut from a compression-moulded sheet. The rectangular shaped test piece containing a centre notch in one face and side notches in the same plane is subjected to a constant static tensile load at a specified test temperature. The time to failure is recorded.

NOTE 1 The test may be carried out on test pieces machined from pipe and fitting products or butt welds (see Annex A).

The following characteristics are described in this method:

- the shape and dimensions of the test piece;
- the notch depth and the depth of the side grooves;
- the number of test pieces;
- the test temperature of the test pieces;
- the method of preparation of the test pieces.

The following parameters shall be specified by the referring standard (a standard making reference to this International Standard in its own provisions):

- the test piece thickness and notch depth if different from the preferred dimensions (see 6.1);
- the stress to be applied to the test piece for the duration of the test;
- the number of test pieces if differing from the number specified in 6.4;
- the test temperature if differing from the value specified in this method (see 5.2).

NOTE 2 The applied stress chosen is such as to preclude ductile behaviour by inducing a fracture surface which is flat, exhibiting no visible permanent material deformation (i.e. stretching, elongation or necking down). Such a surface as a result of the gradual extension of the crack with time is considered to be akin to slow crack growth. Typically, a load to give a stress level of 2,4 MPa at 80 °C will produce a mode of failure related to slow crack growth in polyethylene materials. Alternative stress levels may be used providing a similar mode of failure is produced.

5 Apparatus

5.1 **Test rig**, consisting of the following.

5.1.1 **Test machine**, capable of applying, via grips (see 5.1.2) an axial load on the test piece controlled with an accuracy of within 0,5 % of the calculated or applied load, e.g. a lever-loading machine, with a lever arm ratio of around 5:1 to 10:1 be applied directly using dead weights or a constant load.

5.1.2 **Grips**, having a low friction universal action to prevent bending and to ensure that the load is transmitted axially through the test piece. The grips shall be designed to prevent slippage of the test piece (e.g. serrated grips).

NOTE Measurement of the extension of the test piece or movement of the lever arm provides useful information. The rate of extension of the test piece will increase when initiation of the crack has occurred and will increase rapidly when failure is imminent (see Annex B).

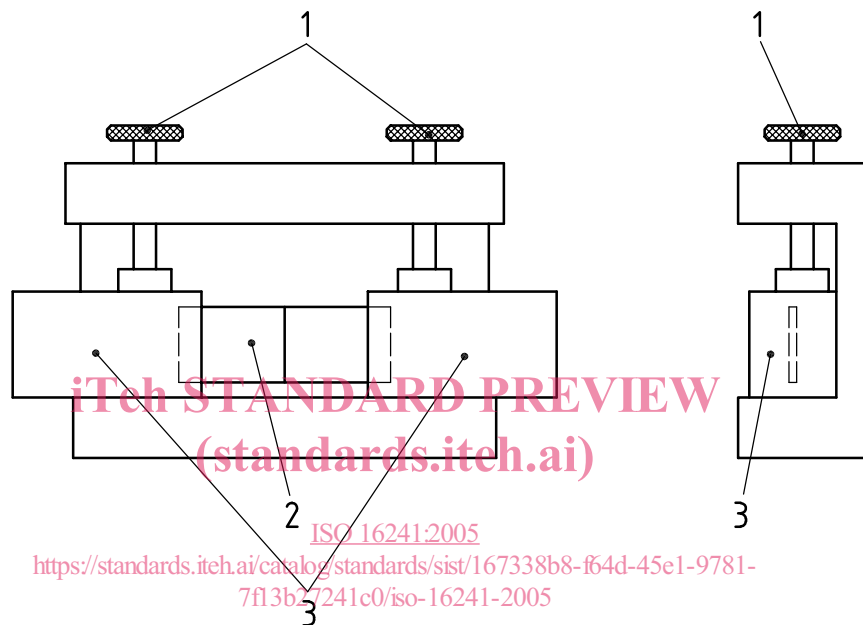
5.2 **Heating chamber or oven**, where the loading frame shall be located with air circulation by a fan or other means to maintain the test piece at $(80 \pm 1,0)$ °C or an alternative test temperature specified by the referring standard.

5.3 Temperature measuring device, i.e. calibrated thermometer or a thermocouple, capable of checking conformity to 5.2.

NOTE Temperature is a critical parameter and measurement made remote from the test piece may not be indicative of temperature of the test piece.

5.4 Clock or timing device, for recording the elapsed time, which shall automatically stop or record the point when the test piece is deemed to fail by either fracture or excessive displacement of the grips.

5.5 Alignment jig, as shown in Figure 1 or similar, to facilitate the alignment the grips and the test piece when it is being tightened in the grips.



Key

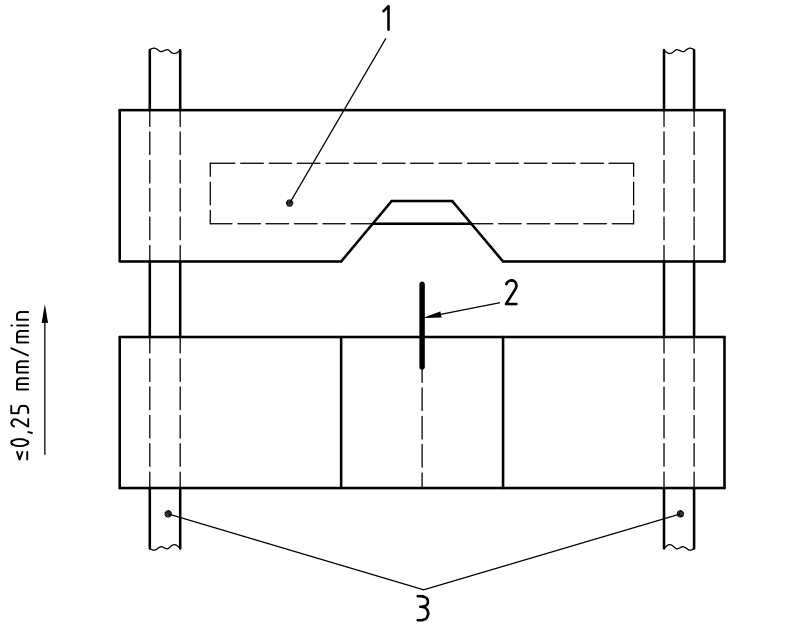
- 1 screw clamps
- 2 test piece
- 3 grips

Figure 1 — Typical arrangement for an alignment jig

5.6 Notching apparatus, for notching the test piece (see Figure 2) so that the main notch and any side notches are coplanar and the plane of the notching is perpendicular to the tensile axis of the test piece. A blade of approximate thickness of 0,15 mm to 0,25 mm shall be used for preparing the notch. The notch-machining equipment shall have a blade penetration speed of not more than 0,25 mm/min and be capable of producing a specified notch depth to within $\pm 0,1$ mm.

NOTE The indicated notch depth can be checked by notching and measurement of a dummy test piece.

5.7 Microscope, suitable for measuring the notch depth and examining the fracture surface.



Key

- 1 test piece
- 2 razor blade
- 3 guides

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Figure 2 — Typical arrangement for apparatus for notching test pieces

[ISO 16241:2005](https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005)

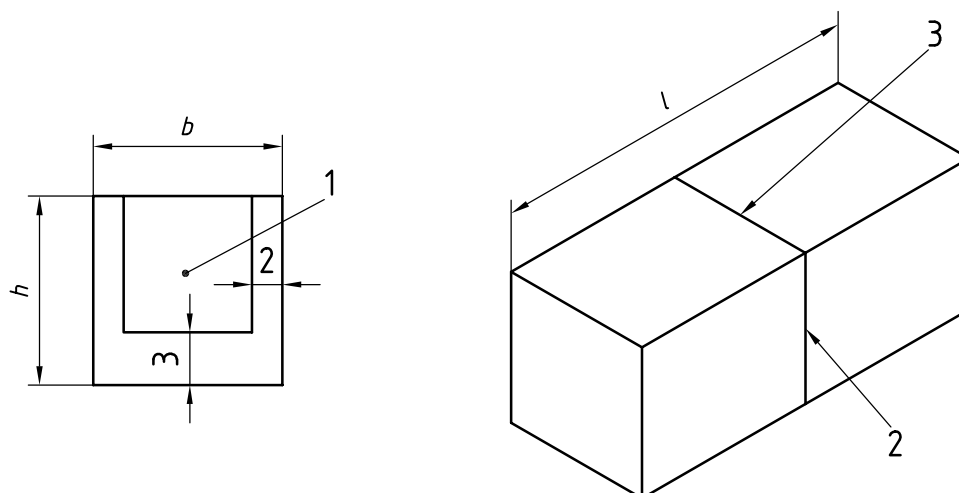
<https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005>

6 Test piece preparation

6.1 Test piece geometry

The test piece geometry is shown in Figure 3, with a preferred nominal width, b , not less than 25 mm and not greater than the width of the grips used, a thickness, h , of a nominal 10 mm, a principal notch depth (3) of 3,5 mm and with side notch depths (2) of 1 mm. Alternative thickness samples with appropriate notch depths are given in Table C.1. The depth of the principal notch for test pieces of thickness other than those given in the table may be obtained by linear interpolation. The length of the test piece, l , shall be sufficient to allow at least 10 mm between the end of each grip and the notch, see 8.2.

NOTE Significant variation from the preferred width could influence the result.

**Key**

- l* length
- b* width
- h* thickness (sheet thickness)
- 1 ligament area
- 2 side notch
- 3 principal notch

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Figure 3 — Test piece geometry

[ISO 16241:2005](https://standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005)

6.2 Test piece preparation standards.iteh.ai/catalog/standards/sist/167338b8-f64d-45e1-9781-7f13b27241c0/iso-16241-2005

Test pieces shall be prepared from compression-moulded sheets made from the material to be tested. Alternatively, test pieces can be prepared from pipe and fitting products or butt welds (see Annex A).

For the compression moulding of the sheets from polyethylene materials, general instructions are given in ISO 1872-2 and ISO 293, but the following specific procedure shall be applied.

Heat the material in granular form in the range of 140 °C to 160 °C and then apply and remove the pressure three times. Increase the temperature in the range of 170 °C to 190 °C for between 10 min and 15 min without pressure. Then apply and remove the pressure three times in order to eliminate voids. Turn off the heat and apply a nominal pressure (force per unit area) of 1,7 MPa. Allow cooling at a rate such that either the time to cool between 130 °C and 90 °C is greater than 80 min or so that the time to cool from the moulding temperature to about room temperature is greater than 5 h. During cooling the pressure shall be maintained.

After allowing at least one day of storage of the sheet following moulding, the test pieces shall be machined from the sheet to the required geometry (see 6.1) in accordance with ISO 2818.

NOTE 1 Higher moulding temperatures of ≤ 200 °C are advised for lower MFR materials, i.e those of MFR $\leq 0,5$ (5 kg load, Condition T, in accordance with ISO 1133).

NOTE 2 The cooling conditions specified are crucial and any deviation from the specified conditions could influence the result of the test. The moulding and thermal processing cycle specified above might not be representative of the manufacturing process to which the material will be subjected.

6.3 Test piece notching

The principal notch shall be machined by pressing a sharp blade, e.g. a razor blade with a blade tip radius of less than 10 μm , into the specimen at a speed of not more than 0,25 mm/min; the tolerance on the required