INTERNATIONAL STANDARD

ISO 13479

First edition
1997-05-01

Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes (notch test)

Tubes en polyoléfines pour le transport des fluides — Résistance à la propagation de la fissure — Méthode d'essai de la propagation lente de la fissure d'un tube entaillé (essai d'entaille)

Reference number
ISO 13479:1997(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 13479 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.*

Annexes A and B of this International Standard are for information only.

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

Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes (notch test)

1 Scope

This International Standard specifies a method of test for determining the resistance to slow crack growth of polyolefin pipes, expressed in terms of time to failure in a hydrostatic pressure test on a pipe with machined longitudinal notches in the outside surface. The test is applicable to pipes of wall thickness greater than 5 mm.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 161-1:1996, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.*

ISO 1167:1996, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method.*

ISO 6108:1978, *Double equal angle cutters with plain bore and key drive.*

ISO 11922-1:1997, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 161-1 and ISO 11922-1 apply.

4 Principle

Lengths of pipe with four machined longitudinal external notches are subject to a constant-pressure hydrostatic pressure test whilst immersed in a water tank at 80 °C. The time to failure is recorded.

5 Apparatus

5.1 Pipe pressure-testing equipment, as specified in ISO 1167.

5.2 Notch-machining equipment, i.e. a milling machine with a horizontal mandrel rigidly fixed to the bed to enable the pipe to be securely clamped to give a straight test piece. The mandrel shall support the pipe bore beneath and along the full length of the notch to be machined. The milling cutter mounted on a horizontal arbor shall be a 60°-included-angle "V"-cutter conforming to ISO 6108, having a cutting rate of (0,010 ± 0,002) (mm/rev)/tooth (see example below).

The milling cutter shall be carefully protected against damage. The cutter shall be subject to a running-in treatment amounting to 10 m of notching prior to its first use for preparation of test pieces. It shall not be used for any other material or purpose and shall be replaced after 100 m of notching.

EXAMPLE

A cutter with 20 teeth rotating at 700 rpm, traversed at a speed of 150 mm/min, has a cutting rate of 150/(20 × 700) = 0,011 (mm/rev)/tooth.

6 Test piece preparation

6.1 Test pieces

Each test piece shall comprise a length of pipe sufficient to give a minimum free length of pipe of ($3d_n \pm 5$) mm between the end caps, when fitted for pressure testing in accordance with ISO 1167, where d_n is the nominal outside diameter of the pipe. For pipes with a nominal outside diameter greater than 315 mm, a minimum free length of ($3d_n \pm 5$) mm shall be used where practical; otherwise a minimum free length of greater than or equal to 1 000 mm shall be used.

6.2 Notch location

Positions shall be marked for machining four notches equally spaced around the pipe circumference (see figure 1).

6.3 Machining the notches

6.3.1 If the wall thickness of the test piece is greater than 50 mm, the material shall be machined with a slot drill of 15 mm to 20 mm diameter to leave approximately 10 mm to be removed by the "V"-cutter used in accordance with 6.3.2.

6.3.2 Each notch shall be machined by climb milling to a depth so as to produce a pipe wall ligament of thickness between 0,78 and 0,82 times the minimum wall thickness, as specified in ISO 11922-1, for the diameter and pressure series of the pipe as shown in table 1 (see note). The ends of each notch shall be aligned circumferentially as shown in figures 1 and 2.

The length of each notch, at full depth, shall be equal to the pipe nominal outside diameter ± 1 mm. For pipes with a free length of pipe of less than ($3\ d_n \pm 5$) mm, the length of each notch, at full depth, shall be equal to the free length minus (500 ± 1) mm.

NOTE — To achieve a remaining ligament within the required tolerance range, it is advisable to aim for a remaining ligament at the top of the tolerance range. This is because the pipe wall can move due to release of residual stresses, resulting in a deeper than anticipated notch.

6.3.3 The test piece shall have end caps fitted which ensure that any longitudinal internal pressure load will act fully on the pipe (e.g. as shown for the type A arrangement in ISO 1167).

Table 1 — Remaining ligament thicknesses for pipe series

Dimensions in millimetres

Nominal outside diameter	SDR6 S2,5		SDR7,4 S3,2		SDR9 S4		SDR11 S5		SDR13,6 S6,3		SDR17 S8		SDR17,6 S8,3		SDR21 S10		SDR26 S12,5		SDR33 S16		SDR41 S20	
	Ligament thickness																					
d_n	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
32	4,2	4,4																				
40	5,2	5,5	4,3	4,5																		
50	6,5	6,8	5,4	5,7	4,4	4,6																
63	8,2	8,6	6,7	7,1	5,5	5,8	4,5	4,8														
75	9,8	10,3	8,0	8,4	6,5	6,9	5,3	5,6	4,3	4,5												
90	11,7	12,3	9,6	10,1	7,9	8,3	6,4	6,7	5,1	5,4	4,2	4,4	4,0	4,2								
110	14,3	15,0	11,8	12,4	9,6	10,1	7,8	8,2	6,3	6,6	5,1	5,4	4,9	5,2	4,1	4,3						
125	16,2	17,1	13,3	14,0	10,9	11,5	8,9	9,3	7,2	7,5	5,8	6,1	5,5	5,8	4,7	4,9						
140	18,2	19,1	15,0	15,7	12,2	12,9	9,9	10,4	8,0	8,4	6,5	6,8	6,2	6,6	5,2	5,5	4,2	4,4				
160	20,7	21,8	17,1	18,0	14,0	14,7	11,4	12,0	9,2	9,7	7,4	7,8	7,1	7,5	6,0	6,3	4,8	5,1				
180	23,3	24,5	19,2	20,2	15,7	16,5	12,8	13,4	10,4	10,9	8,3	8,8	8,0	8,4	6,7	7,1	5,4	5,7	4,3	4,5		
200	25,9	27,2	21,4	22,5	17,5	18,4	14,2	14,9	11,5	12,1	9,3	9,8	8,9	9,3	7,5	7,9	6,0	6,3	4,8	5,1		
225	29,2	30,7	24,0	25,3	19,6	20,6	16,0	16,8	12,9	13,6	10,5	11,0	10,0	10,5	8,4	8,9	6,7	7,1	5,4	5,7	4,3	4,5
250	32,4	34,0	26,7	28,0	21,8	22,9	17,7	18,6	14,4	15,1	11,5	12,1	11,1	11,6	9,3	9,8	7,5	7,9	6,0	6,3	4,8	5,0
280	36,3	38,1	29,9	31,4	24,3	25,6	19,8	20,8	16,1	16,9	12,9	13,6	12,4	13,0	10,5	11,0	8,3	8,8	6,7	7,1	5,4	5,7
315	40,8	42,9	33,6	35,3	27,3	28,7	22,3	23,5	18,2	19,1	14,6	15,3	14,0	14,7	11,7	12,3	9,4	9,9	7,6	8,0	6,0	6,3
355	46,0	48,4	37,8	39,8	30,8	32,4	25,2	26,5	20,4	21,4	16,5	17,3	15,8	16,6	13,2	13,9	10,6	11,2	8,5	8,9	6,8	7,1
400			42,7	44,9	34,7	36,5	28,4	29,8	22,9	24,1	18,5	19,4	17,8	18,7	14,9	15,7	11,9	12,5	9,6	10,1	7,6	8,0
450			48,1	50,6	39,0	41,0	31,9	33,5	25,8	27,1	20,8	21,9	19,9	21,0	16,8	17,6	13,4	14,1	10,8	11,3	8,6	9,0
500					43,4	45,6	35,5	37,3	28,7	30,2	23,1	24,3	22,2	23,3	18,6	19,6	14,9	15,7	11,9	12,5	9,5	10,0
560							39,7	41,7	32,1	33,8	25,9	27,2	24,9	26,2	20,8	21,9	16,7	17,5	13,4	14,1	10,7	11,2
630							44,7	47,0	36,2	38,0	29,1	30,6	27,9	29,4	23,4	24,6	18,8	19,8	15,1	15,8	12,0	12,6
710									40,8	42,9	32,8	34,5	31,4	33,0	26,4	27,8	21,2	22,3	17,0	17,9	13,6	14,3
800									45,9	48,3	37,0	38,9	35,3	37,1	29,7	31,2	23,9	25,1	19,1	20,1	15,3	16,1
900											41,7	43,9	39,8	41,8	33,5	35,2	27,1	28,5	21,5	22,6	17,2	18,0
1 000											46,3	48,6	44,1	46,4	37,2	39,1	30,0	31,6	23,9	25,1	19,0	20,0
1 200															44,6	46,9	36,0	37,9	28,4	29,8	22,8	24,0
1 400																	42,0	44,2	33,1	34,8	26,7	28,0
1 600																	48,0	50,4	37,8	39,8	30,5	32,1

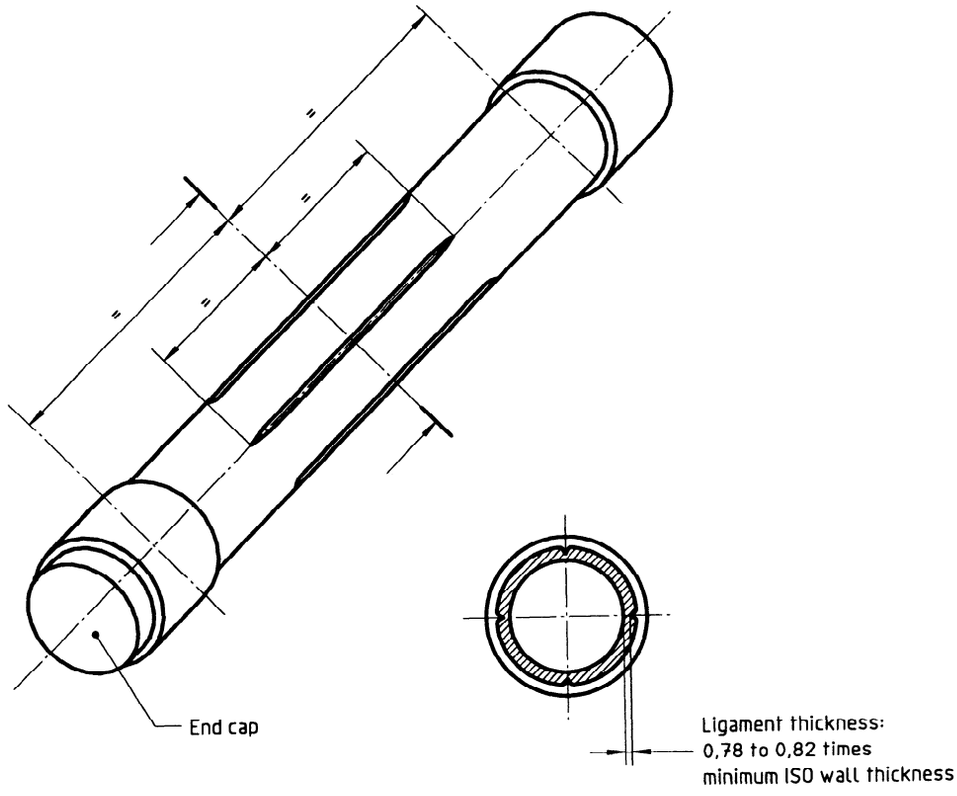

Figure 1 — Pipe test piece

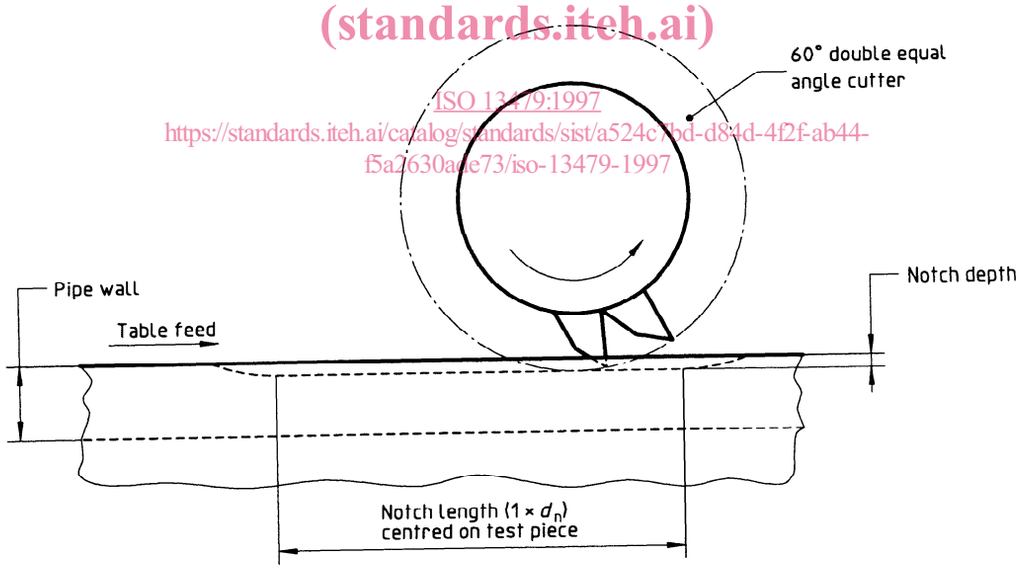

Figure 2 — Notching method

6.4 Number of test pieces

Prepare a minimum of three test pieces unless specified otherwise in the referring standard.

7 Conditioning

The test pieces shall be filled with water, immersed in a water tank at 80 °C and allowed to condition for 24 h for pipes of wall thickness up to 25 mm and 48 h for greater wall thicknesses.

8 Procedure

8.1 Hydrostatic-pressure testing

Pressurize the test piece with water in accordance with ISO 1167 at a test temperature of 80 °C, applying and maintaining the pressure specified in the referring standard. During the procedure of applying the pressure, ensure that the pressure is increased smoothly and progressively, and the required pressure is not exceeded. Maintain the pressure until either the test piece ruptures or a specified minimum time to failure has elapsed, whichever occurs first. Record the time under pressure to the nearest hour. In the case of failure, record the location of the failure for each test piece.

NOTE — Table A.1 gives applicable pressure levels, dependent on material type and pipe series.

8.2 Notch-depth measurement

On completion of the pressure test, remove the test piece from the water tank and allow to cool to ambient temperature. Cut a section of pipe out from round the position of each notch. Open up the notch to give clear access to one of the machined surfaces of the notch. Measure the width of the machined surface of the notch to an accuracy ± 0,1 mm with a microscope or equivalent means, e.g. as shown in figure 3. If required by the referring standard, measure the depth of penetration of the crack.

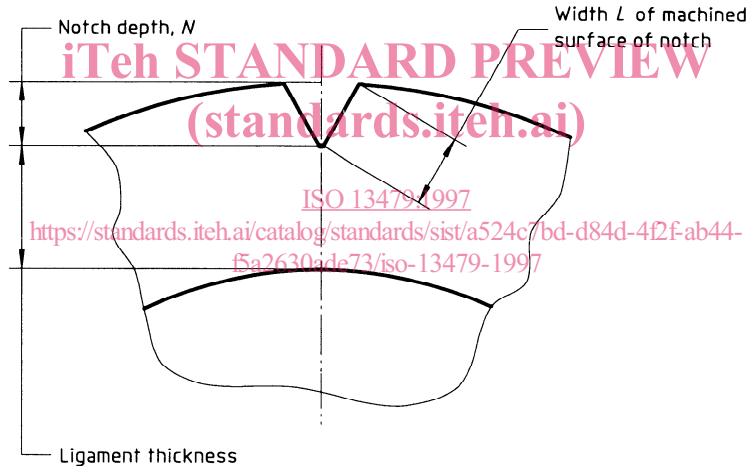

Figure 3 — Measurement to calculate notch depth

Calculate the notch depth N, in millimetres, using the following equation:

$$N = 0{,}5\left[\left(d_{em} - \sqrt{\left(d_{em}^2 - L^2\right)}\right)\right] + 0{,}866\,L$$

where

L is the width of machined surface of the notch, in millimetres;

d_{em} is the measured mean pipe outside diameter, in millimetres.

Calculate the ligament thickness from the notch depth and the individual average wall thickness alongside each notch position.

9 Test report

The test report shall include the following information:

a) a reference to this International Standard and to the referring standard;

b) all details necessary for complete identification of the pipe (manufacturer, type of pipe, production date);

c) the cutter size and number of teeth;

d) the cutter speed, in revolutions per minute, and traverse speed, in millimetres per minute;

e) the mean pipe outside diameter, in millimetres;

f) the ligament thickness for each notch;

g) the notch depth and percentage notch depth for each notch, and location of any failed notch;

h) the test pressure;

i) the time under pressure or the time to failure, in hours, as applicable;

j) details of any factors which may have affected the results, such as any incidents or any operations not specified in this International Standard;

k) the date of the test.

Annex A
(informative)
Test-pressure levels and recommended specifications for polyethylene

NOTE — The test is applicable to other polyolefin materials such as polypropylene, but test parameters and specifications have not been developed.

A.1 Test-pressure levels

For a notch test for slow crack growth in polyethylene (PE) pipe, at the test temperature of 80 °C the applicable pressure levels depend on the material type and pipe series as given in table A.1.

Table A.1 — Test-pressure levels

SDR	S	Test pressure, p bar	
		PE 80	PE 100
41	20	2	2,3
33	16	2,5	2,88
26	12,5	3,2	3,68
21	10	4	4,6
17,6	8,3	4,82	5,54
17	8	5	5,75
13,6	6,3	6,35	7,3
11	5	8	9,2
9	4	10	11,5
7,4	3,2	12,5	14,38
6	2,5	16	18,4

NOTE — These pressure levels are calculated to give nominal plain-pipe hydrostatic stress levels of 4,0 MPa in PE 80 materials and 4,6 MPa in PE 100 material by use of the following equations:

$$p = \frac{10\sigma}{S}$$

or

$$p = \frac{20\sigma}{(SDR - 1)}$$

where

σ is the hydrostatic stress, in megapascals;

S is the pipe series;

SDR is the standard dimension ratio.