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Edition 1

ISO 4437-2:2014
Edition 1

SOUTH AFRICAN NATIONAL STANDARD

Plastics piping systems for the supply of gaseous fuels — Polyethelene (PE)

Part 2: Pipes

This national standard is the identical implementation of ISO 4437-2:2014, and is adopted with the permission of the International Organization for Standardization.

WARNING
This document references other documents normatively.

Published by the South African Bureau of Standards
1 Dr Lategan Road Groenkloof ✉ Private Bag X191 Pretoria 0001
Tel: +27 12 428 7911 Fax: +27 12 344 1568
www.sabs.co.za

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SANS 4437-2:2014
Edition 1
ISO 4437-2:2014
Edition 1

Table of changes

Change No.	Date	Scope

National foreword

This South African standard was prepared by National Committee SABS/TC 138/SC 06, *Water and sanitation – Equipment and systems – Plastics pipes and fittings*, in accordance with procedures of the South African Bureau of Standards, in compliance with annex 3 of the WTO/TBT agreement.

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Compliance with this document cannot confer immunity from legal obligations.

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INTERNATIONAL STANDARD

ISO 4437-2

First edition
2014-01-15

Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) —

Part 2: **Pipes**

Systèmes·de·canalisations·en·matières·plastiques·pour·la·distribution·de·combustibles·gazeux· — ·Polyéthylène·(PE) —

Partie 2: Tuyaux

Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This first edition of ISO 4437-2 together with the first editions of ISO 4437-1, ISO 4437-3 and ISO 4437-5 cancel and replace ISO 4437:2007, ISO 8085-1:2001, ISO 8085-2:2001 and ISO 8085-3:2001, of which they constitute a technical revision.

ISO 4437 consists of the following parts, under the general title *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 4: Valves*

— *Part 5: Fitness for purpose of the system*

Introduction

This part of ISO 4437 specifies the requirements for a piping system and its components made from polyethylene (PE), and which is intended to be used for the supply of gaseous fuels.

Requirements and test methods for material and components, other than pipes, are specified in ISO 4437-1, ISO 4437-3, and ISO 4437-4.

Characteristics for fitness for purpose of the system are covered in ISO 4437-5.

Recommended practice for installation is given in ISO/TS 10839.[1]

This part of ISO 4437 covers the characteristics of pipes.

INTERNATIONAL STANDARD ISO 4437-2:2014(E)

Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) —

Part 2: Pipes

1 Scope

This part of ISO 4437 specifies the characteristics of pipes made from polyethylene (PE) for piping systems in the field of the supply of gaseous fuels.

It also specifies the test parameters for the test methods referred to in this International Standard.

In conjunction with part of ISO 4437-1, ISO 4437-3, ISO 4437-4, and ISO 4437-5, it is applicable to PE pipes, fittings and valves, their joints, and joints with components of PE and other materials intended to be used under the following conditions:

a) the maximum operating pressure (MOP) is based on the design stress determined from the compound minimum required strength (MRS) divided by the *C* factor, and taking into account rapid crack propagation (RCP) requirements;

b) a temperature of 20 °C as reference temperature for the design basis.

NOTE 1 For other operating temperatures, guidance is given in ISO 4437-5:2014.

For above ground application of pipes conforming to this International Standard, the pipes should be protected by a casing pipe, taking into account any relevant national regulations and installation practices or codes.

This part of ISO 4437 covers three types of pipes:

— PE pipes (outside diameter d_n) including any identification stripes;

— PE pipes with co-extruded layers on either or both the outside and/or inside of the pipe (total outside diameter d_n) as specified in Annex A, where all PE layers have the same MRS rating;

— PE pipes (outside diameter d_n) with a peelable and contiguous thermoplastics additional layer on the outside (coated pipe) as specified in Annex B.

NOTE 2 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1167-1:2006, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 4065, *Thermoplastics pipes — Universal wall thickness table*

ISO 4437-1:2014, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 1: General*

ISO 4437-5:2014, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 5: Fitness for purpose of the system*

ISO 6259-1, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

ISO 6259-3, *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes*

ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

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

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*

ISO 13478, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST)*

ISO 13479:2009, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes*

ISO 13968, *Plastics piping and ducting systems — Thermoplastics pipes — Determination of ring flexibility*

ISO 13480, *Polyethylene pipes — Resistance to slow crack growth — Cone test method*

EN 12106, *Plastics piping systems — Polyethylene (PE) pipes — Test method for the resistance to internal pressure after application of squeeze-off*

3 Terms and definitions, symbols, and abbreviations

For the purposes of this document, the terms and definitions in ISO 4437-1:2014 and the following apply.

4 Material

4.1 Compound for pipes

The pipes shall be made from virgin material or own reprocessible material from the same PE compound or a mixture of both materials. Reprocessible material from co-extruded pipes or from pipes reprocessed with the peelable layer attached shall not be used. Own reprocessible material from the base pipe of peelable-layer pipes can be used.

The compound(s) from which the pipes are made shall conform to ISO 4437-1:2014.

4.2 Compound for identification stripes

For pipes with identifications stripes, the compound used for these identification stripes shall be made from the same base polymer (PE) as one of the pipe compounds for which fusion compatibility has been proven.

4.3 Recyclable material

Recyclable material including reprocessable material obtained from external sources shall not be used.

5 General characteristics

5.1 Appearance

When viewed without magnification, the internal and external surfaces of pipes shall be smooth and clean and shall have no scoring, cavities, and other surface defects to an extent that would prevent conformity to this part of ISO 4437.

The ends of the pipes shall be cut cleanly and square to the axis of the pipes.

5.2 Colour

Pipes shall be black (PE 80 or PE 100), yellow (PE 80), or orange (PE 100). In addition, black PE 80 pipes can be identified by yellow stripes and black PE 100 pipes can be identified by yellow or orange stripes, according to national preference.

The outer co-extruded layer of co-extruded pipes (see Annex A) or the outer peelable layer of peelable-layer pipes (see Annex B) shall be either black, yellow, or orange. In addition, identification stripes can be used according to national preference.

6 Geometrical characteristics

6.1 Measurement of dimensions

The dimensions of the pipes shall be measured in accordance with ISO 3126 and rounded to the next 0,1 mm. In case of dispute, the measurement shall not be made less than 24 h after manufacture and after being conditioned for at least 4 h at (23 ± 2) °C.

Indirect measurement at the stage of production is allowed at shorter time periods, provided that evidence is shown of correlation.

6.2 Mean outside diameters, out-of-roundness (ovality), and tolerances

The mean outside diameters of the pipes, d_{em}, shall conform to Table 1.

For straight pipes, the maximum out-of-roundness shall conform to Table 1. For coiled pipes, the maximum out-of-roundness shall be specified by an agreement between the manufacturer and the end-user.

Table 1 — Mean outside diameters and out-of-roundness

Dimensions in millimetres

Nominal size DN/ OD	Nominal outside diameter d_n	Mean outside diameter		Maximum out-of-roundness for straight pipes[b] [c]
		$d_{em,min}$	$d_{em,max}$[a]	
16	16	16,0	16,3	1,2
20	20	20,0	20,3	1,2
25	25	25,0	25,3	1,2
32	32	32,0	32,3	1,3
40	40	40,0	40,4	1,4
50	50	50,0	50,4	1,4
63	63	63,0	63,4	1,5
75	75	75,0	75,5	1,6
90	90	90,0	90,6	1,8
110	110	110,0	110,7	2,2
125	125	125,0	125,8	2,5
140	140	140,0	140,9	2,8
160	160	160,0	161,0	3,2
180	180	180,0	181,1	3,6
200	200	200,0	201,2	4,0
225	225	225,0	226,4	4,5
250	250	250,0	251,5	5,0
280	280	280,0	281,7	9,8
315	315	315,0	316,9	11,1
355	355	355,0	357,2	12,5
400	400	400,0	402,4	14,0
450	450	450,0	452,7	15,6
500	500	500,0	503,0	17,5
560	560	560,0	563,4	19,6
630	630	630,0	633,8	22,1

[a] Grade B according to ISO 11922-1:1997.

[b] Measurement of out-of-roundness shall be made at the point of manufacturing.

[c] If other values for the out-of-roundness than those given in Table 1 are necessary (e.g. coiled pipes), they shall be agreed between the manufacturer and the end-user.

6.3 Wall thicknesses and related tolerances

6.3.1 Minimum wall thicknesses

The use of any standard dimension ratio (SDR) derived from the pipe series *S* given according to ISO 4065 is permitted.

The minimum wall thickness, e_{min}, of pipes shall conform to Table 2.

Table 2 — Minimum wall thicknesses

Nominal outside diameter d_n	Minimum wall thickness e_{min}[a]						
	SDR 9	SDR 11[b]	SDR 13,6	SDR 17[b]	SDR 17,6[c]	SDR 21	SDR 26
16	3,0	2,3[d]	—	—	—	—	—
20	3,0	2,3[d]	—	—	—	—	—
25	3,0	2,3[d]	2,3[d]	—	—	—	—
32	3,6	3,0	2,4[d]	2,3[d]	2,3[d]	—	—
40	4,5	3,7	3,0	2,4[d]	2,3[d]	2,3[d]	—
50	5,6	4,6	3,7	3,0	2,9[d]	2,4[d]	2,3[d]
63	7,1	5,8	4,7	3,8	3,6	3,0	2,5[d]
75	8,4	6,8	5,6	4,5	4,3	3,6	2,9[d]
90	10,1	8,2	6,7	5,4	5,2	4,3	3,5
110	12,3	10,0	8,1	6,6	6,3	5,3	4,2
125	14,0	11,4	9,2	7,4	7,1	6,0	4,8
140	15,7	12,7	10,3	8,3	8,0	6,7	5,4
160	17,9	14,6	11,8	9,5	9,1	7,7	6,2
180	20,1	16,4	13,3	10,7	10,3	8,6	6,9
200	22,4	18,2	14,7	11,9	11,4	9,6	7,7
225	25,2	20,5	16,6	13,4	12,8	10,8	8,6
250	27,9	22,7	18,4	14,8	14,2	11,9	9,6
280	31,3	25,4	20,6	16,6	15,9	13,4	10,7
315	35,2	28,6	23,2	18,7	17,9	15,0	12,1
355	39,7	32,2	26,1	21,1	20,2	16,9	13,6
400	44,7	36,4	29,4	23,7	22,8	19,1	15,3
450	50,3	40,9	33,1	26,7	25,6	21,5	17,2
500	55,8	45,5	36,8	29,7	28,4	23,9	19,1
560	—	50,9	41,2	33,2	31,9	26,7	21,4
630	—	57,3	46,3	37,4	35,8	30,0	24,1

[a] $e_{min} = e_n$.

[b] Preferred series.

[c] SDR 17, 6 series can be removed at the next revision of this International Standard.

[d] Minimum wall thickness values greater than limits of 2,3 mm, 2,4 mm, 2,5 mm, and 2,9 mm can be imposed for practical reasons in accordance with national requirements. See manufacturer's technical files or national specifications for advice.

6.3.2 Tolerance on the wall thicknesses

The tolerance on the wall thickness at any point shall conform to Table 3 footnote a, which is derived from grade V of ISO 11922-1:1997.

Table 3 — Tolerance on wall thicknesses

Dimensions in millimetres

Nominal wall thickness e_n[a]		Plus tolerance t_y[b]	Nominal wall thickness e_n[a]		Plus tolerance t_y[b]
>	≤		>	≤	
–	2,0	0,3	30,0	31,0	3,2
2,0	3,0	0,4	31,0	32,0	3,3
3,0	4,0	0,5	32,0	33,0	3,4
4,0	5,0	0,6	33,0	34,0	3,5
5,0	6,0	0,7	34,0	35,0	3,6
6,0	7,0	0,8	35,0	36,0	3,7
7,0	8,0	0,9	36,0	37,0	3,8
8,0	9,0	1,0	37,0	38,0	3,9
9,0	10,0	1,1	38,0	39,0	4,0
10,0	11,0	1,2	39,0	40,0	4,1
11,0	12,0	1,3	40,0	41,0	4,2
12,0	13,0	1,4	41,0	42,0	4,3
13,0	14,0	1,5	42,0	43,0	4,4
14,0	15,0	1,6	43,0	44,0	4,5
15,0	16,0	1,7	44,0	45,0	4,6
16,0	17,0	1,8	45,0	46,0	4,7
17,0	18,0	1,9	46,0	47,0	4,8
18,0	19,0	2,0	47,0	48,0	4,9
19,0	20,0	2,1	48,0	49,0	5,0
20,0	21,0	2,2	49,0	50,0	5,1
21,0	22,0	2,3	50,0	51,0	5,2
22,0	23,0	2,4	51,0	52,0	5,3
23,0	24,0	2,5	52,0	53,0	5,4
24,0	25,0	2,6	53,0	54,0	5,5
25,0	26,0	2,7	54,0	55,0	5,6
26,0	27,0	2,8	55,0	56,0	5,7
27,0	28,0	2,9	56,0	57,0	5,8
28,0	29,0	3,0	57,0	58,0	5,9
29,0	30,0	3,1			

[a] See Table 2 footnote a.

[b] The tolerance is expressed in the form $^{+t_y}_{0}$ mm.

6.4 Circumferential reversion of pipes with d_n equal to or greater than 250 mm

The circumferential reversion of pipes with d_n equal to or greater than 250 mm shall be determined between 24 h and 48 h after manufacture and after conditioning in water at 80 °C. The conditioning shall be in accordance with ISO 1167-1:2006. The pipe test pieces shall be $3d_n$ in length. With the test piece at (23 ± 2) °C, circumferential measurement shall be made to establish d_{em} made at distance of 0,1 d_n

and 1,0 d_n, respectively, from the end of the test piece. The difference between these d_{em} measurements shall not be greater than the d_{em} tolerance range specified in Table 1.

NOTE Circumferential reversion or "tow-in" of the pipe end is created by the residual stress of the pipes during extrusion. This results in a small reduction of diameter at the cut end of the pipes.

6.5 Coiled pipe

During production, the pipe shall be coiled such that localized deformation, e.g. buckling and kinking, is prevented.

The minimum internal diameter of the coil shall not be less than 18 d_n.

6.6 Lengths

No requirements have been set concerning particular lengths of coiled or straight pipes or the tolerance thereon. Hence it is necessary for lengths of pipes to be supplied by an agreement between the purchaser and the manufacturer.

7 Mechanical characteristics

7.1 Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 4.

7.2 Requirements

When tested in accordance with the test methods as specified in Table 4 using the indicated parameters, the pipes shall have mechanical characteristics conforming to the requirements given in Table 4. The requirements for co-extruded pipes are given in Annex A, for peelable pipes in Annex B, and for squeezed-off pipes in Annex C.

Table 4 — Mechanical characteristics

Characteristic	Requirements	Test parameters		Test method
		Parameter	Value	
Hydrostatic strength (20 °C, 100 h)[i]	No failure during the test period of any test piece	End caps Orientation Conditioning time at test temperature Number of test pieces[a] Type of test Circumferential (hoop) stress for: PE 80 PE 100 Test period Test temperature	Type A of ISO 1167-1:2006 Free Shall conform to ISO 1167-1:2006 3 Water-in-water 9,0 MPa 12,0 MPa 100 h 20 °C	ISO 1167-1:2006 and ISO 1167-2
Hydrostatic strength (80 °C, 165 h)[i]	No failure during the test period of any test piece[b]	End caps Orientation Conditioning time at test temperature Number of test pieces[a] Type of test Circumferential (hoop) stress for: PE 80 PE 100 Test period Test temperature	Type A of ISO 1167-1:2006 Free Shall conform to ISO 1167-1:2006, 3 Water-in-water 4,5 MPa 5,4 MPa 165 h 80 °C	ISO 1167-1:2006 and ISO 1167-2

Table 4 — *(continued)*

Characteristic	Requirements	Test parameters		Test method
		Parameter	Value	
Hydrostatic strength (80 °C, 1 000 h)[i]	No failure during the test period of any test piece	End caps Orientation Conditioning time at test temperature Number of test pieces[a] Type of test Circumferential (hoop) stress for: PE 80 PE 100 Test period Test temperature	Type A of ISO 1167-1:2006 Free Shall conform to ISO 1167-1:2006 3 Water-in-water 4 MPa 5 MPa 1 000 h 80 °C	ISO 1167-1:2006 and ISO 1167-2
Elongation at break for $e \leq 5$ mm	≥350 %[c d]	Test piece shape Speed of test Number of test pieces[a]	Type 2 100 mm/min Shall conform to ISO 6259-1	ISO 6259-1 and ISO 6259-3
Elongation at break for 5 mm < $e \leq 12$ mm	≥350 %[c d]	Test piece shape Speed of test Number of test pieces[a]	Type 1[e] 50 mm/min Shall conform to ISO 6259-1	ISO 6259-1 and ISO 6259-3
Elongation at break for $e > 12$ mm	≥350 %[c d]	Test piece shape Speed of test Number of test pieces[a]	Type 1[e] 25 mm/min Shall conform to ISO 6259-1	ISO 6259-1 and ISO 6259-3
		or		
		Test piece shape Speed of test Number of test pieces[a]	Type 3[e] 10 mm/min Shall conform to ISO 6259-1	
Resistance to slow crack growth for $e \leq 5$ mm (Cone test)	≤10 mm/day	Number of test pieces[a]	Shall conform to ISO 13480	ISO 13480
Resistance to slow crack growth for $e > 5$ mm (Notch test)	No failure during the test period	Test temperature Internal test pressure for: PE 80, SDR 11 PE 100, SDR 11 Test period Type of test Number of test pieces[a]	80 °C 8 bar[f] 9,2 bar[f] 500 h Water-in-water Shall conform to ISO 13479	ISO 13479

Table 4 — *(continued)*

Characteristic	Requirements	Test parameters		Test method
		Parameter	Value	
Resistance to rapid crack propagation (Critical pressure, p_c)[g]	$p_c \geq 1{,}5$ MOP with $p_c = 3{,}6p_{c,s4} + 2{,}6$[h]	Test temperature Number of test pieces[a]	0 °C Shall conform to ISO 13477	ISO 13477

[a] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 4. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance for assessment of conformity can be found in CEN/TS 1555–7.[2]

[b] Only brittle failures shall be taken into account. If a ductile failure occurs before 165 h, the test can be repeated at a lower stress (see 7.3). The stress and the associated test period shall be selected from Table 5 or from a line based on the stress/time points given in Table 5.

[c] Where the rupture takes place outside the gauge marks, the test is accepted if the value conforms to the requirements.

[d] The test can be terminated when the requirement is met, without necessarily carrying out the test up to the rupture of the test piece.

[e] Where practical, machine or die cut type 2 test pieces can be used for pipe wall thickness equal to or less than 25 mm.

[f] For other SDR classes, values are given in Annex B of ISO 13479:2009.

[g] Rapid crack propagation testing is only required by the pipe manufacturer when the wall thickness of the pipe is greater than the wall thickness of the pipe tested by the PE compound supplier (see Table 2 of ISO 4437-1:2012). Rapid crack propagation testing is required at sub-zero temperatures for applications at such temperatures.

[h] Full scale/S4 correlation factor is equal to 3,6 and is defined as the full scale/S4 critical absolute pressures ratio: $(p_{c,\text{full scale}} + 1) = 3{,}6\ (p_{c,s4} + 1)$. If the requirement is not met or S4 test equipment is not available, then retesting by using the full scale test shall be performed in accordance with ISO 13478. In this case: $p_c = p_{c,\text{full scale}}$.

[i] Alternatively, for $d_n > 450$ mm, the test can be performed in air. In case of dispute, water-in-water shall be used.

7.3 Retest in case of failure at 80 °C

A fracture in a brittle mode in less than 165 h shall constitute a failure; however, if a sample in the 165 h-test fails in a ductile mode in less than 165 h, a retest shall be performed at a selected lower stress in order to achieve the minimum required time for the selected stress obtained from the line through the stress/time points given in Table 5.

Table 5 — Test parameters for the retest of the hydrostatic strength at 80 °C

PE 80		PE 100	
Stress MPa	**Test period** h	**Stress** MPa	**Test period** h
4,5	165	5,4	165
4,4	233	5,3	256
4,3	331	5,2	399
4,2	474	5,1	629
4,1	685	5,0	1 000
4,0	1 000	—	—

8 Physical characteristics

8.1 Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 6.

8.2 Requirements

When tested in accordance with the test methods as specified in Table 6 using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 6.

Table 6 — Physical characteristics

Characteristic	Requirements	Test parameters		Test method
		Parameter	Value	
Oxidation induction time (Thermal stability)	≥20 min	Test temperature Number of test pieces[a] [c] Test environment Specimen weight	200 °C[b] 3 Oxygen 15 mg ± 2 mg	ISO 11357-6
Melt mass-flow rate (MFR)	After processing maximum deviation of ±20 % of the value measured on the batch used to manufacture the pipe	Loading mass Test temperature Time Number of test pieces[a]	5 kg 190 °C 10 min Shall conform to ISO 1133-1	ISO 1133-1
Longitudinal reversion (≤16 mm wall thickness)	≤3 % original appearance of the pipe shall remain	Test temperature Length of test piece Immersion time Test method Number of test pieces[a]	110 °C 200 mm 1 h Free Shall conform to ISO 2505	ISO 2505

[a] The number of test pieces given indicates the number required to establish a value for the characteristic described in the table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance for assessment of conformity can be found in CEN/TS 1555–7.[2]

[b] Test can be carried out as an indirect test at 210 °C or 220 °C provided that clear correlation has been established with the results at 200 °C. In case of dispute, the reference temperature shall be 200 °C.

[c] Samples shall be taken from the outer and inner pipe surfaces.

9 Performance requirements

When pipes conforming to this part of ISO 4437 are assembled to each other or to components conforming to other parts of ISO 4437 the joints shall conform to ISO 4437-5:2014.

10 Marking

10.1 General

10.1.1 The marking elements shall be printed or formed directly on the pipes in such a way that after storage, weathering, handling, and installation, legibility is maintained during the use of the pipes.

NOTE The manufacturer is not responsible for marking being illegible, due to actions caused during installation and use such as painting, scratching, covering of the components, or by use of detergents, etc. on the components unless agreed or specified by the manufacturer.

10.1.2 Marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipes.

10.1.3 If printing is used, the colour of the printed information shall differ from the basic colour of the pipes.

10.1.4 The size of the marking shall be such that it is legible without magnification.

10.1.5 In case of pipes made from own reprocessable material, the use of appropriate marking should be subject to agreement between the manufacturer and the end-user.

10.2 Minimum required marking

The minimum required marking shall conform to Table 7.

Table 7 — Minimum required marking

Aspects	Mark or symbol
Reference to this International Standard Manufacturer's name and/or trademark	ISO 4437 Name or symbol
For pipes $d_n \leq 32$ mm: – Nominal outside diameter × nominal wall thickness ($d_n \times e_n$)	 e.g. 32 × 3,0
For pipes $d_n > 32$ mm: – Nominal outside diameter, d_n – SDR	 e.g. 200 e.g. SDR 11
Type of pipe if applicable Material and designation Manufacturer's information Intended use[b]	e.g. co-extruded or peelable layer e.g. PE 100 [a] GAS
[a] For providing traceability, the following details shall be given: — the production period, year, and month, in figures or in code; — name or code for the production site, if the manufacturer is producing in different sites; — materials used by name or code. [b] Information on abbreviations can be found in national rules.	

The frequency of the marking shall not be less than once per metre.

The length of coiled pipes is permitted to be indicated on the coil; the remaining length of pipes on drums is permitted to be indicated on the pipes.

Co-extruded and peelable pipes shall be marked accordingly including any specific instructions related to these types of pipes.

Annex A
(normative)

Pipes with co-extruded layers

A.1 General

This annex specifies the additional geometrical, mechanical, and physical properties of polyethylene (PE) pipes with co-extruded layer(s), intended to be used for the supply of gaseous fuels. Additional marking requirements are given. The outside diameter, d_e, is defined as the total outside diameter, including the co-extruded black or pigmented layer(s) at the outside of the pipe, and the wall thickness, e_n, is defined as the total wall thickness including all layers, on either or both the outside and/or inside of the pipe. The PE compounds used for the layer(s) of the pipes shall be in accordance with ISO 4437-1:2014 and of the same MRS rating. Rework material from co-extruded pipes shall not be used for these products.

NOTE Other types of layered pipes are covered by other international standards, e.g. ISO 17484-1[3] or ISO 18225.[4]

A.2 Geometrical characteristics

The geometrical characteristics of the pipe, inclusive of the co-extruded layer(s), shall be in accordance with Clause 6. The manufacturer shall declare the thickness of each layer and tolerance in the technical file.

A.3 Mechanical characteristics

The mechanical characteristics of each pipe construction and compound combination shall be in accordance with Clause 7.

In addition, the requirements for RCP and Slow Crack Growth in accordance with Table 4 shall be fulfilled by the manufactured pipe, and Note g does not apply. The RCP test is to be performed on the maximum wall thickness of the manufacturer's range.

A.4 Physical characteristics

The physical characteristics shall be in accordance with Clause 8. The requirements for thermal stability and for melt flow rate shall apply to the individual layers, respectively. Heat reversion shall be applicable to the pipe, inclusive of the co-extruded layer(s).

A.5 Marking

The marking of pipes with co-extruded layer(s) shall be in accordance with Clause 10.

A.6 Delamination

No delamination shall occur during all tests of the co-extruded pipe.

A.7 Integrity of the structure

When tested in accordance with the test methods as specified in Table A.1 using the indicated parameters, the pipes shall have the structural performance conforming to the requirements given in Table A.1.

Table A.1 — Integrity of the structure

Characteristic	Requirement	Test parameters		Test method
Integrity of the structure after deflection	>80 % of the initial stiffness value	Deflection Position of test piece	30 % of d_{em} When applicable, at 0, 45 and 90 from the upper plate	ISO 13968

For the determination of the integrity of the structure after deflection of co-extruded pipes, the following procedure shall be applied:

a) determine the initial ring stiffness of the pipe according to ISO 9969;

b) carry out the ring flexibility test according to ISO 13968;

c) after a 1 h period for recovery, determine again the ring stiffness according to ISO 9969.

The ring stiffness of the co-extruded pipe shall be at least 80 % of the initial ring stiffness.

Annex B
(normative)

Pipes with peelable layer

B.1 General

This annex specifies the geometrical, mechanical, and physical properties of those polyethylene (PE) pipes (outside diameter d_n) having a peelable and contiguous thermoplastics layer on the outside of the pipe (coated pipe), intended to be used for the supply of gaseous fuels. Marking requirements are also given.

The PE compound used for the production of the base pipe shall be in accordance with ISO 4437-1:2014 and the base pipe shall fulfil all the requirements of this part of ISO 4437 after removal of the peelable layer with the exception of appearance, colour, and marking.

The external coating shall be manufactured from a thermoplastic material. When attached, the coating shall not affect the ability of the PE pipe to meet the performance requirements of this part of ISO 4437.

If an adhesive layer is used to attach the peelable layer, it shall be easily removed, without affecting the jointing process. The preparation for the jointing process shall follow normal procedures.

NOTE Other types of layered pipes are covered by other international standards e.g. ISO 17484-1[3] or ISO 18225[4].

B.2 Geometrical characteristics

The geometrical characteristics of the pipe, with the coating removed, shall be in accordance with Clause 6.

B.3 Mechanical characteristics

The coating shall not have a detrimental effect on the pipe or vice versa. The mechanical characteristics of the pipe, with the coating removed shall be in accordance with Clause 7, and the attachment of the coating shall not affect the ability of the pipe to conform to those requirements.

When the pipe is tested with the coating attached, conformity to Clause 7 before and after weathering according to Table 2 of ISO 4437-1:2014 shall be assessed. The conditions selected shall ensure that pipe is subjected to the specified test stresses.

B.4 Physical characteristics

The physical characteristics of the pipe, with the coating removed, shall be in accordance with Clause 8. The coating shall not have a detrimental effect on the pipe or vice versa.

B.5 Coating adhesion

The coating shall be resistant to detachment during storage and installation.

The coating shall be manually removable prior to jointing using simple tools.

B.6 Marking

Marking shall be applied to the coating and shall be in accordance with Clause 10.

In addition, the coating shall be provided with marking clearly distinguishing the pipe from non-coated pipes in service, for example, identification stripes can be used for this purpose.

The coating shall also carry marking that warns that the coating shall be removed prior to electrofusion, buttfusion, and mechanical jointing.

Annex C
(normative)

Squeeze-off technique

C.1 General

In certain countries, the squeeze-off technique is used to restrict the flow of gas in PE piping systems while effecting maintenance and repair operations.

If the end-user desires to employ the technique, evidence shall be provided to the end-user that after squeeze-off, in accordance with the method recommended by the manufacturer of pipes, the requirements for hydrostatic strength of the pipe at 20 °C for 100 h and 80 °C for 1 000 h according to Table 4 shall be fulfilled. These tests on squeezed-off pipes also fulfil the requirements of these hydrostatic tests on pipes in accordance with Table 4.

C.2 Terms and definitions

For the purposes of Annex C, the following terms and definitions apply.

C.2.1

squeeze-off

gas flow restricted by squeezing the pipe when compressed between two clamps in such a way that the distance between both clamps is less than twice the nominal wall thickness

C.3 Test method

The evidence in accordance with C.1 shall be obtained using the procedure specified in EN 12106.

Bibliography

[1] ISO/TS 10839:2000, *Polyethylene pipes and fittings for the supply of gaseous fuels — Code of practice for design, handling and installation* for design, handling and installation

[2] CEN/TS 1555-7, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 7: Guide for the assessment of conformity*

[3] ISO 17484-1, *Plastics piping systems — Multilayer pipe systems for indoor gas installations with a maximum operating pressure up to and including 5 bar (500 kPa) — Part 1: Specifications for systems*

[4] ISO 18225, *Plastics piping systems — Multilayer piping systems for outdoor gas installations — Specifications for systems*