BS ISO 4427-2:2019

BSI Standards Publication

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE)

Part 2: Pipes

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INTERNATIONAL STANDARD

ISO 4427-2

Second edition
2019-08

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) —

Part 2: Pipes

Systèmes de canalisations en plastique destinés à l'alimentation en eau et aux branchements et collecteurs d'assainissement sous pression — Polyéthylène (PE) —

Partie 2: Tubes

Reference number
ISO 4427-2:2019(E)

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Published in Switzerland

Contents

Page

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 of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fitting and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

This second edition cancels and replaces the first edition (ISO 4427-2:2007), which has been technically revised. It also incorporates Amendment ISO 4427-2:2007/Amd. 1:2014.

The main changes compared to the previous edition are:

— Update of the normative references;

— Technical consistency with ISO 4437-2 (see Bibliography [1]).

A list of all parts in the ISO 4427 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 4427 series of standards are a set of system standards that specify the requirements for a piping system and its components when made from polyethylene (PE). The piping system is intended to be used in buried or above ground applications, for the conveyance of water for human consumption, raw water prior to treatment, drainage and sewerage under pressure, vacuum sewer systems, and water for other purposes.

In respect of potential adverse effects on the quality of water intended for human consumption caused by the products covered by the ISO 4427 series, it does not provide information on the restriction on the use of products.

NOTE Guidance for assessment of conformity can be found in Reference [2] in the Bibliography.

Plastics piping systems for water supply, and for drainage and sewerage under pressure — Polyethylene (PE) —

Part 2: Pipes

1 Scope

This document specifies the pipes made from polyethylene (PE) for buried or above ground applications, intended for the conveyance of:

— water for human consumption;

— raw water prior to treatment;

— drainage and sewerage under pressure;

— vacuum sewer systems;

— water for other purposes.

NOTE 1 The intended uses include sea outfalls, laid in water and pipes suspended below bridges.

Pipes complying with this document are not intended for the transport of water intended for human consumption in contaminated soils unless special consideration has been taken.

NOTE 2 For example, ISO 21004 provides an alternative solution for use in contaminated soils. See Reference [3] in the Bibliography.

This document specifies three types of pipe:

— 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) where all layers have the same MRS rating;

— PE pipes (outside diameter d_n) having a peelable and contiguous thermoplastics additional layer on the outside of the pipe ("coated pipe").

This document also specifies the test parameters for the test methods referred to in this document.

In conjunction with the other parts of the ISO 4427 series, this document is applicable to PE pipes, their joints and to joints with components made of PE and other materials, intended to be used under the following conditions:

a) a maximum allowable operating pressure (PFA) up to and including 25 bar[1)];

b) an operating temperature of 20 °C as the reference temperature.

NOTE 3 For other operating temperatures, guidance is given in ISO 4427-1:2019, Annex A.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

This document covers a range of maximum allowable operating pressures and gives requirements concerning colours.

NOTE 4 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and installation practices or codes.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 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 4427-1:2019, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General*

ISO 4427-5:2019, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 5: Fitness for purpose of the system*

ISO 4433-1, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 1: Immersion test method*

ISO 4433-2, *Thermoplastics pipes — Resistance to liquid chemicals — Classification — Part 2: Polyolefin pipes*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4427-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

3.1
application code
code letter which identifies the intended use of the product

Note 1 to entry: The code letter mentioned in this document is W indicating "water intended for human consumption".

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO 4427-1 apply.

5 Material

5.1 Compound

The pipes shall be made from virgin material or own reprocessed material from the same PE compound or a mixture of both materials.

Own reprocessed material from the base pipe of peelable-layer pipes can be used. Reprocessed (both own and external) material from peelable layers shall not be used.

The compound(s) from which the pipes are made shall conform to ISO 4427-1.

NOTE Since PE 40 is not commonly used for pressure applications, it is the intention of ISO/TC 138/SC 2 to withdraw all references to this compound at the next revision of the ISO 4427 series (all parts).

5.2 Identification compound

The compound used for identification stripes and co-extruded layers (see 6.2) shall be manufactured from a PE base polymer, which is the same as for one of the material producer's pipe compounds for which fusion compatibility has been proven

The compound used for identification stripes shall comply with the fusion compatibility requirements in ISO 4427-1 and with the resistance to weathering as described in ISO 4427-1:2019, Table 2.

The resistance to weathering of the identification stripe compound shall be declared by the manufacturer of the compound, confirming whether either a cumulative radiant exposure of >3,5 GJ/m^2 or >7 GJ/m^2 related to the outdoor storage ability limit is applicable.

For co-extruded layers used for identification purposes, Annex A applies.

5.3 Reprocessed and recycled material

Clean, reprocessed material generated from a manufacturer's own production and works testing of products according to the ISO 4427 series may be used if it is derived from the same compound as used for the relevant production.

Reprocessed material obtained from external sources and recycled material shall not be used.

6 General characteristics

6.1 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 of the pipe to this document.

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

6.2 Colour

Blue pipes or black pipes with blue stripes are intended for the conveyance of water for human consumption only.

The outer coextruded layer of coextruded pipes (see Annex A) or the peelable layer of peelable layer pipes (see Annex B) for pipes intended for the conveyance of water for human consumption shall be either black or blue or black with blue stripes.

Pipes intended for drainage and sewerage under pressure shall be black or black with brown stripes or according to national preference.

For above-ground installations, all components with colours other than black should be protected from direct UV light.

NOTE Yellow and orange colours are only used for gas applications, in accordance with the ISO 4437 series (all parts).

6.3 Effect on water quality

For pipes to be used in contact with water intended for human consumption, see ISO 4427-1.

7 Geometrical characteristics

7.1 Measurements

The dimensions of the pipe shall be measured in accordance with ISO 3126. In case of dispute, the measurements of dimensions shall be made not less than 24 h after manufacture and after conditioning 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.

7.2 Mean outside diameter and out-of-roundness (ovality)

The mean outside diameters, $d_{em,}$ and the out-of-roundness (ovality) shall conform to Table 1. For coiled pipes, the maximum out-of-roundness shall be specified by agreement between the manufacturer and the end-user.

Pipe from PE 40 materials shall be limited to diameters up to and including 63 mm.

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

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter	Mean outside diameter[a]		Maximum out-of-roundness (ovality)[b]
	d_n	$d_{em\,min}$	$d_{em\,max}$	
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

[a] In accordance with ISO 11922-1:2018 , grade B, for sizes ≤630 and grade A for sizes ≥710. (See Reference [4] in the Bibliography).

[b] In accordance with ISO 11922-1:2018 , grade N, for sizes ≤800, to be measured at the point of manufacture.

[c] Tolerance calculated as 0,009 d_{em} and does not conform to grade A in ISO 11922-1:2018 .

[d] For straight pipes with diameters ≥900, the maximum out-of-roundness shall be specified by an agreement between the manufacturer and the end-user.

Table 1 *(continued)*

Nominal size DN/OD	Nominal outside diameter	Mean outside diameter[a]		Maximum out-of-roundness (ovality)[b]
	d_n	$d_{em\ min}$	$d_{em\ max}$	
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
710	710	710,0	716,4	24,9
800	800	800,0	807,2	28,0
900	900	900,0	908,1	—[d]
1 000	1 000	1 000,0	1 009,0	—[d]
1 200	1 200	1 200,0	1 210,8[c]	—[d]
1 400	1 400	1 400,0	1 412,6[c]	—[d]
1 600	1 600	1 600,0	1 614,4[c]	—[d]
1 800	1 800	1 800,0	1 816,2[c]	—[d]
2 000	2 000	2 000,0	2 018,0[c]	—[d]
2 250	2 250	2 250,0	2 270,3[c]	—[d]
2 500	2 500	2 500,0	2 522,5[c]	—[d]
2 800	2 800	2 800,0	2 825,2c	—[d]
3 000	3 000	3 000,0	3 027,0[c]	—[d]

[a] In accordance with ISO 11922-1:2018 , grade B, for sizes ≤630 and grade A for sizes ≥710. (See Reference [4] in the Bibliography).

[b] In accordance with ISO 11922-1:2018 , grade N, for sizes ≤800, to be measured at the point of manufacture.

[c] Tolerance calculated as 0,009 d_{em} and does not conform to grade A in ISO 11922-1:2018 .

[d] For straight pipes with diameters ≥900, the maximum out-of-roundness shall be specified by an agreement between the manufacturer and the end-user.

NOTE Tolerance bands in accordance with ISO 11922-1:2018 , are calculated as follows, as applicable (see Reference [3] in the Bibliography):

a) Grade A: 0,009d_n rounded to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 10,0 mm.

b) Grade B: 0,006d_n rounded up to the next greater 0,1 mm with a minimum value of 0,3 mm and a maximum value of 4,0 mm.

c) Grade N:

1) for diameters ≤75 mm	(0,008 d_n + 1) mm,
2) for diameters ≥90 mm and ≤250 mm	(0,02 d_n) mm,
3) for diameters >250 mm	(0,035 d_n) mm,
4) rounded up to the next greater 0,1 mm.	

7.3 Wall thicknesses and their tolerances

The wall thickness shall be in accordance with Table 2.

NOTE The relationship between PN, MRS, S and SDR is given in Annex C.

Table 2 — Wall thicknesses

	Pipe series									
	SDR 6	SDR 7,4	SDR 9	SDR 11	SDR 13,6	SDR 17	SDR 21	SDR 26	SDR 33	SDR 41
	S 2,5	S 3,2	S 4	S 5	S 6,3	S 8	S 10	S 12,5	S 16	S 20
	Nominal pressure (PN) bar									
PE 40	—	PN 10	PN 8	PN 6	PN 5	PN 4	PN 3,2	PN 2,5	—	—
PE 80	PN 25	PN 20	PN 16	PN 12,5	PN 10	PN 8	PN 6	PN 5	PN 4	PN 3,2
PE 100	—	PN 25	PN 20	PN 16	PN 12,5	PN 10	PN 8	PN 6	PN 5	PN 4

Nominal size	Wall thicknesses[b] mm																			
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
16	3,0	3,4	2,3[a]	2,7	2,0[a]	2,3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
20	3,4	3,9	3,0	3,4	2,3[a]	2,7	2,0[a]	2,3	—	—	—	—	—	—	—	—	—	—	—	—
25	4,2	4,8	3,5	4,0	3,0	3,4	2,3[a]	2,7	2,0[a]	2,3	—	—	—	—	—	—	—	—	—	—
32	5,4	6,1	4,4	5,0	3,6	4,1	3,0	3,4	2,4[a]	2,8	2,0[a]	2,3	—	—	—	—	—	—	—	—
40	6,7	7,5	5,5	6,2	4,5	5,1	3,7	4,2	3,0	3,5	2,4[a]	2,8	2,0[a]	2,3	—	—	—	—	—	—
50	8,3	9,3	6,9	7,7	5,6	6,3	4,6	5,2	3,7	4,2	3,0	3,4	2,4[a]	2,8	2,0[a]	2,3	—	—	—	—
63	10,5	11,7	8,6	9,6	7,1	8,0	5,8	6,5	4,7	5,3	3,8	4,3	3,0	3,4	2,5[a]	2,9	—	—	—	—
75	12,5	13,9	10,3	11,5	8,4	9,4	6,8	7,6	5,6	6,3	4,5	5,1	3,6	4,1	2,9[a]	3,3	—	—	—	—
90	15,0	16,7	12,3	13,7	10,1	11,3	8,2	9,2	6,7	7,5	5,4	6,1	4,3	4,9	3,5	4,0	—	—	—	—
110	18,3	20,3	15,1	16,8	12,3	13,7	10,0	11,1	8,1	9,1	6,6	7,4	5,3	6,0	4,2	4,8	—	—	—	—
125	20,8	23,0	17,1	19,0	14,0	15,6	11,4	12,7	9,2	10,3	7,4	8,3	6,0	6,7	4,8	5,4	—	—	—	—
140	23,3	25,8	19,2	21,3	15,7	17,4	12,7	14,1	10,3	11,5	8,3	9,3	6,7	7,5	5,4	6,1	—	—	—	—
160	26,6	29,4	21,9	24,2	17,9	19,8	14,6	16,2	11,8	13,1	9,5	10,6	7,7	8,6	6,2	7,0	—	—	—	—

NOTE 1 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

NOTE 2 PN values are based on C = 1,25.

NOTE 3 Tolerances in accordance with ISO 11922-1:2018 , grade V, calculated from $(0{,}1e_{min} + 0{,}1)$ mm rounded up to the next 0,1 mm. For certain applications for e > 30 mm, ISO 11922-1:2018 , grade T, tolerances may be used calculated from 0,15 e_{min} rounded up to the next 0,1 mm. (See Reference [3] in the Bibliography.)

NOTE 4 The calculated value of e_{min} according to ISO 4065:2018 is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements (see Reference [5] in the Bibliography.)

[a] For practical reasons, a minimum wall thickness of 3,0 mm is recommended for electrofusion jointing and jointing with butt fusion fittings and for lining applications.

[b] See also Annex C for actual calculated values.

Table 2 *(continued)*

	Pipe series									
	SDR 6	SDR 7,4	SDR 9	SDR 11	SDR 13,6	SDR 17	SDR 21	SDR 26	SDR 33	SDR 41
	S 2,5	S 3,2	S 4	S 5	S 6,3	S 8	S 10	S 12,5	S 16	S 20
	Nominal pressure (PN) bar									
PE 40	—	PN 10	PN 8	PN 6	PN 5	PN 4	PN 3,2	PN 2,5	—	—
PE 80	PN 25	PN 20	PN 16	PN 12,5	PN 10	PN 8	PN 6	PN 5	PN 4	PN 3,2
PE 100	—	PN 25	PN 20	PN 16	PN 12,5	PN 10	PN 8	PN 6	PN 5	PN 4

Nominal size	Wall thicknesses[b] mm																			
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
180	29,9	33,0	24,6	27,2	20,1	22,3	16,4	18,2	13,3	14,8	10,7	11,9	8,6	9,6	6,9	7,7	—	—	—	—
200	33,2	36,7	27,4	30,3	22,4	24,8	18,2	20,2	14,7	16,3	11,9	13,2	9,6	10,7	7,7	8,6	—	—	—	—
225	37,4	41,3	30,8	34,0	25,2	27,9	20,5	22,7	16,6	18,4	13,4	14,9	10,8	12,0	8,6	9,6	—	—	—	—
250	41,5	45,8	34,2	37,8	27,9	30,8	22,7	25,1	18,4	20,4	14,8	16,4	11,9	13,2	9,6	10,7	—	—	—	—
280	46,5	51,3	38,3	42,3	31,3	34,6	25,4	28,1	20,6	22,8	16,6	18,4	13,4	14,9	10,7	11,9	—	—	—	—
315	52,3	57,7	43,1	47,6	35,2	38,9	28,6	31,6	23,2	25,7	18,7	20,7	15,0	16,6	12,1	13,5	9,7	10,8	7,7	8,6
355	59,0	65,0	48,5	53,5	39,7	43,8	32,2	35,6	26,1	28,9	21,1	23,4	16,9	18,7	13,6	15,1	10,9	12,1	8,7	9,7
400	—	—	54,7	60,3	44,7	49,3	36,3	40,1	29,4	32,5	23,7	26,2	19,1	21,2	15,3	17,0	12,3	13,7	9,8	10,9
450	—	—	61,5	67,8	50,3	55,5	40,9	45,1	33,1	36,6	26,7	29,5	21,5	23,8	17,2	19,1	13,8	15,3	11,0	12,2
500	—	—	—	—	55,8	61,5	45,4	50,1	36,8	40,6	29,7	32,8	23,9	26,4	19,1	21,2	15,3	17,0	12,3	13,7
560	—	—	—	—	62,5	68,9	50,8	56,0	41,2	45,5	33,2	36,7	26,7	29,5	21,4	23,7	17,2	19,1	13,7	15,2
630	—	—	—	—	70,3	77,5	57,2	63,1	46,3	51,1	37,4	41,3	30,0	33,1	24,1	26,7	19,3	21,4	15,4	17,1
710	—	—	—	—	79,3	87,4	64,5	71,1	52,2	57,6	42,1	46,5	33,9	37,4	27,2	30,1	21,8	24,1	17,4	19,3

NOTE 1 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

NOTE 2 PN values are based on C = 1,25.

NOTE 3 Tolerances in accordance with ISO 11922-1:2018 , grade V, calculated from ($0{,}1e_{min}$ + 0,1) mm rounded up to the next 0,1 mm. For certain applications for e > 30 mm, ISO 11922-1:2018 , grade T, tolerances may be used calculated from 0,15 e_{min} rounded up to the next 0,1 mm. (See Reference [3] in the Bibliography.)

NOTE 4 The calculated value of e_{min} according to ISO 4065:2018 is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements (see Reference [5] in the Bibliography.)

[a] For practical reasons, a minimum wall thickness of 3,0 mm is recommended for electrofusion jointing and jointing with butt fusion fittings and for lining applications.

[b] See also Annex C for actual calculated values.

Table 2 *(continued)*

	Pipe series																			
	SDR 6		SDR 7,4		SDR 9		SDR 11		SDR 13,6		SDR 17		SDR 21		SDR 26		SDR 33		SDR 41	
	S 2,5		S 3,2		S 4		S 5		S 6,3		S 8		S 10		S 12,5		S 16		S 20	
	Nominal pressure (PN) bar																			
PE 40	—		PN 10		PN 8		PN 6		PN 5		PN 4		PN 3,2		PN 2,5		—		—	
PE 80	PN 25		PN 20		PN 16		PN 12,5		PN 10		PN 8		PN 6		PN 5		PN 4		PN 3,2	
PE 100	—		PN 25		PN 20		PN 16		PN 12,5		PN 10		PN 8		PN 6		PN 5		PN 4	
Nominal size	Wall thicknesses[b] mm																			
	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}	e_{min}	e_{max}
800	—	—	—	—	89,3	98,4	72,6	80,0	58,8	64,8	47,4	52,3	38,1	42,1	30,6	33,8	24,5	27,1	19,6	21,7
900	—	—	—	—	—	—	81,7	90,0	66,1	73,0	53,3	58,8	42,9	47,3	34,4	38,3	27,6	30,5	22,0	24,3
1 000	—	—	—	—	—	—	90,2	99,4	73,5	79,9	59,3	65,4	47,7	52,6	38,2	42,2	30,6	33,5	24,5	27,1
1 200	—	—	—	—	—	—	—	—	88,2	97,2	71,1	74,8	57,2	63,1	45,9	50,6	36,7	40,5	29,4	32,5
1 400	—	—	—	—	—	—	—	—	102,8	113,3	83,0	90,8	66,7	73,5	53,5	59,0	42,9	47,3	34,3	37,9
1 600	—	—	—	—	—	—	—	—	117,5	129,5	94,8	103,7	76,2	84,0	61,2	67,5	49,0	54,0	39,2	43,3
1 800	—	—	—	—	—	—	—	—	—	—	106,6	116,6	85,8	94,4	68,8	76,2	55,1	60,1	44,0	48,3
2 000	—	—	—	—	—	—	—	—	—	—	118,5	129,5	95,3	104,9	76,4	84,7	61,2	66,8	48,9	53,8
2 250	—	—	—	—	—	—	—	—	—	—	—	—	107,2	118,1	86,0	94,8	68,9	75,9	55,0	60,7
2 500	—	—	—	—	—	—	—	—	—	—	—	—	119,1	131,2	95,5	105,2	76,5	84,3	61,2	67,5
2 800	—	—	—	—	—	—	—	—	—	—	—	—	133,4	146,9	107,0	117,8	85,7	94,4	68,5	75,5
3 000	—	—	—	—	—	—	—	—	—	—	—	—	142,9	157,3	114,6	126,2	91,8	101,1	73,4	80,9

NOTE 1 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

NOTE 2 PN values are based on C = 1,25.

NOTE 3 Tolerances in accordance with ISO 11922-1:2018 , grade V, calculated from (0,1e_{min} + 0,1) mm rounded up to the next 0,1 mm. For certain applications for e > 30 mm, ISO 11922-1:2018 , grade T, tolerances may be used calculated from 0,15 e_{min} rounded up to the next 0,1 mm. (See Reference [3] in the Bibliography.)

NOTE 4 The calculated value of e_{min} according to ISO 4065:2018 is rounded up to the nearest value of either 2,0, 2,3 or 3,0. This is to satisfy certain national requirements (see Reference [5] in the Bibliography.)

[a] For practical reasons, a minimum wall thickness of 3,0 mm is recommended for electrofusion jointing and jointing with butt fusion fittings and for lining applications.

[b] See also Annex C for actual calculated values.

7.4 Coiled pipe

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

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

7.5 Lengths

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

8 Mechanical characteristics

8.1 Conditioning

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C prior to testing.

8.2 Requirements

The test pieces shall be tested in accordance with Table 3. When tested using the test method and parameters specified therein, the pipe shall have mechanical characteristics conforming to the requirements of Table 3.

For dimensions above and including DN1600, the requirements of Table 3 may be assessed by indirect testing. The indirect test method used and the correlation or safe relationship of the indirect testing to the specification of Table 3 shall be documented in the manufacturer's quality plan. The indirect test method shall be agreed between the manufacturer and the end user.

Table 3 — Mechanical characteristics

Characteristic	Requirement	Test parameters		Test method(s)
		Parameter	Value	
Hydrostatic strength at 20 °C	No failure of any test piece during test period	End caps	Type a)[a]	ISO 1167-1[b] ISO 1167-2
		Conditioning period	According to ISO 1167-1	
		Number of test pieces[c]	3	
		Type of test	Water-in-water[d]	
		Test temperature	20 °C	
		Test period	100 h	
		Circumferential (hoop) stress for:		
		PE 40	7,0 MPa	
		PE 80	10,0 MPa	
		PE 100	12,0 MPa	
Hydrostatic strength at 80 °C	No failure of any test piece during test period	End caps	Type a)[a]	ISO 1167-1[f] ISO 1167-2
		Conditioning period	According to ISO 1167-1	
		Number of test pieces[c]	3	
		Type of test	Water-in-water[d]	
		Test temperature	80 °C	
		Test period	165 h[e]	
		Circumferential (hoop) stress for:		
		PE 40	2,5 MPa	
		PE 80	4,5 MPa	
		PE 100	5,4 MPa	
Hydrostatic strength at 80 °C	No failure of any test piece during test period	End caps	Type a)[a]	ISO 1167-1[b] ISO 1167-2
		Conditioning period	According to ISO 1167-1	
		Number of test pieces[c]	3	
		Type of test	Water-in-water[d]	
		Test temperature	80 °C	
		Test period	1 000 h	
		Circumferential (hoop) stress for:		
		PE 40	2,0 MPa	
		PE 80	4,0 MPa	
		PE 100	5,0 MPa	

NOTE The characteristic resistance to slow crack growth is dealt with in ISO 4427-1 as a material property measured in the form of pipe.

[a] Type b) end caps may be used for batch release tests for diameters ≥500 mm.

[b] The test shall be realized on basis of measured dimensions (OD and thickness), in accordance with ISO 1167-1:2006, 7.2.

[c] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[d] For d_n > 1 000 mm, the test can also be performed water-in-air. In case of dispute, water in water shall be used.

[e] Premature ductile failures are not to be taken into account. For retest procedure, apply 8.3.

[f] The test shall be realized on basis of nominal dimensions (OD and thickness), in accordance with ISO 1167-1:2006, 7.3.

8.3 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 4.

Table 4 — Test parameters for the retest of the hydrostatic strength at 80 °C

PE 40		PE 80		PE 100	
Stress MPa	**Test period** h	**Stress** MPa	**Test period** h	**Stress** MPa	**Test period** h
2,5	165	4,5	165	5,4	165
2,4	230	4,4	233	5,3	256
2,3	323	4,3	331	5,2	399
2,2	463	4,2	474	5,1	629
2,1	675	4,1	685	5,0	1 000
2,0	1 000	4,0	1 000		

9 Physical characteristics

9.1 Conditioning

Unless otherwise specified in the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C prior to testing.

9.2 Requirements

The test pieces shall be tested in accordance with Table 5. When tested using the test method and parameters specified therein, the pipe shall have physical characteristics conforming to the requirements of Table 5.

Table 5 — Physical characteristics — All pipes

Characteristic	Requirement	Test parameters		Test method(s)
		Parameter	**Value**	
Elongation at break for $e \leq 5$ mm	≥350 %	Test piece shape Test speed Number of test pieces[a]	Type 2 100 mm/min According to ISO 6259	ISO 6259-1 ISO 6259-3
Elongation at break for $5 \text{ mm} < e \leq 12$ mm	≥350 %	Test piece shape Test speed Number of test pieces[a]	Type 1[b] 50 mm/min According to ISO 6259	ISO 6259-1 ISO 6259-3
Elongation at break for $e > 12$ mm	≥350 %	Test piece shape Test speed Number of test pieces[a] OR Test piece shape Test speed Number of test pieces[a]	Type 1[b] 25 mm/min According to ISO 6259 Type 3[b] 10 mm/min According to ISO 6259	ISO 6259-1 ISO 6259-3

Table 5 *(continued)*

Characteristic	Requirement	Test parameters		Test method(s)
		Parameter	Value	
Longitudinal reversion[c]	≤3 % No effect on surface	Length of pipe[d] and number of test pieces	According to ISO 2505	ISO 2505
		Test temperature:		
		PE 40	100 ± 2 °C	
		PE 80, PE 100	110 ± 2 °C	
		Time	See ISO 2505	
Melt mass-flow rate MFR for PE 40	Change of MFR by processing ±20 %[e]	Load	2,16 Kg	ISO 1133-1,
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces[a]	According to ISO 1133-1	
Melt mass-flow rate MFR for PE 80, PE 100	Change of MFR by processing ±20 %[e]	Load	5,0 Kg	ISO 1133-1,
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces[a]	According to ISO 1133-1	
Oxidation induction time	≥20 min	Test temperature	200 °C[f]	ISO 11357-6
		Test environment	Oxygen	
		Number of test pieces[a,g]	3	
Effect on water quality	National regulations apply			

[a] The number of test pieces given indicates the quantity required to establish a value for the characteristic described in this table. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan.

[b] Where practical, machined type 2 test pieces may be used for pipe wall thicknesses ≤25 mm. The test may be terminated when the requirement is met, without continuing until the rupture of the test piece.

[c] Only applicable for pipes with thickness ≤16 mm.

[d] For pipes with an outside diameter >200 mm, longitudinally cut segments may be used.

[e] Value as measured on the pipe relative to the value measured on the compound used.

[f] The test may be carried out as an indirect test at 210 °C or 220 °C provided that a clear correlation has been established. In case of dispute, the test temperature shall be 200 °C.

[g] Samples are to be taken from the inner wall surface.

10 Chemical characteristics of pipes in contact with chemicals

If, for a particular application, it is necessary to evaluate the chemical resistance of the pipe, then the pipe shall be classified in accordance with ISO 4433-1 and ISO 4433-2.

NOTE Guidance for the resistance of polyethylene pipes to chemicals is given in ISO/TR 10358 (see Reference [6] in the Bibliography). This guidance only addresses chemical resistance of products not submitted to any stress, and can need to be completed to additional testing.

11 Performance requirements

When pipes conforming to this document are assembled to each other or to components conforming to other parts of the ISO 4427 series, the joints shall be in accordance with ISO 4427-5.

12 Marking

12.1 General

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.

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

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

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

12.2 Minimum required marking of pipes

The minimum required marking shall be in accordance with Table 6, with the frequency of marking being not less than once per metre.

Table 6 — Minimum required marking

Aspect	Marking
Standard number	ISO 4427-2
Manufacturer's identification	Name or symbol
Dimensions ($d_n \times e_n$)	e.g. 110 × 10
SDR series (for $d_n > 32$)	e.g. SDR 11
Material and designation	e.g. PE 100
Pressure rating in bar	e.g. PN 16
Intended use	e.g. W[a,b]
Meterage[c]	
Type of pipe, if applicable	e.g. co-extruded or peelable layer
Traceability information	e.g. 0204[d]

[a] Applicable for blue pipes and black pipes with blue stripes.

[b] Instead of W, marking according to local or national rules may be applied (e.g. "Drinking water" or "potable water").

[c] Only for coiled pipes, indicating remaining length on coil.

[d] In clear figures or in code providing traceability to the production period within year and month and, if the manufacturer is producing at different sites, the production site.

In addition to Table 6, the minimum marking of pipes with peelable layer shall comply with the requirements of Annex B.

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 in buried or above ground applications for the conveyance of water for general purposes, including water intended for human consumption and raw water prior to treatment.

NOTE Other types of pipes with co-extruded layers are covered by other standards (e.g. References [3] in Bibliography).

A.2 Material

The PE compounds used for the layer(s) of the pipes shall be in accordance with ISO 4427-1 and have the same MRS rating. The use of reprocessed or recycled material shall be in accordance with 5.3.

A.3 Geometrical characteristics

The wall thickness, e_n, is defined as the total wall thickness including all layers.

The outside diameter, d_e, is defined as the total outside diameter.

A.4 Pipe with coloured identification layer

A.4.1 Geometrical characteristics

The geometrical characteristics of the pipe, inclusive of the coloured identification layer, shall be in accordance with Clause 7.

A.4.2 Mechanical characteristics

The mechanical characteristics of the pipe, inclusive of the coloured identification layer, shall be in accordance with Clause 8.

A.4.3 Physical characteristics

The physical characteristics shall be in accordance with Clause 9. The requirements for thermal stability (OIT) and for melt-flow rate shall apply to the individual layers respectively. Longitudinal heat reversion shall be applicable to the pipe, inclusive of the coloured identification layer.

A.4.4 Marking

The marking of pipes with coloured identification layers shall be in accordance with Clause 12.

A.5 Delamination

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

A.6 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"). Marking requirements are also given.

The PE compound used for the production of the base pipe shall be in accordance with ISO 4427-1 and the base pipe shall fulfil all the requirements of this document after removal of the peelable layer, with the exception of appearance, colour, and marking.

The peelable layer shall be manufactured from a thermoplastic material. When attached, the peelable layer shall not affect the ability of the PE pipe to meet the performance requirements of this document.

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 (See References [7] and [8] in the Bibliography).

B.2 Geometrical characteristics

The geometrical characteristics of the pipe, with the peelable layer removed, shall be in accordance with Clause 7.

B.3 Mechanical characteristics

The peelable layer shall not have a detrimental effect on the pipe or vice versa.

The mechanical characteristics of the pipe, with the peelable layer removed shall be in accordance with Clause 8, and the attachment of the peelable layer shall not affect the ability of the pipe to conform to those requirements.

When the pipe is tested with the peelable layer attached, conformity to Clause 8 before and after weathering according to ISO 4427-1:2019, Table 2 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 peelable layer removed, shall be in accordance with Clause 9. The peelable layer shall not have a detrimental effect on the pipe or vice versa.

B.5 Peelable layer adhesion

The peelable layer shall be resistant to detachment during storage and installation.

The peelable layer shall be easily removed using an appropriate tool as recommended by the pipe manufacturer.

B.6 Marking

Marking shall be applied to the coating and shall be in accordance with Clause 12.

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

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

Annex C
(informative)

Relationship between PN, MRS, S and SDR

The relationship between nominal pressure, PN, design stress, σ_s, and the series S/SDR is given by the following formula:

$$PN = \frac{10\sigma_S}{S} \text{ or } PN = \frac{20\sigma_S}{SDR-1}$$

Examples of the relationship between PN, MRS, S, and SDR based on

$$\sigma_S = \frac{MRS}{C}$$

are given in Table C.1, where C = 1,25.

NOTE The nominal pressures (PN) given in Table C.1 are based on the use of an overall design coefficient of C = 1,25. However, if a higher value for C is required, the PN values will have to be recalculated using the above equations and based on the calculated design stress, σ_s, for each material class. A higher value for C can also be obtained by choosing a higher PN class.

Table C.1 — Examples of the relationship between PN, MRS, S and SDR at 20 °C (C = 1,25)

SDR	S	Nominal pressure for material class bar		
		PE 40	PE 80	PE 100
41	20	—	3,2	4
33	16	—	4	5
26	12,5	2,5	5	6[a]
21	10	3,2	6[a]	8
17	8	4	8	10
13,6	6,3	5	10	12,5
11	5	—	12,5	16
9	4	8	16	20
7,4	3,2	10	20	25
6	2,5	—	25	—

NOTE 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

[a] Actual calculated values are 6,4 bar for PE 100 and 6,3 bar for PE 80.

Bibliography

[1] ISO 4437-2, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes*

[2] CEN/TS 12201-7, *Plastics piping systems for water supply — Polyethylene (PE) — Part 7: Guidance for the assessment of conformity*

[3] ISO 21004, *Plastics piping systems — Multilayer pipes and their joints, based on thermoplastics, for water supply*

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

[5] ISO 4065, *Thermoplastics pipes — Universal wall thickness table*

[6] ISO/TR 10358, *Plastics pipes and fittings — Combined chemical-resistance classification table*

[7] 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*

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