INTERNATIONAL STANDARD

ISO 4427

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Polyethylene (PE) pipes for water supply — Specifications

Tubes en polyéthylène (PE) destinés à l'alimentation en eau — Spécifications

Reference number
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Contents

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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.

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 4427 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

Annex A forms an integral part of this International Standard.

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Polyethylene (PE) pipes for water supply — Specifications

1 Scope

This International Standard specifies the required properties of pipes made from polyethylene (PE) to be used for buried water mains and services and for water supply above ground both inside and outside buildings. In addition, it specifies some general properties of the material from which these pipes are made, including a classification scheme.

This International Standard applies to pipes with a nominal pressure of PN 3,2, PN 4, PN 6, PN 8, PN 10, PN 12,5 and PN 16, and nominal outside diameters from 16 to 1 600 (see ISO 161-1), intended to be used for the conveyance of water under pressure at temperatures between 0 °C and 40 °C for general purposes, as well as for the supply of drinking water.

NOTE 1 — Some countries may require specific colour identification for pipes for water intended for human consumption.

For temperatures between 20 °C and 40 °C, the working pressure factor given in figure 1 shall be applied, provided that extrapolation results obtained in accordance with ISO/TR 9080 show this to be possible.

If PE pipes are used above ground, they should preferably be physically protected against UV light in accordance with recommended practice.

NOTE 2 — For information, certain requirements, figures or remarks are given, which have been extracted from appropriate International Standards.

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 1133:1996, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.*

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

ISO 2505-1:1994, *Thermoplastics pipes — Longitudinal reversion — Part 1: Determination methods.*

ISO 2505-2:1994, *Thermoplastics pipes — Longitudinal reversion — Part 2: Determination parameters.*

ISO 3126:1974, *Plastic pipes — Measurement of dimensions.*

ISO 4065:1996, *Thermoplastic pipes — Universal wall thickness table.*

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

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

ISO 6259-3:— [1], *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes.*

ISO 6964:1986, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis— Test method and basic specification.*

ISO/TR 9080:1992, *Thermoplastics pipes for the transport of fluids — Methods of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastics pipe materials.*

ISO/TR 10837:1991, *Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings.*

ISO 11420:1996, *Method for the assessment of the degree of carbon black dispersion in polyolefin pipes, fittings and compounds.*

ISO 11922-1:— [2], *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series.*

ISO 12162:1995, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient.*

ISO 13761:1996, *Plastics pipes and fittings — Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20 °C.*

ISO 13949:— [1], *Method for the assessment of the degree of pigment dispersion in polyolefin pipes, fittings and compounds.*

Guidelines for drinking water quality, Volume 1: Recommendations, WHO, Geneva, 1984.

EEC Council Directive of 15th July 1980 on the quality of water intended for human consumption, Official Journal of the European Communities, L229, pp.11 to 29.

3 Material

3.1 Compounds

3.1.1 General

The pipes shall be manufactured from polyethylene containing only those antioxidants, UV stabilizers and pigments necessary for the manufacture of pipes conforming to this specification and for its end use, including weldability when it is possible. The pipes for drinking water shall be either black or blue or black with blue stripes.

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1) To be published.

2) To be published. (Revision of ISO 3606:1976, ISO 3607:1977, ISO 3608:1976 and ISO 3609:1977)

3.1.2 Black pipes

For black pipes, the carbon black content in the compound shall be (2,25 ± 0,25) % by mass, when measured in accordance with ISO 6964.

3.1.3 Blue pipes and stripes

The use of the colour blue or black with blue stripes shall be specified in accordance with national requirements.

The material for the stripes shall be of the same type of resin as used in the base compound for the pipe.

3.2 Dispersion of pigments in compounds

3.2.1 Dispersion of carbon black

When determined in accordance with ISO 11420, the dispersion of the carbon black shall be equal to or less than grade 3.

3.2.2 Dispersion of blue pigments

When determined in accordance with ISO 13949, the dispersion of blue pigment shall be equal to or less than grade 3.

3.3 Thermal stability

When determined in accordance with ISO/TR 10837, the induction time for materials PE 63, PE 80 and PE 100 shall be either at least 20 min when tested at 200 °C or an equivalent period when tested at 210 °C, provided the equivalence is supported by a clear correlation between results obtained at 200 °C or 210 °C, respectively.

In cases of dispute, the test temperature shall be 200 °C.

3.4 Reworked material

Clean reworked material generated from a manufacturer's own production of pipe in accordance with this specification may be used if it is derived from the same resin as used for the relevant production.

3.5 Effects on water quality of pipes intended for the conveyance of water for human consumption

When used under conditions for which they are designed, materials in contact with or likely to come into contact with drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to unpleasant taste or odour, cloudiness or discoloration of the water.

The concentrations of substances, chemicals and biological agents leached from materials in contact with drinking water, and measurements of the relevant organoleptic/physical parameters, shall not exceed the maximum values recommended by the World Health Organization in its publication *Guidelines for drinking water quality*, Volume 1: *Recommendations*, or as required by the EEC Council Directive of 15 July 1980 on the quality of water intended for human consumption, whichever is the more stringent in each case.

NOTE — Certain additional requirements may apply, as required, due to local water quality and safety regulations.

3.6 Designation and classification

The compound shall be designated by the material type (e.g. PE 80) conforming to the applicable level of minimum required strength (MRS) specified in table 1, when the lower confidence limit σ_{LCL} for the compound is determined in accordance with ISO/TR 9080 and this σ_{LCL} is classified in accordance with ISO 12162 to obtain the MRS.

The validity of the designation shall be certified by the compound manufacturer or, in the case of master-batches, by the pipe manufacturer.

The design stress σ_s of a pipe shall be obtained by applying a design coefficient C of not less than 1,25 to the MRS value for the material.

NOTE — Engineers may wish to apply a greater design coefficient in accordance with ISO 12162, depending on operating conditions and environmental considerations.

Table 1 — Designation of material

Designation of material	MRS at 50 years and 20 °C MPa	Maximum allowable hydrostatic design stress, σ_s MPa
PE 100	10	8
PE 80	8	6,3
PE 63	6,3	5
PE 40	4	3,2
PE 32	3,2	2,5

The relationship between MRS and σ_s for various design coefficients is given in table 2.

Table 2 — Relationship between MRS, σ_s and design coefficient C at 20 °C

Hydrostatic design stress of pipe, σ_s MPa	Minimum required strength of material MPa				
	10	8	6,3	4	3,2
	Design coefficient, C				
8	1,25				
6,3	1,6	1,25			
5	2	1,6	1,25		
4	2,5	2	1,6		
3,2	3,2	2,5	2	1,25	
2,5	—	3,2	2,5	1,6	1,25

3.7 Melt flow rate and density

The pipe manufacturer shall provide evidence of the density and the melt flow rate of the raw compound.

When measured in accordance with ISO 1133, the melt flow rate shall conform to the following conditions:

a) the melt flow rate of the compound shall not deviate by more than ± 30 % from the value specified by the manufacturer;

b) the change in MFR caused by processing, i.e. the difference between the measured value for material from the pipe and the measured value for the compound, shall not be more than 25 %.

4 Geometrical characteristics

4.1 Dimensions of pipes: outside diameters, nominal pressures and wall thicknesses

4.1.1 The dimensions of pipes shall be measured in accordance with ISO 3126.

4.1.2 Nominal outside diameters shall conform to ISO 161-1. The selected nominal outside diameters and the wall thicknesses in accordance with the selected nominal pressures are given in table 3 (σ_s = 8 MPa), table 4 (σ_s = 6,3 MPa), table 5 (σ_s = 5 MPa) and table 6 (σ_s = 2,5 MPa and 3,2 MPa).

4.1.3 The tolerances on the outside diameters shall be in accordance with ISO 11922-1, as follows:

grade A for normal-tolerance (NT) pipes

grade B for close-tolerance (CT) pipes

Table 3 — Polyethylene pipes with a design stress σ_s of 8 MPa

Nominal outside diameter d_n	Pipe series [1]		
	S 8	S 6,3	S 5
	Standard dimension ratio		
	SDR 17	SDR 13,6	SDR 11
	Nominal pressure PN [2] for σ_s = 8 MPa		
	PN 10	PN 12,5	PN 16
	Nominal wall thickness, e_n mm		
32	—	—	3,0
40	—	—	3,7
50	—	—	4,6
63	—	4,7	5,8
75	4,5	5,6	6,8
90	5,4	6,7	8,2
110	6,6	8,1	10,0
125	7,4	9,2	11,4
140	8,3	10,3	12,7
160	9,5	11,8	14,6
180	10,7	13,3	16,4
200	11,9	14,7	18,2
225	13,4	16,6	20,5
250	14,8	18,4	22,7
280	16,6	20,6	25,4
315	18,7	23,2	28,6
355	21,1	26,1	32,2
400	23,7	29,4	36,3
450	26,7	33,1	40,9
500	29,7	36,8	45,4
560	33,2	41,2	50,8
630	37,4	46,2	57,2
710	42,1	52,2	—
800	47,4	58,8	—
900	53,3	—	—
1 000	59,3	—	—

1) The pipe series number is derived from the ratio σ_s/p_{PMS}, where σ_s is the design stress at 20 °C and p_{PMS} is the maximum allowable operating pressure of the pipe at 20 °C.

2) The nominal pressure PN corresponds to the maximum allowable operating pressure p_{PMS}, in bars, of the pipe at 20 °C.

Table 4 — Polyethylene pipes with a design stress σ_s of 6,3 MPa

Nominal outside diameter	Pipe series [1]				
	S 10	S 8	S 6,3	S 5	S 4
	Standard dimension ratio				
	SDR 21	SDR 17	SDR 13,6	SDR 11	SDR 9
	Nominal pressure PN [2] for σ_s = 6,3 MPa				
	PN 6 [3]	PN 8	PN 10	PN 12,5	PN 16
d_n	Nominal wall thickness, e_n mm				
16	—	—	—	—	2,3
20	—	—	—	—	2,3
25	—	—	—	2,3	2,8
32	—	—	—	3,0	3,6
40	—	—	—	3,7	4,5
50	—	—	—	4,6	5,6
63	—	—	4,7	5,8	7,1
75	—	4,5	5,6	6,8	8,4
90	4,3	5,4	6,7	8,2	10,1
110	5,3	6,6	8,1	10,0	12,3
125	6,0	7,4	9,2	11,4	14,0
140	6,7	8,3	10,3	12,7	15,7
160	7,7	9,5	11,8	14,6	17,9
180	8,6	10,7	13,3	16,4	20,1
200	9,6	11,9	14,7	18,2	22,4
225	10,8	13,4	16,6	20,5	25,2
250	11,9	14,8	18,4	22,7	27,9
280	13,4	16,6	20,6	25,4	31,3
315	15,0	18,7	23,2	28,6	35,2
355	16,9	21,1	26,1	32,2	39,7
400	19,1	23,7	29,4	36,3	44,7
450	21,5	26,7	33,1	40,9	50,3
500	23,9	29,7	36,8	45,4	55,8
560	26,7	33,2	41,2	50,8	—
630	30,0	37,4	46,3	57,2	—
710	33,9	42,1	52,2	—	—
800	38,1	47,4	58,8	—	—
900	42,9	53,3	—	—	—
1 000	47,7	59,3	—	—	—
1 200	57,2	—	—	—	—
1 400	—	—	—	—	—
1 600	—	—	—	—	—

1) The pipe series number is derived from the ratio σ_s / p_{PMS}, where σ_s is the design stress at 20 °C and p_{PMS} is the maximum allowable operating pressure of the pipe at 20 °C.

2) The nominal pressure PN corresponds to the maximum allowable operating pressure p_{PMS}, in bars, of the pipe at 20 °C.

3) For calculation purposes, a nominal pressure of 6,3 bar (0,63 MPa) has been used.

Table 5 — Polyethylene pipes with a design stress σ_s of 5 MPa

Nominal outside diameter d_n	Pipe series [1]							
	S 16	S 12,5	S 8,3	S 8	S 6,3	S 5	S 4	S 3,2
	Standard dimension ratio							
	SDR 33	SDR 26	SDR 17,6	SDR 17	SDR 13,6	SDR 11	SDR 9	SDR 7,4
	Nominal pressure PN [2] for σ_s = 5 MPa							
	PN 3,2	PN 4	PN 6	PN 6,3	PN 8	PN 10	PN 12,5	PN 16
	Nominal wall thickness, e_n mm							
16	—	—	—	—	—	2,3	2,3	2,3
20	—	—	—	—	2,3	2,3	2,3	2,8
25	—	—	2,3	2,3	2,3	2,3	2,8	3,5
32	—	—	2,3	2,3	2,4	2,9	3,6	4,4
40	—	2,3	2,3	2,4	3,0	3,7	4,5	5,5
50	—	2,3	2,9	3,0	3,7	4,6	5,6	6,9
63	2,3	2,5	3,6	3,8	4,7	5,8	7,1	8,6
75	2,3	2,9	4,3	4,5	5,6	6,8	8,4	10,3
90	2,8	3,5	5,1	5,4	6,7	8,2	10,1	12,3
110	3,4	4,2	6,3	6,6	8,1	10,0	12,3	15,1
125	3,9	4,8	7,1	7,4	9,2	11,4	14,0	17,1
140	4,3	5,4	8,0	8,3	10,3	12,7	15,7	19,2
160	4,9	6,2	9,1	9,5	11,8	14,6	17,9	21,9
180	5,5	6,9	10,2	10,7	13,3	16,4	20,1	24,6
200	6,2	7,7	11,4	11,9	14,7	18,2	22,4	27,4
225	6,9	8,6	12,8	13,4	16,6	20,5	25,2	30,8
250	7,7	9,6	14,2	14,8	18,4	22,7	27,9	34,2
280	8,6	10,7	15,9	16,6	20,6	25,4	31,3	38,3
315	9,7	12,1	17,9	18,7	23,2	28,6	35,2	43,1
355	10,9	13,6	20,1	21,1	26,1	32,2	39,7	48,5
400	12,3	15,3	22,7	23,7	29,4	36,3	44,7	54,7
450	13,8	17,2	25,5	26,7	33,1	40,9	50,3	61,5
500	15,3	19,1	28,3	29,7	36,8	45,4	55,8	—
560	17,2	21,4	31,7	33,2	41,2	50,8	—	—
630	19,3	24,1	35,7	37,4	46,3	57,2	—	—
710	21,8	27,2	40,2	42,1	52,2	—	—	—
800	24,5	30,6	45,3	47,4	58,8	—	—	—
900	27,6	34,4	51,0	53,3	—	—	—	—
1 000	30,6	38,2	56,6	59,3	—	—	—	—
1 200	36,7	45,9	—	—	—	—	—	
1 400	42,9	53,5	—	—	—	—	—	
1 600	49,0	61,2	—	—	—	—	—	

1) The pipe series number is derived from the ratio σ_s/p_{PMS}, where σ_s is the design stress at 20 °C and p_{PMS} is the maximum allowable operating pressure of the pipe at 20 °C.

2) The nominal pressure PN corresponds to the maximum allowable operating pressure p_{PMS}, in bars, of the pipe at 20 °C.