SLOVENSKI STANDARD
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Zakopane polietilenske (PE) cevi za oskrbo s plinastimi gorivi - Metrična serija - Označevanje

Buried polyethylene (PE) pipes for the supply of gaseous fuels -- Metric series -- Specification

Canalisations enterrées en polyéthylène (PE) pour réseaux de distribution de combustibles gazeux -- Série métrique -- Spécifications

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МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ

Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specification

Canalisations enterrées en polyéthylène (PE) pour réseaux de distribution de combustibles gazeux — Série métrique — Spécifications

Reference number
ISO 4437 : 1988 (E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 4437 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specification

1 Scope and field of application

This International Standard specifies the required physical properties of pipes of polyethylene (PE) intended to be used for the supply of gaseous fuels. In addition, it specifies some general properties of the material from which these pipes are made.

This International Standard also lays down dimensional requirements and acceptable pressure ratings for pipes.

When using polyethylene pipes for the transport of gaseous fuels, the presence of other constituents in the gas must be taken into account, as, at a certain level of concentration, these constituents could impair the properties of the pipe.

2 References

ISO 161-1, *Thermoplastics pipes for the transport of fluids — Nominal outside diameters and nominal pressures — Part 1 : Metric series.*

ISO 1167, *Plastics pipes for the transport of fluids — Determination of the resistance to internal pressure.*

ISO/R 1183, *Plastics — Methods for determining the density and relative density (specific gravity) of plastics excluding cellular plastics.*

ISO 1872, *Polyethylene thermoplastic materials — Designation.*[1]

ISO 2506, *Polyethylene pipes (PE) — Longitudinal reversion — Test methods and specification.*

ISO 3126, *Plastics pipes — Measurement of dimensions.*

ISO 3607, *Polyethylene (PE) pipes — Tolerances on outside diameters and wall thicknesses.*

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

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

ISO 6259, *Polyethylene (PE) pipes — Determination of tensile properties.*[2]

3 Material

3.1 The base material from which the pipe is produced shall be polyethylene to which shall be added only those anti-oxidants, UV stabilizers and pigments necessary for the manufacture of pipes to the specification and to its end use including weldability. (See annex A, clause A.3.) The nominal density of the base material, when determined in accordance with 6.1, shall be greater than 930 kg/m^3.[3]

All additives shall be uniformly dispersed.[4]

3.2 Clean rework, generated from a manufacturer's own production of pipe to this specification, may be used, if it is derived from the same resin as used for the relevant production.

3.3 When tested by the method described in 6.5, the material, tested as pipe, shall meet the requirements of 4.2.1, 4.2.2 and 4.2.3.

From the data obtained, the manufacturer shall state whether the material conforms with the requirements of type A, B or C (see table 1).

4 Performance requirements

4.1 Effects of gas constituents on the hydrostatic strength

When tested by the method described in 6.4, the pipe shall withstand a hoopstress of 2 MPa at 80 °C for at least 30 h. The test shall be carried out on 32, 40 or 50 mm SDR 11 (or S 5) pipe.

4.2 Hydrostatic strength[5]

4.2.1 Long-term hydrostatic strength at 20 °C

When tested in accordance with 6.5.1, the material in pipe form shall be shown to have a 95 % lower confidence limit of the

1) For the purposes of this International Standard, this reference is specifically to the 1972 edition.

2) At present at the stage of draft.

3) A PE of density greater than 930 kg/m^3 corresponds to classification 3, 4 or 5 in accordance with clause 3 of ISO 1872. (See 6.1.)

4) Specifications and test methods are being developed.

5) These requirements are tentative and subject to revision.

hoopstress corresponding to a failure time of 100 000 h of at least 8 MPa calculated from the ductile failure results.

No brittle failures should occur before 10 000 h. The tests shall be carried out on 32 mm pipe (SDR 11 or equivalent to S 5) for all materials.

4.2.2 Long-term hydrostatic strength at 20 °C derived from elevated temperature testing

4.2.2.1 When tested by the method described in 6.5.2 and 6.5.3, the material in pipe form shall be shown to have a 95 % lower confidence limit of the hoopstress corresponding to a failure time of 50 years of at least 6,5 MPa. The test shall be carried out on 32 mm SDR 11 (or S 5) pipe.

4.2.2.2 If, when tested by the method described in 6.5.2.3, no brittle failure occurs within 10 000 h at a minimum hoopstress of 5 MPa at 60 °C, the requirements of 4.2.2.1 do not apply.

4.2.3 Short-term hydrostatic strength

4.2.3.1 For this test, all sizes of pipes from the manufacturer's range shall be evaluated.

When tested by the method described in 6.9, the resistance to internal pressure shall be determined and the pipe categorized in accordance with table 1 which shows pipes categorized on the basis of performance into types A, B or C.

Table 1 — Short-term hydrostatic strength

Type	T = 20 °C		T = 80 °C	
	Hoop-stress MPa	Minimum burst time h	Hoop-stress MPa	Minimum burst time h
A	15	1	3	170
B	12	1	4	170
C	12	1	3	170

4.2.3.2 For pipes meeting the requirements of type C in 4.2.3.1, compliance with 4.2.1 and 4.2.2 shall be established by testing every fourth size commencing with the smallest size failing to meet the requirements of type A or type B. If the tests are successful, it is assumed that the two intermediate sizes also meet these requirements. If, on the largest size tested, the pipe fails to meet the requirements, the intermediate sizes may be tested.

Compliance with this specification for type C pipe can only be claimed for the size range successfully tested.

4.3 Properties after weathering

The pipe shall be weathered in accordance with 6.6. After weathering a total energy of at least 3,5 GJ/m², the pipe shall be tested and shall meet the requirements of 5.2.4 and 5.2.5 and retain its welding characteristics. (See annex A, clause A.3.)

5 General requirements for manufactured pipes

5.1 Dimensions

5.1.1 Outside diameters and wall thicknesses

The pipe shall have nominal outside diameters and nominal wall thicknesses as given in table 2. For diameters smaller than 40 mm, a minimum wall thickness of 2 mm, 2,3 mm or 3 mm shall be selected. (See annex C.)

Table 2 — Nominal dimensions for PE gas pipes
(see annex A, clauses A.1, A.2)

Dimensions in millimetres

Nominal outside diameter d_e	Nominal wall thickness, e			
	SDR[1] 26	SDR[1] 17,6	SDR[1] 17	SDR[1] 11
	equivalent to S 12,5	equivalent to S 8,3	equivalent to S 8	equivalent to S 5
20		(See text)		
25				
32				
40		2,3	2,4	3,7
50		2,9	3	4,6
63		3,6	3,8	5,8
75		4,3	4,5	6,8
90		5,2	5,4	8,2
110		6,3	6,6	10
125		7,1	7,4	11,4
140		8	8,3	12,7
160		9,1	9,5	14,6
180		10,3	10,7	16,4
200	7,7	11,4	11,9	18,2
225	8,6	12,8	13,4	20,5
250	9,6	14,2	14,8	22,7
280	10,7	16	16,6	25,4
315	12,1	17,9	18,7	28,6
355	13,6	20,2	21,1	32,3
400	15,3	22,8	23,7	36,4
450	17,2	25,6	26,7	41
500	19,1	28,5	29,6	45,5
560	21,4	31,9	—	51
630	24,1	35,8	—	57,3

1) SDR (Standard dimension ratio) $= \frac{d_e}{e} = \frac{\text{nominal outside diameter}}{\text{nominal specified wall thickness}}$

5.1.2 Length of pipe

The length of straight pipes and coils shall be agreed between supplier and user.

The diameter of the coil for the types of PE, as classified in 5.2.3, shall not be less than 20 times the outside diameter of the pipe with a minimum of 0,6 m for type B and type C, and 24 times the outside diameter of the pipe with a minimum of 0,6 m for type A.

5.1.3 Tolerances

5.1.3.1 Wall thickness

The maximum permissible variation between the nominal wall thickness, e, and the wall thickness at any point, e_i, shall be in accordance with ISO 3607.

5.1.3.2 Mean outside diameter[1)]

The maximum permissible variation between the mean outside diameter, d_m, and the nominal outside diameter, d_e, for normal tolerance pipe shall be in accordance with ISO 3607, and for close tolerance pipe as given in table 3 (see 6.2 and annex A, clause A.4).

Table 3 — Dimensions for close and normal tolerance pipe

Dimensions in millimetres

Outside diameter	Tolerance	
nom.	min. CT	normal
20		
25	+0,3 / 0	+0,3 / 0
32		
40		+0,4 / 0
50	+0,4 / 0	+0,5 / 0
63		+0,6 / 0
75	+0,5 / 0	+0,7 / 0
90		+0,9 / 0
110	+0,6 / 0	+1 / 0
125		+1,2 / 0
140	+0,8 / 0	+1,3 / 0
160	+1 / 0	+1,5 / 0
180	+1,2 / 0	+1,7 / 0
200	+1,3 / 0	+1,8 / 0
225	+1,4 / 0	+2,1 / 0
250	+1,5 / 0	+2,3 / 0

5.1.3.3 Roundness

The roundness shall be specified by agreement between user and manufacturer.

1) This clause is provisional : tolerances are under study.

5.2 Pipe properties

5.2.1 Surface finish

The internal and external surfaces of the pipe shall be clean, smooth and reasonably free from grooving or other defects (see 6.3), which might impair its functional properties.

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

5.2.2 Heat reversion

When tested by the method described in 6.7, at no point around the pipe shall the length change by more than 3 %.

On inspection after testing, the pipe shall show no faults such as cracks, cavities and blisters.

5.2.3 Tensile strength at yield

When tested by the method described in 6.8, the tensile strength at yield at 23 °C for each of the specimens tested shall not be less than the values stated in table 4.

Table 4 — Tensile strength at yield

Type	B and C	A
Minimum tensile strength at yield, MPa	15	19

5.2.4 Elongation at break

When tested by the method described in 6.8, the elongation at break at 23 °C for each of the specimens tested shall not be less than 350 %.

5.2.5 Resistance to internal hydraulic pressure

When tested by the method described in 6.9, the time to failure shall not be less than the values stated in table 1 for the type declared in 3.3.

6 Test methods

6.1 Density of material

The nominal density shall be determined in accordance with ISO/R 1183 and the sample shall be prepared in accordance with ISO 1872.

6.2 Dimensional measurements

Dimensions shall be measured in accordance with ISO 3126.

6.3 Surface finish

The internal and external surfaces of the pipe shall be visually examined without magnification.

6.4 Effect of gas constituents on the hydrostatic strength

For this test, a synthetic condensate shall be prepared from a mixture of 50 % (*m/m*) *n*-decane and 50 % (*m/m*) trimethylbenzene.

Prior to testing, the pipe shall be conditioned by filling it with condensate and allowing it to stand in air for 1 500 h at 23 ± 2 °C. The test shall be carried out in accordance with 6.9 but using the synthetic condensate inside the pipe at a temperature of 80 °C.

6.5 Hydrostatic strength[1)]

6.5.1 Long-term hydrostatic strength at 20 °C

The test shall be carried out in accordance with the method described in 6.9 at a temperature of 20 °C. The hoopstress values for this test shall be selected so that a minimum of 25 failure stress time points above 10 h is obtained, spread over at least five pressure levels. It is required that at least one failure point is recorded at each pressure level. For statistical reasons, it is recommended that more failure points are recorded at each pressure level.

	Failure points
10 to 100 h	at least 8
100 to 1 000 h	at least 8
1 000 to 7 000 h	at least 5
7 000 to 9 000 h	at least 4
above 9 000 h	at least 1

Plot the results for each test specimen on a log (stress) versus log (time) graph where the hoopstress is in megapascals and the time to failure in hours. Calculate the 95 % lower confidence limit, to obtain the failure stress at a time of 100 000 h.

Samples which have not failed at the lowest pressure levels shall be used in the calculation as failure points if they increase the value of the long-term hydrostatic strength [Standard Extrapolation Method (SEM)]; if not then they shall be deleted.

To be able to take advantage of advanced statistical methods, guidance is given that the differences between subsequent pressure levels will follow the relation log stress = constant.

6.5.2 Long-term hydrostatic strength at 20 °C derived from elevated temperature testing

6.5.2.1 General

The test shall be performed in accordance with 6.9. The method is mainly graphical and requires the determination of the log σ (σ = hoopstress) to log t (t = failure time) relationship, using abscissa in which one decade of stress (expressed in megapascals) is equivalent to five decades of time (expressed in hours). Water is the test medium for both inside and outside the pipe.

The test shall be carried out on one batch of PE pipes with an outside diameter of 32 mm and a wall thickness of at least 2 mm.

6.5.2.2 Estimated regression line of 60 °C

If it has been determined that at 60 °C using a stress of 5 MPa, no failure of a brittle nature occurs before 10 000 h, further tests at 60 °C are not required. If brittle failures have occurred, the brittle part of the 60 °C regression line shall be determined, selecting five stress levels from the ductile — brittle transition zone downwards.

For each stress level, five specimens shall be tested. Calculate the standard deviation and hence the average failure line over at least one decade from the data obtained in the test described in this clause, using the method of least squares. Testing may be discontinued after 10 000 h. If, as a result, the slope of the failure line cannot be calculated over one decade, then estimate the time and stress level where the ductile — brittle failure transition occurs.

From this point on, a line is drawn parallel to the 80 °C failure curve. This line represents the estimated 60 °C average failure line.

6.5.2.3 Regression line at 80 °C

The brittle part of the failure at 80 °C is determined by selecting five stress levels which result in failure times more or less equally distributed over at least one decade.

For each stress level, five specimens shall be tested. Calculate the standard deviation and hence the average failure line over at least one decade from the data obtained in the test described in this clause, using the method of least squares. Testing may be discontinued after 10 000 h. If, as a result, the slope of the failure line cannot be calculated over one decade, then estimate the time and stress level where the ductile — brittle failure transition occurs.

6.5.3 Extrapolation of the brittle part of the line to 20 °C

The separation distances at a hoopstress of 2 MPa between the 80 °C average failure curve and either the calculated 60 °C average failure or the estimated 60 °C average failure line is determined.

At a distance from the 60 °C failure curve, equal to 2,4 times the separation distance determined above, a line is drawn parallel to the 60 °C failure line. This line represents the extrapolated average line for brittle failure at 20 °C.

Estimate the 95 % lower confidence limit of this extrapolated line for brittle failure using the standard deviation calculated for the 80 °C results, which should intercept the 50 year ordinate at a value defined in 4.2.2.

1) Under study.