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Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications

*Tubes et raccords en poly(chlorure de vinyle) non plastifié (PVC-U) pour
l'adduction d'eau — Spécifications*



Reference number
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Foreword

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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 4422 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*.

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Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications

1 Scope

This International Standard specifies the required properties of pipes, joints and fittings made of unplasticized poly(vinyl chloride) (PVC-U) intended to be used for water supply.

It applies to pipes, joints and fittings (post-formed and moulded) intended for buried water mains and services and for water supplies above ground, both inside and outside buildings.

The pipes, joints and fittings covered by this International Standard are intended for the conveyance of water under pressure at temperatures up to 45 °C for general purposes, and for the supply of drinking water.

Fittings made by hot gas and hot plate welding techniques are excluded from this International Standard.

NOTE 1 For installation of components covered by this International Standard, the user is referred to ISO/TR 4191.

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 161-1:1978, *Thermoplastics pipes for the transport of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.*

ISO 264:1976, *Unplasticized polyvinyl chloride (PVC) fittings with plain sockets for pipes under pressure — Laying lengths — Metric series.*

ISO 580:1973, *Moulded fittings in unplasticized polyvinyl chloride (PVC) for use under pressure — Oven test.*

ISO 727:1985, *Fittings of unplasticized polyvinyl chloride (PVC-U), chlorinated polyvinyl chloride (PVC-C) or acrylonitrile/butadiene/styrene (ABS) with plain sockets for pipes under pressure — Dimensions of sockets — Metric series.*

ISO 1167:—¹⁾, *Thermoplastics pipes for the transport of fluids — Resistance to internal pressure — Test method and basic specification.*

ISO 2035:1974, *Unplasticized polyvinyl chloride (PVC) moulded fittings for elastic sealing ring type joints for use under pressure — Pressure-resistance test.*

ISO 2043:1974, *Unplasticized polyvinyl chloride (PVC) moulded fittings for elastic sealing ring type joints for use under pressure — Oven test.*

ISO 2044:1974, *Unplasticized polyvinyl chloride (PVC) injection-moulded solvent-welded socket fittings for use with pressure pipe — Hydraulic internal pressure test.*

ISO 2045:1988, *Single sockets for unplasticized poly(vinyl chloride) (PVC-U) and chlorinated poly(vinyl chloride) (PVC-C) pressure pipes with elastic sealing ring type joints — Minimum depths of engagement.*

ISO 2048:1990, *Double-socket fittings for unplasticized poly(vinyl chloride) (PVC-U) pressure pipes with elastic sealing ring type joints — Minimum depths of engagement.*

1) To be published. (Revision of ISO 1167:1973)

ISO 2505:1981, *Unplasticized polyvinyl chloride (PVC) pipes — Longitudinal reversion — Test methods and specification.*

ISO 2507:1982, *Unplasticized polyvinyl chloride (PVC) pipes and fittings — Vicat softening temperature — Test method and specification.*

ISO 2536:1974, *Unplasticized polyvinyl chloride (PVC) pressure pipes and fittings, metric series — Dimensions of flanges.*

ISO 3114:1977, *Unplasticized polyvinyl chloride (PVC) pipes for potable water supply — Extractability of lead and tin — Test method.*

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

ISO 3127:1980, *Unplasticized polyvinyl chloride (PVC) pipes for the transport of fluids — Determination and specification of resistance to external blows.*

ISO 3474:1976, *Unplasticized polyvinyl chloride (PVC) pipes — Specification and measurement of opacity.*

ISO 3603:1977, *Fittings for unplasticized polyvinyl chloride (PVC) pressure pipes with elastic sealing ring type joints — Pressure test for leakproofness.*

ISO 3604:1976, *Fittings for unplasticized polyvinyl chloride (PVC) pressure pipes with elastic sealing ring type joints — Pressure test for leakproofness under conditions of external hydraulic pressure.*

ISO 3606:1976, *Unplasticized polyvinyl chloride (PVC) pipes — Tolerances on outside diameters and wall thicknesses.*

ISO 4065:1978, *Thermoplastic pipes — Universal wall thickness table.*

ISO 4132:1979, *Unplasticized polyvinyl chloride (PVC) and metal adaptor fittings for pipes under pressure — Laying lengths and size of threads — Metric series.*

ISO/TR 4191:1989, *Unplasticized polyvinyl chloride (PVC-U) pipes for water supply — Recommended practice for laying.*

ISO 4434:1977, *Unplasticized polyvinyl chloride (PVC) adaptor fittings for pipes under pressure — Laying length and size of threads — Metric series.*

ISO 4633:1983, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials.*

ISO 6455:1983, *Unplasticized polyvinyl chloride (PVC) fittings with elastic sealing ring type joints for pipes under pressure — Dimensions of laying lengths — Metric series.*

ISO 6992:1986, *Unplasticized polyvinyl chloride (PVC-U) pipes for drinking water supply — Extractability of cadmium and mercury occurring as impurities.*

ISO 7676:—²⁾, *Unplasticized poly(vinyl chloride) (PVC-U) pipes — Dichloromethane test.*

ISO/TR 9853:—²⁾, *Injection-moulded poly(vinyl chloride) (PVC-U) fittings for pressure pipe systems — Crushing test and basic specification.*

World Health Organization, *Guidelines for drinking water quality, Vol.1: Recommendations*, Geneva, 1984.

3 Material

3.1 The material from which the pipes and fittings are made shall consist substantially of unplasticized poly(vinyl chloride), to which may be added only those additives that are needed to facilitate the manufacture of the polymer, and the production of sound, durable pipes and fittings of good surface finish, mechanical strength and opacity. None of these additives shall be used, separately or together, in quantities sufficient to constitute a toxic, organoleptic or microbial growth hazard or to impair the fabrication or welding properties of the product or to impair the chemical and physical properties (in particular long-term mechanical and impact strength) as defined in this International Standard.

3.2 The use of the manufacturer's own rework material produced during manufacture and works testing of products complying with this International Standard is permissible. No other rework material shall be used.

4 Geometrical characteristics

The pipes and fittings shall be designed with due regard to good practice in relation to their hydrodynamic characteristics, and manufactured with such dimensions and within such tolerances as will permit their use to meet the performance requirements of this International Standard.

2) To be published.

4.1 Dimensions of pipes

The dimensional requirements and pressure ratings of unplasticized poly(vinyl chloride) (PVC-U) pipes, joints and fittings are based on ISO 161-1.

4.1.1 Outside diameters and wall thicknesses

The nominal outside diameters selected from ISO 161-1 and the wall thicknesses selected from ISO 4065, together with an additional S series of 16,7 are given in table 1.

The tolerances on outside diameters and wall thicknesses shall be in accordance with ISO 3606.

The dimensions of pipes shall be measured as specified in ISO 3126.

4.1.2 Nominal pressures and safety factors

The nominal pressure (PN) of a pipe is the maximum continuous working pressure at 20 °C and is related to the S values given in table 1 by the formula

$$PN = \frac{\sigma}{S}$$

where σ is the hydrostatic design stress.

The value of the hydrostatic design stress (HDS) is based on the value of the lower confidence limit (LCL), obtained by long-term extrapolation, and a safety factor shall be applied.

The extrapolation shall be carried out as agreed between the interested parties, pending publication of ISO/TR 9080 which will specify the method to be used.

For PVC-U pipes intended for water supply, the LCL shall equal 25 MPa (250 daN/cm²)³⁾, and this defines the material as "PVC 250" (this designation shall be considered as a temporary one). The safety factor shall be equal to 2,0 or 2,5, depending on national requirements, resulting in a value for HDS of 12,5 MPa or 10 MPa respectively.

In order to avoid any ambiguity, the marking of pipes as specified in 7.1 shall in consequence include an indication of the material, the safety factor and the nominal pressure.

A supplementary derating factor shall be applied for operating temperatures between 25 °C and 45 °C. The values of this factor are given in table 2 and figure 1. The derating factor enables the maximum working pressure at temperatures over 25 °C to be determined.

3) 1 daN/cm² = 1 bar

Table 1 — Nominal wall thicknesses

Nominal outside diameter <i>D</i> mm	Pipe series S and nominal pressure PN in MPa (bar)							
	S20 PN 0,5 MPa (5 bar)	S16,7 PN 0,6 MPa (6 bar)	S16 PN 0,63 MPa (6,3 bar)	S12,5 PN 0,8 MPa (8 bar)	S10 PN 1 MPa (10 bar)	S8 PN 1,25 MPa (12,5 bar)	S6,3 PN 1,6 MPa (16 bar)	S4 PN 2,5 MPa (25 bar)
	Nominal wall thickness, <i>e</i> (mm)							
10								1,5 ¹⁾
12								1,5
16								1,8
20								2,3
25								2,8
32								3,6
40								4,5
50								5,6
63	1,6	1,9	2	2,4	3	3,8	4,7	7,1
75	1,9	2,2	2,3	2,9	3,6	4,5	5,5	8,4
90	2,2	2,7	2,8	3,5	4,3	5,4	6,6	10,1
110	2,7	3,2	3,4	4,2	5,3	6,6	8,1	12,3
125	3,1	3,7	3,9	4,8	6	7,4	9,2	14
140	3,5	4,1	4,3	5,4	6,7	8,3	10,3	15,7
160	4	4,7	4,9	6,2	7,7	9,5	11,8	17,9
180	4,4	5,3	5,5	6,9	8,6	10,7	13,3	
200	4,9	5,9	6,2	7,7	9,6	11,9	14,7	
225	5,5	6,6	6,9	8,6	10,8	13,4	16,6	
250	6,2	7,3	7,7	9,6	11,9	14,8	18,4	
280	6,9	8,2	8,6	10,7	13,4	16,6	20,6	
315	7,7	9,2	9,7	12,1	15	18,7	23,2	
355	8,7	10,4	10,9	13,6	16,9	21,1	26,1	
400	9,8	11,7	12,3	15,3	19,1	23,7	29,4	
450	11	13,2	13,8	17,2	21,5	26,7	33,1	
500	12,3	14,6	15,3	19,1	23,9	29,6	36,8	
560	13,7	16,4	17,2	21,4	26,7			
630	15,4	18,4	19,3	24,1	30			
710	17,4	20,7	21,8	27,2				
800	19,6	23,3	24,5	30,6				
900	22	26,2	27,6					
1 000	24,5	29,1	30,6					

NOTES

1 The wall thicknesses are based on an induced stress at 20 °C of 10 N/mm² (≈ 100 kgf/cm²).

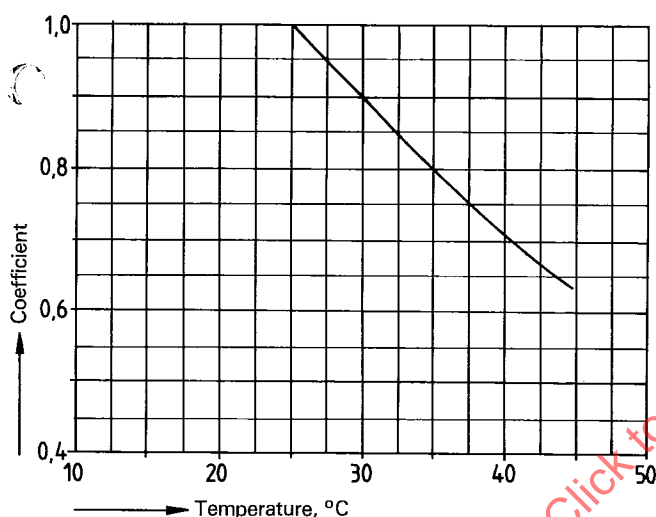
2 For outside diameters *D* > 63 mm, the wall thicknesses may be based on an induced stress at 20 °C of 12,5 N/mm² (≈ 125 kgf/cm²).

1) Under certain circumstances, the minimum wall thickness may be 1 mm.

Table 2 — Maximum admissible working pressures for water temperatures up to 45 °C^{*)}

Water temperature, t °C	Coefficient to be applied to the nominal pressure (PN)
$0 < t \leq 25$	1
$25 < t \leq 35$	0,8
$35 < t \leq 45$	0,63

^{*)} For more accurate calculations of temperature corrections, the coefficients taken from figure 1 shall be used.

**Figure 1 — Maximum working pressure (coefficient) for temperatures up to 45 °C**

4.1.3 Length of pipe (recommended)

It is recommended that pipes be supplied in lengths of:

4 m — 6 m — 10 m — 12 m.

This length does not include the depth of any socket or sockets.

If transport requirements dictate a different length, the provisions of national standards may be applied.

4.1.4 Pipes with socket(s)

The minimum depth of engagement of single sockets with elastomeric sealing ring type joints shall be in accordance with ISO 2045.

Dimensions of sockets for solvent cementing shall be in accordance with ISO 727.

4.1.5 Pipes with plain end(s)

Pipes with plain end(s) to be used with elastomeric sealing ring type joints shall be chamfered as described in ISO 2045.

The sharp edge shall be removed on pipes to be used for solvent cementing.

4.2 Dimensions of fittings

4.2.1 Fittings for solvent cementing

Laying lengths shall be in accordance with ISO 264.

The socket lengths and tolerances shall be in accordance with ISO 727.

4.2.2 Fittings for elastomeric sealing ring type joints

Laying lengths shall be in accordance with ISO 6455.

The minimum depth of engagement for fittings shall be in accordance with ISO 2045.

The minimum depth of engagement for double sockets shall be in accordance with ISO 2048.

The minimum depth of engagement of sockets on moulded bends, tees and reducers shall be in accordance with ISO 2048.

The inside diameter of the socket, the form of the groove for the elastomeric sealing ring and the form of the elastomeric sealing ring shall be such that the requirements of 8.1 are met.

4.2.3 Adaptor fittings

Where applicable the laying length and size of thread for PVC-U adaptor fittings shall be in accordance with ISO 4434.

Where applicable the laying length and size of thread for PVC-U and metal adaptor fittings shall be in accordance with ISO 4132.

4.3 Dimensions of flanges

The basic dimensions for flanges shall be in accordance with ISO 2536.

The adaptor dimensions shall be in accordance with ISO 4132.

5 Mechanical characteristics

5.1 Pipes

The following tests shall be carried out:

5.1.1 Resistance to internal pressure

The pipe shall be tested in accordance with ISO 1167 using the test parameters given in table 3.

Table 3 — Test parameters for resistance of pipes to internal pressure

Test temperature °C	Test time h	Induced stress MPa
20	1 100	42 35
60	1 000	12,5

5.1.2 External impact resistance at 20 °C

The pipe shall be tested at 20 °C in accordance with section one of ISO 3127:1980, and meet the requirements of section two of ISO 3127:1980.

5.2 Fittings

The following tests shall be carried out, as appropriate:

5.2.1 Injection-moulded solvent cement type fittings shall be tested in accordance with the requirements of ISO 2044, using the test parameters given in table 4.

5.2.2 Injection-moulded elastomeric sealing ring type fittings shall be tested in accordance with the requirements of ISO 2035, using the test parameters given in table 4. The test at 20 °C/1 h/4,2 × PN may require reinforcement of the mouth of the fitting to prevent creep of the socket, and subsequent extrusion of the sealing ring.

5.2.3 Flattening test: injection-moulded fittings shall be tested in accordance with, and meet the requirements of ISO 9853.

5.2.4 Where fittings are manufactured from pipe, the pipe shall conform to the requirements given in 5.1.1 and 5.1.2 above, and to 6.2.1.1, 6.2.1.2 and 6.2.1.3.

The fittings themselves shall be tested in accordance with ISO 2044 or ISO 2035, depending on their method of jointing.

The performance of the fittings shall be equal to or greater than 1 h at 20 °C, under an internal pressure equal to 4,2 times the nominal pressure for which they are designed.

Table 4 — Test parameters for injection-moulded fittings and injection-moulded test specimens in the form of a pipe

Test specimen	Test temperature °C	Test time h	Test pressure ¹⁾ bar	Induced stress MPa
In- jection- moulded fitting	20	1 1 000	4,2 × PN 3,2 × PN	— —
In- jection- moulded specimen ²⁾	60	1 000	—	10

1) The test pressure is obtained by multiplying the nominal pressure (PN) for which the fitting is designed by the factor given.

2) This requirement is for an injection-moulded specimen in the form of a pipe with a nominal outside diameter *D* of between 50 mm and 110 mm and a wall thickness calculated from an admissible stress of 10 MPa.

6 Physical characteristics

6.1 General

6.1.1 Appearance

The internal and external surfaces of pipes and fittings shall be smooth, clean and free from scoring, cavities and other surface defects. The material shall not contain visible impurities. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

6.1.2 Effect of materials on water quality

When used under the conditions for which they are designed, non-metallic 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 any unpleasant taste or odour, or to cloudiness or discoloration of the water.

Concentrations of chemicals, biological agents or other substances leached from materials in contact with drinking water, and the values of the relevant organoleptic/physical parameters, shall not exceed the maximum values recommended by the World Health Organisation in its publication, "Guidelines for drinking water quality", Vol. 1: "Recommendations" (WHO, Geneva, 1984).

If lead or mono/di-alkyl tin compounds are permitted to be used as stabilisers, the quantities of lead or tin, measured as metals, shall be determined in accordance with the method described in ISO 3114.

The levels shall not exceed the limits permitted in the appropriate national standards.

Cadmium and mercury shall not exceed the levels specified in ISO 6992.

6.1.3 Compliance with national regulations

Where applicable, pipes and fittings shall satisfy the current national regulations concerning substances to be used in contact with drinking water.

6.2 Pipes

6.2.1 The mandatory tests in 6.2.1.1 to 6.2.1.3 shall be applied.

6.2.1.1 The Vicat softening temperature shall not be less than 80 °C when measured in accordance with ISO 2507.

6.2.1.2 The pipe shall not change in length by more than 5 % when the longitudinal reversion test is applied in accordance with ISO 2505.

6.2.1.3 A gelation test shall be carried out in accordance with ISO 7676 or another method⁴⁾ agreed on between the interested parties, depending upon national requirements.

When the test is carried out in accordance with ISO 7676, there shall be no attack on the inside or outside of the pipe wall, and the degree of attack on the cut surface of the exposed pipe end shall be less than 30 % of the cross-section of the pipe.

6.2.2 If a pipe is required to be opaque for use in above-ground applications, a test shall be carried out in accordance with ISO 3474. The wall of the pipe shall not transmit more than 0,2 % of visible light falling on it.

6.3 Injection-moulded fittings

6.3.1 The following mandatory tests shall be applied:

6.3.1.1 The Vicat softening temperature shall not be less than 76 °C when measured in accordance with ISO 2507.

6.3.1.2 Oven test

a) Injection-moulded fittings for solvent cementing shall be tested in accordance with, and meet the requirements of, ISO 580.

b) Injection-moulded fittings with elastomeric sealing ring type joints shall be tested in accordance with, and meet the requirements of, ISO 2043.

7 Marking

7.1 Pipes

All pipes shall be recognisably marked at the maximum intervals given below:

- $D \leq 50$ mm: marking data every metre;
- $63 \leq D \leq 160$ mm: marking data every two metres;
- $D \geq 180$ mm: marking data at least every six metres, or one set of marking data every standard length.

The marking shall show at least the following information:

- a) a reference to this International Standard;
- b) the manufacturer's name or trade mark;
- c) the outside diameter D and nominal wall thickness e ;
- d) the pipe material (PVC 250) (note that this is only a temporary designation);
- e) the safety factor, e.g. F-2 or F-2,5;
- f) the nominal pressure PN in bars.

Other information may be added, such as the pipe series S, e.g. S16,7.

NOTE 2 It is permitted to mark a pipe with two alternative nominal pressures and the corresponding safety factors.

7.2 Fittings

All fittings shall be marked or labelled to show at least the following information:

- a) the fitting material (PVC-U);
- b) the manufacturer's name or trade mark;
- c) the nominal pressure PN;
- d) the fitting size(s).

The pipe series S for which the fitting is designed may also be included.

4) An alternative method, also using dichloromethane, will be specified in ISO/TR 9852.