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Buried, high-impact poly(vinyl chloride) (PVC-HI) pipes for the supply of gaseous fuels — Specification

Tubes enterrés en poly(chlorure de vinyle) à résistance au choc améliorée (PVC-HI) pour réseaux de combustibles gazeux — Spécifications

Reference number
ISO 6993 : 1990 (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. 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 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 6993 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids.*

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Buried, high-impact poly(vinyl chloride) (PVC-HI) pipes for the supply of gaseous fuels — Specification

1 Scope

This International Standard specifies the requirements for pipes made of high-impact poly(vinyl chloride) (PVC-HI), as defined in clause 4, for the supply of gaseous fuels through buried pipelines.

The pipes are suitable for those gases which do not contain potentially damaging components in such concentrations as to impair the properties of the pipe material.

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/R 527 : 1966, *Plastics — Determination of tensile properties.*

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

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

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

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

3 Classification

It is recognized that all countries will not use the same gas distribution pressures. Table 1 gives four series of pipes for use with various gas pressures under good and bad conditions, from which each national standards body will select the series applicable to its own usage. (Table 2 gives the nominal pipe dimensions for each series.)

Guidance is given to determine the classification of conditions**).

Table 1

Installation conditions	Range of nominal outside diameters D mm	Series of pipes[1] suitable for use under a maximum service pressure of							
		20 kPa (0,2 bar)		100 kPa (1 bar)		250 kPa (2,5 bar)		400 kPa (4 bar)	
Good	$D \leqslant 200$	SDR41	S20	SDR33	S16	SDR21	S10	SDR13,6	S6,3
Bad	$D \leqslant 200$	SDR41	S20	SDR33	S16	SDR13,6	S6,3	—	—
Good	$D > 200$	SDR41	S20	SDR33	S16	SDR13,6	S6,3	—	—
Bad	$D > 200$	SDR41	S20	SDR21	S10	—	—	—	—

1) SDR, the standard dimension ratio, is equal to the nominal outside diameter divided by the nominal specified wall thickness, i.e. D/e. The relationship between SDR and S is defined in ISO 4065 as SDR = 2S + 1.

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

**) When considering the use of high-impact PVC pipes and fittings, the impact strength and the environmental conditions may have more influence than the effect of internal pressure on the application for which the pipe is suitable.

Transport, handling and storage of pipes, climatic conditions and other, unknown, variables due to the environment of the buried pipes (notably soil loading) will vary in different countries. It will therefore be necessary to refer to the codes of practice and the local regulations within each country.

4 Definition of material*)

The material from which the pipe is produced shall be one of the following:

a) a mixture based on PVC;

b) a blend based on PVC;

c) a copolymer based on PVC;

d) a combination of these types, to which may be added only those additives which are necessary to facilitate the manufacture of the polymer and the production of pipe complying with this International Standard.

The proportion of PVC in the material shall be at least 80 % by mass.

5 Required characteristics

5.1 Dimensions

5.1.1 Outside diameter and wall thickness

The nominal outside diameters and nominal wall thicknesses are given in table 2.

Table 2

Dimensions in millimetres

Nominal outside diameter[1] D	Pipe series			
	SDR41 S20	SDR33 S16	SDR21 S10	SDR13,6 S6,3
	Nominal wall thickness, e[2]			
20	2	2	2	2
25	2	2	2	2
32	2	2	2	2,4
40	2	2	2	3
50	2	2	2,4	3,7
63	2	2	3	4,7
75	2	2,3	3,6	5,5
90	2,2	2,8	4,3	6,6
110	2,7	3,4	5,3	8,1
125	3,1	3,9	6	9,2
140	3,5	4,3	6,7	10,3
160	4	4,9	7,7	11,8
180	4,4	5,5	8,6	13,3
200	4,9	6,2	9,6	14,7
225	5,5	6,9	10,8	16,6
250	6,2	7,7	11,9	18,4
280	6,9	8,6	13,4	20,6
315	7,7	9,7	15	23,2
355	8,7	10,9	16,9	26,1
400	9,8	12,3	19,1	29,4
450	11	13,8	21,5	33,4
500	12,3	15,3	23,9	37,1
560	13,7	17,2	26,7	41,5
630	15,4	19,3	30	46,7

1) In accordance with ISO 161-1.

2) In order to meet the requirements on handling and resistance to earth load, a minimum wall thickness of 2 mm is chosen for all series.

5.1.2 Length of pipe

The effective length of the pipe should preferably be one of the following:

4 m; 5 m; 6 m; 9 m; 10 m; 12 m.

5.1.3 Tolerances

5.1.3.1 The maximum permissible variation between the mean outside diameter D_m and the nominal outside diameter D shall be in accordance with ISO 3606.

5.1.3.2 The maximum permissible variation between the outside diameter D_i at any point and the nominal outside diameter D shall be in accordance with ISO 3606.

5.1.3.3 The maximum permissible variation between the wall thickness e_i at any point and the nominal wall thickness e shall be in accordance with ISO 3606.

5.2 Physical properties

5.2.1 Appearance

The internal and external surfaces of the pipe shall be clean, smooth and reasonably free from grooving and other defects (see 6.1). The ends shall be cleanly cut and square with the axis of the pipe.

5.2.2 Longitudinal reversion

The mean longitudinal reversion of the three test pieces shall not be greater than 5 %, measured in accordance with the test method specified in 6.2. Cracks, voids and blisters shall not be present.

5.2.3 Modulus of elasticity

The modulus of elasticity shall be at least 2 000 N/mm^2 measured in accordance with the test method specified in 6.7.

5.2.4 Resistance to stress crazing

No initiation of stress crazing shall be observed in a ring, originating from a pipe, which is subjected to a strain of 0,9 % as specified in 6.8 and which is simultaneously exposed for 1 300 h at 20 °C ± 3 °C to nitrogen containing 75 mg/m^3 ± 5 mg/m^3 of tetrahydrothiophene (THT).

5.3 Mechanical properties

5.3.1 Resistance to internal hydraulic pressure

At the stresses and temperatures given in table 3, the time to burst shall be not less than that stated in table 3, measured in accordance with the test method specified in 6.3.

*) In this International Standard only materials, such as PVC/CPE, PVC/EPR and PVC/A (see table 3 for definitions), for which studies have been completed by ISO/TC 138, are included.

Table 3

Material[1]	Test temperature °C	Hoop stress MPa	Minimum burst time h
PVC/CPE and PVC/EPR PVC/A	20	30 30	1
PVC/CPE and PVC/EPR PVC/A	20	23 25	100
PVC/CPE PVC/EPR and PVC/A	60	6,5 9	1 000

1) CPE, chlorinated polyethylene; EPR, ethylene propylene rubber; A, acrylate.

5.3.2 Resistance to external blows

The true impact rate (failure rate) shall not exceed 5 % at a level given in table 4, column a), measured in accordance with the test method specified in 6.4.

5.3.3 Resistance to external blows after weathering

The true impact rate (failure rate) shall not exceed 5 % at a level given in table 4, column b), after weathering using the method described in 6.5 and testing using the method specified in 6.4.

5.3.4 Resistance to weathering

The pipe shall meet the requirements of 5.2.1, 5.2.2, 5.3.1, 5.3.3 and 5.4, measured in accordance with the test method described in 6.5.

5.4 Thermal property — Vicat softening temperature

The Vicat softening temperature shall be not less than 76 °C, measured in accordance with the test method specified in 6.6.

6 Methods of test

6.1 Appearance

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

6.2 Longitudinal reversion

The longitudinal reversion shall be determined in accordance with ISO 2505.

6.3 Resistance to internal hydraulic pressure

The resistance to internal hydraulic pressure shall be determined in accordance with ISO 1167.

6.4 Resistance to external blows

The resistance to external blows shall be determined at 0 °C in accordance with ISO 3127.

6.5 Resistance to weathering

6.5.1 Apparatus

The equipment shall be capable of supporting specimens of pipe such that the whole length of the pipe is exposed directly to the sun. The test site shall be chosen such that shadows do not fall across the specimens and it shall be equipped to measure the solar energy and ambient temperature.

6.5.2 Specimens

Sufficient pipe specimens to allow all the properties of the pipe to be determined shall be taken. Specimens will normally be selected from the thinnest-walled pipe within the specified range to include a range of diameters. If it is found necessary to provide protective covers for the pipe as supplied to the purchaser, then further specimens together with the covers will be required.

6.5.3 Exposure

The pipe specimens shall be identified and full particulars recorded. They shall be exposed to sunlight for at least 3,5 GJ/m^2 at the selected site, at 45° facing south for countries in the northern hemisphere and at 45° facing north for countries in the southern hemisphere.

6.5.4 Procedure

After the specimens have weathered, tests shall be carried out in accordance with 6.1, 6.2, 6.3, and 6.4.

6.6 Vicat softening temperature

The Vicat softening temperature shall be determined in accordance with ISO 2507.

Table 4

Nominal outside diameter D mm	Total mass kg		Height of fall m	
	a)	b)	corresponding to column a)	corresponding to column b)
$D < 32$	0,5	0,25	2	1
$32 \leq D \leq 50$	1	0,25	2	2
63 and 75	2	0,5	2	2
90	4	1	2	2
110	4	1	2	2
$D \geq 125$	4	2	2	2

6.7 Modulus of elasticity

The modulus of elasticity shall be determined in accordance with ISO/R 527.

6.8 Resistance to stress crazing

A high-impact PVC pipe which conforms in all other respects to this specification shall be used for this test. Five rings of length 10 mm ± 0,1 mm shall be cut from the sample pipe. The wall thickness and outside diameter of the rings shall be measured to check that they are within the tolerances specified in 5.1.3.

The rings shall be placed in a U-shaped holder in which the arms of the U are (x ± 0,05) mm apart.

x shall be derived from the following formulae:

$$\varepsilon = \frac{e}{2r_o} \times \frac{r_1 - r_o}{r_1} \times 100$$

$$r_1 = r_o \times \frac{(1 + \Delta r/r_o)^2}{(1 - \Delta r/r_o)}$$

$$x = D - 2\,\Delta r$$

where

ε is the required strain (0,9 %) in accordance with 5.2.4;

e is the nominal wall thickness of the ring;

r_o is the inside radius of the unbent ring;

r_1 is the smallest inside radius of the bent ring;

D is the nominal outside diameter of the ring;

$\Delta r/r_o$ is the fractional deformation in the ring which produces the required strain ε.

After 15 h, the U-shaped holder with the rings shall be placed in a desiccator which is connected to a reservoir filled with nitrogen containing 75 mg/m³ ± 5 mg/m³ of THT (see 5.2.4) such that the gas mixture flows gently through the desiccator.

The parts of the test ring which are in contact with the gas mixture shall not absorb THT. The concentration of THT shall be checked by means of gas chromatography before and after the test.

After the required exposure time of at least 1 300 h, the rings shall be removed from the U-shaped holder and shall be exposed for at least 1 h to room conditions.

From one ring, two segments shall be taken, such that they include the place at which the maximum tensile stress has occurred on the inside surface. The segments shall be approximately 20 mm long.

Each segment shall be placed in special clamps in a microtome apparatus with the length direction parallel to the cutting direction (see figure 1 for the design of the clamps).

When clamping the segment, use shall be made of a torque wrench and a filling piece to ensure that the original radius of the segment is preserved and that the introduction of bending stresses is prevented.

Each segment shall not be clamped with more than 0,5 cm exposed above the clamps.

The microtome knife (see figure 1) shall be adequately supported to prevent bending. After several slices have been cut to give a smooth surface to the segment, slices 7 µm thick shall be cut. The knife shall be sharpened after cutting 20 slices.

Microscope slides shall be prepared from these slices using n-hexadecane as the contact liquid.

The slides shall be examined using transmitted light with a magnification of ×100. No irregularities, cracks or crazes greater than 0,05 mm shall be observed. At least 10 usable slices shall be cut from the whole breadth of the segment.

It is recommended that this method is checked using a segment from a control specimen, i.e. a sample of pipe which has been clamped in the U-shaped holder but not exposed to the gas mixture, to ensure that the correct apparatus is being used and that the technique is completely controlled.

No crazes, cracks or irregularities shall be observed in the slices taken from the control specimen.

7 Marking

All marking shall be in accordance with the relevant national standard and shall include the word "Gas", the name or tradename of the manufacturer and the date of production.