INTERNATIONAL STANDARD

ISO 22621-2

First edition
2007-11-15

Plastics piping systems for the supply of gaseous fuels for maximum operating pressures up to and including 2 MPa (20 bar) — Polyamide (PA) —

Part 2: **Pipes**

Systèmes de canalisations en matières plastiques pour la distribution de combustibles gazeux pour des pressions maximales de service inférieures ou égales à 2 MPa (20 bar) — Polyamide (PA) —

Partie 2: Tubes

Reference number
ISO 22621-2:2007(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 22621-2 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

ISO 22621 consists of the following parts, under the general title *Plastics piping systems for the supply of gaseous fuels for maximum operating pressures up to and including 2 MPa (20 bar) — Polyamide (PA)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

Fitness for purpose of the system is to form the subject of a future part 5.

Introduction

As polyamide material is used for piping systems for the supply of gaseous fuels both at low and high pressure, ISO/TC 138/SC 4 experts decided to split the standardization programme into two series of International Standards, with one series covering low pressures up to 0,4 MPa (4 bar), and ISO 22621 high pressures up to 2 MPa (20 bar).

Thin wall thickness pipes and solvent cement joints are used typically for pressures up to 0,4 MPa (4 bar), while thicker wall thickness pipes and butt fusion, electrofusion and mechanical joints are typically used for pressures up to 2 MPa (20 bar). For technical and safety reasons, it is not possible to mix the components of the two types of piping system (thin wall thickness pipes cannot be jointed by butt fusion or mechanical joints and vice versa). In particular, solvent cement joints must not be used for jointing for high pressure piping systems.

Plastics piping systems for the supply of gaseous fuels for maximum operating pressures up to and including 2 MPa (20 bar) — Polyamide (PA) —

Part 2: Pipes

1 Scope

This part of ISO 22621 specifies the physical and mechanical properties of pipes made from polyamide (PA) in accordance with ISO 22621-1, intended to be buried and used for the supply of gaseous fuels at maximum operating pressures (MOP) up to and including 20 bar [1)].

It also specifies the test parameters for the test methods to which it refers.

In addition, it lays down dimensional characteristics and requirements for the marking of pipes.

Pipes conforming to this part of ISO 22621 are jointed typically by using mechanical, electrofusion or butt fusion (see Annex A) techniques, but not by solvent cement jointing.

2 Normative references

The following referenced documents are indispensable for the application 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 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 307, *Plastics — Polyamides — Determination of viscosity number*

ISO 1133:2005, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

ISO 1167-1, *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*

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

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

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

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 11922-1:1997, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*

ISO 13479, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes (notch test)*

ISO 22621-1, *Plastics piping systems for the supply of gaseous fuels for maximum operating pressures up to and including 2 MPa (20 bar) — Polyamide (PA) — Part 1: General*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in ISO 22621-1 apply.

4 Compound

The pipes shall be made from virgin material. Rework material shall not be used.

The compound from which the pipes are made shall be in accordance with ISO 22621-1.

5 Appearance

When viewed without magnification, the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities and other surface defects which can affect pipe performance. The pipe ends shall be cut cleanly and square to the axis of the pipe.

6 Geometrical characteristics

6.1 Measurement of dimensions

Dimensions shall be measured in accordance with ISO 3126 at (23 ± 2) °C, after being conditioned for at least 4 h. The measurement shall not be made less than 24 h after manufacture.

6.2 Mean outside diameters, out-of-roundness and their tolerances

The mean outside diameter of the pipe, d_{em}, and the out-of-roundness and their tolerances shall be in accordance with Table 1.

For maximum mean outside diameter grade B tolerances, ISO 11922-1 shall apply.

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

Dimensions in millimetres

Nominal outside diameter	Mean outside diameter		Maximum of absolute out-of-roundness [a]	
d_n	$d_{em,min}$	$d_{em,max}$	Grade K [b]	Grade N
16	16,0	16,3	1,2	1,2
20	20,0	20,3	1,2	1,2
25	25,0	25,3	1,5	1,2
32	32,0	32,3	2,0	1,3
40	40,0	40,4	2,4	1,4
50	50,0	50,4	3,0	1,4
63	63,0	63,4	3,8	1,5
75	75,0	75,5	—	1,6
90	90,0	90,6	—	1,8
110	110,0	110,7	—	2,2
125	125,0	125,8	—	2,5
140	140,0	140,9	—	2,8
160	160,0	161,0	—	3,2
180	180,0	181,1	—	3,6
200	200,0	201,2	—	4,0
225	225,0	226,4	—	4,5
250	250,0	251,5	—	5,0

[a] Measurement of out-of-roundness shall be made at the point of manufacture according to ISO 3126.

[b] For coiled pipe with $d_n \leqslant 63$ mm, grade K applies; for pipe with $d_n \geqslant 75$ mm, the maximum out-of roundness shall be specified by agreement.

6.3 Wall thicknesses and tolerances

6.3.1 Minimum wall thickness

The minimum wall thickness, e_{min}, shall be in accordance with Table 2. Small diameter pipes are characterized by wall thickness. Large diameter pipes are characterized by their standard dimension ratio (SDR).

The use of any SDR derived from the pipe series S given according to ISO 4065 and ISO 161-1 is permitted.

NOTE In order to minimize the possibility of damage to small-diameter gas pipes by external influences, the use of pipes having a wall thickness of not less than 3,0 mm — even if higher than the minimal SDR value — can be considered.

Table 2 — Minimum wall thickness

Dimensions in millimetres

Nominal outside diameter d_n	Minimum wall thickness e_{min}						
	SDR 7,4	SDR 9	SDR 11	SDR 13,6	SDR 17	SDR 21	SDR 26
16	2,2	—	—	—	—	—	—
20	2,8	2,3	—	—	—	—	—
25	3,5	2,8	2,3	—	—	—	—
32	4,4	3,6	2,9	2,4	—	—	—
40	5,5	4,5	3,7	3,0	2,4	2,0	—
50	6,9	5,6	4,6	3,7	3,0	2,4	2,0
63	8,6	7,1	5,8	4,7	3,8	3,0	2,5
75	10,3	8,4	6,8	5,6	4,5	3,6	2,9
90	12,3	10,1	8,2	6,7	5,4	4,3	3,9
110	15,1	12,3	10,0	8,1	6,6	5,3	4,2
125	17,1	14,0	11,4	9,2	7,4	6,0	4,8
140	19,2	15,7	12,7	10,3	8,3	6,7	5,4
160	21,9	17,9	14,6	11,8	9,5	7,7	6,2
180	24,6	20,1	16,4	13,3	10,7	8,6	6,9
200	27,4	22,4	18,2	14,7	11,9	9,6	7,7
225	30,8	25,2	20,5	16,6	13,4	10,8	8,6
250	34,2	27,9	22,7	18,4	14,9	12,0	9,6

6.3.2 Tolerances on wall thickness at any point

The tolerances on the wall thickness at any point shall be in accordance with ISO 11922-1:1997, Grade V. The maximum permissible variation between the nominal wall thickness, e_n, and the wall thickness at any point, e, shall be in accordance with Table 3.

Table 3 — Tolerances on wall thickness at any point

Dimensions in millimetres

Minimum wall thickness e_{min}		Permitted positive deviation	Minimum wall thickness e_{min}		Permitted positive deviation
>	⩽		>	⩽	
2,0	3,0	0,4	18,0	19,0	2,0
3,0	4,0	0,5	19,0	20,0	2,1
4,0	5,0	0,6	20,0	21,0	2,2
5,0	6,0	0,7	21,0	22,0	2,3
6,0	7,0	0,8	22,0	23,0	2,4
7,0	8,0	0,9	23,0	24,0	2,5
8,0	9,0	1,0	24,0	25,0	2,6
9,0	10,0	1,1	25,0	26,0	2,7
10,0	11,0	1,2	26,0	27,0	2,8
11,0	12,0	1,3	27,0	28,0	2,9
12,0	13,0	1,4	28,0	29,0	3,0
13,0	14,0	1,5	29,0	30,0	3,1
14,0	15,0	1,6	30,0	31,0	3,2
15,0	16,0	1,7	31,0	32,0	3,3
16,0	17,0	1,8	32,0	33,0	3,4
17,0	18,0	1,9	33,0	34,0	3,5
			34,0	35,0	3,6
			35,0	36,0	3,7

7 Mechanical characteristics

7.1 Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned for at least 16 h at 23 °C and 50 % relative humidity in accordance with ISO 291 before testing in accordance with Table 4.

7.2 Requirements

The test pieces shall be tested in accordance with Table 4. When tested using the test method and parameters specified therein, the pipe shall have mechanical characteristics conforming to the requirements of Table 4.

Table 4 — Mechanical characteristics

Characteristic	Requirement	Test parameters		Test method(s)
		Parameter	Value	
Hydrostatic strength at 20 °C for 1 000 h	No failure of any test piece during test period	End caps Orientation Conditioning period Type of test Test temperature Test period Circumferential (hoop) stress: PA 11 160 and PA 12 160 [a] PA 11 180 and PA 12 180 [a]	Type a) Free 6 h Water-in-water 20 °C 1 000 h 19,0 MPa 20,0 MPa	ISO 1167-1 ISO 1167-2
Hydrostatic strength at 80 °C for 165 h	No failure of any test piece during test period	End caps Orientation Conditioning period Type of test Test temperature Test period Circumferential (hoop) stress: PA 11 160 and PA 12 160 [a] PA 11 180 and PA 12 180 [a]	Type a) Free 6 h Water-in-water 80 °C 165 h 10,0 MPa 11,5 MPa	ISO 1167-1 ISO 1167-2
Elongation at break	$\geqslant$ 200 %	Test speed	25 mm/min	ISO 6259-1 ISO 6259-3
Melt volume rate (MVR) [b]	$< 25\ cm^3/10$ min or as recommended by the material supplier — whichever is the lower for PA 11 and PA 12 compounds	Temperature Load	235 °C 10 kg	ISO 1133
Resistance to slow crack growth for $e > 5$ mm (notch test)	No failure during the test period	Test temperature SDR Type of test Test period Test pressure: PA 11 160 and PA 12 160 [a] PA 11 180 and PA 12 180 [a]	80 °C 11 Water-in-water 500 h 18 bar [c] 20 bar [c]	ISO 13479
Resistance to rapid crack propagation (critical pressure, p_c) [d]	$p_c \geqslant$ 1,5 MOP with $p_c = 7{,}8\ p_{c,s4} + 6{,}8$ [e]	Test temperature	0 °C	ISO 13477

[a] For material classification and designation, see ISO 22621-1:2007, 5.4.

[b] It is essential that the water content of the sample be < 0,1 %, because PA resin is sensitive to hydrolyses. Therefore, the test sample shall be dried prior to testing at 80 °C in a dry air or vacuum dryer for 3 h, or as recommended by the PA resin producer.

[c] Test pressure levels for other SDR are given in Table 5.

[d] Testing is only required when the wall thickness of the pipe is greater than that of the pipe used in the RCP test to qualify the compound (see ISO 22621-1:2007, Table 2). For severe conditions (e.g. sub-zero temperatures), RCP testing is also recommended for establishing the critical pressure of the working temperature.

[e] Alternatively, the full-scale test (FST) method according to see ISO 22621-1:2007, Annex C may be used. The relation between the FST and the S4 test is defined by the formula $p_{C,FS} + p_{atm} = 7{,}8\ (p_{C,S4} + p_{atm})$. In this case, $p_C = p_{C,FS}$. In case of dispute, the FST shall be decisive.

Table 5 — Test pressure levels

SDR	Test pressure bar [b]	
	PA 11 160 and PA 12 160 [a]	PA 11 180 and PA 12 180 [a]
7,4	28,12	31,25
9	22,5	25
11	18,0	20
13,6	14,28	15,87
17	11,25	12,5
21	9,0	10
26	7,2	8

These pressure levels are calculated to give nominal pipe hydrostatic levels of either 9 MPa (in PA 11 160 and PA12 160 materials) [a] or 10 MPa (in PA 11 180 and PA 12 180 materials), [a] using the following equation:

$$p = \frac{20\sigma}{\mathrm{SDR} - 1}$$

where

σ is the hydrostatic stress, in megapascals;

SDR is the standard dimension ratio.

[a] For material classification and designation, see ISO 22621-1:2007, 5.4.

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

8 Physical characteristics

8.1 Conditioning

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at normal atmosphere 23/50 according to ISO 291 before testing.

8.2 Requirements

The test pieces shall be tested in accordance with Table 6. When tested using the test method and parameters specified therein, the pipe shall have physical characteristics conforming to the requirements of Table 6.

Table 6 — Physical characteristics

Characteristic	Requirement	Test parameters		Test method(s)
		Parameter	Value	
Viscosity number	⩾ 180 ml/g	Solvent	m-Cresol	ISO 307
Longitudinal reversion	⩽ 3 % The pipe shall retain its original appearance.	Heating fluid Test temperature Length of test piece Duration of exposure	Air 150 °C 200 mm According to ISO 2505	ISO 2505

9 Marking

All pipes shall be permanently and legibly marked with the minimum information specified in Table 7 so that the marking does not initiate cracks or other types of failure or weaken the pipe, and so that normal storage, weathering, handling, installation or use does not affect the legibility of the marking.

The length of coiled pipes may be indicated on the coil.

If printing is used, the colour of the printed information shall differ from the basic colour of the product. The frequency of the printing shall be at intervals not greater than 1 m.

The quality and size of the marking shall be so that it is easily legible without magnification.

Table 7 — Minimum information for marking

Information	Marking or symbol
Manufacturer or trademark	Name or symbol
Internal fluid	Gas
Dimensions	e.g. $d_n \times e_n$
SDR (for $d_n \geqslant 40$ mm)	e.g. SDR 17
Material and designation	e.g. PA11 160 [a]
Production period	Date, code
Reference to this part of ISO 22621	ISO 22621-2

[a] For material classification and designation, see ISO 22621-1:2007, 5.4