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**Plastics piping systems for non-pressure  
underground drainage and sewerage —  
Structured-wall piping systems  
of unplasticized poly(vinyl chloride)  
(PVC-U), polypropylene (PP) and  
polyethylene (PE) —**

**Part 2:  
Pipes and fittings with smooth external  
surface, Type A**

*Systèmes de canalisations en plastique pour les branchements  
et les collecteurs d'assainissement sans pression enterrés — Systèmes  
de canalisations à parois structurées en poly(chlorure de vinyle)  
non plastifié (PVC-U), polypropylène (PP) et polyéthylène (PE) —*

*Partie 2: Tubes et raccords avec une surface externe lisse, type A*



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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.

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 21138-2 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 1, *Plastics pipes and fittings for soil, waste and drainage (including land drainage)*.

ISO 21138 consists of the following parts, under the general title *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE)*:

- *Part 1: Material specifications and performance criteria for pipes, fittings and system*
- *Part 2: Pipes and fittings with smooth external surface, Type A*
- *Part 3: Pipes and fittings with non-smooth external surface, Type B*

## Introduction

ISO 21138 is the system standard covering the plastics piping systems for non-pressure underground drainage and sewerage, in particular thermoplastics structured-wall piping systems.

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# Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) —

## Part 2: Pipes and fittings with smooth external surface, Type A

### 1 Scope

This part of ISO 21138, together with ISO 21138-1, specifies the definitions and requirements for pipes with a smooth external surface (Type A), fittings and systems based on unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) structured-wall piping in the field of non-pressure systems for underground drainage and sewerage.

NOTE 1 These pipes, fittings and the system can be used for highway drainage and surface water.

This part of ISO 21138 specifically refers to PVC, PP and PE materials.

NOTE 2 Other thermoplastic materials can be added via an addendum.

This part of ISO 21138 specifies test methods and test parameters.

This part of ISO 21138 covers a range of pipe and fitting sizes, materials, pipe constructions and nominal ring stiffnesses, and gives recommendations concerning colours.

NOTE 3 It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

In conjunction with ISO 21138-1, it is applicable to PVC-U, PP and PE structured-wall pipes and fittings, to their joints and to joints with components of other plastics and non-plastics materials intended to be used for buried piping systems for the transport of drainage and sewage.

It is applicable to PVC-U, PP and PE structured-wall pipes and fittings with or without an integral socket with elastomeric ring seal joints as well as welded and fused joints.

NOTE 4 For dimensions larger than DN/OD 1200, or DN/ID 1200, this part of ISO 21138 can serve as a general guide regarding appearance, colour, physical and mechanical characteristics as well as performance requirements.

Test methods are not included in this document.

### 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 21138-2:2007(E)

ISO 178, *Plastics — Determination of flexural properties*

ISO 306:1994, *Plastics — Thermoplastic materials — Determination of Vicat softening temperature (VST)*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 580:2005, *Plastics piping and ducting systems — Injection-moulded thermoplastics fittings — Methods for visually assessing the effects of heating*

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 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test methods and parameters*

ISO 2507-1, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 1: General test method*

ISO 2507-2, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 2: Test conditions for unplasticized poly(vinyl chloride) (PVC-U) or chlorinated poly(vinyl chloride) (PVC-C) pipes and fittings and for high impact resistance poly(vinyl chloride) (PVC-Hi) pipes*

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

ISO 3127:1994, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

ISO 3451-1:1997, *Plastics — Determination of ash — Part 1: General methods*

ISO 4435:2003, *Plastics piping systems for non-pressure underground drainage and sewerage — Unplasticized poly(vinyl chloride) (PVC-U)*

ISO 8772:2006, *Plastics piping systems for non-pressure underground drainage and sewerage — Polyethylene (PE)*

ISO 8773:2006, *Plastics piping systems for non-pressure underground drainage and sewerage — Polypropylene (PP)*

ISO 9852, *Unplasticized poly(vinyl chloride) (PVC-U) pipes — Dichloromethane resistance at specified temperature (DCMT) — Test method*

ISO 9967, *Thermoplastics pipes — Determination of creep ratio*

ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

ISO 11173:1994, *Thermoplastics pipes — Determination of resistance to external blows — Staircase method*

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

ISO 21138-1, *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) — Part 1: Material specifications and performance criteria for pipes, fittings and the system*

ISO 21138-3, *Plastics piping systems for non-pressure underground drainage and sewerage — Structured-wall piping systems of unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) and polyethylene (PE) — Part 3: Pipes and fittings with a non-smooth external surface, Type B*

ISO 22088-3, *Plastics — Determination of resistance to environmental stress cracking (ESC) — Part 3: Bent strip method*

EN 922, *Plastics piping and ducting systems — Pipes and fittings of unplasticized poly(vinyl chloride) (PVC-U) — Specimen preparation for determination of the viscosity number and calculation of the K-value*

EN 1053, *Plastics piping systems — Thermoplastics piping systems for non-pressure applications — Test method for watertightness*

EN 1277:2003, *Plastics piping systems — Thermoplastics piping systems for buried non-pressure applications — Test methods for leaktightness of elastomeric sealing ring type joints*

EN 1437:2002, *Plastics piping systems — Piping systems for underground drainage and sewerage — Test method for resistance to combined temperature cycling and external loading*

EN 1446, *Plastics piping and ducting systems — Thermoplastics pipes — Determination of ring flexibility*

EN 1905, *Plastics piping systems — Unplasticized poly(vinyl chloride) (PVC-U) pipes, fittings and material — Method for assessment of the PVC content based on total chlorine content*

EN 1979, *Plastics piping and ducting systems — Thermoplastics spirally-formed structured-wall pipes — Determination of the tensile strength of a seam*

EN 10204:2004, *Metallic products — Types of inspection documents*

EN 12099, *Plastics piping systems — Polyethylene piping materials and components — Determination of volatile content*

EN 14741, *Thermoplastics piping and ducting systems — Joints for buried non-pressure applications — Test method for the long-term sealing performance of joints with elastomeric seals by estimating the sealing pressure*

EN 15344:—<sup>1)</sup>, *Plastics — Recycled plastics — Characterisation of polyethylene (PE) recyclates*

EN 15345:—<sup>1)</sup>, *Plastics — Recycled plastics — Characterisation of polypropylene (PP) recyclates*

EN 15346:—<sup>1)</sup>, *Plastics — Recycled plastics — Characterisation of poly(vinyl chloride) (PVC) recyclates*

### 3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the following terms, definitions, symbols and abbreviated terms apply.

#### 3.1 Terms and definitions

The terms and definitions given in ISO 21138-1 apply.

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1) To be published.

### 3.2 Symbols

$A$	length of engagement, or maximum pull-out whilst maintaining tightness
$C$	depth of sealing zone
$D_i$	socket inside diameter
$d_e$	outside diameter
$d_{em}$	mean outside diameter
$d_i$	inside diameter
$d_{im}$	mean inside diameter
$d_{sm,min}$	minimum mean inside diameter of a socket
$e$	wall thickness (at any point)
$e_c$	construction height
$e_2$	wall thickness of the socket
$e_3$	wall thickness of the groove
$e_4$	wall thickness of the inside layer (waterway wall thickness)
$e_5$	wall thickness of the inside layer under a hollow section
$L_1$	minimum length of spigot
$l$	effective length of a pipe

### 3.3 Abbreviated terms

$\text{CaCO}_3$	calcium carbonate
CT	close tolerance
DN	nominal size
DN/ID	nominal size related to inside diameter
DN/OD	nominal size related to outside diameter
ID	inside diameter
$\text{MgCO}_3$	magnesium carbonate
MFR	melt mass-flow rate
OD	outside diameter
OIT	oxidation induction time
PE	polyethylene

PP	polypropylene
PVC-U	unplasticized poly(vinyl chloride)
S	pipe series S
SDR	standard dimension ratio
SN	nominal ring stiffness
TIR	true impact rate
TPE	thermoplastic elastomer
VST	Vicat softening temperature

## 4 Material

### 4.1 General

The material shall be one of the following: unplasticized poly(vinyl chloride) (PVC-U), polypropylene (PP) or polyethylene (PE) to which are added those additives that are needed to facilitate the manufacture of components conforming to this part of ISO 21138, including the relevant annexes.

### 4.2 Unplasticized poly(vinyl chloride) (PVC-U)

#### 4.2.1 General

The raw material shall be PVC-U to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this ISO 21138 (see also Annex A).

NOTE Additional information of the characteristics of PVC-U material or components made thereof is given in ISO 21138-1:2007, Annex A.

#### 4.2.2 Pipe and fitting material characteristics

When tested in accordance with the test method specified in Table 1, using the indicated parameters, the material shall have characteristics conforming to the requirements given in Table 1.

**Table 1 — Material characteristics of PVC-U pipes and injection-moulded fittings**

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure  a, b, c	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Orientation	Free	ISO 1167-2
		Number of test pieces	3	
		Test temperature	60 °C	
		Circumferential stress		
		— pipe material	10 MPa	
		— fitting material	6,3 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
Test period	1 000 h			
<p><sup>a</sup> For extrusion compounds, this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.</p> <p><sup>b</sup> For injection-moulding compounds, this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.</p> <p><sup>c</sup> Not required for the intermediate layer of Type A1 pipes.</p>				

**4.2.3 Utilization of non-virgin materials**

For the utilization of non-virgin PVC-U materials, conditions and requirements are given in Annex B, and the PVC recyclates shall conform to the characterization specified in EN 15346.

NOTE Annex G gives a survey of the possible use of reprocessible and recyclable materials.

**4.3 Polypropylene (PP)**

**4.3.1 General**

The compound for pipes and fittings shall be PP base material to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this part of ISO 21138. See also Annex C.

NOTE Additional information on the characteristics of PP material or components made thereof is given in ISO 21138-1:2007 Annex A.

**4.3.2 Pipe and fitting material characteristics**

When tested in accordance with the test methods specified in Table 2, using the indicated parameters, the material shall have characteristics conforming to the requirements given in Table 2.

Table 2 — Material characteristics of PP pipes and injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 140 h <sup>a, b, d</sup>	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	4,2 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	140 h	
Resistance to internal pressure 1 000 h <sup>a, b, d</sup>	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	95 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	2,5 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	≤ 1,5 g/10 min	Temperature	230 °C	ISO 1133
		Loading mass	2,16 kg	Condition M
Thermal stability, OIT <sup>c</sup>	≥ 8 min	Temperature	200 °C	ISO 11357-6
<p><sup>a</sup> For extrusion compounds, this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.</p> <p><sup>b</sup> For injection-moulding compounds, this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.</p> <p><sup>c</sup> This requirement is only valid for pipes and fittings intended to be jointed in the field by fusing or welding.</p> <p><sup>d</sup> Not required for the intermediate layer of Type A1 pipes.</p>				

#### 4.3.3 Melt mass-flow rate classification

Materials for pipes and fittings intended for jointing in the field by fusion or welding shall be designated by the following MFR classes:

- Class A: MFR ≤ 0,3 g/10 min
- Class B: 0,3 g/10 min < MFR ≤ 0,6 g/10 min
- Class C: 0,6 g/10 min < MFR ≤ 0,9 g/10 min
- Class D: 0,9 g/10 min < MFR ≤ 1,5 g/10 min

In the case where a raw material, because of its MFR tolerance, arbitrarily falls in one of two adjacent classes, the manufacturer of the components may mark the MFR class on the product as follows:

- for an MFR value across the border between A and B, it is permitted to classify it as class A;
- for an MFR value across the border between B and C, it is permitted to classify it as class C;
- for an MFR value across the border between C and D, it is permitted to classify it as class D.

#### **4.3.4 Utilization of non-virgin materials**

For the utilization of non-virgin PP materials, conditions and requirements are given in Annex D, and the PP recyclates shall conform to the characterization specified in EN 15345.

NOTE Annex G gives a survey of the possible use of reprocessable and recyclable materials.

### **4.4 Polyethylene (PE)**

#### **4.4.1 General**

The base material shall be polyethylene (PE) to which are added those additives that are needed to facilitate the manufacture of components conforming to this part of ISO 21138. See also Annex E.

NOTE Additional information on the characteristics of PE material or components made thereof is given in ISO 21138-1:2007, Annex A.

#### **4.4.2 Material characteristics of pipes and injection-moulded fittings**

When tested in accordance with the test method specified in Table 3, using the indicated parameters, the material shall have characteristics conforming to the requirements given in Table 3.

Table 3 — Material characteristics of PE pipes and injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 165 h <sup>a, b, d</sup>	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	4,0 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	165 h	
Resistance to internal pressure 1 000 h <sup>a, b, d</sup>	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	ISO 1167-2
		Orientation	Free	
		Number of test pieces	3	
		Circumferential stress	2,8 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	≤ 1,6 g/10 min	Temperature	190 °C	ISO 1133
		Loading mass	5 kg	Condition T
Thermal stability, OIT <sup>c</sup>	≥ 20 min	Temperature	200 °C	ISO 11357-6
Reference density	≥ 930 kg/m <sup>3</sup>	In accordance with ISO 1183-1		ISO 1183-1
<p><sup>a</sup> This test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.</p> <p><sup>b</sup> For injection-moulding compounds, this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.</p> <p><sup>c</sup> This requirement is only valid for pipes and fittings intended to be jointed in the field by fusing or welding.</p> <p><sup>d</sup> Not required for the intermediate layer of Type A1 pipes.</p>				

#### 4.4.3 Material characteristics of rotational-moulded fittings

When tested in accordance with the test methods specified in Table 4, using the indicated parameters, the material shall have characteristics conforming to the requirements given in Table 4.

Table 4 — Material characteristics of PE rotational-moulded fittings

Characteristic	Requirements	Test parameters		Test
Resistance to internal pressure 165 h <sup>a</sup>	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Orientation	Free	
		Number of test pieces	3	ISO 1167-2
		Test temperature	60 °C	
		Circumferential stress	3,9 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	165 h	
Resistance to internal pressure 1 000 h <sup>a</sup>	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Orientation	Free	
		Number of test pieces	3	ISO 1167-2
		Test temperature	60 °C	
		Circumferential stress	3,2 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	3 g/10 min ≤ MFR ≤ 1,6 g/10 min	Temperature	190 °C	ISO 1133
		Loading mass	5 Kg	Condition T
Thermal stability OIT	≥ 10 min	Temperature	200 °C	ISO 11357-6
Reference density	≥ 925 kg/m <sup>3</sup>	Temperature	(23 ± 2) °C	ISO 1183-1

<sup>a</sup> This test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.

#### 4.4.4 Utilization of non-virgin materials

For the utilization of non-virgin PE materials, conditions and requirements are given in Annex F, and the PE recyclates shall conform to the characterization specified in EN 15344.

NOTE Annex G gives a survey of the possible use of reprocessible and recyclable materials.

## 5 Designation of wall construction and examples of typical jointing methods

NOTE The figures are schematic sketches only, to indicate the relevant dimensions. They do not necessarily represent the manufactured components.

### 5.1 Wall constructions designated as Type A

#### 5.1.1 Multilayer construction or hollow-wall construction with axial hollow sections, Type A1 constructions

A pipe or fitting with plain inside and outside surfaces and in which the outer and inner walls are connected by internal axial ribs or a foamed or non-foamed intermediate layer of thermoplastics shall be designated Type A1. Typical examples of Type A1 constructions are shown in Figure 1.

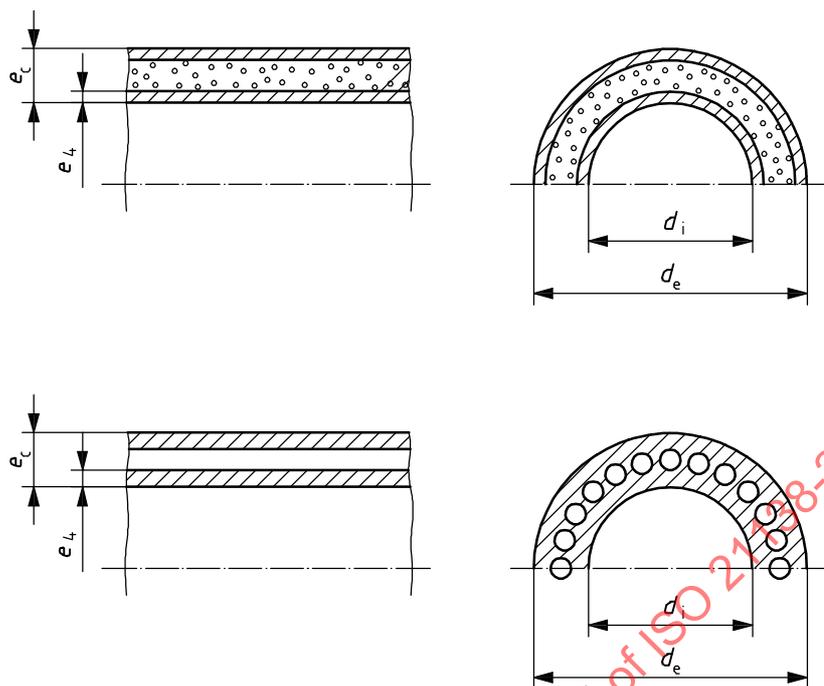


Figure 1 — Typical examples of wall construction Type A1

### 5.1.2 Hollow-wall construction with spirally or radially formed hollow sections, Type A2 constructions

A pipe or fitting with plain inside and outside surfaces and in which the outer and inner walls are connected by internal spirally or radially formed ribs shall be designated Type A2. A typical example of Type A2 constructions is shown in Figure 2.

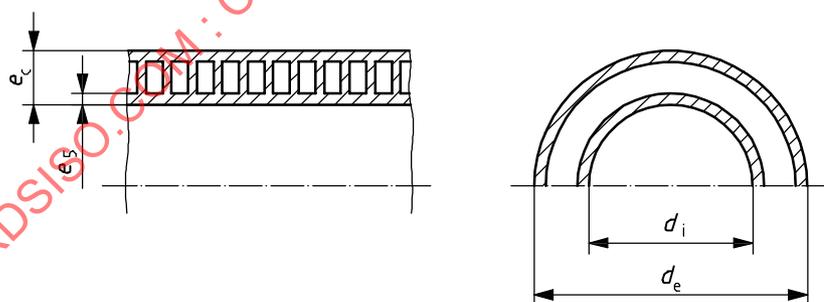


Figure 2 — Typical example of wall construction Type A2

### 5.1.3 Typical jointing methods for Type A structured-wall pipes

Relevant dimensions for typical joints of Type A pipes are shown in Figure 3. When factory-mounted sealing rings are used, the dimensions  $A$  and  $C$  may be defined relative to the effective sealing point.

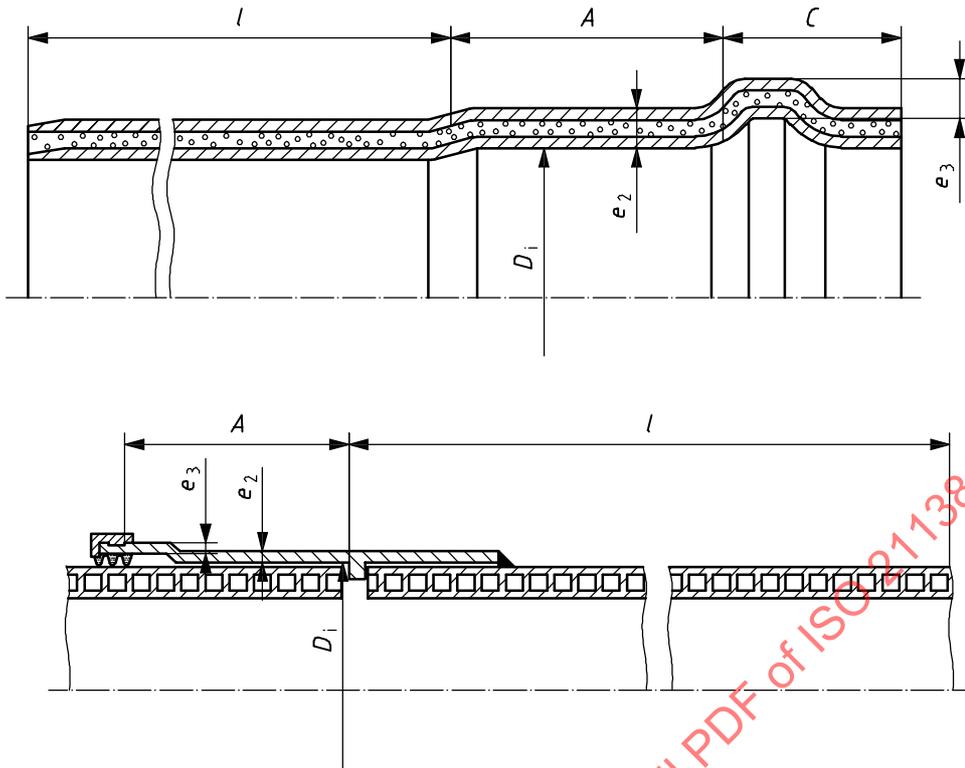


Figure 3 — Typical examples of joints for Type A constructions

## 5.2 Designation and design of joints

Pipes and fittings may be designed with spigot ends and sockets of another construction than the pipe or fitting body. Such constructions may be Type A1, Type A2 or Type B or solid plain. For definitions and specifications for Type B, see ISO 21138-3.

NOTE Joints with elastomeric sealing rings are designed either with the sealing ring positioned on the spigot or in the socket. See Figure 3.

## 6 General characteristics for pipes and fittings — Colour

Colour is specified in ISO 21138-1.

## 7 Geometrical characteristics

### 7.1 General

All dimensions shall be measured in accordance with ISO 3126.

### 7.2 Dimensions

#### 7.2.1 Designation

Pipes and fittings are sized either according to their outside diameter (DN/OD-series) and/or according to their inside diameter (DN/ID-series).

### 7.2.2 Lengths of pipe

The effective length of pipe,  $l$ , shall be not less than that specified by the manufacturer when measured as shown in Figure 3.

### 7.2.3 Diameters of Type A pipes and Type A spigots of pipes or fittings

The outside diameters and the tolerances of Type A pipes and plain spigots for OD series of pipes and fittings intended to have jointing dimensions conforming to ISO 4435, ISO 8772 or ISO 8773 shall conform to Table 5.

The nominal sizes and minimum mean inside diameters,  $d_{im,min}$  for DN/OD and DN/ID series are specified in Table 9. Other nominal sizes greater than DN/ID 100 and DN/OD 110 are permitted.

For DN/ODs and DN/IDs not specified in Table 9, the minimum inside diameter,  $d_{im,min}$  shall be linearly interpolated between the adjacent values specified in Table 9.

**Table 5 — Mean outside diameters and tolerances**

Dimensions in millimetres

Nominal size DN/OD	Mean outside diameter		
	$d_{em,min}$	Close tolerances (CT) $d_{em,max}$	Enlarged tolerances <sup>a</sup> $d_{em,max}$
110	110,0	110,3	111,0
125	125,0	125,3	126,2
160	160,0	160,4	161,5
200	200,0	200,5	201,8
250	250,0	250,5	252,3
315	315,0	315,6	317,9
400	400,0	400,7	403,6
500	500,0	500,9	504,5
630	630,0	631,1	635,7
800	800,0	801,3	807,2
1 000	1 000,0	1 001,6	1 009,0
1 200	1 200,0	1 202,0	1 210,0

<sup>a</sup> Enlarged tolerances are permitted for PP for DN/OD  $\geq$  200 and for DN/OD  $\geq$  110 for PE.

Other dimensions are permitted and shall be selected from ISO 161-1.

### 7.2.4 Diameters and jointing dimensions of sockets and spigots

Diameters and jointing dimensions of sockets and spigots shall conform to Table 6, Table 7 and Table 8 as appropriate.

**Table 6 — Diameters and lengths of elastomeric ring seal sockets and spigots of PVC-U pipes and fittings**

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter $d_n$	Socket			Spigot $L_{1,min}$
		$d_{sm,min}$	$A_{min}$	$C_{max}$	
110	110	110,4	32	26	60
125	125	125,4	35	26	67
160	160	160,6	42	32	81
200	200	200,6	50	40	99
250	250	250,8	55	70	125
315	315	316,0	62	70	132
400	400	401,2	70	80	150
500	500	501,5	80	80 <sup>a</sup>	160
630	630	631,9	93	95 <sup>a</sup>	188
800	800	802,4	110	110 <sup>a</sup>	220
1 000	1 000	1 003,0	130	140 <sup>a</sup>	270
1 200	1 200	—	150	—	—

<sup>a</sup> Higher values for  $C$  are allowed, provided the manufacturer states in his documentation the actual value of  $L_{1,min}$  required by the equation  $L_{1,min} = A_{min} + C$ .

Other dimensions are permitted and shall be selected from ISO 161-1.

**Table 7 — Diameters and lengths of elastomeric ring seal sockets and spigots of PP pipes and fittings**

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter $d_n$	Socket			Spigot $L_{1,min}$
		$d_{sm,min}$	$A_{min}$ <sup>a</sup>	$C_{max}$ <sup>b</sup>	
110	110	110,4	40	22	62
125	125	125,4	43	26	68
160	160	160,5	50	32	82
200	200	200,6	58	40	98
250	250	252,4	68	50	118
315	315	318,0	81	63	144
400	400	403,7	98	80	178
500	500	504,6	118	100	218
630	630	635,8	144	126	270
800	800	807,4	160	160	338
1 000	1 000	1 009	180	200	418
1 200	1 200	1 211	200	240	498

<sup>a</sup> The socket is designed for an effective length of pipe of 6 m.

<sup>b</sup> Higher values for  $C$  are allowed. In that case the manufacturer shall state in his documentation the actual value of  $L_{1,min}$  required by the equation  $L_{1,min} = A_{min} + C$ .

For pipes lengths longer than 6 m, the length of engagement,  $A$ , in the socket, expressed in millimetres, shall be calculated from the equation  $A = (0,2d_n + 3l)$ , where  $l$  is the effective pipe length, in metres.

**Table 8 — Diameters and lengths of elastomeric ring seal sockets and spigots of PE pipes and fittings**

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter $d_n$	Socket			Spigot $L_{1,min}$
		$d_{sm,min}$	$A_{min}^a$	$C_{max}$	
110	110	111,1	40	22	62
125	125	126,3	43	26	68
160	160	161,6	50	32	82
200	200	201,9	58	40	98
250	250	252,4	68	50	118
315	315	318,0	81	63	144
400	400	403,7	98	80	178
500	500	504,6	118	100	218
630	630	635,8	144	126	270
800	800	807,4	160	160	338
1 000	1 000	1 009	180	200	418
1 200	1 200	1 211	200	240	498

<sup>a</sup> The socket is designed for an effective length of pipe of 6 m.

For pipe lengths longer than 6 m, the length of engagement,  $A$ , in the socket, expressed in millimetres, shall be calculated from the equation  $A = (0,2d_n + 3l)$ , where  $l$  is the pipe length, in metres.

## 7.2.5 Wall thicknesses

### 7.2.5.1 Pipes — Type A1 or A2 construction

The wall thickness of the inside layer,  $e_4$  and/or  $e_5$ , as applicable, of pipes and spigots (see Figures 1 and 2) shall conform to Table 9.

The construction height,  $e_c$ , for pipes and spigots of pipes or fittings up to DN/OD 200 and up to 200 mm actual outside diameter of pipes of DN/ID series shall be at least as specified for  $e_{min}$  in:

- the SDR 41 series in ISO 4435:2003;
- the SDR 33 series in ISO 8773:2006;
- the SDR 26 series in ISO 8772:2006;

for PVC-U, PP and PE respectively.

In the case of DN/ID series pipes, the calculation shall be based on the actual outside diameter of the pipes.

For sizes not specified in those standards, the values shall be linearly interpolated between the adjacent dimensions.

In the case where a pipe or fitting is designed with a plain solid-wall spigot, the requirements in 7.2.5.2 apply.

**Table 9 — Nominal sizes, minimum mean inside diameters, thickness of inside layers and socket length**

Dimensions in millimetres

DN/OD	Diameters				Minimum wall thickness		
	DN/OD series		DN/ID series		A1		A2
	PVC-U <sup>a</sup>	PP/PE <sup>a, b</sup>	DN/ID	<sup>b</sup>	Multi-layer	Hollow wall	
	$d_{im,min}$	$d_{im,min}$		$d_{im,min}$	$e_{4,min}$	$e_{4,min}$	$e_{5,min}$
110	97	90	100	95	0,4	0,6	1,0
125	107	105			0,4	0,6	1,1
			125	120			1,2
160	135	134			0,5	0,8	1,2
			150	145			1,3
200	172	167			0,6	1,0	1,4
			200	195			1,5
250	216	209	225	220	0,7	1,1	1,7
			250	245			1,8
315	270	263			0,8	1,2	1,9
			300	294			2,0
400	340	335			1,0	1,5	2,3
			400	392			2,5
500	432	418			1,3	2,1	2,8
			500	490			3,0
630	540	527			1,6	2,6	3,3
			600	588			3,5
800	680	669			2,0	3,0	4,1
			800	785			4,5
1 000	864	837			2,5	3,5	5,0
			1 000	985			5,0
1 200	1 037	1 005			2,8	4,7	5,0
			1 200	1185			5,0

<sup>a</sup> The actual inside diameter of a pipe depends on the material, construction and stiffness. It may be considerably higher than the minimum specified in this table. For more information see the manufacturer's documentation.

<sup>b</sup> The minimum mean inside diameter,  $d_{im,min}$ , of a fitting shall be not less than 98 % of the specified minimum mean inside diameter of the pipe for which it is designed or it shall conform to this table, whichever is the greater value.

Other dimensions are permitted and shall be selected from ISO 161-1.

**7.2.5.2 Wall thickness of sockets and joint design requirements**

Sockets of Type A1 and A2 pipes and fittings shall have a minimum wall thickness,  $e_2$ , of  $0,9e$ .

When a socket contains a groove,  $e_3$  shall have a minimum value of  $0,75e$ .

Fittings or ancillaries based on Type B and adapted to Type A components shall conform with the minimum dimensions given in ISO 21138-3.

### 7.2.5.3 Fabricated fittings

The wall thickness of the body of fittings fabricated from pipes shall conform to the requirements of the corresponding pipe. Wall thickness reduction due to the process is permitted provided there be conformance with the performance requirements in Table 13.

The jointing design shall conform to 7.2.5.2.

The socket and spigot dimensions shall comply with 7.2.4.

### 7.2.5.4 Rotational-moulded fittings

The minimum wall thickness in the body of rotational-moulded fittings,  $e_{4,\min}$ , shall be  $1,25 \times$  the values specified for injection-moulded fittings, rounded to the next higher 0,1 mm.

If a rotational-moulded fitting has a solid plain spigot and/or socket, the minimum required wall-thicknesses  $e_2$ ,  $e_3$  and  $e_4$  as applicable shall be  $1,25 \times$  the values derived from 7.2.5.2.

## 7.3 Types of fitting

The type of fitting covered by this part of ISO 21138 is specified in ISO 21138-1.

## 8 Physical characteristics

### 8.1 Unplasticized poly(vinyl chloride) (PVC-U)

#### 8.1.1 Physical characteristics of PVC-U pipes

When tested in accordance with the test methods specified in Table 10, using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 10.

Table 10 — Physical characteristics of PVC-U pipes

Characteristic	Requirements	Test parameters		Test method
Vicat softening temperature (VST) <sup>a</sup>	VST ≥ 79 °C	In accordance with ISO 2507-1 and ISO 2507-2		ISO 2507-1 and ISO 2507-2
Resistance to dichloromethane <sup>b</sup>	No attack	Test temperature Immersion time Chamfering	15 °C 30 min No	ISO 9852
Longitudinal reversion	≤ 5 %  The pipe shall show no delaminations, cracks or bubbles <sup>d</sup>	Temperature Immersion time <sup>c</sup> for:	(150 ± 2) °C	ISO 2505 Method A, liquid
		<i>e</i> ≤ 8 mm <i>e</i> > 8 mm	15 min 30 min	
		Or		
		Temperature Immersion time <sup>c</sup> for:	(150 ± 2) °C	ISO 2505 Method B, air
		<i>e</i> ≤ 8 mm <i>e</i> > 8 mm	30 min 60 min	
<sup>a</sup> Not applicable to the foamed part of a pipe. If <i>e</i> <sub>4</sub> is less than 1,8 mm the test shall be carried out on a profile extruded from the material; indirect testing may be carried out using the pipe sample. <sup>b</sup> Only applicable to pipes with wall thickness <i>e</i> <sub>4</sub> > 3 mm. Not applicable to the foamed part of a pipe. Profiles for spirally wound pipes may be tested before winding. <sup>c</sup> For the wall thickness, <i>e</i> , the maximum measured wall thickness of the pipe shall be taken. <sup>d</sup> Bubbles in the foamed structure are exempt from this requirement.				

8.1.2 Physical characteristics of PVC-U fittings

When tested in accordance with the test methods specified in Table 11, using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in Table 11.

Table 11 — Physical characteristics of PVC-U injection-moulded fittings

Characteristic	Requirements	Test parameters		Test method
Vicat softening temperature (VST) <sup>a</sup>	VST ≥ 77 °C	In accordance with ISO 2507-1 and ISO 2507-2		ISO 2507-1 and ISO 2507-2
Effect of heating <sup>a</sup>	<sup>b</sup>	Test temperature Heating time	(150 ± 2) °C In accordance with ISO 580 <sup>c</sup>	ISO 580:2005 Method A, air
<sup>a</sup> Only applicable to injection-moulded fittings and injection-moulded components for fabricated fittings. <sup>b</sup> <ol style="list-style-type: none"> <li>1) Within a radius of 15 × the wall thickness around the injection point(s), the depth of cracks, delamination or blisters shall not exceed 50 % of the wall thickness at that point.</li> <li>2) Within a distance of 10 × the wall thickness from the diaphragm zone, the depth of cracks, delamination or blisters shall not exceed 50 % of the wall thickness at that point.</li> <li>3) Within a distance of 10 × the wall thickness from the ring gate, the length of cracks running through the overall thickness of the wall shall not exceed 50 % of the wall thickness at that point.</li> <li>4) The weld line shall not have opened more than 50 % of the wall thickness at that line.</li> <li>5) In all other parts of the surface, the depth of cracks and delaminations shall not exceed 30 % of the wall thickness at that point. Blisters shall not exceed a length of 10 × the wall thickness.</li> </ol> <sup>c</sup> For the wall thickness, <i>e</i> , the maximum measured wall thickness of the fitting excluding <i>e</i> <sub>c</sub> shall be taken.				

## 8.2 Polypropylene (PP)

### 8.2.1 Physical characteristics of PP pipes

When tested in accordance with the test methods specified in Table 12, using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 12.

**Table 12 — Physical characteristics of PP pipes**

Characteristic	Requirements	Test parameters		Test method
Longitudinal reversion	$\leq 2\%$ The pipe shall show no delamination, cracks or bubbles <sup>b</sup>	Temperature	(150 ± 2) °C	ISO 2505, Method A, liquid
		Immersion time <sup>a</sup> for:		
		$e \leq 8$ mm $e > 8$ mm	15 min 30 min	
OR				
		Temperature	(150 ± 2) °C	ISO 2505, Method B, air
		Immersion time <sup>a</sup> for:		
		$e \leq 8$ mm $e > 8$ mm	30 min 60 min	
<sup>a</sup> For the wall thickness, $e$ , the maximum measured wall thickness of the pipe shall be taken.				
<sup>b</sup> Bubbles in the foamed structure are exempt from this requirement.				

### 8.2.2 Physical characteristics of PP fittings

When tested in accordance with the test method specified in Table 13, using the indicated parameters, the fittings shall have physical characteristics conforming to the requirements given in Table 13.

**Table 13 — Physical characteristics of PP injection-moulded components**

Characteristic	Requirements	Test parameters		Test method
Effect of heating <sup>a</sup>	<sup>b</sup>	Test temperature	(150 ± 2) °C	ISO 580, air
		Heating time <sup>c</sup> for:		
		$e \leq 3$ mm $3 \text{ mm} < e \leq 10$ mm $10 \text{ mm} < e \leq 20$ mm	15 min 30 min 60 min	
<sup>a</sup> Only applicable to injection-moulded fittings and injection-moulded components for fabricated fittings.				
<sup>b</sup> The depth of cracks, delamination or blisters shall not be more than 20 % of the wall thickness around the injection point(s). No part of the weld line shall open to a depth of more than 20 % of the wall thickness.				
<sup>c</sup> For the wall thickness, $e$ , the maximum measured wall thickness of the fitting excluding $e_c$ shall be taken.				

## 8.3 Polyethylene (PE)

### 8.3.1 Physical characteristics of PE pipes

When tested in accordance with the test methods specified in Table 14, using the indicated parameters, the pipe shall have physical characteristics conforming to the requirements given in Table 14.

Table 14 — Physical characteristics of PE pipes

Characteristic	Requirements	Test parameters		Test method
Longitudinal reversion	$\leq 3 \%$ The pipe shall show no delaminations, cracks or bubbles <sup>b</sup>	Temperature	(110 ± 2) °C	ISO 2505, Method A, liquid
		Immersion time <sup>a</sup> for:		
		$e \leq 8 \text{ mm}$ $e > 8 \text{ mm}$	15 min 30 min	
OR				
		Temperature	(110 ± 2) °C	ISO 2505, Method B, air
		Immersion time <sup>a</sup> for:		
		$e \leq 8 \text{ mm}$ $e > 8 \text{ mm}$	30 min 60 min	
<sup>a</sup> For the wall thickness, $e$ , the maximum measured wall thickness of the pipe shall be taken. <sup>b</sup> Bubbles in the foamed structure are exempt from this requirement.				

8.3.2 Physical characteristics of PE fittings

When tested in accordance with the test method specified in Table 15, using the indicated parameters, the fitting shall have physical characteristics conforming to the requirements given in Table 15.

Table 15 — Physical characteristics of PE injection-moulded components

Characteristic	Requirements	Test parameters		Test method
Effect of heating <sup>a</sup>	<sup>b</sup>	Test temperature	(110 ± 2) °C	ISO 580:2005 Method A, air
		Heating time	In accordance with ISO 580 <sup>c</sup>	
<sup>a</sup> Only applicable to injection-moulded fittings and injection-moulded components for fabricated fittings. <sup>b</sup> The depth of cracks, delamination or blisters shall be not more than 20 % of the wall thickness around the injection point(s). No part of the weld line shall open to a depth of more than 20 % of the wall thickness. <sup>c</sup> For the wall thickness, $e$ , the maximum measured wall thickness of the fitting excluding $e_c$ shall be taken.				

9 Mechanical characteristics

9.1 Mechanical characteristics of pipes

9.1.1 General

When tested in accordance with the test methods specified in Table 16, using the indicated parameters, the pipe shall have mechanical characteristics conforming to the requirements given in Table 16.

The pipes shall be designated in one of the following nominal ring stiffness classes (SN):

- DN ≤ 500: SN 4, SN 8 or SN 16;
- DN > 500: SN 2, SN 4, SN 8 or SN 16.

For DN ≥ 500 the manufacturer's guaranteed minimum stiffness, between the SN values, of a component may be used for calculation purposes only. Such pipes shall be classified and marked as the next lower stiffness class.

Table 16 — Mechanical characteristics of pipes

Characteristic	Requirements	Test parameters		Test method
Ring stiffness	$\geq$ relevant SN	In accordance with ISO 9969		ISO 9969
Impact strength	TIR $\leq$ 10 %	Test temperature	(0 $\pm$ 1) °C	ISO 3127:1994
		Conditioning medium	Water or air	
		Type of striker	d90	
		Mass of striker for <sup>a</sup>		
		$d_{im,max} \leq 100$ mm	0,5 kg	
		100 mm < $d_{im,max} \leq 125$ mm	0,8 kg	
		125 mm < $d_{im,max} \leq 160$ mm	1,0 kg	
		160 mm < $d_{im,max} \leq 200$ mm	1,6 kg	
		200 mm < $d_{im,max} \leq 250$ mm	2,0 kg	
		250 mm < $d_{im,max} \leq 315$ mm	2,5 kg	
		315 mm < $d_{im,max}$	3,2 kg	
		Fall height of striker for <sup>a</sup>		
		$d_{em,min} \leq 110$ mm	1 600 mm	
		$d_{em,min} > 110$ mm	2 000 mm	
Ring flexibility	In accordance with 9.1.2 at 30 % of $d_{em}$	Deflection	30 %	EN 1446
		Length of test piece	Shall incorporate at least 5 ribs/spirals <sup>b</sup>	
		Position of test piece	Mould split line, when applicable, at 0°, 45° and 90° from the upper plate	
Creep ratio	PVC-U: $\leq 2,5$ at 2 year extrapolation PP and PE: $\leq 4$ at 2 year extrapolation	In accordance with ISO 9967		ISO 9967
Tensile strength of seam <sup>b</sup>	In accordance with 9.1.3	Rate of movement	15 mm/min	EN 1979
<sup>a</sup> Refer to the specified $d_{em,min}$ . <sup>b</sup> Only applicable to spirally formed pipes.				

### 9.1.2 Ring flexibility

When tested in accordance with the test method described in Table 16, using the indicated parameters, and visually inspected without magnification, a) and b) shall be satisfied during the test:

- a) there shall be no decrease of the measured force;
- b) there shall be no cracking in any part of the wall structure.

Also, c) to e) shall be satisfied after the test:

- c) there shall be no wall delamination except possible delamination between the outside and inside wall of double-wall pipes occurring in the reduced welding zone in the ends of the test piece; processes aiding the profile of a material other than the pipe material, see Figure 1, are not subject to this requirement;
- d) there shall be no other types of rupture in the test piece;
- e) permanent buckling in any part of the structure of the pipe wall including depressions and craters shall not occur in any direction.

**9.1.3 Tensile strength of seams (Type A2)**

When tested in accordance with Table 16, the minimum required tensile strength of the seam shall conform to Table 17.

**Table 17 — Minimum tensile strength of seam**

Nominal size DN/ID or DN/OD	Minimum tensile force N
DN ≤ 375	380
400 ≤ DN ≤ 560	510
600 ≤ DN ≤ 710	760
DN ≥ 800	1 020

**9.1.4 Additional requirements**

Pipes intended to be used in areas where installation is carried out at a temperature less than -10 °C shall conform to the requirements of an impact test (staircase method) as specified in Table 18.

**Table 18 — Low temperature installation performance test**

Characteristic	Requirements	Test parameters		Test method
Impact resistance (Staircase method )	H50 ≥ 1 000 mm No break below 500 mm	Test and conditioning temperature	(-10 ± 1) °C	ISO 11173:1994
		Type of striker	d90	
		Fall mass for a:		
		$d_{em,min} \leq 110$ mm	4,0 kg	
		$110 \text{ mm} < d_{em,min} \leq 125$ mm	5,0 kg	
		$125 \text{ mm} < d_{em,min} \leq 160$ mm	6,25 kg	
		$160 \text{ mm} < d_{em,min} \leq 200$ mm	8,0 kg	
$200 \text{ mm} < d_{em,min} \leq 225$ mm	10,0 kg			
	$225 \text{ mm} < d_{em,min}$	12,5 kg		

<sup>a</sup> Refer to the specified  $d_{em,min}$ .

## 9.2 Mechanical characteristics of fittings

The mechanical characteristics of fittings shall conform to the requirements given in ISO 4435, ISO 8772 and ISO 8773 as relevant.

The fittings shall be designated in one of the following nominal stiffness classes (SN):

- DN  $\leq$  500: SN 4, SN 8 or SN 16;
- DN  $>$  500: SN 2, SN 4, SN 8 or SN 16.

NOTE For DN  $\geq$  500 the manufacturer's guaranteed minimum stiffness, between the SN nominal values of a component, can be used for calculation purposes.

## 10 Performance requirements

When tested in accordance with the test methods specified in Table 19, using the indicated parameters, the joints and the system shall have characteristics conforming to the requirements given in Table 19.

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Table 19 — Performance requirements

Characteristic	Requirements	Test parameters		Test method
Tightness of elastomeric ring seal joint		Temperature	(23 ± 2) °C	EN 1277:2003, Condition B
		Spigot deflection	10 %	
		Socket deflection	5 %	
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	≤ -27 kPa (-0,27 bar)	Air pressure	-30 kPa (-0,3 bar)	
Tightness of elastomeric ring seal joint		Temperature	(23 ± 2) °C	EN 1277:2003, Condition C
		Joint deflection for:		
		$d_e \leq 315$ mm	2°	
		$315 \text{ mm} < d_e \leq 630$ mm	1,5°	
	$d_e > 630$ mm	1°		
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	≤ -27 kPa (-0,27 bar)	Air pressure	-30 kPa (-0,3 bar)	
Resistance to combined temperature cycling and external loading <sup>b</sup>	<sup>a</sup>	For $d_{im} \leq 160$ mm: in accordance with EN 1437:2002, Method A		EN 1437:2002 Method A, hot and cold water
		For $d_{im} > 160$ mm: in accordance with EN 1437:2002, Method B		EN 1437:2002 Method B, hot water
Long-term performance of TPE seals	Tube pressure, extrapolated to 100 years: ≥ 150 kPa (1,5 bar)	Test temperature	(23 ± 2) °C	EN 14741
Watertightness <sup>c</sup>	No leakage	Water pressure	50 kPa (0,5 bar)	EN 1053
		Duration	1 min	
Tensile test of welded or fused joints	No break in the joint	Minimum tensile force	In accordance with Table 15	EN 1979 <sup>d</sup>

<sup>a</sup> The following requirements apply:

- vertical deformation: ≤ 9 %;
- deviation from surface evenness in bottom: ≤ 3 mm;
- radius of bottom: ≥ 80 % of original;
- opening of weld line: ≤ 20 % of wall thickness;
- tightness at 35 kPa (0,35 bar)/15 min: no leakage allowed.

<sup>b</sup> Only for components in accordance with this part of ISO 21138 at DN/OD ≤ 335 and DN/ID ≤ 300.

<sup>c</sup> Only for fabricated fittings made from more than one piece. A sealing ring retaining component is not considered as a piece.

<sup>d</sup> This test is applicable for all pipe and fitting constructions when jointed by fusion or welding. The test pieces shall be cut longitudinally in the fusion area. The length of the test piece shall include the joint plus a length at each end sufficient to ensure a proper grip in the tensile testing machine.

## 11 Marking

### 11.1 General

Marking elements shall be labelled or printed or formed directly on the pipe or the fitting, in such a way that after storage, weathering, handling and installation, legibility is maintained.

Marking shall not initiate cracks or other types of defect that adversely influence the performance of the pipe or the fitting.

### 11.2 Minimum required marking

#### 11.2.1 Pipes

Pipes shall be marked at intervals of maximum 2 m and at least once per pipe.

The minimum required marking of pipes shall conform to Table 20.

**Table 20 — Minimum required marking of pipes**

Information	Marking or symbols
Number of this document	ISO 21138-2
Diameter series, nominal size/actual guaranteed min. inside diameter <sup>a</sup> for:	
DN/OD series	DN/OD 200/178
DN/ID series	DN/ID 180/178
Manufacturer's name and/or trade mark	XXX
Stiffness class	e.g. SN 8
Material	Either PVC-U, PVC <sup>b</sup> , PP or PE
MFR class <sup>c</sup>	e.g. MFR-B
Manufacturer's information	d
Low temperature installation performance	❄ (ice crystal) <sup>e</sup>
Close tolerance class	CT <sup>f</sup>
<sup>a</sup> The marking of the guaranteed minimum mean inside diameter is voluntary, but if marked it shall be as shown. <sup>b</sup> PVC-U is preferred to PVC. <sup>c</sup> Only applicable for PP pipes intended to be jointed by butt fusion in the field. <sup>d</sup> Shall be given in clear figures or in a code providing traceability to the following details: — the production period year and month; — the production site if the manufacturer is producing in different sites, nationally and/or internationally. <sup>e</sup> This marking is only applicable to pipes which by testing have proved to conform to 9.1.4. <sup>f</sup> Only applicable for PP and PE pipes with spigots as specified in ISO 8772 or ISO 8773.	

11.2.2 Fittings

The minimum required marking of fittings shall conform to Table 21.

Table 21 — Minimum required marking of fittings

Information	Marking or symbols
Number of this document	ISO 21138-2
Diameter series, nominal size/actual guaranteed minimum inside diameter <sup>a</sup> for:	
DN/OD series, interchangeable <sup>b</sup>	DN/OD 200/178 <sup>c</sup>
DN/OD series, not interchangeable <sup>b</sup>	DN/OD 200/178 <sup>c</sup>
DN/ID series	DN/ID 200/198 <sup>c</sup>
Manufacturer's name and/or trade mark	XXX
Nominal angle	e.g. 45°
Stiffness class	e.g. SN 8
Material	Either PVC-U, PVC <sup>d</sup> , PP or PE
Manufacturer's information	e
Close tolerance class	CT <sup>f</sup>
<p><sup>a</sup> The marking of the guaranteed minimum mean inside diameter is voluntary, but if marked it shall be as shown.</p> <p><sup>b</sup> In this case interchangeability means use with pipes and/or fittings in accordance with ISO 4435, ISO 8772 or ISO 8773.</p> <p><sup>c</sup> If a component is designed for both DN/OD and DN/ID series, one of them may be marked on a label.</p> <p><sup>d</sup> PVC-U is preferred to PVC.</p> <p><sup>e</sup> Shall be given in clear figures or in a code providing traceability to the following details:</p> <ul style="list-style-type: none"> <li>— the production period year and month;</li> <li>— the production site if the manufacturer is producing in different sites, nationally and/or internationally.</li> </ul> <p><sup>f</sup> Only applicable for PP and PE fittings with spigots as specified in ISO 8772 or ISO 8773.</p>	

## Annex A (normative)

### Virgin PVC-U material

The virgin material shall be PVC-U to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this part of ISO 21138.

When calculated on the basis of a known formulation or, in case of dispute/unknown formulation, determined in accordance with EN 1905, the PVC-U content shall conform, as applicable, to item a) or item b) as follows.

- a) The content of PVC-U shall be at least 80 % in mass fraction for pipes and 85 % in mass fraction for injection-moulded fittings.
- b) A further reduction of the PVC-U content (for pipes only) is permitted provided the PVC-U is substituted by  $\text{CaCO}_3$  conforming to item c).

The content of PVC-U shall be as follows:

- specified intermediate layer of Type A1 pipes:  $\geq 60$  % in mass fraction;
  - other layers:  $\geq 75$  % in mass fraction.
- c)  $\text{CaCO}_3$  can be used with or without coating as follows:
    - The composition of the  $\text{CaCO}_3$ , before coating if any, shall conform to the following:
      - content of  $\text{CaCO}_3 \geq 96$  % in mass fraction;
      - content of  $\text{MgCO}_3 \leq 4$  % in mass fraction;
      - content of  $\text{CaCO}_3$  and  $\text{MgCO}_3$  in total  $\geq 98$  % in mass fraction.
    - The physical properties of the material shall conform to the following:
      - mean particle size  $D_{50} \leq 2,5 \mu\text{m}$ ;
      - top cut  $D_{98} \leq 20 \mu\text{m}$ .

## Annex B (normative)

### Utilization of non-virgin PVC-U material

#### B.1 Reprocessable and recyclable material from pipes and fittings

NOTE For the purpose of this Annex the term “pipes” means extruded pipes and any parts of a fabricated fitting which is made from an extruded pipe. The term “fitting” means injection-moulded fittings and injection-moulded parts of a fabricated fitting.

The use of clean own reprocessable material from components in conformity with this part of ISO 21138 for the production of pipes and fittings is permitted without limitations. If fitting material is used for the production of pipes it shall be considered as recyclable material.

#### B.2 External reprocessable and recyclable materials with agreed specification

##### B.2.1 Material from PVC-U pipes and fittings

External reprocessable and recyclable material with an agreed specification from PVC-U pipes and fittings that are available in relevant quantities and intervals of time shall be permitted to be used alone or added to virgin or own reprocessable material or a mixture of those two materials for the production of pipes, provided that all the following conditions are met.

- a) A specification for each material shall be agreed between the supplier of external reprocessable or recyclable material, the pipe manufacturer and, if applicable, the certification body. It shall at least cover the characteristics in accordance with EN 15346 given in Table B.1.
- b) When determined in accordance with the test methods given in Table B.1, the actual values for these characteristics shall conform to the agreed value, and the permitted deviations shall conform to those given in Table B.1.

The quality system of the supplier of external reprocessable or recyclable material should conform to ISO 9002. For the purposes of this subclause, the manufacturer is responsible for claiming and ensuring that the quality plan conforms to or is not less stringent than the relevant requirements of ISO 9001. It is not essential for the manufacturer to be approved and registered for operation in accordance with ISO 9001.

- c) Each delivery shall be covered by a certificate according to 3.1 of EN 10204:2004 showing conformity to the agreed specification.
- d) Where a certificate of conformity is not provided with external reprocessable and recyclable material, the manufacturer shall conduct verification testing on all material to confirm it conforms to the requirements.
- e) The maximum quantity of external reprocessable and/or recyclable material that is intended to be added shall be specified by the pipe manufacturer.
- f) The quantity of external reprocessable and/or recyclable material that is actually added in each production series shall be recorded by the pipe manufacturer.
- g) The PVC-U content of the end product shall conform to the requirements specified in Annex A.
- h) Type testing shall be carried out on the end product with the maximum specified amount and with each form of external reprocessable or recyclable material with an agreed specification. Approved results shall be taken as proving conformity also of components containing lower levels of external or recyclable material.

**Table B.1 — Specification of characteristics to be covered by the agreement and maximum permitted deviations for these characteristics**

Characteristic	Test method	Maximum permitted deviations
PVC-U content <sup>a</sup>	EN 1905	± 4 % absolute in mass fraction
K-value <sup>a</sup>	EN 922	± 3 units
Density <sup>a</sup>	ISO 1183-1	± 20 kg/m <sup>3</sup>
Vicat softening temperature <sup>a</sup>	ISO 2507-1 and ISO 2507-2 or ISO 306:1994, Method B	± 2 °C
Particle size and distribution <sup>b, c</sup>	Requirements shall be agreed and stated in the specification. Test methods in accordance with Annexes D <sup>d</sup> and E <sup>e</sup> of EN 15346:—.	
Type of stabilizer <sup>a, b</sup>	Requirements and test method shall be agreed and stated in the specification.	
Impurities <sup>b</sup>	Based on the source of material and the recycling process the requirements shall be agreed and stated in the specification. Test method in accordance with Annex C of EN 15346:—.	
<sup>a</sup> If the source of the material is pipes and fittings produced under a national or European quality mark, it is not required to test those material characteristics if the requirement covered by the quality mark conforms to the requirement given in this table. <sup>b</sup> The relevant requirements depend on the recycling process and on the end product. <sup>c</sup> The particle size shall not be greater than 50 % of the minimum wall thickness of the end product. <sup>d</sup> Only applicable for micronized recycled PVC compounds. <sup>e</sup> Only applicable for recycled PVC crushes.		

### B.2.2 Material from PVC-U products other than pipes and fittings

External reprocessable and recyclable materials with an agreed specification from PVC-U products, which are available in relevant quantities and intervals of time, shall be permitted to be used up to 100 % by mass or added to virgin or own reprocessable materials or a mixture of those two materials for the specified intermediate layer of Type A1 pipes provided that all the following conditions are met:

- the material shall conform to all the conditions given in a) to f) of B.2.1 and to all of the additional specifications given in Table B.2;
- the material shall be clean and dry;
- the quantity of external reprocessable and recyclable material that is actually added in each production series shall be recorded by the pipe manufacturer;
- the pipe manufacturer shall test the material for impurities before using the material.

**Table B.2 — Specifications for external reprocessable and recyclable material from PVC-U products other than pipes and fittings**

Characteristic	Requirements	Test method
PVC-U content	≥ 80 % by mass	EN 1905
K-value	56 ≤ K-value ≤ 70	EN 922
Density	1 390 kg/m <sup>3</sup> ≤ density ≤ 1 500 kg/m <sup>3</sup>	ISO 1183-1
Vicat softening temperature (VST)	≥ 62 °C	ISO 2507-1 and ISO 2507-2 or ISO 306:1994 Method B
Impurities	≤ 1 500 mg/kg for particle size ≤ 1 000 μm ≤ 1 500 mg/kg for 1 000 μm < particle size < 1 400 μm	<sup>a</sup>
Particle size	> 1 000 μm: maximum 15 % in mass fraction < 1 400 μm: 100 % in mass fraction	Test methods in accordance with Annexes D and E of EN 15346:—
Source of the material	PVC-U products	
<sup>a</sup> Based on the source of material and the recycling process, the requirements shall be agreed and stated in the specification. Test method in accordance with Annex C of EN 15346:—.		
NOTE Attention is drawn to possible national regulations regarding heavy metals, e.g. cadmium.		

### B.3 External reprocessable and recyclable materials not covered by an agreed specification

#### B.3.1 Material from PVC-U pipes and fittings

External reprocessable and recyclable materials not covered by an agreed specification from PVC-U pipes and fittings, which are available in relevant quantities and intervals of time, shall be permitted to be used alone or added to virgin or own reprocessable material or a mixture of those two materials for the production of pipes provided that all of the following conditions are met:

- a) when such materials are used, the production shall be considered as at least one batch and shall be tested accordingly;
- b) the materials shall be clean and dry;
- c) for specified intermediate layers of a pipe of Type A1, up to 100 % by mass of external reprocessable or recyclable material is permitted to be used;
- d) in other cases, the maximum permitted amount of reprocessable and recyclable material shall depend on the difference in K-value of the virgin material and the reprocessable and recyclable material as follows:
  - if the difference in K-value, when determined in accordance with EN 922, is equal to or less than four units, then up to 10 % in mass fraction may be added;
  - if the difference in K-value is greater than 4 units or not determined, then up to 5 % in mass fraction may be added;
- e) the quantity of external reprocessable and recyclable materials that is actually added in each production series shall be recorded by the pipe manufacturer.

#### B.3.2 Material from PVC-U products other than pipes and fittings

External reprocessable and/or recyclable material not covered by an agreed specification from PVC-U products other than pipes and fittings shall not be used for the production of pipes and fittings conforming to this part of ISO 21138.

## Annex C (normative)

### Virgin PP material

The virgin material shall be PP to which are added those additives that are needed to facilitate the manufacture of components conforming to the requirements of this part of ISO 21138. Coated calcium carbonate ( $\text{CaCO}_3$ ) conforming to c), or talcum conforming to d), may be added as mineral modifiers under the following conditions.

When calculated on the basis of a known formulation or, in case of dispute/unknown formulation, determined in accordance with ISO 3451-1, the PP content shall conform as applicable to item a) or item b) as follows.

- a) For outside and single layers of Type A1 pipes, the content of PP shall be at least 75 % in mass fraction for pipes and 80 % in mass fraction for injection-moulded fittings.
- b) For a specified intermediate layer of Type A1 pipes, the PP content shall be at least 60 % in mass fraction.

c) Specification for  $\text{CaCO}_3$ :

- the composition of the  $\text{CaCO}_3$ , before coating, shall conform to the following:

- content of  $\text{CaCO}_3 \geq 96$  % in mass fraction;
- content of  $\text{MgCO}_3 \leq 4$  % in mass fraction;
- content of  $\text{CaCO}_3$  and  $\text{MgCO}_3$  in total  $\geq 98$  % in mass fraction;

- the physical properties of the  $\text{CaCO}_3$  shall conform to the following:

- mean particle size,  $D_{50} \leq 2,5$   $\mu\text{m}$ ;
- top cut,  $D_{98} \leq 20$   $\mu\text{m}$ .

d) Specification for talc:

The content of magnesium silicate,  $\text{Mg}_3\text{Si}_4\text{O}_{10}(\text{OH})_2$  shall be at least 97 % in mass fraction;

- the physical properties of the talc shall conform to the following:

- mean particle size,  $D_{50} \leq 7$   $\mu\text{m}$ ;
- top cut,  $D_{98} \leq 30$   $\mu\text{m}$ .

## Annex D (normative)

### Utilization of non-virgin PP material

#### D.1 Reprocessable and recyclable material from pipes and fittings

NOTE For the purpose of this annex the term “pipes” means extruded pipes and any parts of a fabricated fitting which is made from an extruded pipe. The term “fitting” means injection-moulded fittings and injection-moulded parts of a fabricated fitting.

The use of clean own reprocessable material of components conforming to this part of ISO 21138 for the production of pipes and fittings is permitted without limitations.

#### D.2 External reprocessable and recyclable materials with an agreed specification

##### D.2.1 Material from PP pipes and fittings

External reprocessable and recyclable materials with an agreed specification from PP pipes and fittings that are available in relevant quantities and intervals of time shall be permitted to be used alone or added to virgin or own reprocessable material or a mixture of those two materials for the production of pipes (and fittings, if relevant) provided all of the following conditions are met.

- a) A specification for each material shall be agreed upon between the supplier of external reprocessable or recyclable material, the pipe manufacturer and, if applicable, the certification body. It shall at least cover the characteristics in accordance with EN 15345 given in Table D.1.
- b) When determined in accordance with the test methods given in Table D.1, the actual values for these characteristics shall conform to the agreed value and the permitted deviations shall conform to those given in Table D.1.

The quality system of the supplier of external reprocessable or recyclable material should conform to ISO 9002. For the purposes of this subclause, the manufacturer is responsible for claiming and ensuring that the quality plan conforms to or is no less stringent than the relevant requirements of ISO 9001. It is not essential for the manufacturer to be approved and registered for operation in accordance with ISO 9001.

- c) Each delivery shall be covered by a certificate according to 3.1 of EN 10204:2004, showing conformity to the agreed specification.
- d) Where a certificate of conformity is not provided with external reprocessable and recyclable material, the manufacturer shall conduct verification testing on all material to confirm it conforms to the requirements.
- e) The maximum quantity of external reprocessable and/or recyclable material that is intended to be added shall be specified by the manufacturer.
- f) The quantity of external reprocessable and/or recyclable material that is actually added in each production series shall be recorded by the manufacturer.
- g) The material of the end product shall conform to the requirements specified in 4.3 and Annex C except as per D.2.1 h).
- h) The material shall be clean and free from visible contamination. Material filtering during pelletising or extrusion shall be carried out.