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

Part 5: Fitness for purpose of the system

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 5: Aptitude à l'emploi du système

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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 22621-5 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*

— *Part 5: Fitness for purpose of the system*

— *Part 6: Code of practice for design, handling and installation*

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 [ISO 15439 (all parts)] covering low pressures up to 0,4 MPa (4 bar), and the other (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 5: Fitness for purpose of the system

1 Scope

This part of ISO 22621 specifies the requirements of fitness for purpose of the polyamide (PA) piping system, intended to be buried and used for the supply of gaseous fuels at maximum operating pressures (MOP) up to and including 2 MPa (20 bar[1)]).

It specifies the definitions of electrofusion and butt fusion joints.

It also specifies the method of preparation of test piece joints and the tests to be carried out on these joints for assessing the fitness for purpose of the system under normal and extreme conditions.

In addition, it specifies the test parameters for the test methods to which it refers.

In conjunction with the other parts of ISO 22621, it is applicable to PA fittings, their joints and joints with components of PA.

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

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 1167-4, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies*

ISO 6259-1, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

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

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 13955, *Plastics pipes and fittings — Crushing decohesion test for polyethylene (PE) electrofusion assemblies*

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*

ISO 22621-2, *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*

ISO 22621-3, *Plastics piping systems for the supply of gaseous fuels for maximum operating pressures up to and including 2 MPa (20 bar) — Polyamide (PA) — Part 3: Fittings*

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 and the following apply.

3.1 Terms and definitions — General

3.1.1
electrofusion joint
joint between a PA electrofusion socket or saddle fitting and a pipe or a spigot end fitting

NOTE The electrofusion fittings are heated by the Joule effect of the heating element incorporated at their jointing surfaces, causing the material adjacent to them to melt and the pipe and fitting surfaces to fuse.

3.1.2
butt fusion joint (using heated tool)
joint made by heating the planed ends the surfaces of which match by holding them against a flat heating plate until the PA material reaches fusion temperature, removing the heating plate quickly and pushing the two softened ends against one another

3.1.3
fusion compatibility
ability of two similar or dissimilar polyamide materials to be fused together to form a joint which conforms to the performance requirements of this standard

3.1.4
transition fitting
fitting that makes a transition joint between a polyamide (PA) piping and a metallic pipe

3.1.5
transition joint
joint at which two different piping materials (the PA and metal piping) are connected

3.1.6
anodeless riser
type of transition fitting which is designed to transport gas from an underground polyamide (PA) service line to above-ground steel piping

NOTE In an anodeless riser, the PA pipe is always the gas carrier, at least, in the below ground section.

3.2 Terms and definitions for preparation of test assemblies by electrofusion

3.2.1
reference time
t_R
theoretical fusion time indicated by the fitting manufacturer for the reference ambient temperature

See Annex B.

3.2.2
fusion energy
electrical energy supplied during the fusion-jointing cycle as measured at the terminals of the fitting at a given ambient temperature, T_a, and for electrical parameters whose values lie within the tolerance ranges declared by the manufacturer

NOTE 1 The fitting manufacturer is generally required to state in the technical file any variations in fusion energy input required as a function of the ambient temperature in the range T_{min} to T_{max}.

NOTE 2 Where applicable, energy measurement should exclude the effect of terminal contact resistance.

3.2.3
reference energy
energy supplied to a fitting having a nominal electrical resistance and using the nominal fusion parameters defined by the manufacturer at the reference ambient temperature, T_R

See Annex B.

3.2.4
maximum energy
maximum value of the fusion energy supplied for jointing at a given ambient temperature, T_a

See Annex B.

3.2.5
minimum energy
minimum value of the fusion energy supplied for jointing at a given ambient temperature, T_a

See Annex B.

3.2.6
nominal energy
nominal energy supplied for jointing at a given ambient temperature, T_a

See Annex B.

3.3 Symbols

Application	Symbol	Description	Unit
Symbols used in more than one phase of the fusion-jointing cycle[a]	e_n	nominal pipe wall thickness	mm
	d_n	nominal external diameter of the pipe	
	p	pressure applied to the butt fusion joint interface	
	t	duration of each phase in the fusion cycle	
	T_{nom}	nominal temperature (23 ± 2) °C	°C
	T_{max}	maximum permissible ambient temperature	°C
	T_{min}	minimum permissible ambient temperature	°C

Application	Symbol	Description	Unit
Symbols for joint geometry[a]	Δa	misalignment between the pipes or fittings to be butt-fused, expressed in terms of the difference between the external diameters	mm
	Δw	clearance between the fusion faces, expressed in terms of the gap between the prepared faces	mm
Symbols for ambient temperature[ab]	T_a	ambient temperature at which the joint is made	°C
Symbols for butt fusion cycle parameters[a]**:** — **General**	T	heater-plate temperature, measured in the zone of the heater-plate surface in contact with the pipe or spigot ends to be butt-fused	°C
— **Phase 1: heating**	p_1	interface pressure during the heating phase, i.e. the pressure applied in the contact zone	MPa
	B_1	initial bead width taken as the bead width at the end of the heating phase	mm
	t_1	heating time, taken as the time necessary to obtain a bead of width B_1 in the joint region during the heating phase	s
— **Phase 2: heat soak**	p_2	pressure between the heater plate and the pipe or spigot ends during the heat soak phase	MPa
	t_2	duration of internal heating during the heat soak phase	s
— **Phase 3: withdrawal of heater plate**	t_3	time between the moment when the heater plate is removed from the pipe and/or spigot ends and the moment when the pipe and/or spigot ends are placed in contact with each other	s
— **Phase 4: pressure increase**	t_4	time required to establish the butt fusion pressure	s
— **Phase 5: butt fusion**	p_5	pressure applied to the contact zone during the butt fusion phase	MPa
	t_5	time during which the assembly remains under the butt fusion pressure in the machine	min
— **Phase 6: cooling**	t_6	cooling time during which the butt-fused assembly is not subjected to any rough handling; this cooling can take place outside the machine	min
	B_2	bead width obtained at the end of the cooling phase	mm
Symbols for the preparation of test assemblies by electrofusion[c]	D_{im}	mean inside diameter of the fusion zone of a fitting in the radial plane located a distance $L_3 + 0{,}5L_2$ from the face of the fitting socket	
	$D_{im,max}$	maximum theoretical value of D_{im} as declared by the fitting manufacturer	
	$D_{i,max}$	maximum inside diameter of the fusion zone of the fitting	
	$D_{i,min}$	minimum inside diameter of the fusion zone of the fitting	
	d_e	outside diameter of a pipe or fitting spigot	
	d_{em}	mean outside diameter of a pipe or fitting spigot in conformance with ISO 22621-2 and ISO 22621-3, as applicable, and calculated from the measured circumference	

Application	Symbol	Description	Unit
	d_{emp}	mean outside diameter of a pipe or fitting spigot after preparation for assembly with the outer layer, removed by scraping or peeling and calculated from the circumference measured in a radial plane coincident with the centre of the fusion zone at a distance $L_3 + 0{,}5L_2$ from the face of the fitting socket after assembly	
	e_n	nominal wall thickness of the pipe	mm
	e_s	depth of scraping or the thickness of material removed from the pipe surface by peeling	mm
	L_2	nominal length of the fusion zone as indicated by the fitting manufacturer	
	L_3	nominal distance from the face of the fitting socket to the leading edge of the fusion zone	

[a] See Annex A.

[b] The ambient temperature may vary from the minimum temperature, T_{min}, to the maximum temperature, T_{max}, defined by agreement between the manufacturer and purchaser.

[c] See Figure B.1; see Annex B.

4 Fitness for purpose

4.1 Method of preparation of assemblies for testing

4.1.1 General

The joints shall be made by using pipes conforming to ISO 22621-2 or fittings conforming to ISO 22621-3.

Test pieces for pressure test shall be closed with pressure-tight, end-load-bearing end caps, plugs or flanges, which shall be provided with connections for the entry of water and release of air.

4.1.2 Butt fusion joints

PA pipes and spigot end fittings intended to be used for jointing by butt fusion shall be prepared and assembled in accordance with Annex A.

4.1.3 Electrofusion jointing

PA pipes and fittings intended to be used for jointing by electrofusion shall be prepared and assembled in accordance with Annex B.

For joints with electrofusion socket fittings and joints with electrofusion saddle fittings, test joints shall be prepared to check the fitness for purpose of the fittings under extreme jointing conditions.

For joints with electrofusion saddle fittings, the electrofusion saddle fitting shall be fused to the pipe, while it is pneumatically pressurized to the allowable maximum operating pressure. The pipe shall be cut immediately after the manufacturer-prescribed cooling time has elapsed.

These joints with electrofusion saddle fitting should be prepared taking national safety regulations into consideration.

For straight equal electrofusion socket fittings (couplers), test joints on selected diameters out of the product range shall be prepared with a gap of $0{,}05d_n$ between the pipe end and the maximum theoretical depth of

penetration of the fitting, where for diameters greater than 225 mm, the adjoining pipes shall be arranged to provide the maximum angular deflection possible for the fitting, limited to 1,5°.

4.2 Requirements for fitness for purpose

4.2.1 Fitness for purpose for butt fusion joints

4.2.1.1 Under normal conditions — Ambient temperature 23 °C

For the assessment of fitness for purpose under normal conditions, butt fusion joints shall have the characteristic of tensile strength conforming to the requirement given in Table 5, using the parameters as specified in Annex A, Table A.2 and Table A.3, at an ambient temperature of (23 ± 2) °C and the scheme listed in Table 1.

Table 1 — Scheme for butt fusion joints

Pipe/spigot end fitting	Pipe			
	PA 11 160	PA 11 180	PA 12 160	PA 12 180
PA 11 160	X	X[a]	Jointing not allowed	Jointing not allowed
PA 11 180	X[a]	X	Jointing not allowed	Jointing not allowed
PA 12 160	Jointing not allowed	Jointing not allowed	X	X[a]
PA 12 180	Jointing not allowed	Jointing not allowed	X[a]	X

This table should be interpreted as follows: as an example, for a pipe or a spigot end fitting made from a PA 11 160 compound, a joint should be tested with a pipe made from PA 11 160 compound. When requested by the purchaser or end user, for mixed compound joints, test pieces should be used incorporating PA 11 160 and PA 11 180 compounds.

[a] Only when requested by the purchaser or end user.

The pipe manufacturer shall declare, according to 4.2.1.1, which pipes from his own product range conforming to ISO 22621-2 are compatible with each other for butt fusion.

The fitting manufacturer shall declare, according to 4.2.1.1, the SDR range and MRS values of pipes conforming to ISO 22621-2, to which his fittings conforming to ISO 22621-3 can be fused by using the same procedures (e.g. times, temperatures, fusion pressures) to conform to this part of ISO 22621. If there is a need for deviation in fusion procedures, the fitting manufacturer shall state this clearly.

4.2.1.2 Under extreme conditions

For butt fusion joints, the characteristics to be examined for fitness for purpose under extreme conditions shall conform to Table 2.

Table 2 — Relationship between the joints and fitness for purpose characteristics

Butt fusion joint	Associated characteristic
Both components of the joint: same MRS and same SDR Joint: minimum and maximum condition[a]	Hydrostatic strength (80 °C, 165 h)
Both components of the joint: same MRS and same SDR Joint: minimum and maximum condition	Tensile strength for butt fusion joint

[a] As specified in Annex A concerning misalignment [A.5 a)] and the limit values of fusion parameters (Table A.4).