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Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing —

Part 5: Fitness for purpose of the system

Systèmes de canalisations en matières plastiques pour la distribution de combustibles gazeux — Systèmes de canalisations en polyamide non plastifié (PA-U) avec assemblages par soudage et assemblages mécaniques —

Partie 5: Aptitude à l'emploi du système

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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

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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 16486-5 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*.

This first edition of ISO 16486-5 cancels and replaces the first edition of ISO 22621-5:2010 which has been technically revised.

ISO 16486 consists of the following parts, under the general title *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing*:

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— *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

Thin wall thickness unplasticized polyamide (PA-U) pipes and solvent cement joints are used typically for low pressures, while thicker wall thickness pipes and butt fusion, electrofusion or mechanical joints are typically used for high pressures.

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.

So for the time being, the standardization programme dealing with unplasticized polyamide (PA-U) piping systems for the supply of gaseous fuels is split into two series of International Standards, with one series (ISO 17467) covering piping systems the components of which are connected by solvent cement jointing and the other (ISO 16486) the components of which are connected by fusion jointing and/or mechanical jointing. When more experience will be gained from the field, it might be reasonable to merge the ISO 17467 series and the ISO 16486 series in one single series applicable to PA-U piping systems.

A similar series (ISO 17135) for fusion and mechanically jointed plasticized polyamide (PA-P) piping systems is in preparation.

Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing —

Part 5: Fitness for purpose of the system

1 Scope

This part of ISO 16486 specifies the requirements of fitness for purpose of the unplasticized polyamide (PA-U) piping system, intended to be buried and used for the supply of gaseous fuels. It also specifies the definitions of electrofusion and butt fusion joints.

This part of ISO 16486 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. It also specifies the test parameters for the test methods to which it refers.

ISO 16486 is applicable to PA-U piping systems the components of which are connected by fusion jointing and/or mechanical jointing.

In conjunction with the other parts of ISO 16486, it is applicable to PA-U fittings, their joints and to joints with components of PA-U.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

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 13956:2010, *Plastics pipes and fittings — Decohesion test of polyethylene (PE) saddle fusion joints — Evaluation of ductility of fusion joint interface by tear test*

ISO 16486-1, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 1: General*

ISO 16486-2, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — Part 2: Pipes*

ISO 16486-3, *Plastics piping systems for the supply of gaseous fuels — Unplasticized polyamide (PA-U) piping systems with fusion jointing and mechanical jointing — 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 16486-1 and the following apply.

3.1 Terms and definitions — General

3.1.1
electrofusion joint
joint between a PA-U 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-U 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 unplasticized polyamide materials of the same type to be fused together to form a joint which conforms to the performance requirements of this part of ISO 16486

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

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

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

NOTE In an anodeless riser, the PA-U 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

NOTE 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.

NOTE 3 See Annex B.

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

NOTE See Annex B.

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

NOTE See Annex B.

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

NOTE See Annex B.

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

NOTE See Annex B.

3.2.1 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_{nor}	normal temperature (23 ± 2) °C	°C
	T_{max}	maximum permissible ambient temperature	°C
	T_{min}	minimum permissible ambient temperature	°C
Symbols for joint geometry[a]	Δ_a	misalignment between the pipes or fittings to be butt fused, expressed in terms of the difference, in millimetres, between, the external diameters	mm
	Δ_w	clearance between the fusion faces, expressed in terms of the gap, in millimetres, between the prepared faces	mm
Symbols for ambient temperature[ab]	T_a	ambient temperature at which the joint is made	°C
Symbols 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

Application	Symbol	Description	Unit
— 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	s
— 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	mm
	$D_{im,max}$	maximum theoretical value of D_{im} as declared by the fitting manufacturer	mm
	$D_{i,max}$	maximum inside diameter of the fusion zone of the fitting	mm
	$D_{i,min}$	minimum inside diameter of the fusion zone of the fitting	mm
	d_e	outside diameter of a pipe or fitting spigot	mm
	d_{em}	mean outside diameter of a pipe or fitting spigot in conformance with ISO 16486-2 and ISO 16486-3, as applicable, and calculated from the measured circumference	mm
	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	mm
	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	mm
	L_3	nominal distance from the face of the fitting socket to the leading edge of the fusion zone	mm

a See Annex A.

b The ambient temperature may vary from the minimum temperature, T_{min}, to the maximum temperature, T_{max}, as defined by agreement between the manufacturer and the 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 16486-2 or fittings conforming to ISO 16486-3.

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-U 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-U 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.