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Plastics piping systems for hot and cold water installations — Polybutene (PB) —

Part 5: Fitness for purpose of the system

Systèmes de canalisations en plastique pour les installations d'eau chaude et froide — Polybutène (PB) —

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

ISO 15876-5 was prepared by the European Committee Standardization (CEN) Technical Committee CEN/TC 155, *Plastics pipings systems and ducting systems*, in collaboration with ISO Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 15876-5:2003), which has been technically revised with the following changes:

— introduction of polybutene random copolymer (PB-R) and renaming existing polybutene (PB) into polybutene homopolymer (PB-H);

— revision of specifications for conditioning of samples.

A list of all parts in the ISO 15876 series can be found on the ISO website.

Introduction

The System Standard ISO 15876, of which this document is Part 5, specifies the requirements for a piping system when made from polybutene (PB). The piping system is intended to be used for hot and cold water installations.

In respect of potential adverse effects on the quality of water intended for human consumption, caused by the product covered by ISO 15876 (all parts):

— ISO 15876 (all parts) provides no information as to whether the product may be used without restriction in any of the Member States of the EU or EFTA;

— it should be noted that, while awaiting the adoption of verifiable European criteria, existing national regulations concerning the use and/or the characteristics of this product remain in force.

Requirements and test methods for material and components of the piping system are specified in ISO 15876-1, ISO 15876-2 and ISO 15876-3. ISO/TS 15876-7 gives guidance for the assessment of conformity.

This document specifies the characteristics of fitness for purpose of the piping systems.

At the date of publication of this standard, System Standards for piping systems of other plastics materials used for the same application include ISO 15874, ISO 15875, ISO 15876, ISO 15877, ISO 21003 and ISO 22391.

Plastics piping systems for hot and cold water installations — Polybutene (PB) —

Part 5: Fitness for purpose of the system

1 Scope

This document specifies the characteristics of the fitness for purpose of polybutene-1 (PB-1) piping systems, intended to be used for hot and cold water installations within buildings for the conveyance of water, whether or not intended for human consumption, (domestic systems) and for heating systems, under design pressures and temperatures according to the class of application (see ISO 15876-1).

The designation polybutene is used together with the abbreviation PB throughout this document.

This document covers a range of service conditions (application classes) and design pressure classes. For values of T_D, T_{max} and T_{mal} in excess of those in ISO 15876-1:2016, Table 1, this document does not apply.

NOTE 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.

It also specifies the test parameters for the test methods referred to in this document.

In conjunction with the other parts of ISO 15876, it is applicable to PB pipes, fittings, their joints and to joints with components of other plastics and non-plastics materials intended to be used for hot and cold water installations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 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 1167-3, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components*

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 3501, *Plastics piping systems — Mechanical joints between fittings and pressure pipes — Test method for resistance to pull-out under constant longitudinal force*

ISO 3503, *Plastics piping systems — Mechanical joints between fittings and pressure pipes — Test method for leaktightness under internal pressure of assemblies subjected to bending*

ISO 13056, *Plastics piping systems — Pressure systems for hot and cold water — Test method for leaktightness under vacuum*

ISO 15876-1, *Plastics piping systems for hot and cold water installations — Polybutene (PB) — Part 1: General*

ISO 19892, *Plastics piping systems — Thermoplastics pipes and fittings for hot and cold water — Test method for the resistance of joints to pressure cycling*

ISO 19893, *Plastics piping systems — Thermoplastics pipes and fittings for hot and cold water — Test method for the resistance of mounted assemblies to temperature cycling*

3 Terms and definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions, symbols and abbreviated terms given in ISO 15876-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Fitness for purpose of the joints and the piping system

4.1 General

Intended combinations of materials of pipes and fittings, e.g. PB-R pipes and PB-H fittings, shall fulfil the corresponding requirements of the pipe materials.

When tested in accordance with the applicable test methods as specified in Table 1, using the indicated parameters given in 4.2 to 4.7, as applicable, the combinations of PB types for pipes and fittings shall have characteristics conforming to the requirements of the pipes given in the applicable clauses.

For the tests described, the fittings shall be connected to the pipe with which they are intended to be used.

Table 1 specifies the tests applicable for each different type of jointing system covered by this document.

Table 1 — Joint tests

Test	Jointing system[a]			Test parameters	Test method
	SW	EF	M		
Internal pressure test	Y	Y	Y	Shall conform to 4.2	ISO 1167-1, ISO 1167-2, ISO 1167-3 and ISO 1167-4
Bending test	N	N	Y	Shall conform to 4.3	ISO 3503
Pull-out test	N	N	Y	Shall conform to 4.4	ISO 3501
Thermal cycling test	Y	Y	Y	Shall conform to 4.5	ISO 19893
Pressure cycling test	N	N	Y	Shall conform to 4.6	ISO 19892
Vacuum test	N	N	Y	Shall conform to 4.7	ISO 13056

[a] SW — Socket welded joint
EF — Electro-fusion joint
M — Mechanical joint
Y — Denotes test applicable
N — Denotes test not applicable

4.2 Internal pressure test

When tested in accordance with ISO 1167-1, ISO 1167-2, ISO 1167-3 and ISO 1167-4 using the test parameters given in Table 2 or Table 3 for the relevant classes, the joint assemblies shall not leak.

The test pressure, p_J, for a given time to failure and test temperature shall be determined by Formula (1):

$$p_J = p_D \times \frac{\sigma_P}{\sigma_{DP}} \quad (1)$$

where

p_J is the hydrostatic test pressure, in bars, to be applied to the joint assembly during the test period;

σ_P is the hydrostatic stress value, in megapascals, for the pipe material corresponding to time to failure/test temperature points given in Table 2 or Table 3;

σ_{DP} is the design stress value, in megapascals, for the pipe material as determined for each class and listed in ISO 15876-2;

p_D is the design pressure of 4 bar, 6 bar, 8 bar or 10 bar, as applicable.

NOTE 1 bar = 10^5 N/m^2 = 0,1 MPa.

Table 2 — Derivation of test pressure, p_J, for PB-H

	Application			
	Class 1	Class 2	Class 4	Class 5
Maximum design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	5,72	5,04	5,46	4,30
Test temperature[a], T_{test}, in °C	95	95	80	95
Test duration, t, in h	1 000	1 000	1 000	1 000
Hydrostatic stress of pipe material, σ_P, in MPa	6,0	6,0	8,2	6,0
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	5,5[b]	5,5[b]	7,7[b]	5,6
6 bar	6,3	7,2	9,2	8,4
8 bar	8,4	9,6	12,2	11,2
10 bar	10,5	12,0	15,3	14,0
Number of test pieces	3	3	3	3

[a] Generally, the highest test temperature is taken to be (T_{max} + 10) °C with an upper limit of 95 °C. However, to match existing test facilities, the highest test temperature for classes 1 and 2 is also set at 95 °C. The hydrostatic stresses given correspond to the given test temperatures.

[b] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 15876-1).

Table 3 — Derivation of test pressure, p_J, for PB-R

	Application			
	Class 1	Class 2	Class 4	Class 5
Maximum design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	5,16	5,12	4,33	4,13
Test temperature[a], T_{test}, in °C	95	95	80	95
Test duration, t, in h	1 000	1 000	1 000	1 000
Hydrostatic stress of pipe material, σ_P, in MPa	4,9	4,9	7,3	4,9
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	4,5[b]	4,5[b]	6,8	4,8
6 bar	5,7	5,8	10,2	7,2
8 bar	7,6	7,7	13,5	9,5
10 bar	9,5	9,6	16,9	11,9
Number of test pieces	3	3	3	3

[a] Generally, the highest test temperature is taken to be (T_{max} + 10) °C with an upper limit of 95 °C. However to match existing test facilities the highest test temperature for classes 1 and 2 is also set at 95 °C. The hydrostatic stresses given correspond to the given test temperatures.

[b] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 15876-1).

In special circumstances if joint tests according to this subclause cause leaks resulting from differential elongation induced deformations, a test pressure may be determined from the stress and creep data (relative to a design period of 50 years) for the different materials used.

4.3 Bending test

When tested in accordance with ISO 3503 to the applicable pressure for the 20 °C, 1 h condition given in Table 4 or Table 5, as applicable, using a bending radius equal to the minimum radius of bending for the pipes as recommended by the system supplier, the joint assembly shall not leak.

This test is only applicable to pipes that are declared as bendable by the system supplier.

Table 4 — Test parameters for bending test of PB-H

	Application class			
	Class 1	Class 2	Class 4	Class 5
Maximum design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	5,72	5,04	5,46	4,30
Test temperature, T_{test}, in °C	20	20	20	20
Test duration, t, in h	1	1	1	1
Hydrostatic stress of pipe material, σ_P, in MPa	15,5	15,5	15,5	15,5
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	14,3[a]	14,3[a]	14,3[a]	14,5
6 bar	16,3	18,5	17,1	21,7
8 bar	21,7	24,7	22,8	28,9
10 bar	27,1	30,8	28,4	36,1
Number of test pieces	3	3	3	3

[a] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 15876-1).

Table 5 — Test parameters for bending test of PB-R

	Application class			
	Class 1	Class 2	Class 4	Class 5
Maximum design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	5,16	5,12	4,33	4,13
Test temperature, T_{test}, in °C	20	20	20	20
Test duration, t, in h	1	1	1	1
Hydrostatic stress of pipe material, σ_P, in MPa	15,3	15,3	15,3	15,3
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	14,1[a]	14,1[a]	14,2	14,9
6 bar	17,8	18,0	21,3	22,3
8 bar	23,8	24,0	28,3	29,7
10 bar	29,7	29,9	35,4	37,1
Number of test pieces	3	3	3	3

[a] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see ISO 15876-1).

4.4 Pull-out test

When tested in accordance with ISO 3501 using the parameters given in Table 6, the joint assemblies shall withstand the pull-out force, without being separated.

The force, F, shall be calculated from Formula (2):

$$F = \frac{\pi}{4} d_n^{\,2} \times p_D \tag{2}$$

where:

F is the force, expressed in newtons (N);

d_n is the nominal outside diameter of the pipe, expressed in millimetres (mm);

p_D is the design pressure of 4 bar, 6 bar, 8 bar or 10 bar, as applicable, expressed in megapascals [in the case of the classification "All classes", the design pressure shall be 10 bar, expressed in megapascals (MPa)].

Table 6 — Test parameters for pull-out test

	All application classes	Application class			
		Class 1	Class 2	Class 4	Class 5
Maximum design temperature, T_{max}, in °C	—	80	80	70	90
Test temperature, in °C	23	90	90	80	95
Test period, in h	1	1	1	1	1
Pull-out force, in N	1,5 × F	F	F	F	F
Number of test pieces	3	3	3	3	3

4.5 Thermal cycling test

When tested in accordance with ISO 19893 using the parameters given in Table 7, the pipes, fittings or joints, as applicable, shall withstand the test without leakage.

The test for flexible pipes shall only be used when the manufacturer declares that the pipe can be bent to the configuration shown. The bending radius shall not be smaller than the minimum declared bending radius. In all other cases, the test for rigid pipes shall apply.

Table 7 — Test parameters for thermal cycling

	Application class			
	Class 1	**Class 2**	**Class 4**	**Class 5**
Maximum design temperature, T_{max}, in °C	80	80	70	90
Highest test temperature, in °C	90	90	80	95
Lowest test temperature, in °C	20	20	20	20
Test pressure, in bars	p_D	p_D	p_D	p_D
Number of cycles[a]	5 000	5 000	5 000	5 000
Number of test pieces	One set of fittings in accordance with the configuration shown in ISO 19893			

[a] Each cycle shall comprise 15 $^{+1}_{0}$ min at the highest test temperature and 15 $^{+1}_{0}$ min at the lowest (i.e. the duration of one cycle is 30 $^{+2}_{0}$ min).

The tensile stress, σ_t, used to calculate the pre-stress force required in ISO 19893 shall be calculated based on E-modulus values obtained for given grades of PB-H and PB-R. Typical values are as follows:

— PB-H: 450 MPa;

— PB-R: 330 MPa.

NOTE The tensile stress can be calculated using Formula (3):

$$\sigma_t = \alpha \times \Delta T \times E \tag{3}$$

where

σ_t is the tensile stress, expressed in megapascals (MPa);

α is the coefficient of thermal expansion expressed in reciprocal kelvins (1/K);

ΔT is the temperature difference, expressed in kelvins (K);

E is the modulus of elasticity, expressed in megapascals (MPa).

In this document, the following values apply:

a) $\alpha = 1{,}3 \times 10^{-4}\ K^{-1}$;

b) $\Delta T = 20$ K;

c) E = to be obtained for given grade of PB-H and PB-R.

4.6 Pressure cycling test

When tested for leak tightness under pressure cycling in accordance with ISO 19892 using the parameters given in Table 8, the pipes, fittings or joints, as applicable, shall not leak.

