INTERNATIONAL STANDARD

ISO 15874-5

Second edition
2013-02-15

Plastics piping systems for hot and cold water installations — Polypropylene (PP) —

Part 5: Fitness for purpose of the system

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

Partie 5: Aptitude à l'emploi du système

Reference number
ISO 15874-5:2013(E)

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Contents

Page

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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.

ISO 15874-5 was prepared by Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in collaboration with Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, and 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 15874-5:2003), which has been technically revised. In 4.2, Tables 2, 3 and 4, values have been adjusted; in Table 5, the material PP-RCT has been included; and in 4.3, Tables 6, 7 and 8, values have been adjusted.

ISO 15874 consists of the following parts[1)] under the general title *Plastics piping systems for hot and cold water installations — Polypropylene (PP)*:

— *Part 1: General;*

— *Part 2: Pipes;*

— *Part 3: Fittings;*

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

— *Part 7: Guidance for the assessment of conformity* [Technical specification].

1) For ancillary equipment separate standards can apply. Guidance on installation of plastics piping systems made from different materials intended to be used for hot and cold water installations is given by CEN/TR 12108 [1].

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Introduction

This part of ISO 15874 specifies the requirements for a piping system and its components when made from polypropylene (PP). The piping system is intended to be used for hot and cold water installations.

Regarding potential undesirable effects on the quality of water intended for human consumption, caused by the product covered by ISO 15874

— no information is provided as to whether the product can be used without restriction, and

— existing national regulations concerning the use and/or the characteristics of this product remain in force.

Requirements and test methods for components of the piping system are specified in ISO 15874-1, ISO 15874-2 and ISO 15874-3. ISO/TS 15874-7 gives guidance for the assessment of conformity.

This part of ISO 15874 specifies the characteristics of fitness for purpose of the piping systems.

At the date of publication of this part of ISO 15874, the following system International Standards for piping systems of other plastics materials used for the same application are

— ISO 15875, *Plastics piping systems for hot and cold water installations — Crosslinked polyethylene (PE-X)*

— ISO 15876, *Plastics piping systems for hot and cold water installations — Polybutylene (PB)*

— ISO 15877, *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C)*

— ISO 22391, *Plastics piping systems for hot and cold water installations - Polyethylene of raised temperature resistance (PE-RT)*

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Plastics piping systems for hot and cold water installations — Polypropylene (PP) —

Part 5: Fitness for purpose of the system

1 Scope

This part of ISO 15874 specifies the characteristics of the fitness for purpose of polypropylene (PP) 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 Table 1 of ISO 15874-1:2013).

This part of ISO 15874 covers a range of service conditions (classes of application) and design pressure classes. For values of T_D, T_{max} and T_{mal} in excess of those in Table 1 of ISO 15874-1:2013 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 part of ISO 15874.

In conjunction with the other parts of ISO 15874, it is applicable to PP 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, 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.

EN 712, *Thermoplastics piping systems — End-load bearing mechanical joints between pressure pipes and fittings — Test method for resistance to pull-out under constant longitudinal force*

EN 713, *Plastics piping systems — Mechanical joints between fittings and polyolefin pressure pipes — Test method for leak tightness under internal pressure of assemblies subjected to bending*

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*

EN 12294, *Plastics piping systems — Systems for hot and cold water — Test method for leak tightness under vacuum*

ISO 15874-1:2013 *Plastics piping system for hot and cold water installations — Polypropylene (PP) — Part 1: General*

ISO 15874-2:2013, *Plastics piping system for hot and cold water installations — Polypropylene (PP) — Part 2: Pipes*

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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*

ISO 19892 *Plastics piping systems — Thermoplastics pipes and associated fittings for hot and cold water — Test method for resistance of joints to pressure 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 15874-1 apply.

4 Fitness for purpose of the joints and the piping system

4.1 General

Intended combinations of materials of pipes and fittings, e.g. PP-RCT pipes and PP-R 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 PP 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 part of ISO 15874.

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	EN 713
Pull-out test	N	N	Y	Shall conform to 4.4	EN 712
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	EN 12294
[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, 3, 4 or 5 for the relevant classes the joint assemblies shall not leak.

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The test pressure, p_J, for a given time to failure and test temperature shall be determined by the following equation:

$$p_J = p_D \times \frac{\sigma_P}{\sigma_{DP}}$$

where:

p_J is the hydrostatic test pressure, in bars[2)], 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, 3, 4 or 5;

σ_{DP} is the design stress value, in megapascals, for the pipe material as determined for each class and listed in Table 2 of ISO 15874-2:2013;

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

Table 2 — Derivation of test pressure p_J for PP-H

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	2,88	1,99	3,23	1,82
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	3,6	3,6	5,0	3,6
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	5,7 [b]	7,2	8,0 [b]	7,8
6 bar	7,5	10,8	9,3	11,8
8 bar	9,9	14,4	12,4	15,7
10 bar	12,4	18,0	15,5	19,6
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 15874-1:2013, Clause 4).

2) 1 bar = 10 5 N/m2 = 0,1 MPa.

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Table 3 — Derivation of test pressure p_J for PP-B

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max} , in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	1,66	1,19	1,94	1,19
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	2,6	2,6	3,7	2,6
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	6,4	8,9	7,6	8,9
6 bar	9,5	13,3	11,5	13,3
8 bar	12,7	17,8	15,3	17,8
10 bar	15,9	22,2	19,1	22,2
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.

Table 4 — Derivation of test pressure p_J for PP-R

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	3,02	2,12	3,29	1,89
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	3,5	3,5	4,6	3,5
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	5,1 [b]	6,6 [b]	6,6 [b]	7,4
6 bar	7,0	9,9	8,3	11,1
8 bar	9,3	13,2	11,1	14,8
10 bar	11,6	16,5	13,9	18,5
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 15874-1:2013, Clause 4).

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Table 5 — Derivation of test pressure p_J for PP-RCT

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	3,64	3,40	3,67	2,92
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	3,8	3,8	5,0	3,8
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	4,6 [b]	4,6 [b]	6,1 [b]	5,2
6 bar	6,2	6,7	8,2	7,8
8 bar	8,3	8,9	10,9	10,4
10 bar	10,4	11,1	13,7	12,9
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 15874-1:2013, Clause 4).

In special circumstances if joint tests according to this clause 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 EN 713 to the applicable pressure for the 20 °C, 1 h condition given in Table 6, 7, 8 or 9, 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 of nominal diameter greater than or equal to 32 mm.

Table 6 — Test parameters for bending test for PP-H

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	2,88	1,99	3,23	1,82
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	21	21	21	21
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	33,6 [a]	42,3	33,6 [a]	46,1
6 bar	43,8	63,5	39,1	69,1
8 bar	58,4	84,7	52,1	92,2
10 bar	73,0	105,9	65,1	115,2
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 15874-1:2013, Clause 4).

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Table 7 — Test parameters for bending test for PP-B

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	1,66	1,19	1,94	1,19
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	16	16	16	16
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	38,5	53,8	32,9	53,8
6 bar	57,7	80,7	49,4	80,7
8 bar	77,0	107,6	65,9	107,7
10 bar	96,2	134,5	82,3	134,6
Number of test pieces	3	3	3	3

Table 8 — Test parameters for bending test for PP-R

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	3,02	2,12	3,29	1,89
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	16	16	16	16
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	23,1 [a]	30,3	23,1 [a]	33,9
6 bar	31,8	45,4	29,2	50,8
8 bar	42,5	60,5	38,9	67,7
10 bar	53,1	75,6	48,7	84,6
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 15874-1:2013, Clause 4).				

Table 9 — Test parameters for bending test for PP-RCT

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max. design temperature, T_{max}, in °C	80	80	70	90
Design stress of pipe material, σ_{DP}, in MPa	3,64	3,40	3,67	2,92
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	15	15	15
Test pressure, p_J, in bars, for a design pressure, p_D, of:				
4 bar	18,2 [a]	18,2 [a]	18,2 [a]	20,5
6 bar	24,7	26,4	24,5	30,8
8 bar	33,0	35,2	32,6	41,1
10 bar	41,2	44,1	40,8	51,3
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 15874-1:2013, Clause 4).				

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4.4 Pull-out test

When tested in accordance with EN 712 using the parameters given in Table 10, the joint assemblies shall withstand the pull-out force, without being separated.

The force, F, shall be calculated from the following equation:

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

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, 6, 8 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 10 — Test parameters for pull-out test

	All application classes	Application class			
		Class 1	Class 2	Class 4	Class 5
Max 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	$1{,}5 \times F$	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 11 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 11 — Test parameters for thermal cycling

	Application class			
	Class 1	Class 2	Class 4	Class 5
Max 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.			

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The tensile stress, σ_t, used to calculate the pre-stress force required in ISO 19893 shall be 3,6 MPa for PP-H, 3,0 MPa for PP-B, 2,4 MPa for PP-R and 2,7 MPa for PP-RCT.

NOTE The tensile stress is calculated using the following equation:

$$\sigma_t = \alpha \times \Delta T \times E$$

where:

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

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

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

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

In this part of ISO 15874 the following values apply:

$\alpha = 1{,}5 \times 10\text{-}4$ K-1;

$\Delta T = 20$ K;

$E =$ 1200 MPa (PP-H), 1 000 MPa (PP-B), 800 MPa (PP-R), 800 MPa (PP-RCT).

4.6 Pressure cycling test

When tested for leak tightness under pressure cycling in accordance with ISO 19892 using the parameters given in Table 12, the pipes, fittings or joints, as applicable, shall not leak.

Table 12 — Test parameters for pressure cycling

Characteristics	Requirement	Test parameters			Test method
Pressure cycling	No leakage	Test temperature	23 °C		ISO 19892
		Number of test pieces	3		
		Frequency of test cycles	(30 ± 5) cycles per min		
		Number of cycles	10 000		
		Test pressure limits for a design pressure of:	Upper limit	Lower limit	
		4 bar	6,0 bar	0,5 bar	
		6 bar	9,0 bar	0,5 bar	
		8 bar	12,0 bar	0,5 bar	
		10 bar	15,0 bar	0,5 bar	

4.7 Leak tightness under vacuum

When tested for leak tightness under vacuum in accordance with EN 12294 using the parameters given in Table 13, the change in vacuum pressure shall not be greater than 0,05 bar.

Table 13 — Test parameters for leak tightness under vacuum

Characteristics	Requirements	Test parameters		Test method
Leak tightness under vacuum	Change in vacuum pressure ≤ 0,05 bar	Test temperature	23 °C	EN 12294
		Test duration	1 h	
		Test pressure	−0,8 bar	
		Number of test pieces	3	

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ICS 23.040.20; 91.140.60

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