INTERNATIONAL STANDARD

ISO 15874-2

Second edition
2013-02-15

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

Part 2: **Pipes**

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

Partie 2: Tubes

Reference number
ISO 15874-2:2013(E)

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Published in Switzerland

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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 15874-2 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 15874-2:2003 and ISO 15874-2:2003/Amd 1:2007), which has been technically revised. In Clause 6, 6.2.2, Table 5, the material PP-RCT has been included, and Annex A, Table A.6, pipe dimensions have been extended to 160 mm.

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].

Introduction

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

Regarding potential adverse 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;

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

Requirements and test methods for material and components, other than pipes, are specified in ISO 15874-1 and ISO 15874-3. Characteristics for fitness for purpose (mainly for joints) are covered in ISO 15874-5. ISO/TS 15874-7 gives guidance for the assessment of conformity.

This part of ISO 15874 specifies the characteristics of pipes.

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 2: Pipes

1 Scope

This part ISO 15874 specifies the requirements of pipes made from polypropylene (PP) for 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 operating pressures and temperatures appropriate to the class of application (see ISO 15874-1:2013, Table 1).

This part of ISO 15874 covers a range of service conditions (application classes), design pressures and pipe dimension classes. For values of T_D, T_{max} and T_{mal} in excess of those in Table 1 of ISO 15874-1:2013 do not apply.

NOTE 1 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, this part of ISO 15874 is applicable to PP pipes, their joints and to joints with components of PP, other plastics and non-plastics materials intended to be used for hot and cold water installations.

It is applicable to pipes with or without (a) barrier layer(s).

NOTE 2 In the case of plastics pipes provided with a thin barrier layer, e.g. to prevent or greatly diminish the diffusion of gases and the transmission of light into or through the pipe wall, the design stress requirements are totally met by the base polymer (PP).

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 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

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

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

ISO 4065:1996, *Thermoplastics pipes — Universal wall thickness table*

ISO 7686 *Plastics pipes and fittings — Determination of opacity*

ISO 9080 *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO 9854-1:1994 *Thermoplastics pipes for the transport of fluids — Determination of pendulum impact strength by the Charpy method — Part 1: General test method*

ISO 9854-2:1994, *Thermoplastics pipes for the transport of fluids — Determination of pendulum impact strength by the Charpy method — Part 2: Test conditions for pipes of various materials*

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

ISO 15874-3, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 3: Fittings*

ISO 15874-5, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 5: Fitness for purpose of the system*

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 Material

4.1 Pipe material

The pipe material from which the pipe is made shall comply with ISO 15874-1:2013, 5.1.

4.2 Evaluation of σ_{LPL}-values

The pipe material shall be evaluated in accordance with ISO 9080 or equivalent where internal pressure tests are made in accordance with ISO 1167-1 and ISO 1167-2 to find the σ_{LPL}-values. The σ_{LPL}-value thus determined shall at least be as high as the corresponding values of the reference curves given in Figure 1, 2, 3 or 4.

NOTE One equivalent way of evaluation is to calculate the σ_{LPL} -value for each temperature (for example 20 °C, 60 °C and 95 °C) individually.

The reference curves in Figures 1, 2, 3 and 4 in the temperature range of 10 °C to 95 °C are derived from the following equations:

First branch (i.e. the left hand portion of the lines as shown in Figures 1, 2 ,3 and 4)

$$\text{for PP-H: } \log t = -46{,}364 - \frac{9601{,}1 \log \sigma}{T} + \frac{20381{,}5}{T} + 15{,}24 \log \sigma \quad (1)$$

$$\text{for PP-B: } \log t = -56{,}086 - \frac{10157{,}8 \log \sigma}{T} + \frac{23971{,}7}{T} + 13{,}32 \log \sigma \quad (2)$$

$$\text{for PP-R: } \log t = -55{,}725 - \frac{9484{,}1 \log \sigma}{T} + \frac{25502{,}2}{T} + 6{,}39 \log \sigma \quad (3)$$

$$\text{for PP-RCT: } \log t = -119{,}546 + 52176{,}696 \frac{1}{T} + 31{,}279 \log(\sigma) - 23738{,}797 \frac{\log \sigma}{T} \quad (4)$$

Second branch (i. e. the right hand portion of the lines as shown in Figures 1, 2 and 3)

$$\text{for PP-H: } \log t = -18{,}387 + \frac{8918{,}5}{T} - 4{,}1 \log \sigma \quad (5)$$

$$\text{for PP-B: } \log t = -13{,}699 + \frac{6970{,}3}{T} - 3{,}82 \log \sigma \quad (6)$$

$$\text{for PP-R: } \log t = -19{,}98 + \frac{9507}{T} - 4{,}11 \log \sigma \tag{7}$$

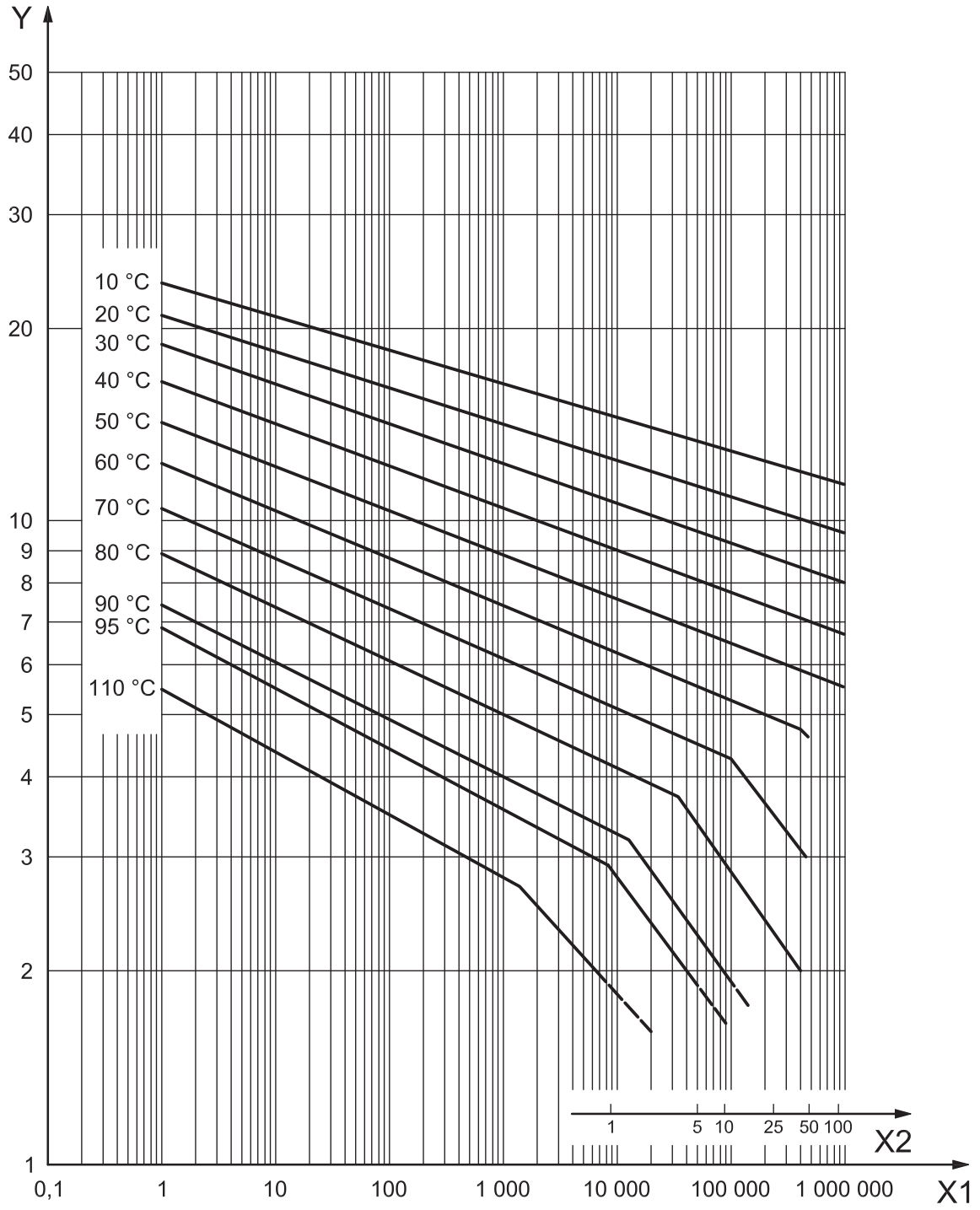
To demonstrate conformance to the reference lines pipe samples should be tested at following temperatures and at various hoop stresses such that, at each of the temperatures given, at least three failure times fall in each of the following time intervals:

Temperatures 20 °C; 60 °C to 70 °C; 95 °C;

Time intervals 10 h to 100 h, 100 h to 1000 h,1000h to 8760 h and above 8760 h.

In tests lasting more than 8760 h, once failure is reached at a stress and time at least on or above the reference line, any time after that may be considered as the failure time. Testing should be carried out in accordance with ISO 1167-1 and -2.

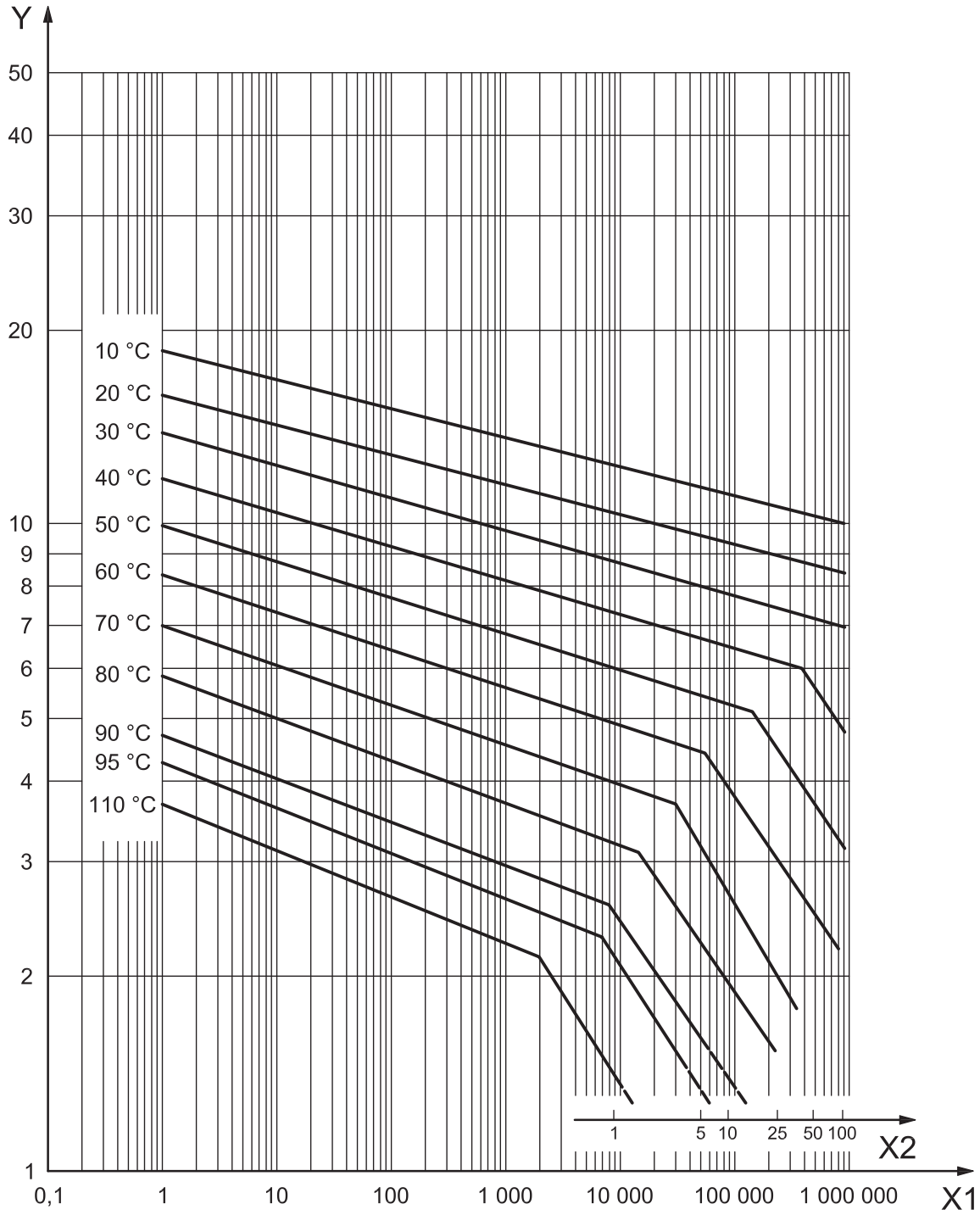
Conformance with the reference lines should be demonstrated by plotting the individual experimental results on the graph. At least 97,5% of them should lie on or above the reference line.



Key

X1	time, t_1, to fracture, in hours
X2	time, t_2, to fracture, in years
Y	hoop stress, σ, in megapascal

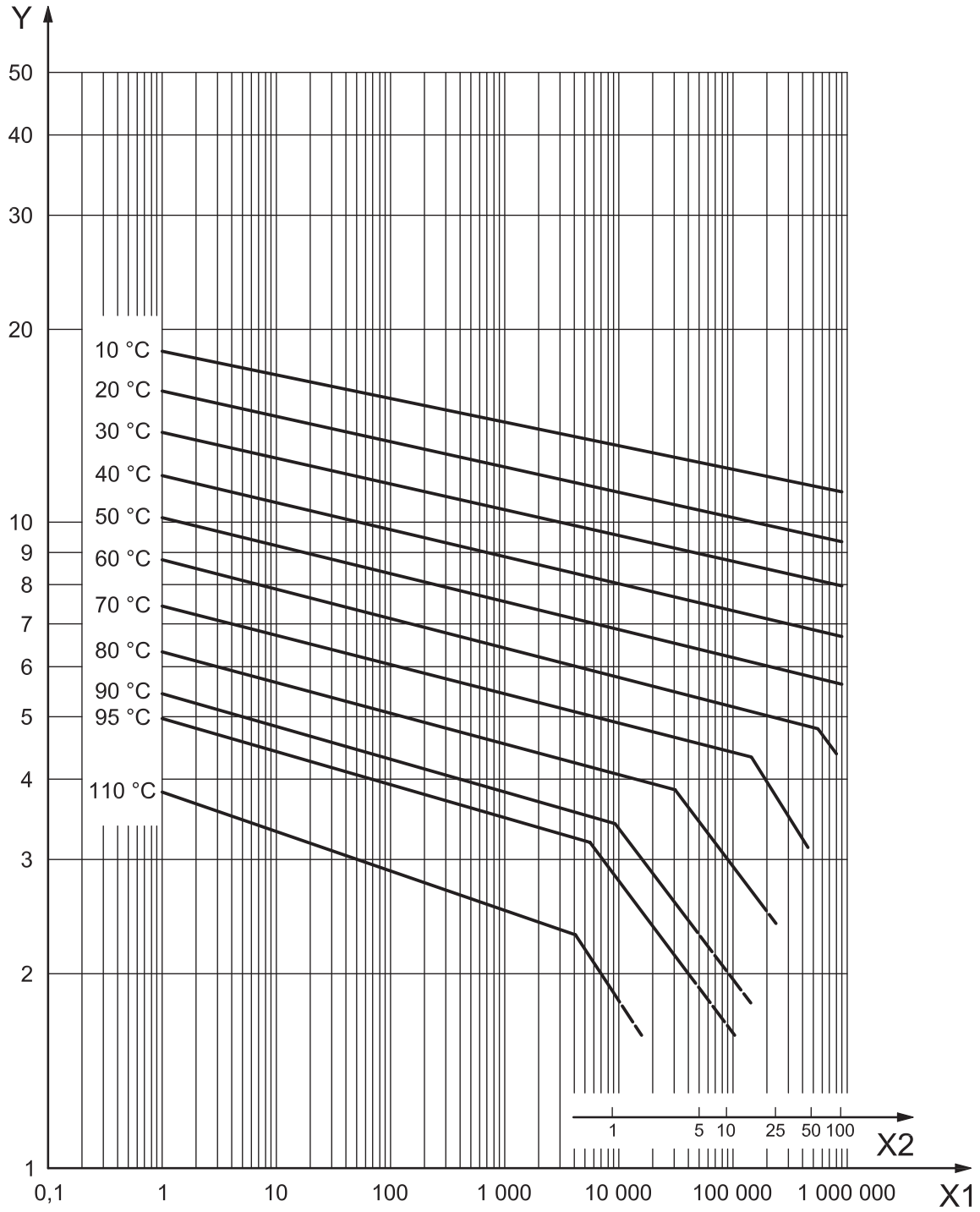
Figure 1 — Reference curves for expected strength of PP-H



Key

X1	time, t_1, to fracture, in hours
X2	time, t_2, to fracture, in years
Y	hoop stress, σ, in megapascal

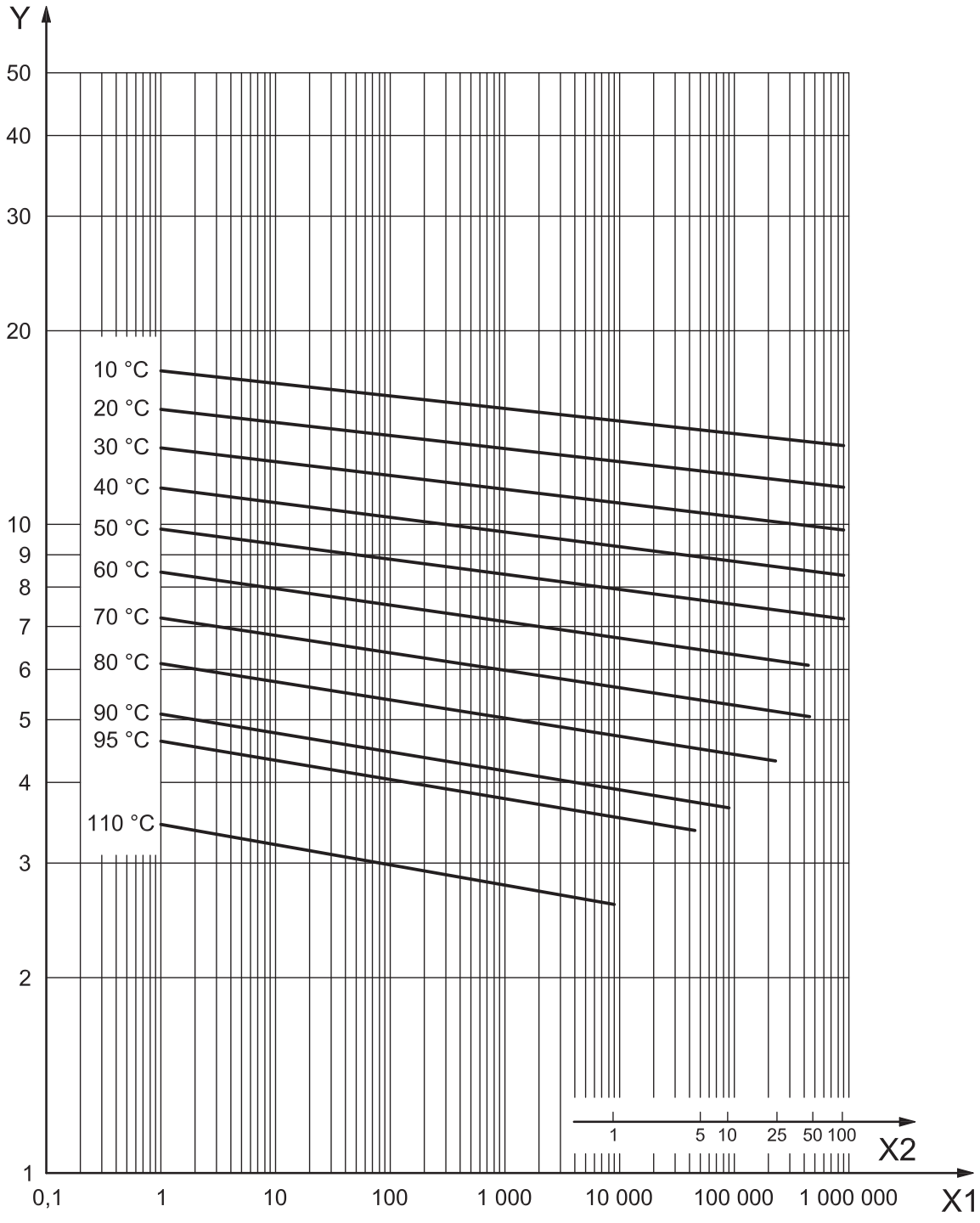
Figure 2 — Reference curves for expected strength of PP-B



Key

X1	time, t_1, to fracture, in hours
X2	time, t_2, to fracture, in years
Y	hoop stress, σ, in megapascal

Figure 3 — Reference curves for expected strength of PP-R



Key

X1	time, t_1, to fracture, in hours
X2	time, t_2, to fracture, in years
Y	hoop stress, σ, in megapascal

Figure 4 – Reference curves for expected strength of PP-RCT

4.3 Influence on water intended for human consumption

The material shall conform to ISO 15874-1.

5 General characteristics

5.1 Appearance

When viewed without magnification the internal and external surfaces of pipes shall be smooth, clean and free from scoring, cavities, and other surface defects to an extent that would prevent conformity to this standard. The material shall not contain visible impurities. Slight variations in appearance of the colour are permitted. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

5.2 Opacity

Polypropylene pipes that are declared to be opaque shall not transmit more than 0,2 % of visible light, when tested in accordance with ISO 7686.

6 Geometrical characteristics

6.1 General

Dimensions shall be measured in accordance with ISO 3126.

The maximum calculated pipe value of $S_{calc,max}$, for the applicable class of service conditions and design pressure, p_D, is given in Table 1, 2, 3 or 4.

Table 1 — $S_{calc,max}$-values for PP-H

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	6,3	5,0	6,3	4,6
6	4,8	3,3	5,4	3,0
8	3,6	2,5	4,0	2,3
10	2,9	2,0	3,2	1,8

[a] The values are rounded to the first place of decimals.

NOTE 1 bar = 10^5 N/mm^2.

Table 2 — $S_{calc,max}$-values for PP-B

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	4,2	3,0	4,9	3,0
6	2,8	2,0	3,2	2,0
8	2,1	1,5	2,4	1,5
10	1,7	1,2	1,9	1,2

[a] The values are rounded to the first place of decimals.

Table 3 — $S_{calc,max}$-values for PP-R

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	6,9	5,3	6,9	4,7
6	5,0	3,5	5,5	3,2
8	3,8	2,6	4,1	2,4
10	3,0	2,1	3,3	1,9

[a] The values are rounded to the first place of decimals.

Table 4 — $S_{calc,max}$-values for PP-RCT

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	8,2	8,2	8,2	7,3
6	6,1	5,7	6,1	4,9
8	4,5	4,3	4,6	3,7
10	3,6	3,4	3,7	2,9

[a] The values are rounded to the first place of decimals.

NOTE The derivation of $S_{calc,max}$ is provided in Annex A. The method described takes account of the properties of PP under the service conditions of different classes given in Table 1 of ISO 15874-1:2013.

The values of outside diameter and/or wall thickness apply to the polypropylene pipe and are exclusive of additional outside layers. For pipes with barrier layer, the values of outside diameter and wall thickness may apply to the finished product, including the barrier layer, provided that the thickness of the outside barrier layer, including any adhesive layer, is ≤ 0,4 mm and the design calculation using the values of outside diameter and wall thickness of base pipe (PP) meet the $S_{calc,max}$ values according to Table 1 to 4.

The manufacturer shall state the dimensions and tolerances of the base pipe in his documentation when different from Tables 5 to 9 of this part of ISO 15874.

Pipes with non-circular cross section are permitted if they conform to the requirements of this standard.

6.2 Dimensions of pipes

6.2.1 Outside diameters

For the applicable pipe dimension class, the mean outside diameter, d_{em}, of a pipe shall conform to Table 5, 6, 7 or 8, as applicable.

6.2.2 Wall thicknesses and their tolerances

For any particular class of service conditions, design pressure and nominal size, the minimum wall thickness, e_{min}, shall be chosen in such a way that the corresponding S series or S_{calc}-value is equal to or less than the values of $S_{calc,max}$ given in Table 1, 2, 3 or 4.

For the applicable pipe dimension class, the wall thickness of the base pipe or finished pipe (see clause 6.1), shall conform to Table 5, 6, 7 or 8, as applicable, in relation to the pipe series S and S_{calc}-values, respectively. However, pipes intended to be joined together by fusion shall have a minimum wall thickness of 2,0 mm.

The tolerance on the wall thickness, e, shall conform to Table 9.

Table 5 — Pipe dimensions for dimension class A
(sizes in accordance with ISO 4065:1996 and applicable for all classes of service conditions)

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter	Mean outside diameter		Pipe series						
				S 8 [a]	S 6,3 [a]	S 5	S 4 [a]	S 3,2	S 2,5	S 2
				Wall thicknesses						
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} and e_n						
12	12	12	12,3	1,8	1,8	1,8	1,8	1,8	2,0	2,4
16	16	16	16,3	1,8	1,8	1,8	1,8	2,2	2,7	3,3
20	20	20	20,3	1,8	1,8	1,9	2,3	2,8	3,4	4,1
25	25	25	25,3	1,8	1,9	2,3	2,8	3,5	4,2	5,1
32	32	32	32,3	1,9	2,4	2,9	3,6	4,4	5,4	6,5
40	40	40	40,4	2,4	3,0	3,7	4,5	5,5	6,7	8,1
50	50	50	50,5	3,0	3,7	4,6	5,6	6,9	8,3	10,1
63	63	63	63,6	3,8	4,7	5,8	7,1	8,6	10,5	12,7
75	75	75	75,7	4,5	5,6	6,8	8,4	10,3	12,5	15,1
90	90	90	90,9	5,4	6,7	8,2	10,1	12,3	15,0	18,1
110	110	110	111	6,6	8,1	10,0	12,3	15,1	18,3	22,1
125	125	125	126,2	7,4	9,2	11,4	14,0	17,1	20,8	25,1
140	140	140	141,3	8,3	10,3	12,7	15,7	19,2	23,3	28,1
160	160	160	161,5	9,5	11,8	14,6	17,9	21,9	26,6	32,1

[a] Only valid for PP-RCT

Table 6 — Pipe dimensions for dimension class B1
(sizes based on copper pipe sizes for all classes of service conditions)

Dimensions in millimetres

Nominal size DN/OD	Nominal outside diameter	Mean outside diameter		Pipe series						
				S 8 [a]	S 6,3 [a]	S 5	S 4 [a]	S 3,2	S 2,5	S 2
				Wall thicknesses						
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} and e_n						
10	10	9,9	10,2	1,8	1,8	1,8	1,8	1,8	1,8	2,0
12	12	11,9	12,2	1,8	1,8	1,8	1,8	1,8	2,0	2,4
15	15	14,9	15,2	1,8	1,8	1,8	1,8	2,0	2,5	3,0
18	18	17,9	18,2	1,8	1,8	1,8	2,0	2,4	3,0	3,6
22	22	21,9	22,2	1,8	1,8	2,0	2,5	3,0	3,7	4,4
28	28	27,9	28,2	1,8	2,1	2,5	3,2	3,8	4,7	5,6
35	35	34,9	35,4	2,1	2,6	3,2	3,9	4,8	5,8	7,0

[a] Only valid for PP-RCT

Table 7 — Pipe dimensions for dimension class B2
(sizes based on copper pipe sizes for all classes of service conditions)

Dimensions in millimetres

Nominal size DN/ OD	Nominal outside diameter	Mean outside diameter		Wall thicknesses	S_{calc}
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} and e_n	
14,7	14,7	14,63	14,74	1,6	4,1
21	21	20,98	21,09	2,05	4,6
27,4	27,4	27,33	27,44	2,6	4,8
34	34	34,08	34,19	3,15	4,9

Table 8— Pipe dimensions for dimension class C
(non-preferred pipe sizes used for example for heating systems.)

Dimensions in millimetres

Nominal size DN/ OD	Nominal outside diameter	Mean outside diameter		Wall thicknesses	S_{calc}
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} and e_n	
14	14	14,0	14,3	2,0	3,0
15	15	15,0	15,3	2,0	3,2
16	16	16,0	16,3	2,0	3,5
17	17	17,0	17,3	2,0	3,8
18	18	18,0	18,3	2,0	4,0
20	20	20,0	20,3	2,0	4,5

Table 9 — Tolerance on wall thicknesses

Dimensions in millimetres

Minimum wall thickness e_{min}		Tolerance [a] X	Minimum wall thickness e_{min}		Tolerance [a] X
>	≤		>	≤	
1,0	2,0	0,3	17,0	18,0	1,9
2,0	3,0	0,4	18,0	19,0	2,0
3,0	4,0	0,5	19,0	20,0	2,1
4,0	5,0	0,6	20,0	21,0	2,2
5,0	6,0	0,7	21,0	22,0	2,3
6,0	7,0	0,8	22,0	23,0	2,4
7,0	8,0	0,9	23,0	24,0	2,5
8,0	9,0	1,0	24,0	25,0	2,6
9,0	10,0	1,1	25,0	26,0	2,7
10,0	11,0	1,2	26,0	27,0	2,8
11,0	12,0	1,3	27,0	28,0	2,9
12,0	13,0	1,4	28,0	29,0	3,0
13,0	14,0	1,5	29,0	30,0	3,1
14,0	15,0	1,6	30,0	31,0	3,2
15,0	16,0	1,7	31,0	32,0	3,3
16,0	17,0	1,8	32,0	33,0	3,4

[a] The tolerance is expressed in the form $^{+X}_{0}$ mm, where "x" is the value of the tolerance given.

The level of the tolerances conforms to Grade V in ISO 11922-1 [2].

7 Mechanical characteristics

When tested in accordance with the test methods as specified in Table 10 using the indicated parameters, the pipe shall withstand the hydrostatic (hoop) stress without bursting. In the case of pipes with (a) barrier layer(s) the test shall be carried out on test pieces produced without the barrier layer(s).

Table 10 — Mechanical characteristics of pipes

Characteristic	Requirement	Test parameters for the individual tests				Test method
		PP-H				
Resistance to internal pressure	No failure during the test period	**Hydrostatic (hoop) stress** MPa	**Test temp.** °C	**Test period** h	**Number of test pieces**	ISO 1167-1, ISO 1167-2
		21,0	20	1	3	
		5,1	95	22	3	
		4,2	95	165	3	
		3,6	95	1000	3	
		PP-B				
		Hydrostatic (hoop) stress MPa	**Test temp.** °C	**Test period** h	**Number of test pieces**	
		16,0	20	1	3	
		3,5	95	22	3	
		3,0	95	165	3	
		2,6	95	1000	3	
		PP-R				
		Hydrostatic (hoop) stress MPa	**Test temp.** °C	**Test period** h	**Number of test pieces**	
		16,0	20	1	3	
		4,3	95	22	3	
		3,8	95	165	3	
		3,5	95	1000	3	
		PP-RCT				
		Hydrostatic (hoop) stress MPa	**Test temp.** °C	**Test period** h	**Number of test pieces**	
		15,0	20	1	3	
		4,2	95	22	3	
		4,0	95	165	3	
		3,8	95	1000	3	
		Test parameters for all tests				
		Sampling procedure	[a]			
		Type of end cap	Type A			
		Orientation of test piece	Not specified			
		Type of test	Water-in-water			

[a] The sampling procedure is not specified. For guidance see ISO/TS 15874-7 [3].

8 Physical and chemical characteristics

When tested in accordance with the test methods as specified in Table 11 using the indicated parameters, the pipe shall conform to the requirements given in this table.

Table 11 — Physical and chemical characteristics of pipes

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Longitudinal reversion	≤ 2 %	Test temperature		Method B of ISO 2505 (oven test)
		PP-H	150 °C	
		PP-B	150 °C	
		PP-R	135 °C	
		PP-RCT	135 °C	
		Duration of exposure for:		
		$e_n \leq 8$ mm	1 h	
		8 mm < $e_n \leq 16$ mm	2 h	
		$e_n > 16$ mm	4 h	
		Number of test pieces	3	
Thermal stability by hydrostatic pressure testing	No bursting during the test period	Sampling procedure	[a]	ISO 1167-1, ISO 1167-2
		Hydrostatic (hoop) stress		
		PP-H	1,9 MPa	
		PP-B	1,4 MPa	
		PP-R	1,9 MPa	
		PP-RCT	2,6 MPa	
		Test temperature	110 °C	
		Type of test	Water-in-air	
		End cap	Type A	
		Orientation	Not specified	
		Test period	8760 h	
		Number of test pieces	1	
Impact resistance	≤ 10 %	Sampling procedure	[a]	ISO 9854-1, ISO 9854-2
		Test temperature PP-H	23 °C	
		PP-B	0 °C	
		PP-R	0 °C	
		PP-RCT	0 °C	
		Number of test pieces	10	
Melt flow rate (compound)	≤ 0,5 g/10 min	Test temperature	230 °C	ISO 1133-1
		Mass	2,16 kg	
		Number of test pieces	3	
Melt flow rate (pipe)	30 % maximum difference compared with compound from the same batch.	Test temperature	230 °C	ISO 1133-1
		Mass	2,16 kg	
		Number of test pieces	3	

[a] The sampling procedure is not specified. For guidance see ISO/TS 15874-7 [3].

9 Performance requirements

When pipes conforming to this part of ISO 15874 are jointed to each other or to components conforming to ISO 15874-3, the pipes and the joints shall conform to ISO 15874-5.

10 Marking

10.1 General requirements

Marking details shall be printed or formed directly on the pipe not less than once per metre in such a way that after storage, handling, and the installation, (e.g. in accordance with CEN/TR 12108 [1]) legibility is maintained.

NOTE The manufacturer is not responsible for marking being illegible, due to actions such as painting, scratching, covering of the components or by use of detergent etc. on the components unless agreed or specified by the manufacturer.

Marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe.

If printing is used, the colouring of the printed information shall differ from the basic colouring of the pipe.

The size of the marking shall be such that the marking is legible without magnification.

10.2 Minimum required marking

The minimum required marking of the pipe is specified in Table 12.

Table 12 — Minimum required marking

Aspects	Marking or symbol
- Number of this International Standard	ISO 15874
- Manufacturer's name and/or trade mark	Name or code
- Nominal outside diameter and nominal wall thickness	e.g. 16 × 2,2
- Pipe dimension class	e.g. A
- Material	e.g. PP-R
- Application class combined with operating pressure	e.g. Class 1/10 bar
- Opacity [a]	e.g. opaque
- Manufacturer's information	[b]

[a] If declared by the manufacturer.

[b] For proving traceability the following details shall be given:

a) the production period, year and month, in figures or in code;

b) a name or code for the production site if the manufacturer is producing at different sites.

NOTE Attention is drawn to the possible need to include CE marking when required for legislative purposes.

Annex A
(informative)

Derivation of $S_{calc,max}$

A.1 General

This annex details the principles regarding the calculation of $S_{calc,max}$-values and, hence, of minimum wall thicknesses, e_{min}, of pipes relative to the classes of service conditions (application class) given in Table 1 of ISO 15874-1:2013 and the applicable design pressure, p_D.

A.2 Design stress

The design stress, σ_D, for a particular class of service conditions (application class) is calculated from equation (1), (2), (3) or (4) and equation (5), (6) or (7) (see Note 2 of 4.2) using Miner's rule in accordance with ISO 13760 [4] and taking into account the applicable class requirements given in ISO 15874-1:2013, Table 1 and the service coefficients given in Table A.1.

Table A.1 — Design coefficients

Temperature °C	Design coefficient C			
	PP-H	PP-B	PP-R	PP-RCT
T_{operD}	1,5	1,5	1,5	1,5
$T_{max.}$	1,3	1,3	1,3	1,3
T_{mal}	1,0	1,0	1,0	1,0
T_{cold}	1,6	1,4	1,4	1,4

The resulting design stress, σ_D, has been calculated relative to each class and is given in Table A.2.

Table A.2 — Design stress

Application class	Design stress [a] σ_D MPa			
	PP-H	PP-B	PP-R	PP-RCT
1	2,88	1,66	3,02	3,64
2	1,99	1,19	2,12	3,40
4	3,23	1,94	3,29	3,67
5	1,82	1,19	1,89	2,92
20 °C/50 years:	6,26	6,22	6,93	8,25

[a] Values given are rounded to the second place of decimals (i.e. the nearest 0,01 MPa).

A.3 Derivation of maximum value of S_{calc} ($S_{calc,max}$)

$S_{calc,max}$ is the smaller value of

either $\frac{\sigma_{DP}}{p_D}$

where:

σ_{DP} is the design stress in the pipe material taken from Table A.2 in megapascals (MPa);

p_D is the design pressure of 4 bar or 6 bar or 8 bar or 10 bar, as applicable, expressed in megapascals (MPa);

or $\frac{\sigma_{cold}}{p_D}$

where:

σ_{cold} is the design stress at 20 °C relative to a service life of 50 years;

p_D is the design pressure of 10 bar, expressed in megapascals (MPa).

The values of $S_{calc,max}$, relative to each class of service condition (see ISO 15874-1) are given in Tables A.3, A.4, A.5 and A.6.

Table A.3 — $S_{calc,max}$-values for PP-H

P_D	Application			
	Class 1	Class 2	Class 4	Class 5
Bar	$S_{calc,max}$-values [a]			
4	6,3 [b]	5,0	6,3 [b]	4,6
6	4,8	3,3	5,4	3,0
8	3,6	2,5	4,0	2,3
10	2,9	2,0	3,2	1,8

[a] The values are rounded to the first place of decimals.
[b] Based on σ_{cold}: p_D.

Table A.4 — $S_{calc,max}$-values for PP-B

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	4,2	3,0	4,9	3,0
6	2,8	2,0	3,2	2,0
8	2,1	1,5	2,4	1,5
10	1,7	1,2	1,9	1,2

[a] The values are rounded to the first place of decimals.

Table A.5 — $S_{calc,max}$-values for PP-R

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	6,9 [b]	5,3	6,9 b	4,7
6	5,0	3,5	5,5	3,2
8	3,8	2,6	4,1	2,4
10	3,0	2,1	3,3	1,9

[a] The values are rounded to the first place of decimals.
[b] Based on σ_{cold}: p_D.

Table A.6 — $S_{calc,max}$-values for PP-RCT

p_D	Application			
	Class 1	Class 2	Class 4	Class 5
bar	$S_{calc,max}$-values [a]			
4	8,2 [b]	8,2 [b]	8,2 [b]	7,3
6	6,1	5,7	6,1	4,9
8	4,5	4,3	4,6	3,7
10	3,6	3,4	3,7	2,9

[a] The values are rounded to the first place of decimals.
[b] Based on σ_{cold}: p_D.

A.4 Use of ($S_{calc,max}$) to determine wall thickness

The S series and S_{calc} values shall be chosen for each application class and design pressure from Table 5, 6, 7 or 8, as applicable, in such a way that S or S_{calc} is not greater than $S_{calc,max}$ in Table A.3, A.4, A.5 or A.6 (see also 6.2).

Bibliography

[1] CEN/TR 12108, *Plastics piping systems — Guidance for the installation inside buildings of pressure piping systems for hot and cold water intended for human consumption*

[2] ISO 11922-1, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

[3] ISO 13760, *Plastics pipes for the conveyance of fluids under pressure — Miner's rule — Calculation method for cumulative damage*

[4] ISO/TS 15874-7, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 7: Guidance for the assessment of conformity*

ICS 23.040.20; 91.140.60

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