BRITISH STANDARD

BS EN ISO
15874-2:2003

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

Part 2: Pipes

The European Standard EN ISO 15874-2:2003 has the status of a British Standard

ICS 23.040.20; 91.140.60

BSI
British Standards

National foreword

This British Standard is the official English language version of EN ISO 15874-2:2003. It is identical with ISO 15874-2:2003.

The UK participation in its preparation was entrusted by Technical Committee PRI/88, Plastics piping systems, to Subcommittee PRI/88/2, Plastics piping systems for pressure applications, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Additional information

The UK voted against the acceptance of this standard at the CEN Formal Vote, and PRI 88/2 will maintain BS 7291-1:2001[1)], BS 7291-2:2001[2)] and BS 7291-3:2001[3)] and strongly recommends the continued use of polybutylene (PB) and crosslinked polyethylene (PE-X) piping systems certified to BS 7291-2 or BS 7291-3, Class S, for the following reasons.

a) Attention is drawn to the statement in the Scope of BS EN ISO 15874-1 relating to the exclusion from it of piping systems having service conditions in excess of those quoted in BS EN ISO 15874-1, Table 1. Central heating systems in the UK fall into this category. BS 7291-1 states the service conditions for UK systems where the maximum system service temperature for sealed central heating systems, designated as Class S, is 105 °C and the system malfunction temperature is 114 °C. Both these temperatures are significantly in excess of those specified in BS EN ISO 15874-1, Table 1 and these UK systems are therefore not covered by this standard.

1) BS 7291-1:2001, *Thermoplastics pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings — Part 1: General requirements.*
2) BS 7291-2:2001, *Thermoplastics pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings — Part 2: Specification for polybutylene (PB) pipes and associated fittings.*
3) BS 7291-3:2001, *Thermoplastics pipes and associated fittings for hot and cold water for domestic purposes and heating installations in buildings — Part 3: Specification for cross-linked polyethylene (PE-X) pipes and associated fittings.*

Amendments issued since publication

Amd. No.	Date	Comments

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b) In addition to the above:

1) The normal maximum operating cold water supply pressure in the UK is 12.5 bar[4] which some categories of piping systems in the BS EN ISO 15874 series of standards do not meet.

2) The BS EN ISO 15874 series of standards does not specifically describe push fit joints, which are the predominant jointing method in the UK.

3) There is a disparity between the malfunction temperature quoted in BS EN ISO 15874-1, Table 1 (100 °C) and the malfunction temperatures applicable to boilers (110 °C) conforming to BS EN 297:1994[5], BS EN 483:2000[6] and BS EN 625:1996[7]. Consequently piping systems could be subjected to temperatures in service for which they have not been tested.

4) The unique and traditional practice in the UK is to use products certified to BS 7291-2 or BS 7291-3, Class S, for all applications, as defined in BS 7291-1. This is recognized in the national annex to BS EN 12828[8], which recommends the use of systems suitable for the maximum temperatures and pressures for their intended application specified in BS 7291-1.

Updated versions of BS 7291-1, BS 7291-2 and BS 7291-3 are being prepared, which maintain these traditional UK operating conditions, and measures are being taken to address this issue in appropriate harmonized European Standards.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, page i, a blank page, the EN title page, pages 2 to 20, an inside back cover and a back cover.

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[4] 1 bar = 100 kPa.
[5] BS EN 297:1994, *Gas-fired central heating boilers — Type B_{11} and B_{11BS} boilers fitted with atmospheric burners of nominal heat input not exceeding 70 kW.*
[6] BS EN 483:2000, *Gas-fired central heating boilers — Type C boilers of nominal heat input not exceeding 70 kW.*
[7] BS EN 625:1996, *Gas-fired central heating boilers — Specific requirements for the domestic hot water operation of combination boilers of nominal heat input not exceeding 70 kW.*
[8] BS EN 12828, *Heating systems in buildings — Design for water-based heating systems.*

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 15874-2

December 2003

ICS 23.040.20; 91.140.60

English version

Plastics piping systems for hot and cold water installations - Polypropylene (PP) - Part 2: Pipes (ISO 15874-2:2003)

Systèmes de canalisations en plastique pour les installations d'eau chaude et froide - Polypropylène (PP) - Partie 2: Tubes (ISO 15874-2:2003)

Kunststoff-Rohrleitungssysteme für die Warm- und Kaltwasserinstallation - Polypropylen (PP) - Teil 2: Rohre (ISO 15874 -2:2003)

This European Standard was approved by CEN on 14 March 2003.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN ISO 15874-2:2003) has been prepared by Technical Committee CEN/TC 155 “Plastics piping systems and ducting systems”, the secretariat of which is held by NEN, in collaboration with Technical Committee ISO/TC 138 "Plastics pipes, fittings and valves for the transport of fluids".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2004, and conflicting national standards shall be withdrawn at the latest by December 2005.

NOTE 1 This standard was submitted for CEN enquiry as prEN 12202-2:1995.

This standard is part of a System Standard for plastics piping systems of a particular material for a specified application. There are a number of such System Standards.

System Standards are based on the results of the work undertaken in ISO/TC 138 "Plastics pipes, fittings and valves for the transport of fluids", which is a Technical Committee of the International Organization for Standardization (ISO).

They are supported by separate Standards on test methods to which references are made throughout the System Standard.

The System Standards are consistent with general standards on functional requirements and recommended practices for installation.

EN 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* (the present standard)
— *Part 3: Fittings*
— *Part 5: Fitness for purpose of the system*
— Part 7: *Guidance for the assessment of conformity* (CEN ISO/TS 15874-7).

This Part of EN ISO 15874 includes the following:

— Annex A (informative): Derivation of $S_{calc,max}$
— Bibliography

At the date of publication of this standard, System Standards for piping systems of other plastics materials used for the same application are the following:

EN ISO 15875, *Plastics piping systems for hot and cold water installations — Crosslinked polyethylene (PE-X) (ISO 15875:2003)*

EN ISO 15876, *Plastics piping systems for hot and cold water installations — Polybutylene (PB) (ISO 15876:2003)*

EN ISO 15877, *Plastics piping systems for hot and cold water installations — Chlorinated poly(vinyl chloride) (PVC-C) (ISO 15877:2003)*

For pipes and fittings which have conformed to the relevant national standard before 1st November 2003, as shown by the manufacturer or by a certification body, the national standard may continue to apply until 30th November 2005.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

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1) This System Standard does not incorporate a Part 4 *Ancillary equipment* or a Part 6: *Guidance for installation.* 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 ENV 12108 [1].

Introduction

The System Standard, of which this is Part 2, 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.

In respect of potential adverse effects on the quality of water intended for human consumption, caused by the product covered by this standard:

— This standard 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, other than pipes, are specified in Part 1 and Part 3 of EN ISO 15874:2003. Characteristics for fitness for purpose (mainly for joints) are covered in Part 5. Part 7 (CEN ISO/TS 15874-7:2003) gives guidance for the assessment of conformity.

This part of EN ISO 15874 specifies the characteristics of pipes.

1 Scope

This part of EN ISO 15874 specifies the characteristics 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 Table 1 of EN ISO 15874-1:2003).

This standard 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 1of Part 1, this standard does 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 standard.

In conjunction with the other parts of EN ISO 15874 (see Foreword) it 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

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to, or revisions of, any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 578, *Plastics piping systems — Plastics pipes and fittings — Determination of the opacity*

EN 743:1994, *Plastics piping and ducting systems — Thermoplastics pipes — Determination of the longitudinal reversion*

EN 921:1994, *Plastics piping systems — Thermoplastics pipes — Determination of resistance to internal pressure at constant temperature*

EN ISO 15874-1:2003, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 1: General (ISO 15874-1:2003)*

EN ISO 15874-5, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 5: Fitness for purpose of the system (ISO 15874-5:2003)*

EN ISO 3126, *Plastics piping systems — Plastics components — Measurement of dimensions (ISO 3126:2003)*

EN ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation (ISO 9080:2003)*

ISO 1133, *Plastics — Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics*

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

ISO 9854-2, *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*

3 Terms and definitions, symbols and abbreviated terms

For the purposes of this standard the terms and definitions, symbols and abbreviated terms given in EN ISO 15874-1:2003 apply.

4 Material

4.1 Pipe material

The material from which the pipe is made shall be polypropylene (PP).

4.2 Evaluation of σ_{LCL}-values

The pipe material shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN 921:1994 to find the σ_{LCL}-values. The σ_{LCL}-value thus determined shall at least be as high as the corresponding values of the reference curves given in Figure 1, 2 or 3, over the complete range of times in Figure 1, 2 or 3.

NOTE 1 One equivalent way of evaluation is to calculate the σ_{LCL} -value for each temperature (for example 20 °C, 60 °C and 95 °C) individually.

NOTE 2 The reference curves in Figures 1, 2 and 3 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 and 3)

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

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

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

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

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

for PP-B: $$\log t = -13{,}699 + \frac{6970{,}3}{T} - 3{,}82 \log \sigma \quad (5)$$

for PP-R: $$\log t = -19{,}98 + \frac{9507}{T} - 4{,}11 \log \sigma \quad (6)$$

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 tempeatures given, at least three failure times fall in each of the following time intervals:

Tempertures 20; 60-70; 95; °C;

Time intervals 10-100 h, 100-1000 h,1000-8760 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 can be considered as the failure time. Testing should be carried out in accordance with EN 921:1994.

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.

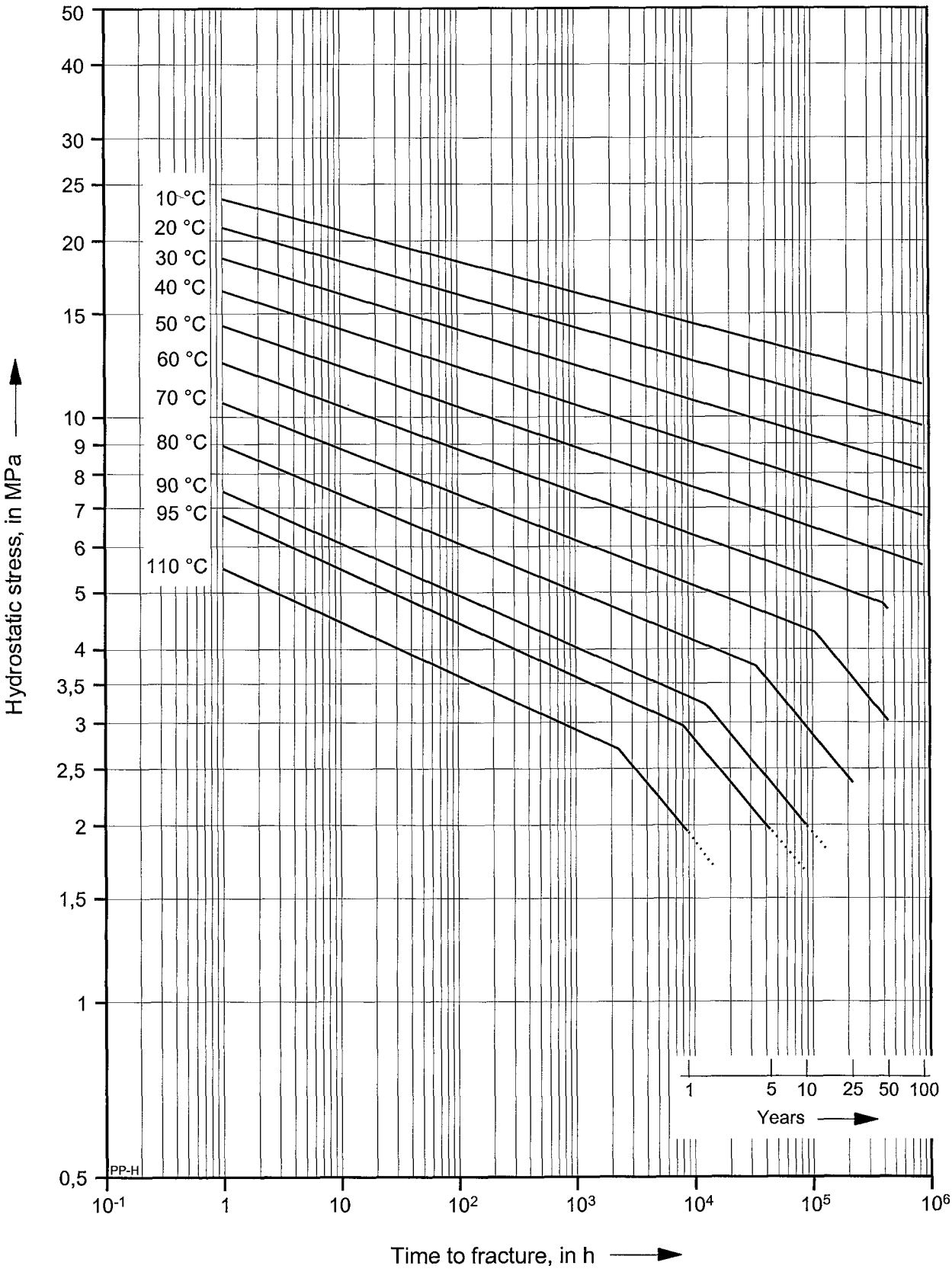

Figure 1 — Reference curves for expected strength of polypropylene homopolymer

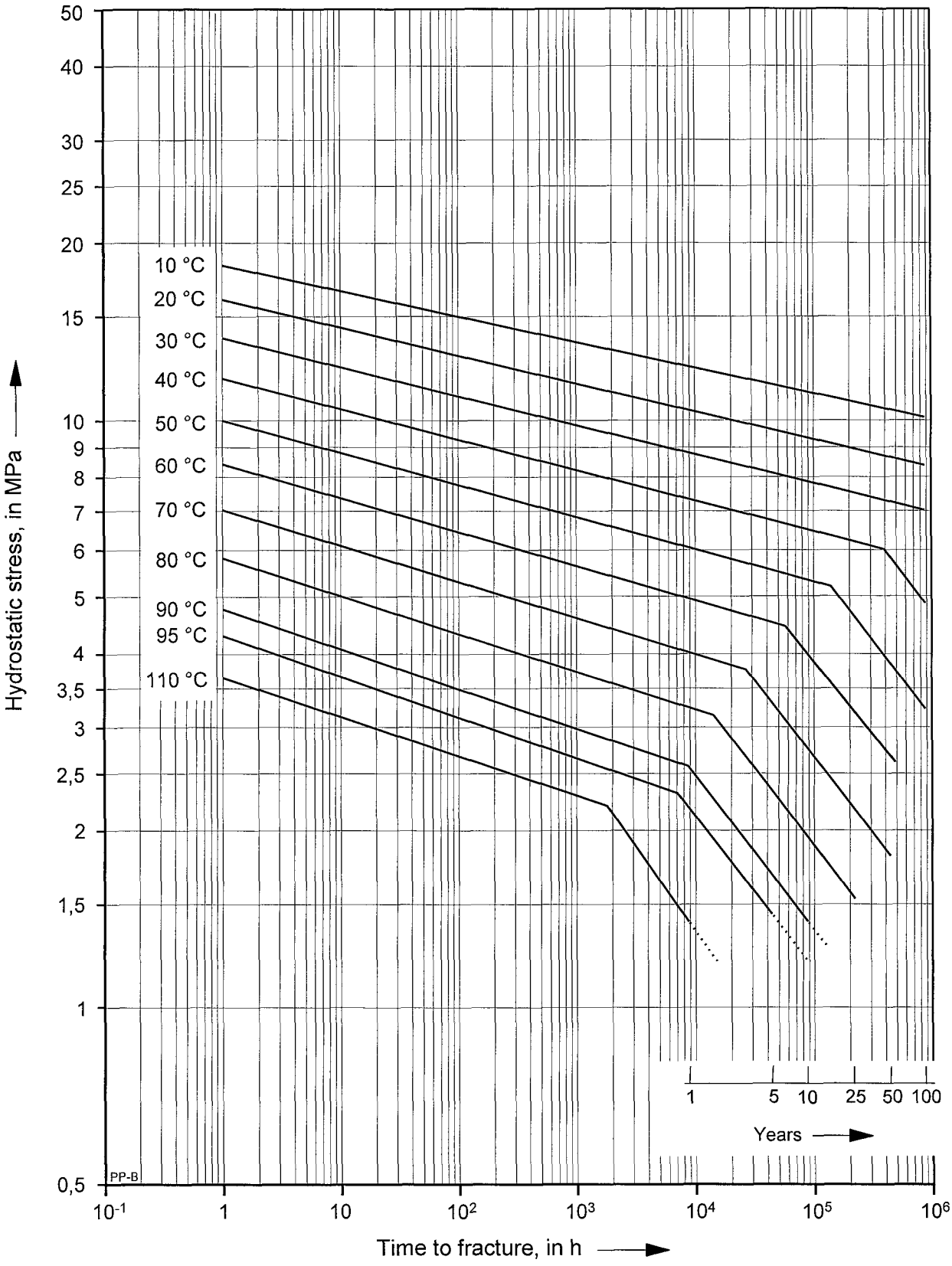

Figure 2 — Reference curves for expected strength of polypropylene block copolymer

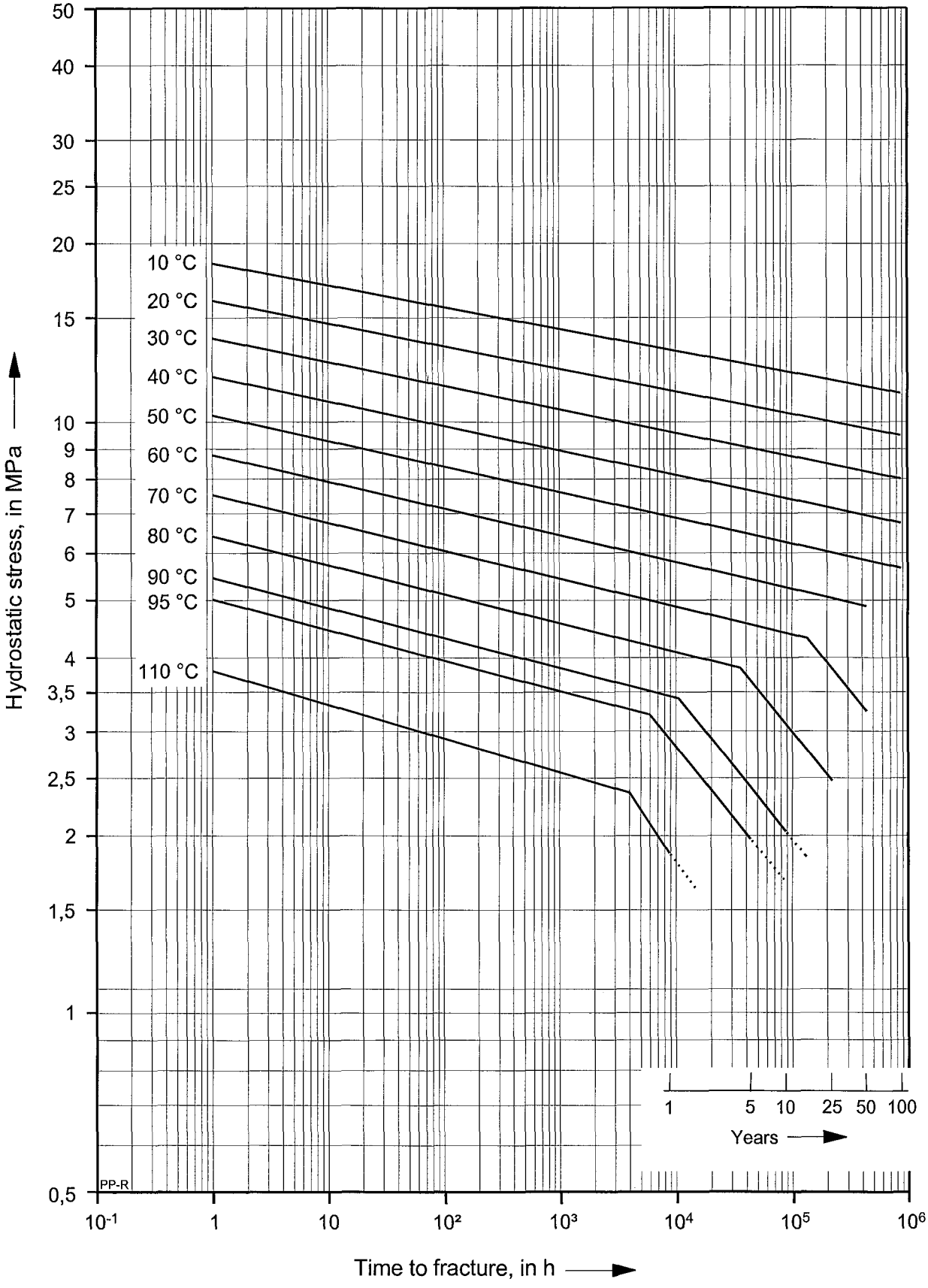

Figure 3 — Reference curves for expected strength of polypropylene random copolymer

4.3 Influence on water intended for human consumption

The material shall conform to EN ISO 15874-1:2003.

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 EN 578.

6 Geometrical characteristics

6.1 General

6.1.1 Dimensions shall be measured in accordance with EN ISO 3126.

6.1.2 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 or 3.

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

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

[a] 1 bar = 10^5 N/mm^2.
[b] The values are rounded to the first place of decimals.

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	3,3	2,0
8	2,1	1,5	2,4	1,5
10	1,7	1,2	2,0	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	4,8
6	5,2	3,6	5,5	3,2
8	3,9	2,7	4,1	2,4
10	3,1	2,1	3,3	1,9
[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 EN ISO 15874-1:2003.

6.1.3 The values of outside diameter and/or wall thickness apply to the polypropylene pipe and are exclusive of any barrier layer thickness.

6.1.4 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 4, 5, 6 or 7, 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 or 3.

For the applicable pipe dimension class, the wall thicknesses, e_{min} and e_n respectively, shall conform to Table 4, 5, 6 or 7, 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 8.

Table 4 — Pipe dimensions for dimension class A
(sizes conform to ISO 4065:1996 [2] and are applicable for all classes of service conditions)

Dimensions in millimetres

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

[a] A non-preferred wall thickness of 1,1 mm is permitted for d_n = 12.

Table 5 — 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 5	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	2
12	12	11,9	12,2	1,8	1,8	2	2,4
15	15	14,9	15,2	1,8	2	2,5	3
18	18	17,9	18,2	1,8	2,4	3	3,6
22	22	21,9	22,2	2	3	3,7	4,4
28	28	27,9	28,2	2,5	3,8	4,7	5,6
35	35	34,9	35,4	3,2	4,8	5,8	7

Table 6 — 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 7 — 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 8 — 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	11,0	12,0	1,3
2,0	3,0	0,4	12,0	13,0	1,4
3,0	4,0	0,5	13,0	14,0	1,5
4,0	5,0	0,6	14,0	15,0	1,6
5,0	6,0	0,7	15,0	16,0	1,7
6,0	7,0	0,8	16,0	17,0	1,8
7,0	8,0	0,9	17,0	18,0	1,9
8,0	9,0	1,0	18,0	19,0	2,0
9,0	10,0	1,1	19,0	20,0	2,1
10,0	11,0	1,2	20,0	21,0	2,2
			21,0	22,0	2,3

[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 11922-1:1997 [3].

7 Mechanical characteristics

When tested in accordance with the test methods as specified in Table 9 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 9 — 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**	EN 921:1994
		21,0	20	1	3	
		5,1	95	22	3	
		4,2	95	165	3	
		3,5	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	
		Test parameters for all tests				
		Sampling procedure Type of end cap Orientation of test piece Type of test		[a] Type a) Not specified Water-in-water		

[a] The sampling procedure is not specified. For guidance see CEN ISO/TS 15874-7 [4].

8 Physical and chemical characteristics

When tested in accordance with the test methods as specified in Table 10 using the indicated parameters, the pipe shall conform to the requirements given in this table.

Table 10 — Physical and chemical characteristics of pipes

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Longitudinal reversion	≤ 2 %	Test temperature PP-H PP-B PP-R Duration of exposure for: $e_n \leq 8$ mm 8 mm < $e_n \leq 16$ mm $e_n > 16$ mm Number of test pieces	 150 °C 150 °C 135 °C 1 h 2 h 4 h 3	Method B of EN 743:1994 (oven test)
Thermal stability by hydrostatic pressure testing	No bursting during the test period	Sampling procedure Hydrostatic (hoop) stress PP-H PP-B PP-R Test temperature Type of test End cap Orientation Test period Number of test pieces	[a] 1,9 MPa 1,4 MPa 1,9 MPa 110 °C Water-in-air Type a) Not specified 8760 h 1	EN 921:1994
Impact resistance	< 10 %	Sampling procedure Test temperature PP-H PP-B PP-R Number of test pieces	[1)] 23 °C 0 °C 0 °C 10	ISO 9854
Melt flow rate (compound)	≤ 0,5 g/10 min	Test temperature Mass Number of test pieces	230 °C 2,16 kg 3	ISO 1133
Melt flow rate (pipe)	30 % maximum difference compared with compound	Test temperature Mass Number of test pieces	230 °C 2,16 kg 3	ISO 1133

[a] The sampling procedure is not specified. For guidance see CEN ISO/TS 15874-7 [4].

9 Performance requirements

When pipes conforming to this standard are jointed to each other or to components conforming to EN ISO 15874-3 [5], the pipes and the joints shall conform to EN ISO 15874-5.

10 Marking

10.1 General requirements

10.1.1 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 ENV 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.

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

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

10.1.4 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 11.

Table 11 — Minimum required marking

Aspects	Marking or symbol
- Number of this standard	EN 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 EN ISO 15874-1:2003 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) or (3) and equation (4), (5) or (6) (see Note 2 of 4.2) using Miner's rule in accordance with EN ISO 13760 [6] and taking into account the applicable class requirements given in EN ISO 15874-1:2003, Table 1 and the service coefficients given in Table A.1.

Table A.1 — Overall service (design) coefficients

Temperature °C	**Overall service (design) coefficient** ***C***		
	PP-H	PP-B	PP-R
T_{operD}	1,5	1,5	1,5
$T_{max.}$	1,3	1,3	1,3
T_{mal}	1,0	1,0	1,0
T_{cold}	1,6	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
1	2,90	1,67	3,09
2	1,99	1,19	2,13
4	3,24	1,95	3,30
5	1,83	1,19	1,90
20 °C/50 years:	6,25	6,21	6,93

[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 $\dfrac{\sigma_{DP}}{p_D}$

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 $\dfrac{\sigma_{cold}}{p_D}$

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 EN ISO 15874-1:2003) are given in Tables A.3, A.4 and A.5.

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 [2)]	5,0	6,3 [b]	4,6
6	4,8	3,3	5,4	3,0
8	3,6	2,5	4,1	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	3,3	2,0
8	2,1	1,5	2,4	1,5
10	1,7	1,2	2,0	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 [2)]	5,3	6,9 [b]	4,8
6	5,2	3,6	5,5	3,2
8	3,9	2,7	4,1	2,4
10	3,1	2,1	3,3	1,9

[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 4, 5, 6 or 7, as applicable, in such a way that S or S_{calc} is not greater than $S_{calc,max}$ in Table A.3, A.4 or A.5 (see also 6.2).

Bibliography

[1] ENV 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 4065:1996, *Thermoplastics pipes – Universal wall thickness table*

[3] ISO 11922-1:1997, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

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

[5] EN ISO 15874-3, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) — Part 3: Fittings (ISO 15874-3:2003)*

[6] EN ISO 13760, *Plastics pipes for the conveyance of fluids under pressure — Miner's rule — Calculation method for cumulative damage (ISO 13760:1998)*

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