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EAST AFRICAN STANDARD

Plastics piping systems for hot and cold water installations — Polybutylene (PB) — Part 2: Pipes

EAST AFRICAN COMMUNITY

First Edition 2010

Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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Introduction

In the preparation of this East African Standard, the following source was consulted extensively:

ISO 15876-2:2003, *Plastics piping systems for hot and cold water installations — Polybutylene (PB) — Part 2: Pipes*

Assistance derived from this source and others inadvertently not mentioned is hereby acknowledged.

INTERNATIONAL STANDARD

ISO 15876-2

First edition
2003-12-01

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

Part 2: **Pipes**

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

Partie 2: Tubes

Reference number
ISO 15876-2:2003(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15876-2 was prepared by the European Committee for Standardization (CEN) in collaboration with 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).

Throughout the text of this document, read "...this European Standard..." to mean "...this International Standard...".

ISO 15876 consists of the following parts, under the general title *Plastics piping systems for hot and cold water installations — Polybutylene (PB)*:

— *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]

Contents

Foreword

This document (EN ISO 15876-2:2003) 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 This draft was submitted for CEN enquiry as prEN 12319-2:1996.

This standard is a 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 Organisation 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 15876 consists of the following Parts [1)], under the general title “*Plastics piping systems for hot and cold water installations — Polybutylene (PB)*”

— *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 15876-7).

This Part of EN ISO 15876 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 15874, *Plastics piping systems for hot and cold water installations — Polypropylene (PP) (ISO 15874:2003)*

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

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, 2003.

1) This System Standard does not incorporate a Part 4 *Ancillary equipment* or a Part 6 *Recommended practice 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].

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.

Introduction

The System Standard, of which this is Part 2, specifies the requirements for a piping system when made from polybutylene (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 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 15876:2003. Characteristics for fitness for purpose (mainly for joints) are covered in Part 5. Part 7 (CEN ISO/TS 15876-7) gives guidance for the assessment of conformity.

This Part of EN ISO 15876 specifies the characteristics of pipes.

1 Scope

This Part of EN ISO 15876 specifies the characteristics of pipes made of polybutylene (PB) 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 design pressures and temperatures appropriate to the class of application (see Table 1 of EN ISO 15876-1:2003).

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 1 of 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 15876 (see Foreword) it is applicable to PB pipes, their joints and to joints with components of PB, 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 and where the design stress requirements are totally met by the base polymer (PB).

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 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 15876-1:2003, *Plastics piping systems for hot and cold water installations — Polybutylene (PB) — Part 1: General (ISO 15876-1:2003)*

EN ISO 15876-5, *Plastics piping systems for hot and cold water installations — Polybutylene (PB) — Part 5: Fitness for purpose of the system (ISO 15876-5:2003)*

EN ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions (ISO 3126:2003) (revision of prEN 496:1991 and ISO 3126:1974)*

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*

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 15876-1:2003 apply.

4 Material

4.1 Pipe material

The material from which the pipe is made shall be polybutylene (PB).

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, over the complete range of times.

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 Figure 1 in the temperature range of 10 °C to 110 °C are derived from the following equations:
First branch (i.e. the left hand portion of the lines as shown in Figure 1),

$$\log t = -430{,}866 - \frac{125010 \log \sigma}{T} + \frac{173892{,}7}{T} + 290{,}0569 \log \sigma \qquad (1)$$

Second branch (i.e. the right hand portion of the lines as shown in Figure 1),

$$\log t = -129{,}895 - \frac{37262{,}7 \log \sigma}{T} + \frac{52556{,}48}{T} + 88{,}56735 \log \sigma \qquad (2)$$

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 to 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.

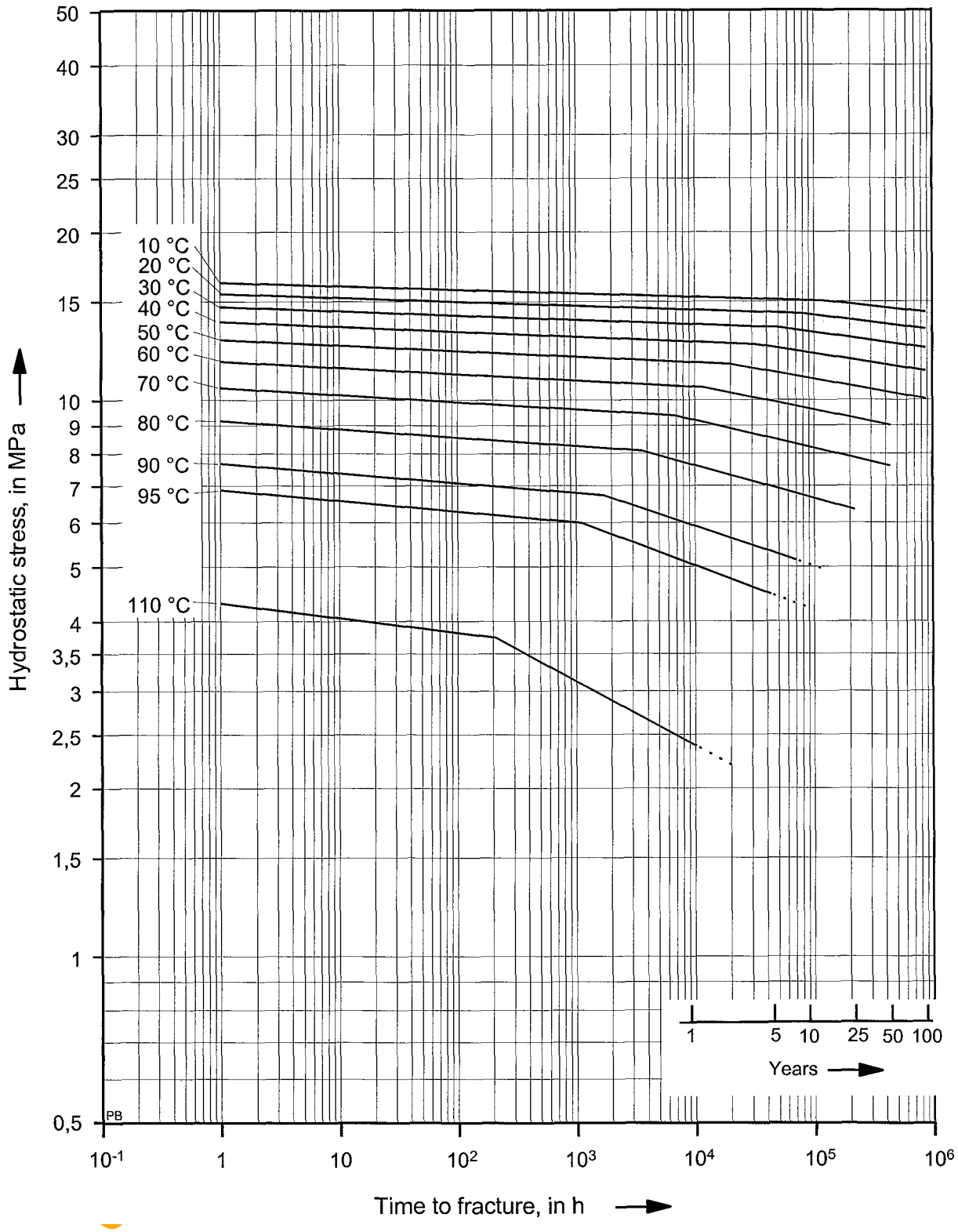

Figure 1 — Reference curves for expected strength of polybutylene

4.3 Influence on water intended for human consumption

The material shall conform to EN ISO 15876-1:2003.

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 conformance with this standard. The material shall not contain visible impurities. Slight variations in the appearance of the colour shall be permitted. The ends of the pipe shall be cut cleanly and square to the axis of the pipe.

5.2 Opacity

Polybutylene 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 pipe value, $S_{calc,max}$, for the applicable class of service condition and design pressure, p_D, shall conform to Table 1.

Table 1 — $S_{calc,max}$-values

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

a The values are rounded to the first place of decimals.
b The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see clause 4 of EN ISO 15876-1:2003).

NOTE The derivation of $S_{calc,max}$ is provided in Annex A. The method described takes account of the properties of PB under the service conditions for the classes given in Table 1 of EN ISO 15876-1:2003.

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

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 2, 3, 4 or 5, as applicable.

6.2.2 Wall thicknesses and their tolerances

For any particular class of service condition, 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.

For the applicable pipe dimension class, the wall thicknesses, e_{min} and e_n respectively, shall conform to Table 2, 3, 4 or 5, 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 1,9 mm.

The tolerance on the wall thickness, e, shall conform to Table 6.

Table 2 — Pipe dimensions for dimension class A
(sizes conform to ISO 4065 [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 10	S 8	S 6,3	S 5	S 4	S 3,2
				Wall thicknesses					
	d_n	$d_{em,min}$	$d_{em,max}$	e_{min} and e_n					
12	12	12,0	12,3	1,3 [a]	1,3 [a]	1,3 [a]	1,3 [a]	1,4	1,7
16	16	16,0	16,3	1,3	1,3	1,3	1,5	1,8	2,2
20	20	20,0	20,3	1,3	1,3	1,5	1,9	2,3	2,8
25	25	25,0	25,3	1,3	1,5	1,9	2,3	2,8	3,5
32	32	32,0	32,3	1,6	1,9	2,4	2,9	3,6	4,4
40	40	40,0	40,4	1,9	2,4	3,0	3,7	4,5	5,5
50	50	50,0	50,5	2,4	3,0	3,7	4,6	5,6	6,9
63	63	63,0	63,6	3,0	3,8	4,7	5,8	7,1	8,6
75	75	75,0	75,7	3,6	4,5	5,6	6,8	8,4	10,3
90	90	90,0	90,9	4,3	5,4	6,7	8,2	10,1	12,3
110	110	110,0	111,0	5,3	6,6	8,1	10,0	12,3	15,1
125	125	125,0	126,2	6,0	7,4	9,2	11,4	14,0	17,1
140	140	140,0	141,3	6,7	8,3	10,3	12,7	15,7	19,2
160	160	160,0	161,5	7,7	9,5	11,8	14,6	17,9	21,9

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

Table 3 — Pipe dimensions for dimension class B1
(sizes based on copper pipe sizes and applicable for all classes of service conditions)

Dimensions in millimetres

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

Table 4 — Pipe dimensions for dimension class B2
(sizes based on copper pipe sizes and applicable 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 5 — 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	
12	12	12,0	12,3	2,0	2,5
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 6 — Tolerance on wall thicknesses

Dimensions in millimetres

Minimum wall thickness e_{min}		Tolerance [a]	Minimum wall thickness e_{min}		Tolerance [a]
>	≤	*x*	>	≤	*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 7 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 without the barrier layer(s).

Table 7 — Mechanical characteristics of pipes

Characteristic	Requirement	Test parameters for the individual tests				Test method
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 of 1994
		15,5	20	1	3	
		6,5	95	22	3	
		6,2	95	165	3	
		6,0	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 15876-7 [4].

8 Physical and chemical characteristics

When tested in accordance with the test methods as specified in Table 8 using the indicated parameters, the pipe shall conform to the requirements given in this table.

Table 8 — Physical and chemical characteristics of pipes

Characteristic	Requirement	Test parameters		Test method
		Parameter	Value	
Longitudinal reversion	≤ 2 %	Temperature Duration of exposure for: $e_n \leq 8$ mm 8 mm < $e_n \leq 16$ mm $e_n > 16$ mm Number of test pieces	110 °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 End cap Orientation Type of test Hydrostatic (hoop) stress Test temperature Test period Number of test pieces	[a] Type a) Free Water-in-air 2,4 MPa 110 °C 8760 h 1	EN 921:1994
Melt mass-flow rate MFR	0,3 g/10 min in maximum difference compared to compound	Mass Test temperature Test period Number of test pieces	5 kg 190 °C 10 min 3	ISO 1133
[a] The sampling procedure is free. For guidance see EN 15876-7 [4].				

9 Performance requirements

When pipes conforming to this standard are jointed to each other or to components conforming to EN ISO 15876-3 [5], the pipes and the joints shall conform to EN ISO 15876-5.

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 meter in such a way that after storage, handling and 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 9.

Table 9 — Minimum required marking

Aspects	Marking or symbol
Number of this standard	EN 15876
Manufacturer's name and/or trade mark	Name or code
Nominal outside diameter and nominal wall thickness	e.g. 32 × 2,9
Pipe dimensions class	e.g. A
Material	PB
Application class combined with design pressure	e.g. Class 2/10 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 15876-1:2003 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) and equation (2) (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 Table 1 of EN ISO 15876-1:2003 and the service coefficients given in Table A.1.

Table A.1 — Overall service (design) coefficients

Temperature °C	Overall service (design) coefficient *C*
T_D	1,5
T_{max}	1,3
T_{mal}	1,0
T_{cold}	1,25

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

Table A.2 — Design stress

Application class	Design stress [a] σ_D MPa
1	5,73
2	5,04
4	5,46
5	4,31
20 °C for 50 y	10,92
[a] Values given are rounded to the second place of decimals (i.e. the nearest 0,01 MPa).	

A.3 Deriviation 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 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 EN ISO 15876-1:2003*)* are given in Table A.3 (reproduced as Table 1).

Table A.3 — $S_{calc,max}$ values

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

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

[b] The 20 °C, 10 bar, 50 years, cold water requirement, being higher, determines this value (see clause 4 of EN ISO 15876-1:2003;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 2, 3, 4 or 5, as applicable, in such a way that *S* or S_{calc} is not greater than $S_{calc,max}$ in Table A.3 (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 15876-7, *Plastics piping systems for hot and cold water installations — Crosslinked polybutylene (PB) — Part 7: Guidance for assessment of conformity*

[5] EN ISO 15876-3, *Plastics piping systems fot hot and cold water installations — Polybutylene (PB) — Part 3 : Fittings (ISO 15876-3:2003)*

[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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