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ISO 15876-1

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

Part 1: General

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

Partie 1: Généralités

Reference number
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Contents

Page

Foreword

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

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

ISO 15876-1 was prepared by the European Committee Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in collaboration with ISO Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 15876-1:2003), which has been technically revised with the following changes:

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

— revision of specifications for conditioning of samples.

It also incorporates the Amendment ISO 15876-1:2003/Amd 1:2007.

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

Introduction

The System Standard ISO 15876, of which this document is Part 1, specifies the requirements for a piping system when made from polybutene (PB). The piping system is intended to be used for hot and cold water installations.

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

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

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

Requirements and test methods for material and components of the piping systems are specified in ISO 15876-2 and ISO 15876-3. Characteristics for fitness for purpose (mainly for joints) are covered in ISO 15876-5. ISO/TS 15876-7 gives guidance for the assessment of conformity.

This document specifies the general aspects of the plastics piping system.

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

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

Part 1: General

1 Scope

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

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

This document covers a range of service conditions (application classes) and design pressure and pipe dimension classes. Values of T_D, T_{max} and T_{mal} in excess of those in Table 1 do not apply.

NOTE It is the responsibility of the purchaser or specifier to make the appropriate selections from these aspects, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

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

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

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 472, *Plastics — Vocabulary*

ISO 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

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

ISO 15876-3, *Plastics piping system for hot and cold water installations — Polybutene (PB) — Part 3: Fittings*

ISO 15876-5, *Plastics piping system for hot and cold water installations — Polybutene (PB) — 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 472 and ISO 1043-1 and the following apply.

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

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

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

3.1 Terms and definitions

3.1.1 Geometrical terms and definitions

3.1.1.1
nominal size
DN
numerical designation of the size of a component, which is a convenient round number, approximately equal to the manufacturing dimensions in millimetres (mm)

3.1.1.2
nominal size
DN/OD
nominal size, related to outside diameter

3.1.1.3
nominal outside diameter
d_n
specified diameter, in millimetres, assigned to a nominal size DN/OD

3.1.1.4
outside diameter (at any point)
d_e
measured outside diameter through the cross-section at any point of a pipe or spigot end of a fitting, rounded up to the nearest 0,1 mm

3.1.1.5
mean outside diameter
d_{em}
measured length of the outer circumference of a pipe or spigot end of a fitting in any cross section divided by $\pi (\approx 3,142)$ rounded up to the nearest 0,1 mm

3.1.1.6
minimum mean outside diameter
$d_{em,min}$
minimum value of the mean outside diameter as specified for a given nominal size

3.1.1.7
maximum mean outside diameter
$d_{em,max}$
maximum value of the mean outside diameter as specified for a given nominal size

3.1.1.8
mean inside diameter of socket
d_{sm}
arithmetical mean of two measured inside diameters perpendicular to each other at the midpoint of the socket length

3.1.1.9
out-of-roundness
ovality
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-sectional plane of a pipe or spigot end of a fitting, or the difference between the measured maximum inside diameter and the measured minimum inside diameter in the same cross-sectional plane of a socket

3.1.1.10
nominal wall thickness
e_n
numerical designation of the wall thickness of a component, approximately equal to the manufacturing dimension in millimetres (mm)

3.1.1.11
wall thickness (at any point)
e
measured wall thickness at any point around the circumference of a component, rounded up to the nearest 0,1 mm

3.1.1.12
minimum wall thickness (at any point)
e_{min}
minimum wall thickness at any point around the circumference of a component, as specified

3.1.1.13
maximum wall thickness (at any point)
e_{max}
maximum wall thickness at any point around the circumference of a component, as specified

3.1.1.14
tolerance
permitted variation of the specified value of a quantity expressed as the difference between the permitted maximum and permitted minimum value

3.1.1.15
pipe series
S
dimensionless number for pipe designation conforming to ISO 4065

Note 1 to entry: According to ISO 15876 (all parts), the pipe series S is used as a means for selecting pipe sizes for practical purposes (see ISO 15876-2).

3.1.1.16
calculated pipe value
S_{calc}
value for a specific pipe calculated according to the following equation, rounded up to the nearest 0,1 mm:

$$S_{calc} = \frac{d_n - e_n}{2e_n}$$

where

d_n is the nominal outside diameter, in millimetres;

e_n is the nominal wall thickness, expressed in millimetres.

3.1.2 Terms and definitions related to service conditions

3.1.2.1
design pressure
p_D
highest pressure related to the circumstances for which the system has been designed and is intended to be used

Note 1 to entry: The design pressure (p_D) is equal to the maximum design pressure (MDP), as specified in EN 806-1.

3.1.2.2
hydrostatic stress
σ
stress, expressed in megapascals, induced in the wall of a pipe when a pressure is applied using water as a medium

Note 1 to entry: Hydrostatic stress is calculated using the following approximate formula:

$$\sigma = p \times \frac{(d_{em} - e_{min})}{2e_{min}}$$

where

p is the applied pressure, in megapascals;

d_{em} is the mean outside diameter of the pipe, in millimetres;

e_{min} is the minimum wall thickness, in millimetres.

3.1.2.3
design temperature
T_D
temperature or a combination of temperatures of the conveyed water dependent on the service conditions for which the system has been designed

3.1.2.4
maximum design temperature
T_{max}
highest design temperature, T_D, occurring for short periods only

3.1.2.5
malfunction temperature
T_{mal}
highest temperature that can be reached when the control limits are exceeded

3.1.2.6
cold water temperature
T_{cold}
temperature of conveyed cold water of up to approximately 25 °C

Note 1 to entry: For design purposes, 20 °C is used.

3.1.2.7
treated water for heating installations
water, intended for heating installations, which contains additives which have no detrimental effect on the system

3.1.3 Terms and definitions related to material characteristics

3.1.3.1
lower confidence limit of the predicted hydrostatic strength
σ_{LPL}
quantity, in megapascals (MPa), with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at the given temperature, T, and time, t

3.1.3.2
design stress
σ_D
allowable stress, in megapascals (MPa) in the pipe material, σ_{DP}, or in the plastics fitting material, σ_{DF}, for a given application or set of service conditions, respectively

Note 1 to entry: See also ISO 15876-2:2016, Annex A.

3.1.3.3
overall service (design) coefficient
C
overall coefficient with a value greater than one, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit of the predicted hydrostatic strength, σ_{LPL}

3.1.3.4
own reprocessable material
material prepared from rejected unused pipes and fittings, including trimmings from the production of pipes and fittings, that will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer by a process such as moulding or extrusion and for which the complete formulation or material specification is known

3.1.3.5
pipes with barrier layer
plastics pipes provided with a thin barrier layer, (e.g. to prevent or greatly diminish the diffusion of gases and the transmission of light through the pipe wall) and where the design stress requirements are totally met by the base polymer (PB)

Note 1 to entry: Such pipes typically have an outside (barrier) layer of maximum 0,4 mm thickness, including any adhesive. Pipes with an outside layer greater than 0,4 mm are considered as multilayer pipes (see Reference [9]), with the outside layer then being the first of multiple layers rather than having only barrier function.

3.2 Symbols

C	overall service (design) coefficient
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
$d_{em,min}$	minimum mean outside diameter
$d_{em,max}$	maximum mean outside diameter
d_n	nominal outside diameter
d_{sm}	mean inside diameter of socket
e	wall thickness at any point
e_{max}	maximum wall thickness at any point
e_{min}	minimum wall thickness at any point
e_n	nominal wall thickness
p	internal hydrostatic pressure
p_D	design pressure

S_{calc}	calculated pipe value
$S_{calc,max}$	maximum calculated pipe value
T	temperature
T_{cold}	cold water temperature
T_D	design temperature
T_{mal}	malfunction temperature
T_{max}	maximum design temperature
t	time
σ	hydrostatic stress
σ_{cold}	design stress at 20 °C
σ_D	design stress
σ_{DF}	design stress of plastics fitting material
σ_{DP}	design stress of plastics pipe material
σ_F	hydrostatic stress values of plastics fitting material
σ_P	hydrostatic stress values of plastics pipe material
σ_{LPL}	lower confidence limit of the predicted hydrostatic strength

3.3 Abbreviated terms

DN	nominal size
DN/OD	nominal size, outside diameter related
LPL	lower confidence limit of predicted strength
MDP	maximum design pressure
PB	polybutene
PB-H	polybutene homopolymer
PB-R	polybutene random copolymer
S	pipe series

4 Classification of service conditions

The performance requirements for piping systems conforming to ISO 15876 (all parts) are specified for four different application classes shown in Table 1.

NOTE Each class is related to a typical field of application and for a design period of 50 years. The classification is taken from ISO 10508. The fields of application are given as a guideline and are not obligatory. Class 3 (low temperature underfloor heating) given in ISO 10508 does not apply to ISO 15876 (all parts).

For any application, the parties concerned shall agree the selection of the applicable class conforming to Table 1. Each application class shall be combined with a design pressure, p_D, of 4 bar[1)], 6 bar, 8 bar or 10 bar, as applicable.

Table 1 — Classification of service conditions

Application class	Design temperature, T_D °C	Time at T_D years	T_{max} °C	Time at T_{max} years	T_{mal} °C	Time at T_{mal} h	Typical field of application
1[a]	60	49	80	1	95	100	Hot water supply (60 °C)
2[a]	70	49	80	1	95	100	Hot water supply (70 °C)
4[b]	20 Followed by 40 Followed by 60	2,5 20 25	70	2,5	100	100	Underfloor heating and low temperature radiators
	Followed by (see next column)		Followed by (see next column)				
5[b]	20 Followed by 60 Followed by 80	14 25 10	90	1	100	100	High temperature radiators
	Followed by (see next column)		Followed by (see next column)				

[a] country may select either class 1 or class 2 to conform to its national regulations.

[b] Where more than one design temperature appears for any class, the times should be aggregated (e.g. the design temperature profile for 50 years for class 5 is: 20 °C for 14 years followed by 60 °C for 25 years, 80 °C for 10 years, 90 °C for 1 year and 100 °C for 100 h).

NOTE For values of T_D, T_{max} and T_{mal} in excess of those in this table, this document does not apply.

All systems which satisfy the conditions specified in Table 1 shall also be suitable for the conveyance of cold water for a period of 50 years at a temperature of 20 °C and a design pressure of 10 bar.

All heating installations shall only use water or treated water as the transfer fluid.

The manufacturer of plastics pipes and fittings should give guidance on the type of treatment required and on aspects of application such as oxygen permeation.

5 Material

5.1 General

The material from which the pipes and fittings are made shall be polybutene (PB) which shall conform to ISO 15876-2 and ISO 15876-3, as applicable.

This document is applicable to two types of polybutene (PB), as follows:

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

Polybutene homopolymer PB-H

Polybutene random copolymer PB-R

where

PB-H compound prepared by polymerisation of no less than 95 % butene-1 by weight;

PB-R compound prepared by polymerisation of no less than 85 % butene-1 and no less than 95 % of total olefins by weight.

5.2 Influence on water intended for human consumption

All plastics and non-plastics materials for components of PB piping systems, when in permanent or temporary contact with water which is intended for human consumption, shall not adversely affect the quality of the drinking water.

5.3 Crystallisation

After extrusion or moulding, PB undergoes a crystalline phase transition (usually called ageing) before it develops its final properties. The minimum required transition time depends on temperature and product characteristics. The same final material performance is obtained once completion of crystalline phase transition is achieved, irrespective of transition conditions. For quality control purposes, therefore, test specimens shall be taken immediately after processing and be conditioned in accordance with recommendations obtained from the compound supplier prior to testing.

The crystalline phase transition is dependent on time and temperature. For guidance, a minimum time of five days for PB-H and one day for PB-R should be allowed at 23 °C unless accelerated ageing is performed.

NOTE The crystalline phase transition can be considerably accelerated upon applying higher hydrostatic pressure of approx. 1 kbar to 2 kbar. Accelerated ageing at higher pressure can be accepted if test results can be proven reproducible and equal to those obtained at atmospheric pressure.

Because of the slow crystallization, transformation and shrinkage which takes places after PB-H and PB-R plastics are cooled from the melt, physical testing should be delayed after extrusion or moulding until this morphological transition is complete.

5.4 Reprocessable material

The use of the manufacturer's own reprocessable material obtained during the product and works testing of products conforming to this document is permitted in addition to the use of virgin material. Reprocessable material obtained from external sources and recyclable material shall not be used.

6 System performance requirements

Pipes conforming to ISO 15876-2 and fittings conforming to ISO 15876-3, or other types of fittings used, when jointed together, shall be tested in accordance with ISO 15876-5.

Pipes and fittings shall have the same application class for use as a system.

For combinations of pipes and fittings having different design pressures (4 bar, 6 bar, 8 bar or 10 bar), the design pressure of the system shall be defined by the lowest design pressure rating.

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 4065, *Thermoplastics pipes — Universal wall thickness table*

[3] EN 806-1, *Specifications for installations inside buildings conveying water for human consumption — Part 1: General*

[4] ISO 10508, *Plastics piping systems for hot and cold water installations — Guidance for classification and design*

[5] ISO 15874 (all parts), *Plastics piping systems for hot and cold water installations — Polypropylene (PP)*

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

[7] ISO 15876 (all parts), *Plastics piping systems for hot and cold water installations — Polybutylene (PB)*

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

[9] ISO 21003 (all parts), *Multilayer piping systems for hot and cold water installations inside buildings*

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

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