INTERNATIONAL STANDARD

ISO 22391-1

Second edition
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Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) —

Part 1: General

Systèmes de canalisations en plastique pour les installations d'eau chaude et froide — Polyéthylène de meilleure résistance à la température (PE-RT) —

Partie 1: Généralités

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 22391-1 was prepared by 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*.

This second edition cancels and replaces the first edition (ISO 22391-1:2007), which is extended from only dealing with PE-RT material (referred to as Type I) to cover PE-RT materials Type I and Type II.

ISO 22391 consists of the following parts[1)], under the general title *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

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

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 for installation of plastics piping systems made from different materials, intended to be used for hot and cold water installations, is covered by ENV 12108.

Introduction

The System Standard, of which this is Part 1, specifies the requirements for a piping system and its components when made from polyethylene of raised temperature resistance (PE-RT). 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 products covered by ISO 22391, the following are relevant.

a) This part of ISO 22391 provides no information as to whether the products can be used without restriction.

b) Existing national regulations concerning the use and/or characteristics of the products remain in force.

This part of ISO 22391 specifies the general aspects of the plastics piping system. At the date of publication of this part of ISO 22391, System Standards Series for piping systems of other plastics materials used for the same application are the following:

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

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

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

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

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

Part 1: General

1 Scope

This part of ISO 22391 specifies the general characteristics of piping systems made of

— polyethylene of raised temperature resistance (PE-RT), Type I, and

— polyethylene of raised temperature resistance (PE-RT), Type II,

intended to be used for hot and cold water installations within buildings for the conveyance of water, whether or not the water is intended for human consumption (domestic systems) and for heating systems, under specified design pressures and temperatures appropriate to the class of application.

This part of ISO 22391 covers a range of service conditions (classes of application), design pressures and pipe dimension classes, and also specifies test parameters and defines terms. In conjunction with the other parts of ISO 22391, it is applicable to PE-RT pipes, fittings, their joints and to joints having components of PE-RT, as well as of other plastics and non-plastics materials, respectively, used for hot and cold water installations.

It is not applicable to values of design temperature, maximum design temperature or malfunction temperature in excess of those it specifies.

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.

2 Normative references

The following referenced documents are indispensable for the application 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 4065*, Thermoplastics pipes — Universal wall thickness table*

ISO 22391-2, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 2: Pipes*

ISO 22391-3, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 3: Fittings*

ISO 22391-5, *Plastics piping systems for hot and cold water installations — Polyethylene of raised temperature resistance (PE-RT) — Part 5: Fitness for purpose of the system*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and ISO 1043-1 and the following apply.

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 π (= 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 mid-point 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
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
e_{min}
minimum wall thickness at any point around the circumference of a component, as specified

3.1.1.13
maximum wall thickness
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 the permitted minimum value

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

NOTE According to ISO 22391, the pipe series, S, is used as a means for selecting pipe sizes for practical purposes (see ISO 22391-2).

3.1.1.16
calculated pipe value
S_{calc}
value for a specific pipe calculated using Equation (1), rounded up to the nearest 0,1 mm,

$$S_{calc} = \frac{d_n - e_n}{2e_n} \quad (1)$$

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 The design pressure is equivalent to the maximum design pressure, MDP, as specified in EN 806-1.

3.1.2.2
hydrostatic stress
σ
stress induced in the wall of a pipe when a pressure is applied using water as a medium, and calculated using the approximate Equation (2):

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

where

p is the applied pressure, in megapascal;

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

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

NOTE It is expressed in megapascal.

3.1.2.3
design temperature
T_D
temperature or combination of temperatures and times 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 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 For design purposes, 20 °C is used.

3.1.2.7
treated water
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 with the dimensions of stress, representing the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature, T and time, t

NOTE 1 It is given by $\sigma_{LPL} = \sigma_{(T, t, 0,975)}$.

NOTE 2 It is expressed in megapascal.

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

See ISO 22391-2:2009, Annex A.

NOTE It is expressed in megapascal.

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, 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

NOTE If material containing a barrier layer is to be reprocessed, the barrier layers are removed beforehand and discarded.

3.1.3.5
pipes with barrier layer
plastics pipes provided with a thin outside 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 (PE-RT)

3.2 Symbols

C	overall service (design) coefficient
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
$d_{em, max}$	maximum mean outside diameter
$d_{em, min}$	minimum 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_{test}	test 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_{LPL}	lower confidence limit of the predicted hydrostatic strength
σ_P	hydrostatic stress values of plastics pipe material

3.3 Abbreviated terms

DN	nominal size
DN/OD	nominal size, outside diameter related
LCL	lower confidence limit
MDP	maximum design pressure
PE-RT	polyethylene of raised temperature resistance
S	pipe series

4 Classification of service conditions

The performance requirements for piping systems conforming to ISO 22391 are specified for four different application classes in accordance with 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 22391.

For any application, the selection of the applicable class conforming to Table 1 shall be agreed on by the parties concerned.

Each application class shall be combined with a design pressure, p_D, of 4 bar[2)], 6 bar, 8 bar or 10 bar, as applicable.

All systems satisfying 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 provide guidance on the type of treatment required and on aspects of application, such as oxygen permeation.

Table 1 — Classification of service conditions

Application classes	Design temperature T_D °C	Time[a] 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 | 2,5 Followed by: 40 | 20 Followed by: 60 | 25 Followed by: (see next column)		70	2,5	100	100	Underfloor heating and low temperature radiators
5[b]	20 | 14 Followed by: 60 | 25 Followed by: 80 | 10 Followed by: (see next column)		90 Followed by: (see next column)	1	100	100	High temperature radiators
ISO 22391 is not applicable to values of T_D, T_{max} and T_{mal} in excess of those given in this table.							

[a] A country may select either Class 1 or 2 in order to conform to its national guidelines.

[b] Where more than one design temperature appears for any class, the times should be aggregated. For example, 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.

2) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

5 Material

5.1 General

The material from which the pipes are made shall be in accordance with ISO 22391-2 and the material from which the fittings are made shall be in accordance with ISO 22391-3, as applicable.

5.2 Influence on water intended for human consumption

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

5.3 Reprocessable material

The use of the manufacturer's own reprocessable material obtained during the product and works testing of products conforming to ISO 22391 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 requirement

Pipes conforming to ISO 22391-2 and fittings conforming to ISO 22391-3, or other types of fittings used, when jointed together, shall be in accordance with ISO 22391-5.

Bibliography

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

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

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

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