INTERNATIONAL STANDARD

ISO 15494

Second edition
2015-10-01

Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), polypropylene (PP) — Metric series for specifications for components and the system

Systèmes de canalisations en matières plastiques pour les applications industrielles — Polybutène (PB), polyéthylène (PE), polyéthylène de meilleure résistance à la température (PE-RT), polyéthylène réticulé (PE-X), polypropylène (PP) — Séries métriques pour les spécifications pour les composants et le système

Reference number
ISO 15494:2015(E)

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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 WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is Technical Committee ISO/TC 138, *Plastics piping systems*, Subcommittee SC 3, *Plastics pipes and fittings for industrial applications*.

This second edition cancels and replaces the first edition (ISO 15494:2003), which has been technically revised.

Introduction

This International Standard specifies the characteristics and requirements for a piping system and its components made from polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), or polypropylene (PP), as applicable, intended to be used for industrial applications above ground or below ground by authorities, design engineers, certification bodies, inspection bodies, testing laboratories, manufacturers, and users.

At the date of publication of this International Standard, standards for piping systems of other plastics used for industrial applications are the following:

ISO 10931, *Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF) — Specifications for components and the system*

ISO 15493, *Plastics piping systems for industrial applications — Acrylonitrile-butadiene-styrene (ABS), unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) — Specifications for components and the system — Metric series*

Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE), polyethylene of raised temperature resistance (PE-RT), crosslinked polyethylene (PE-X), polypropylene (PP) — Metric series for specifications for components and the system

1 Scope

This International Standard specifies the characteristics and requirements for components such as pipes, fittings, and valves made from one of the following materials intended to be used for thermoplastics piping systems in the field of industrial applications above and below ground:

— polybutene (PB);

— polyethylene (PE);

— polyethylene of raised temperature resistance (PE-RT);

— crosslinked polyethylene (PE-X);

— polypropylene (PP).

NOTE 1 Requirements for industrial valves are given in this International Standard and/or in other standards. Valves are to be used with components conforming to this International Standard provided that they conform additionally to the relevant requirements of this International Standard.

This International Standard is applicable to either PB, PE, PE-RT, PE-X, or PP pipes, fittings, valves, and their joints and to joints with components of other plastics and non-plastic materials, depending on their suitability, intended to be used for the conveyance of liquid and gaseous fluids as well as solid matter in fluids for industrial applications such as the following:

— chemical plants;

— industrial sewerage engineering;

— power engineering (cooling and general purpose water);

— mining;

— electroplating and pickling plants;

— semiconductor industry;

— agricultural production plants;

— fire fighting;

— water treatment;

— geothermal.

NOTE 2 Where relevant, national regulations (e.g. water treatment) are applicable.

Other application areas are permitted if the requirements of this International Standard and/or applicable national requirements are fulfilled.

National regulations in respect of fire behaviour and explosion risk are applicable.

The components have to withstand the mechanical, thermal, and chemical demands to be expected and have to be resistant to the fluids to be conveyed.

Characteristics and requirements which are applicable for all materials (PB, PE, PE-RT, PE-X, or PP) are covered by the relevant clauses of this International Standard. Those characteristics and requirements which are dependent on the material are given in the relevant normative annex for each material (see Table 1).

Table 1 — Material-specific annexes

Material	Annex
Polybutene (PB)	A
Polyethylene (PE)	B
Polyethylene of raised temperature resistance (PE-RT)	C
Crosslinked polyethylene (PE-X)	D
Polypropylene (PP)	E

Components conforming to any of the product standards listed in the bibliography or with national standards, as applicable, may be used with components conforming to this International Standard, provided that they conform to the requirements for joint dimensions and to the relevant requirements of this International Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 179-2, *Plastics — Determination of Charpy impact properties — Part 2: Instrumented impact test*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 472, *Plastics — Vocabulary*

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

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

ISO 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 1167-3, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components*

ISO 1167-4, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pyknometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

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

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

ISO 4427-1:2007, *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply — Part 1: General*

ISO 4437-2, *Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) — Part 2: Pipes*

ISO 6964, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method and basic specification*

ISO 9080:2012, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO 10147, *Pipes and fittings made of crosslinked polyethylene (PE-X) — Estimation of the degree of crosslinking by determination of the gel content*

ISO 11357-6, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT)*

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

ISO 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient*

ISO 13477, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Small-scale steady-state test (S4 test)*

ISO 13478, *Thermoplastics pipes for the conveyance of fluids — Determination of resistance to rapid crack propagation (RCP) — Full-scale test (FST)*

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

ISO 14531-1, *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 1: Pipes*

ISO 15512, *Plastics — Determination of water content*

ISO 15853, *Thermoplastics materials — Preparation of tubular test pieces for the determination of the hydrostatic strength of materials used for injection moulding.*

ISO 16135, *Industrial valves — Ball valves of thermoplastics materials*

ISO 16136, *Industrial valves — Butterfly valves of thermoplastics materials*

ISO 16137, *Industrial valves — Check valves of thermoplastics materials*

ISO 16138, *Industrial valves — Diaphragm valves of thermoplastics materials*

ISO 16139, *Industrial valves — Gate valves of thermoplastics materials*

ISO 16871, *Plastics piping and ducting systems — Plastics pipes and fittings — Method for exposure to direct (natural) weathering*

ISO 18553, *Method for the assessment of the degree of pigment or carbon black dispersion in polyolefin pipes, fittings and compounds*

ISO 21787, *Industrial valves — Globe valves of thermoplastics materials*

IEC 60529, *Degrees of protection provided by enclosures (IP-code)*

EN 712, *Thermoplastics piping systems — End-load bearing mechanical joints between pressure pipes and fittings — Test method for resistance to pull-out under constant longitudinal force*

EN 12099, *Plastics piping systems — Polyethylene piping materials and components — Determination of volatile content*

3 Terms and definitions

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

3.1 Geometrical definitions

NOTE The symbols d_e and e correspond to d_{ey} and e_y, given in other International Standards such as ISO 11922-1.

3.1.1
nominal outside diameter
d_n
specified outside diameter assigned to a nominal size DN/OD

Note 1 to entry: The nominal inside diameter of a socket is equal to the nominal outside diameter of the corresponding pipe.

Note 2 to entry: It is expressed in millimetres.

3.1.2
outside diameter at any point
d_e
value of the measurement of the outside diameter through its cross-section at any point of the pipe, rounded to the next greater 0,1 mm

3.1.3
mean outside diameter
d_{em}
value of the measurement of the outer circumference of the pipe or spigot end of a fitting in any cross-section divided by π (= 3,142), rounded to the next greater 0,1 mm

3.1.4
mean inside diameter of a socket
arithmetical mean of two measured inside diameters perpendicular to each other

3.1.5
nominal size
DN/OD
numerical designation of the size of a component, other than a component designated by thread size, which is a convenient round number, approximately equal to the manufacturing dimension in millimetres (mm) and related to the outside diameter

3.1.6
nominal size of flange
DN
numerical designation of the size of a flange for reference purposes and related to the manufacturing dimension in millimetres

3.1.7
out-of-roundness
ovality
difference between the maximum and the minimum outside diameter in the same cross-section of a pipe or spigot

3.1.8
nominal wall thickness
e_n
numerical designation of the wall thickness of a component, which is a convenient round number, approximately equal to the manufacturing dimension in millimetres (mm)

Note 1 to entry: For thermoplastics components conforming to the different annexes of ISO 15494, the value of the nominal wall thickness, e_n, is identical to the specified minimum wall thickness at any point, e_{min}.

3.1.9
wall thickness at any point
e
wall thickness at any point around the circumference of a component rounded to the next greater 0,1 mm

3.1.10
minimum wall thickness at any point
e_{min}
minimum value for the wall thickness at any point around the circumference of a component, as specified

Note 1 to entry: The symbol for the wall thickness of the fittings and valves body at any point is E.

3.1.11
pipe series
S
dimensionless number for pipe designation conforming to ISO 4065

Note 1 to entry: The relationship between the pipe series, S, and the standard dimension ratio, SDR, is given by the following formula as specified in ISO 4065:

$$S = \frac{SDR - 1}{2}$$

Note 2 to entry: Flanges are designated on the basis of PN.

3.1.12
standard dimension ratio
SDR
numerical designation of a pipe series, which is a convenient round number, approximately equal to the dimension ratio of the nominal outside diameter, d_n, and the nominal wall thickness, e_n

3.2 Material definitions

3.2.1
melt mass-flow rate
MFR
value relating to the viscosity of the molten material at a specified temperature and load

Note 1 to entry: It is expressed in grams per 10 min (g/10 min).

3.2.2
virgin material
material in a form such as granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessable or recyclable materials have been added

3.2.3
own reprocessable material
material prepared from clean rejected unused pipes, fittings, or valves, including trimmings from the production of pipes, fittings, or valves, that will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer in the production of components by, for example, injection-moulding or extrusion

Note 1 to entry: Only those thermoplastics parts of valves may be used which are made from material conforming to this International Standard.

3.3 Definitions related to material characteristics

3.3.1
lower confidence limit of the predicted hydrostatic strength
σ_{LPL}
quantity with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature, θ, and time, t

Note 1 to entry: It is expressed in megapascals.

3.3.2
minimum required strength
MRS
value of σ_{LPL} at 20 °C and 50 years, rounded down to the next smaller value of the R10 series or the R20 series

Note 1 to entry: The R10 series conforming to ISO 3 and the R20 series to ISO 497.

3.3.3
design stress
σ_S

allowable stress for a given application at 20 °C that is derived from the MRS by dividing it by the coefficient C

Note 1 to entry: Design stress can be calculated using the following formula:

$$\sigma_S = \frac{MRS}{C}$$

Note 2 to entry: It is expressed in megapascals.

3.3.4
design coefficient
C
coefficient with a value greater than one which takes into consideration service conditions as well as the properties of the components of a piping system other than those represented in the lower confidence limit

3.4 Definitions related to service conditions

3.4.1
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the components of a piping system

Note 1 to entry: A pressure, in bar, with the numerical value of PN is identical with the pressure, PS, as defined by Reference [16] if both pressures are taken at 20 °C.

Note 2 to entry: For plastics piping systems conveying water, it corresponds to the maximum continuous operating pressure in bar, which can be sustained for water at 20 °C for 50 years, based on the following minimum design coefficient:

$$PN = \frac{10\sigma_s}{[S]} = \frac{20\sigma_s}{SDR - 1}$$

where

σ_s is expressed in MPa;

PN is expressed in bar.

Note 3 to entry: 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa= 1 N/mm^2.

3.4.2
hydrostatic stress
σ
stress induced in the wall of a pipe when an internal hydrostatic pressure is applied

Note 1 to entry: The hydrostatic stress is related to the applied internal hydrostatic pressure, in bar p, the wall thickness, e, at any point and the mean outside diameter, d_{em}, of a pipe and calculated using the following formula:

$$\sigma = p\frac{d_{em} - e_{min}}{20e_{min}}$$

Note 2 to entry: Formula is applicable for pipes only.

Note 3 to entry: It is expressed in megapascals.

3.4.3
long-term hydrostatic stress

σ_{LTHS}
quantity with the dimensions of stress, which represents the predicted mean strength at a temperature T and time t

Note 1 to entry: It is expressed in megapascals.

[SOURCE: ISO 9080:2012, 3.9]

4 Symbols and abbreviated terms

4.1 Symbols

C	design coefficient (design factor)
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
d_n	nominal outside diameter
DN	nominal size of flange
e	wall thickness (at any point)
e_n	nominal wall thickness
l_0	free length

p internal hydrostatic pressure

p_S maximum allowable pressure

T temperature

t time

ρ material density

σ hydrostatic stress

σ_{LPL} lower confidence limit of the predicted hydrostatic strength

σ_{LTHS} long-term hydrostatic strength

σ_S design stress

4.2 Abbreviated terms

MFR melt mass-flow rate

MOP maximum operating pressure

MRS minimum required strength

OIT oxidation induction time

PB polybutene

PE polyethylene

PE-RT polyethylene of raised temperature resistance

PE-X crosslinked polyethylene

PP polypropylene

PP-H polypropylene homopolymer

PP-B polypropylene block-copolymer

PP-R polypropylene random-copolymer

PP-RCT polypropylene random-copolymer with modified crystallinity

PN nominal pressure

S pipe series S

SDR standard dimension ratio

TIR true impact rate

5 Material

5.1 General

The material from which the components are made shall either be PB, PE, PE-RT, PE-X, or PP, as applicable, to which are added those additives that are needed to facilitate the manufacture of pipes, fittings, and valves conforming to this International Standard.

If additives are used, they shall be uniformly dispersed.

The additives shall not be used separately or together in quantities sufficient to impair the fabrication or fusion characteristics of the component or to impair the chemical, physical, or mechanical characteristics as specified in this International Standard.

5.2 Hydrostatic strength properties

The material shall be evaluated according to ISO 9080 by analysis of pressure tests carried out in accordance with ISO 1167-1 and ISO 1167-2 to classify the material in accordance with ISO 12162.

Conformity of the relevant material to the reference curves given for PB (see Annex A), PE (see Annex B), PE-RT (see Annex C), PE-X (see Annex D), and PP (see Annex E) shall be proven according to the applicable Annex of this International Standard. At least 97,5 % of the data points shall be on or above the reference curves. For design, these reference curves shall be used as a basis.

The material shall be classified by the raw material producer.

NOTE In some cases, the component manufacturer can be regarded as the raw material producer.

Where fittings and valves are manufactured from the same material as pipes, the material classification shall be the same as for pipes.

For the classification of a material intended only for the manufacture of fittings and valves, the test piece shall be an injection-moulded or extruded test piece in form of a pipe where a test pressure is applied according to ISO 1167-1. The free length shall be $3d_n$, as defined in ISO 1167-2 or ISO 15853.

5.3 Material characteristics

The details of the material characteristics of PB, PE, PE-RT, PE-X, and PP mechanical and physical properties with requirements are given in the applicable Annex of this International Standard.

5.4 Reprocessable and recyclable material

The use of own reprocessable material obtained during the production and testing of components according to this International Standard is permitted in addition to virgin material, with the exception of PE-X.

Reprocessable material obtained from external sources and recyclable material shall not be used.

5.5 Materials for components not made from PB, PE, PE-RT, PE-X, or PP

5.5.1 General

All components shall conform to the relevant International Standard(s). Alternative standards may be applied in cases where suitable International Standard(s) do not exist. In all cases, fitness for purpose of the components shall be demonstrated.

Materials and constituent elements used in making the relevant component (including rubber, greases, and any metal parts as may be used) shall have comparable resistance to the external and internal environments as all other elements of the piping system according to this International Standard.