INTERNATIONAL STANDARD

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Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE) and polypropylene (PP) — Specifications for components and the system — Metric series

Systèmes de canalisations en matières plastiques pour les applications industrielles — Polybutène (PB), polyéthylène (PE) et polypropylène (PP) — Spécifications pour les composants et le système — Série métrique

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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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15494 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 3, *Plastics pipes and fittings for industrial applications*.

This document has been prepared under a mandate given by the European Commission and the European Free Trade Association and supports essential requirements of EU Directives.

At the date of publication of this International Standard, the following standards had been published for piping systems, used for industrial applications, made from other types of plastic:

ISO 10931 (all parts), *Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF)*

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

Annexes A, B and C form a normative part of this International Standard.

This corrected version of ISO 15494:2003 incorporates the following corrections:

— in Table A.1, footnote “c”, the reference to Table D.4 has been deleted;

— in Table C.2, footnote “c”, the reference to Table D.22 has been deleted.

Introduction

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

Plastics piping systems for industrial applications — Polybutene (PB), polyethylene (PE) and polypropylene (PP) — Specifications for components and the system — Metric series

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:

— polybutene (PB);

— polyethylene (PE);

— polypropylene (PP);

intended to be used for thermoplastics piping systems in above-ground industrial applications.

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

— chemical plants;

— industrial sewerage engineering;

— power engineering (cooling and general-purpose water supply);

— electroplating and pickling plants;

— the semiconductor industry;

— agricultural production plants;

— water treatment.

NOTE 1 Where relevant, national regulations for specific applications (e.g. water treatment) apply.

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

Relevant regulations in respect of fire behaviour and explosion risk are applicable if applications are envisaged for inflammable media.

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 to all three materials (PB, PE and PP) are covered by the relevant clauses of this International Standard. Those characteristics and requirements which are dependent on the material are given for each material in the relevant annex (see Table 1).

Table 1 — Material-specific annexes

Material	Annex
Polybutene (PB)	A
Polyethylene (PE)	B
Polypropylene (PP)	C

NOTE 2 Components conforming to any of the product standards listed in the bibliography or to national standards, as applicable, may be used with components conforming to this International Standard provided they conform to the requirements for joint dimensions and to the other relevant requirements of this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

ISO 179-2:1997, *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 265-1, *Pipes and fittings of plastics materials — Fittings for domestic and industrial waste pipes — Basic dimensions: Metric series — Part 1: Unplasticized poly(vinyl chloride) (PVC-U)*

ISO 472, *Plastics — Vocabulary*

ISO 727-1, *Fittings made from unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) or acrylonitrile/butadiene/styrene (ABS) with plain sockets for pipes under pressure — Part 1: Metric series*

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

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

ISO 1167:1996, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method*

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

ISO 2505-1:1994, *Thermoplastics pipes — Longitudinal reversion — Part 1: Determination methods*

ISO 2505-2:1994, *Thermoplastics pipes — Longitudinal reversion — Part 2: Determination parameters*

ISO 3126, *Plastics piping systems — Plastics piping components — Measurement and determination of dimensions*

ISO 3213, *Polypropylene (PP) pipes — Effect of time and temperature on expected strength*

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

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

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

ISO/TR 10358, *Plastics pipes and fittings — Combined chemical-resistance classification table*

ISO/TR 10837, *Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings*

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

ISO 12092, *Fittings, valves and other piping system components made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C), acrylonitrile-butadiene-styrene (ABS) and acrylonitrile-styrene-acrylester (ASA) for pipes under pressure — Resistance to internal pressure — Test method*

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

ISO 12230, *Polybutene (PB) pipes — Effect of time and temperature on the expected strength*

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 13949, *Method for the assessment of the degree of pigment dispersion in polyolefin pipes, fittings and compounds*

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

ISO 16135:—[1)], *Industrial valves — Ball valves of thermoplastics materials*

ISO 16136:—[1)], *Industrial valves — Butterfly valves of thermoplastics materials*

ISO 16137:—[1)], *Industrial valves — Check valves of thermoplastics materials*

ISO 16138:—[1)], *Industrial valves — Diaphragm valves of thermoplastics materials*

ISO 16139:—[1)], *Industrial valves — Gate valves of thermoplastics materials*

ISO 21787:—[1)], *Industrial valves — Globe valves of thermoplastics materials*

IEC 60364-1, *Electrical installations of buildings — Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60449, *Voltage bands for electrical installations of buildings*

IEC 60529, *Degrees of protection provided by enclosures (IP code)* (Consolidated edition including Amendment 1)

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1) To be published.

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in ISO 472 and ISO 1043-1, plus 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 of a component, which is identical to the minimum mean outside diameter, $d_{em,min}$, in millimetres

NOTE The nominal inside diameter of a socket is equal to the nominal outside diameter of the corresponding pipe.

3.1.2
outside diameter at any point
d_e
outside diameter measured through the cross-section at any point on a pipe, or the spigot end of a fitting, rounded up to the nearest 0,1 mm

3.1.3
mean outside diameter
d_{em}
measured length of the outer circumference of a pipe, or the spigot end of a fitting, divided by π ($\approx$ 3,142), rounded up to the nearest 0,1 mm

3.1.4
mean inside diameter of a socket
d_{im}
arithmetic mean of two measured inside diameters perpendicular to each other

3.1.5
nominal size of flange
DN
numerical designation for the size of a flange for reference purposes, related to the manufactured dimension in millimetres

3.1.6
out-of-roundness
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-sectional plane of a pipe, or the 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

3.1.7
nominal wall thickness
e_n
wall thickness, in millimetres, corresponding to the minimum wall thickness, e_{min}

3.1.8
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

3.1.9
pipe series
S
dimensionless number related to the nominal outside diameter, d_n, and the nominal wall thickness, e_n

NOTE 1 The pipe series S is related to the pipe geometry as shown in equation (1):

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

NOTE 2 Flanges are designated on the basis of PN.

3.1.10
standard dimension ratio
SDR
ratio of the nominal outside diameter, d_n, of a pipe to its nominal wall thickness, e_n

NOTE In accordance with ISO 4065, the standard dimension ratio SDR and the pipe series S are related as shown in equation (2):

$$SDR = 2S + 1 \quad (2)$$

3.2 Definitions of materials

3.2.1
virgin material
material in a form such as granules or powder that has not been previously processed other than for compounding and to which no reprocessable or recyclable materials have been added

3.2.2
reprocessable material
material prepared from clean unused rejected pipes, fittings or valves, produced in a manufacturer's plant by a process such as moulding or extrusion, which will be reprocessed in the same plant and for which the complete formulation or material specification is known

NOTE 1 Such material may include trimmings from the production of such pipes, fittings and valves.

NOTE 2 In the case of valves, only those thermoplastics parts which are made from material conforming to this International Standard may be considered as reprocessable material.

3.3 Definitions related to material characteristics

3.3.1
lower confidence limit
σ_{LCL}
quantity with the dimensions of stress, expressed in megapascals, which can be considered as a property of the material and represents the 97,5 % lower confidence limit of the predicted long-term hydrostatic strength at a given temperature, T, and time, t, determined by pressurizing internally with water

3.3.2
minimum required strength
MRS
value of σ_{LCL} at 20 °C and 50 years, rounded down to the next lower value in the R 10 series when σ_{LCL} is less than 10 MPa, or to the next lower value in the R 20 series when σ_{LCL} is greater than or equal to 10 MPa

NOTE The R 10 and R 20 series are the Renard number series as defined in ISO 3 and ISO 497.

3.3.3
design stress
σ_s
allowable stress, in megapascals, for a given application or set of service conditions

NOTE It is derived by dividing the MRS by the coefficient C, as in equation (3), then rounding to the next lower value in the R 10 or R 20 series, as applicable:

$$\sigma_s = \frac{MRS}{C} \quad (3)$$

3.3.4
overall service (design) coefficient
C
overall 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, σ_{LCL}

3.3.5
melt mass-flow rate
MFR
value relating to the viscosity of a molten plastics material at a specified temperature and rate of shear, expressed in grams per ten minutes (g/10 min)

3.4 Definitions related to service conditions

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

NOTE 1 A pressure, in bars, numerically equal to PN is identical to the maximum allowable pressure, PS, as defined by EU Directive 97/23/ECC (PED), if both pressures are taken at 20 °C.

NOTE 2 For plastics piping systems conveying water, PN corresponds to the maximum continous operating pressure in bars which can be sustained for water at 20 °C for 50 years, based on the minimum overall service (design) coefficient and calculated using the following equation:

$$PN = \frac{10\sigma_s}{S} = \frac{20\sigma_s}{SDR - 1} \quad (4)$$

where

— σ_s is expressed in N/mm^2;

— PN is expressed in bars [2].

2) 1 bar = 0,1 MPa = 10^5 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 The hydrostatic stress, in megapascals, is related to the applied internal hydrostatic pressure, p, the wall thickness, e, at any point and the mean outside diameter, d_{em}, of a pipe and calculated using the following equation:

$$\sigma = p \times \frac{d_{em} - e}{2e} \quad (5)$$

NOTE 2 Equation (5) is applicable to pipes only.

3.4.3
long-term hydrostatic stress
constant hydrostatic stress that is maintained in a component for a sustained period of time

4 Symbols and abbreviated terms

4.1 Symbols

C	overall service (design) coefficient (design factor)
d_e	outside diameter (at any point)
d_{em}	mean outside diameter
d_{im}	mean inside diameter of socket
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
T	temperature
t	time
ρ	density of material
σ	hydrostatic stress
σ_{LCL}	lower confidence limit
σ_s	design stress

4.2 Abbreviations

MFR melt mass-flow rate

MOP maximum operating pressure

MRS minimum required strength

OIT oxidation induction time

PB polybutene

PE polyethylene

PP polypropylene

PP-H polypropylene homopolymer

PP-B polypropylene block-copolymer

PP-R polypropylene random-copolymer

PN nominal pressure

PS maximum allowable pressure

PT test pressure (corresponds to the symbol p usually used)

S pipe series

SDR standard dimension ratio

TIR true impact rate

5 Material

5.1 General

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

If additives are used, they shall be uniformly dispersed.

Additives shall not be used, separately or together, in quantities sufficient to impair the fabrication or fusion-jointing characteristics of the components or to impair the chemical, physical or mechanical characteristics as specified in this International Standard.

5.2 Hydrostatic strength properties

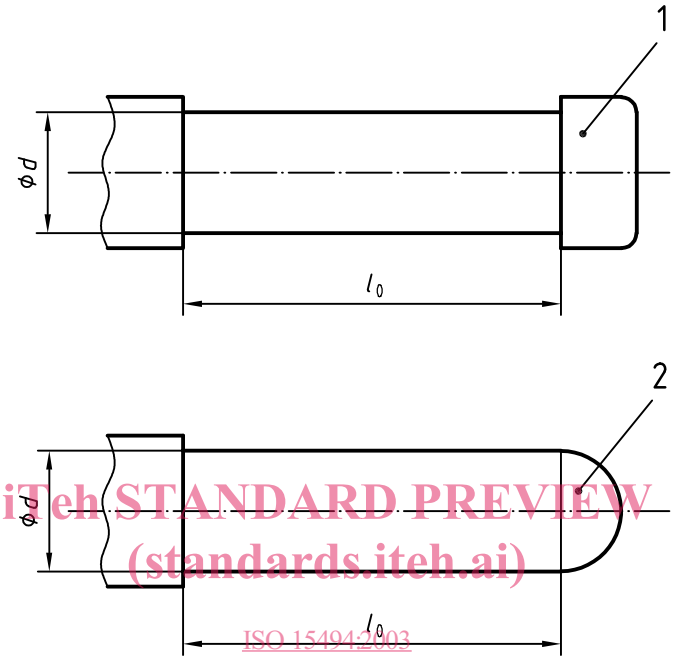
The material shall be evaluated in accordance with ISO 9080 where a pressure test is carried out in accordance with ISO 1167 to find the MRS-value in accordance with ISO 12162. The test shall be carried out using test pieces of pipe series S $\leqslant$ 16.

Conformity of the relevant material to the reference curves given for PB (see Annex A), PE (see Annex B) and PP (see Annex C) shall be demonstrated in accordance with the applicable annex to this International Standard. At least 97,5 % of the data points shall be on or above the reference curves.

The material shall be as classified by 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, an injection-moulded or extruded test piece in the form of a pipe shall be used (see Figure 1) and the test pressure applied in accordance with ISO 1167. The free length l_0 shall be $3d_n$, as defined in ISO 15853.



Key

1 End cap
2 Injection-moulded end

Figure 1 — Free length, l_0, of test piece

5.3 Other characteristics of material

Details of requirements on other characteristics of PB, PE and PP material are given in the applicable annex to this International Standard.

5.4 Reprocessable and recyclable material

The use of reprocessable material obtained during the production and testing of components in accordance with this International Standard is permitted in addition to virgin material, provided that the requirements of this International Standard are fulfilled.

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