INTERNATIONAL STANDARD

ISO 14531-1

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Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications —

Part 1:
Pipes

Tubes et raccords en matières plastiques — Systèmes de tubes en polyéthylène réticulé (PE-X) pour le transport de combustibles gazeux — Série métrique — Spécifications —

Partie 1: Tubes

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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.

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 part of ISO 14531 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14531-1 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

ISO 14531 consists of the following parts, under the general title *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications*:

— *Part 1: Pipes*

— *Part 2: Fittings for heat-fusion jointing*

— *Part 3: Fittings for mechanical jointing (including PE-X/metal transitions)*

— *Part 4: System design and installation guidelines*

Annexes B, C and D form a normative part of this part of ISO 14531. Annexes A and E are for information only.

The inclusion of annex E is an interim measure. The content of annex E is also incorporated in ISO 14531-4, the system design and installation guide. Annex E will be deleted from this part of ISO 14531 as soon as ISO 14531-4 is available as a draft International Standard (DIS).

In this corrected version of ISO 14531-1:2002, Table 7 (page 12) has been amended in two places:

— the requirement for elongation at break has been corrected from "$\leqslant$ 350" to "$\geqslant$ 350";

— the test method for squeeze-off properties has been corrected from "Annex C" to "Annex D".

Introduction

Further to the publication of International Standards for crosslinked polyethylene (PE-X) hot-water pipes, it has become evident that the properties of PE-X, in particular its high fracture resistance and its socket and saddle fusion-jointing capability, render it suitable for use in high-performance gas-distribution systems. The philosophy of ISO 14531 is to provide the platform for the introduction of PE-X gas pipe systems by embracing a performance envelope beyond that covered by existing PE standards, whilst taking its application into regimes of higher operating pressure and extremes of operating temperature.

ISO 14531-1 is therefore one part of a four-part system standard covering pipes, fittings for heat-fusion jointing, fittings for mechanical jointing and design and installation guidelines. The content is suitable for use by procurement authorities and distribution engineers responsible for the design, installation and operation of pipeline systems.

Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications —

Part 1: Pipes

1 Scope

This part of ISO 14531 specifies the physical properties and mechanical-performance requirements for crosslinked polyethylene (PE-X) pipes intended for use in the supply of gaseous fuels. In addition, it lays down dimensional requirements and specifies some general material properties (including chemical resistance) together with a classification scheme for PE-X produced in the form of pipe.

This part of ISO 14531, when used in conjunction with the other parts of ISO 14531, is applicable as the basis for the design, manufacture and installation of PE-X piping systems (PE-X pipes, PE-X fusion fittings and mechanical fittings) for the supply of category D and category E hydrocarbon-based fuels (see ISO 13623) at

a) maximum operating pressures (MOPs) up to and including 16 bar[1)];

b) a maximum operating temperature of + 60 °C;

c) a minimum operating temperature of

   i) − 50 °C

   ii) − 35 °C

   iii) − 20 °C.

This part of ISO 14531 may also be used in conjunction with the restricted specification for PE heat-fusion fittings detailed in ISO 14531-2 to support the introduction of a hybrid PE-X pipe/PE fitting system for operation within a narrower temperature range (− 20 °C to + 40 °C) with a maximum pressure as determined by ISO 8085-3.

For installation, this standard provides for the jointing of PE-X fusion fittings and mechanical fittings to PE-X pipes within the temperature range − 5 °C to + 40 °C.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 14531. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 14531 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 3, *Preferred numbers — Series of preferred numbers*

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

1) 1 bar = 10^5 N/m^2 = 100 kPa

ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

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

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

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

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

ISO 4437, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications*

ISO 6259-1, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

ISO 6259-3, *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes*

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

ISO 8085-3, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 3: Electrofusion fittings*

ISO 9080:—[1], *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/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 12162, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (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 13479, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes (notch test)*

ISO 13623, *Petroleum and natural gas industries — Pipeline transportation systems*

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

ISO 14531-2:—[2], *Plastics pipes and fittings — Crosslinked polyethylene (PE-X) pipe systems for the conveyance of gaseous fuels — Metric series — Specifications — Part 2: Fittings for heat-fusion jointing*

ISO 16871:—[3], *Plastics piping and ducting systems — Plastics pipes and fittings — Method for exposure to direct (natural) weathering*

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1) To be published. (Revision of ISO/TR 9080:1992)

2) To be published.

3) To be published.

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

3 Terms and definitions

For the purposes of this part of ISO 14531, the following terms and definitions apply.

3.1 Geometrical terms

3.1.1
nominal outside diameter
d_n
numerical designation of size which is common to all components in a thermoplastics piping system other than flanges and components designated by thread size

NOTE 1 It is a convenient round number for reference purposes.

NOTE 2 The nominal outside diameter expressed in millimetres is the minimum mean outside diameter $d_{em,min}$ defined in 3.1.3.

3.1.2
mean outside diameter
d_{em}
value of the outer circumference of the pipe at any cross-section divided by π[1)] and rounded up to the nearest 0,1 mm

3.1.3
minimum mean outside diameter
$d_{em,min}$
minimum value of the mean outside diameter of the pipe specified for a given nominal outside diameter

3.1.4
maximum mean outside diameter
$d_{e,max}$
maximum value of the mean outside diameter of the pipe specified for a given nominal outside diameter

3.1.5
outside diameter at any point
d_{ey}
value of the outside diameter through the pipe cross-section at any point along the pipe

3.1.6
absolute out-of-roundness
ovality
difference between the measured maximum mean outside diameter $d_{em,max}$, and the measured minimum mean outside diameter $d_{em,min}$ at any point in the same cross-section of the pipe

3.1.7
nominal wall thickness
e_n
wall thickness, in millimetres, tabulated in ISO 4065, corresponding to the minimum wall thickness at any point $e_{y,min}$

3.1.8
wall thickness at any point
e_y
value of the wall thickness at any point around the circumference of the pipe

1) The value of π is taken to be 3,141 6.

3.1.9
minimum wall thickness at any point
$e_{y,min}$
minimum permissible value of the wall thickness e_y at any point around the circumference of the pipe

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

$$\text{SDR} = \frac{d_n}{e_n}$$

3.2 Terms relating to materials

3.2.1
crosslinked polyethylene
PE-X
polyethylene structure within which the polymer chains are interconnected by chemical bonds to create a three-dimensional polymer network

NOTE The properties of the three-dimensional structure ensure that it is not possible to melt or dissolve the polymer. The extent of crosslinking is related to the mass of insoluble material remaining following solvent extraction and can be determined by measurement of the gel content.

3.2.2
base material
physical blend of non-crosslinked polyethylene(s) and additives formulated to facilitate conversion to PE-X during the production of pipe to meet the requirements of this part of ISO 14531

3.2.3
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 in water

NOTE It is denoted as $\sigma_{LPL} = \sigma_{(\theta,t,\ 0,975)}$.

3.2.4
long-term hydrostatic strength
σ_{LTHS}
quantity, with the dimensions of stress, which represents the predicted mean strength at a temperature θ and time t in water

3.2.5
minimum required strength
MRS
value of σ_{LPL} at a temperature of 20 °C and a time of 50 years ($\sigma_{(20,\ 50\ years,\ 0,975)}$) rounded down to the nearest lower value in the R10 or R20 series as specified in ISO 3 and ISO 497, depending on the value of σ_{LPL}

3.2.6
overall service (design) coefficient
C
overall coefficient, with a value greater than 1, that takes into consideration service conditions as well as properties of the components of a piping system other than those represented in σ_{LPL}

NOTE See annex E and ISO 12162 for information regarding the minimum permissible service (design) coefficient for PE-X pipes.

3.3 Terms related to service conditions

3.3.1
gaseous fuel
any fuel which is in the gaseous state at a temperature of + 15 °C and a pressure of 1 bar

3.3.2
category D gaseous fuel
natural gas

NOTE Categories of gaseous and liquid fuel are defined in detail in ISO 13623.

3.3.3
category E gaseous fuel
LPG vapour or natural gas conveyed in association with liquid condensate

NOTE Categories of gaseous and liquid fuel are defined in detail in ISO 13623.

3.3.4
maximum operating pressure
MOP
highest effective pressure, in bars, of the gas in the piping system which is allowed in continuous use

3.3.5
operating temperature(s)
assumed temperature(s) of a pipe/fitting component at its intended service location

NOTE Such temperatures are used in designing a pipeline for operation at its MOP.

3.3.6
ancillary pipe
pipe used within buildings to facilitate the supply of gas from the distribution service pipe to the gas appliance(s)

3.3.7
pipeline operator
private or public organization authorized to design, construct and/or operate and maintain the gas supply

4 Materials

4.1 General

Base material used in the manufacture of pipes meeting the performance requirements described in clause 5 shall be crosslinked by the peroxide (PE-Xa), silane (PE-Xb) or electron beam (PE-Xc) crosslinking process or, subject to consultation with the pipeline operator, by another process.

Base material shall contain only those additives necessary for the manufacture and end use of pipes conforming to this specification including fusion jointing using socket and saddle fittings that meet the requirements of ISO 14531-2 and ISO 8085-3.

Other materials (plastics and metals) utilized in the manufacture of pipes to this part of ISO 14531 shall be supplied in accordance with a relevant ISO standard (e.g. ISO 4437 for PE 80 and PE 100 material).

The manufacturer of the pipes shall maintain the availability of a technical file (generally confidential) with all relevant material data to prove the conformity of pipes to this part of ISO 14531. It shall include all the results of type testing. Any change in the materials used that is likely to affect product quality and performance shall require a re-assessment of material performance against the requirements of this part of ISO 14531.

4.2 PE-X

4.2.1 Performance

PE-X shall conform to the performance requirements given in Tables 1 and 2 when tested in the form of pipe. Conformity shall be demonstrated by the pipe manufacturer and shall relate to one source of base material and associated pipe manufacturing method.

Table 1 — Chemical and fracture characteristics of PE-X (tested in the form of extruded pipe)

Characteristic	Units	Requirements	Test parameters	Test method
Resistance to gas constituents	h	No failure when tested to 1 000 h	Temperature: 80 °C Stress: 2 MPa	Annex B Pipe test piece $d_n = 32$ mm, SDR 11
Slow crack growth[a]	h	No failure when tested to 5 000 h	Temperature: 80 °C Pressure: PE-X 80: 8,0 bar PE-X 100: 9,2 bar PE-X 125: 10,8 bar	ISO 13479 Pipe test piece $d_n = 110$ mm or 125 mm, SDR 11
RCP arrest temperature[b, c]	°C	$\leqslant -50$[d]	Stress: PE-X 80: 6,4 MPa PE-X 100: 8,0 MPa PE-X 125: 10,0 MPa	ISO 13477 Pipe test piece $d_n \geqslant 90$ mm
Long-term stability	h	No failure when tested to 8 760 h	Temperature: 110 °C Stress: 2,5 MPa	ISO 1167 Type A end caps Water-in-air Pipe test piece $d_n = 32$ mm, SDR 11
Degree of crosslinking	%	$\geqslant 60$ but $\leqslant 90$ at any point through the wall thickness		ISO 10147 Pipe test pieces $d_n = 32$ mm, SDR 11 and $d_n = 110$ mm or 125 mm, SDR 11

[a] For materials intended for pipes with $e_{y,min} > 5$ mm.

[b] All materials to be evaluated with extruded pipe test pieces having diameter and wall thickness conforming to Table 5 (see also footnote b to Table 7).

[c] RCP evaluation of materials intended for pipes of $d_n < 90$ mm is unnecessary.

[d] Alternative temperature limits of −20 °C or −35 °C may be used to qualify material for minimum operating temperatures higher than −50 °C (see clause 1).