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Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) —

Part 1: **General**

Systèmes de canalisations en matières plastiques pour la distribution de combustibles gazeux — Polyéthylène (PE) —

Partie 1: Généralités

Reference number
ISO 4437-1:2014(E)

Contents

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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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 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*.

This first edition of ISO 4437-1 together with the first editions of ISO 4437-2, ISO 4437-3 and ISO 4437-5 cancel and replace ISO 4437:2007, ISO 8085-1:2001, ISO 8085-2:2001 and ISO 8085-3:2001, of which they constitute a technical revision.

ISO 4437 consists of the following parts, under the general title *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 4: Valves*

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

Introduction

This part of ISO 4437 specifies the requirements for a piping system and its components made from polyethylene (PE), and which is intended to be used for the supply of gaseous fuels.

Requirements and test methods for components of the piping system are specified in ISO 4437-2, ISO 4437-3, and ISO 4437-4.

Characteristics for fitness for purpose of the system are covered in ISO 4437-5. Recommended practice for installation is given in ISO/TS 10839.[1]

This part of ISO 4437 covers the general aspects of the plastics piping system.

Plastics piping systems for the supply of gaseous fuels - Polyethylene (PE) —

Part 1: General

1 Scope

This part of ISO 4437 specifies the general properties of polyethylene (PE) compounds for the manufacture of pipes and fittings intended to be used for the supply of gaseous fuels.

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

In conjunction with ISO 4437-2, ISO 4437-3, ISO 4437-4, and ISO 4437-5, it is applicable to PE pipes, fittings and valves, their joints, and joints with components of PE and other materials intended to be used under the following conditions:

a) the maximum operating pressure (MOP), is based on the design stress determined from the compound minimum required strength (MRS) divided by the *C* factor, and taking into account rapid crack propagation (RCP) requirements;

b) a temperature of 20 °C as reference temperature for the design basis.

NOTE 1 For other operating temperatures, guidance is given in ISO 4437-5:2014.

NOTE 2 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 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 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 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 4437-2:2014, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 2: Pipes*

ISO 4437-3:2014, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 3: Fittings*

ISO 4437-4:—[1)], *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 4: Valves*

ISO 4437-5:2014, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 5: Fitness for purpose of the system*

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

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

ISO 11413:2008, *Plastics pipes and fittings — Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting*

ISO 11414:2009, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion*

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 13479, *Polyolefin pipes for the conveyance of fluids — Determination of resistance to crack propagation — Test method for slow crack growth on notched pipes*

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene (PE) electrofusion assemblies of nominal outside diameter greater than or equal to 90 mm*

ISO 15512, *Plastics — Determination of water content*

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*

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

1) To be published. (Revision of ISO 10933:1997)

3 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 Geometrical definitions

3.1.1
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

3.1.2
nominal outside diameter
d_n
specified outside diameter, in millimetres, assigned to a nominal size DN/OD

3.1.3
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

3.1.4
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

3.1.5
minimum mean outside diameter
$d_{em,min}$
minimum value for the mean outside diameter as specified for a given nominal size

3.1.6
maximum mean outside diameter
$d_{em,max}$
maximum value for the mean outside diameter as specified for a given nominal size

3.1.7
out-of-roundness
ovality
difference between the maximum and the minimum outside diameters 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 parts of ISO 4437, 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

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

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

3.1.11
maximum wall thickness at any point
e_{max}
maximum value for the wall thickness at any point around the circumference of a component, as specified

3.1.12
mean wall thickness
e_m
arithmetical mean of a number of measurements of the wall thickness, regularly spaced around the circumference and in the same cross-section of a component, including the measured minimum and the measured maximum values of the wall thickness in that cross-section

3.1.13
tolerance
permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value

3.1.14
wall thickness tolerance
t_y
permitted difference between the wall thickness at any point, *e*, and the nominal wall thickness, e_n

Note 1 to entry: $e_n \leq e \leq e_n + t_y$

3.1.15
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

3.1.16
pipe series
S
dimensionless number for pipe designation conforming to ISO 4065[2]

Note 1 to entry: The relationship between the pipe series *S* and the standard dimension ratio (SDR) is given by the following equation as specified in ISO 4065.[2]

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

3.2 Material definitions

3.2.1
virgin material
material in a form such as granules 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

3.2.2
own reprocessable material
material prepared from clean, rejected, and unused pipes, fittings, or valves, including trimmings from the production of pipes, fittings, or valves, that is 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

3.2.3
compound
homogenous extruded mixture of base polymer (PE) and additives, i.e. anti-oxidants, pigments, carbon black, UV-stabilizers, and others at a dosage level necessary for the processing and use of components conforming to the requirements of 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 when σ_{LPL} is below 10 MPa, or to the next lower value of the R20 series when σ_{LPL} is 10 MPa or greater

Note 1 to entry: The R10 series conforms to ISO 3[3] and the R20 series conforms to ISO 497.[4]

3.3.3
design coefficient
C
coefficient with a value greater than 1 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

3.3.4
design stress
σ_S
allowable stress for a given application at 20 °C, that is derived from the MRS by dividing it by the design coefficient *C*, i.e.

$$\sigma_s = \frac{\mathrm{MRS}}{C}$$

Note 1 to entry: It is expressed in megapascals.

3.3.5
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).

3.4 Definitions related to service conditions

3.4.1
gaseous fuel
fuel which is in gaseous state at a temperature of 15 °C, and a pressure of 1 bar

3.4.2
maximum operating pressure
MOP
maximum effective pressure of the fluid in the piping system, expressed in bar, which is allowed in continuous use

Note 1 to entry: It is expressed in bar and takes into account the physical and the mechanical characteristics of the components of a piping system and it is calculated using the following equation:

$$\mathrm{MOP} = \frac{20 \times \mathrm{MRS}}{C \times (\mathrm{SDR} - 1)}$$

3.4.3
reference temperature
temperature for which the piping system is designed

Note 1 to entry: It is used as the base for further calculation when designing a piping system or parts of a piping system for operating temperatures different from the reference temperature (see ISO 4437-5).

3.5 Definitions related to joints

3.5.1
butt fusion joint using heated tool
joint made by heating the planed ends of pipes or spigot end fittings, the surfaces of which match by holding them against a flat heating plate until the PE material reaches fusion temperature, removing the heating plate quickly and pushing the two softened ends against one another

3.5.2
fusion compatibility
ability of two similar or dissimilar polyethylene materials to be fused together to form a joint which conforms to the performance requirements of this International Standard

3.5.3
electrofusion joint
joint between a PE electrofusion socket or saddle fitting and a pipe or a spigot end fitting

Note 1 to entry: The electrofusion fittings are heated by the Joule effect of the heating element incorporated at their jointing surfaces, causing the material adjacent to them to melt and the pipe and fitting surfaces to fuse.

3.5.4
socket fusion joint
joint between a PE socket or saddle fitting and a pipe or a spigot end fitting

Note 1 to entry: The socket fittings are heated by a purpose-made heated tool causing the material on the jointing surface to melt and the pipe and fitting surfaces to fuse.

4 Symbols

For the purposes of this document, the following symbols apply.

C	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
E	wall thickness (at any point) of a fitting and valve body
e	wall thickness (at any point) around the circumference of a component
e_m	mean wall thickness
e_{max}	maximum wall thickness (at any point)
e_{min}	minimum wall thickness (at any point)
e_n	nominal wall thickness
t_y	wall thickness tolerance
σ_s	design stress
σ_{LPL}	lower confidence limit of the predicted hydrostatic strength

5 Abbreviated terms

For the purposes of this document, the following abbreviations apply.

DN/OD	nominal size, outside diameter related
LPL	lower predicted limit
MFR	melt mass-flow rate
MOP	maximum operating pressure
MRS	minimum required strength
PE	polyethylene
R	series of preferred numbers, conforming to the Renard series
SDR	standard dimension ratio

6 Material

6.1 Material of the components

The pipes, fittings, and valves shall be made of polyethylene compound conforming to this International Standard.

6.2 Compound

6.2.1 Additives

The compound shall be made by adding to the polyethylene base polymer only those additives, pigments, or carbon black necessary for the manufacture of pipes and fittings conforming to ISO 4437-2:2014, ISO 4437-3:2014, and ISO 4437-4:—[2] as applicable, and for their fuseability, storage, and use.

All additives used shall take into account national legislation.

6.2.2 Colour

The colour of the compound shall be yellow (PE 80), orange (PE 100), or black (PE 80 and PE 100). The carbon black used in the production of black compound shall have an average (primary) particle size of 10 nm to 25 nm.

Other colours and non-pigmented compounds are permitted for coated pipe, providing the outer coated layer material is either yellow, orange, or black (see ISO 4437-2:2014, Annex B).

6.2.3 Characteristics

6.2.3.1 Characteristics of the compound in the form of granules

The compound in the form of granules used for the manufacture of pipes, fittings, and valves shall have characteristics conforming to the requirements given in Table 1.

6.2.3.2 Characteristics of the compound in the form of pipe

Unless otherwise specified by the applicable test method, the test pieces shall be conditioned at (23 ± 2) °C before testing in accordance with Table 2.

The compound in the form of pipe used for the manufacture of pipes and fittings shall have characteristics conforming to the requirements given in Table 2.

2) To be published. (Revision of ISO 10933:1997)

Table 1 — Characteristics of the compound in the form of granules

Characteristic	Requirements[a]	Test parameters		Test method
		Parameter	Value	
Compound density	≥930 kg/m^3	Test temperature	23 °C	ISO 1183-1 or ISO 1183-2
		Number of samples[b]	Shall conform to ISO 1183-1 or ISO 1183-2	
Oxidation induction time (Thermal stability)	>20 min	Test temperature	200 °C[c]	ISO 11357-6
		Number of test pieces[b]	3	
		Test atmosphere	Oxygen	
		Sample weight	15 ± 2 mg	
Melt mass-flow rate (MFR)	(0,20 ≤ MFR ≤ 1,40) g/10 min[d i] Maximum deviation of ±20 % of the nominated value	Loading mass	5 kg	ISO 1133-1
		Test temperature	190 °C	
		Time	10 min	
		Number of test pieces[b]	Shall conform to ISO 1133-1	
Volatile content	≤350 mg/kg	Number of test pieces[b]	1	EN 12099
Water content[e]	≤300 mg/kg (Equivalent to <0,03 % by mass)	Number of test pieces[b]	1	ISO 15512
Carbon black content[f]	(2,0 to 2,5) % (by mass)	Shall conform to ISO 6964		ISO 6964
Carbon black dispersion[f]	Grade ≤ 3 Rating of dispersion A1, A2, A3, or B	Preparation of test pieces	Free[g]	ISO 18553
		Number of test pieces[b]	Shall conform to ISO 18553	
Pigment dispersion[h]	Grade ≤ 3 Rating of dispersion A1, A2, A3, or B	Preparation of test pieces	Free[g]	ISO 18553
		Number of test pieces[b]	Shall conform to ISO 18553	

[a] Conformity to these requirements shall be proved by the compound producer.

[b] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 1. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 1555–7.[5]

[c] Test can be carried out at 210 °C or 220 °C provided that a clear correlation has been established. In case of dispute, the reference temperature shall be 200 °C.

[d] Nominated value given by the compound manufacturer.

[e] Only applicable if the measured volatile content is not in conformity to its specified requirement. In case of dispute, the requirement for water content shall be used. As an alternative method, ISO 760[6] can apply. The requirement applies to the compound producer at the stage of manufacturing and to the compound user at the stage of processing (if the water content exceeds the limit, drying is required prior to use).

[f] Only for black compound.

[g] In case of dispute, the test pieces shall be prepared by compression method.

[h] Only for non-black compounds.

[i] Materials 0,15 ≤ MFR < 0,20 can be introduced, in such case attention is drawn to the fusion compatibility (see 6.3). The lowest MFR value resulting from the maximum lower deviation of the nominated value should be not less than 0,15.

Table 2 — Characteristics of compound in the form of pipe

Characteristic	Requirements[a]	Test parameters		Test method
		Parameter	Value	
Resistance to gas condensate	No failure during the test period of all test pieces	End caps	Type A of ISO 1167-1	ISO 1167-1 and ISO 1167-2
		Test temperature	80 °C	
		Orientation	Free	
		Number of test pieces[b]	3	
		Circumferential (hoop) stress	2,0 MPa	
		Pipe dimensions:		
		d_n	32 mm	
		e_n	3 mm	
		Type of test	Synthetic condensate[c] in water	
		Test period	20 h	
		Conditioning period (pipe filled with condensate)	1 500 h in air at 23 °C	
Resistance to weathering[d]	The weathered test pieces shall fulfil the requirements of the following characteristics, a), b) and c) below:	Preconditioning (weathering): Cumulative radiant exposure	≥3,5 GJ/m²	ISO 16871
		Number of test pieces[b]	See below	
a) Decohesion of an electrofusion joint (d_n: 110 mm SDR 11)	a) Sample prepared in accordance with ISO 11413:2008, Jointing condition 1: 23 °C; ≤33 % brittle failure			a) ISO 13954
b) Hydrostatic strength (1 000 h at 80 °C)	b) Shall conform to Table 4 of ISO 4437-2:2014			b) ISO 1167-1 and ISO 1167-2
c) Elongation at break	c) Shall conform to Table 4 of ISO 4437-2:2014			c) ISO 6259-1 and ISO 6259-3
Resistance to rapid crack propagation (Critical pressure, p_c) (e ≥ 15 mm)	$P_c \geq 1,5$ MOP with $p_c = 3,6p_{c,s4} + 2,6$[e]	Test temperature	0 °C	ISO 13477
		Number of test pieces[b]	Shall conform to ISO 13477	
Resistance to slow crack growth (d_n: 110 mm SDR 11)	No failure during the test period	Test temperature	80 °C	ISO 13479
		Internal test pressure for:		
		PE 80	8,0 bar	
		PE 100	9,2 bar	
		Test period	500 h	
		Type of test	Water-in-water	
		Number of test pieces[b]	Shall conform to ISO 13479	

a Conformity to these requirements shall be proved by the compound producer.

b The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 2. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 1555–7.[5]

c 50 % (by mass) n-decane and 50 % (by mass) 1–3-5 trimethylbenzene.

d Only for non-black compounds.

e Full scale/S4 correlation factor is equal to 3,6 and is defined as the full scale/S4 critical absolute pressure ratio: $(p_{c,full\ scale}+1) = 3,6\ (p_{c,s4}+1)$.

If the requirement is not met or S4 test equipment is not available, then (re)testing by using the full scale test shall be performed in accordance with ISO 13478. In this case: $p_c = p_{c,full\ scale}$.

NOTE Attention is drawn to the fact that the correlation factor can be modified when revising this International Standard, according to the result of the work of ISO/TC 138/SC 5.

6.3 Fusion compatibility

6.3.1 The compounds conforming to Table 1 shall be fusible. This shall be demonstrated by the compound manufacturer for each compound of his own product range by checking that the requirement for the failure mode in a tensile test given in Table 3 is fulfilled for a butt fusion joint prepared by using the parameters specified in Annex A of ISO 11414:2009 at an ambient temperature of (23 ± 2) °C from pipes both manufactured from that compound.

For 0,15 ≤ MFR < 0,20 compounds, fusion compatibility of larger diameter thicker-walled pipes should be investigated to confirm compatibility. If electrofusion is used, appropriate testing should be carried out to verify the fusion capability of such pipes.

6.3.2 The compounds conforming to Table 1 are considered fusible to each other. If requested, the compound manufacturer shall demonstrate this by checking that the requirement for the failure mode in a tensile test given in Table 3 is fulfilled for a butt fusion joint prepared by using the parameters as specified in Annex A of ISO 11414:2009 at an ambient temperature of (23 ± 2) °C from two pipes manufactured from the compounds from his own range covered by this request.

Table 3 — Characteristic of compound in the form of a butt fusion joint

Characteristic	Requirement[a]	Test parameters		Test method
		Parameter	Value	
Determination of the failure mode in a tensile test on butt fusion weld (d_n: 110 mm SDR 11)	Test to failure: Ductile – pass Brittle – fail	Test temperature Number of test pieces[b]	23 °C Shall conform to ISO 13953	ISO 13953

[a] The conformity to these requirements shall be proven by the compound producer.

[b] The number of test pieces given indicates the number required to establish a value for the characteristic described in Table 3. The number of test pieces required for factory production control and process control should be listed in the manufacturer's quality plan. Guidance on assessment of conformity can be found in CEN/TS 1555–7.[5]

6.4 Classification and designation

Compounds shall be designated by the type of PE material. The minimum required strength (MRS) shall conform to Table 4 when tested in the form of pipe.

Table 4 — Classification and designation of compounds

Classification by MRS MPa	Designation
8,0	PE 80
10,0	PE 100

The compound shall be evaluated in accordance with ISO 9080 from pressure tests on pipes in accordance with ISO 1167-1 and ISO 1167-2 performed on pipes at least at three temperatures, where two of the temperatures are fixed to 20 °C and 80 °C and the third temperature is free between 30 °C and 70 °C, to find the σ_{LPL}. The MRS value shall be derived from the σ_{LPL} and the compound shall be classified by the compound producer in accordance with ISO 12162.

At 80 °C, there shall be no knee detected in the regression curve at t < 5 000 h.

NOTE Testing has shown that for many compounds, no knee is detected before 1 year at 80°C.

The conformity of the designation of the compound to the classification given in Table 4 shall be demonstrated by the compound producer.

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

For the classification of a compound intended only for the manufacture of fittings, test pieces in the form of extruded pipe made from the compound shall be used.

6.5 Design coefficient and design stress

The design coefficient, *C*, for pipes, fittings, and valves for the supply of gaseous fuels shall be greater than or equal to 2.

The maximum value for the design stress, σ_S, shall be 4,0 MPa for PE 80 and 5,0 MPa for PE 100, at the reference temperature of 20 °C.

A higher design coefficient should be considered for the use of LPG or manufactured gas (see Annex A).

6.6 Change of compound formulation

Any change in dosage levels or manufacturing process of the compound affecting the performance can require a new qualification of the compound.

NOTE Guidance can be found in References [5] and [7].

Annex A
(informative)

LPG and manufactured gas

A.1 General

Internal fluids such as gases and condensates when absorbed can have the effect of reducing the material strength upon which the design stress is based, the influence of gas being much less severe than condensate. For LPG gas, the *C* factor should be 10 % greater than that of natural gases, i.e. a minimum of 2,2. This difference is in line with the values already in use by the gas industry in the ISO codes of practice. The factor for manufactured gas should take into consideration the analysis of the gas with special reference to liquid hydrocarbons and should be at least 2,4. However, this component needs to be the subject of further discussion. See References [8] and [9].

Bibliography

[1] ISO/TS 10839, *Polyethylene pipes and fittings for the supply of gaseous fuels — Code of practice for design, handling and installation*

[2] ISO 4065, *Thermoplastics pipes — Universal wall thickness table*

[3] ISO 3, *Preferred numbers — Series of preferred numbers*

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

[5] CEN/TS 1555-7, *Plastics piping systems for the supply of gaseous fuels — Polyethylene (PE) — Part 7: Guide for the assessment of conformity*

[6] ISO 760, *Determination of water — Karl Fischer method (General method)*

[7] PPI TR-3, *Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe*

[8] PPI TR-22/2006, *Polyethylene piping distribution systems for components of liquid petroleum gases*

[9] PPI MS-2. *Model specification for polyethylene plastic pipe, tubing and fittings for fuel gas distribution systems*, 2000

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