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Plastics pipes and fittings — Mechanical-joint compression fittings for use with polyethylene pressure pipes in water supply systems

Tubes et raccords en matières plastiques — Raccords mécaniques à joint de compression utilisés avec les tubes pression en polyéthylène dans les systèmes d'adduction d'eau

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

International Standard ISO 14236 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*.

Annex A of this International Standard is given for information only.

Plastics pipes and fittings — Mechanical-joint compression fittings for use with polyethylene pressure pipes in water supply systems

1 Scope

This International Standard specifies the required properties and test methods for mechanical fittings intended to join polyethylene pressure pipes of nominal outside diameters not greater than 160 mm, used in water supply systems conveying potable water and water for general purposes at temperatures up to and including 40 °C. The nominal pressure of the specified mechanical fittings corresponds at least to the PN of the water supply system for which they are designed and is usually of PN 6, PN 10 or PN 16.

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 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 161-1:1996, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameter and nominal pressure — Part 1: Metric series.*

ISO 197-1:1983, *Copper and copper alloys — Terms and definitions — Part 1: Materials.*

ISO 197-4:1983, *Copper and copper alloys — Terms and definitions — Part 4: Castings.*

ISO 228-1:1994, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation.*

ISO 426-1:1983, *Wrought copper-zinc alloys — Chemical composition and forms of wrought products — Part 1: Non-leaded and special copper-zinc alloys.*

ISO 426-2:1983, *Wrought copper-zinc alloys — Chemical composition and forms of wrought products — Part 2: Leaded copper-zinc alloys.*

ISO 427:1983, *Wrought copper-tin alloys — Chemical composition and forms of wrought products.*

ISO 1083:1987, *Spheroidal graphite cast iron — Classification.*

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

ISO 3459:1976, *Polyethylene (PE) pressure pipes — Joints assembled with mechanical fittings — Internal under-pressure test method and requirement.*

ISO 3501:1976, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of resistance to pull out.*

ISO 3503:1976, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of leakproofness under internal pressure when subjected to bending.*

ISO 4427:1996, *Polyethylene (PE) pipes and fittings for water supply — Specifications.*

ISO 5922:1981, *Malleable cast iron.*

ISO 7686:1992, *Plastics pipes and fittings — Opacity — Test method.*

ISO 9080:—[1)], *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation.*

ISO 9853:1991, *Injection-moulded unplasticized poly(vinyl chloride) (PVC-U) fittings for pressure pipe systems — Crushing test.*

ISO 12092:—[2)], *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 12162:1995, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient.*

ISO 15853:1999, *Thermoplastics materials — Preparation of tubular test pieces for the determination of the hydrostatic strength of materials used for injection moulding.*

EN 1254-3:1998, *Copper and copper alloys — Plumbing fittings — Part 3: Fittings with compression ends for use with plastics pipes.*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
mechanical-joint compression fitting
fitting in which the joint is made by the compression of a ring or sleeve on the outside wall of the pipe, with or without additional sealing elements and with or without internal support

3.2
nominal size
d_n
nominal outside diameter of the pipe which can be connected to the fitting

3.3
nominal pressure
PN
maximum working pressure at which a piping component is required to operate under normal service conditions

3.4
design stress
σ_s
allowable stress for a given application

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

2) To be published.

3.5
test stress
σ_T
stress for the relevant test period and temperature

4 Classification

For the purposes of this International Standard, mechanical fittings shall be classified as follows:

a) according to the connecting system, as follows:

   — type 1: external-grip fittings (compression-type fittings), which grip the pipe only at its outer surface,

   — type 2: internal/external-grip fittings, which grip or support the pipe both at the inner and outer surface of the pipe;

b) according to the resistance of the fitting to the longitudinal forces which develop as a result of the internal pressure, as follows:

   — class 1: end-load-bearing compression fittings,

   — class 2: non-end-load-bearing compression fittings.

5 Material

5.1 General

The material of the fitting components which are in contact with the water should conform to relevant national standards, where applicable, and shall not contain toxic additives.

NOTE Attention is drawn to the need to comply with national regulations concerning the effects of materials in contact with water for the purposes of water supply.

5.2 Plastics

The fitting body shall be opaque. When measured in accordance with ISO 7686, the percentage of light which passes through the wall of the fitting shall be less than or equal to 0,2 %.

The composition of the plastics parts of the fitting exposed to ultra-violet radiation shall include a UV stabilizer.

The body should preferably be made from one or more of the types of material listed in Table 1.

Table 1 — Plastics fitting materials

Fitting material	MRS MPa	Specified design stress, σ_S MPa
PVC-U	<25	10
PP-H	10	6,3
PP-B, PP-R	8	6,3
POM homopolymer	10	6,3
POM copolymer	10	6,3
ABS	12,5	8

5.3 Metals

Metal fittings should preferably be made from one or more of the materials listed in Table 2. The materials shall be corrosion-resistant or shall be protected against corrosion.

NOTE Some grades of stainless steel and mild steel are also suitable.

Table 2 — Metallic fitting materials

Material designation symbol		Relevant ISO standard
Copper: Cu-DHP		ISO 197-1
Copper alloys, e.g.	$CuSn_5Zn_5Pb_5$-C	ISO 427, ISO 197-4
	$CuZn_{39}Pb_3$	ISO 426-2, ISO 197-4
	$CuZn_{36}Pb_2As$	ISO 426-2, ISO 197-4
	$CuZn_{33}Pb_2$-C	ISO 426-2, ISO 197-4
	$CuZn_{15}As$-C	ISO 426-1, ISO 197-4
Ductile cast iron		ISO 1083
Malleable cast iron		ISO 5922

6 Workmanship and appearance

6.1 Plastics materials

The internal and external surfaces of fittings made of plastics materials shall be clean and free from grooves, pinholes, voids and other features likely to cause the fittings to fail to conform to any requirement of this International Standard.

6.2 Metal or metal-alloy materials

6.2.1 Castings

Castings shall in all respects be sound and free from laps, blowholes and pitting, and both the external and the internal surfaces shall be clean, smooth and free from sand.

6.2.2 Manufactured fittings

Manufactured fittings shall be sound in all respects. In particular, they shall be free from laps, blowholes and pitting, and both the external and internal surfaces shall be clean and smooth.

6.2.3 Fittings made by other processes

Fittings made by other processes shall be sound in all respects and, in particular, free from laminations.

7 Geometrical characteristics

7.1 General

Fittings shall be designed with due regard to good practice in relation to their hydrodynamic characteristics. They shall be manufactured with such dimensions and within such tolerances as will permit their use with polyethylene pipes conforming to ISO 161-1 and ISO 4427.

The dimensions shall be such that joints with pipes conform to the requirements of clause 8.

7.2 Minimum bore diameter

The minimum bore diameter of pre-assembled pipe/fitting assemblies shall be as stated by the manufacturer in his technical specifications.

7.3 Minimum wall thickness of metal fittings

The minimum wall thickness of the fitting body shall conform to Table 3 for castings, stampings and fittings made from rods.

The minimum wall thickness specified shall not apply along the cone angle or at the point of minimum thickness of the loose ring or sleeve where such a ring or sleeve has been deformed to form a seal. It shall also not apply to internal pipe supports.

7.4 Fitting threads

The size and length of jointing threads for connections with the water supply system shall conform to ISO 7-1. Fastening threads shall conform to ISO 228-1.

Table 3 — Minimum wall thicknesses of metallic fittings

Nominal outside diameter of pipe, d_n	Copper and copper alloys[a]		Ductile and malleable cast iron
	Stampings, or fittings made from rods	Castings	
mm	mm	mm	mm
16	1,2	1,2	Due to limitations in casting techniques, the wall thickness is always greater than that required by the design strength.
20	1,4	1,4	
25	1,4	1,6	
32	1,6	1,8	
40	1,8	2,0	
50	1,9	2,3	
63	2,0	2,4	
75	2,6	2,8	
90	2,9	3,1	
110	3,3	3,5	

[a] The minimum wall thicknesses are in conformity with EN 1254-3.

8 Mechanical and hydraulic characteristics

8.1 General

If the fittings are tested, the tests specified in this International Standard shall be used. For this purpose, the fittings shall be joined to polyethylene pipes conforming to ISO 4427. The nominal pressure of the pipes used in the tests shall be equivalent to the nominal pressure of the fittings.

Test methods and requirements for fittings made from metals or metal alloys are given in 8.2.

Test methods and requirements for fittings made from plastics materials are given in 8.3.

8.2 Test methods and requirements for fittings made of metal or metal alloy

8.2.1 Leaktightness under internal pressure when subjected to bending

When a straight fitting (coupling) assembly is tested in accordance with ISO 3503, it shall conform to the requirement given in Table 4.

Table 4 — Performance requirements for metal fittings — Leaktightness when subjected to bending

Pipe material	Test temperature °C	Test duration h	Test stress, σ_T MPa	Test pressure, p_T bar	Requirement
PE 63	20 ± 5	1	9,0	$1{,}8 \times PN$	No leakage during test
PE 80	20 ± 5	1	11,4	$1{,}8 \times PN$	
PE 100	20 ± 5	1	14,4	$1{,}8 \times PN$	

For class 2 fittings, a fitting assembly capable of sustaining the longitudinal forces generated by the internal water pressure shall be used.

The test pressure shall be calculated, in bars, from the equation

$$p_T = \frac{\sigma_T}{\sigma_S} \times PN$$

where

σ_T is the applicable test stress given in Table 4 (MPa);

σ_S is the design stress in accordance with ISO 4427;

PN is the nominal pressure.

NOTE 1 1 bar = 0,1 MPa.

NOTE 2 For diameters larger than 63 mm, the use of special equipment might be necessary to create the bending radius required for the pipe under test.

8.2.2 Resistance to pull-out (only for class 1 fittings)

When a fitting assembly is tested in accordance with ISO 3501, it shall conform to the requirement given in Table 5, the test force F_T being calculated, in newtons, from the following equation:

$$F_T = 1{,}5\,\sigma_T\,\pi\,e_n\,(d_n - e_n)$$

where

σ_T is the applicable test stress given in Table 5 (MPa);

e_n is the wall thickness of the pipe (mm);

d_n is the nominal outside diameter of the pipe (mm).

NOTE For diameters larger than 63 mm, the use of special equipment, such as hydraulic rams, might be necessary to produce the force required. See also testing in ISO 10838-2:2000, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 2: Metal fittings for pipes of nominal outside diameter greater than 63 mm.*

Table 5 — Performance requirements for metal fittings — Pull-out test

Pipe material	Test temperature °C	Test duration h	Test stress, σ_T [a] MPa	Requirement
PE 63	20 ± 5	1	4,5	Displacement of pipe during test does not affect leaktightness of joint
PE 80	20 ± 5	1	5,7	
PE 100	20 ± 5	1	7,2	

[a] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as test stresses in Table 4.

8.2.3 Leaktightness under internal vacuum

When a fitting assembly is tested at two pressures in accordance with ISO 3459, it shall conform to the requirement given in Table 6.

Table 6 — Performance requirements for metal fittings — Leaktightness under vacuum

Pipe material	Test temperature °C	Test duration (two periods)	Test pressure bar	Requirement
PE 63	20 ± 5	1 h at	$0{,}1^{+0{,}05}_{0}$	No leakage during either test period
PE 80		followed by		
PE 100		1 h at	$0{,}8^{+0{,}05}_{0}$	

8.2.4 Long-term pressure test for leaktightness of assembled joints

When an assembly comprising at least one fitting with one or more pipe(s) jointed to it is tested in accordance with ISO 1167, the joint shall conform to the requirement given in Table 7.

For class 2 fittings, a fitting assembly capable of withstanding the longitudinal forces generated by the internal water pressure shall be used.

Table 7 — Performance requirements for metal fittings — Leaktightness of assembled joints

Pipe material	Test duration (two periods)	Test temperature	Test pressure ($f \times$ PN)	Requirement
PE 63	1 000 h at	20 °C and	1,5 × PN bar	No failures (leakage, fractures, cracking) in joint area of fitting or pipe during either test period
PE 80	followed by			
PE 100	1 000 h at	40 °C and	1,1 × PN bar	

The pressure factor f is calculated as follows:

At 20 °C $\quad \dfrac{\sigma_{T,1000}}{\sigma_s} = f$

At 40 °C $\quad \dfrac{\sigma_{T,1000}}{\sigma_s} \times f_t = f$

where

$\sigma_{T,1000}$ is the test stress at 1 000 h and 20 °C, interpolated from an MRS regression curve (1 h, 100 h, 50 years) (see 8.3.2.1);

σ_s is the design stress in accordance with ISO 4427;

f_t is a derating factor for temperatures above 20 °C, in accordance with ISO 4427.

Both PN values shall be rounded to the next higher tenth.

8.3 Test methods and requirements for fittings made of plastics materials

8.3.1 Fitting materials

The material from which the fitting body is made should be in accordance with the specifications given in Table 1.

The use of the manufacturer's own reprocessed material produced during the manufacture and works testing of products conforming to this International Standard is permissible. No other reprocessed material shall be used.

8.3.2 Testing of material

8.3.2.1 MRS value

The material specified for the fitting body shall be tested in accordance with ISO 9080 and ISO 12162 to determine the MRS value.

8.3.2.2 Verification of long-term behaviour

The long-term behaviour of the material of the fitting body shall be verified in a type test on an injection-moulded pipe specimen with an outside diameter of not less than 50 mm produced in accordance with ISO 15853 from the same material as that of the fitting body. The wall thickness of the specimen shall not be less than that of a PN 6 pipe and not more than that of a PN 16 pipe of the corresponding size and of the same material.

When the specimen is pressure-tested in accordance with the procedure described in ISO 1167, it shall conform to the applicable requirement given in Table 8.

Table 8 — Performance requirements for plastics fittings — Testing of material

Fitting material	Test temperature °C	Test duration h	Induced stress MPa	Requirement
PVC-U	60	1 000	10	No failures during test
PP-H	95	1 000	3,5	
PP-B	95	1 000	2,6	
PP-R	95	1 000	3,5	
POM homopolymer	60	1 000	10	
POM copolymer	95	400	6	
ABS	70	1 000	4	

8.3.3 Testing of fittings

8.3.3.1 Resistance to internal pressure

When an injection-moulded fitting body is tested in accordance with ISO 12092 using the test parameters given in Table 9, it shall conform to the applicable requirements given in Table 9. Special sealing plugs may be used.

NOTE The test requirements are related to the PN of the fitting.

Table 9 — Performance requirements for plastics fittings — Testing of fitting

Fitting material	Test temperature °C	Test duration h	Test pressure bar	Requirement
PVC-U	20	1 1 000	4,2 × PN 3,2 × PN	No failures (leakage, fractures, cracking) of fitting during test
PP-H	20 95	1 1 000	3,3 × PN 0,55 × PN	
PP-B	20 95	1 1 000	2,5 × PN 0,4 × PN	
PP-R	20 95	1 1 000	2,5 × PN 0,55 × PN	
POM homopolymer	20 60	1 1 000	6,3 × PN 1,5 × PN	
POM copolymer	20 60	1 1 000	5,0 × PN 0,95 × PN	
ABS	20 70	1 1 000	3,1 × PN 0,5 × PN	

8.3.3.2 **Crushing test** (only for fittings made of PVC-U)

When injection-moulded parts of fittings made from PVC-U to which hydraulic pressure cannot be applied are crush-tested in accordance with ISO 9853, the fitting parts shall not shatter at a percentage deformation less than 20 % of the diameter.

8.3.4 Assembly tests

8.3.4.1 Test specimens

For the assembly tests given in 8.3.4.2 to 8.3.4.5, each test specimen shall comprise a fitting assembled with a PE pipe of the highest PN for which the fitting is intended to be used.

8.3.4.2 Leaktightness under internal pressure when subjected to bending

When a straight fitting (coupling) assembly is tested in accordance with ISO 3503, the assembly shall conform to the requirement given in Table 10.

Table 10 — Performance requirements for plastics fitting assemblies — Leaktightness when subjected to bending

Pipe material	Test temperature °C	Test duration h	Test stress, σ_T MPa	Test pressure, p_T bar	Requirement
PE 63	20 ± 5	1	9,0	$1{,}8 \times PN$	No failures (leakage, fractures, cracking) of fitting during test
PE 80	20 ± 5	1	11,4	$1{,}8 \times PN$	
PE 100	20 ± 5	1	14,4	$1{,}8 \times PN$	

For class 2 fittings, a fitting assembly capable of sustaining the longitudinal forces generated by the internal water pressure shall be used.

The test pressure p_T shall be calculated, in bars, from the equation

$$p_T = \frac{\sigma_T}{\sigma_S} \times PN$$

where

σ_T is the applicable test stress given in Table 4 (MPa);

σ_S is the design stress in accordance with ISO 4427;

PN is the nominal pressure.

NOTE 1 1 bar = 0,1 MPa.

NOTE 2 For diameters larger than 63 mm, the use of special equipment might be necessary to create the bending radius required for the pipe under test.

8.3.4.3 Resistance to pull-out (only for class 1 fittings)

When a fitting assembly is tested in accordance with ISO 3501, the assembly shall conform to the requirement given in Table 11, the test force F_T being calculated, in newtons, from the equation given in 8.2.2.

NOTE For diameters larger than 63 mm, the use of special equipment, such as hydraulic rams, might be necessary to produce the force required. See also testing in ISO 10838-2:2000, *Mechanical fittings for polyethylene piping systems for the supply of gaseous fuels — Part 2: Metal fittings for pipes of nominal outside diameter greater than 63 mm.*

Table 11 — Performance requirements for plastics fitting assemblies — Pull-out test

Pipe material	Test temperature °C	Test duration h	Test stress, σ_T [a] MPa	Requirement
PE 63	20 ± 5	1	4,5	Displacement of pipe during test does not affect leaktightness of joint
PE 80	20 ± 5	1	5,7	
PE 100	20 ± 5	1	7,2	

[a] These are longitudinal stresses, and their values are therefore half those of the circumferential stresses given as test stresses in Table 10.

8.3.4.4 Leaktightness under internal vacuum

When a fitting assembly is tested at two pressures in accordance with ISO 3459, the assembly shall conform to the performance requirement given in Table 12.

Table 12 — Performance requirement for plastics fitting assemblies — Leaktightness under vacuum

Pipe material	Test temperature °C	Test duration (two periods)	Test pressure bar	Requirement
PE 63	20 ± 5	1 h at	$0{,}1^{+0{,}05}_{0}$	No leakage during either test period
PE 80		followed by		
PE 100		1 h at	$0{,}8^{+0{,}05}_{0}$	

8.3.4.5 Long-term pressure test for leaktightness of assembled joints

When an assembly comprising at least one fitting with one or more pipe(s) jointed to it is tested in accordance with ISO 1167, the joint shall conform to the requirement given in Table 13.

For class 2 fittings, a fitting assembly capable of withstanding the longitudinal forces generated by the internal water pressure shall be used.

The figures given in Table 13 for different fitting materials are valid for non-reinforced materials. If a reinforced material (e.g. fibre-glass) is used for the fitting, then the test pressures given in Table 7 for fittings made from metal or metal alloy shall be used.

Table 13 — Performance requirements for plastics fitting assemblies — Leaktightness of assembled joints

Fitting material	Pipe material	Test duration (two periods)	Test temperatures	Test pressure bar	Requirement
PVC-U	PE 63 PE 80 PE 100	1 000 h at followed by 1 000 h at	20 °C and 40 °C and	1,5 × PN 1,1 × PN	No leakage from joint or cracking of pipe during either test period
PP-H	PE 63 PE 80 PE 100	1 000 h at followed by 1 000 h at	20 °C and 40 °C and	1,5 × PN 1,1 × PN	
PP-B andPP-R	PE 63 PE 80 PE 100	1 000 h at followed by 1 000 h at	20 °C and 40 °C and	1,2 × PN 0,8 × PN	
POM	PE 63 PE 80 PE 100	1 000 h at followed by 1 000 h at	20 °C and 40 °C and	1,5 × PN 1,1 × PN	
ABS	PE 63 PE 80 PE 100	1 000 h at followed by 1 000 h at	20 °C and 40 °C and	1,5 × PN 1,1 × PN	

NOTE The test pressures have been determined by calculating the strain in each fitting material corresponding to the nominal stress in the system over a period of 50 years and the isochronous curves relevant to the material. A detailed explanation of the method of calculation of the test pressures in this table and the philosophy behind the method is given in annex A.

9 Pressure losses

In order to avoid excessive pressure losses in straight-line fittings, any internal support used in internal/external-grip fittings shall not cause any narrowing of the internal cross-section of the fitting by more than that stated in EN 1254-3.

10 Marking

Fittings shall be marked with at least the following information:

— manufacturer’s name and/or trademark;

— type of fitting-body material (plastics fittings only);

— nominal outside diameter of the pipe for which the fitting is intended;

— nominal pressure (PN)[3];

— nominal diameter of the thread, if one end of the fitting is threaded[3];

— manufacturing code (plastics fittings only).

The manufacturer's name or trade mark, the nominal outside diameter of the pipe, the nominal pressure of the fitting and the nominal diameter of the thread shall be printed or embossed when marked on the fitting. Additional information may be given in the form of a label affixed to the fitting or package.

3) May optionally be marked on the package.

Annex A
(informative)

Calculation of pressure to be used for long-term leaktightness testing

A.1 General

The long-term leaktightness test for mechanical joints with fittings made of plastics materials is based on the principle that these joints will have to remain watertight for the whole service life of the assembly, i.e. 50 years. This requires that any deformation occurring in the joint area due to creep does not cause any leakage.

The test is therefore carried out under conditions such that the expected creep deformation after 50 years is reached in 1 000 h. The strain in the fitting material corresponding to the nominal stress in the system over 50 years can be determined from isochronous stress/strain diagrams for the material at the service temperature [for example at 20 °C (see Figure A.1) and at 40 °C (see Figure A.2) for PP-H].

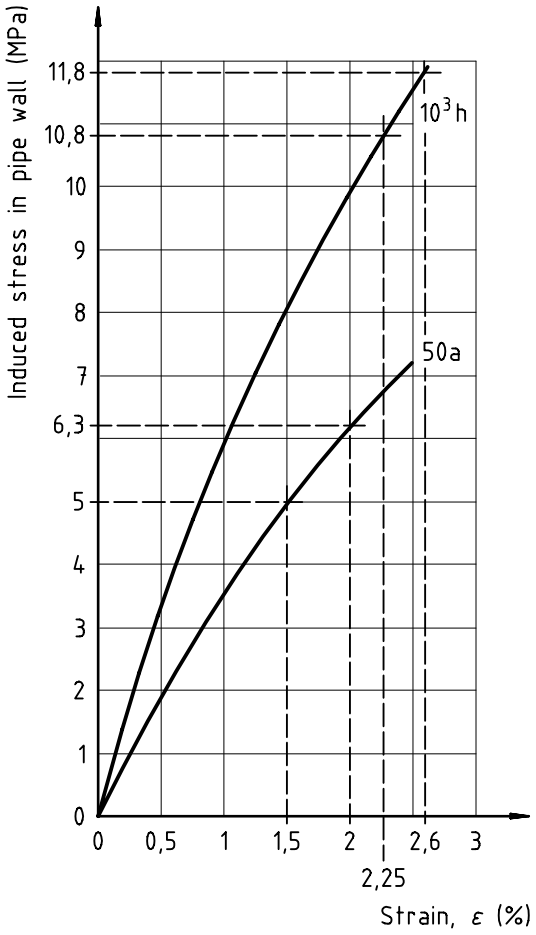

Figure A.1 — Isochronous stress/strain diagram for PP-H at 20 °C

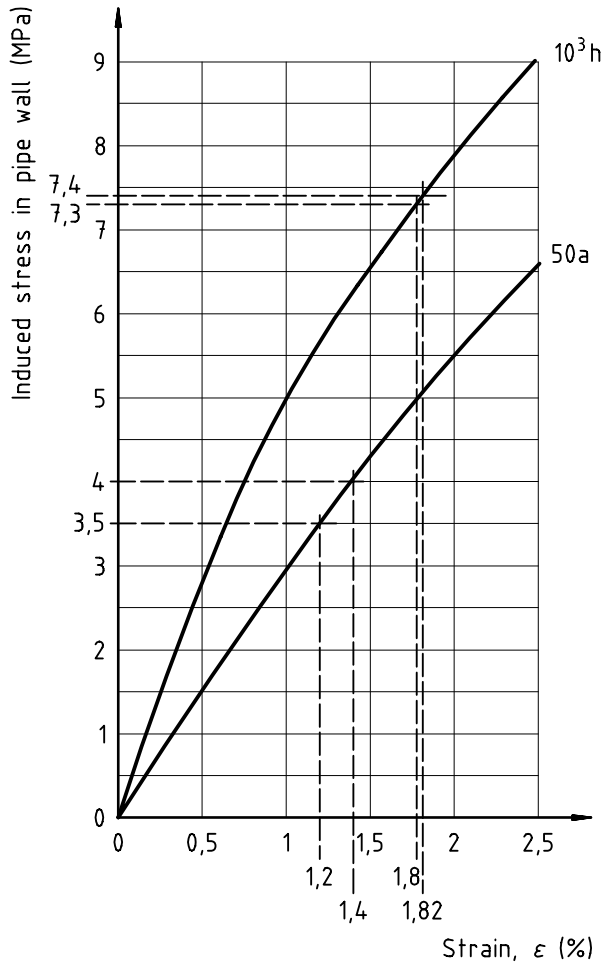

Figure A.2 — Isochronous stress/strain diagram for PP-H at 40 °C

From the strain value obtained above, the stress to be used in the 1 000 h test is determined, again from the isochronous stress/strain diagram (see Figures A.1 and A.2). This test stress is then converted into the test pressure, using the following equation:

$$p_T = \frac{\sigma_T}{\sigma_S} \times PN$$

where

p_T is the test pressure acting on the assembly;

σ_T is the test stress in the fitting material;

σ_S is the design stress for the fitting material;

PN is the nominal pressure of the fitting.

A.2 Calculation of test pressure to be used for PP-H fittings

Irrespective of whether the pipe material and fitting material are the same or different, the strain corresponding to the design stress σ_S in a pipe of the same nominal size and the same material as the fitting is calculated using the overall service (design) coefficient C in accordance with ISO 12162.

This calculation assumes an induced stress which is equal to the design stress. An additional test strain of for example 0,3 times the calculated strain is then added in the case of PP-H.

The appropriate working pressure at 40 °C is calculated using the PE pipe-derating factor graph given in Figure 1 of ISO 4427:1996.

The calculation of the test pressure to be used at each of the two test temperatures is given in Table A.1.

If the test pressure calculated for the assembly results in a stress in the pipe greater than the value for 1 000 h given by the long-term stress/strain diagram, then the test pressure has to be reduced.

Table A.1 — Calculation of pressure factors for the long-term leaktightness test for an assembly of PP-H fittings and PE 63, PE 80 or PE 100 pipes

	Fitting material: PP-H	
Temperature, °C	20	40
Temperature derating factor t_f for PE pipes	1	0,63
50 year design stress σ_S for each temperature, MPa	6,3	4,0
Strain ε at an induced stress equal to σ_S at 50 years (see Figures A.1 and A.2)	2,0	1,4
Additional test strain ε_A	0,6	0,42
Total test strain $\varepsilon_T = \varepsilon + \varepsilon_A$	2,6	1,82
Test stress σ_T at 1 000 h corresponding to ε_T (see Figures A.1 and A.2), MPa	11,8	7,4
Pressure p_T for 1 000 h test, calculated from the equation $p_T = \frac{\sigma_T}{\sigma_S} \times PN$	$p_T = \frac{11{,}8 \times PN}{6{,}3} = 1{,}87 \times PN$	$p_T = \frac{7{,}4 \times PN}{6{,}3} = 1{,}17 \times PN$

The test pressures calculated in this way should not, of course, be higher than the highest permissible test pressure for the PE pipe used, which is $1{,}5 \times PN$ at 20 °C and $1{,}1 \times PN$ at 40 °C, otherwise the PE pipe would rupture. If they are, the test pressure for a PP-H fitting assembly with PE 63, PE 80 or PE 100 pipes will have to be reduced to $1{,}5 \times PN$ at 20 °C and $1{,}1 \times PN$ at 40 °C (see Table 13).

NOTE The same pressures, based on the rupture stress of PE pipes, are also used for assemblies with fittings made from metal or metal alloy (see Table 7).

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Price based on 16 pages