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Pipe joint assemblies and fittings for high-density polyethylene (PE-HD) pressure pipes

General quality requirements and testing

DIN 16963 Part 5

Rohrverbindungen und Rohrleitungsteile für Druckrohrleitungen aus Polyethylen hoher Dichte (PE-HD); allgemeine Qualitätsanforderungen, Prüfung

Supersedes July 1977 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

Dimensions in mm

All pressures specified in this standard are gauge pressures, in bar.

1 Field of application

This standard specifies requirements (and the relevant methods of test) for high-density polyethylene (PE-HD) pressure pipes. In the technical delivery conditions for specific applications, individual requirements may be omitted or supplemented.

2 Material

The material from which pipe fittings are to be made shall be high-density polyethylene (PE-HD), stabilized by the addition of carbon black and suitable antioxidants (cf. DIN 8075), stabilizer and other additives being selected by the fitting manufacturer. Moulding materials of unknown composition shall not be used.

3 Requirements

3.1 Condition on delivery

Fittings and components of pipe joint assemblies ('joint assemblies', for short) shall be free from voids, blisters, inhomogeneities and flash which would impair their performance in service.

3.2 Behaviour in long-term hydrostatic test

Pipe fittings and joint assemblies are to be subjected to three tests: material test, component test and test on joint assembly.

3.2.1 Material test

Material testing shall be carried aut on test pieces (see figure 1) as described in subclause 4.2.2.1, their material and method of manufacture being the same as those of fittings. When tested as described in subclause 4.2, the test pieces shall, under the conditions given in table 1, neither leak nor fracture.

Table 1. **Behaviour of test pieces in long-term hydrostatic test**

Test temperature, in °C	Test period (minimum service life), in h	Proof stress, σ_0, in N/mm²
80	170	4

3.2.2 Component test

Component testing shall be carried out on pipe fittings. When these are tested as described in subclause 4.2.2.2, the fittings shall, under the conditions given in table 2, neither leak nor fracture.

Table 2. **Behavior of fittings in long-term hydrostatic test**

Test temperature, in °C	Storage medium	Test pressure, $p_{e,p}$	Test period (minimum service life), in h
80	Water	0,8 · PN	170
PN = pressure rating of relevant pipe series.			

3.2.3 Testing of joint assemblies

For testing pipe joints, assemblies either made up of a fitting and pipes or of a number of fittings shall be used.

3.2.3.1 Welded joints

For testing welded pipe joints, assemblies consisting of a fitting to which or into which pipes are welded shall be used. When these are tested as described in subclause 4.2, they shall, under the conditions given in table 3, neither leak nor fracture.

Table 3. **Behaviour of welded joints in long-term hydrostatic test**

Test temperature, in °C	Storage medium	Test pressure, $p_{e,p}$	Test period (minimum service life), in h
80	Water	0,8 · PN	170
PN = pressure rating of relevant pipe series.			

3.2.3.2 Joint assemblies

For testing joint assemblies, pipe couplings as specified in DIN 16963 Part 15 and flanged joint assemblies made up of components as specified in DIN 16963 Part 4 or DIN 16963 Part 11 shall be used.

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When these are tested as described in subclause 4.2, they shall, under the conditions given in table 4, neither leak nor fracture.

Table 4. **Behaviour of joint assemblies in long-term hydrostatic test**

Test temperature, in °C	Storage medium	Test pressure, $p_{e,p}$	Test period (minimum service life), in h
20	Air or water	1,48 · PN	1000
70*)	Water	0,52 · PN	1000
80*)	Water	0,33 · PN	1000

PN = pressure rating of relevant pipe series.

*) A temperature of 70 °C is the maximum operating temperature specified in table 5 of DIN 8074, September 1987 edition. For technical reasons, testing may alternatively be carried out at 80 °C (see Explanatory notes).

3.3 Heat reversion

Fittings and joint assemblies shall, when tested as described in subclause 4.3, exhibit no cracks, blistering or delamination, except near the gate where the depth affected shall not exceed 20 % of the wall thickness or the area affected, 20 % of the socket depth.

3.4 Surface condition

Fittings and joint assemblies shall exhibit no zones burnt by overheating during their manufacture. Fittings made from pipe sections shall be free from sink marks.

When checked as described in subclause 4.4, joint assemblies and fittings shall have smooth outer surfaces consistent with the manufacturing method.

3.5 Dimensions and limit deviations

For the dimensions (and limit deviations) of pipe fittings and joint assemblies, the specifications given in the relevant dimensional standards shall apply. All other dimensions shall be designed so that the components are capable of withstanding any stresses likely to occur in service besides those covered in subclause 3.2 of the present standard.

4 Testing

4.1 Time of testing

Testing shall be carried out not earlier than 15 hours after manufacture.

4.2 Long-term hydrostatic test

4.2.1 Number of samples

Depending on the test conditions given in tables 1 to 4, three test pieces, pipe fittings or joint assemblies shall be subjected to testing.

4.2.2 Arrangement of samples

4.2.2.1 Material test

Test pieces as shown in figure 1 shall be tested with end seals. In the case of test pieces to be produced by injection moulding, the tubular ram method shall be applied.

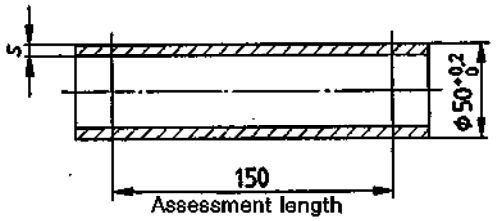

Figure 1. Test piece

4.2.2.2 Component test

Injection-moulded fittings as specified in DIN 16963 Parts 6 to 10 and 14 shall be tested using assemblies as described under item a), b) or c) below, the assemblies being so designed as to permit the significant parts of the fittings to be loaded. Although the performance of joints, brackets and seals is not the object of this test, their design shall be such that they are not the cause of the system failing.

a) The test assembly shall be made up of fittings joined by welding with sections of pipe as specified in DIN 8074, belonging to the same series, the length of the latter being chosen in accordance with table 5.

Table 5. **Length of welded-on pipe sections**

Pipe outside diameter	Length of pipe section
Up to 75	200
90 to 225	300
250 or more	500

Where fittings are part of a joint assembly incorporating a rubber seal ring or gasket (e. g. pipe couplings or flanged joints), they shall be tested as integrated in the assembly. The seal rings used are permitted to have a higher Shore hardness than normally required for this type of assembly to allow them to accommodate the stresses due to the test pressure, which is higher than the permitted working pressure. For the same purpose, the use of bracing in the sealing zone is also permitted.

b) The fittings, without pipe sections connected, shall be held in clamps, the stress applied being the same as for assemblies. The test assembly shall be designed so that the axial forces resulting from the internal pressure are accommodated by the fitting wall.

c) The test assembly shall be made up of reducers as specified in DIN 16963 Part 14 provided with sockets as specified in DIN 16963 Part 10, joined by welding to pipe sections as specified under item a).

4.2.2.3 Testing of joint assemblies

The pipe sections used to prepare the samples described in subclauses 4.2.2.3.1 to 4.2.2.3.3 shall have a length as specified in table 5, their free ends being provided with end seals designed so that the axial forces resulting from the internal pressure are accommodated by the joints. The samples shall, when mounted, be free to expand.

4.2.2.3.1 Welded joints

Fittings shall be joined by welding with sections of pipe as specified in DIN 8074, belonging at least to series 5.

4.2.2.3.2 Pipe couplings

Pipe couplings as specified in DIN 16963 Part 15 shall be joined by welding with sections of pipe as specified in DIN 8074, belonging at least to series 5.

4.2.2.3.3 Flanged joints

Flanged joints shall be made up of fittings as specified in DIN 16963 Part 4 or 11, joined by welding with pipe sections. The length of the pipe sections shall be chosen from table 5.

4.2.3 Procedure

The samples prepared as described in subclauses 4.2.2.1 to 4.2.2.3 shall be filled with water of a temperature not more than 5 °C above test temperature through a closable opening in one of the end seals and placed in a water bath or an oven maintained at test temperature to within ±2 °C, and kept there for one hour to reach temperature equilibrium. Then, the specified test pressure, $p_{e,p}$, shall be steadily applied to the sample within 10 to 15 s and maintained for the given period (minimum service life) to within ±2,5 %.

The test pressure for the material test shall be calculated from the following formula:

$$p_{e,p} = \frac{2 \cdot s \cdot \sigma_0}{d - s}$$

where

d is the sample diameter; here, $d = 50$ mm;

s is the sample wall thickness; of the test piece;

σ_0 is the proof stress as specified in table 1.

The relevant test pressure for component testing and for testing joint assemblies shall be chosen from tables 2 to 4.

4.2.4 Evaluation

It shall be established whether the samples leak or otherwise fail during the specified test period. Results of tests (on test pieces, fittings or joint assemblies) in which components fail shall be ignored and the test repeated.

The same shall apply when joint assemblies are tested in which the fittings, pieces of pipe or clamping devices have fractured or leakage has occurred.

4.3 Heat reversion

At least three items per type of fitting or joint assembly shall be placed socket down on an even surface in an oven with forced-air circulation as specified in DIN 50011 Part 12 and conditioned in accordance with table 6. After cooling down to ambient temperature, the samples shall be checked for any cracks, blistering or delamination.

Table 6. **Test conditions for heat reversion test**

Wall thickness, s	Minimum test period, in min	Test temperature, in °C
Up to 3	15	110 ± 2
Over 3 up to 10	30	
Over 10 up to 20	60	
Over 20 up to 30	140	
Over 30 up to 40	220	
Over 40	240	

4.4 Finish

The outer and, if possible, the inner surfaces of fittings shall be examined visually with the aid of a suitable light source.

4.5 Dimensions and limit deviations

The mean internal diameter of fittings for socket welding and heated tool butt welding shall be determined, using a dial gauge, as the arithmetic means from two measurements made at right angles to each other in the middle of the weld. All other dimensions shall be determined with the aid of suitable devices.

4.6 Certificate

Subject to agreement, the manufacturer shall issue a DIN 50049 certificate covering the results of testing at his works.

Standards referred to

DIN 8074	High-density polyethylene (PE-HD) pipes; dimensions
DIN 8075	High-density polyethylene (PE-HD) pipes; general quality requirements and testing
DIN 16963 Part 4	Pipe joint assemblies and fittings for high-density polyethylene (PE-HD) pressure pipes; adaptors for heated tool butt welding, flanges and sealing elements; dimensions
DIN 16963 Part 6	Pipe joint assemblies and fittings for high-density polyethylene (PE-HD) pressure pipes; injection-moulded fittings for butt welding; dimensions
DIN 16963 Part 7	Pipe joint assemblies and fittings for high-density polyethylene (PE-HD) pressure pipes; fittings for resistance welding; dimensions
DIN 16963 Part 8	Pipe joint assemblies and fittings for high-density polyethylene (PE-HD) pressure pipes; injection-moulded elbows for socket welding; dimensions
DIN 16963 Part 9	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; injection-moulded tees for socket welding; dimensions
DIN 16963 Part 10	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; injection-moulded sockets and caps for socket welding; dimensions
DIN 16963 Part 11	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; adaptors, flanges and sealing elements for socket welding; dimensions
DIN 16963 Part 14	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; injection-moulded reducers and nipples for socket welding; dimensions
DIN 16963 Part 15	Pipe joint assemblies and fittings for high-density polyethylene (PE-HD) pressure pipes; pipe couplings; dimensions
DIN 50011 Part 12	Artificial climates in technical applications; air temperature as a climatological quantity in controlled-atmosphere test installations
DIN 50049	Materials testing certificates

Other relevant standards

DIN 16963 Part 1	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; gusseted bends for butt welding; dimensions
DIN 16963 Part 2	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; gusseted tees and branches produced by necking, for butt welding; dimensions
DIN 16963 Part 3	Pipe joint assemblies and fittings for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes; bends formed from pipes, for butt welding; dimensions

Previous edition

DIN 16963 Part 5: 07.77.

Amendments

The following amendments have been made to the July 1977 edition.

a) The standard has been editorially revised.

b) The long-term hydrostatic pressure resistance is now to be verified by a material test, a component test and a test on joint assemblies.

Explanatory notes

This standard has been prepared by Subcommittee 504.4 *Kunststoff-Fittings für Rohre aus Thermoplasten* of the *Normenausschuß Kunststoffe* (Plastics Standards Committee) of *DIN*. It is a basic standard which specifies general quality requirements for PE-HD pipe joint assemblies and fittings and describes methods of test, but does not deal with any special requirements.

The most important test for assessing the performance of fittings and joint assemblies is the long-term hydrostatic test which is here devised so as to cover three different aspects.

Material testing is designed to prove the general suitability of a particular moulding material both at ambient and elevated temperature, the test conditions being the same as those for pipes as specified in DIN 8075. Component testing is based on the creep strength curves for pipes as is the testing of welded joints with components made of the same type of polypropylene.

In the case of assemblies such as pipe couplings screwed joints and flanged joints made up of components of dissimilar materials, the application of the test conditions specified in DIN 8075 for pipes to fittings would result in the latter suffering a strain exceeding that occurring under service conditions, which unavoidably causes leakage. For this reason, the test conditions had to be modified.

That pipe joints do not leak under the service conditions specified in table 5 of the May 1987 edition of DIN 8075 may be considered a basic requirement. The object of the test is thus to establish the degree of strain exhibited by the material used for the fittings under the said conditions and to verify that joints remain tight under the strain occurring.

This may be achieved by a short-term test or a creep test, in which a pressure or stress is applied producing the same strain (with a safety factor as given in table 7) as the operating pressure specified in table 5 of DIN 8074.

The user of fittings may assume that these are designed (with allowance being made for their shape) for a stress, σ_{zul}, of 5 N/mm^2. This gives values of strain, ε, in the stress-strain diagram as specified in table 7 as a function of the design service life.

Table 7. **Strain of fittings as a function of loading period**

Test temperature, in °C	Loading period, in years	Permissible stress, σ_{zul}, in N/mm²	Strain, ε, as a percentage
20	50 years	5	2,15
70 [2]	One year	1,6	1,2
80 [1], [3]	5000 h	1,1	0,9

[1] Test condition derived from creep strength curves for pipes (including safety factor of 1,6).
[2] Test condition derived from table 5 of DIN 8074, September 1987 edition.
[3] Test condition derived from creep strength curve specified in DIN 8075.

The tensile strain due to tensile stress shall be converted into circumferential strain by the following equation:

$$\varepsilon_t = \varepsilon_z \left(1 - \frac{\mu}{2}\right)$$

where
ε_t is the circumferential strain;
ε_z is the tensile strain;
μ is the Poisson's ratio; here, $\mu = 0{,}4$.

Table 8. **Safety factors and test pressures for pipe couplings and flanged joints**

Influence factor	Safety factor	Notes		
Scatter of extrapolated values	1,3	Covered by component test.		
Brittleness		Stresses are due to curvature or misalignment of pipeline, and tightening forces.		
Superimposed stresses resulting from pipe laying	1,05	Tensile and bending forces such as are caused by soil settlement.		
Additional stresses due to external forces	1,07			
Additional stresses due to fluctuations in temperature	1,03			
Overall safety factor	1,5			
Test pressures				
Temperature, in °C		20	70	80
Strain, ε, as a percentage		3,22	1,8	1,35
Loading period, in h		1000	1000	1000
Stress, σ_0, in N/mm²		7,4	2,6	1,65
Test pressure, $p_{e,p}$, in bar		1,48 · PN	0,52 · PN	0,33 · PN

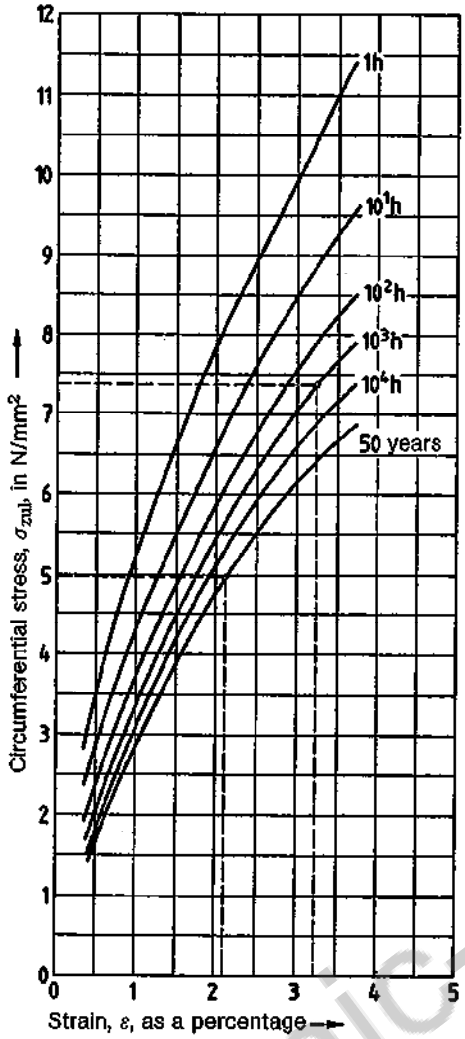

Figure 2. Stress-strain diagram for PE-HD at 20°C

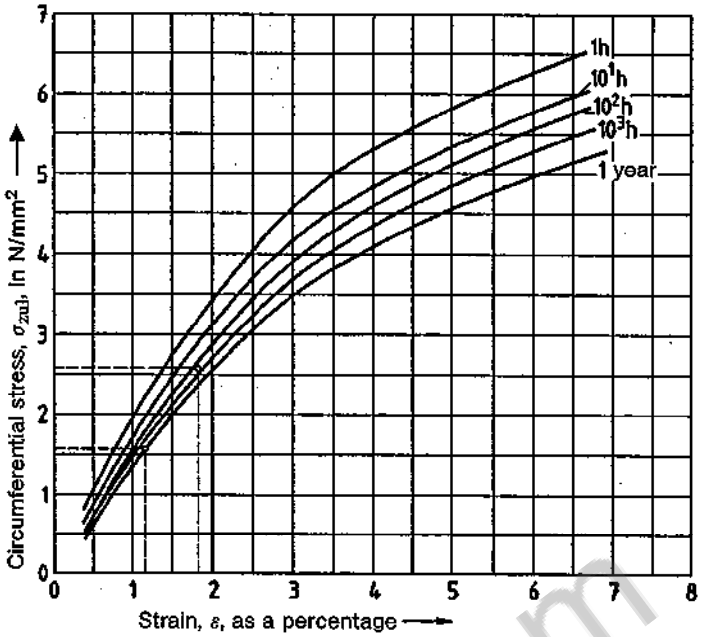

Figure 3. Stress-strain diagram for PE-HD at 70°C

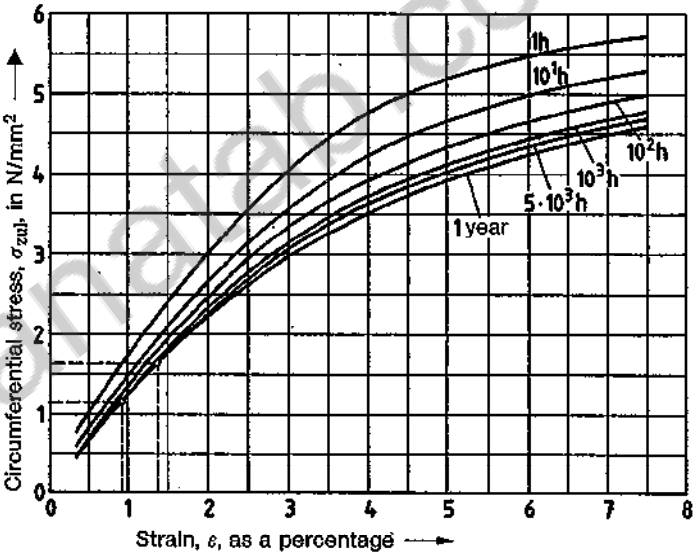

Figure 4. Stress-strain diagram for PE-HD at 80°C

The following moulding materials specified in DIN 16776 Part 1 are generally used for the manufacture of fittings as specified in this standard:

Moulding material DIN 16776 – PE, M ., .. T ...

- Polyethylene
- Injection moulding
- Additive (e.g. carbon black)
- Density groups (35 to 50)
- MFI test condition T 190°C/5 kg
- MFI groups (003 to 022)

The following symbols shall be used to denote fittings, in accordance with footnote 2 in DIN 16776 Part 1, December 1984 edition:

005: over 0,4 up to 0,7;

010: over 0,7 up to 1,3;

020: over 1,3 up to 3.

Here, the melt flow rate (MFI) shall be determined using test condition T.

International Patent Classification

G 01 N 3 F 16 L 47/00 E 03 B 7/00 B 29 D 23/22