Pipe fittings and joint assemblies for PE 80 and PE 100 polyethylene pressure pipes

General quality requirements and testing

DIN 16963-5

ICS 23.040.45

Supersedes October 1989 edition.

Rohrverbindungen und Formstücke für Druckrohrleitungen aus Polyethylen (PE) PE 80 und PE 100 – Teil 5: Allgemeine Qualitätsanforderungen, Prüfung

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.

Contents

Foreword

This standard has been prepared by Technical Committee *Fittings für Druckrohre aus Thermoplasten* of the *Normenausschuss Kunststoffe* (Plastics Standards Committee).

Amendments

This standard differs from the October 1989 edition in that it has been editorially revised, polyethylene of type PE 100 has been included, long-term hydrostatic resistance requirements have been modified, and the materials testing procedure has been changed.

Previous editions

DIN 16963-5: 1977-07, 1989-10.

Continued on pages 2 to 9.

Translation by DIN-Sprachendienst.

In case of doubt, the German-language original should be consulted as the authoritative text.

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All dimensions are in millimetres.

1 Scope

This standard specifies requirements and test methods for pipe fittings and joint assemblies for polyethylene (PE) pressure pipes of types PE 80 and PE 100, as in DIN 16963-1 to DIN 16963-4 and DIN 16963-6 to 16963-15. Individual requirements may be superseded by technical delivery conditions for specific applications.

NOTE: Any relevant European Standards which cover such applications shall be observed.

2 Normative references

This standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text, and the titles of the publications are listed below. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

DIN 8074	Polyethylene pipes – Dimensions
DIN 8075	Polyethylene pipes – General quality requirements and testing
DIN 16963-1	Pipe fittings and joint assemblies for types 1 and 2 polyethylene (PE-HD) pressure pipes – Gusseted bends for butt welding – Dimensions
DIN 16963-2	Pipe fittings and joint assemblies for types 1 and 2 polyethylene (PE-HD) pressure pipes – Gusseted tees and branches produced by necking, for butt welding – Dimensions
DIN 16963-3	Pipe fittings and joint assemblies for types 1 and 2 polyethylene (PE-HD) pressure pipes – Bends formed from pipes, for butt welding – Dimensions
DIN 16963-4	Pipe fittings and joint assemblies for high-density polyethylene (PE-HD) pressure pipes – Adaptors for heated tool butt welding, flanges and sealing elements – Dimensions
DIN 16963-6	Pipe fittings and joint assemblies for high-density polyethylene (PE-HD) pressure pipes – Injection-moulded fittings for butt welding – Dimensions
DIN 16963-7	Pipe fittings and joint assemblies for high-density polyethylene (PE-HD) pressure pipes – Fittings for resistance welding – Dimensions
DIN 16963-8	Pipe fittings and joint assemblies for high-density polyethylene (PE-HD) pressure pipes – Injection-moulded elbows for socket welding – Dimensions
DIN 16963-9	Pipe fittings and joint assemblies for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes – Injection-moulded tees for socket welding – Dimensions
DIN 16963-10	Pipe fittings and joint assemblies for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes – Injection-moulded sockets and caps for socket welding – Dimensions
DIN 16963-11	Pipe fittings and joint assemblies for PE 80 and PE 10 polyethylene pressure pipes – Dimensions of bushings, flanges and sealing elements for socket welding
DIN 16963-14	Pipe fittings and joint assemblies for types 1 and 2 high-density polyethylene (PE-HD) pressure pipes – Injection moulded reducers and nipples for socket welding – Dimensions
DIN 16963-15	Pipe fittings and joint assemblies for high-density polyethylene (PE-HD) pressure pipes – Pipe couplings – Dimensions
DIN EN 10204	Inspection documents for metallic products (includes Amendment A 1 : 1995)
DIN EN ISO 12162	Thermoplastics materials for pipes and fittings for pressure applications – Classification and designation – Overall service (design) coefficient (ISO 12162 : 1995)

3 Concept and material designation

3.1 Long-term hydrostatic pressure resistance

The strength of a pipe required to resist an induced internal hydrostatic pressure, in N/mm², calculated as follows:

$$\sigma = p\frac{d - s}{2s} \qquad (1)$$

where

σ is the induced hydrostatic pressure;

d is the outside diameter;

s is the wall thickness.

3.2 Material designation

The designation of polyethylene moulding materials, based on the minimum required strength, MRS, in water at 20 °C for 50 years, as specified in DIN EN ISO 12162 (see table 1).

NOTE: By extrapolation, the service life of pipe joint assemblies and fittings conforming to this standard may be assumed to be 100 years at 20 °C (see DIN 8074 and DIN 8075).

Table 1: Material designation

Material designation	Minimum required strength, MRS, in N/mm²
PE 80	8,0
PE 100	10,0

4 Material

Fittings and joint assemblies shall be made from PE 80 or PE 100 polyethylene, stabilized using suitable antioxidants (see DIN 8075). Any stabilizers and other additives shall be chosen by the pipe manufacturer. Moulding materials of unknown composition shall not be used.

5 Requirements

5.1 Form supplied

Fittings and joint assemblies shall be free from blisters and irregularities or foreign matter which would impair their performance. The cut edges shall not impede handling.

5.2 Surface finish

When checked as in subclause 6.2, fittings and joint assemblies shall have a smooth outer surface consistent with the manufacturing process used, and no scorched areas due to overheating.

5.3 Dimensions and tolerances

The dimensions and tolerances for pipe joint assemblies and fittings shall be in accordance with the relevant standards listed in clause 2. All other dimensions shall be such that fittings and assemblies fulfil the requirements as in subclause 5.4, as well as any additional requirements in service.

5.4 Long-term hydrostatic pressure resistance

5.4.1 Testing of materials

When tested as in subclause 6.4.2.1, in accordance with the specifications of table 2, test pieces shall neither leak nor fracture. Fittings made from pipes as in DIN 8074 and conforming to the requirements specified in DIN 8075 (see DIN 16963-1 to DIN 16963-3) are considered to fulfil these requirements without testing.

Table 2: Long-term hydrostatic pressure resistance of test pieces (test conditions)

Test temperature, in °C	Exposure medium[1)]	Test period (minimum service life), in h	Proof stress, σ_0, in N/mm²	
			PE 80	PE 100
20	Air or water	100	10,0	12,4
80		165	4,6	5,5
Follow-up test if brittle fracture occurs at 80 °C[2)]:				
80	Air or water	1 000	4,0	5,0

[1)] In arbitration cases, water shall be used.

[2)] If brittle fracture occurs within 165 hours, the test shall be considered failed. In this case, a follow-up test over 1 000 hours shall be carried out.

5.4.2 Fittings

When tested as in subclause 6.4.2.2, as specified in table 3, fittings shall neither leak nor fracture.

Table 3: Long-term hydrostatic pressure resistance of fittings (test conditions)

Test temperature, in °C	Exposure medium [1)]	Test period (minimum service life), in h	Proof pressure, $p_{e,p}$, in bar	
			PE 80	PE 100
80	Air or water	165	$\frac{92}{SDR-1}$	$\frac{110}{SDR-1}$
Follow-up test if brittle fracture occurs at 80 °C[2)]:				
80	Air or water	1 000	$\frac{80}{SDR-1}$	$\frac{100}{SDR-1}$

SDR-1: Nominal value for the diameter/wall thickness ratio of the fitting specified in DIN 8074 for pipe series 1.

NOTE: In the case of components made from gusseted pipes, resistance to hydrostatic pressure is less than that of the original pipe. The allowable working pressure for gusseted bends as in DIN 16963-1 shall therefore be reduced by a factor of 0,8 and by a factor of 0,5 for gusseted tees as in DIN 16963-2. Any reduction factors used for testing are subject to agreement with the manufacturer.

1) In arbitration cases, water shall be used.

2) If brittle fracture occurs within 165 hours, the test shall be considered failed. In this case, a follow-up test over 1000 hours shall be carried out.

5.4.3 Joint assemblies

5.4.3.1 Welded assemblies

When tested as in subclause 6.4.2.3.1 in accordance with the specifications of table 4, welded assemblies shall show no signs of leakage.

Table 4: Long-term hydrostatic pressure resistance of welded assemblies (test conditions)

Test temperature, in °C	Exposure medium [1)]	Test period (minimum service life), in h	Proof pressure, $p_{e,p}$, in bar	
			PE 80	PE 100
80	Air or water	165	$\frac{92}{SDR-1}$	$\frac{110}{SDR-1}$

SDR-1: Nominal value for the relationship between the diameter and the wall thickness of the fitting specified in DIN 8074 for pipe series 1.

1) In arbitration cases, water shall be used.

5.4.3.2 Coupling assemblies

When tested as in subclause 6.4.2.3.2 or subclause 6.4.2.3.3 in accordance with the specifications of table 5, assemblies made up of compression couplings as in DIN 16963-15 and flanges as in DIN 16963-4 or DIN 16963-11 shall show no signs of leakage.

Table 5: Long-term hydrostatic pressure resistance of coupling assemblies (test conditions)

Test temperature, in °C	Exposure medium [1]	Test period (minimum service life), in h	Proof pressure, $p_{e,p}$, in bar	
			PE 80	PE 100
80	Air or water	1 000	$\frac{146}{SDR-1}$	$\frac{184}{SDR-1}$

SDR-1: Nominal value for the relationship between the diameter and the wall thickness of the fitting specified in DIN 8074 for pipe series 1.

[1]) In arbitration cases, water shall be used.

6 Testing

6.1 Time of testing

Testing shall be carried out no sooner than 15 hours after manufacture of fittings.

6.2 Form supplied and surface finish

The outside surface and, if possible, the inside surface of fittings shall be inspected using suitable lighting.

6.3 Dimensions and tolerances

The inside diameter of the socket shall be calculated to be the mean of two measurements taken at right angles to each other at the middle of the socket depth. The ovality of fittings shall be taken to be the difference between the minimum and maximum inside diameters of a socket at the same cross section. Other dimensions shall be measured appropriately.

6.4 Long-term hydrostatic pressure resistance

6.4.1 Number of test pieces

Three test pieces, fittings or joint assemblies shall be used for testing as in tables 2 to 5.

6.4.2.1 Testing of material

The following test pieces, including end-fittings, shall be tested:

extruded pipe sections: test pieces as specified in DIN 8075;

injection-moulded test pieces: as shown in figure 1.

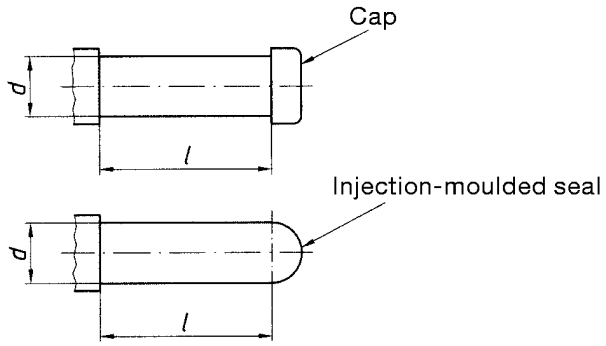


Figure 1: Form of test pieces

The test piece outside diameter, d, shall be at least 50 mm, and its free length shall be at least equal to 3 d (see figure 1), with the exception of test pieces with an outside diameter of 50 mm, whose minimum free length shall be 140 mm.

6.4.2.2 Testing fittings

Fittings as specified in DIN 16963-1 to DIN 16963-4 and DIN 16963-6 to DIN 16963-15 shall be tested using test assemblies as described below under item a), b) or c). Test pieces shall be arranged so that the significant parts of the fittings are loaded.

Although joints, brackets and seals are not covered by this standard, their design shall not cause the system to fail. The seal zone may be reinforced to prevent undue strain when pressures are exceeded during testing. Fittings which are part of a sealed assembly, such as screwed joints and flanged joints, shall be tested as a joint assembly (see subclause 6.4.2.3).

a) The test assembly shall be made up of fittings welded to sections of pipe as in DIN 8074 from the same or a lower series (except fittings for butt welding). The pipe section length shall be as specified in table 6.

Table 6: Length of welded pipe sections

Pipe outside diameter	Pipe section length
Up to 75	200
From 90 to 225	300
250 or more	500

b) The test assembly shall be made up of fittings clamped, without pipe sections, in such a way that test conditions are the same as those described under item a) above. Joints shall resist the axial thrust resulting from the hydrostatic pressure.

c) The test assembly shall be made up of reducers as specified in DIN 16963-14 welded to sockets as specified in DIN 16963-10, and joined as specified under item a) above.

6.4.2.3 Testing joint assemblies

6.4.2.3.1 Welded joints

Fittings shall be joined to sections of pipe as in DIN 8074 from at least series S5 or SDR 11.

6.4.2.3.2 Pipe couplings

Pipe couplings as in DIN 16963-15 shall be joined to sections of pipe as in DIN 8074 from at least series S5 or SDR 11.

6.4.2.3.3 Flanged joints

Flanged joints shall be made up of fittings as in DIN 16963-4 or DIN 16963-11. Necks and bushes shall be welded to pipe sections of lengths as in table 6. The ends of the pipe sections shall be provided with caps so that the axial stress generated during testing is accommodated. The test assemblies shall be free to move in all directions.

6.4.3 Test procedure

Samples prepared as in subclauses 6.4.2.1 to 6.4.2.3 shall be filled with water at test temperature (maintained to within 5 K) through a closable opening in one of the end caps, and placed in a water bath or oven maintained at test temperature (to within 1 K) where it shall be kept for one hour to reach thermal equilibrium. If the samples are filled with water of a lower temperature, they shall be kept in the water bath or oven for 12 hours to reach thermal equilibrium.

Subsequently, the pressure in the water bath or oven shall be steadily increased to reach proof pressure, $p_{e,p}$, within about one minute. The proof pressure shall be maintained to within 2,5 % during the test period. The proof pressure for the material test shall be calculated using the following equation:

$$p_{e,p} = \frac{2 \cdot s_{min} \cdot \sigma_0}{\overline{d} - s_{min}} \qquad (2)$$

where

$\overline{d}$ is the test piece diameter;

s_{min} is the minimum wall thickness of the test piece;

σ_0 is the proof stress as specified in table 2.

The relevant proof pressure for testing fittings and joint assemblies shall be selected from tables 3 to 5.

6.4.4 Evaluation

It shall be established whether the samples leak or otherwise fail during testing. Results of tests on test pieces, fittings or joint assemblies in which the components fail shall be disregarded, and the test shall be repeated. The same shall apply when joint assemblies are tested and the fittings, pipe sections or clamping devices have fractured or have shown any signs of leakage.

6.5 Certificate

By agreement, the manufacturer shall issue a DIN EN 10204 inspection document covering the results of testing.

Explanatory notes

This standard is a basic standard and therefore does not cover the scope of testing, inspection or requirements relating to special applications.

The standard focuses on the long-term hydrostatic testing of material and components. Materials testing at elevated temperature demonstrates the suitability of the moulding material for the manufacture of fittings. The test conditions specified for material and fittings are based on the long-term hydrostatic behaviour of the material, which correlates well with that of PE 80 or PE 100 pipes as in DIN 8075.

In the case of gusseted bends, where the hydrostatic resistance is lower than that of the pipe from which the fittings are made, lower operating pressures shall be used, i.e. the pressure for gusseted bends as in DIN 16963-1 should be lower by a factor of 0,8, and for gusseted tees as in DIN 16963-2 lower by a factor of 0,5. All lower pressures shall be agreed with the manufacturer.

In the case of assemblies made of dissimilar materials, such as pipe couplings or flanged joints, applying the test conditions for pipes to fittings would result in these being subjected to a greater stress than that incurred under service conditions, resulting in leakage. The test conditions have therefore been modified accordingly.

It is a basic requirement of pipe assemblies that they are not to leak under normal service conditions. For assemblies conforming to this standard, a service life of 50 years at an operating temperature of 20 °C is based on a basic stress, $\sigma_{v,\,zul}$, as set out in table 7. The strain under service conditions shall be calculated for temperatures of 20 °C and 80 °C using the safety factors given in table 7. Subsequently, the leaktightness of the joints under this strain shall be checked. This may be done by means of a short-term test or a creep test, in which the pressure applied (with an additional safety factor) produces the same stress as the basic stress. The hydrostatic pressure, p_t, in bar, as a function of the stress, σ_T, in N/mm², shall be calculated using equation (3).

Table 7: Service and test conditions for polyethylene pipe assemblies

Material	PE 80		PE 100	
Service conditions:				
Temperature, in °C	20	80	20	80
Service life in years	50	1	50	1
Basic stress, $\sigma_{v,\,zul}$, at 20 °C for 50 years, in N/mm² [1])	5	1,3	6,3	1,9
Strain, ε, as a percentage	2,5	0,9	3,8	1,7
Test conditions:				
Safety factor for ε_{ts} , in percentage points	1,25	0,45	1,9	0,9
Strain, ε_{ts}, as a percentage	3,75	1,35	5,7	2,6
Exposure period, in hours	1 000		1 000	
Proof stress, σ_0, in N/mm²	7,3	2,1	9,2	2,8
Proof pressure, $p_{e,\,p}$, in bar	$\frac{146}{SDR-1}$	$\frac{42}{SDR-1}$	$\frac{184}{SDR-1}$	$\frac{56}{SDR-1}$

[1]) Based on reference curves as in DIN 8075 and a safety factor of 1,6.

NOTE: The strain due to tensile stress shall be converted into strain due to hoop stress, ε_t, using the following equation:

$\varepsilon_t = \varepsilon_z \qquad (1 - \mu : 2)$

where

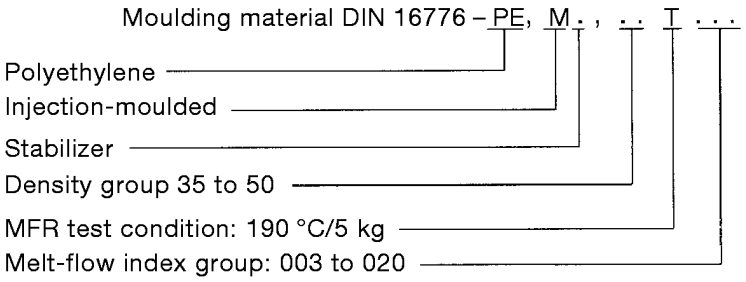
ε_z is the tensile strain;

μ is the Poisson's ratio (here, $\mu = 0{,}4$).

$$p_t = \frac{20 \cdot \sigma_T}{SDR - 1} \qquad (3)$$

where SDR-1 is the nominal value of diameter/wall thickness ratio of the fitting. The specifications set out in tables 3 to 5 are also based on equation (3), and the calculated values are given in table 7, with figures 2 to 5 showing the stress-strain characteristics.

The following moulding materials, specified in DIN 16776-1, are generally used for the manufacture of fittings covered by this standard.



Specifications with regard to the composition of the pipe material and methods of manufacture have not been included so as not to impede technical innovation. The specification that moulding material of unknown composition should not be used is intended to prevent the use of unsuitable material, while allowing the manufacturers to derive technical and economic advantages from using reworked material.

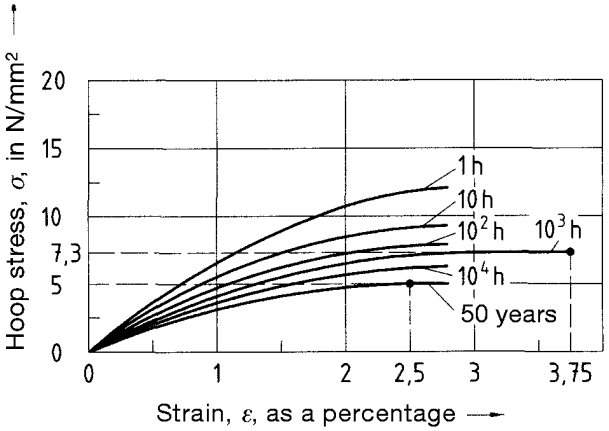


Figure 2: Stress-strain diagram for PE 80 at 20 °C

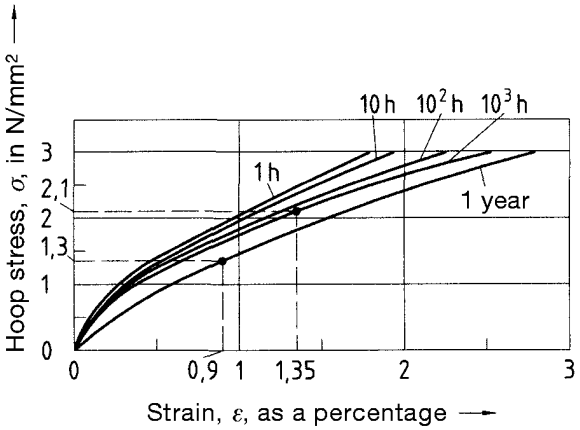


Figure 3: Stress-strain diagram for PE 80 at 80 °C

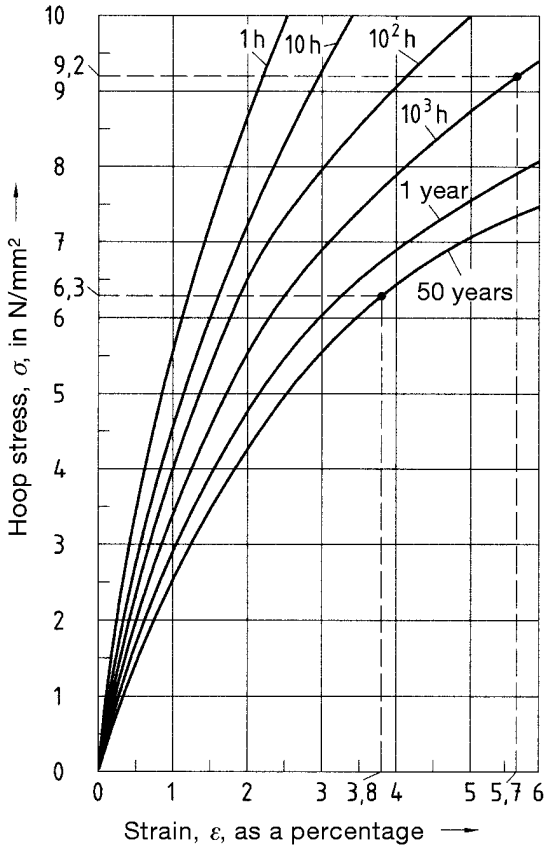


Figure 4: Stress-strain diagram for PE 100 at 20 °C

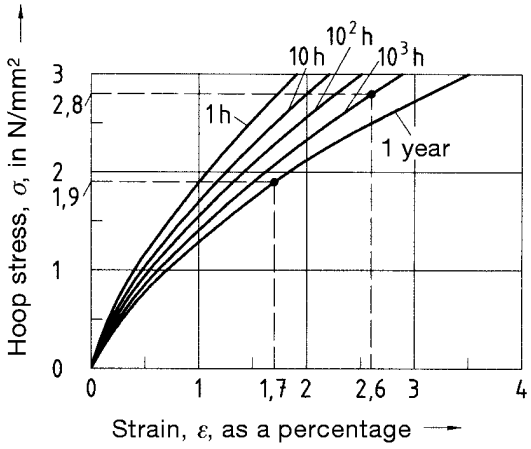


Figure 5: Stress-strain diagram for PE 100 at 80 °C

Other relevant standards

DIN 16776-1	Polyethylene (PE) moulding materials – Classification and designation
DIN EN 12107	Injection-moulded thermoplastics fittings, valves and ancillary equipment – Determination of the long-term hydrostatic strength of thermoplastics materials for injection moulding of piping components
DIN EN ISO 1872-2	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties (ISO 1872-2 : 1997, including Amendment 1 : 2000)
ISO 161-1 : 1996	Thermoplastics pipes for the conveyance of fluids – Nominal outside diamters and nominal pressures – Part 1: Metric series
ISO 4065 : 1996	Thermoplastics pipes – Universal wall thickness table