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Ductile iron pressure pipes and fittings for gas and water pipelines

Technical delivery conditions

DIN 28 600

Druckrohre und Formstücke aus duktilem Gusseisen für Gas- und Wasserleitungen; technische Lieferbedingungen

Supersedes August 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.

Ductile iron is an iron-carbon casting material whose carbon content, in the form of graphite, as in the case of cast iron with spheroidal graphite in accordance with DIN 1693 Part 1, is characterized by its basically spheroidal form.

The content of this standard complies to a large extent with ISO 2531.

1 Scope and field of application

The technical delivery conditions specified in this standard apply both to gas and water pipelines if the conditions are printed over the whole width of the page.

Specifications given only on the

left-hand side	**right-hand side**
apply to	
water pipelines up to and including DN 2000 for pressure ratings up to and including PN 40, and to gas pipelines up to and including DN 600 for permissible working pressures of up to 4 bar[1].	gas pipelines up to and including DN 600 for permissible working pressures ranging from greater than 4 up to and including 16 bar.

This standard applies to the following types of ductile iron pressure pipes and fittings for gas and water pipelines:

a) pressure pipes centrifugally cast in metal or sand moulds; these include FFS pipes specified in DIN 28 615;

b) fittings cast in sand moulds; these include FFG pipes specified in DIN 28 614;

c) special fittings produced by welding[3].

2 Types of joints

2.1 Spigot and socket joints

As a rule, the different types of socket are provided with elastomer sealing rings.

Sealing rings for water pipelines are dealt with in DIN 28 617 and sealing rings for gas pipelines in DIN 3535 Part 3. The sealing rings shall be supplied by the pipe manufacturer.

Specifications on the mating dimensions for spigot and socket joint assemblies are given in the following standards:

DN 40 to DN 400 screwed socket joint assemblies, in DIN 28 601 Part 1 to Part 3;

DN 500 to DN 1200 mechanical joint assemblies, in DIN 28 602 Part 1 to Part 3;

DN 80 to DN 2000 push-in joint assemblies, in DIN 28 603.

Subject to particular agreement, pipes and fittings may also be supplied:

a) with other flexible joints;

b) with tension-resistant spigot and socket joints, or

c) with additional devices for ensuring tension-resistant joints.

Tension-resistant joints are covered by *DVGW-Merkblatt* (Instruction sheet) GW 368.

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1) See *DVGW-Arbeitsblatt* (Data sheet) G 461/I *Errichtung von Gasleitungen bis 4 bar Betriebsüberdruck aus Druckrohren und Formstücken aus duktilem Gusseisen* (Construction of gas pipelines for working pressures up to 4 bar of ductile iron pressure pipes and fittings).

2) See *DVGW-Arbeitsblatt* G 461/II *Errichtung von Gasleitungen mit Betriebsüberdrücken von mehr als 4 bar bis 16 bar aus Druckrohren und Formstücken aus duktilem Gusseisen* (Construction of gas pipelines for working pressures ranging from 4 to 16 bar of ductile iron pressure pipes and fittings).

3) Special fittings produced in the manufacturing works by welding are for example pipe sections with welded-on single-ended flange nipples, standard crosses, flanges or brickwork flanges, such pipe sections being used in place of MMA, T, MMB or F pieces, insofar as specifications on these are given in the relevant documents (e.g. DVS 1502 Part 1, DVS 1502 Part 2 and DVS 1148).

Continued on pages 2 to 12

2.2 Flanged joints

The design dimensions of flanged joints are specified in DIN 28604 to DIN 28607.

3 Wall thicknesses of pipes and fittings

3.1 Spigot and socket pipes

The wall thicknesses s_1, in mm, specified in

DIN 28610 Part 1 | DIN 28610 Part 2

are applicable for spigot and socket pipes. These wall thicknesses are calculated as a function of their nominal size (DN), by the formula

$$s_1 = K\,(0{,}5 + 0{,}001\,DN) \qquad (1)$$

where

10, 9 or 8 | 10 or 9

is inserted for K.

The lower limit for the wall thickness shall be $s_1 = 6$ mm.

Subject to particular agreement, spigot and socket pipes may, while maintaining the external pipe diameter d_1, also be produced

with greater or smaller wall thicknesses. | with greater wall thicknesses.

The dimensioning of the wall thickness is to be carried out separately according to internal pressure and external loading. The following formula applies for dimensioning according to internal pressure p:

$$s_1 = 2{,}8 + \frac{p \cdot d_1}{2610 + p} + 0{,}001\,DN \qquad (2)$$

In this formula, a value of 1,5 mm is included in the wall thickness, to allow for the effect of the casting skin [4].

In the case of a bedding which does not comply with the standard conditions (see e.g. DIN 19630) and/or in the case of deviations in the external loading from the values specified in DIN 28610 Part 1 or Part 2, a static calculation in accordance with the state of the art shall be carried out.

3.2 Flanged pipes

Flanged pipes with flanges cast on (FFG pipes) are covered by DIN 28614.

Flanged pipes with flanges not cast on (FFS pipes) are covered by DIN 28615.

3.3 Fittings

The wall thicknesses specified in DIN 28622 to DIN 28630, DIN 28632, DIN 28634, DIN 28637 to DIN 28639, DIN 28643, DIN 28645, DIN 28646 and DIN 28648 are applicable for fittings.

4 Requirements

4.1 Condition of pipes and fittings

Pipes and fittings shall have smooth external and internal surfaces. It shall be possible to cut, drill, or work them by other mechanical means.

Caulking of defects in pipes and fittings is not permitted.

Welding repairs to isolated pores and deposition welding, e.g. to improve the shape of the sockets, are permitted. Other methods of repair by welding are not permitted.

Pipes and fittings with small imperfections caused by the method of manufacture which do not affect the use of pipes and fittings and in other respects meet the requirements of this standard shall be deemed to comply with this standard.

The depth of pinholes shall not exceed 1/3 of the wall thicknesses specified in DIN 28610 Part 1 and Part 2.

Special fittings produced by welding [3] shall meet the requirements with regard to surface quality to be complied with by cast fittings.

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3) See page 1.

4) *K. Wellinger* and *H. Gassmann, Die Berechnung duktiler Schleudergussrohre* (Design of ductile centrifugally cast pipes) *Techn.-wiss. Ber. MPA Stuttgart* (1965), vol. 65-01.

4.2 Permissible deviations in external diameter of pipes and for spigot and socket and flanged joints

4.2.1 External diameter

The deviations in external diameter of the spigot ends of the pipe in the area of the intended joints (approximately equal to three times the spigot insert depth) and for the spigot and socket joints and flanged joints are specified in the dimensional standards for pipe joint assemblies (DIN 28601 Part 1 to Part 3, DIN 28602 Part 1 to Part 3 and DIN 28603 to DIN 28607).

Up to size DN 300, the barrel of pipes supplied shall be accurate to size within the deviations specified, beginning 1 m from the end face of the socket.

Above size DN 300, subject to agreement, some of the pipes may be ordered in accordance with the specifications applicable for pipes up to and including size DN 300. These pipes are to be identified by a continuous longitudinal line.

4.2.2 Out-of-roundness

Pipes and fittings shall as far as possible be circular internally and externally. The permissible out-of-roundness of the mating ends in the joint zone

$$U = \frac{d_{1\,max} - d_{1\,min}}{d_1} \cdot 100 \qquad (3)$$

is specified in each case in the standards on spigot and socket joints for cast iron pipes (DIN 28601 Part 1 to Part 3, DIN 28602 Part 1 to Part 3 and DIN 28603).

4.3 Permissible deviations in wall thickness and flange thickness

The permissible deviations in wall thickness and flange thickness are specified in table 1:

Table 1.

Type of casting	Dimension	Permissible deviations mm
Centrifugally cast pipes	Wall thickness	$-(1{,}3 + 0{,}001\ DN)$ 5), 6)
	Flange thickness	$\pm (2 + 0{,}05\ c)$
Fittings and pipeline accessories	Wall thickness	$-(2{,}3 + 0{,}001\ DN)$ 5), 7)
	Flange thickness	$\pm (3 + 0{,}05\ c)$

5) No value has been specified for the upper deviation limit.

6) Applicable for a nominal wall thickness s_1 exceeding 6 mm; the permissible deviation for s_1 = 6 mm shall be – 1,3 mm.

7) Applicable for a nominal wall thickness s_1 exceeding 7 mm; the permissible deviation for s_1 = 7 mm shall be – 2,3 mm. The wall thickness of fittings cast in one piece may be reduced to the minimum wall thickness of a pipe of the same nominal size, related to the wall thickness series K 10. This deviation in wall thickness shall not extend over an area in excess of 1/10 of the internal pipe cross-sectional area.

In table 1

c is the flange thickness, in mm;

DN is the numerical value of the nominal size.

4.4 Permissible deviations in length

The following deviations given in table 2 shall apply for the manufacturing lengths of pipes and fittings:

Table 2.

Type of casting	Nominal size	Permissible deviations mm
Centrifugally cast pipes (except flanged pipes)	All sizes	± 100
Fittings (except flanged fittings)	Up to and including DN 400	± 20
	Above DN 400	+ 20 − 30
Flanged pipes Flanged fittings	All sizes	± 10

If smaller deviations in length are required, e.g. in the case of flange adapters, these deviations shall be subject to particular agreement. In this case, the minimum permissible deviation shall be ± 1 mm.

Up to 5 % of the total length of the pipes to be supplied in each nominal size (except for flanged pipes) may be supplied in shorter lengths (manufacturing length minus underlength) than specified in table 3.

Table 3.

Manufacturing lengths in m	Permissible underlength [8], in m			
5 to 8	0,5	1	1,5	2

[8] From DN 700, subject to agreement, cut lengths in 0,1 m increments are permitted in addition to the 0,5 m increments specified. In this case, special marking is required.

A further 10 % may be 0,5 m shorter than the manufacturing length.

4.5 Permissible deviations from straightness

The pipes shall be straight. The deviations of the pipe from the straight, in mm, shall not exceed 1,25 times the effective length of the pipe, in m.

For the purposes of measurement, the pipe may be placed on two supports positioned at a distance from each other of two thirds of the pipe length.

4.6 Permissible deviations in mass

The masses specified in the standards for pipes and fittings, excluding inside and outside coating and calculated taking the average density as 7,05 kg/dm^3, shall be complied with.

The permissible deviations in mass shall be as specified in table 4.

Table 4.

Type of casting		Permissible deviations %
Centrifugally cast pipes	DN ≤ 200	± 8
	DN > 200	± 5
Fittings except for those specified below		± 8
Bends, fittings with branches and fittings not covered in dimensional standards		± 12

Individual castings whose mass exceeds the maximum permissible mass, shall be deemed to comply with the standard if they meet the other requirements of the standards.

4.7 Material characteristics

The following material characteristics shall apply for pipes and fittings:

4.7.1 Structure

Centrifugally cast pipes: mainly ferritic.

Fittings: ferritic/perlitic.

For special fittings produced by welding, different structures are permitted in the weld zone[3].

4.7.2 Strength properties

The test of compliance with the strength values specified in table 5 shall be carried out on a machined round specimen.

Table 5.

Type of casting		Tensile strength N/mm² min.	0,2 % proof stress [9] N/mm² min.	Elongation after fracture ($L_o = 5\,d_o$) % min.
Centrifugally cast pipes	DN ≤ 1000	420	300 [11]	10 [10]
	DN > 1000			7
Fittings		400	300	5

Footnotes 9, 10 and 11 shall apply only for the specifications given on left-hand side of the page (see clause 1).

9) The 0,2 % proof stress shall only be determined subject to agreement.

10) Individual values between 7 % and 10 % of the elongation after fracture are permitted for test bars less than 5 mm in diameter. In this case, the proportion of ferrite determined by metallographic methods shall be not less than 75 %.

11) For pipes of size not less than DN 900, 0,2 % proof stress values between 270 and 300 N/mm² are permitted if the elongation after fracture is not less than 12 %.

4.7.3 Hardness

The hardness shall not exceed the following values:

centrifugally cast pipes: 230 HB 5/750;

fittings: 250 HB 5/750.

For special fittings produced by welding, higher hardness levels are permitted in the weld zone[3].

4.7.4 Ductility

In the case of centrifugally cast pipes, the deformation at failure in the bending test shall be not less than 3 %.

4.7.5 Other strength properties

On the basis of tests carried out in the course of research by *DVGW*[12] on underground drinking water pipelines, the following minimum strength values are applicable for ductile cast iron pressure pipes:

bursting strength: 300 N/mm²;

crushing strength: 550 N/mm²;

longitudinal bending strength: 420 N/mm².

4.8 Protective coatings

4.8.1 Inside coating (lining)

Pipes shall generally be provided with a cement mortar lining as specified in *DVGW-Arbeitsblatt* W 342, fittings with a cement mortar or a cement-based lining; subject to particular agreement, fittings may be provided with a bitumen-based lining as specified in *DVGW-Arbeitsblatt* GW 6 [13].

The type of lining of pipes and fittings shall be subject to particular agreement.

For 3), see page 2.

12) Research on underground drinking water pipelines made of various materials. Report II. Available from: *DVGW Deutscher Verein des Gas- und Wasserfaches e.V.*, D-6236 Eschborn 1.

13) Revised version in preparation.

In the region of sockets, pipes and fittings shall generally be provided with a bituminous top coating of uniform thickness.

Pipes intended for gas pipelines, subject to particular agreement, may be provided with a different lining or with no lining at all.

The lining of pipes and fittings for drinking water pipelines shall comply with the relevant food regulations. In order to determine whether the lining used complies with these requirements, tests shall be carried out in accordance with the *KTW-Empfehlungen* (Recommendations) of the *Bundesgesundheitsamt* (Federal Health Office) [14].

4.8.2 Outside coating

4.8.2.1 Pipes

Pipes to be used for soil groups I to III in accordance with *DVGW-Arbeitsblatt* GW 9 shall be provided at the manufacturing works with a polyethylene coating in accordance with DIN 30674 Part 1 or a cement mortar coating in accordance with DIN 30674 Part 2.

If the soil group is not known, pipes with coatings suitable for soil groups I to III shall be used.

Pipes to be used for soil groups I and II in accordance with *DVGW-Arbeitsblatt* GW 9 shall be provided at the manufacturing works with a zinc coating with topcoat in accordance with DIN 30674 Part 3 [15].

Pipes to be used for soil group I in accordance with *DVGW-Arbeitsblatt* GW 9 shall be provided at the manufacturing works with a bituminous coating in accordance with DIN 30674 Part 4 [16].

4.8.2.2 Fittings

Fittings shall generally be provided with a coating; a standard is in preparation.

5 Testing

5.1 Testing of finish, dimensions and masses

The finish and the dimensions of pipes and fittings are to be tested by random sampling.

All pipes and fittings are to be checked for accuracy to size and with regard to external and, where possible, internal surface quality.

After elimination of possible defects, the tests shall be repeated.

The masses shall be determined on a random sample basis.

The external diameter shall be checked for compliance with the permissible deviation, using a circometer.

The criterion for compliance with the permissible out-of-roundness as specified in subclause 4.2.2 shall be the difference between the greatest and smallest axis at the spigot end of the pipe, related to the external diameter d_1.

Agreements may be made with regard to more extensive tests.

5.2 Testing of material characteristics

5.2.1 Scope of tests

5.2.1.1 Tests carried out by manufacturer during production

During production the manufacturer shall carry out regular tests on the number of samples required to ensure a sufficiently accurate statistical result.

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[14] Test certificates are issued by:
Bundesanstalt für Materialprüfung, Berlin;
Hygiene-Institut des Ruhrgebietes, Gelsenkirchen;
DVGW-Forschungsstelle des Engler-Bunte-Institutes, Karlsruhe.

[15] Pipes with this type of coating may also be used for soil group III if they are also provided with a PE film on site; a standard is in preparation.

[16] Pipes with this type of coating may also be used for soil group II if they are also provided with a PE film on site; a standard is in preparation.

5.2.1.2 Tests to be carried out by purchaser on acceptance

In order to check compliance with the requirements specified in subclauses 4.7.2 and 4.7.3 for centrifugally cast pipes, at the discretion of the inspector a sample ring shall be taken from the spigot end of the pipe, as follows:

one sample per lot of 100 pipes up to and including size DN 300;
one sample per lot of 50 pipes from size DN 350;
one sample per lot of 25 pipes for sizes between DN 600 and DN 1000 inclusive;
one sample per lot of 10 pipes above size DN 1000.

Pipes from which sample rings have been taken shall be accepted by the purchaser as complete lengths.

Compliance with the above mentioned requirements in the case of fittings shall be tested on samples cast separately in accordance with DIN 1693 Part 1 for each 4 tons of castings.

In the case of pipes,

subject to agreement, some of the tests on machined round samples may be replaced by verifying the ductility specified in subclause 4.7.4 by means of a bending test in accordance with subclause 5.2.5.

the ductility specified in subclause 4.7.4 shall be verified for each treatment unit by means of a bending test in accordance with subclause 5.2.5[17].

5.2.2 Sampling and sample shape

5.2.2.1 Centrifugally cast pipes

From each sample ring as specified in subclause 5.2.1 a round bar ($L_o = 5\,d_o$) in accordance with DIN 50125 shall be taken. The bar shall be taken from the wall of the pipe in such a way that it is undamaged and free from defects.

For test bar diameters, see table 6.

Table 6.

Wall thickness of pipe mm	Diameter of test bar mm
up to 6	2,5
over 6 to 8	3,5
over 8 to 12	5
over 12	6

5.2.2.2 Fittings

From each sample as specified in subclause 5.2.1 a round bar ($L_o = 5\,d_o$) as specified in DIN 50125 shall be taken.

5.2.3 Tensile test

The samples taken in accordance with subclause 5.2.2 shall be subjected to a tensile test as described in DIN 50145 to determine tensile strength, elongation after fracture and 0,2% proof stress, as appropriate; in the case of pipes, attention shall be paid to the particular factors resulting from the small sample size specified in DIN 50145.

If the result of the test does not comply with the requirements, two further test bars taken from the same pipe or sample shall be tested and both shall meet the requirements specified in subclause 4.7.2.

If this is not the case, the whole lot shall be deemed unacceptable. However, in the case of pipes, it may be agreed that the test be carried out on each pipe.

5.2.4 Hardness test

5.2.4.1 Centrifugally cast pipes

The hardness test shall be carried out in accordance with DIN 50351 on the remaining pieces of the samples taken in accordance with subclauses 5.2.1 and 5.2.2.

If the result of the test does not comply with the requirements specified in subclause 4.7.3, the pipe shall be rejected and the test repeated on two further pipes from the same series. Pipes rejected due to excessive hardness may be submitted for retesting after being subjected to an annealing process.

5.2.4.2 Fittings

The hardness test shall only be carried out subject to special agreement, it being specified whether the test is to be carried out on the component itself or on a sample.

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[17] A treatment unit denotes the amount of iron in the ladle in which the molten iron is subjected to a magnesium treatment to produce the spheroidal shape of the graphite.

5.2.5 Bending test

The bending test shall be carried out on a pipe section (30 ± 5) mm in width with plane-parallel cut end faces and unworked surfaces. The edges of the pipe section may be broken.

The radius of curvature ϱ of the outer fibre at the point of fracture shall be taken as the criterion of ductility. It is to be determined over a chord length 2 c of 30 mm either directly by means of a radius temperplate or indirectly by measuring the height of the arc f using a gauge (see figure 1).

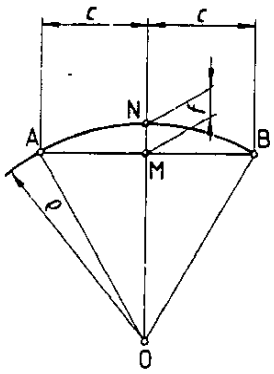

Figure 1. Determination of f

The following relationship exists between the radius of curvature ϱ and the height of the arc f:

$$\varrho = \frac{f^2 + c^2}{2 \cdot f} \tag{4}$$

The measured value limit in the determination of the radius of curvature ϱ is to be calculated by the following formula:

$$\varrho_{1,2} = \frac{1000 \cdot \varrho}{1000 \pm \varrho} \mp 1, \text{ in mm} \tag{5}$$

If the result of the measurement on the first sample does not meet the requirements, two further sections shall be taken from the same pipe, both of which shall comply with the requirements specified in subclause 4.7.4.

If this is not the case,

the inspection lot | the treatment unit

shall be deemed unacceptable. However, it may then be agreed that the test be carried out on each pipe.

5.2.5.1 Centrifugally cast pipes up to and including size DN 300

The test shall be carried out on a ring on the lines of DIN 50 136.

The deformation after fracture ε, in %, shall be calculated by the following formulae:

crack at 3 or 9 o'clock position

$$\varepsilon = \frac{100 \cdot s_1}{d_1} \cdot \frac{d_1 - 2\varrho}{2\varrho - s_1} \tag{6}$$

crack at 6 or 12 o'clock position

$$\varepsilon = \frac{100 \cdot s_1}{d_1 - 2s_1} \cdot \frac{2\varrho - d_1}{2\varrho - s_1} \tag{7}$$

where

s_1 is the wall thickness at location of crack, in mm;

d_1 is the external diameter of pipe before test, in mm;

ϱ is the radius of curvature, in mm.

If negative arc heights are measured at the 6 or 12 o'clock position, these shall be included in the calculation. If no correct measurement is possible at the point of fracture, the measurement may be carried out on the opposite side of the ring.

5.2.5.2 Centrifugally cast pipes over size DN 300

The test shall be carried out on a ring segment with a chord length h = 250 mm (see figure 2).

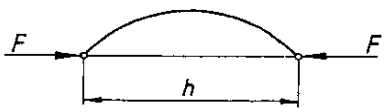

Figure 2.

The deformation after fracture, in %, shall be calculated by the following formula:

$$\varepsilon = \frac{100 \cdot s_1}{d_1} \cdot \frac{d_1 - 2\varrho}{2\varrho - s_1} \tag{8}$$

5.3 Leak tightness tests

Before application of the protective coating, except for the zinc coating, pipes and fittings shall be subjected to a hydrostatic pressure test as described in DIN 50104. The test pressure shall be not less than 1,5 times the rated pressure, the 0,2 % proof stress, however, only being utilized to a maximum of 90 %.

The minimum duration of the test shall be 15 seconds. No leaks shall be evident. Pipes and fittings with leaks shall be excluded from the supply.

5.3.1 Unless otherwise agreed, centrifugally cast pipes with spigot and socket shall be tested in the manufacturing works with the pressures specified in table 7:

Table 7.

Nominal size DN	Test pressure, in bar for class	
	K 10, K 9	K 8
up to 150	60	
over 150 to 300	60	50
over 300 to 600	50	40
over 600 to 1200	40	32
over 1200	30	25

Nominal size DN	Test pressure, in bar for class	
	K 10	K 9
up to 300	70	65
over 300 to 600	60	55

The pipes shall be tested over an extended period of approximately 30 seconds.

5.3.2 Subject to agreement, the leak tightness test using water for fittings may be replaced by another recognized test method if the wall thickness and material tests ensure that the fitting is free from defects. The test carried out may for example be a leak tightness test using air or a non-destructive test method.

The fittings are to be subjected to an additional leak tightness test using air with a test pressure of 2 bar. At the same time, the test pieces are to be treated with a slightly foaming test medium or immersed in water.

5.4 Acceptance inspection

The supply of pipes and fittings

may | shall

include an acceptance inspection.

The acceptance inspection may be carried out by an authorized representative of the manufacturing works or by an authorized representative of the purchaser. If the inspection is to be carried out by an authorized representative of the purchaser, this shall be expressly specified in the order.

All tests, including the acceptance inspection, shall be carried out at the manufacturing works in such a way that the production in the manufacturing works is not unduly impaired.

6 Marking

Each pipe shall bear the manufacturer's trade mark, the nominal size and the year of manufacture. Pipes which do not conform to wall thickness series K 10 as specified in DIN 28610 Part 1 and Part 2 shall be specially marked. For fittings, further characteristics shall be specified, where necessary, e.g. central angle, in degrees, for bends. It is not necessary to specify the year of manufacture for fittings up to and including size DN 300.

Pipes shall be clearly and permanently marked, the marking being either raised or embossed, on the end face of the socket or in the socket at a location where the functioning of the joint is not adversely affected. Fittings shall be marked on the external surface.

In order to identify the material "ductile iron", three dots arranged in a triangle or three parallel notches shall be applied.

Each pipe and each fitting shall in addition be marked with a yellow ring of paint approx. 5 cm in width behind a socket or a flange.

The marking with regard to the external coating of the pipes shall be in accordance with DIN 30674 Parts 1 to 4. The use of this marking indicates that the manufacturer assures compliance of the pipes and fittings with this standard.

7 Documents on testing and acceptance inspection

The test results

shall, subject to agreement, be recorded in a certificate of compliance with the order or in inspection certificate 3.1 B conforming to DIN 50049.

shall be recorded in inspection certificate 3.1 B conforming to DIN 50049.

Standards referred to and other relevant documents

DIN 1693 Part 1	Spheroidal graphite cast iron; unalloyed and low alloy grades
DIN 3535 Part 3	Sealants for use in gas supplies elastomeric sealants for gas supply mains and gas pipelines; safety requirements and testing of materials
DIN 19630	Guideline for the construction of water pipelines; DVGW Code of practice
DIN 28601 Part 1	Ductile iron pressure pipes and fittings for gas and water pipelines; screwed socket joint assemblies; assembly sockets, screw rings
DIN 28601 Part 2	Ductile iron pressure pipes and fittings for gas and water pipelines; screwed socket joint assemblies; sealing rings
DIN 28601 Part 3	Ductile iron pressure pipes and fittings for gas and water pipelines; screwed socket joint assemblies; axial ring seals
DIN 28602 Part 1	Ductile iron pressure pipes and fittings for gas and water pipelines; mechanical joint assemblies; assembly, sockets, gland rings
DIN 28602 Part 2	Ductile iron pressure pipes and fittings for gas and water pipelines; mechanical joint assemblies; sealing rings
DIN 28602 Part 3	Ductile iron pressure pipes and fittings for gas and water pipelines; mechanical joint assemblies; T head bolts and nuts
DIN 28603	Ductile iron pressure pipes and fittings; push-in joint assemblies; mating dimensions and masses
DIN 28604	Ductile iron pressure pipes and fittings for gas and water pipelines; PN 10 flanges; dimensions
DIN 28605	Ductile iron pressure pipes and fittings for gas and water pipelines; PN 16 flanges; dimensions
DIN 28606	Ductile iron pressure pipes and fittings for gas and water pipelines; PN 25 flanges; dimensions
DIN 28607	Ductile iron pressure pipes and fittings for gas and water pipelines; PN 40 flanges; dimensions
DIN 28610 Part 1	Ductile iron pressure pipes with socket with cement mortar lining for gas and water pipelines; dimensions, masses and fields of application
DIN 28610 Part 2	Ductile iron pressure pipes with socket for gas pipelines for pressures between 4 and 16 bar; dimensions, masses and fields of application
DIN 28614	Ductile iron pressure pipes with cast-on flanges for gas and water pipelines; FFG pipes; dimensions
DIN 28615	Ductile iron pressure pipes with flanges not cast on for gas and water pipelines; FFS pipes; dimensions and masses
DIN 28617	Gaskets for cast iron pressure pipes and fittings for water pipelines; requirements and testing
DIN 28622	Ductile iron pressure pipes and fittings for gas and water pipelines; push-on flanged sockets
DIN 28623	Ductile iron pressure pipes and fittings for gas and water pipelines; flanged spigots
DIN 28624	Ductile iron pressure pipes and fittings for gas and water pipelines; push-on sockets
DIN 28625	Ductile iron pressure pipes and fittings for gas and water pipelines; double socket 90° bends
DIN 28626	Ductile iron pressure pipes and fittings for gas and water pipelines; double socket 45° bends
DIN 28627	Ductile iron pressure pipes and fittings for gas and water pipelines; double socket 30° bends
DIN 28628	Ductile iron pressure pipes and fittings for gas and water pipelines; double socket 22 1/2° bends
DIN 28629	Ductile iron pressure pipes and fittings for gas and water pipelines; double socket 11 1/4° bends
DIN 28630	Ductile iron pressure pipes and fittings for gas and water pipelines; double-flanged bends
DIN 28632	Ductile iron pressure pipes and fittings for gas and water pipelines; all-socketed tees
DIN 28634	Ductile iron pressure pipes and fittings for gas and water pipelines; double-socket tapers
DIN 28637	Ductile iron pressure pipes and fittings for gas and water pipelines; double-flanged 90° bends
DIN 28638	Ductile iron pressure pipes and fittings for gas and water pipelines; double-flanged 90° duckfoot bends
DIN 28639	Ductile iron pressure pipes and fittings for gas and water pipelines; double-flanged 45° bends
DIN 28643	Ductile iron pressure pipes and fittings for gas and water pipelines; all-flanged tees
DIN 28645	Ductile iron pressure pipes and fittings for gas and water pipelines; double-flanged tapers
DIN 28646	Ductile iron pressure pipes and fittings for gas and water pipelines; blank flanges
DIN 28648	Ductile iron pressure pipes and fittings for gas and water pipelines; hydrant duckfoot 90° bends

DIN 30674 Part 1 Coating of ductile iron pipes; polyethylene coatings

DIN 30674 Part 2 Coating of ductile iron pipes; cement mortar coatings

DIN 30674 Part 3 Coating of ductile cast iron pipes; zinc coatings

DIN 30674 Part 4 Coating of ductile iron pipes; oil asphalt coatings

DIN 50049 Documents on materials testing

DIN 50104 Internal pressure test for hollow bodies of any shape up to a certain internal pressure (hydrostatic pressure test)

DIN 50125 Testing of metallic materials; tensile specimens guidelines for production

DIN 50136 Testing of metallic materials; flattening test for tubes

DIN 50145 Testing of metallic materials; tensile test

DIN 50351 Testing of metallic materials; Brinell hardness test

DVGW-Arbeitsblatt G 461/I*)
Errichtung von Gasleitungen bis 4 bar Betriebsüberdruck aus Druckrohren und Formstücken aus duktilem Gusseisen
(Construction of gas pipelines for working pressures up to 4 bar of ductile iron pressure pipes and fittings)

DVGW-Arbeitsblatt G 461/II*)
Errichtung von Gasleitungen mit einem Betriebsüberdruck von mehr als 4 bar bis 16 bar aus Druckrohren und Formstücken aus duktilem Gusseisen
(Construction of gas pipelines with working pressures ranging from 4 to 16 bar of ductile iron pressure pipes and fittings)

DVGW-Arbeitsblatt GW 6*)
Umhüllung und Auskleidung auf bituminöser Grundlage für Guss- und Stahlrohre
(Bitumen-based covering and linings for cast iron and steel pipes)

DVGW-Arbeitsblatt GW 9*)
Beurteilung der Korrosionsgefährdung von Eisen und Stahl im Erdboden
(Assessment of corrosion risk to iron and steel under ground)

DVGW-Arbeitsblatt W 342*)
Werkseitig hergestellte Zementmörtelauskleidungen für Guss- und Stahlrohre; Anforderungen und Prüfungen, Einsatzbereiche
(Cement mortar linings provided by the manufacturer for cast iron and steel pipes; requirements and testing, fields of application)

DVGW-Merkblatt GW 368*)
Hinweise für Herstellung und Einbau von zugfesten Verbindungsteilen zur Sicherung nicht längskraftschlüssiger Rohrverbindungen
(Information on the manufacture and installation of tension-resistant joint components for securing pipe joint assemblies not held by friction in the longitudinal direction)

DVS 1148**) *Prüfung von Schweissern; Lichtbogenhandschweissen an Rohren aus duktilem Gusseisen für Rohrleitungen der öffentlichen Gas- und Wasserversorgung*
(Qualification testing of welders; manual arc welding on ductile iron pipes for public gas and water supply pipelines)

DVS 1502 Part 1**) *Lichtbogenhandschweissen an Rohren aus duktilem Gusseisen für Rohrleitungen der öffentlichen Gas- und Wasserversorgung; Schweisstechnische Grundsätze*
(Manual arc welding on ductile iron pipes for public gas and water supply pipelines; welding principles)

DVS 1502 Part 2**) *Lichtbogenhandschweissen an Rohren aus duktilem Gusseisen für Rohrleitungen der öffentlichen Gas- und Wasserversorgung; Anschweissen von Teilen aus duktilem Gusseisen oder aus Stahl*
(Manual arc welding on ductile iron pipes for public gas and water pipelines; welding on of ductile iron or steel parts)

K. Wellinger and H. Gassmann. *Die Berechnung duktiler Schleudergussrohre,* (Design of ductile centrifugally cast pipes) *Techn.-Wiss. Ber. MPA Stuttgart* (1965), vol. 65-01.

Previous editions

DIN 28600: 08.68, 08.77

*) Available from *ZfGW-Verlag GmbH,* Voltastrasse 79, D-6000 Frankfurt 90.

**) Available from *Deutscher Verlag für Schweisstechnik (DVS),* Aachener Strasse 174, D-4000 Düsseldorf 1.

Amendments

The following amendments have been made in comparison with the August 1977 edition:

a) The scope has been extended to include sizes DN 2000 for water pipelines and up to DN 600 and 16 bar for gas pipelines.

b) Welded special fittings have been included.

c) Wall thickness classes K 9 and K 8 have been included.

d) Specifications with regard to protective coatings have been included.

Explanatory notes

The August 1977 edition, which differed from the August 1968 edition only in that the units were changed to comply with the statutory units, has been completely revised by Technical Committee *Gusseiserne Druckrohre und Formstücke* of the *Normenausschuss Rohre, Rohrverbindungen und Rohrleitungen* (Pipes, Pipe joint assemblies and Pipelines Standards Committee).

The scope has been extended to include water pipelines up to size DN 2000 and the nominal size range up to and including size DN 600 extended to gas pipelines with permissible working pressures up to and including 16 bar. In keeping with the state of the art, certain structural and manufacturing weldings (see footnote 3 and subclause 4.1) have been included. In the case of such weldings, structural phenomena (nickel-martensite, ledeburite and martensite) occur in the weld zone (transition between weld and base material) in layers less than 0,2 mm in thickness, this deviating from the specifications given in subclause 4.7.1. This results in hardness levels higher than those specified in subclause 4.7.3 (up to approx. HV 600). However, the above-mentioned deviations do not have any detrimental effect on the functional characteristics.

The formula for dimensioning the wall thickness as a function of the internal pressure, and wall thickness classes K 9 and K 8 have also been included.

The internal and external coatings of pipes and fittings have been dealt with in greater detail than in the previous edition. The various types of outside coatings and their fields of application in soils of different degrees of corrosive action are based on experience gained in the last few years.

The requirements and test methods for the coating and information on their application are currently being specified in DIN Standards.

The minimum deformation after fracture in the bending test as a measure of the ductility of the casting now applies to centrifugally cast pipes of all nominal sizes.

The test pressures for centrifugally cast pipes with spigot and socket (see subclause 5.3.1) are now graded according to wall thickness classes. In addition, a more stringent hydrostatic pressure test has been specified for pressure pipes intended for use in gas pipelines with permissible working pressures between 4 bar and 16 bar.

International Patent Classification

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