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Heat resisting steel castings
Technical delivery conditions

DIN 17465

Hitzebeständiger Stahlguß; technische Lieferbedingungen

Supersedes
September 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.

The symbol • denotes items which shall, the symbol •• denoting items which may, be agreed upon at the time of ordering.

1 Scope and field of application

1.1 This standard specifies technical delivery conditions for steel castings (including products manufactured by centrifugal casting) made from the steel grades specified in table 1. Such grades are used for the manufacture of unpressurized components subjected predominantly to operating temperatures exceeding 600 °C and are suitable for exposure to aggressive gaseous substances.

NOTE: Cast steel used for the manufacture of components subjected to pressure are specified in *Stahl-Eisen-Werkstoffblatt* (Iron and steel materials sheet) 595.

1.2 The specifications given in DIN 1690 Parts 1 and 2 shall be complied with unless otherwise stated here.

2 Concept

Heat resisting cast steel is steel characterized by its resistance to the scaling effect of gases at temperatures exceeding 600 °C.

3 Designation

3.1 The steel grade symbols and numbers used in the designation have been taken from DIN EN 10 027 Parts 1 and 2, respectively.

3.2 The standard designation shall give the name of the product (steel casting), the DIN number (DIN 17 465), and the material designation or number.

EXAMPLE:

Designation of a steel casting complying with this standard, made of a material identified by material designation GX40CrNiSi25-20 (material number 1.4848):

Steel casting DIN 17465 – GX40CrNiSi25-20

or

Steel casting DIN 17465 – 1.4848

4 Steel grades

The materials covered in this standard are mainly classified according to their chemical composition.

5 Requirements

5.1 Steelmaking process

The steel shall be made in an electric furnace.

5.2 Heat treatment condition

• Castings made from heat resisting ferritic steel with a maximum chromium content of 18 % by mass are to be supplied in the annealed or not heat treated condition (cf. table 3). The heat treatment condition shall be agreed at the time of ordering.

Castings made from other grades of ferritic steel or from ferritic-austenitic or austenitic steel shall be supplied in the as-cast condition.

5.3 Chemical composition

5.3.1 The chemical composition, as determined by cast analysis, shall be in compliance with table 1.

5.3.2 Where a product analysis of a cast-on test piece or a separately cast test piece is to be carried out, the results may deviate from the values given in table 1 by the amounts listed in table 2.

5.3.3 •• Subject to agreement, deviations from the specifications given in subclauses 5.3.1 and 5.3.2 are permitted, provided the mechanical properties, weldability, and the performance of the finished product are not adversely affected. If necessary, limit deviations shall be agreed at the time of ordering.

5.4 Mechanical properties

5.4.1 •• Where ferritic steel is supplied in the annealed condition, with a maximum chromium content of 18 % by mass, the values of hardness specified in table 3 shall be complied with. Where supplied in the as-cast condition, hardness values shall be the subject of agreement.

5.4.2 In the case of austenitic steel (except for grades G-CoCr 28 and G-NiCr 28 W), the values of mechanical properties specified in table 3, as determined on a cast-on test piece or a separately cast test piece, shall be complied with. In the case of products manufactured by centrifugal casting, these values shall be determined on annular test pieces taken from samples in their as delivered condition.

5.4.3 In the case of steel grades not covered in subclauses 5.4.1 and 5.4.2, no specifications have been made for their mechanical properties at ambient temperature.

5.4.4 Guideline values for elevated temperature 1 % creep limit after 10 000 h are given in table 4. The values are mean values from scatterbands established to date and may be revised at a later date, as investigations continue.

5.5 Physical properties

5.5.1 Guideline values for physical properties are given in table 5.

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5.5.2 Calculation of the mass of castings shall be based on the density values specified in table 5.

5.6 Scaling resistance

Owing to their chromium and silicon content, the steel grades covered here are particularly resistant to scaling as a result of exposure to hot gases and combustion products. Their degree of resistance, however, is a function of the conditions of exposure, and cannot be assessed on the basis of one particular test method. For example, when used at a very high service temperature in air (e.g. 1150 °C), the resistance of castings may be significantly lower as a result of the presence of sulfuric or chloritic constituents in the gas or in pulverized fuel ash. In this regard, it is suggested to consult the material supplier in cases of uncertainty. The service temperatures given in table 4 may be taken as guidance for assessment of the resistance of castings to scaling in air.

5.7 Surface quality

5.7.1 • The general surface quality requirements specified in DIN 1690 Part 2 shall be complied with, the specific severity level to which the castings are to be classified being the subject of agreement.

5.7.2 Imperfections shall be remedied as described in subclause 5.8.

5.8 Welding

5.8.1 The general welding requirements specified in DIN 1690 Part 1 shall be complied with, account being taken of the specifications given in subclauses 5.8.2 to 5.8.4.

5.8.2 Filler metals shall be selected so that the scaling resistance of the weld metal (after welding) is similar to that of the parent metal. See table 6 for suitable filler metals. With regard to weldability, it should be noted that not all filler metals are suitable for producing a weld with the same mechanical properties as the parent metal.

5.8.3 Guidance information regarding preheating and post-weld heat treatment is given in table 6.

5.8.4 All production welds shall be ground smooth.

6 Testing

6.1 Inspection documents

6.1.1 •• It may be agreed at the time of ordering to supply castings with a DIN 50 049 inspection document.

6.1.2 In the case of castings assigned to severity level 4 or 5 and which have not been subjected to non-destructive testing, it shall be permitted to supply them with no inspection document, or with a certificate of compliance with the order or a test report.

6.1.3 In all other cases, the specific test report, inspection certificate or inspection report shall include the following particulars:

a) the results of cast analysis for all elements specified in table 1 for the relevant steel grade;

b) the results of the tests used to verify compliance with the values for mechanical properties specified in table 3;

c) in the case of castings assigned to severity levels S 01 to S 3 or V 1 to V 3 as specified in DIN 1690 Part 2, the results of non-destructive testing used to verify the general casting quality and basis for assignment to a particular severity level;

d) the results of any additional tests agreed upon;

e) marking (cf. clause 7);

f) the inspector's mark in the case of an inspection certificate or an inspection report.

• Where required (e.g. in the case of inspection certificate 3.1.C as specified in DIN 50 049), the address of the inspector or inspection body shall be given at the time of ordering.

6.2 Tests on castings as supplied

6.2.1 General

Where castings are to be supplied with one of the documents listed in subclause 6.1.3, either the castings supplied or a batch therefrom shall be tested in accordance with DIN 1690 Parts 1 and 2, account being taken of the requirements given in subclauses 6.2.2 to 6.2.5.

6.2.2 Properties to be tested

Castings shall be subjected to the tests referred to in subclause 6.1.3, items a) to d).

6.2.3 Scope of testing

6.2.3.1 Where it has been agreed to test batches of castings for compliance with the requirements specified in table 3, the mass of a batch shall be a maximum of:

a) 2500 kg where it consists of products made from the same material or originating from the same cast;

b) 1500 kg where it consists of products from the same heat treatment batch.

Remainders with a total mass of not more than half the maximum amounts specified above may be distributed uniformly among the other batches.

6.2.3.2 Testing of batches as delivered is not permitted.

6.2.3.3 When testing products originating from the same cast, not more than four batches per cast need be tested.

6.2.3.4 In the case of steel for which only the hardness has been specified in table 3, the hardness of one casting per batch shall be determined.

6.2.4 Sampling

Sampling shall be carried out in accordance with DIN 1690 Part 1, the maximum section thickness of cast-on test pieces or those cast separately being 25 mm. In the case of products manufactured by centrifugal casting, annular test pieces shall be taken.

7 Marking

7.1 Castings supplied with no inspection document, or with a certificate of compliance with the order or a test report, shall be marked in accordance with DIN 1690 Part 1.

7.2 Castings supplied with a specific test report, an inspection certificate or an inspection report as specified in DIN 50 049 shall be marked in accordance with subclause 6.1 of DIN 1690 Part 1.

Table 1: Steel grades and their chemical composition as determined by cast analysis [1)]

Material designation	Material number	Percentage by mass C	Si	Mn	Cr	Ni	Nb	Others
GX30CrSi6	1.4710	0,20 to 0,35	1,0 to 2,5	0,5 to 1,0	6,0 to 8,0	–	–	
GX40CrSi13	1.4729	0,30 to 0,45	1,0 to 2,5	0,5 to 1,0	12,0 to 14,0	–	–	
GX40CrSi17	1.4740	0,30 to 0,45	1,0 to 2,5	0,5 to 1,0	16,0 to 18,0	–	–	
GX40CrSi23	1.4745	0,30 to 0,45	1,0 to 2,5	0,5 to 1,0	22,0 to 24,0	–	–	
GX40CrSi29	1.4776	0,30 to 0,45	1,0 to 2,5	0,5 to 1,0	27,0 to 30,0	–	–	
GX130CrSi29	1.4777	1,20 to 1,40	1,0 to 2,5	0,5 to 1,0	27,0 to 30,0	–	–	
GX40CrNiSi27-4	1.4823	0,35 to 0,50	1,0 to 2,5	≤ 1,5	25,0 to 28,0	3,5 to 5,5	–	
GX25CrNiSi18-9	1.4825	0,15 to 0,30	1,0 to 2,5	≤ 1,5	17,0 to 19,0	8,0 to 10,0	–	
GX40CrNiSi22-9	1.4826	0,30 to 0,50	1,0 to 2,5	≤ 1,5	21,0 to 23,0	9,0 to 11,0	–	
GX25CrNiSi20-14	1.4832	0,15 to 0,30	1,0 to 2,5	≤ 1,5	19,0 to 21,0	13,0 to 15,0	–	
GX40CrNiSi25-12	1.4837	0,30 to 0,50	1,0 to 2,5	≤ 1,5	24,0 to 26,0	11,0 to 14,0	–	
GX40CrNiSi25-20	1.4848	0,30 to 0,50	1,0 to 2,5	≤ 1,5	24,0 to 26,0	19,0 to 21,0	–	
GX40NiCrSi38-18	1.4865	0,30 to 0,50	1,0 to 2,5	≤ 1,5	17,0 to 19,0	36,0 to 39,0	–	
GX40NiCrSi35-25	1.4857	0,30 to 0,50	1,0 to 2,5	≤ 1,5	24,0 to 26,0	34,0 to 36,0	–	
GX30CrNiSiNb24-24	1.4855	0,25 to 0,40	0,5 to 2,0	≤ 1,5	23,0 to 25,0	23,0 to 25,0	1,2 to 1,8	
GX40NiCrSiNb38-18	1.4849	0,30 to 0,50	1,0 to 2,5	≤ 1,5	17,0 to 19,0	36,0 to 39,0	1,2 to 1,8	
GX40NiCrSiNb35-25	1.4852	0,35 to 0,45	1,0 to 2,5	≤ 1,5	24,0 to 26,0	33,0 to 35,0	0,8 to 1,8	
G-CoCr 28	2.4778	0,10 to 0,20	0,5 to 1,5	≤ 1,5	27,0 to 30,0	–	–	Co 48,0 to 52,0
G-NiCr 28 W	2.4879	0,35 to 0,50	0,5 to 2,0	≤ 1,5	27,0 to 30,0	47,0 to 50,0	–	W 4,0 to 5,5

[1)] The maximum contents of phosphorous and sulfur shall not exceed 0,035 % and 0,030 % by mass, respectively.

Table 2: Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified for cast analysis

Element	Limiting values as determined by cast analysis, as in table 1, as a percentage by mass	Limit deviation for product analysis[1]), as a percentage by mass
C	≤ 0,10	− 0,01
	> 0,10 to ≤ 0,30	± 0,02
	> 0,30 to ≤ 0,50	± 0,03
	≥ 1,20 to ≤ 1,40	± 0,05
Si	≤ 2,00	± 0,1
	> 2,00 to ≤ 2,50	+ 0,2
Mn	≤ 0,80	− 0,07
	> 0,80 to ≤ 1,50	± 0,1
P	≤ 0,035	+ 0,005
S	≤ 0,030	+ 0,005
Co	≤ 52,00	± 0,8
Cr	≤ 13,50	± 0,2
	> 13,50 to ≤ 20,00	± 0,3
	> 20,00 to ≤ 30,00	± 0,6
Nb	≤ 1,80	± 0,1
Ni	≤ 5,00	± 0,2
	> 5,00 to ≤ 11,00	± 0,3
	> 11,00 to ≤ 25,00	± 0,5
	> 25,00 to ≤ 50,00	± 0,8
W	≤ 5,50	± 0,2

[1]) If a number of product analyses are to be carried out, the deviations shown by an element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the cast analysis, but not both at the same time.

Table 3: Mechanical properties at ambient temperature as a function of heat treatment condition

Material designation	Material number	Heat treatment condition	Maximum hardness HB 30	Min. 0,2 % proof stress, $R_{p0,2}$, in N/mm²	Min. tensile strength [1], R_m, in N/mm²	Min. elongation at fracture [1], A_5, as a percentage
Ferritic steel castings						
GX30CrSi6	1.4710	Annealed at 800 to 850 °C	300 [2]	–	–	–
GX40CrSi13	1.4729		300 [2]			
GX40CrSi17	1.4740		300 [2]			
GX40CrSi23 GX40CrSi29 GX130CrSi29	1.4745 1.4776 1.4777	As-cast condition	–	–	–	–
Ferritic-austenitic steel castings						
GX40CrNiSi27-4	1.4823	As-cast condition	–	–	–	–
Austenitic steel castings						
GX25CrNiSi18-9	1.4825	As-cast condition	–	230	440	15
GX40CrNiSi22-9	1.4826			230	440	8
GX25CrNiSi20-14	1.4832			230	440	10
GX40CrNiSi25-12	1.4837			230	440	7
GX40CrNiSi25-20	1.4848			230	440	6
GX40NiCrSi38-18	1.4865			230	400	5
GX40NiCrSi35-25	1.4857			230	440	5
GX30CrNiSiNb24-24	1.4855			230	440	5
GX40NiCrSiNb38-18	1.4849			220	400	5
GX40NiCrSiNb35-25	1.4852			220	400	5
GCoCr 28	2.4778			–	–	–
GNiCr 28 W	2.4879			–	–	–

[1] Applies for product thicknesses up to 25 mm.

[2] The maximum hardness shall be the subject of agreement in the case of castings supplied in the as-cast condition.

Table 4: Guideline values for elevated temperature 1% creep limit after 10 000 h and maximum service temperature in air

Material		1% creep limit after 10 000 h, in N/mm², at a temperature, in °C, of						Maximum service temperature, in °C
designation	number	600	700	800	900	1000	1100	
GX30CrSi6	1.4710	19,5	8	2,5	–	–	–	750
GX40CrSi13	1.4729	22	9	3,5	1	–	–	850
GX40CrSi17	1.4740	22	9	3,5	1	–	–	900
GX40CrSi23	1.4745	26	11	5	1,5	–	–	1050
GX40CrSi29	1.4776	26	11	5	1,5	–	–	1150
GX130CrSi29	1.4777	–	–	–	–	–	–	1100
GX40CrNiSi27-4	1.4823	–	21	9	4	1,5	–	1100
GX25CrNiSi18-9	1.4825	78	44	22	9,5	–	–	900
GX40CrNiSi22-9	1.4826	82	46	23	10	–	–	950
GX25CrNiSi20-14	1.4832	82	46	23	10	–	–	950
GX40CrNiSi25-12	1.4837	–	50	26	12,5	5,5	–	1050
GX40CrNiSi25-20	1.4848	–	66	36	17	7	–	1100
GX40NiCrSi38-18	1.4865	–	55	32	16	6,5	–	1050
GX40NiCrSi35-25	1.4857	–	70	40	20	8	2	1100
GX30CrNiSiNb24-24	1.4855	–	80	46	22	7,5	–	1050
GX40NiCrSiNb38-18	1.4849	–	60	38	20	8	–	1000
GX40NiCrSiNb35-25	1.4852	–	72	41	22	9	2	1100
G-CoCr 28	2.4778	–	70	34	16	6	–	1100
G-NiCr 28 W	2.4879	–	70	41	22	10	4	1150

Table 5: Guideline values for physical properties

Material		Density, in g/cm³	Thermal conductivity, in W/K·m	Specific heat capacity at 20 °C, in J/g·K	Coefficient of linear thermal expansion, in 10^{-6}/K, at a temperature between 20 °C and		
designation	number				400 °C	800 °C	1000 °C
GX30CrSi6	1.4710	7,7	18,8	0,50	12,5	13,5	–
GX40CrSi13	1.4729	7,7	18,8	0,50	12,5	13,5	–
GX40CrSi17	1.4740	7,7	18,8	0,50	12,5	13,5	–
GX40CrSi23	1.4745	7,6	18,8	0,50	12,0	14,0	16,0
GX40CrSi29	1.4776	7,5	18,8	0,50	11,5	14,0	16,0
GX130CrSi29	1.4777	7,5	18,8	0,50	11,5	14,0	16,0
GX40CrNiSi27-4	1.4823	7,6	16,7	0,50	13,0	14,5	16,5
GX25CrNiSi18-9	1.4825	7,8	14,6	0,50	17,5	18,5	19,5
GX40CrNiSi22-9	1.4826	7,8	14,6	0,50	17,5	18,5	19,5
GX25CrNiSi20-14	1.4832	7,8	14,6	0,50	17,5	18,5	19,5
GX40CrNiSi25-12	1.4837	7,8	14,6	0,50	17,5	18,5	19,0
GX40CrNiSi25-20	1.4848	7,9	14,6	0,50	17,0	18,0	19,0
GX40NiCrSi38-18	1.4865	8,0	14,6	0,50	16,0	17,0	18,5
GX40NiCrSi35-25	1.4857	8,0	14,6	0,50	15,5	17,0	18,0
GX30CrNiSiNb24-24	1.4855	8,0	14,6	0,50	17,0	18,0	18,5
GX40NiCrSiNb38-18	1.4849	8,0	14,6	0,50	16,0	17,0	18,5
GX40NiCrSiNb35-25	1.4852	8,0	14,6	0,50	15,5	17,0	18,0
G-CoCr 28	2.4778	8,1	9,2	0,50	15,5	17,0	18,0
G-NiCr 28 W	2.4879	8,2	14,6	0,50	14,5	16,0	17,0

Table 6: Guideline information regarding preheating and post-weld heat treatment

Material		Suitable filler metal			Heat treatment	
designation	number	Covered electrode (symbol)	Wire or rod (symbol)	Material number	prior to welding	after welding
GX30CrSi6	**1.4710**	9 19 9 18 8 Mn 22 12	X8Cr9 X5CrNi19-9 X15CrNiMn18-8 X12CrNi22-12	1.4716 1.4302 1.4370 1.4829	Preheat to 300 to 500 °C, depending on cross-sectional size.	Stress-relieve at 760 to 800 °C.
GX40CrSi13	**1.4729**	14 22 12	X8Cr15 X12CrNi22-12	1.4733 1.4829		
GX40CrSi17	**1.4740**	18 17 22 12	X8Cr18 X8CrTi18 X12CrNi22-12	1.4015 1.4502 1.4829		
GX40CrSi23	**1.4745**	30 25 4 25 20	X8Cr30 X12CrNi25-4 X12CrNi25-20	1.4773 1.4820 1.4842	Preheat to 700 to 800 °C.	Cool slowly in furnace.
GX40CrSi29	**1.4776**	30 29 9	X8Cr30 X10CrNi30-9	1.4773 1.4337		
GX130CrSi29	**1.4777**	Not usually welded.				
GX40CrNiSi27-4	**1.4823**	25 4 25 20 29 9	X12CrNi25-4 X12CrNi25-20 X10CrNi30-9	1.4820 1.4842 1.4337	Preheat products with large cross sections or differences in cross section.	No treatment.
GX25CrNiSi18-9	**1.4825**	19 9 22 12	X5CrNi19-9 X12CrNi22-12	1.4302 1.4829	Do not or only slightly preheat (until warm to the touch).	No treatment.
GX40CrNiSi22-9	**1.4826**	22 12 25 20 hC [1]	X12CrNi22-12 X40CrNi25-21	1.4829 1.4846		
GX25CrNiSi20-14	**1.4832**	22 12 25 20 hC [1]	X12CrNi22-12 X40CrNi25-21	1.4829 1.4846		
GX40CrNiSi25-12	**1.4837**	25 20 hC [1]	X40CrNi25-21	1.4846		
GX40CrNiSi25-20	**1.4848**	25 20 hC [1]	X40CrNi25-21	1.4846		
GX40NiCrSi38-18	**1.4865**	18 36 25 35 Nb	X12NiCr36-18 X40NiCrNb35-25	1.4863 1.4853		
GX40NiCrSi35-25	**1.4857**	25 35 Nb	X40NiCrNb35-25	1.4853		
GX30CrNiSiNb24-24	**1.4855**	25 24 Nb	X35CrNiNb25-24	1.4830		
GX40NiCrSiNb38-18	**1.4849**	25 35 Nb	X40NiCrNb35-25	1.4853		
GX40NiCrSiNb35-25	**1.4852**	25 35 Nb	X40NiCrNb35-25	1.4853		
G-CoCr 28	**2.4778**	CoCr 28	–	2.4778		
G-NiCr 28 W	**2.4879**	NiCr 28 W	–	2.4879		

[1] The appended symbol hC means a higher carbon content.

Standards and other documents referred to

DIN 1690 Part 1	Technical delivery conditions for castings of metallic materials; general
DIN 1690 Part 2	Technical delivery conditions for castings of metallic materials; classification into severity levels on the basis of non-destructive testing
DIN 50 049	Inspection documents for the delivery of metallic products
DIN EN 10 027 Part 1	Designation systems for steels; steel names and principal symbols
DIN EN 10 027 Part 2	Designation systems for steels; numerical system

Stahl-Eisen-Werkstoffblatt 595 *Stahlguß für Erdöl- und Erdgasanlagen* (Steel castings for crude oil and natural gas plants) [1]

Previous edition

DIN 17465: 09.77.

Amendments

In comparison with the September 1977 edition, the following amendments have been made.

a) The standard now includes the steel grades covered in the August 1976 edition of *Stahl-Eisen-Werkstoffblatt* 471 (which has since been withdrawn), and no longer includes grades GX160CrSi18 and G-CoCr 28 Nb (material numbers 1.4743 and 2.4779, respectively). Grade GX40NiCrSiNb35-25 (material number 1.4852), which is used very often in practice, has been taken from *Stahl-Eisen-Werkstoffblatt* 595, August 1976 edition, and is included for the first time.

b) Closer tolerances have been specified for the carbon content of some steel grades. Some of the values for niobium content have been changed for certain niobium-stabilized steel grades. The specifications of table 2 are included for the first time.

c) Mechanical properties at ambient temperature have only been specified for ferritic steel grades in the annealed condition and for austenitic steel grades. For the latter, minimum values of 0,2 % proof stress are included for the first time. Based on recent investigations, some of the values for 1 % creep limit after 10 000 h have been changed.

d) The information regarding suitable filler metals (cf. subclause 5.8.2 and table 6) has been revised.

e) The standard has been editorially revised.

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[1] Obtainable from *Verlag Stahleisen mbH*, Postfach 82 92, D-40001 Düsseldorf.