UDC 669.14.018.26-42 : 669.018.8

October 1989

Cold heading and cold extruding steels

Technical delivery conditions for stainless steels

DIN 1654 Part 5

Kaltstauch- und Kaltfließpreßstähle; technische Lieferbedingungen für nichtrostende Stähle

Supersedes March 1980 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 clauses and subclauses marked • give specifications which are to be agreed upon at the time of ordering, those marked •• give specifications which are optional and may be agreed at the time of ordering.

1 Field of application

This standard applies to stainless steels with diameters from 5 mm, or subject to particular agreement from 1,5 mm up to 15 mm in the case of ferritic steels, and up to 63 mm in the case of the martensitic steel and the austenitic steels, which should preferably be used for cold heading and cold extruding. It is to be used in conjunction with DIN 1654 Part 1.

2 Concepts

See DIN 1654 Part 1.

3 • Dimensions and limit deviations

See DIN 1654 Part 1.

4 Mass

See DIN 1654 Part 1.

5 Designation and ordering

See DIN 1654 Part 1.

6 Steel grades

See DIN 1654 Part 1.

7 Requirements

7.1 Manufacturing process

See DIN 1654 Part 1.

7.2 Treatment condition of material on delivery

The steel shall normally be supplied in one of the treatment conditions listed in table 1.

7.3 Chemical composition, mechanical properties and hardenability

Table 1 summarizes combinations of usual treatment conditions of the material on delivery, product forms and requirements regarding chemical composition and mechanical properties.

7.3.1 Table 2 shall apply for the chemical composition determined by ladle analysis.

7.3.2 The specifications given in table 3 shall apply for the limit deviations in the product analysis from the limiting values specified for the ladle analysis (see table 2).

7.3.3 The specifications given in table 4 shall apply for the mechanical properties in the usual treatment conditions of the material on delivery.

•• The values given in tables 5 and 6 shall apply for the mechanical properties determined on reference test pieces in the heat treatment conditions specified in table 8.

7.3.4 Requirements regarding hardenability are not specified.

7.4 Structure

Requirements regarding the structure (cf. subclause 7.4 of DIN 1654 Part 1, October 1989 edition) are not specified.

7.5 Surface condition and soundness

See DIN 1654 Part 1.

7.6 Decarburization

The requirements specified in subclause 7.6 of DIN 1654 Part 1 shall apply for martensitic steel.

7.7 Separation of products by casts

See DIN 1654 Part 1.

7.8 Corrosion resistance

The details given in table 8 (see subclause 10.2 of this standard and subclause 1.2 of DIN 1654 Part 1) shall apply for the resistance of the steels to intergranular corrosion.

Note. Since the corrosion behaviour of stainless steel cannot definitely be established in the laboratory, the user must rely on experience with this steel under service conditions. The *DECHEMA-Werkstofftabellen* (DECHEMA Materials lists) may, amongst others, be consulted for information on the behaviour of this steel under certain corrosion conditions.

7.9 Physical properties

The guideline values given in table 7 (see subclause 1.2 of DIN 1654 Part 1) shall apply for the physical properties of the steels in the heat treatment conditions specified in table 8.

8 •• Testing

See DIN 1654 Part 1.

9 Marking

See DIN 1654 Part 1.

10 Heat treatment and further processing

10.1 Guideline values on heat treatment

See table 8.

10.2 Since the resistance of stainless steels to corrosion is only reliably ensured if the surface is metallically clean, it is essential to remove any layers of scale and temper colours which may have formed during heat treatment prior to use. Finished steel components containing approximately 13 % Cr require high-grade surface finishing (precision grinding or polishing) to achieve the maximum possible resistance to corrosion.

11 Complaints

See DIN 1654 Part 1.

Continued on pages 2 to 10

Table 1. **Treatment conditions and product forms in which steels are usually supplied and associated requirements as specified in tables 2 to 4**

No.	1		2		3	4	5	6		
1	Treatment condition of material on delivery		Symbol		Product form			The following requirements shall apply:		
	for ferritic and martensitic steels	for austenitic steels	for ferritic and martensitic steels	for austentic steels	Hot rolled steel bars	Wire rod	Drawn products	6.1	6.2	
2	Spheroidized	Quenched	GKZ	Quenched	×	×	–	Chemical composition as in tables 2 and 3.	Mechanical properties as in table 4,	column 2
3	Spheroidized and peeled	Quenched and peeled	GKZ + SH	Quenched + SH	×	–	–			column 2
4	Cold drawn and spheroidized	Cold drawn and quenched	K + GKZ	K + quenched	–	–	×			column 3
5	Cold drawn and spheroidized and slightly cold redrawn (with a reduction in cross section of 3%, for example)	Cold drawn and quenched and slightly cold redrawn (with a reduction in cross section of 3%, for example)	K + GKZ + K	K + quenched + K	–	–	×			column 4
6	•• If a treatment condition other than those given in lines 2 to 5 is required, this shall be specified in uncoded form in the order; in such cases, the product form and the requirements shall be given in the order (see subclause 7.2 of DIN 1654 Part 1).									

Table 2. **Chemical composition (ladle analysis)** [1]

Steel grade		Percentage by mass								
Material designation [2]	Material number	C	Si	Mn	P max.	S	Cr	Mo	Ni	Others
Ferritic steel										
X 6 Cr 17 [3]	1.4016 [3]	≤ 0,08	1,0	1,0	0,045	0,030	15,5 to 17,5	–	–	–
Martensitic steel										
X 10 Cr 13 [3]	1.4006 [3]	0,08 to 0,12	1,0	1,0	0,045	0,030	12,0 to 14,0	–	–	–
Austenitic steels [4]										
X 2 CrNi 19 11 [3]	1.4306 [3]	≤ 0,030	1,0	2,0	0,045	0,030	18,0 to 20,0	–	10,0 to 12,5	–
X 5 CrNi 18 12 [3]	1.4303 [3]	≤ 0,07	1,0	2,0	0,045	0,030	17,0 to 19,0	–	11,0 to 13,0	–
X 5 CrNiMo 17 12 2 [3]	1.4401 [3]	≤ 0,07	1,0	2,0	0,045	0,030	16,5 to 18,5	2,0 to 2,5	10,5 to 13,5	–
X 2 CrNiN 18 10 [3]	1.4311 [3]	≤ 0,030	1,0	2,0	0,045	0,030	17,0 to 19,0	–	8,5 to 11,5	N: 0,12 to 0,22
X 2 CrNiMoN 17 13 3 [3]	1.4429 [3]	≤ 0,030	1,0	2,0	0,045	0,025	16,5 to 18,5	2,5 to 3,0	12,0 bis 14,5	N: 0,14 to 0,22
X 6 CrNiTi 18 10 [3]	1.4541 [3]	≤ 0,08	1,0	2,0	0,045	0,030	17,0 to 19,0	–	9,0 to 12,0	Ti: 5 X %C to 0,80
X 6 CrNiMoTi 17 12 2 [3]	1.4571 [3]	≤ 0,08	1,0	2,0	0,045	0,030	16,5 to 18,5	2,0 to 2,5	10,5 to 13,5	Ti: 5 X %C to 0,80
X 3 CrNiCu 18 9	1.4567	≤ 0,04	1,0	2,0	0,045	0,030	17,0 to 19,0	–	8,0 to 10,0	Cu: 3,0 to 4,0

[1] Elements for which no percentages have been listed in this table shall not be deliberately added to the steel except for finishing the cast, without the purchaser's approval. Such elements shall not impair the usability and processability of the steel (e.g its weldability), nor shall they affect the properties specified in this standard.

[2] The material designations given in the March 1980 edition of this standard may continue to be used during the period of validity of this standard (see comparision table in the Explanatory notes to DIN 17 440, July 1985 edition).

[3] The values for the chemical composition of this steel are equivalent to those given in DIN 17 440.

[4] The suitability of austenitic steel for cold extruding largely depends on the processing conditions.

Table 3. **Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified in table 2 for the ladle analysis**

Element	Limiting values for the ladle analysis as in table 2, as a percentage by mass	Limit deviation [1], as a percentage by mass
C	≤ 0,030	+ 0,005
	> 0,030 ≤ 0,12	± 0,01
Si	≤ 1,0	+ 0,05
Mn	≤ 1,0	+ 0,03
	> 1,0 ≤ 2,0	+ 0,04
P	≤ 0,045	+ 0,005
S	≤ 0,030	+ 0,005
N	≤ 0,22	± 0,01
Cr	≥ 12,0 < 15,0	± 0,15
	≥ 15,0 ≤ 20,0	± 0,20
Mo	≥ 2,0 ≤ 3,0	± 0,10
Ni	≥ 8,0 < 10,0	± 0,10
	≥ 10,0 ≤ 14,5	± 0,15
Ti	≤ 0,80	± 0,05
Cu	≥ 3,0 ≤ 4,0	± 0,15

[1] If a number of product analyses are to be carried out, the deviations shown by one element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the ladle analysis.

Table 4. **Mechanical properties[1] of steels specified in table 2 in the treatment condition in which they are usually supplied[2],*)**

1		2		3		4	
Steel grade		Treatment condition[2] for X 6 Cr 17 and X 10 Cr 13 steels					
		GKZ or GKZ + SH		K + GKZ		K + GKZ + K	
		Treatment condition[2] for austenitic steels					
		Quenched or quenched + SH		K + quenched		K + quenched + K	
Material designation	Material number	R_m N/mm² max.	Z % min.	R_m N/mm² max.	Z % min.	R_m N/mm² max.	Z % min.
Ferritic steel							
X 6 Cr 17	**1.4016**	560	63	560	65	600	65
Martensitic steel							
X 10 Cr 13	**1.4006**	600	60	600	62	640	62
Austenitic steels							
X 2 CrNi 19 11	**1.4306**	630	55	630	55	680	55
X 5 CrNi 18 12	**1.4303**	650	55	650	55	700	55
X 5 CrNiMo 17 12 2	**1.4401**	660	55	660	55	710	55
X 2 CrNiN 18 10	**1.4311**	730	55	730	55	790	55
X 2 CrNiMoN 17 13 3	**1.4429**	780	55	780	55	840	55
X 6 CrNiTi 18 10	**1.4541**	680	55	680	55	730	55
X 6 CrNiMoTi 17 12 2	**1.4571**	680	55	680	55	730	55
X 3 CrNiCu 18 9	**1.4567**	590	60	590	60	620	55

*) The values are provisional and may have to be corrected in the light of new findings.
1) R_m denotes the tensile strength and Z, the reduction in area after fracture.
2) See subclause 7.2

Table 5. **Mechanical properties [1] of steel in the heat treatment condition specified in table 8**

Steel grade			R_e or $R_{p\,0,2}$	$R_{p\,1,0}$	R_m	A_5	A_v	
Material designation	Material number	Heat treatment condition [2]	N/mm² min.	N/mm² min.	N/mm²	% min.	ISO V-notch test piece [3] in J min.	ISO U-notch test piece [3] in J min.
Ferritic steel								
X 6 Cr 17 [4]	1.4016 [4]	Annealed	270	–	450 to 600	20	–	–
Martensitic steel								
X 10 Cr 13 [4]	1.4006 [4]	Quenched and tempered	420	–	600 to 800	18	50	–
Austenitic steels								
X 2 CrNi 19 11 [4]	1.4306 [4]	Quenched	180	215	460 to 680	50	60	85
X 5 CrNi 18 12 [4]	1.4303 [4]		185	220	490 to 690	50	60	85
X 5 CrNiMo 17 12 2 [4]	1.4401 [4]		205	240	510 to 710	45	60	85
X 2 CrNiN 18 10 [4]	1.4311 [4]		270	305	550 to 760	40	60	85
X 2 CrNiMoN 17 13 3 [4]	1.4429 [4]		295	330	580 to 800	40	60	85
X 6 CrNiTi 18 10 [4]	1.4541 [4]		200	235	500 to 730	40	60	85
X 6 CrNiMoTi 17 12 2 [4]	1.4571 [4]		210	245	500 to 730	40	60	85
X 3 CrNiCu 18 9	1.4567		195	235	470 to 670	45	60	85

[1] R_e = yield strength; $R_{p\,0,2}$ = 0,2 % proof strength; $R_{p\,1,0}$ = 1 % proof strength; R_m = tensile strength; A_5 = elongation after fracture ($L_0 = 5d_0$), A_v = impact value.

[2] See table 8.

[3] •• Unless otherwise agreed at the time of ordering, it is at the manufacturer's discretion whether testing is to be performed using an ISO U-notch or V-notch test piece. The revised edition of this standard will only specify values for the ISO V-notch test piece.

[4] Except for the specifications regarding the impact valued determined on ISO U-notch test pieces and some of the specifications regarding elongation after fracture, the specifications are identical with those given in DIN 17 440.

Table 6. **Minimum values of elevated temperature 0,2 % and 1 % proof strength for steel in the heat treatment conditions specified in table 8**

Steel grade		Heat treatment condition[1]	Minimum 0,2 % proof strength						Minimum 1 % proof strength					
			at a temperature of											
			50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C
Material designation	Material number		in N/mm²						in N/mm²					
Martensitic steel														
X 10 Cr 13[2]	1.4006[2]	Quenched and tempered	430	420	410	400	382	365	–	–	–	–	–	–
Austenitic steel														
X 2 CrNi 19 11[2]	1.4306[2]	Quenched	162	147	132	118	108	100	201	181	162	147	137	127
X 5 CrNi 18 12[2]	1.4303[2]		175	155	142	127	118	110	208	188	172	157	145	135
X 5 CrNiMo 17 12 2[2]	1.4401[2]		196	177	162	147	137	127	230	211	191	177	167	156
X 2 CrNiN 18 10[2]	1.4311[2]		245	205	175	157	145	136	280	240	210	187	175	167
X 2 CrNiMoN 17 13 3[2]	1.4429[2]		265	225	197	178	165	155	300	260	227	208	195	185
X 6 CrNiTi 18 10[2]	1.4541[2]		190	176	167	157	147	136	222	208	195	185	175	167
X 6 CrNiMoTi 17 12 2[2]	1.4571[2]		202	185	177	167	157	145	234	218	206	196	186	175
X 3 CrNiCu 18 9	1.4567		188	180	174	170	167	165	227	215	208	205	202	200

For [1], see table 8.

[2] The values specified here are identical with those given in DIN 17 440.

Table 7. **Physical properties of steels as specified in table 2 in the heat treatment conditions specified in table 8**

Steel grade		Density	Modulus of elasticity at						Thermal expansion between 20 °C and					Thermal conductivity at 20 °C	Specific heat capacity at 20 °C	Electrical resistance at 20 °C	Magnetizability
Material designation	Material number	kg/dm³	20 °C	100 °C	200 °C	300 °C	400 °C	500 °C	100 °C	200 °C	300 °C	400 °C	500 °C	W/(m · K)	J/(kg · K)	Ω · mm²/m	
			kN/mm²						$10^{-6} \cdot K^{-1}$								
Ferritic steel																	
X 6 Cr 17 [1]	1.4016 [1]	7,7	220	218	212	205	197		10,0	10,0	10,5	10,5	11,0	25	460	0,60	Existing
Martensitic steel																	
X 10 Cr 13 [1]	1.4006 [1]	7,7	216	213	207	200	192		10,5	11,0	11,5	12,0	12,0	30	460	0,60	Existing
Austenitic steels																	
X 2 CrNi 19 11 [1]	1.4306 [1]	7,9	200	194	186	179	172	165	16,0	17,0	17,0	18,0	18,0	15	500	0,73	Non-existent [2]
X 5 CrNi 18 12 [1]	1.4303 [1]	7,9	200	194	186	179	172	165	16,0	17,0	17,0	18,0	18,0	15	500	0,73	
X 6 CrNiMo 17 13 2 [1]	1.4401 [1]	7,98	200	194	186	179	172	165	16,5	17,5	17,5	18,5	18,5	15	500	0,75	
X 2 CrNiN 18 10 [1]	1.4311 [1]	7,9	200	194	186	179	172	165	16,0	17,0	17,0	18,0	18,0	15	500	0,73	
X 2 CrNiMoN 17 13 3 [1]	1.4429 [1]	7,98	200	194	186	179	172	165	16,5	17,5	17,5	18,5	18,5	15	500	0,75	
X 6 CrNiTi 18 10 [1]	1.4541 [1]	7,9	200	194	186	179	172	165	16,0	17,0	17,0	18,0	18,0	15	500	0,73	
X 6 CrNiMoTi 17 12 2 [1]	1.4571 [1]	7,98	200	194	186	179	172	165	16,5	17,5	18,5	18,5	18,5	15	500	0,75	
X 3 CrNiCu 18 9	1.4567	7,85	200	194	186	179	172	165	16,5	17,5	17,5	18,5	18,5	15	500	0,75	

[1] The values specified here are identical with those given in DIN 17 440.

[2] Austenitic steels may be slightly magnetizable in the quenched condition. Their magnetizability may increase in direct proportion to the degree of cold forming.

Table 8. **Guideline values regarding temperatures for heat treatment and resistance to intergranular corrosion of steel as specified in table 2**

Steel grade	Annealing		Quench hardening or quenching		Tempering	Resistance to intergranular corrosion when tested as described in DIN 50 914	
	Temperature, in °C	Cooling medium	Temperature, in °C	Cooling medium	Temperature, in °C	in the as delivered condition	in the welded condition
Ferritic steel							
X 6 Cr 17 [1]	750 to 850	Air, water				Yes	No
Martensitic steel							
X 10 Cr 13 [1]	750 to 800	Furnace, air	950 to 1000	Oil, air [2]	680 to 780	No	No
Austenitic steels [3]							
X 2 CrNi 19 11 [1]			1000 to 1080	Water, air [2]		Yes	Yes
X 5 CrNi 18 12 [1]			1000 to 1080			Yes [4]	Yes [5]
X 5 CrNiMo 17 12 2 [1]			1020 to 1100			Yes [4]	Yes [5]
X 2 CrNiN 18 10 [1]			1000 to 1080			Yes	Yes
X 2 CrNiMoN 17 13 3 [1]			1040 to 1120			Yes	Yes
X 6 CrNiTi 18 10 [1]			1020 to 1100			Yes	Yes
X 6 CrNiMoTi 17 12 2 [1]			1020 to 1100			Yes	Yes
X 3 CrNiCu 18 9			1050 to 1100			Yes [4]	Yes [4]

[1] The guideline values are identical with those given in DIN 17 440.

[2] Cooling shall be reasonably rapid.

[3] Where the heat treatment forms part of the further processing, the aim should be to maintain the lower limit of the temperature range specified for solution annealing. If the temperature during hot forming did not drop below 850 °C or if the product was cold formed, the solution annealing temperature of the product during renewed solution annealing may be by 20 K lower than the minimum solution annealing temperature specified.

[4] Applies only to thicknesses not exceeding 6 mm or diameters not exceeding 40 mm.

[5] •• The product size up to which a steel is to be resistant to intergranular corrosion may vary as a function of the actual chemical composition and the welding condition, and shall be agreed at the time of ordering.

Standards and other documents referred to

DIN 1654 Part 1	Cold heading and cold extruding steels; technical delivery conditions, general
DIN 17440	Stainless steels; technical delivery conditions for plate and sheet, hot rolled strip, wire rod, drawn wire, steel bars, forgings and semi-finished products
DIN 50914	Testing the resistance of stainless steel to intergranular corrosion; copper sulfate/sulfuric acid method; Strauß test
DECHEMA-Werkstofftabellen *)	

Previous editions

DIN 1654: 05.43, 08.54; DIN 1654 Part 5: 03.80.

Amendments

The following amendments have been made to the March 1980 edition.

a) The material designation of some steels has been amended on the lines of DIN 17440.

b) The specifications regarding chemical composition, mechanical properties in the heat treated condition, physical properties and heat treatment have been brought into line with DIN 17440.

c) X 3 CrNiCu 18 9 (1.4567) steel has been included for the first time.

d) The specifications regarding mechanical properties of steels in the treatment conditions in which they are usually supplied have been revised.

e) The standard has been editorially revised; requirement classes are no longer specified.

Explanatory notes

See DIN 1654 Part 1.

International Patent Classification

C 22 C 38/00

---

*) Obtainable from *Deutsche Gesellschaft für chemische Apparatewesen e.V.*, Theodor-Heuss-Allee 25, D-6000 Frankfurt 97.