
Ploščati jekleni izdelki za tlačne posode – 7. del: Nerjavna jekla

Flat products made of steels for pressure purposes - Part 7: Stainless steels

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Produits plats en aciers pour appareils à pression - Partie 7
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Nichtrostende Stähle

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (prEN 10028-7:2005) has been prepared by Technical Committee ECISS/TC 22 "Steels for pressure purposes - Qualities", the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 10028-7:2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 97/23/EC.

For relationship with EU Directive 97/23/EC, see informative Annex ZA, which is an integral part of this document.

The steel grades covered by this European Standard have been selected from EN 10088-1.

The other parts of this European Standard are:

— *Part 1: General requirements*

— *Part 2: Non-alloy and alloy steels with specified elevated temperature properties*

— *Part 3: Weldable fine grain steels, normalized*

— *Part 4: Nickel alloy steels with specified low temperature properties*

— *Part 5: Weldable fine grain steels, thermomechanically rolled*

— *Part 6: Weldable fine grain steels, quenched and tempered*

1 Scope

This European Standard specifies requirements for flat products for pressure purposes made of stainless steels, including austenitic creep resisting steels, in thicknesses as indicated in Tables 6 to 9.

The requirements of EN 10028-1 also apply.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 10028-1, *Flat products made of steels for pressure purposes – Part 1: General requirements*

EN 10029, *Hot rolled plates 3 mm thick or above – Tolerances on dimensions, shape and mass*

EN 10088-1:2005, *Stainless steels – Part 1: List of stainless steels*

EN 10204, *Metallic products – Types of inspection documents*

EN ISO 643, *Steels – Micrographic determination of the apparent grain size (ISO 643:2003)*

EN ISO 3651-2, *Determination of the resistance to intergranular corrosion of stainless steels – Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels – Corrosion test in media containing sulfuric acid (ISO 3651-2:1998)*

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3 Definitions

See EN 10028-1. [SIST EN 10028-7:2008
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4 Dimensions and tolerances on dimensions

See EN 10028-1.

5 Calculation of mass

For density values see Table A.1 in EN 10088-1:2005.

6 Classification and designation

See EN 10028-1.

7 Information to be supplied by the purchaser

7.1 Mandatory information

See EN 10028-1.

7.2 Options

A number of options are specified in this document and listed below. Additionally the relevant options of EN 10028-1 apply. If the purchaser does not indicate a wish to implement any of these options at the time of enquiry and order, the products shall be supplied in accordance with the basic specification (see EN 10028-1).

- a) mechanical properties for increased product thicknesses (see Table 7, footnote e);
- b) higher $R_{p0,2}$ and $R_{p1,0}$ values for continuously hot rolled products (see Table 9, footnote d and Table 10, footnote b);

7.3 Example for ordering

10 plates made of a steel grade with the name X5CrNi18-10 and the number 1.4301 as specified in EN 10028-7 with nominal dimensions, thickness = 8 mm, width = 2 000 mm, length = 5 000 mm; tolerances on dimensions, shape and mass as specified in EN 10029 with thickness tolerance class A and "normal" flatness tolerance according to process route 1D (see Table 6), inspection document 3.1 as specified in EN 10204:

10 plates–8Ax2000x5000–EN 10029–steel EN 10028-7–X5CrNi18-10+1D–inspection document 3.1

or

10 plates–8Ax2000x5000–EN 10029–steel EN 10028-7–1.4301+1D–inspection document 3.1

8 Requirements

8.1 Steelmaking process

See EN 10028-1.

8.2 Delivery condition

The products shall be supplied in the delivery condition specified in the order by reference to the process route given in Table 6 and, where alternatives exist, to the treatment conditions given in Tables 7 to 10. Guidelines for further treatment including heat treatment are given in Annex B.

8.3 Chemical composition and chemical corrosion properties

8.3.1 The chemical composition requirements given in Tables 1 to 4 apply in respect of the chemical composition according to the cast analysis.

8.3.2 The product analysis may deviate from the limiting values for the cast analysis given in Tables 1 to 4 by the values listed in Table 5.

8.3.3 Referring to resistance to intergranular corrosion as defined in EN ISO 3651-2, for ferritic, austenitic and austenitic-ferritic steels the specifications in Tables 7, 9 and 10 apply.

NOTE 1 EN ISO 3651-2 is not applicable for testing martensitic steels.

NOTE 2 The corrosion resistance of stainless steels is very dependent on the type of environment and can therefore not always be clearly ascertained through laboratory tests. It is therefore advisable to draw on the available experience of the use of the steels.

8.4 Mechanical properties

8.4.1 The tensile properties at room temperature and the impact energy at room and at low temperatures as specified in Tables 7 to 10 apply for the relevant specified heat treatment condition.

NOTE Austenitic steels are insensitive to brittle fracture in the solution annealed condition. Because they do not have a pronounced transition temperature, which is characteristic of other steels, they are also useful for application at cryogenic temperatures.

8.4.2 The values in Tables 11 to 14 apply for the 0,2 % and 1,0 % proof strength at elevated temperatures. Additionally, the values in Table 15 apply for the tensile strength at elevated temperatures.

Tensile strength values at elevated temperatures for austenitic-ferritic steels are given for guidance in Annex D.

8.4.3 Annex E gives mean values as preliminary data for the purchaser about creep strength and creep rupture. These data apply for the solution annealed condition only.

8.4.4 In Annex F preliminary data on mechanical properties at low temperatures of austenitic steels are listed.

8.5 Surface condition

See EN 10028-1 and Table 6.

8.6 Internal soundness

See EN 10028-1.

8.7 Physical properties

Reference data on some physical properties of austenitic creep resisting steels are given in Annex A. For other stainless steels, see Annex A of EN 10088-1:2005.

8.8 Post weld heat treatment

Guidelines for the purchaser on post weld heat treatment are given in Annex B.

9 Inspection

9.1 Types of inspection and inspection documents

See EN 10028-1.

9.2 Tests to be carried out

See Table 16 and EN 10028-1.

9.3 Re-tests

See EN 10028-1.

10 Sampling

10.1 Frequency of testing

See Table 16 and EN 10028-1.

10.2 Selection and preparation of samples and test pieces

See EN 10028-1.

11 Test methods

See EN 10028-1.

12 Marking

See EN 10028-1.

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Table 1 — Chemical composition (cast analysis)^a of ferritic steels

Steel grade		% by mass										
Steel name	Steel number	C max.	Si max.	Mn max.	P max.	S max.	N max.	Cr	Mo	Nb	Ni	Ti
X2CrNi12	1.4003	0,030	1,00	1,50	0,040	0,015	0,030	10,5 to 12,5	–	–	0,30 to 1,00	–
X6CrNiTi12	1.4516	0,08	0,70	1,50	0,040	0,015	–	10,5 to 12,5	–	–	0,50 to 1,50	0,05 to 0,35
X2CrTi17	1.4520	0,025	0,50	0,50	0,040	0,015	0,015	16,0 to 18,0	–	–	–	0,30 to 0,60
X3CrTi17	1.4510	0,05	1,00	1,00	0,040	0,015	–	16,0 to 18,0	–	–	–	[4 x(C+N) + 0,15] to 0,80 ^b
X2CrMoTi17-1	1.4513	0,025	1,00	1,00	0,040	0,015	0,020	16,0 to 18,0	0,80 to 1,40	–	–	0,30 to 0,60
X2CrMoTi18-2	1.4521	0,025	1,00	1,00	0,040	0,015	0,030	17,0 to 20,0	1,80 to 2,50	–	–	[4 x(C+N) + 0,15] to 0,80 ^b
X6CrMoNb17-1	1.4526	0,08	1,00	1,00	0,040	0,015	0,040	16,0 to 18,0	0,80 to 1,40	[7x(C+N) + 0,10] to 1,00	–	–
X2CrTiNb18	1.4509	0,030	1,00	1,00	0,040	0,015	–	17,5 to 18,5	–	[3xC + 0,30] to 1,00	–	0,10 to 0,60

^a Elements not listed in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing of the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

^b The stabilisation may be made by use of titanium or niobium or zirconium. According to the atomic mass of these elements and the content of carbon and nitrogen, the equivalence shall be the following, in % by mass:

$$\text{Nb} \approx \text{Zr} \approx \frac{7}{4} \text{Ti}$$

Table 2 — Chemical composition (cast analysis)^a of martensitic steels

Steel grade		% by mass								
Steel name	Steel number	C max.	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	N min.
X3CrNiMo13-4	1.4313	0,05	0,70	1,50	0,040	0,015	12,0 to 14,0	0,30 to 0,70	3,5 to 4,5	0,020
X4CrNiMo16-5-1	1.4418	0,06	0,70	1,50	0,040	0,015	15,0 to 17,0	0,80 to 1,50	4,0 to 6,0	0,020

^a Elements not quoted in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

Table 3 — Chemical composition (cast analysis)^a of austenitic steels

Steel grade		% by mass												
Steel name	Steel number	C	Si	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
Austenitic corrosion resisting grades														
X2CrNi18-7	1.4318	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,10 to 0,20	16,5 to 18,5	–	–	–	6,0 to 8,0	–	–
X2CrNi18-9	1.4307	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	17,5 to 19,5	–	–	–	8,0 to 10,5	–	–
X2CrNi19-11	1.4306	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	18,0 to 20,0	–	–	–	10,0 to 12,0	–	–
X5CrNi19-9	1.4315	≤ 0,06	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	18,0 to 20,0	–	–	–	8,0 to 11,0	–	–
X2CrNi18-10	1.4311	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	17,0 to 19,5	–	–	–	8,5 to 11,5	–	–
X5CrNi18-10	1.4301	≤ 0,07	≤ 1,00	2,00	0,045	0,015	≤ 0,11	17,0 to 19,5	–	–	–	8,0 to 10,5	–	–
X6CrNiTi18-10	1.4541	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	17,0 to 19,0	–	–	–	9,0 to 12,0	5 x C to 0,70	–
X6CrNiNb18-10	1.4550	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	17,0 to 19,0	–	–	10 x C to 1,00	9,0 to 12,0	–	–
X1CrNi25-21	1.4335	≤ 0,020	≤ 0,25	2,00	0,025	0,010	≤ 0,11	24,0 to 26,0	–	≤ 0,20	–	20,0 to 22,0	–	–
X2CrNiMo17-12-2	1.4404	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	16,5 to 18,5	–	2,00 to 2,50	–	10,0 to 13,0	–	–
X2CrNiMoN17-11-2	1.4406	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	–	2,00 to 2,50	–	10,0 to 12,5	–	–
X5CrNiMo17-12-2	1.4401	≤ 0,07	≤ 1,00	2,00	0,045	0,015	≤ 0,11	16,5 to 18,5	–	2,00 to 2,50	–	10,0 to 13,0	–	–
X1CrNiMoN25-22-2	1.4466	≤ 0,020	≤ 0,70	2,00	0,025	0,010	0,10 to 0,16	24,0 to 26,0	–	2,00 to 2,50	–	21,0 to 23,0	–	–
X6CrNiMoTi17-12-2	1.4571	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	16,5 to 18,5	–	2,00 to 2,50	–	10,5 to 13,5	5 x C to 0,70	–
X6CrNiMoNb17-12-2	1.4580	≤ 0,08	≤ 1,00	2,00	0,045	0,015	–	16,5 to 18,5	–	2,00 to 2,50	10 x C to 1,00	10,5 to 13,5	–	–
X2CrNiMo17-12-3	1.4432	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	16,5 to 18,5	–	2,50 to 3,00	–	10,5 to 13,0	–	–
X2CrNiMoN17-13-3	1.4429	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	–	2,50 to 3,00	–	11,0 to 14,0	–	–
X3CrNiMo17-13-3	1.4436	≤ 0,05	≤ 1,00	2,00	0,045	0,015	≤ 0,11	16,5 to 18,5	–	2,50 to 3,00	–	10,5 to 13,0	–	–
X2CrNiMo18-14-3	1.4435	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	17,0 to 19,0	–	2,50 to 3,00	–	12,5 to 15,0	–	–
X2CrNiMoN18-12-4	1.4434	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,10 to 0,20	16,5 to 19,5	–	3,0 to 4,0	–	10,5 to 14,0	–	–

Table 3 (continued)

Steel grade		% by mass												
Steel name	Steel number	C	Si	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Nb	Ni	Ti	Others
X2CrNiMo18-15-4	1.4438	≤ 0,030	≤ 1,00	2,00	0,045	0,015	≤ 0,11	17,5 to 19,5	–	3,0 to 4,0	–	13,0 to 16,0	–	–
X2CrNiMoN17-13-5	1.4439	≤ 0,030	≤ 1,00	2,00	0,045	0,015	0,12 to 0,22	16,5 to 18,5	–	4,0 to 5,0	–	12,5 to 14,5	–	–
X1NiCrMoCu31-27-4	1.4563	≤ 0,020	≤ 0,70	2,00	0,030	0,010	≤ 0,11	26,0 to 28,0	0,70 to 1,50	3,0 to 4,0	–	30,0 to 32,0	–	–
X1NiCrMoCu25-20-5	1.4539	≤ 0,020	≤ 0,70	2,00	0,030	0,010	≤ 0,15	19,0 to 21,0	1,20 to 2,00	4,0 to 5,0	–	24,0 to 26,0	–	–
X1CrNiMoCuN25-25-5	1.4537	≤ 0,020	≤ 0,70	2,00	0,030	0,010	0,17 to 0,25	24,0 to 26,0	1,00 to 2,00	4,7 to 5,7	–	24,0 to 27,0	–	–
X1CrNiMoCuN20-18-7	1.4547	≤ 0,020	≤ 0,70	1,00	0,030	0,010	0,18 to 0,25	19,5 to 20,5	0,50 to 1,00	6,0 to 7,0	–	17,5 to 18,5	–	–
X1NiCrMoCuN25-20-7	1.4529	≤ 0,020	≤ 0,50	1,00	0,030	0,010	0,15 to 0,25	19,0 to 21,0	0,50 to 1,50	6,0 to 7,0	–	24,0 to 26,0	–	–
Austenitic creep resisting grades														
X3CrNiMoBN17-13-3	1.4910	≤ 0,04	≤ 0,75	2,00	0,035	0,015	0,10 to 0,18	16,0 to 18,0	–	2,00 to 3,00	–	12,0 to 14,0	–	0,001 5 to 0,005 0 B
X6CrNiTiB18-10	1.4941	0,04 to 0,08	≤ 1,00	2,00	0,035	0,015	–	17,0 to 19,0	–	–	–	9,0 to 12,0	5 x C to 0,80	0,001 5 to 0,005 0 B
X6CrNi18-10	1.4948	0,04 to 0,08	≤ 1,00	2,00	0,035	0,015	≤ 0,11	17,0 to 19,0	–	–	–	8,0 to 11,0	–	–
X6CrNi23-13	1.4950	0,04 to 0,08	≤ 0,70	2,00	0,035	0,015	≤ 0,11	22,0 to 24,0	–	–	–	12,0 to 15,0	–	–
X6CrNi25-20	1.4951	0,04 to 0,08	≤ 0,70	2,00	0,035	0,015	≤ 0,11	24,0 to 26,0	–	–	–	19,0 to 22,0	–	–
X5NiCrAlTi31-20 (+RA)	1.4958 (+RA)	0,03 to 0,08	≤ 0,70	1,50	0,015	0,010	≤ 0,030	19,0 to 22,0	≤ 0,50	–	≤ 0,10	30,0 to 32,5	0,20 to 0,50	0,20 to 0,50 Al Al+Ti: 0,70 ≤ 0,50 Co Ni+Co: 30,00 to 32,50
X8NiCrAlTi32-21	1.4959	0,05 to 0,10	≤ 0,70	1,50	0,015	0,010	≤ 0,030	19,0 to 22,0	≤ 0,50	–	–	30,0 to 34,0	0,25 to 0,65	0,25 to 0,65 Al ≤ 0,50 Co Ni+Co: 30,00 to 34,00
X8CrNiNb16-13	1.4961	0,04 to 0,10	0,30 to 0,60	1,50	0,035	0,015	–	15,0 to 17,0	–	–	≥ 10 x C to 1,20	12,0 to 14,0	–	–

^a Elements not listed in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing of the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

Table 4 — Chemical composition (cast analysis)^a of austenitic-ferritic steels

Steel grade		% by mass										
Steel name	Steel number	C max.	Si max.	Mn max.	P max.	S max.	N	Cr	Cu	Mo	Ni	W
X2CrNiN23-4 ¹⁾	1.4362 ¹⁾	0,030	1,00	2,00	0,035	0,015	0,05 to 0,20	22,0 to 24,0	0,10 to 0,60	0,10 to 0,60	3,5 to 5,5	–
X2CrNiMoN22-5-3	1.4462	0,030	1,00	2,00	0,035	0,015	0,10 to 0,22	21,0 to 23,0	–	2,50 to 3,5	4,5 to 6,5	–
X2CrNiMoCuN25-6-3	1.4507	0,030	0,70	2,00	0,035	0,015	0,20 to 0,30	24,0 to 26,0	1,00 to 2,50	3,0 to 4,0	6,0 to 8,0	–
X2CrNiMoN25-7-4 ¹⁾	1.4410 ¹⁾	0,030	1,00	2,00	0,035	0,015	0,24 to 0,35	24,0 to 26,0	–	3,0 to 4,5	6,0 to 8,0	–
X2CrNiMoCuWN25-7-4	1.4501	0,030	1,00	1,00	0,035	0,015	0,20 to 0,30	24,0 to 26,0	0,50 to 1,00	3,0 to 4,0	6,0 to 8,0	0,50 to 1,00

^a Elements not quoted in this table may not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate precautions are to be taken to avoid the addition of such elements from scrap and other materials used in production which would impair mechanical properties and the suitability of the steel.

¹⁾ Patented steel grade.

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Table 5 — Permissible product analysis tolerances on the limiting values given in Tables 1 to 4 for the cast analysis

Element	Specified limits, cast analysis		Permissible tolerance ^a % by mass
	% by mass		
Carbon	≤	0,030	+ 0,005
	> 0,030	≤ 0,10	± 0,01
Silicon	≤	1,00	+ 0,05
Manganese	≤	1,00	+ 0,03
	> 1,00	≤ 2,00	+ 0,04
Phosphorus	≤	0,045	+ 0,005
Sulfur	≤	0,010	+ 0,003
	> 0,010	≤ 0,030	+ 0,005
Nitrogen	≤	0,35	± 0,01
Aluminium	≤	0,65	± 0,10
Boron	≥ 0,001 5	≤ 0,005 0	± 0,000 3
Chromium	≥ 10,5	< 15,0	± 0,15
	≥ 15,0	≤ 20,0	± 0,20
	> 20,0	≤ 28,0	± 0,25
Copper	≤	1,00	± 0,07
	> 1,00	≤ 2,50	± 0,10
Molybdenum	≤	0,60	± 0,03
	> 0,60	< 1,75	± 0,05
	≥ 1,75	≤ 7,0	± 0,10
Niobium	≤	1,20	± 0,05
Nickel	≤	1,00	± 0,03
	> 1,00	≤ 5,0	± 0,07
	> 5,0	≤ 10,0	± 0,10
	> 10,0	≤ 20,0	± 0,15
	> 20,0	≤ 34,0	± 0,20
Cobalt	≤	0,50	+ 0,05
Titanium	≤	0,80	± 0,05
Tungsten	≤	1,00	± 0,05
^a If several product analyses are carried out on one cast, and the contents of an individual element determined lie outside the permissible range of the chemical composition specified for the cast analysis, then it is only allowed to exceed the permissible maximum value or to fall short of the permissible minimum value, but not both for one cast.			