



SLOVENSKI STANDARD

SIST EN 10028-2:2017

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Nadomešča:

SIST EN 10028-2:2009

Ploščati jekleni izdelki za tlačne posode - 2. del: Nelegirana in legirana jekla s specificiranimi lastnostmi pri povišanih temperaturah

Flat products made of steels for pressure purposes - Part 2: Non-alloy and alloy steels with specified elevated temperature properties

Flacherzeugnisse aus Druckbehälterstählen - Teil 2: Unlegierte und legierte Stähle mit festgelegten Eigenschaften bei erhöhten Temperaturen

Produits plats en aciers pour appareils à pression - Partie 2: Aciers non alliés et alliés avec caractéristiques spécifiées à température élevée

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ICS:

77.140.30	Jekla za uporabo pod tlakom	Steels for pressure purposes
77.140.50	Ploščati jekleni izdelki in polizdelki	Flat steel products and semi-products

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EUROPEAN STANDARD
NORME EUROPÉENNE
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Supersedes EN 10028-2:2009

English Version

**Flat products made of steels for pressure purposes - Part
2: Non-alloy and alloy steels with specified elevated
temperature properties**

Produits plats en aciers pour appareils à pression -
Partie 2 : Aciers non alliés et alliés avec
caractéristiques spécifiées à température élevée

Flacherzeugnisse aus Druckbehälterstählen - Teil 2:
Unlegierte und legierte Stähle mit festgelegten
Eigenschaften bei erhöhten Temperaturen

This European Standard was approved by CEN on 7 May 2017.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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European foreword

This document (EN 10028-2:2017) has been prepared by Technical Committee ECISS/TC 107 “Steels for pressure purposes”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2018 and conflicting national standards shall be withdrawn at the latest by January 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10028-2:2009.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of Directive 2014/68/EU.

For relationship with Directive 2014/68/EU, see informative Annex ZA, which is an integral part of this document.

A list of changes between this document and the previous version can be found in Annex F.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

<https://economy.sist.si/catalog/standards/sist/262161bf-01ce-486e-8690-0280bb873a36/sist-en-10028-2-2017>

EN 10028-2:2017 (E)**1 Scope**

This European Standard specifies requirements for flat products for pressure equipment made of weldable non-alloy and alloy steels with elevated temperature properties as specified in Table 1.

The requirements and definitions of EN 10028-1:2017 also apply.

NOTE Once this European Standard is published in the EU Official Journal (OJEU) under Directive 2014/68/EU, presumption of conformity to the Essential Safety Requirements (ESRs) of Directive 2014/68/EU is limited to technical data of materials in this European Standard (Part 1 and this Part 2 of the series) and does not presume adequacy of the material to a specific item of equipment. Consequently, the assessment of the technical data stated in this material standard against the design requirements of this specific item of equipment to verify that the ESRs of Directive 2014/68/EU are satisfied, needs to be done.

2 Normative references

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

EN 1011-1:2009, *Welding - Recommendations for welding of metallic materials - Part 1: General guidance for arc welding*

EN 1011-2:2001, *Welding - Recommendations for welding of metallic materials - Part 2: Arc welding of ferritic steels*

EN 10028-1:2017, *Flat products made of steels for pressure purposes - Part 1: General requirements*

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 10229:1998, *Evaluation of resistance of steel products to hydrogen induced cracking (HIC)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10028-1:2017 apply.

4 Tolerances on dimensions

See EN 10028-1:2017.

5 Calculation of mass

See EN 10028-1:2017.

6 Classification and designation**6.1 Classification**

In accordance with EN 10020, the grades P235GH, P265GH, P295GH and P355GH are non-alloy quality steels. All other grades are alloy special steels.

6.2 Designation

See EN 10028-1:2017.

7 Information to be supplied by the purchaser

7.1 Mandatory information

See EN 10028-1:2017.

7.2 Options

A number of options are specified in this document and listed below. Additionally the relevant options of EN 10028-1:2017 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 also EN 10028-1:2017).

- 1) limitation of copper and/or tin content (see Table 1, footnote b);
- 2) minimum chromium content of 0,80 % (see Table 1, footnote f);
- 3) maximum carbon content of 0,17 % for nominal thicknesses greater than 150 mm (see Table 1, footnote g);
- 4) tests in the simulated normalized condition (see 8.2.2);
- 5) delivery conditions deviating from those specified in Table 3 (see 8.2.2 and 8.2.3);
- 6) maximum carbon equivalent value for P235GH, P265GH, P295GH and P355GH (see 8.3.3);
- 7) specification of a minimum impact energy of 40 J (see Table 3);
- 8) no option, intentionally left blank;
- 9) specification of the delivery condition +QT where the usual delivery condition is +NT (see Table 3, footnote b and Table 4, footnote b);
- 10) additional impact energy values (see Table 3, footnote e);
- 11) no option, intentionally left blank;
- 12) HIC test in accordance with EN 10229 (see 8.7);
- 13) step cooling test in accordance with Annex E (see 8.8);
- 14) mid thickness test pieces for the impact test (see Clause 10).

7.3 Example for ordering

10 plates with nominal dimensions, thickness = 50 mm, width = 2 000 mm, length = 10 000 mm, made of a steel grade with the name 16Mo3 and the number 1.5415 as specified in EN 10028-2, inspection certificate 3.1 as specified in EN 10204:

10 plates – 50 × 2 000 × 10 000 – EN 10028-2 – 16Mo3 – Inspection certificate 3.1

or

10 plates – 50 × 2 000 × 10 000 – EN 10028-2 – 1.5415 – Inspection certificate 3.1

8 Requirements

8.1 Steelmaking process

See EN 10028-1:2017.

8.2 Delivery condition

8.2.1 Unless otherwise agreed at the time of enquiry and order, the products covered by this document shall be supplied in the usual conditions given in Table 3 (see 8.2.3).

8.2.2 Normalizing may, at the discretion of manufacturer, be replaced with normalizing rolling for the steel grades P235GH, P265GH, P295GH, P355GH and 16Mo3. In this case, additional tests in the simulated normalized condition with an agreed frequency of testing may be agreed at the time of enquiry and order to verify that the specified properties are complied with.

8.2.3 If so agreed at the time of enquiry and order, products made of steel grades P235GH, P265GH, P295GH, P355GH and 16Mo3 may also be delivered in the untreated condition. Products made of one of the other alloy grades may be supplied in the tempered or normalized condition or, in exceptional cases, in the untreated condition if so agreed (Annex A contains heat treatment information for the purchaser).

In these cases, testing shall be carried out on test pieces in the usual delivery condition as indicated in Table 3.

8.2.4 Information on welding are given in Annex B of this standard.

8.3 Chemical composition

8.3.1 The requirements of Table 1 shall apply for the chemical composition according to the cast analysis.

8.3.2 The product analysis shall not deviate from the specified values for the cast analysis as specified in Table 1 by more than the values given in Table 2.

8.3.3 A maximum value for the carbon equivalent may be agreed at time of enquiry and order for steel grades P235GH, P265GH, P295GH and P355GH. In this case, the following formula shall apply for calculation of the carbon equivalent value (CEV):

$$CEV = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Ni + Cu}{15}$$

Table 1 — Chemical composition (cast analysis) ^a

Steel designation		% by mass														
Steel name	Steel number	C	Si	Mn	P max.	S max.	Al _{total}	N	Cr	Cu ^b	Mo	Nb	Ni	Ti max.	V	Others
P235GH	1.0345	≤ 0,16	≤ 0,35	0,60 ^c to 1,20	0,025	0,010	≥ 0,020	≤ 0,012 ^d	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,030	≤ 0,30	0,03	≤ 0,02	Cr+Cu+Mo+Ni ≤ 0,70
P265GH	1.0425	≤ 0,20	≤ 0,40	0,80 ^c to 1,40	0,025	0,010	≥ 0,020	≤ 0,012 ^d	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,030	≤ 0,30	0,03	≤ 0,02	
P295GH	1.0481	0,08 to 0,20	≤ 0,40	0,90 ^c to 1,50	0,025	0,010	≥ 0,020	≤ 0,012 ^d	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,030	≤ 0,30	0,03	≤ 0,02	
P355GH	1.0473	0,10 to 0,22	≤ 0,60	1,10 to 1,70	0,025	0,010	≥ 0,020	≤ 0,012 ^d	≤ 0,30	≤ 0,30	≤ 0,08	≤ 0,040	≤ 0,30	0,03	≤ 0,02	
16Mo3	1.5415	0,12 to 0,20	≤ 0,35	0,40 to 0,90	0,025	0,010	^e	≤ 0,012	≤ 0,30	≤ 0,30	0,25 to 0,35	-	≤ 0,30	-	-	-
18MnMo4-5	1.5414	≤ 0,20	≤ 0,40	0,90 to 1,50	0,015	0,005	^e	≤ 0,012	≤ 0,30	≤ 0,30	0,45 to 0,60	-	≤ 0,30	-	-	-
20MnMoNi4-5	1.6311	0,15 to 0,23	≤ 0,40	1,00 to 1,50	0,020	0,010	^e	≤ 0,012	≤ 0,20	≤ 0,20	0,45 to 0,60	-	0,40 to 0,80	-	≤ 0,02	-
15NiCuMoNb5-6-4	1.6368	≤ 0,17	0,25 to 0,50	0,80 to 1,20	0,025	0,010	≥ 0,015	≤ 0,020	≤ 0,30	0,50 to 0,80	0,25 to 0,50	0,015 to 0,045	1,00 to 1,30	-	-	-
13CrMo4-5	1.7335	0,08 to 0,18	≤ 0,35	0,40 to 1,00	0,025	0,010	^e	≤ 0,012	0,70 ^f to 1,15	≤ 0,30	0,40 to 0,60	-	-	-	-	-
13CrMoSi5-5	1.7336	≤ 0,17	0,50 to 0,80	0,40 to 0,65	0,015	0,005	^e	≤ 0,012	1,00 to 1,50	≤ 0,30	0,45 to 0,65	-	≤ 0,30	-	-	-
10CrMo9-10	1.7380	0,08 to 0,14 ^g	≤ 0,50	0,40 to 0,80	0,020	0,010	^e	≤ 0,012	2,00 to 2,50	≤ 0,30	0,90 to 1,10	-	-	-	-	-
12CrMo9-10	1.7375	0,10 to 0,15	≤ 0,30	0,30 to 0,80	0,015	0,010	^e	≤ 0,012	2,00 to 2,50	≤ 0,25	0,90 to 1,10	-	≤ 0,30	-	-	-
X12CrMo5	1.7362	0,10 to 0,15	≤ 0,50	0,30 to 0,60	0,020	0,005	^e	≤ 0,012	4,00 to 6,00	≤ 0,30	0,45 to 0,65	-	≤ 0,30	-	-	-

EN 10028-2:2017 (E)

Steel designation		% by mass														
Steel name	Steel number	C	Si	Mn	P max.	S max.	Al _{total}	N	Cr	Cu ^b	Mo	Nb	Ni	Ti max.	V	Others
13CrMoV9-10	1.7703	0,11 to 0,15	≤ 0,10	0,30 to 0,60	0,015	0,005	e	≤ 0,012	2,00 to 2,50	≤ 0,20	0,90 to 1,10	≤ 0,07	≤ 0,25	0,03	0,25 to 0,35	B ≤ 0,002, Ca ≤ 0,015
12CrMoV12-10	1.7767	0,10 to 0,15	≤ 0,15	0,30 to 0,60	0,015	0,005	e	≤ 0,012	2,75 to 3,25	≤ 0,25	0,90 to 1,10	≤ 0,07 ^h	≤ 0,25	0,03 ^h	0,20 to 0,30	B ≤ 0,003 ^h , Ca ≤ 0,015 ^h
X10CrMoVNb9-1	1.4903	0,08 to 0,12	≤ 0,50	0,30 to 0,60	0,020	0,005	≤ 0,040	0,030 to 0,070	8,00 to 9,50	≤ 0,30	0,85 to 1,05	0,06 to 0,10	≤ 0,30	-	0,18 to 0,25	-

^a Elements not listed in this table shall not be intentionally added to the steel without the agreement of the purchaser except for finishing the cast. All appropriate measures shall be taken to prevent the addition from scrap or other materials used in steelmaking of these elements which may affect the mechanical properties and usability.

^b A lower maximum copper content and/or a maximum sum of copper and tin content, e.g. Cu + 6 Sn ≤ 0,33 %, may be agreed upon at the time of enquiry and order, e.g. with regard to hot formability for the grades where only a maximum copper content is specified.

^c For nominal thicknesses < 6 mm, a minimum manganese content of 0,20 % lower than specified is permitted.

^d A ratio $\frac{Al}{N} \geq 2$ shall apply.

^e The Al content of the cast shall be determined and given in the inspection document.

^f If resistance to pressurized hydrogen is of importance, a minimum content of 0,80 % Cr may be agreed upon at the time of enquiry and order.

^g For nominal thicknesses greater than 150 mm, a maximum content of 0,17 % C may be agreed upon at the time of enquiry and order.

^h This grade may be produced with additions of either Ti + B or Nb + Ca. The following minimum contents shall apply: Ti ≥ 0,015 % and B ≥ 0,001 % in the case of additions of Ti + B, Nb ≥ 0,015 % and Ca ≥ 0,000 5 % in the case of additions of Nb + Ca.

Table 2 — Permissible product analysis tolerances on the limiting values given in Table 1 for the cast analysis

Element	Specified value in the cast analysis according to Table 1 % by mass	Permissible deviation ^a of the product analysis % by mass
C	≤ 0,23	±0,02
Si	≤ 0,35	±0,05
	> 0,35 to ≤ 1,00	±0,06
Mn	≤ 1,00	±0,05
	> 1,00 to ≤ 1,70	±0,10
P	≤ 0,015	+ 0,003
	> 0,015 to ≤ 0,025	+ 0,005
S	≤ 0,010	+ 0,003
Al	≥ 0,010	±0,005
B	≤ 0,003	±0,000 5
N	≤ 0,020	±0,002
	> 0,020 to ≤ 0,070	±0,005
Cr	≤ 2,00	±0,05
	> 2,00 to ≤ 10,00	±0,10
Cu	≤ 0,30	±0,05
	> 0,30 to ≤ 0,80	±0,10
Mo	≤ 0,35	±0,03
	> 0,35 to ≤ 1,10	±0,04
Nb	≤ 0,10	±0,01
Ni	≤ 0,30	±0,05
	> 0,30 to ≤ 1,30	±0,10
Cr+Cu+Mo+Ni	≤ 0,70	+ 0,05
Ti	≤ 0,03	±0,01
V	≤ 0,05	±0,01
	> 0,05 to ≤ 0,35	±0,03
^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 fall short of the permissible minimum value, but not both for one cast.		

EN 10028-2:2017 (E)**8.4 Mechanical properties**

8.4.1 The values given in Tables 3 and 4 (see also EN 10028-1:2017 and Clause 10) shall apply.

8.4.2 Annex C gives mean values as preliminary data for the purchaser about 1 % (plastic) creep strain and creep rupture.

8.5 Surface condition

See EN 10028-1:2017.

8.6 Internal soundness

See EN 10028-1:2017.

8.7 Resistance to hydrogen induced cracking

Carbon and low alloy steels may be susceptible to cracking when exposed to corrosive H₂S containing environments, usually referred to as 'sour service'.

A test to evaluate the resistance to hydrogen induced cracking in accordance with Annex D may be specified at time of enquiry and order.

8.8 Embrittlement of CrMo steels

CrMo steels may tend to become brittle in service at temperatures between approximately 400 °C and 500 °C. This possible tendency for embrittlement can be simulated in the laboratory with the so called step cooling test. In this test a specimen is exposed to a temperature - time cycle as given in Figure E.1.

The shift of a transition curve before and after the step cooling test is a measure for the embrittlement.

A step cooling test in accordance with Annex E may be specified at time of enquiry and order.

9 Inspection**9.1 Types of inspection and inspection documents**

See EN 10028-1:2017.

9.2 Tests to be carried out

See EN 10028-1:2017 and 8.7 and 8.8.

9.3 Retests, sorting and reprocessing

See EN 10028-1:2017.

10 Sampling

See EN 10028-1:2017.

For the impact test, deviating from EN 10028-1:2017, Table 4, footnote g, the preparation of test pieces taken from the mid thickness may be agreed at the time of enquiry and order. In this case, test temperatures and minimum impact energy values shall also be agreed.

11 Test methods

See EN 10028-1:2017 and Annex D and E.