EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 10222-5

April 2017

ICS 77.140.30; 77.140.85

Supersedes EN 10222-5:1999

English Version

# Steel forgings for pressure purposes - Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels

Pièces forgées en acier pour appareils à pression - Partie 5: Aciers inoxydables austénitiques martensitiques et austénoferritiques

Schmiedestücke aus Stahl für Druckbehälter - Teil 5: Martensitische, austenitische und austenitisch-ferritisch nichtrostende Stähle

This European Standard was approved by CEN on 25 December 2016.

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Ref. No. EN 10222-5:2017 E

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## European foreword

This document (EN 10222-5:2017) has been prepared by Technical Committee ECISS/TC 111 "Steel castings and forgings", the secretariat of which is held by AFNOR.

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of an identical text or by endorsement, at the latest by October 2017, and conflicting national standards shall be withdrawn at the latest by October 2017.

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

This document supersedes EN 10222-5:1999.

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 EU Directive 2014/68/EU.

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

EN 10222 consists of the following parts under the general title "*Steel forgings for pressure purposes*":

— *Part 1: General requirements for open die forgings*

— *Part 2: Ferritic and martensitic steels with specified elevated temperature properties*

— *Part 3: Nickel steels with specified low temperature properties*

— *Part 4: Weldable fine grain steels with high proof strength*

— *Part 5: Martensitic, austenitic and austenitic-ferritic stainless steels.*

Annex C provides details about significant technical changes to EN 10222-5:1999.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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.

# 1 Scope

This European Standard specifies the technical delivery conditions for forgings for pressure purposes, made of stainless steels, including creep resisting steels. Chemical composition and mechanical properties are specified.

NOTE Once this 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 standard 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. The series EN 10222–1 to EN 10222–5 is structured so that the data related to different materials is in the part allocated for that material. The presumption of conformity to the Essential Safety Requirements of Directive 2014/68/EU depends on both the text in part 1 and the data in part 2, 3, 4 or 5.

General information on technical delivery conditions is given in EN 10021.

# 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 10088-1:2014, *Stainless steels - Part 1: List of stainless steels*

EN 10222-1:2017, *Steel forgings for pressure purposes — Part 1: General requirements for open die forgings*

EN ISO 3651-2:1998, *Determination of 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)*

# 3 Terms and definitions

For the purpose of this document, the terms and definitions given in EN 10222-1:2017 apply.

# 4 Classification and designation

## 4.1 Classification

The steel grades covered in this document are classified according to their structure into:

— martensitic steels;

— austenitic steels;

— austenitic-ferritic steels.

NOTE For more details see EN 10088–1.

## 4.2 Designation

See EN 10222-1:2017.

# 5 Information to be supplied by the purchaser

## 5.1 Mandatory information

Shall be in accordance with EN 10222-1.

## 5.2 Options

A number of options are specified in this European Standard and listed below. Additionally the relevant options of EN 10222-1 apply. If the purchaser does not give any information 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 10222-1).

1) test temperature for the tensile test at elevated temperature, if applicable (see 6.4.3);

2) test temperature of the impact test at low temperature (see 6.4.4);

3) controlled sulphur content (see Table 2, footnote b).

# 6 Requirements

## 6.1 Steelmaking process and manufacture of the product

Shall be in accordance with EN 10222-1.

## 6.2 Delivery condition

The products shall be delivered in the heat treatment condition specified in Table 1.

## 6.3 Chemical composition and chemical corrosion properties

### 6.3.1 Cast analysis

The chemical composition (cast analysis), determined in accordance with EN 10222-1 shall conform to the requirements of Table 2.

### 6.3.2 Product analysis

The product analysis shall not deviate from the specified cast analysis (see 6.3.1) by more than the values specified in Table 3.

### 6.3.3 Resistance to intergranular corrosion

The specifications in Table 4 apply in respect to resistance to intergranular corrosion as defined in EN ISO 3651-2, for austenitic and austenitic-ferritic steels.

See EN 10222-1:2017, 9.9, Table 1.

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 as certained through laboratory tests. It is therefore advisable to draw on the available experience of the use of the steels.

## 6.4 Mechanical properties

**6.4.1** When heat treated in accordance with Table 1, the mechanical properties shall conform to the requirements of Table 4.

**6.4.2** Elevated temperature proof strength ($R_{p0,2}$ and $R_{p1,0}$) values shall conform to the requirements of Table 5 and Table 6. Elevated temperature tensile strength ($R_m$) values shall conform to Table 7.

**6.4.3** If verification of specified proof strength at elevated temperature is requested (see EN 10222-1:2017, Table 1), the testing temperature should be agreed at the time of enquiry and order. Otherwise, the test shall be carried out at 300 °C, except for the austenitic-ferritic steels, where the test shall be carried out at 250 °C.

**6.4.4** The impact test, if applicable (see EN 10222-1:2017, Table 1), shall be carried out at 20 °C.

Where impact tests at low temperature have been agreed (see EN 10222-1:2017, Table 1), the test temperature shall also be agreed at the time of enquiry and order.

**6.4.5** Reference data for 1 % (plastic) creep strain and creep rupture are given in Annex A.

## 6.5 Surface condition

See EN 10222-1.

## 6.6 Internal soundness

See EN 10222-1.

## 6.7 Physical properties

For reference data on physical properties, see EN 10088-1:2014, Annex E.

## 6.8 Post weld heat treatment

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

# 7 Inspection

See EN 10222-1.

# 8 Sampling

See EN 10222-1.

# 9 Test methods

See EN 10222-1.

# 10 Retests

See EN 10222-1.

# 11 Marking

See EN 10222-1.

**Table 1 — Heat treatment**

| **Steel grade** | | **Heat treatment[a]** | **Solution annealing** ° C | **Cooling in[b]** |
|---|---|---|---|---|
| Steel name | Steel number | | | |
| Martensitic steel | | | | |
| X3CrNiMo13–4 | 1.4313 | +QT or +T | 950 to 1 050 (for quenching) | a, o[c] |
| | | +QT | | a, o[d] |
| Austenitic steels[e] | | | | |
| X2CrNi18–9 | 1.4307 | +AT | 1 025 to 1 100 | w, a |
| X2CrNi19–11 | 1.4306 | +AT | 1 000 to 1 100 | w, a |
| X2CrNiN18–10 | 1.4311 | +AT | 1 000 to 1 100 | w, a |
| X5CrNi18–10 | 1.4301 | +AT | 1 000 to 1 100 | w, a |
| X6CrNiTi18–10 | 1.4541 | +AT | 1 020 to 1 120 | w, a |
| X6CrNiNb18–10 | 1.4550 | +AT | 1 020 to 1 120 | w, a |
| X6CrNi18–10 | 1.4948 | +AT | 1 050 to 1 120 | w, a |
| X6CrNiTiB18–10 | 1.4941 | +AT | 1 070 to 1 140 | w, a |
| X7 CrNiNb18–10 | 1.4912 | +AT | 1 070 to 1 125 | w, a |
| X2CrNiMo17–12–2 | 1.4404 | +AT | 1 020 to 1 120 | w, a |
| X2CrNiMoN 17–11–2 | 1.4406 | +AT | 1 020 to 1 120 | w, a |
| X5CrNiMo17–12–2 | 1.4401 | +AT | 1 020 to 1 120 | w, a |
| X6CrNiMoTi 17–12–2 | 1.4571 | +AT | 1 020 to 1 120 | w, a |
| X2 CrNiMo17–12–3 | 1.4432 | +AT | 1 020 to 1 120 | w, a |
| X2CrNiMoN 17–13–3 | 1.4429 | +AT | 1 020 to 1 120 | w, a |
| X3CrNiMo17–13–3 | 1.4436 | +AT | 1 020 to 1 120 | w, a |
| X2CrNiMo18–14–3 | 1.4435 | +AT | 1 020 to 1 120 | w, a |
| X3CrNiMoN17–13–3 | 1.4910 | +AT | 1 020 to 1 100 | w, a |
| X2CrNiMoN17–13–5 | 1.4439 | +AT | 1 060 to 1 120 | w, a |
| X1NiCrMoCu25–20–5 | 1.4539 | +AT | 1 060 to 1 120 | w, a |
| X1CrNiMoCuN20–18–7 | 1.4547 | +AT | 1 020 to 1 120 | w, a |
| X1CrNiMoCuN25–20–7 | 1.4529 | +AT | 1 020 to 1 100 | w, a |
| X2CrNiCu19–10 | 1.4650 | +AT | 1 050 to 1 125 | w, a |
| X3CrNiMo18–12–3 | 1.4449 | +AT | 1 050 to 1 125 | w, a |

| **Steel grade** | | **Heat treatment[a]** | **Solution annealing** ° C | **Cooling in[b]** |
|---|---|---|---|---|
| Steel name | Steel number | | | |
| Austenitic-ferritic steels[e] | | | | |
| X2CrNiN23–4 | 1.4362 | +AT | 950 to 1 100 | w, a |
| X2CrNiMoN22–5–3 | 1.4462 | +AT | 1 020 to 1 100 | – |
| X2CrNiMoCuN25–6–3 | 1.4507 | +AT | 1 040 to 1 120 | w, a |
| X2CrNiMoN25–7–4 | 1.4410 | +AT | 1 040 to 1 120 | w, a |
| X2CrNiMoCuWN25–7–4 | 1.4501 | +AT | 1 040 to 1 120 | w, a |

a +AT solution annealed, +T tempered, +QT quenched and tempered.

b a = air ; o = oil ; w = water or water based medium.

c Double tempered at 600 °C to 620 °C.

d Tempered at 570 °C to 600 °C.

e The solution treatment may be omitted if the conditions for hot working and subsequent cooling are such that the requirements for the mechanical properties of the product and the resistance to intergranular corrosion as defined in EN ISO 3651-2 are obtained and provided these requirements are met even after appropriate subsequent solution annealing.

**Table 2 — Chemical composition (cast analysis)[a]**

| Steel grade | | % by mass | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | C | Si max. | Mn max. | P max. | S max. | Cr | Mo | Ni | N | Others |
| Martensitic steels | | | | | | | | | | | |
| 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 | – |
| Austenitic steels | | | | | | | | | | | |
| X2CrNi18–9 | 1.4307 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,5 to 19,5 | – | 8,0 to 10,5 | ≤ 0,10 | – |
| X2CrNi19–11 | 1.4306 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 18,0 to 20,0 | – | 10,0 to 12,0 | ≤ 0,10 | – |
| X2CrNiN18–10 | 1.4311 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,5 to 19,5 | – | 8,5 to 11,5 | 0,12 to 0,22 | – |
| X5CrNi18–10 | 1.4301 | ≤ 0,07 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,5 to 19,5 | – | 8,0 to 10,5 | ≤ 0,10 | – |
| X6CrNiTi18–10 | 1.4541 | ≤ 0,08 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,0 to 19,0 | – | 9,0 to 12,0 | – | Ti:5 x C to 0,70 |
| X6CrNiNb18–10 | 1.4550 | ≤ 0,08 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,0 to 19,0 | – | 9,0 to 12,0 | – | Nb:10 x C to 1,00 |
| X6CrNi18–10 | 1.4948 | 0,04 to 0,08 | 1,00 | 2,00 | 0,035 | 0,015[b] | 17,0 to 19,0 | – | 8,0 to 11,0 | ≤ 0,10 | – |
| X6CrNiTiB18–10 | 1.4941 | 0,04 to 0,08 | 1,00 | 2,00 | 0,035 | 0,015[b] | 17,0 to 19,0 | – | 9,0 to 12,0 | – | Ti: 5 x C to 0,80 B:0,0015 to 0,0050 |
| X7CrNiNb18–10 | 1.4912 | 0,04 to 0,10 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,0 to 19,0 | – | 9,0 to 12,0 | – | Nb:10 x C to 1,20 |
| X2CrNiMo17–12–2 | 1.4404 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,00 to 2,50 | 10,0 to 13,0 | ≤ 0,10 | – |
| X2CrNiMoN17–11–2 | 1.4406 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,00 to 2,50 | 10,0 to 12,5 | 0,12 to 0,22 | – |

| Steel grade | | % by mass | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | C | Si max. | Mn max. | P max. | S max. | Cr | Mo | Ni | N | Others |
| X5CrNiMo17–12–2 | 1.4401 | ≤ 0,07 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,00 to 2,50 | 10,0 to 13,0 | ≤ 0,10 | – |
| X6CrNiMoTi17–12–2 | 1.4571 | ≤ 0,08 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,00 to 2,50 | 10,5 to 13,5 | – | Ti:5 x C to 0,70 |
| X2CrNiMo17–12–3 | 1.4432 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,50 to 3,00 | 10,5 to 13,0 | ≤ 0,10 | – |
| X2CrNiMoN17–13–3 | 1.4429 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,50 to 3,00 | 11,0 to 14,0 | 0,12 to 0,22 | – |
| X3CrNiMo17–13–3 | 1.4436 | ≤ 0,05 | 1,00 | 2,00 | 0,045 | 0,015[b] | 16,5 to 18,5 | 2,50 to 3,00 | 10,5 to 13,0 | ≤ 0,10 | – |
| X2CrNiMo18–14–3 | 1.4435 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015[b] | 17,0 to 19,0 | 2,50 to 3,00 | 12,5 to 15,0 | ≤ 0,10 | – |
| X3CrNiMoBN17–13–3 | 1.4910 | ≤ 0,04 | 0,75 | 2,00 | 0,035 | 0,015 | 16,0 to 18,0 | 2,00 to 3,00 | 12,0 to 14,0 | 0,10 to 0,18 | B:0,0015 to 0,0050 |
| X2CrNiMoN17–13–5 | 1.4439 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015 | 16,5 to 18,5 | 4,00 to 5,00 | 12,5 to 14,5 | 0,12 to 0,22 | – |
| X1NiCrMoCu25–20–5 | 1.4539 | ≤ 0,020 | 0,70 | 2,00 | 0,030 | 0,010 | 19,0 to 21,0 | 4,00 to 5,00 | 24,0 to 26,0 | ≤ 0,15 | Cu: 1,20 to 2,00 |
| X1CrNiMoCuN20–18–7 | 1.4547 | ≤ 0,020 | 0,70 | 1,00 | 0,030 | 0,010 | 19,5 to 20,5 | 6,00 to 7,00 | 17,5 to 18,5 | 0,18 to 0,25 | Cu: 0,50 to 1,00 |
| X1CrNiMoCuN25–20–7 | 1.4529 | ≤ 0,020 | 0,50 | 1,00 | 0,030 | 0,010 | 19,0 to 21,0 | 6,00 to 7,00 | 24,0 to 26,0 | 0,15 to 0,25 | Cu: 0,50 to 1,50 |
| X2CrNiCu19–10 | 1.4650 | ≤ 0,030 | 1,00 | 2,00 | 0,045 | 0,015 | 18,5 to 20,0 | – | 9,0 to 10,0 | ≤ 0,08 | Cu ≤ 1,0 |
| X3CrNiMo18–12–3 | 1.4449 | ≤ 0,035 | 1,00 | 2,00 | 0,045 | 0,015 | 17,0 to 18,2 | 2,25 to 2,75 | 11,5 to 12,5 | ≤ 0,08 | Cu ≤ 1,0 |

| Steel grade | | % by mass | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | C | Si max. | Mn max. | P max. | S max. | Cr | Mo | Ni | N | Others |
| Austenitic-ferritic steels | | | | | | | | | | | |
| X2CrNiN23–4 | 1.4362 | ≤ 0,030 | 1,00 | 2,00 | 0,035 | 0,015 | 22,0 to 24,0 | 0,10 to 0,60 | 3,5 to 5,5 | 0,05 to 0,20 | Cu: 0,10 to 0,60 |
| X2CrNiMoN22–5–3 | 1.4462 | ≤ 0,030 | 1,00 | 2,00 | 0,035 | 0,015 | 21,0 to 23,0 | 2,50 to 3,5 | 4,5 to 6,5 | 0,10 to 0,22 | – |
| X2CrNiMoCuN25–6–3 | 1.4507 | ≤ 0,030 | 0,70 | 2,00 | 0,035 | 0,015 | 24,0 to 26,0 | 3,00 to 4,0 | 6,0 to 8,0 | 0,20 to 0,30 | Cu: 1,00 to 2,50 |
| X2CrNiMoN25–7–4 | 1.4410 | ≤ 0,030 | 1,00 | 2,00 | 0,035 | 0,015 | 24,0 to 26,0 | 3,00 to 4,5 | 6,0 to 8,0 | 0,24 to 0,35 | – |
| X2CrNiMoCuWN25–7–4 | 1.4501 | ≤ 0,030 | 1,00 | 1,00 | 0,035 | 0,015 | 24,0 to 26,0 | 3,00 to 4,0 | 6,0 to 8,0 | 0,20 to 0,30 | W: 0,50 to 1,00<br>Cu: 0,50 to1,00 |

a Elements not listed 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.

b For products to be machined a controlled sulphur content of 0,015 % to 0,030 % is recommended and permitted by agreement.

**Table 3 — Permissible deviations of the product analysis above the maximum or below the minimum limits of the requirement of cast analysis**

| Element | Specified range<br>% | Permissible deviations[a]<br>% |
|---|---|---|
| C | ≤ 0,030 | + 0,005 |
| | > 0,030 to ≤ 0,10 | ±0,01 |
| Si | ≤ 1,00 | + 0,05 |
| Mn | ≤ 1,00 | + 0,03 |
| | > 1,00 to ≤ 2,00 | + 0,04 |
| P | ≤ 0,045 | + 0,005 |
| S | ≤ 0,015 | + 0,003 |
| | > 0,015 to ≤ 0,030 | + 0,005 |
| N | ≤ 0,35 | +0,01 |
| Cr | < 15,0 | +0,15 |
| | ≥ 15,0 to < 20,0 | ±0,20 |
| | ≥ 20,0 to ≤ 26,0 | ±0,25 |
| Mo | ≤ 0,70 | +0,03 |
| | > 0,70 to < 2,50 | ±0,05 |
| | ≥ 2,50 to ≤ 7,0 | ±0,10 |
| Ni | > 3,5 to < 5,0 | ±0,07 |
| | ≥ 5,0 to < 10,0 | ±0,10 |
| | ≥ 10,0 to ≤ 20,0 | ±0,15 |
| | > 20,0 to ≤ 26,0 | ±0,20 |
| Nb | ≤ 1,20 | +0,05 |
| Ti | ≤ 0,80 | +0,05 |
| Cu | ≤ 2,50 | +0,07 |
| B | ≤ 0,0050 | +0,0005 |
| W | ≤ 1,00 | +0,05 |

[a] If several product analyses are carried out for one cast and if, in this case, values for individual elements are established which fall outside the permitted range for the chemical composition, then it is only permissible that the values either exceed the maximum permitted value or fall short of the minimum permitted value. It is not acceptable for both to apply for one cast.

**Table 4 — Mechanical properties at room temperature and for impact energy test at 20°C and −196°C**

| Steel grade | | Heat treatment | Thickness of the ruling section | 0,2 % proof strength | 1,0 % proof strength | Tensile strength | Elongation after fracture[a] | | Impact energy[a] | | | Resistance to intergranular corrosion[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | | $t_R$ mm max. | $R_{p0,2}$ MPa min. | $R_{p1,0}$ MPa min. | $R_m$ MPa | $A$ % min. | | $KV_2$ J min. | | | in the delivery condition | in the sensitized condition |
| | | | | | | | | | at 20 °C | | at −196 °C | | |
| | | | | | | | l | tr, t | l | tr, t | tr | | |
| Martensitic steel | | | | | | | | | | | | | |
| X3CrNiMo13–4 | 1.4313 | +QT or +T | 350 | 550 | – | 750 to 900 | 17 | 16 | 100 | 80 | – | – | – |
| | | +QT | 250 | 650 | – | 780 to 930 | 17 | 15 | 90 | 70 | – | – | – |
| Austenitic steels | | | | | | | | | | | | | |
| X2CrNi18–9 | 1.4307 | +AT | 250 | 200 | 230 | 500 to 700 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X2CrNi19–11 | 1.4306 | +AT | 250 | 180 | 215 | 460 to 680 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X2CrNiN18–10 | 1.4311 | +AT | 250 | 270 | 305 | 550 to 750 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X5 rNi18–10 | 1.4301 | +AT | 250 | 200 | 230 | 500 to 700 | 45 | 35 | 100 | 60 | 60 | yes | no |
| X6CrNiTi18–10 | 1.4541 | +AT | 450 | 200 | 235 | 510 to 710 | 40 | 30 | 100 | 60 | 60 | yes | yes |
| X6CrNiNb18–10 | 1.4550 | +AT | 450 | 205 | 240 | 510 to 710 | 40 | 30 | 100 | 60 | 40 | yes | yes |
| X6CrNi18–10 | 1.4948 | +AT | 250 | 195 | 230 | 490 to 690 | 45 | 35 | 100 | 60 | – | no | no |
| X6CrNiTiB18–10 | 1.4941 | +AT | 450 | 175 | 210 | 490 to 690 | 40 | 30 | 100 | 60 | – | yes | yes |
| X7CrNiNb18–10 | 1.4912 | +AT | 450 | 205 | 240 | 510 to 710 | 40 | 30 | 100 | 60 | 40 | (yes) | (yes) |
| X2CrNiMo17–12–2 | 1.4404 | +AT | 250 | 190 | 225 | 490 to 690 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X2CrNiMoN17–11–2 | 1.4406 | +AT | 160 | 280 | 315 | 580 to 780 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X5CrNiMo17–12–2 | 1.4401 | +AT | 250 | 205 | 240 | 510 to 710 | 45 | 35 | 100 | 60 | 60 | yes | no |

| Steel grade | | Heat treatment | Thickness of the ruling section $t_R$ mm max. | 0,2 % proof strength $R_{p0,2}$ MPa min. | 1,0 % proof strength $R_{p1,0}$ MPa min. | Tensile strength $R_m$ MPa | Elongation after fracture[a] $A$ % min. | | Impact energy[a] $KV_2$ J min. | | | Resistance to intergranular corrosion[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | | | | | | | | at 20 °C | | at −196 °C | in the delivery condition | in the sensitized condition |
| | | | | | | | l | tr, t | l | tr, t | tr | | |
| X6CrNiMoTi17–12–2 | 1.4571 | +AT | 450 | 210 | 245 | 510 to 710 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X2CrNiMo17–12–3 | 1.4432 | +AT | 250 | 190 | 225 | 490 to 690 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X2CrNiMoN17–13–3 | 1.4429 | +AT | 160 | 280 | 315 | 580 to 780 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X3CrNiMo17–13–3 | 1.4436 | +AT | 250 | 205 | 240 | 510 to 710 | 45 | 35 | 100 | 60 | 60 | yes | no |
| X2CrNiMo18–14–3 | 1.4435 | +AT | 160 | 200 | 235 | 520 to 670 | 45 | 35 | 100 | 60 | 60 | yes | yes |
| X2CrNiMoN17–13–5 | 1.4439 | +AT | 160 | 285 | 315 | 580 to 800 | 40 | 35 | 100 | 60 | 42 | – | – |
| X1NiCrMoCu25–20–5 | 1.4539 | +AT | 160 | 220 | 250 | 520 to 720 | 35 | 35 | 120 | 90 | – | – | – |
| X1CrNiMoCuN20–18–7 | 1.4547 | +AT | 160 | 300 | 340 | 650 to 850 | 40 | 35 | 100 | 60 | – | – | – |
| X1CrNiMoCuN25–20–7 | 1.4529 | +AT | 160 | 300 | 340 | 650 to 850 | 40 | 35 | 120 | 90 | 80 | – | – |
| X3CrNiMoBN17–13–3 | 1.4910 | +AT | 75 | 260 | 300 | 550 to 750 | 45 | 40 | 100 | 60 | – | yes | yes |
| X2CrNiCu19–10 | 1.4650 | +AT | 450 | 210 | 245 | 520 to 720 | 45 | 40 | 100 | 60 | 60 | (yes) | (yes) |
| X3CrNiMo18–12–3 | 1.4449 | +AT | 450 | 220 | 255 | 520 to 720 | 45 | 40 | 100 | 60 | 60 | (yes | (yes) |
| Austenitic-ferritic steels | | | | | | | | | | | | | |
| X2CrNiN23–4 | 1.4362 | +AT | 160 | 400 | – | 600 to 830 | 25 | 20 | 120 | 90 | – | yes | yes |
| X2CrNiMoN22–5–3 | 1.4462 | +AT | 350 | 450 | – | 680 to 880 | 30 | 25 | 200 | 100 | – | yes | yes |

| Steel grade | | Heat treatment | Thickness of the ruling section $t_R$ mm max. | 0,2 % proof strength $R_{p0,2}$ MPa min. | 1,0 % proof strength $R_{p1,0}$ MPa min. | Tensile strength $R_m$ MPa | Elongation after fracture[a] $A$ % min. | | Impact energy[a] $KV_2$ J min. | | | Resistance to intergranular corrosion[b] | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | | | | | | | | at 20 °C | | at −196 °C | in the delivery condition | in the sensitized condition |
| | | | | | | | l | tr, t | l | tr, t | tr | | |
| X2CrNiMoCuN25–6–3 | 1.4507 | +AT | 160 | 500 | – | 700 to 900 | 25 | 20 | 150 | 90 | – | yes | yes |
| X2CrNiMoN25–7–4 | 1.4410 | +AT | 160 | 500 | – | 800 to 1000 | 30 | 25 | 200 | 100 | – | yes | yes |
| X2CrNiMoCuWN25–7–4 | 1.4501 | +AT | 160 | 530 | – | 730 to 930 | 25 | 20 | 150 | 90 | – | yes | yes |

a l = longitudinal to main forging direction, t = tangential, tr = transverse to main forging direction.

b When tested in accordance with EN ISO 3651-2.

**Table 5 — Minimum 0,2 % proof strength ($R_{p0,2}$) at elevated temperatures**

| Steel grade | | $R_{p0,2,min.}$ in MPa at a temperature in ° C of: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 |
| Martensitic steel | | | | | | | | | | | |
| X3CrNiMo13–4 | 1.4313 | – | 590 | 575 | 560 | 545 | 530 | 515 | – | – | – |
| Austenitic steels | | | | | | | | | | | |
| X2CrNi18–9 | 1.4307 | – | 147 | 132 | 118 | 108 | 100 | 94 | 89 | 81 | – |
| X2CrNi19–11 | 1.4306 | – | 147 | 132 | 118 | 108 | 100 | 94 | 89 | 81 | – |
| X2CrNiN18–10 | 1.4311 | – | 205 | 175 | 157 | 145 | 136 | 130 | 125 | 119 | – |
| X5CrNi18–10 | 1.4301 | – | 157 | 142 | 127 | 118 | 110 | 104 | 98 | 92 | – |
| X6CrNiTi18–10 | 1.4541 | – | 176 | 167 | 157 | 147 | 136 | 130 | 125 | 119 | – |
| X6CrNiNb18–10 | 1.4550 | – | 177 | 167 | 157 | 147 | 136 | 130 | 125 | 119 | – |
| X6CrNi18–10 | 1.4948 | – | 157 | 142 | 127 | 117 | 108 | 103 | 98 | 88 | 78 |
| X6CrNiTiB18–10 | 1.4941 | – | 162 | 152 | 142 | 137 | 132 | 127 | 123 | 113 | 103 |
| X7CrNiNb18–10 | 1.4912 | – | 171 | 162 | 153 | 147 | 139 | 133 | 129 | 124 | 121 |
| X2CrNiMo17–12–2 | 1.4404 | – | 166 | 152 | 137 | 127 | 118 | 113 | 108 | 100 | – |
| X2CrNiMoN17–11–2 | 1.4406 | – | 211 | 185 | 167 | 155 | 145 | 140 | 135 | 128 | – |
| X5CrNiMo17–12–2 | 1.4401 | – | 177 | 162 | 147 | 137 | 127 | 120 | 115 | 110 | – |
| X6CrNiMoTi17–12–2 | 1.4571 | – | 185 | 177 | 167 | 157 | 145 | 140 | 135 | 129 | – |
| X2CrNiMo17–12–3 | 1.4432 | – | 166 | 152 | 137 | 127 | 118 | 113 | 108 | 100 | – |
| X2CrNiMoN17–13–3 | 1.4429 | – | 211 | 185 | 167 | 155 | 145 | 140 | 135 | 129 | – |
| X3CrNiMo17–13–3 | 1.4436 | – | 177 | 162 | 147 | 137 | 127 | 120 | 115 | 110 | – |
| X2CrNiMo18–14–3 | 1.4435 | – | 165 | 150 | 137 | 127 | 119 | 113 | 108 | 100 | – |
| X3CrNiMoBN17–13–3 | 1.4910 | – | 205 | 187 | 170 | 159 | 148 | 141 | 134 | 127 | 121 |
| X2CrNiMoN17–13–5 | 1.4439 | 260 | 225 | 200 | 185 | 175 | 165 | 155 | 150 | – | – |
| X1NiCrMoCu25–20–5 | 1.4539 | 200 | 175 | 165 | 155 | 145 | 130 | 130 | 125 | 110 | – |
| X1CrNiMoCuN20–18–7 | 1.4547 | 270 | 230 | 205 | 190 | 180 | 170 | 165 | 160 | 148 | – |
| X1CrNiMoCuN25–20–7 | 1.4529 | 270 | 230 | 210 | 190 | 180 | 170 | 165 | 160 | 120 | – |
| X2CrNiCu19–10 | 1.4650 | – | 155 | 140 | 127 | 118 | 110 | 104 | 98 | 92 | – |
| X3CrNiMo18–12–3 | 1.4449 | – | 175 | 158 | 145 | 135 | 127 | 120 | 115 | 110 | 100 |

| **Steel grade** | | **$R_{p0,2,min.}$ in MPa at a temperature in ° C of:** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 |
| Austenitic-ferritic steels | | | | | | | | | | | |
| X2CrNiN23–4 | 1.4362 | – | 330 | 300 | 280 | 265 | – | – | – | – | – |
| X2CrNiMoN22–5–3 | 1.4462 | – | 360 | 335 | 315 | 300 | – | – | – | – | – |
| X2CrNiMoCuN25–6–3 | 1.4507 | – | 450 | 420 | 400 | 380 | – | – | – | – | – |
| X2CrNiMoN25–7–4 | 1.4410 | – | 450 | 420 | 400 | 380 | – | – | – | – | – |
| X2CrNiMoCuWN25–7–4 | 1.4501 | – | 450 | 420 | 400 | 380 | – | – | – | – | – |

**Table 6 — Minimum 1,0 % proof strength ($R_{p1,0}$) for austenitic steels at elevated temperatures**

| **Steel grade** | | **$R_{p1,0,\ min.}$ in MPa at a temperature in ° C of:** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 |
| X2CrNi18–9 | 1.4307 | – | 181 | 162 | 147 | 137 | 127 | 121 | 116 | 109 | – |
| X2CrNi19–11 | 1.4306 | – | 181 | 162 | 147 | 137 | 127 | 121 | 116 | 109 | – |
| X2CrNiN18–10 | 1.4311 | – | 240 | 210 | 187 | 175 | 167 | 161 | 156 | 149 | – |
| X5CrNi18–10 | 1.4301 | – | 191 | 172 | 157 | 145 | 135 | 129 | 125 | 120 | – |
| X6CrNiTi18–10 | 1.4541 | – | 208 | 196 | 186 | 177 | 167 | 161 | 156 | 149 | – |
| X6CrNiNb18–10 | 1.4550 | – | 211 | 196 | 186 | 177 | 167 | 161 | 156 | 149 | – |
| X6CrNi18–10 | 1.4948 | – | 191 | 172 | 157 | 147 | 137 | 132 | 127 | 118 | 108 |
| X6CrNiTiB18–10 | 1.4941 | – | 201 | 191 | 181 | 176 | 172 | 167 | 162 | 152 | 142 |
| X7CrNiNb18–10 | 1.4912 | – | 204 | 192 | 182 | 172 | 166 | 162 | 159 | 155 | 151 |
| X2CrNiMo17–12–2 | 1.4404 | – | 199 | 181 | 167 | 157 | 145 | 139 | 135 | 128 | – |
| X2CrNiMoN17–11–2 | 1.4406 | – | 246 | 218 | 198 | 183 | 175 | 169 | 164 | 158 | – |
| X5CrNiMo17–12–2 | 1.4401 | – | 211 | 191 | 177 | 167 | 156 | 150 | 144 | 139 | – |
| X6CrNiMoTi17–12–2 | 1.4571 | – | 218 | 206 | 196 | 186 | 175 | 169 | 164 | 158 | – |
| X2CrNiMo17–12–3 | 1.4432 | – | 199 | 181 | 167 | 157 | 145 | 139 | 135 | 128 | – |
| X2CrNiMoN17–13–3 | 1.4429 | – | 246 | 218 | 198 | 183 | 175 | 169 | 164 | 158 | – |
| X3CrNiMo17–13–3 | 1.4436 | – | 211 | 191 | 177 | 167 | 156 | 150 | 144 | 139 | – |
| X2CrNiMo18–14–3 | 1.4435 | – | 200 | 180 | 165 | 153 | 145 | 139 | 135 | 128 | – |

| Steel grade | | $R_{p1,0,\,min.}$ in MPa at a temperature in ° C of: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 |
| X3CrNiMoBN17–13–3 | 1.4910 | – | 240 | 220 | 200 | 189 | 178 | 171 | 164 | 157 | 151 |
| X2CrNiMoN17–13–5 | 1.4439 | 290 | 255 | 230 | 210 | 200 | 190 | 180 | 175 | – | – |
| X1NiCrMoCu25–20–5 | 1.4539 | 240 | 205 | 195 | 185 | 175 | 165 | 160 | 155 | 140 | – |
| X1CrNiMoCuN20–18–7 | 1.4547 | 310 | 270 | 245 | 225 | 212 | 200 | 195 | 190 | 180 | – |
| X1CrNiMoCuN25–20–7 | 1.4529 | 310 | 270 | 245 | 225 | 215 | 205 | 195 | 190 | 150 | – |
| X2CrNiCu19–10 | 1.4650 | – | 190 | 170 | 155 | 145 | 135 | 129 | 125 | 120 | – |
| X3CrNiMo18–12–3 | 1.4449 | – | 210 | 190 | 175 | 165 | 155 | 150 | 144 | 139 | 129 |

**Table 7 — Minimum tensile strength ($R_m$) at elevated temperatures**

| Steel grade | | $R_{m,\,min.}$ in MPa at a temperature in ° C of: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Steel name | Steel number | 50 | 100 | 150 | 200 | 250 | 300 | 350 | 400 | 500 | 600 |
| Martensitic steel | | | | | | | | | | | |
| X3CrNiMo13–4 | 1.4313 | – | 710 | 695 | 680 | 665 | 650 | 635 | – | – | – |
| Austenitic steels | | | | | | | | | | | |
| X2CrNi18–9 | 1.4307 | – | 410 | 380 | 360 | 350 | 340 | 340 | – | – | – |
| X2CrNi19–11 | 1.4306 | – | 410 | 380 | 360 | 350 | 340 | 340 | – | – | – |
| X2CrNiN18–10 | 1.4311 | – | 490 | 460 | 430 | 420 | 410 | 410 | – | – | – |
| X5CrNi18–10 | 1.4301 | – | 450 | 420 | 400 | 390 | 380 | 380 | 380 | 360 | – |
| X6CrNiTi18–10 | 1.4541 | – | 440 | 410 | 390 | 385 | 375 | 375 | 375 | 360 | – |
| X6CrNiNb18–10 | 1.4550 | – | 435 | 400 | 370 | 350 | 340 | 335 | 330 | 310 | – |
| X6CrNi18–10 | 1.4948 | – | 440 | 410 | 390 | 385 | 375 | 375 | 375 | 360 | 300 |
| X6CrNiTiB18–10 | 1.4941 | – | 410 | 390 | 370 | 360 | 350 | 345 | 340 | 330 | 300 |
| X7CrNiNb18–10 | 1.4912 | – | 410 | 390 | 370 | 360 | 350 | 345 | 340 | 330 | 300 |
| X2CrNiMo17–12–2 | 1.4404 | – | 430 | 410 | 390 | 385 | 380 | 380 | 380 | 360 | – |
| X2CrNiMoN17–11–2 | 1.4406 | – | 520 | 490 | 460 | 450 | 440 | 435 | – | – | – |
| X5CrNiMo17–12–2 | 1.4401 | – | 430 | 410 | 390 | 385 | 380 | 380 | – | – | – |
| X6 CrNiMoTi17–12–2 | 1.4571 | – | 440 | 410 | 390 | 385 | 375 | 375 | 375 | 360 | – |
| X2CrNiMo17–12–3 | 1.4432 | – | 430 | 410 | 390 | 385 | 380 | 380 | 380 | 360 | – |
| X2CrNiMoN17–13–3 | 1.4429 | – | 520 | 490 | 460 | 450 | 440 | 435 | 435 | 430 | – |
| X3CrNiMo17–13–3 | 1.4436 | – | 460 | 440 | 420 | 415 | 410 | 410 | 410 | 390 | – |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| X2CrNiMo18–14–3 | 1.4435 | – | 420 | 400 | 380 | 375 | 370 | 370 | – | – | – |
| X3CrNiMoBN17–13–3 | 1.4910 | – | 495 | 472 | 450 | 440 | 430 | 425 | 420 | 400 | 365 |
| X2CrNiMoN17–13–5 | 1.4439 | 560 | 520 | 490 | 460 | 450 | 440 | 435 | – | – | – |
| X1NiCrMoCu25–20–5 | 1.4539 | 500 | 440 | 420 | 400 | 390 | 380 | 370 | 360 | 350 | – |
| X1CrNiMoCuN20–18–7 | 1.4547 | 640 | 615 | 585 | 560 | 540 | 525 | 515 | 510 | 495 | – |
| X1CrNiMoCuN25–20–7 | 1.4529 | 630 | 600 | 575 | 555 | 535 | 520 | 515 | 510 | – | – |
| X2CrNiCu19–10 | 1.4650 | – | 450 | 420 | 400 | 390 | 380 | 380 | 380 | 360 | – |
| X3CrNiMo18–12–3 | 1.4449 | – | 460 | 440 | 420 | 415 | 410 | 410 | 410 | 390 | 350 |
| Austenitic-ferritic steels | | | | | | | | | | | |
| X2CrNiN23–4 | 1.4362 | – | 540 | 520 | 500 | 490 | – | – | – | – | – |
| X2CrNiMoN22–5–3 | 1.4462 | – | 590 | 570 | 550 | 540 | – | – | – | – | – |
| X2CrNiMoCuN25–6–3 | 1.4507 | – | 660 | 640 | 620 | 610 | – | – | – | – | – |
| X2CrNiMoN25–7–4 | 1.4410 | – | 680 | 660 | 640 | 630 | – | – | – | – | – |
| X2CrNiMoCuWN25–7–4 | 1.4501 | – | 680 | 660 | 640 | 630 | – | – | – | – | – |

# Annex A
(informative)

# Reference data for creep rupture strength

NOTE 1 The values given in Table A.1 are mean values of the scatter band considered until now.

NOTE 2 The strength values given for the elevated temperatures listed in Table A.1 do not mean that the steels can be used in continuous duty up to these temperatures. The governing factor is the total stressing during operation. Where relevant, the oxidation conditions can also be taken into account.

**Table A.1 — Creep rupture strength**

| Steel grade | | Temperature | Creep rupture strength MPa | | |
|---|---|---|---|---|---|
| Steel name | Steel number | °C | 10 000 h | 100 000 h | 200 000 h |
| X5CrNi18–10[a] | 1.4301[c] | 550 | 156 | 92 | – |
| | | 560 | 138 | 85 | – |
| | | 570 | 124 | 78 | – |
| | | 580 | 113 | 72 | – |
| | | 590 | 104 | 65 | – |
| | | 600 | 97 | 59 | – |
| | | 610 | 90 | 54 | – |
| | | 620 | 83 | 49 | – |
| | | 630 | 76 | 45 | – |
| | | 640 | 70 | 40 | – |
| | | 650 | 64 | 36 | – |
| | | 660 | 59 | 32 | – |
| | | 670 | 54 | 28 | – |
| | | 680 | 49 | 25 | – |
| | | 690 | 43 | 21 | – |
| | | 700 | 38 | 18 | – |
| X2CrNi18–9[b] | 1.4307[c] | 550 | 156 | 92 | – |
| | | 560 | 138 | 85 | – |
| | | 570 | 124 | 78 | – |
| | | 580 | 113 | 72 | – |
| | | 590 | 104 | 65 | – |
| | | 600 | 97 | 59 | – |
| | | 610 | 90 | 54 | – |
| | | 620 | 83 | 49 | – |
| | | 630 | 76 | 45 | – |
| | | 640 | 70 | 40 | – |
| | | 650 | 64 | 36 | – |
| | | 660 | 59 | 32 | – |
| | | 670 | 54 | 28 | – |
| | | 680 | 49 | 25 | – |
| | | 690 | 43 | 21 | – |
| | | 700 | 38 | 18 | – |

| **Steel grade** | | **Temperature** | **Creep rupture strength** MPa | | |
|---|---|---|---|---|---|
| Steel name | Steel number | °C | 10 000 h | 100 000 h | 200 000 h |
| X6CrNi18–10 | 1.4948[d] | 550 | 191 | 140 | 125 |
| | | 560 | 177 | 128 | 114 |
| | | 570 | 165 | 117 | 104 |
| | | 580 | 154 | 107 | 95 |
| | | 590 | 143 | 98 | 86 |
| | | 600 | 132 | 89 | 78 |
| | | 610 | 122 | 81 | 70 |
| | | 620 | 113 | 73 | 62 |
| | | 630 | 104 | 65 | 55 |
| | | 640 | 95 | 58 | 49 |
| | | 650 | 87 | 52 | 43 |
| X6CrNi18–10 | 1.4948 [d] | 660 | 80 | 47 | 38 |
| | | 670 | 73 | 42 | 34 |
| | | 680 | 67 | 37 | 30 |
| | | 690 | 61 | 32 | 26 |
| | | 700 | 55 | 28 | 22 |
| X6CrNiNb18–10[a] | 1.4550[e] | 540 | 258 | 174* | 154* |
| | | 550 | 236 | 161* | 142* |
| | | 560 | 218 | 148* | 131* |
| | | 570 | 202 | 137* | 120* |
| | | 580 | 187 | 127* | 110* |
| | | 590 | 174 | 117* | 101* |
| | | 600 | 162 | 107* | 92* |
| | | 610 | 151 | 98* | 82* |
| | | 620 | 140 | 89* | 72* |
| | | 630 | 131 | 80* | 61* |
| | | 640 | 121 | 71* | – |
| | | 650 | 113 | 58* | – |
| | | 660 | 104 | – | – |
| | | 670 | 96 | – | – |
| | | 680 | 88 | – | – |
| | | 690 | 80 | – | – |
| | | 700 | 71 | – | – |
| X7CrNiNb18–10 | 1.4912[e] | 540 | 253 | 18* | 169* |
| | | 550 | 237 | 172* | 156* |
| | | 560 | 221 | 159* | 144* |
| | | 570 | 206 | 147* | 132* |
| | | 580 | 192 | 135* | 122* |
| | | 590 | 178 | 125* | 112* |
| | | 600 | 166 | 115* | 102* |
| | | 610 | 154 | 106* | 94* |
| | | 620 | 142 | 97* | 86* |
| | | 630 | 132 | 89* | 78* |
| | | 640 | 122 | 81* | 71* |
| | | 650 | 112 | 74* | 64* |

| Steel grade | | Temperature | Creep rupture strength MPa | | |
|---|---|---|---|---|---|
| Steel name | Steel number | °C | 10 000 h | 100 000 h | 200 000 h |
| | | 660 | 104 | 67* | 59* |
| | | 670 | 96 | 61* | (51)* |
| | | 680 | 88 | 54* | – |
| | | 690 | 81 | – | – |
| | | 700 | 74 | – | – |
| X6CrNiTi18–10[a] | 1.4541[e] | 540 | 222 | 154* | 136* |
| | | 550 | 206 | 142* | 123* |
| | | 560 | 192 | 129* | 112* |
| | | 570 | 178 | 118* | 101* |
| | | 580 | 165 | 107* | 91* |
| | | 590 | 152 | 96* | 81* |
| | | 600 | 140 | 86* | 72* |
| | | 610 | 129 | 77* | 63* |
| | | 620 | 118 | 68* | 55* |
| | | 630 | 108 | 60* | 48* |
| | | 640 | 98 | 53* | 42* |
| | | 650 | 88 | 46* | 36* |
| | | 660 | 79 | 40* | 32* |
| | | 670 | 71 | 35* | (28)* |
| | | 680 | 63 | 31* | – |
| | | 690 | 56 | (27)* | – |
| | | 700 | 49 | – | – |
| X6CrNiTiB18–10 | 1.4941[d] | 550 | 223 | 170 | 150 |
| | | 560 | 210 | 154 | 135 |
| | | 570 | 196 | 140 | 122 |
| | | 580 | 182 | 127 | 110 |
| | | 590 | 170 | 114 | 100 |
| | | 600 | 156 | 102 | 91 |
| | | 610 | 142 | 92 | 82 |
| | | 620 | 130 | 84 | 74 |
| | | 630 | 119 | 76 | 67 |
| | | 640 | 108 | 68 | 60 |
| | | 650 | 98 | 62 | 54 |
| | | 660 | 89 | 56 | 49 |
| | | 670 | 80 | 50 | 43 |
| | | 680 | 73 | 44 | 39 |
| | | 690 | 66 | 39 | 33 |
| | | 700 | 60 | 35 | 29 |
| X6CrNiMoTi17–12–2[a] | 1.4571[c] | 540 | 247 | 194 | 178* |
| | | 550 | 233 | 181 | 164* |
| | | 560 | 220 | 167 | 151* |
| | | 570 | 206 | 154 | 138* |
| | | 580 | 193 | 141 | 125 |
| | | 590 | 180 | 128 | 113 |
| | | 600 | 167 | 116 | 102 |

| **Steel grade** | | **Temperature** | **Creep rupture strength** MPa | | |
|---|---|---|---|---|---|
| Steel name | Steel number | °C | 10 000 h | 100 000 h | 200 000 h |
| | | 610 | 155 | 105 | 91 |
| | | 620 | 142 | 94 | 81 |
| | | 630 | 130 | 84 | 72* |
| | | 640 | 119 | 75 | 65* |
| | | 650 | 108 | 67 | 58* |
| | | 660 | 97 | 60 | 52* |
| | | 670 | 87 | 54 | 47* |
| | | 680 | 78 | 49 | (43) * |
| | | 690 | 70 | 44 | – |
| | | 700 | 63 | – | – |
| X2CrNiMoN17–11–2, X2CrNiMoN17–13–3 | 1.4406[c], 1.4429[c] | 550 | 300 | 234* | 213* |
| | | 560 | 284 | 217* | 195* |
| | | 570 | 267 | 199* | 179* |
| | | 580 | 250 | 182* | 162* |
| | | 590 | 236 | 166v | 145* |
| | | 600 | 221 | 151* | 130* |
| | | 610 | 205 | 135* | 114* |
| | | 620 | 189 | 119* | 100* |
| | | 630 | 173 | 105* | 87* |
| | | 640 | 157 | 92v | 76* |
| | | 650 | 143 | 80* | 66* |
| | | 660 | 128 | 71* | 58* |
| | | 670 | 115 | 62* | 51* |
| | | 680 | 102 | 55* | 45* |
| | | 690 | 90 | 48* | 40* |
| | | 700 | 78 | 42* | 35* |
| X5CrNiMo17–12–2[a], X3CrNiMo17–13–3[a, b] | 1.4401[c], 1.4436[c] | 540 | 265 | 205 | 188 |
| | | 550 | 247 | 188 | 172 |
| | | 560 | 230 | 172 | 157 |
| | | 570 | 213 | 158 | 142 |
| | | 580 | 189 | 144 | 129 |
| | | 590 | 183 | 130 | 117 |
| | | 600 | 168 | 118 | 105 |
| | | 610 | 155 | 107 | 94 |
| | | 620 | 142 | 96 | 85 |
| | | 630 | 130 | 87 | 76 |
| | | 640 | 119 | 78 | 68 |
| | | 650 | 109 | 70 | 61 |
| | | 660 | 99 | 63 | 54 |
| | | 670 | 90 | 56 | 48 |
| | | 680 | 82 | 50 | 43 |
| | | 690 | 75 | 45 | 38 |
| | | 700 | 68 | 40 | 34 |

| Steel grade | | Temperature | Creep rupture strength MPa | | |
|---|---|---|---|---|---|
| Steel name | Steel number | °C | 10 000 h | 100 000 h | 200 000 h |
| X3CrNiMoBN17–13–3 | 1.4910[d] | 550 | 290 | 220 | (200) |
| | | 560 | 272 | 202 | (184) |
| | | 570 | 254 | 186 | (166) |
| | | 580 | 237 | 170 | (151) |
| | | 590 | 220 | 155 | (137) |
| | | 600 | 205 | 141 | (122) |
| | | 610 | 190 | 127 | (113) |
| | | 620 | 174 | 114 | (100) |
| | | 630 | 162 | 102 | (91) |
| | | 640 | 148 | 92 | (81) |
| | | 650 | 135 | 83 | (73) |
| | | 660 | 122 | 75 | (65) |
| | | 670 | 112 | 68 | (58) |
| | | 680 | 102 | 61 | (52) |
| | | 690 | 93 | 56 | (46) |
| | | 700 | 84 | 52 | (42) |
| | | 710 | 78 | 48 | (39) |
| | | 720 | 71 | 45 | (36) |
| | | 730 | 65 | 41 | (34) |
| | | 740 | 58 | 37 | (31) |
| | | 750 | 52 | 34 | (28) |
| | | 800 | 33 | 20 | (17) |
| X2CrNi18–9[b] | 1.4307[c] | 550 | 156 | 92 | – |
| | | 560 | 138 | 85 | – |
| | | 570 | 124 | 78 | – |
| | | 580 | 113 | 72 | – |
| | | 590 | 104 | 65 | – |
| | | 600 | 97 | 59 | – |
| | | 610 | 90 | 54 | – |
| | | 620 | 83 | 49 | – |
| | | 630 | 76 | 45 | – |
| | | 640 | 70 | 40 | – |
| | | 650 | 64 | 36 | – |
| | | 660 | 59 | 32 | – |
| | | 670 | 54 | 28 | – |
| | | 680 | 49 | 25 | – |
| | | 690 | 43 | 21 | – |
| | | 700 | 38 | 18 | – |

() Extended stress extrapolation.

* Extended time extrapolation.

a Values apply only for a minimum carbon content of 0,04 %.

b Values apply only for a minimum nitrogen content of 0,06 %.

c These data are based on recommendations of the European Creep Collaborative Committee, ECCC, WG 3.3·

d These data are taken from DIN 17460.

e These data are taken from BS PD 6525–1.

# Annex B
(informative)

# Post weld heat treatment

**B.1** In general, welded assemblies of stainless steels covered by this document are not subjected to any heat treatment with the exception that martensitic grades are tempered, if there is any risk of residual martensite in the heat affected zone; for appropriate temperatures, see Table 1.

**B.2** During heating of high chromium and molybdenum austenitic or austenitic-ferritic steel weldments containing some ferrite, intermetallic phases may be formed which shall be re-dissolved during post weld heat treatment. As most filler metals are overalloyed in comparison with the equivalent basic grades, minimum solution temperatures higher than those given in Table 1 may be necessary.

In the case of fully austenitic weld structures, it should be verified that mechanical properties of heat treated weldments conform to this document.

Oxidation of surfaces which necessitates pickling, and possible distortion of the welded construction may raise further difficulties.

Consequently post weld heat treatment of duplex and austenitic steels should be avoided, and therefore welding be planned carefully.

**B.3** In special cases, e.g. for parts with greater wall thickness, requirements concerning stress-relief and resistance to intergranular corrosion, in order to avoid failure by stress corrosion cracking or corrosion fatigue, may prove the necessity for post weld heat treatment. This should be carried out according to Table B.1 by holding at an intermediate stage below the usual solution temperature (see Table 1) and is defined as stabilizing annealing for the niobium or titanium bearing grades and as stress-relieving for the unstabilized low carbon grades.

In some cases, post weld heat treatment may also be performed as solution annealing according to Table 1 or at a temperature below the precipitation range of carbides and intermetallic phases; however, the latter reduces only peak stresses.

**B.4** Preheating of austenitic-ferritic steels is a very effective precaution against stress increase by shrinkage of thicker welded cross-sections, because temperatures of 200 °C to 250 °C bring down room temperature yield strength by about 50 %. Thus preheating is often more appropriate to avoid high stress levels in those weldments than any post weld heat treatment, and a preheating temperature between 120 °C and 200 °C according to the particular steel and thickness should be applied.

**Table B.1 — Guideline on post weld heat treatment of austenitic steels**

| Steel grade | | Temperature[a] | Type of cooling |
|---|---|---|---|
| Steel name | Steel number | | |
| Stabilized steels | | | |
| X6CrNiTi18–10 | 1.4541 | 900 to 940 | air |
| X6CrNiNb18–10 | 1.4550 | | |
| X6CrNiMoTi17–12–2 | 1.4571 | not recommended | |
| Steels with ≤ 0,07 % C | | | |
| X5CrNi18–10 | 1.4301 | not recommended | |
| X5CrNiMo17–12–2 | 1.4401 | | |
| X3CrNiMo17–13–3 | 1.4436 | | |
| Steels with ≤ 0,03 % C | | | |
| X2CrNi18–9 | 1.4307 | 900 to 940 | air |
| X2CrNi19–11 | 1.4306 | | |
| X2CrNiN18–10 | 1.4311 | | |
| X2CrNiMo17–12–2 | 1.4404 | 960 to 1 040[b] | forced air |
| X2CrNiMoN17–11–2 | 1.4406 | | |
| X2CrNiMo17–12–3 | 1.4432 | | |
| X2CrNiMoN17–13–3 | 1.4429 | | |
| X2CrNiMo18–14–3 | 1.4435 | | |
| X3CrNiMoN18–12–3 | 1.4449 | | |
| X2CrNiMoN17–13–5 | 1.4439 | | |
| X1NiCrMoCu25–20–5 | 1.4539 | | |
| X1CrNiMoCuN20–18–7 | 1.4547 | | |
| X1CrNiMoCuN25–20–7 | 1.4529 | | |
| Creep resisting steels | | | |
| X3CrNiMoBN17–13–3 | 1.4910 | 900 to 950[c] | air |
| X6CrNiTiB18–10 | 1.4941 | | |
| X7CrNiNb18–10 | 1.4912 | | |
| X6CrNi18–10 | 1.4948 | not recommended | |

a Minimum holding time: 30 min.

b Recommended if welded with stabilized filler metal.

c Recommended for components with greater wall thickness.

# Annex C
(informative)

# Significant technical changes to the version EN 10222-5:1999

Significant technical changes to the previous version EN 10222-5:1999 are listed below:

1) updating of the normative references;
2) addition of a new Annex B (informative);
3) updating of steel designations;
4) updating of the mandatory and optional information's in chapter 5.2;
5) new statements concerning steelmaking process and delivery conditions;
6) Table 1 containing values and statements on the heat treatment of the steels updated;
7) new Table 4 containing values for the mechanical properties at room temperature;
8) updating of Annex ZA in relationship with EU Directive 2014/68/EU (previous Annexes ZA and ZB).

# Annex ZA
(informative)

# Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EU

This European Standard has been prepared under a Commission's standardization request M/071 to provide one voluntary means of conforming to Essential Requirements of Directive 2014/68/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of Directive 2014/68/EU, and associated EFTA regulations.

**Table ZA.1 — Correspondence between this European Standard and Annex I of Directive 2014/68/EU**

| Requirements of Directive 2014/68/EU | Clause(s)/subclause(s) of this EN | Remarks/Notes |
|---|---|---|
| 4.1a | 6.4 | Appropriate material properties |
| 4.1d | 6.2, 6.5, 6.6 | Suitable for the processing procedures |
| 4.3 | Clause 7 (EN 10222–1:2017, 7.1) | Inspection<br>Documentation |

**WARNING 1 —** Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

**WARNING 2 —** Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

# Bibliography

[1] EN 10021, *General technical delivery conditions for steel products*