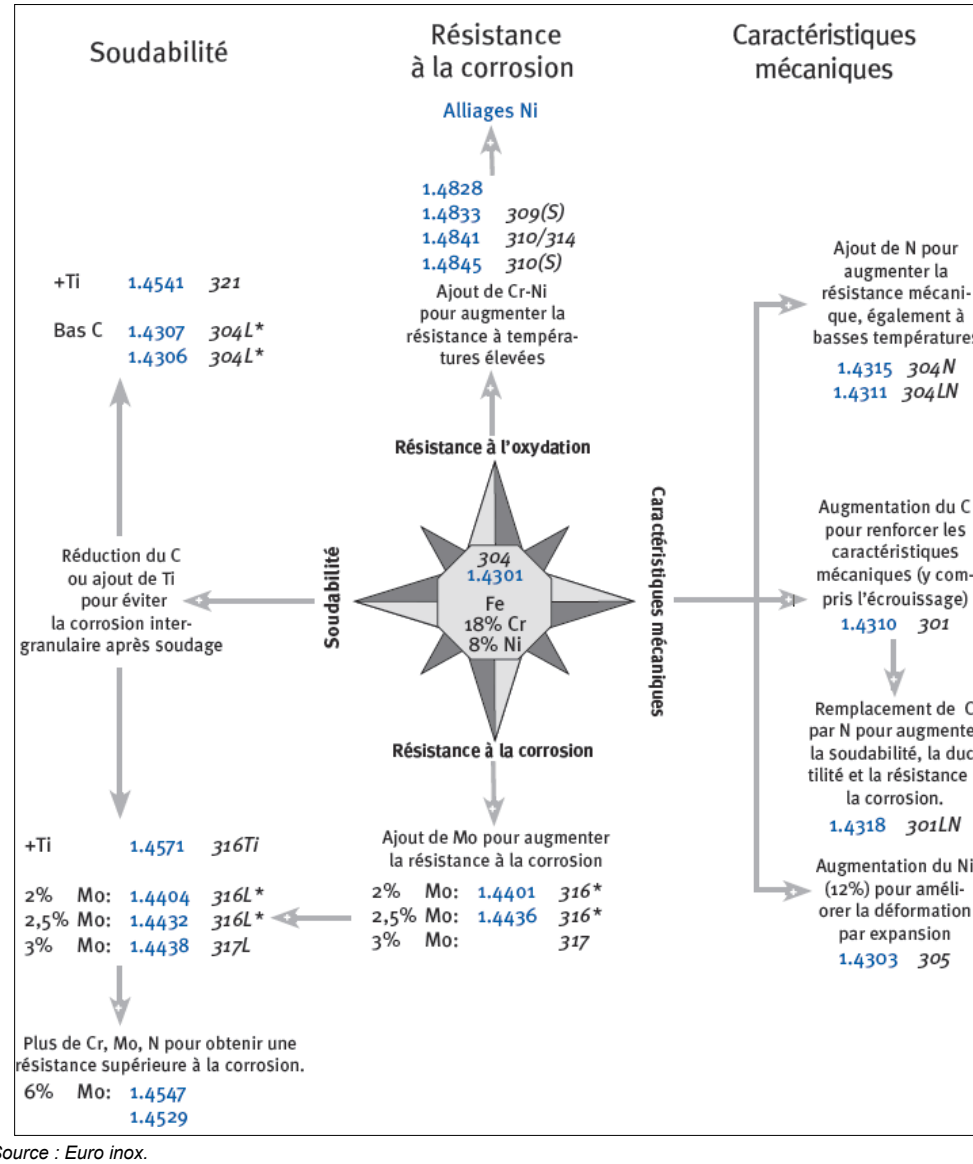
GENERALITIES

According the NFE EN 10020 norm, a stainless steel is a steel which contain at least 10,5% of chromium and at the maximum 1.2% of carbon. Stainless steel is an aloy of iron and elements that give it specific features.



Source : Euro inox.

One of the attribute the most important of stainless steels says « stainless steel » is their corrosion resistance. The resistance of these metal aloys to chimical raids of corrosive products, come from their ability to autoprotect by the spontaneous creation of an oxyde film rich in chromium, called « passive layer », that protects the metal substrate from the generalized corrosion and localized raids. This extremely thin layer, of a thickness around 1,0 or 2,0 nm, makes unimportant the speed of corrosion (cf. passivating).

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CHEMICAL FEATURES

I. Description of stainless steel groups and grades

1. Austenitic stainless steels (grades A1 to A5)

They are the most known and used among stainless steels. They contain, besides a minimal content of chromium about 17%, nickel (generally 7% and more) and potential build-up of molybdenum, titanium, niobium,…

In order to reduce the susceptibility to cold working, some copper may be added to A1 to A5 graded steels.

- Their mecanical features in tensile are generally low but can be, for certain grades, significantly increased by cold working. However, they are very indicated, due to the absence of fragility in low temperature, for the cryogenic uses.
- Their corrosion resistance increase with the content in chromium and molybdenum. Their oxidation resistance extends with their chromium content.
- The insertion of stabilizing elements like titanium or niobium enable to avoid the inter-granular corrosion, in particular on welds, and step the mechanical resistance up in high temperature.
- Temperature of use accepted in the job between -328°F and -688°F (-200°C and +400°C) (constant temperature).

When the risk of corrosion is high, experts will have to be consulted.

The final choice of the chemical composition for the specified steel grade is unknowed by the supplier, except preliminary agreement between him and the client.

Composition group	Steel grades	Chemical composition[a] massive fraction, %									Notes
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	
Austenitic	A1	0,12	1	6,5	0,2	0,15 to 0,35	16 to 19	0,7	5 to 10	1,75-2,25	b)c)d)
	A2	0,1	1	2	0,05	0,03	15 to 20	e)	8 to 19	4	f)g)
	A3	0,08	1	2	0,045	0,03	17 to 19	e)	9 to 12	1	h)
	A4	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10 to 15	4	g)i)
	A5	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10,5 to 14	1	h)i)

Norm ISO 3506-1.

a) Except opposite instruction, values are maximal.

b) Sulfur can be replaced by selenium.

c) If Ni < 8%, the Mn minimum must be 5%.

d) Any minimal limit for Cu content while the Ni content is > 8%.

e) The manufacturer can choose to add molybdenum. However, if some applications require a limitation of the molybdenum content, this requirement has to be stipulated by the client at the time of the order..

f) If the Cr content < 17%, the minimal Ni content has to be 12%.

g) For the austenitic stainless steels with a maximal 0.03% C content, the nitrogen content is limited to 0.22%.

h) Necessity to contain titanium ≥ 5 x C until 0,8% maximum for stabilization, and to be printed appropriately to this table or necessity to contain niobium and/or tantalum ≥ 10 x C until 1% maximum for stabilization and to be printed appropriately to this table.

i) The manufacturer can choose to increase the carbon content when the obtaining of mechanical features for higher diameters require it, but doesn't exceed 0,12% for the austenitic steels.

Composition	Grades	French designation	German designation	N°	USA AISI
Austenitic	A1	Z10CNF18.09	X10CrNi18-8	1.4310	301
		Z12CN18.09			
	A2		X3CrNiCu18-9-4	1.4567	302HQ
		Z8CNF18.09	X8CrNiS18-9	1.4305	303
		Z2CN18.10			
		ZCN18.09	X5CrNi18-10	1.4301	304
		Z6CNNb18.10	X6CrNiNb18-10	1.4550	347
		Z2CNU18.09			
		Z2CNU18.10			
		Z4CN18.12			
		Z3CN19.11	X2CrNi19-11	1.4306	304L
		Z5CN18.11 FF	X4CrNi18-12	1.4303	305
				1.4304	
				1.4329	
		Z3CN18.10	X2CrNi18-09	1.4307	304L
	A4	Z2CND17.12			
		Z6CND17.11			
		Z4CNUD17.11			
		Z3CND17.11.02	X2CrNiMo17-12-2	1.4404	316L
		Z7CND17.12.02	X5CrNiMo17-12-2	1.4401	316
		Z6CNDT17.12	X6CrNiMoTi17-12-12	1.4571	316Ti
		Z6CNDNb17.12	X6CrNiMoNb17-12-2	1.4580	316Cb
		Z3CND18.14.03	X2CrNiMo18-14-3	1.4435	316L
		Z6CND18.12.03	X3CrNiMo17-13-3	1,4136	316
	Resistant	Z15CNS25-20	X15CrNiSi25-20	1.4841	310
		Z8CN25-20	X8CrNi25-21	1.4845	310S
		Z6CNT18.10	X6CrNiti18-10	1.4541	321

(NF E 25-033 / NF A 35-602 / NF EN 10088-1 / NF EN 10095 / DIN 267 Teil 11).

A. A1 graded steels

A1 graded steels are specially reserved for machining. This steels group has a lesser resistance in the corrosion than the steels at the rate of normal sulfur due to the high rate of sulfur which they contain.

B. A2 graded steels

A2 graded steels are stainless steels the most used. They are used for cooking equipment, machines for chemical industry, fixing elements...

C. A3 graded steels

A3 graded steels are stabilized stainless steels with A2 graded steels features.

D. A4 graded steels

A4 graded steels, aloyed with molybdenum, are «acid resistants» and give a better corrosion resistance. A4 quality is very much used in cellulose industry since this steel grade is developped for boiled sulfuric acid (hence the « acid resistant » name), it is also suitable for chlorinated environments in a certain measure. A4 quality is also often used by food industry and shipbuilding industry.

E. A5 graded steels

A5 graded steels are stabilized steels «acids resistants».

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2. Martensitic stainless steels (C1 to C4 grades)

These steels contain generally 12 to 19 % chromium, there content in carbon varies from 0,08 to 1,2%, they may contain nickel and molybdenum and some build-up elements such as copper, titanium or vanadium.

Most of the time, they are delivered to the annealed state. Obviously, it is recommended to use them - in the same way as alloy steels for the mechanical engineering - in the returned tempered state - representing the best compromise between the mechanical properties and the corrosion resistance. They present a certain interest in the hot applications when the temperature of service does not exceed 650 ° C (turbines of power production).

In practice, we use them :
• Either after quenching and come back from slack around 392°F (200° C), which allows to keep the maximal mechanical resistance,
• Or after quenching and come back from 1022°F and 1292°F (550 et 700°C), so assuring a better compromise resistance - impact strength – corrosion stability.

These steels allow associate an interesting corrosion resistance (however lower than austenitic stainless steels), with equivalent mechanical features with top of the range alloyed steels' ones. They can be forged for the obtaining of a better resistance and they are magnetic.

The definitive choice about the chimical composition for the specified steel grade is unknown by the supplier, except preliminary agreement between him and the client.
A3 and A5 stabilized stainless steels or A2 and A4 stainless steel with a content in carbon not exceeding 0,03 % are recommended in the applications presenting a risk of intergranular corrosion.

Composition group	Steel grades	Chemical composition[a] massive fraction, %									Notes
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	
Martensitics	C1	0.09 to 0.15	1	1	0.05	0.03	11.5 to 14	-	1	-	i)
	C3	0.17 to 0.25	1	1	0.04	0.03	16 to 18	-	1.5 to 2.5	-	-
	C4	0.06 to 0.15	1	1.5	0.06	0.15 to 0.35	12 to 14	0,6	1	-	b) i)

Norm ISO 3506-1.

a) Except contrary indications, values are maximal.

b) Sulfur can be replaced by selenium.

i) The manufacturer can choose to increase the carbon content when the obtaining of mechanical features for higher diameters require it, but doesn't exceed 0,12% for the austenitic steels.

Composition group	Grade	French designation	German designation	N°	USA / AISI
Martensitics	C1	Z6C13			
		Z12C13			
		Z20C13	X20Cr13	1.4021	420
		Z30C13			
		Z10C13	X12Cr13	1.4006	410
		Z33C13	X30Cr13	1.4028	420F
		Z44C14	X46Cr13	1.4034	
	C3	Z15CN16.02	X17CrNi16-2	1.4057	431
		Z6CNU17.04			
	C4	Z12CF13			
		Z30CF13			
		Z11CF13	X12CrS13	1.4005	416

(NF E 25-033 / NF A 35-602 / NF EN 10088-1 / NF EN 10095 / DIN 267 Teil 11)

A. C1 graded steels
C1 graded steels have a limited corrosion resistance. They are used in turbines, pumps and cutlery.

B. C3 graded steels
C3 graded steels have a limited corrosion resistance even if it is better than C1 graded steels' one. They are used in pumps and valves.

C. C4 graded steels
C4 graded steels have a limited corrosion resistance. They are supposed to machining and they are, for the rest, similar to the C1 graded steels.

II. Informations

1. Warning about electrochimical zinc plating

The electrochimical zinc plating is a method of surface treatment allowing the improvement the corrosion resistance performance.

This method is used on quite small pieces, mass produced, like screws, nuts, hooks, etc.

Zinc covers applied in a electrolytic way receive a passivation in the chromium to improve the protection anticorrosion. Within the framework of the European legislation and the relative directive ROHS has the limitation of the use of certain dangerous substances such as the hexavalent chromium (chromium VI), all the measures were taken towards our suppliers so that the constituent materials of the products which we store having were the object of a surface treatment, do not contain forbidden substances by the current regulations.

However, it is established that this type of treatment can have as possible consequence the embrittlement of the product by the hydrogen.

This is a consequence known for electrolytic covers. This phenomenon can be stressed since the mechanical resistance or the hardness of the element of fixation is raised.

The hydrogen which weakens the product can be introduced (ref: ISO 4042):
· Within the framework of procedures of smoothing, scrouping, phosphatation or electrolytic deposit
· Within the framework of the environment of service further to reactions of cathodic protections or the corrosion reactions.
· Within the framework of operation of chaudronnage, fluorescent turning, machining and drilling because of the decomposition of inappropriate lubricating products as well as during the operations of soldering and brazing.
Hypothetically, the consequence may be a postponed break from the fixation element.
To decrease the known risk, the degassing operation further electrolytic coating is necessary because it gonna eliminate hydrogen.
The fixation elements in zinc-plated steel proposed by ACTON are supplied with imperative degassing.

Nevertheless, it is clearly established that the recommended degassing can not eliminate totally and in every case the embrittlement by hydrogen. When the risk is not acceptable, for safety pieces or the particular conditions of use, it will be advisable to use processes of covers of surfaces allowing a protection without introduction of hydrogen (DACRO-PUTS, DEPTON, GEOMET) or choose products not dressed in type stainless steel.

2. Seizing

The state of surface of the material is generally a dominating factor in the appearance of the phenomena of seizing.

However, for stainless steels, other parameters come into play. When we tighten a screw on a nut, only 10 % of the tightening torque really contributes to the tightening (axial effort), the rest dissipates in the frictions on the threading and under the head of screw (tangential effort). The friction is necessary to avoid the loosening in time. However, if it becomes too important, there is seizing, which results from micro-stickings occurring for example between nets: the loosening of the nut becomes impossible and the screw under the effort can break. It is thus necessary to find solutions to avoid the increase of the friction. By the measure, we know how to determine from which tightening torque the seizing risks to arise: indeed, knowing that the coefficient of friction must be constant, from a certain value of the torque, a sensitive increase of this coefficient reveals a phenomenon of seizing. It is thus necessary, to raise the threshold of seizing, to act on the coefficient of friction nets / nets.

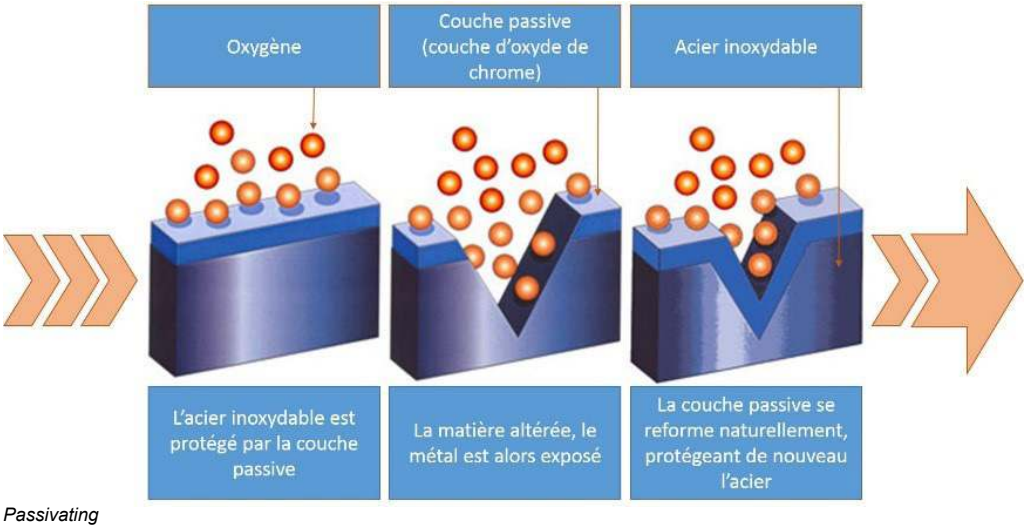
The resistance of seizing can be reduced thanks to the contribution of various types of treatments such as:

- Decontamination, passivating: return to surfaces their homogeneity and reconstitute the film of passivity,
- Cover of lubrication reducing the coefficient of friction.
- The argenture: very interesting in the field of the friction and especially used for the improvement of the resistance in the seizing of stainless steels
- Type Molykote's covers (containing of the bisulfite of molybdenum) or PTFE (teflon).

Use one screw of a grande and a nut of another grade do not really avoid the risks of seizing. (Stainless Id source)

3. Passivating

Faculty of the stainless steel to auto-protect itself by spontaneous training on its surface of a film of oxides rich in chromium, called « passive layer ».



Passivating

4. Salt spray

The corrosion resistance of the elements in stainless steel fixation depends essentially:

Of the layer of passivation: creation on the surface of the metal, the fine layer of oxide of chromium.

The importance of the protection varies according to the thickness of the film, its homogeneity, its adhesion and some distribution of the oxygen and the metal inside the oxide. But also of the state of surface of the element of fixation (Presence of small ferrous particles, defects… inherent to the various used manufacturing processes).

To resist the corrosion, an element of stainless steel fixation has to be:
- Cleaned: elimination of the disruptive chemical elements of the surface (ex: small ferrous particles.)
- Passivated : we can thus consider that a correctly cleaned piece and passivated will present an excellent corrosion resistance.

Salt spray resistance (For information purposes) of:

- The A2 stainless steel: is situated betwwen 200h and 600h.
- The A4 stainless steel: is situated between 600h and 1000h.

However, it does not exist a method allowing to make a perfect piece, exempt small ferrous particles or defects of surface.
There is thus really no rule concerning the corrosion resistance of a stainless steel. The appearance of spots of rust before 200 or 600 hours is possible if the cleaning or the passivation did not allow to obtain a satisfactory result, but it will be about a located esthetic corrosion which will not affect the mechanical features of the element of fixation.

5. Electrochemical torque

The association of metallic materials of various nature can accelerate the corrosion of the lowest material: galvanic corrosion.

6. Finition

Unless otherwise specified, the elements of fixation must be supplied clean and brilliant. It is recommended to proceed to a passivation to obtain a maximal corrosion resistance.

We shall also note that to obtain a good corrosion resistance, it is necessary to assemble the screw with a stainless steel internal thread of the same nature (ex: screw A2 with nut A2).

▸ MECHANICAL FEATURES

The indicated features below concern elements of fixations made with austenitic and martensitic grades of stainless steels.

The concerned products are planned to be used in a current corrosive atmosphere and their mechanical features are established at room temperature between 59°F and 77°F (15 ° C and 25 ° C).
The particular conditions, such as temperature or potential variations, alternations of the corrosive action, the strain hardening premises or state of surface of the metal,… can modify considerably the behavior of determined steel when it is subjected to the action of a corrosive environment.
In the case of use in a particular corrosive atmosphere, or for temperatures which go away from trial conditions, an agreement has to intervene with order between the customer and the supplier concerning the level of the corrosion resistance and the wished mechanical features.

I. For screws and studs

Field of application:

The mechanical features below are applicable to screws and studs :
• Nominal diameter of threading d ≤ 2,4233e-5 miles (d ≤ 39 mm)
• In ISO triangular metric thread among whom the diameter and the step are in accordance with the ISO68-1, with the ISO 261 and with the ISO 262.
• Of any shape,
• They don’t apply to screws possessing special features such as weldability.

1. Screws

All the screws with hexagonal head and six lobe pan head machine screws or hexagon socket head cap screws whose nominal diameter of thread is d ≥ 3,1069e-6 miles (d ≥ 5 mm) have to be clearly marked. The marking has to include the grade of steel and the quality class.

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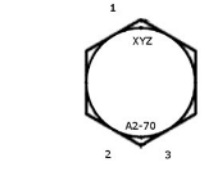
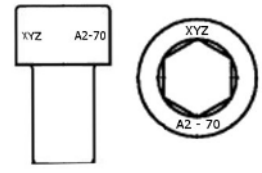
2. Studs

The studs of nominal diameter with thread d ≥ 3,7282e-6 miles (d = 6 mm) must be clearly marked.

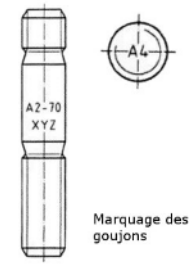
The marking must be applied to the part not threaded by the stud and has to contain the grade and the quality class of the steel. If it turns out impossible to mark the not thread part, only the grade of steel is marked in the extremity thread by the stud.



Marquage des vis à tête hexagonale



Marquage des vis à tête cylindrique à six pans creux et à six lobes internes



Marquage des goujons

1 = Identification du fabricant
2 = Nuance d'acier
3 = Classe de qualité

Mechanical features for screws and studs - Austenitic steel grades

Composition group	Grades	Quality	Traction resistance Rm[a] min MPa	Conventional elasticity limit (0.2%) Rp 0.2[a] min MPa	Elongation after rupture A[b] min mm
Austenitic	A1, A2, A3, A4, A5	50	500	210	0.6 d
		70	700	450	0.4 d
		80	800	600	0.3 d

Norm ISO 3506-1.

a) the tensile strength is calculated according to the resistance of the section (ISO 3506-1 annexe A)

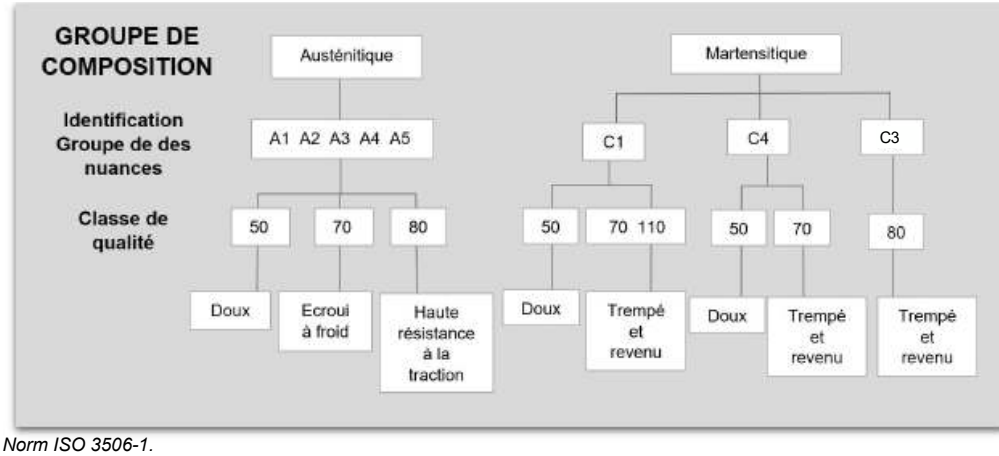
b) to determine in compliance with ISO 5506 - 7.2.4 according to the real length of the screw and not on a prepared test tube.

Minimal breaking torque, MBmin – Austenitic stainless steel screw M1,6 to M16 (coarse pitch).

Minimal values of breaking torques of martensitic steel fixation elements have to be the subject of an agreement between the client and the supplier.

Threading	Breaking torque, Mb (min. Nm.)		
	Quality		
	50	70	80
M 1.6	0.15	0.2	0.24
M 2	0.3	0.4	0.48
M 2.5	0.6	0.9	0.96
M 3	1.1	1.6	1.8
M 4	2.7	3.8	4.3
M 5	5.5	7.8	8.8
M 6	9.3	13	15
M 8	23	32	37
M 10	46	65	74
M 12	80	110	130
M 16	210	290	330

Norm ISO 3506.1

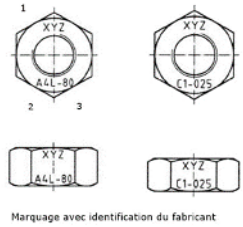


Norm ISO 3506-1.

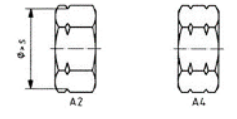
I. For nuts

The mechanical features below are applicable for nuts :

Nominal diameter of threading D ≤ 2,4233e-5 (D≤39 mm).
• Triangular ISO metric thread whose diameter and pitch are in accordance with ISO 68-1, with l'ISO 261 and with ISO 262.
• Of any shape
• with quotations such as specified in the ISO 272.
•whose the nominal height m ≥ 0,5 D.
They don't apllied nuts getting specific features such as :



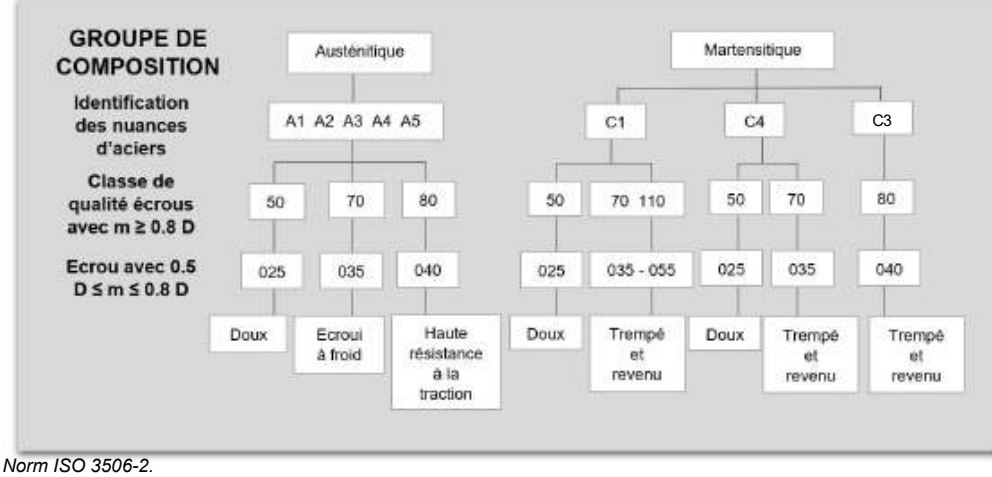
Marquage avec identification du fabricant



Marquage par entailles pour nuances d'acier A2 et A4 uniquement

• Braking loadibility
• Weldability

The marking is compulsory on the nuts of nominal diameter of threading d ≥ 5 mm. It has to include the grade and the quality class of the steel. The marking of a single face of the nut is acceptable and has to be in hollow only when it is applied to the face of contact of the nut. The marking is also tolerated on the side of the nut. When the marking is established by notches (see the drawing 2) without indication of the quality class, it is the quality class 50 or 025 which applies.



Norm ISO 3506-2.

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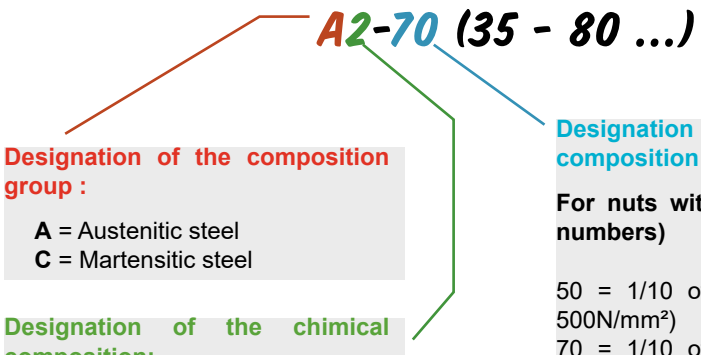
The designation by a code composed of a lettre followed with 2 numbers on the meaning below :



A2 - 70 would thus indicate austenitic steel forged under cold conditions, whose minimal resistance in the tensial is equal to 700 N / mm ² (700 MPa).
The marking of low-carbon stainless steels not exceeding 0.03 % can be completed by the letter L (Ex: A4L - 80).

Mechanical features for nuts - Austenitic steel grades

Composition group	Steel grades	Quality		Resistance to the load test SP min MPa	
		Nuts with m ≥ 0.8 D	Nuts with 0.5 D ≤ m < 0.8 D	Nuts with m ≥ 0.8 D	Nuts with 0.5 D ≤ m < 0.8 D
Austenitic	A1, A2, A3, A4, A5	50	025	500	250
		70	035	700	350
		80	040	800	400

Norm ISO 3506-2.

III. For socket set screws

Hexagon socket set screws have to be in accordance with tensial torques requirements below :

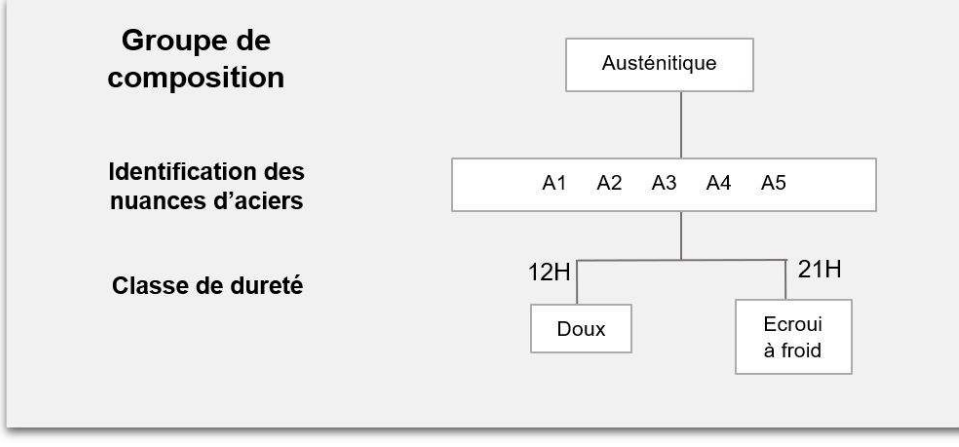
Threading nominal diameter (d) min	Min. length[a] of the tested socket set screwi				Hardness	
					12 H	21 H
	Flat end	Cone point	Bout à téton	Bout à cuvette	Testing torque min Nm	
1.6	2.5	3	3	2.5	0.03	0.05
2	4	4	4	3	0.06	0.1
2.5	4	4	5	4	0.18	0.3
3	4	5	6	5	0.25	0.42
4	5	6	8	6	0.8	1.4
5	6	8	8	6	1.7	2.8
6	8	8	10	8	3	5
8	10	10	12	10	7	12
10	12	12	16	12	14	24
12	16	16	20	16	25	42
16	20	20	25	20	63	105
20	25	25	30	25	126	210
24	30	30	35	30	200	332

1/10th of the minimal hardness Vickers followed by the letter H indicating the hardness.

Designation of the quality according to Vickers hardness

Quality class	12 H	21 H
Vickers hardness HV min	125	210

Norm ISO 3506-3.



Norm ISO 3506-3.

The marking of socket set screws and similar threaded fixation elements is not compulsory.

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III. For self-tapping screws

Tensial strength
Stainless steel self-tapping screws must have a tensial strength such as the necessary torque necessary to cause a failure is equal or upper to the minimal values of torques given in the board following for the class of considered quality:

Forming capacity of the threading
Stainless steel self-tapping screws must create a corresponding thread, without distortion of their own thread, according to the following prescriptions:

The screw (dressed or not) must be screwed in a plate until a complete net crosses it completely.

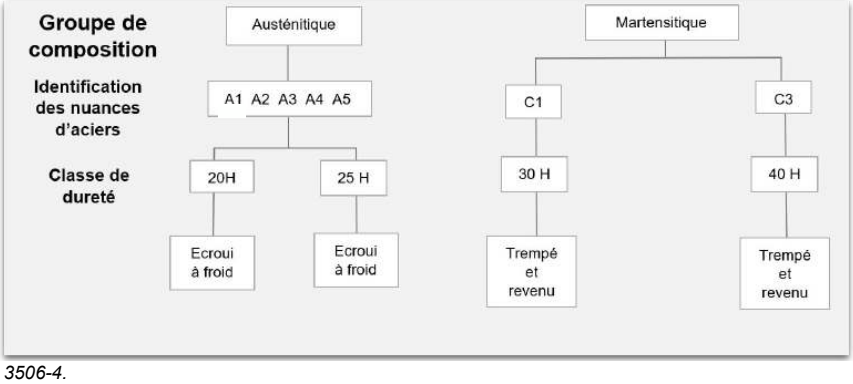
For more information, refer to the family of self-tapping screws.

The marking of self-tapping screws is not compulsory.
1/10th of the minimal hardness Vickers followed by the letter H indicating the hardness.

Threading	Breaking torque, Mb min, Nm			
	Hardness class			
	20 H	25 H	30 H	40 H
ST 2.2	0.38	0.48	0.54	0.6
ST 2.6	0.64	0.8	0.9	1
ST 2.9	1	1.2	1.4	1.5
ST 3.3	1.3	1.6	1.8	2
ST 3.5	1.7	2.2	2.4	2.7
ST 3.9	2.3	2.9	3.3	3.6
ST 4.2	2.8	3.5	3.9	4.4
ST 4.8	4.4	5.5	6.2	6.9
ST 5.5	6.9	8.7	9.7	10.8
ST 6.3	11.4	14.2	15.9	17.7
ST 8	23.5	29.4	32.9	36.5

Norm ISO 3506-4.

ST = abreviation of « Spaced Thread »



Norm ISO 3506-4.

1/10th of the minimal hardness Vickers followed by the letter H indicating the hardness.

III. For self-drilling screws

Self-drilling screws are elements of assembly allowing to realize in a single operation, the drilling of a front correct hole, the tapping by distortion and the reliable fixation.

They are screws intended for not structural assemblies (effort of low tightening, not or few requests in service).

Main applications :
- Panels
- Air and heating duct
- Holdhouse appliances
- Body work
- Window frame and blinds
- Facades and cladding

Conditions of installation:
The installation has to be realized with electric tools according to the screwing only. The use of the function impact is forbidden.

So that screws have an optimal capacity of drilling, the parameters below must be applied and respected:

NB: the failure to respect the conditions of installation can lead to the deterioration of the screw and to the incapacity of drilling.
In case the pressure of assembly is insufficient during the drilling and/or the rotation speed is too important, the point can overheat and prevent the realization of the before-hole.

Threading dimensions	Maximum thickness of plates (mm)	Recommended axial force (N)	Optimum rotation speed under load (tr/min)	Minimum breaking torque (Nm)
ST 2.9	0,7 + 0,7 = 1,4	150	between 1 800 and 2 500	1.5
ST 3.5	1 + 1 = 2	150	between 1 800 and 2 500	2.8
ST 3.9	1 + 1 = 2	150	between 1 800 and 2 500	3.4
ST 4.2	1,5 + 1,5 = 3	250	between 1 800 and 2 500	4.5
ST 4.8	2 + 2 = 4	250	between 1 800 and 2 500	6.5
ST 5.5	2 + 3 = 5	350	between 1 000 and 1 800	10
ST 6.3	2 + 3 = 5	350	between 1 000 and 1 800	14

ST = abreviation of « Spaced Thread »

Breaking torque :

The aim of the self-drilling screws is not replace elements of bolt manufacture. So, they don't have the same resistances (tensile, shearing and torsion).

The norms do not determine tensile tests and shearing for self-drilling screws.
These values, which depend on the nature of materials and on the strengths in presence, can be determined only in real conditions.
Thus it is advisable to appeal to an engineering consulting firm to obtain a specifications.
The engineering consulting firm is also going to determine the nature of the element of fixation (Zinc-plated Steel, Galvanized, stainless Steel etc. …) the most adapted in the environment in which this element of fixation will be put.

III. For wood screws

Screws wood are standardized according to the NF norm E25-600 among which this one determines the main dimensions.

This norm defined also minimal tensile torque (to see board below) but it does not standardize the resistances in the stripping and in the shearing.
The resistance in stripping and in the shearing of a wood screw depends on conditions of installation (nature of the wood, the rate of humidity in the wood, force in presence etc.)
These values can be determined only in real conditions, it is thus advisable to appeal to an engineering consulting firm to obtain a specifications.
The engineering consulting firm also goes to determine the nature of the element of fixation (zinc-plated, stainless steel…) the most adapted in the environment in which this element of fixation will be put.

Diameter (d)	Minimal torque (Nm)
1.6	0.2
2.	0.3
2.5	0.4
3	0.8
3.5	1.2
4	1.5
4.5	2.5
5	3.5
5.5	4
6	5
7	8
8	15
10	25
12	40
14	70
16	120
18	170
20	250