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Technical data sheet

Title	Mechanical properties of corrosion-resistant stainless steel fasteners. Part 2 Nuts.
Standard	ISO 3506-2:2009

1.- Purpose and field of application.

This part of the ISO 3506 standard specifies the mechanical properties of corrosion-resistant austenitic, martensitic and ferritic stainless steel nuts, tested at an ambient temperature of between 10ºC and 35ºC. These properties will vary at higher and lower temperatures.

It applies to nuts:

- with nominal thread diameter (*d*) of up to 39 mm, inclusive;
- With ISO triangular metric thread with diameter and pitch in accordance with the ISO 68-1, ISO 261 and ISO 262 standards;
- or any shape.
- with distances between faces as specified in the ISO 272 standard;
- with nominal height of 0.5*d* or above.

This part of the ISO 3506 standard does not apply to nuts with special characteristics, such as:

- locking capacity;
- weldability.

This part of the ISO 3506 standard does not define resistance to corrosion or oxidation in particular environments.

This part of the ISO 3506 standard aims to establish a classification of the quality classes of the corrosion-resistant stainless steel fasteners. Some materials can be used at low temperatures, up to -200ºC, while others can be used at high temperatures, up to 800ºC in the air. Annex E provides some information about how temperature influences the mechanical properties.

Resistance to corrosion and oxidation, as well as the mechanical properties at high temperatures or at temperatures below zero degrees, must be agreed upon between the customer and the manufacturer for each case. Annex F shows how the risk of intergranular corrosion at high temperatures depends on the carbon content.

All the austenitic stainless steel fasteners are non-magnetic in hyper-tempered [annealing status]; some magnetic properties may be revealed after a cold deformation (see Annex G).

2- Designation, marking and finish.

2.1 Designation

The designation system for the classed products and quality classes of stainless steels for nuts is illustrated in figure 1. The material designation consists of two groups of characters separated by a dash. The first designates the steel classed product and the second designates the quality class.

The designation of the steel classed product (first group) consists of one of the following letters:

A for austenitic steels;

C for martensitic steels;

F for ferritic steels.

which designates the steel group and a number that designates the chemical composition within the steel group.

The designation of the quality class (second group), for nuts with height of $m \geq 0.8d$ (type 1), consists of two numbers that indicate 1/10 of the resistance at the test load, and three numbers for nuts with height of $0.5d \leq m < 0.8d$ (narrow nuts), of which the first number indicates that the nut has a reduced permissible test load, and the next two numbers indicate 1/10 of the resistance at the test load.

Examples of material designation:

1) **A2-70** indicates:

an austenitic steel, hardened by cold deformation, with tensile strength of 700 N/mm^2 (700 Mpa) (type 1 nut).

2) **C4-70** indicates:

a martensitic steel, hardened and tempered, with tensile strength of 700 N/mm^2 (700 Mpa) (type 1 nut).

3) **A2-035** indicates:

an austenitic steel, hardened by cold deformation, with minimum tensile strength of 350 N/mm^2 (350 Mpa) (narrow nut).

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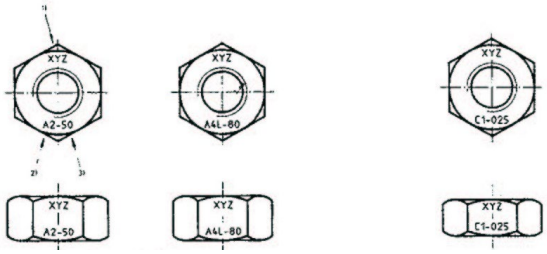
Fig. 1 – Designation system for classed products and classes of stainless steels for nuts

2.2 Marking

The pieces must be marked and/or described with the designation system described in section 2.1, only if all the conditions established in this part of the ISO 3506 standard are met.

2.2.1 Nuts. Marking is required on nuts with nominal thread diameter $d \geq 5$mm, and must be done as indicated in section 2.1 and in figures 1 and 2; it must include the classed product and the quality class of the steel and the manufacturer identification mark whenever technically possible. Marking is allowed on one face only and, when on the contact face of the nut, must be done using indentation. Marking is also permitted on a lateral face of the nut.

When the marking is done using notches (see figure 2), without indication of the quality class, it shall be understood to refer to classes 50 or 025.

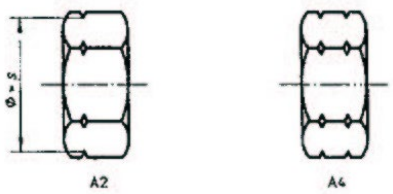


1) Manufacturer identification mark

2) Classed product

3) Quality class

Marking with manufacturer identification mark and material designation



s is the width between faces

Fig. 2 – Marking of nuts

2.2.3 Packaging. All packages of any size must be marked with the designation and with the manufacturer's registered trademark. As defined in the ISO 16426 standard.

2.3. Finish. Except when indicated otherwise, fasteners that meet the requirements of this part of the ISO 3506 standard must be supplied clean and shiny. If a passivation is done for greater resistance to corrosion, it must be done in accordance with ISO 16048.

3- Chemical composition.

The chemical composition of the stainless steels of the fasteners that meet the requirements of this part of the ISO 3506 standard are included in table 1.

Except when otherwise agreed upon beforehand by the buyer and the manufacturer, the definitive chemical composition chosen for the steel classed product is left to the manufacturer.

For applications with a risk of intergranular corrosion, it is recommended to do the test described in the ISO 3651-1 standard or in the ISO 3651-2 standard. In these cases, stabilised steels A3 and A5 or stainless steels A2 and A4 with carbon content not exceeding 0.03% are recommended.

4- Mechanical properties.

The mechanical properties of the nuts that meet the requirements of this part of the ISO 3506 standard must comply with the values given in tables 2 or 3.

For the purposes of acceptance, the mechanical properties specified in this chapter apply and must be tested as follows:

- Hardness test, as indicated in section 7.1 (only for products in class C1, C3 and C4, after a hardening and tempering treatment);
- test load test, as indicated in section 7.2.

5- Testing methods.

5.1 HB, HRC or HV Hardness

The hardness test must be done as indicated in the standards ISO 6506-1 (HB), ISO 6508-1 (HRC) or ISO 6507-1 (HV).

In the event of a dispute, the Vickers hardness test is taken as a reference for acceptance.

The operational procedure for the test must be done as specified in the standards ISO 898-2 and ISO 898-6.

The hardness values must fall between the limits established in table 3.

Table 1

Stainless steel classed products. Chemical composition

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Group	Classed product	Chemical composition % (m/m)[a]									Notes
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	
Austenitic	A1	0.12	1	6.5	0.2	0.15-0.35	16 to 19	0.7	5 to 10	1.75 to 2.25	bcd
	A2	0.10	1	2	0.05	0.03	15 to 20	-[e]	8 to 19	4	fg
	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	gi
	A5	0.08	1	2	0.045	0.03	16 to 18.5	2 to 3	10.5 to 14	1	hi
Martensitic	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	0.08 to 0.15	1	1.5	0.06	0.15-0.35	12 to 14	0.6	1	--	bi
Ferritic	F1	0.12	1	1	0.04	0.03	15 to 18	j	1	--	kl

NOTES

1. Annex A includes a description of the groups and stainless steel classed products, including their properties and applications.
2. Annexes B and C include examples of stainless steels standardised in the ISO 683-13 and ISO 4954 standards, respectively.
3. Annex D includes materials for specific uses.

a) Except when indicated otherwise, the values are maximum values.
b) Sulphur may be substituted for selenium.
c) If the nickel content is under 8%, the minimum magnesium content must be 5%.
d) There is no limit on the copper content as long as the nickel content is above 8%.
e) Molybdenum may be added at the manufacturer's discretion. However, when it is necessary to limit the content of this element for certain applications, the buyer must specify as such in the order.
f) If the chromium content is under 17%, the minimum nickel content must be 12%.
g) For austenitic stainless steels with a maximum carbon content of 0.03%, the nitrogen may be limited to 0.22%.
h) If to stabilise the steel it is necessary to add titanium, niobium or tantalum, in order to designate these steels according to this table, the titanium content must be 5 x C or above, with a maximum of 0.8%, or the niobium and/or tantalum content must be 10 x C or above, with a maximum of 1%.
i) The carbon content may be increased, at the manufacturer's discretion, when required to obtain the mechanical properties at larger diameters, but it must not ex austenitic steels
j) Molybdenum may be added at the manufacturer's discretion.
k) It may contain titanium at 5 x C or less, to a maximum of 0.8%.
l) It may contain niobium and/or tantalum at 10 x C or less, to a maximum of 1%.

Table 2

Mechanical properties of the nuts. Austenitic steels

Group	Classed product	Quality class		Strength in the test load S_p min. N/mm$_2$ (MPa)	
		Type 1 nut ($m \geq 0.8d$)	Narrow nuts ($0.5 \leq m < 0.8d$)	Type 1 nut ($m \geq 0.8d$)	Narrow nuts ($0.5 \leq m < 0.8d$)
Austenitic	A1, A2	50	025	500	250
	A3, A4	70	035	700	350
	A5	80	040	800	400

Table 3

Mechanical properties of the nuts. Martensitic and ferritic steels

Group	Classed product	Quality class		Strength in the test load, S_p min. N/mm² (MPa)		Hardness		
		Type 1 nut ($m \geq 0.8d$)	Narrow nuts ($0.5 \leq m < 0.8d$)	Type 1 nut ($m \geq 0.8d$)	Narrow nuts ($0.5 \leq m < 0.8d$)	HB	HRC	HV
Martensitic	C1	50	025	500	250	147 to 209	--	155 to 220
		70	--	700	--	209 to 314	20 to 34	220 to 330
		110[a]	055[a]	1100	550	--	36 to 45	350 to 440
	C3	80	040	800	400	228 to 323	21 to 35	240 to 340
	C4	50	--	500	--	147 to 209	--	155 to 220
		70	035	700	350	209 to 314	20 to 34	220 to 330
Ferritic	F1[b]	45	020	450	200	128 to 209	--	135 to 220
		60	030	600	300	171 to 271	--	180 to 285

[a] Tempered and hardened at a minimum temperature of 275ºC.

[b] Nominal thread diameter $d \leq 24$ mm.

5.2 Test load

The operational procedure and the test criteria must be in accordance with the ISO 892-2 and 898-6 standards.

ANNEX E (Informative)

MECHANICAL PROPERTIES AT HIGH TEMPERATURES;

APPLICATION AT LOW TEMPERATURES

NOTE – If the bolts, screws and studs are calculated correctly, the corresponding nuts will automatically meet the requirements. However, in applications at high and low temperatures, it is enough to consider the mechanical properties of the bolts, screws and studs.

D.1 Yield stress limit or conventional yield strength at 0.2% at elevated temperatures

The values given in this annex are for information purposes only. Users must understand that, due to the current chemistry, the loads to which the fasteners are subjected and the medium may vary significantly. Customers must consult the manufacturer if the loads fluctuate and if there are long periods of operating at high temperatures or if the possibility of increased corrosion is significant.

Table E.1 includes the variation percentages of the yield stress limit (R_{eL}) and the conventional yield strength ($R_{p0.2}$) at high temperatures, compared to these yield strength limits at ambient temperature.

Table E.1

Influence of temperature on R_{eL} and $R_{p0.2}$

Steel classed product	R_{eL} and $R_{p0.2}$ %			
	Temperature			
	+100ºC	+200ºC	+300ºC	+400ºC
A2, A3, A4, A5	85	80	75	70
C1	95	90	80	65
C3	90	85	80	60

NOTE – Only for quality classes 70 and 80.

E.2

Application of stainless steel bolts, screws and studs at low

Temperatures (only austenitic steels)

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Classed product	Lower operating temperature limits in continuous use	
A2, A3	-200ºC	
A4, A5	Bolts and screws [a]	-60ºC
	Studs	-200ºC

[a] In relation to the alloying element Mo, the stability of the austenite is reduced and the transition temperature is brought to higher values if the fastener is subjected to a strong deformation during manufacturing.

ANNEX F (Informative)

MAGNETIC PROPERTIES OF AUSTENITIC STAINLESS STEELS

All the austenitic stainless steel fasteners are normally not magnetic; after a cold deformation some magnetic properties may be revealed.

Every material is characterised by its ability to magnetize (magnetization), and this law also applies to stainless steels. They are only likely to be completely non-magnetic in a vacuum. The measure of permeability of a material placed in a magnetic field is the permeability value μ_r of this material in relation to a vacuum. The material has a weaker permeability the closer μ_r gets to 1.

EXAMPLES:

A2: $\mu_r \approx 1.8$

A4: $\mu_r \approx 1.015$

A4L: $\mu_r \approx 1.005$

F1: $\mu_R \approx 5$