KARA Ferritic Stainless Steel

K45 20% Chromium, Niobium stabilized

KARA key for value

Chemical Composition

Elements (%)	C	Si	Mn	Cr	Nb	Cu
K45	0.015	0.25	0.25	20.20	0.45	0.45

Typical values

European designation	American designation
X2CrNbCu21/1.4621 [1]	UNS 44500 [2]

[1] According to NF EN 10088-2

[2] According to ASTM A 240

This grade complies with:

- Stainless Europe Material Safety Data Sheet No. 1: stainless steels (European Directive 2001/58/EC).
- European Commission Directive 2000/53/EC for end-of-life vehicles, and Annex II, dated 27 June 2002
- Standard NFA 36 711 "Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption" (non packaging steel)
- NSF/ANSI 51-2009 edition International Standard for "Food Equipment Materials" and F.D.A. (United States Food and Drug Administration) requirements regarding materials used for food contact
- French Decree No. 92-631, dated 8 July 1992, and Regulation No. 1935/2004 of the European Parliament and the Council, dated 27 October 2004, on materials and articles intended to come into contact with food (and repealing Directives 80/590/EEC and 89/109/EEC)
- French Order, dated 13 January 1976, relating to materials and articles made of stainless steel in contact with foodstuffs

Key Features

- Resistance to pitting corrosion is equivalent to grade 304
- Suitable for exposure in moderately aggressive industrial and urban environments
- Good resistance to salt spray test
- Excellent polishability
- Good mechanical properties at high temperatures

Applications

- Automotive: internal and external decorative trims, model name plates, sill and door protectors, roof rails, hub caps and lock-nuts, various fasteners and accessories
- External parts of refrigerated trailers
- Household appliances and domestic equipment
- Cookware
- Commercial food equipment, various parts and equipment for catering
- Elevators, doors and cabins.
- Construction: traditional roofing, roofing profiles, self-supporting trays, facades, cassette panels, composite panels, street furniture, decoration, accessories

Product Range

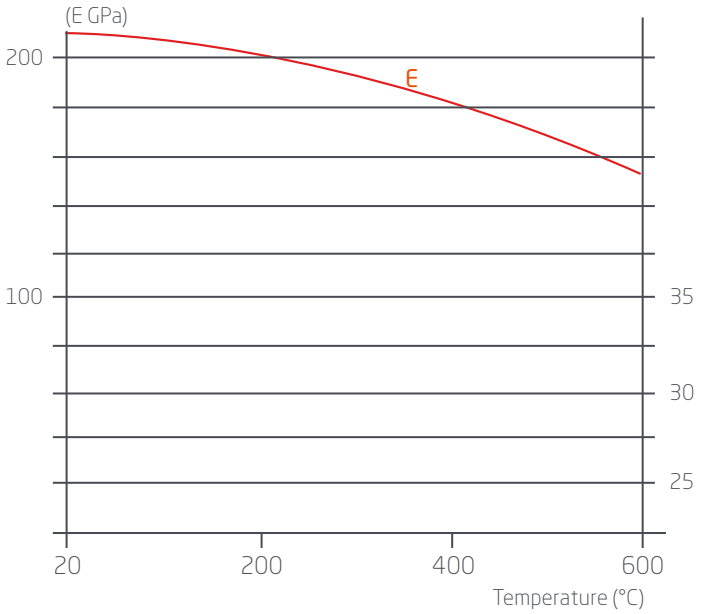
	Coils	Sheets / Blanks	Discs
Thickness (mm)	0.40 up to 4	0.40 up to 4	0.40 up to 2
Width (mm)	up to 1,524	up to 1,250	Ø 15 up to 1,000
Finish	2R / 2B / 2D	2R / 2B / 2D	2R / 2B / 2D

Please contact us regarding all other dimensions, forms and finishes.

Physical Properties

Cold rolled and annealed sheet

Density	d	kg/dm³	20°C	7.7
Melting temperature		°C		1,500
Specific heat	c	J/kg.K	20°C	450
Thermal conductivity	k	W/m.K	20°C	21.3
Mean thermal expansion coefficient	α	10^{-6}/K	20-200°C 20-400°C 20-600°C 20-800°C	11.5 12 12.6 13.5
Electric resistivity	ρ	Ω mm²/m	20°C	0.70
Magnetic resistivity	μ	at 0.8 kA/m DC or AC	20°C	550
Young's modulus	E	GPa	20°C	210



Mechanical Properties

Test piece

Length = 80 mm (thickness < 3 mm)
Length = 5.65 √ S_o (thickness ≥ 3 mm)

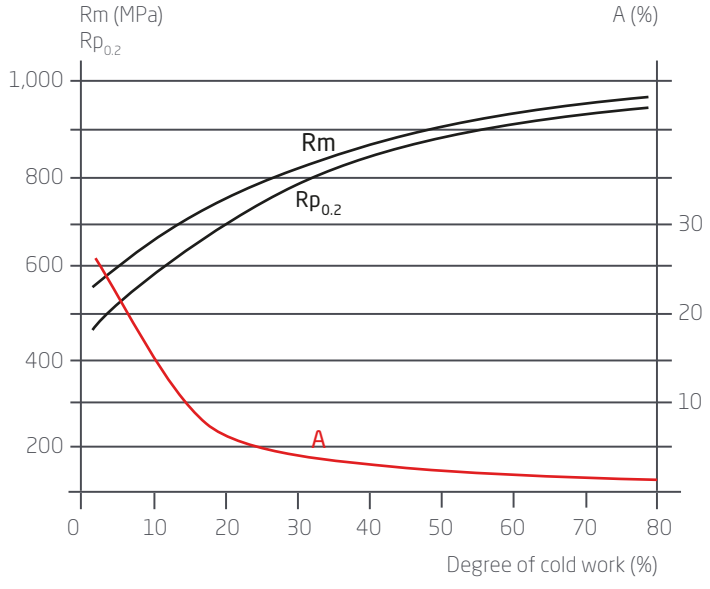
In the annealed condition

In accordance with ISO 6892-1, part 1
Test piece perpendicular to rolling direction

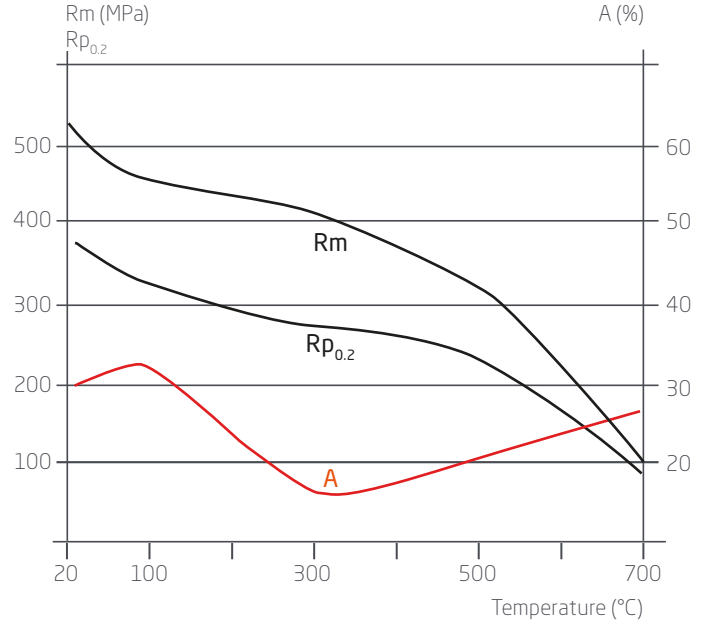
Grade	Condition	Rm(1) (MPa)	$Rp_{0.2}$(2) (MPa)	A(3) %	HRB
K41	Cold- rolled	480	310	30	78

1 MPa = 1 N/mm² - Typical values
(1) Ultimate Tensile Strength (UTS) - (2) Yield Strength (YS) - (3) Elongation (A)

Effect of cold rolling (Typical values)



At high temperatures (Typical values)



Corrosion Resistance

With a chromium content in excess of 20%, this grade offers good resistance to pitting corrosion (resistance is equivalent to that of our 304 grade).
Our K45 grade also has good resistance to urban and rural atmospheres and to fresh water.
Furthermore, K45 exhibits good resistance to salt spray corrosion and is not susceptible to stress corrosion cracking.

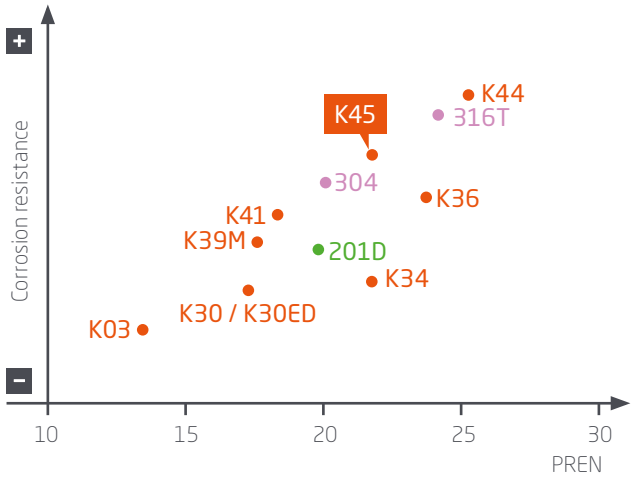
Resistance to localised corrosion

Grades	Norms		
	ASTM	UNS	EN
K03		S41003	1.4003
K30/K30ED	430	S43000	1.4016
K39M	430Ti	S43036	1.4510
K41	441(1)	S43932	1.4509
K34	434		1.4113
K45	445(1)	S44500	1.4621(2)
K36	436	S43600	1.4526
K44	444	S44400	1.4521
201D	201.1	S20100(3)	1.4618(2)
304	304	S30400	1.4301
316T	316Ti	S31635	1.4571

(1) Common designation - (2) Pending update of the standard - (3) With copper addition and 2010.1 "rich side" properties per ASTM A240

Pitting corrosion

Typical values of pitting corrosion potential in NaCl 0.02M, 23°C, pH6.6 as a function of PREN (%Cr+3.3%Mo+16%N).



Forming

Our K45 grade can be cold formed using all common processes (folding, contour forming, bending, deep drawing, slitting, etc.).
Thicknesses less than 0.7 mm can be folded sharply through 180°. For larger thicknesses, the minimum bending radius (r) is related to the thickness (t) by r ≥ 0.5 t. Deep drawing operations are facilitated by the production of a large radius preform.

Erichsen trial (stretching trial) & LDR (Deep drawing trial)

Grades	European designation	ASTM A 240	Erichsen deflection*(mm)
K45	1.4621	UNS44500	10.8

Typical values – 2.0 mm thick sheet

Welded tube bending

K45's bending ratio are stated in the table below. These are based on laboratory results for a bending angle of 90°, where D is the tube diameter and R is the bending radius.

Bending	Ra=R/Dmini
Tube Ø 40 mm x 1.5mm	1.3
Tube Ø 50 mm x 1.5mm	1.3

Typical values – 2.0 mm thick sheet
Ra = bending ratio - D = tube diameter - R = bending radius - Angle = 90°

Welding

Our K45 grade can be resistance welded using both spot and seam techniques. Good results can be obtained without post treatment, so long as the weld forming is sufficient. Do not add hydrogen or nitrogen to the argon, as these gases decrease the ductility of the welds. Nitrogen shielding must not be employed for the same reason. CO_2 additions must be limited to 3%.

Welding process	No filler material	With filler metal			Shielding gas*
	Typical thicknesses	Thicknesses	Filler material		* Hydrogen and nitrogen forbidden in all cases
			Rod	Wire	
Resistance: spot, seam	≤ 2 mm				
TIG	< 1.5 mm	> 0.5 mm	ER 316 L (Si)	ER 316 L (Si)	Ar Ar + He
PLASMA		> 0.5 mm		ER 316 L (Si)	Ar Ar + He
MIG		> 0.8 mm		ER 316 L (Si)	Ar + 2% CO_2 Ar + 2% O_2 Ar + 2% CO_2 + He
SAW		> 2		ER 316 L	
Electrode		Repairs	E 316 L		
Laser	< 5 mm				He Ar in certain conditions

To restrict grain growth in the HAZ, the use of excessive welding power must be avoided. For example, in automatic TIG welding, power should not exceed 2.5 kJ/cm for a sheet thickness of 1.5 mm.

Pulsed MIG/MAG welding has a lower power input than conventional MIG welding, thus enabling better control of both bead geometry and grain size. Post-weld heat treatment is generally not necessary.

The welds must be mechanically or chemically descaled, then passivated and decontaminated. Oxyacetylene torch welding should be avoided.

Heat Treatment and Finishing

Annealing

- Thorough pickling is necessary prior to any heat treatment operation
- After cold work, annealing for a few minutes at 825-850°C, followed by rapid cooling, will restore the microstructure

Pickling

- Nitric-hydrofluoric acid mixture (10% HNO_3 + 2% HF)
- Use descaling pastes for weld zones

Passivation

- 20-25% cold nitric acid bath at 20 °C
- Use passivating pastes for weld beads

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