KARA Ferritic Stainless Steel

K41 18% Chromium, Titanium and Niobium stabilized

KARA key for value

Chemical Composition

Elements (%)	C	Si	Mn	Cr	Ti+Nb
K41	0.02	0.40	0.25	17.50	0.50

Typical values

European designation	American designation
X2CrTiNb18/1.4509 (1)	S43932 / S43940, type 441 (2)

(1) According to NF EN 10088-2

(2) According to ASTM A 240

This grade complies with:

- Aperam Stainless Europe - Safety Information Sheet for Stainless Steel
- European Directive 2000/53/EC on end-of-life vehicles and later modifications
- French standard NFA 36 711 "Non packaging steel - Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption"
- NSF/ANSI 51–2009 edition international standard for "Food Equipment Materials" and FDA(United States Food and Drug Administration) requirements regarding materials used in contact with foodstuffs
- French decree No. 92-631, dated 8 July 1992 and European Regulation (EC) No. 1935/2004, dated 27 October 2004 on materials and articles intended to come into contact with food (and abrogative Directives 80/590/EEC and 89/109/EEC)
- French Ministerial Order, dated 13 January 1976, relating to materials and articles made of stainless steel in contact with foodstuffs
- Standard EN 10028-7 "Flat products made of steels for pressure purposes, Stainless steels"

Key Features

- Good weldability
- Easy to form
- Suitability for surface finishing (polishing, brushing, scotch brite)
- Good resistance to pitting corrosion
- Elevated hot mechanical properties without risk of σ phase formation at intermediate temperatures
- Resistance to high temperature oxidation (up to 950°C)
- Good corrosion resistance in boiler and burner gas atmospheres
- Greater thermal conductivity and lower coefficient of expansion than austenitics

Applications

- Catering kitchen cladding, trolleys, work surfaces
- Extractor hoods, hobs, oven casings and linings
- Sinks
- Cooking utensils
- Lift doors and cabins
- Construction: profiles, fascias, panels, decorative tubes
- Domestic boiler burners
- Condensing boilers
- Fume pipes (chimneys)
- Exchangers for cold ceiling.
- Welded structures under mild corrosion conditions or when components are exposed to temperatures of up to 950°C

Product Range

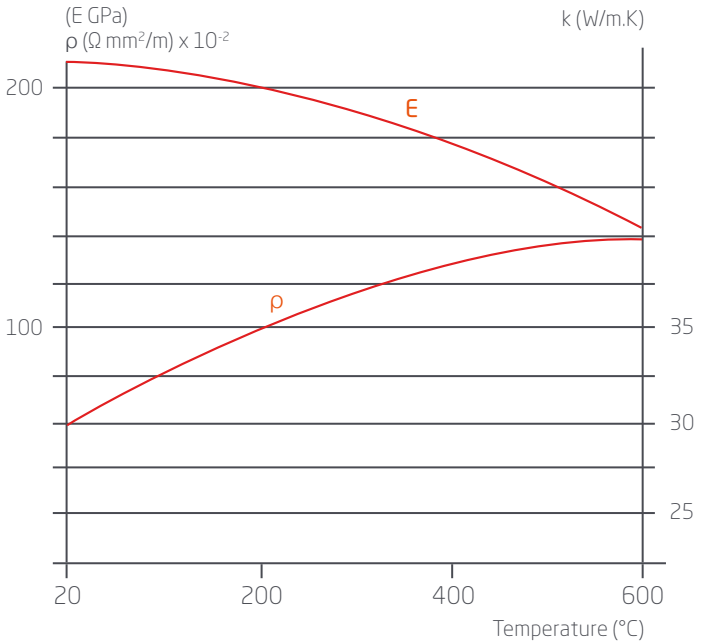
	Coils	Sheets / Blanks	Discs	Precision Strip	Precision Sheet	Flat Bars
Thickness (mm)	0.40 up to 6	0.40 up to 6	0.38 up to 2.50	0.06 up to 2.50	0.20 up to 2.50	2 up to 20
Width (mm)	up to 1,500	up to 1,250	Ø 15 up to 1,000	3 up to 700	40 up to 670	10 up to 300
Finish	1D / 2R / 2D / 2B / 2M	1D / 2R / 2D / 2B / 2M	1D / 2R / 2D / 2B / 2M	2R / 2B / 2D / 2H /2F	2R / 2B / 2D / 2H /2F	1D / Polished

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		1,505
Specific heat	c	J/kg.K	20°C	460
Thermal conductivity	k	W/m.K	20°C 500°C	25 26.3
Mean thermal expansion coefficient	α	10^{-6}/K	20-200°C 20-400°C 20-600°C 20-800°C	11.7 12.1 12.7 14.2
Electric resistivity	ρ	Ω mm²/m	20°C	0.60
Magnetic resistivity	μ	at 0.8 kA/m DC or AC	20°C	850
Young's modulus	E	GPa	20°C	220



Mechanical Properties

Test piece

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

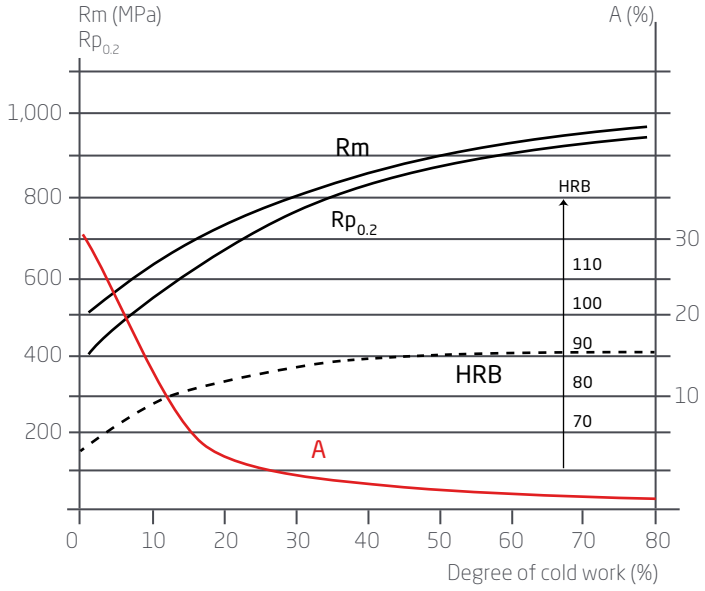
In the annealed condition

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

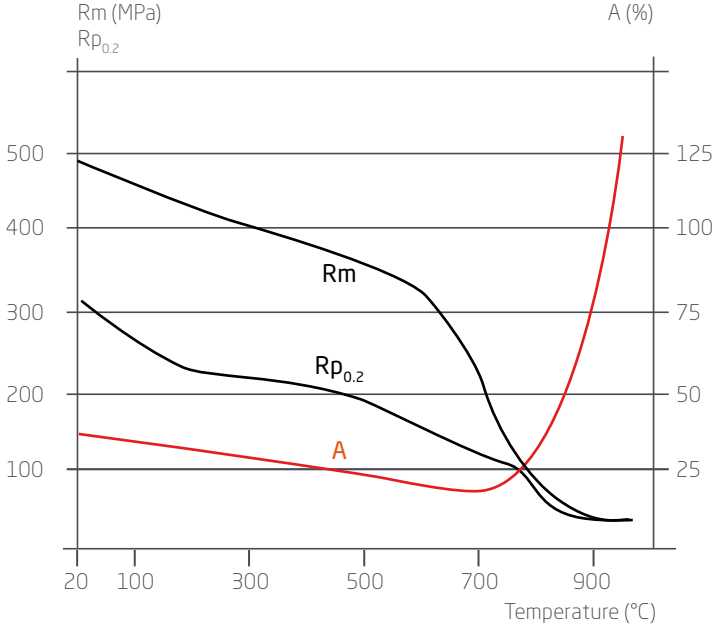
Grade	Condition	Rm(1) (MPa)	Rp0.2(2) (MPa)	A(3) %	HRB
K41	Cold- rolled	490	320	30	78

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)

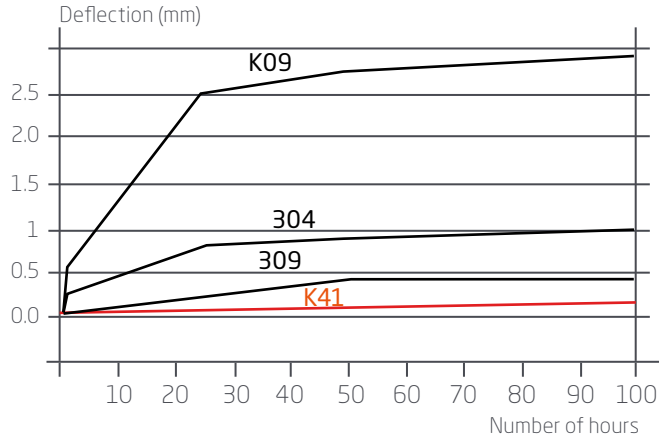


At high temperatures (Typical values)

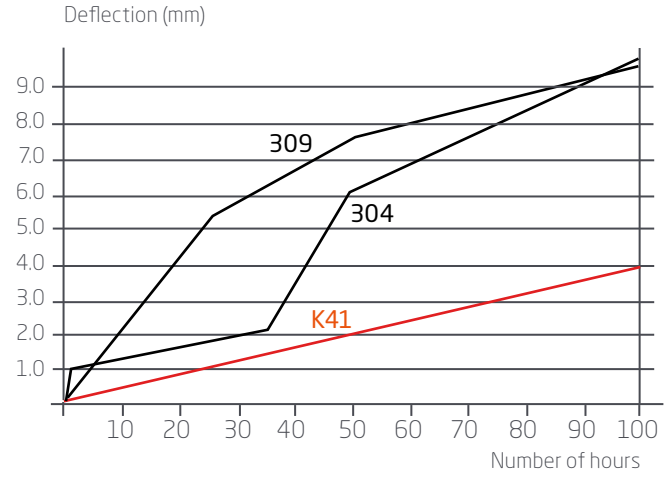


Creep Properties

Sag test at 850°C* (thickness 2 mm)



Sag test at 950°C* (thickness 2 mm)



* According to Stainless Europe analysis and process

Corrosion Resistance

Our K41 grade's pitting corrosion resistance is equivalent to that of 1.4301. The performance differential measured between K41 and K30 is equivalent to that measured between 1.4404/1.4571 and 1.4301. Like all ferritic grades, K41 is not susceptible to stress corrosion. Resistance to weld and heat-affected zone corrosion is similar to that of the parent metal. Furthermore, dual stabilisation with titanium and niobium gives K41 excellent resistance to grain boundary corrosion.

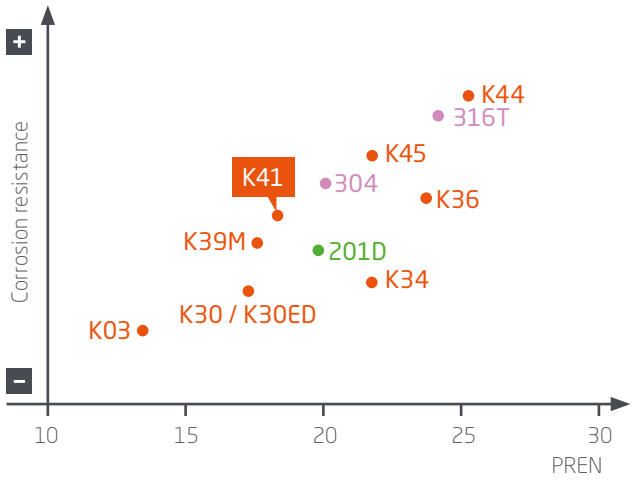
Resistance to localised corrosion

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).

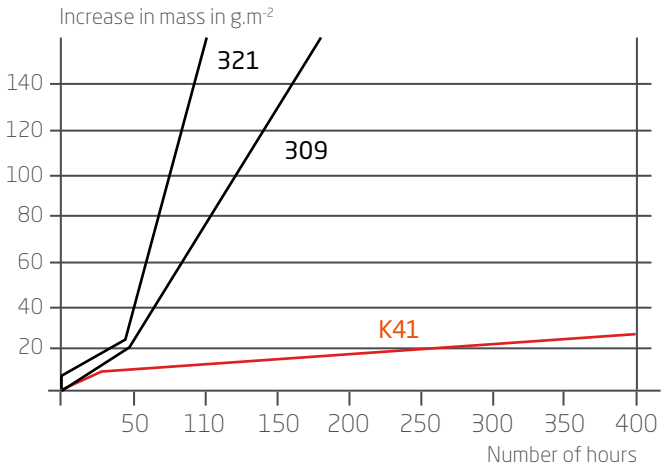


Resistance to Oxidation

Cyclic oxidation

At high temperatures, K41 exhibits high resistance to oxidation and, in particular, cyclic oxidation, enabling its use in temperatures up to 980°C. This characteristic is particularly useful for heating and gas circulation systems.

Cyclic oxidation kinetics (increase in mass = quantity of oxide formed to the detriment of the parent metal that is consumed and reduced in thickness) of grades 18-10T, 309 (R20-12) and K41 at 950°C for up to 400 hours.



Forming

Our K41 grade can be cold formed using all common processes (folding, deep drawing, hydroforming, bending).

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

Grades	European designation	ASTM A 240	Erichsen deflection*(mm)
K41	1.4513	1.4513	10.2

Typical values – 2.0 mm thick sheet

Welded tube bending

Bending	Ra=R/Dmini
Tube Ø 50 mm x 1.5mm	1.2

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

Welding

Our K41 grade is weldable using the following processes: resistance (spot, seam), electrical arc, high frequency, LASER and electron beam. Good results are obtained without post treatment so long as the weld is sufficiently forged. Its dual stabilisation with titanium and niobium eliminates any risk of grain boundary corrosion, grain growth and embrittlement at high temperatures.

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	G 19 9L [1] or 18L Nb [1] ER 308L [2] or 430LNb 1.4316 or 1.4511 [5]	G 19 9L [1] or 18L Nb [1] ER 308L [2] or 430LNb 1.4316 or 1.4511 [5]	Ar Ar + He
PLASMA		> 0.5 mm		G 19 9LSi [1] or 18L Nb [1] ER 308LSi [2] or 430LNb 1.4316 or 1.4511 [5]	Ar Ar + He
MIG		> 0.8 mm		G 19 9LSi [1] or 18L Nb [1] ER 308LSi [2] or 430LNb 1.4316 or 1.4511 [5]	Ar + 2% CO_2 Ar + 2% O_2 Ar + 2% CO_2 + He
Electrode		Repairs	E 19 9 L [3] E 308 L [4]		
Laser	< 5 mm				He Under certain conditions: Ar

[1] In accordance with EN ISO 14343 - [2] In accordance with AWS A5.9 - [3] In accordance with EN 1600 - [4] In accordance with AWS A5.4 - [5] In accordance with VDEH

The addition of hydrogen or nitrogen to the argon must be avoided as this reduces weld ductility. For similar reasons, the use of nitrogen is forbidden and the use of CO_2 is restricted to 3%. In order to restrict grain growth in the HAZ, the use of excessive welding power must be avoided. For example, in automatic TIG welding, the power should not exceed 2.5 kJ/cm for a sheet thickness of 1.5 mm. Furthermore, as pulsed MIG/MAG welding has a lower power input than conventional MIG welding, it allows for a better control of both bead geometry and grain size.

K41 also exhibits excellent high- and medium-frequency induction weldability. Post-weld heat treatment is generally not necessary.
Welds must be mechanically or chemically descaled and then passivated and decontaminated.
Oxyacetylene torch welding must be avoided.

Heat Treatment and Finishing

Annealing

- 960°C followed by air cooling. Avoid exceeding 1,000°C
- Parts must be degreased prior to any heat treatment operation

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