KARA Ferritic Stainless Steel

K09X Titanium stabilized extra mild - 12 % Chromium

KARA key for value

"X" marks the spot for exhaust applications. K09X guarantees:

- Just in time deliveries
- Reliable quality
- The continuous improvement that the automotive market demands

Chemical Composition

Elements (%)	C	Si	Mn	Cr	Ti
K09X	0.01	0.45	0.30	11.30	0.19

Typical values

European designation	American designation	IMDS
X2CrTi12/1.4512 (1)	AISI 409 (2)	336833190

(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

Key Features

- Good weldability
- Excellent formability (similar to) that of low alloy steels
- Great oxidation resistance (up to 800°C)
- Good corrosion resistance in natural and in moderately aggressive environments

Applications

- Automotive exhaust systems: manifolds, front pipes, catalytic shells, mufflers
- Welded structures exposed to relatively unaggressive corrosion conditions or subjected to temperatures below 800°C

Product Range

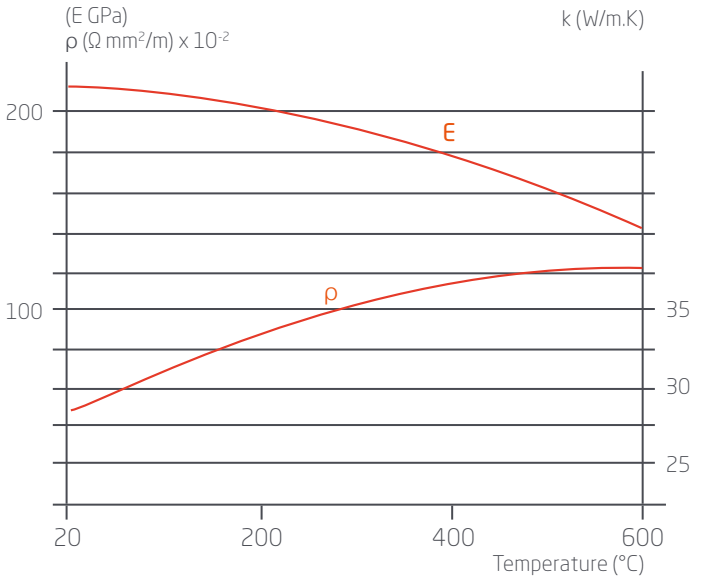
	Coils	Tubes
Thickness (mm)	0.40 up to 8	0.80 up to 2
Width (mm)	up to 1,524	Ø 8 up to 168
Finish	2B / 2D	2D

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	Liquidus	1,460
Specific heat	c	J/kg.K	20°C	460
Thermal conductivity	k	W/m.K	20°C 500°C	26 28.7
Mean thermal expansion coefficient	α	10^{-6}/K	20-200°C 20-400°C 20-600°C 20-800°C	11.0 11.5 12.1 12.8
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	Rolling direction at 20°C	215



Mechanical Properties

Test piece

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

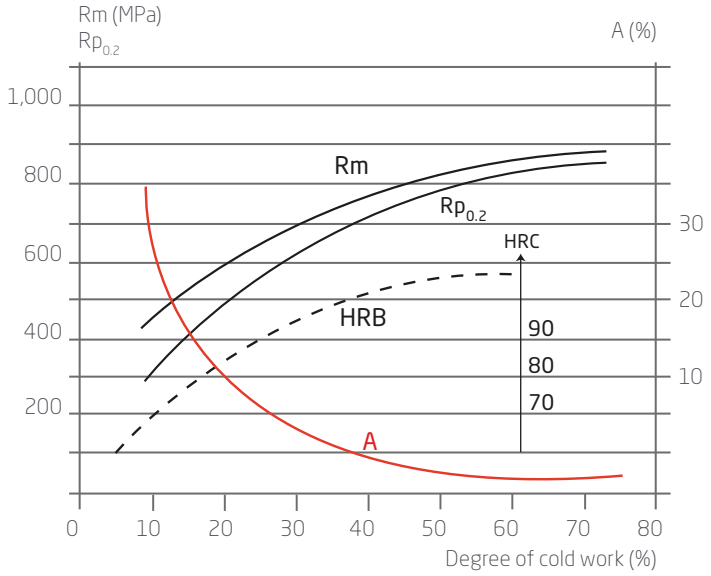
In the annealed condition

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

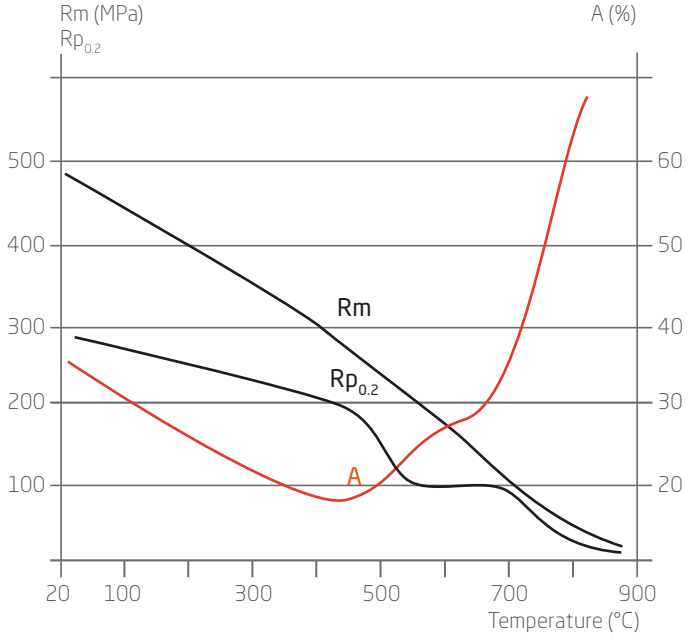
Grade	Condition	Rm(1) (MPa)	Rp0.2 (2) (MPa)	A(3) %	HV
K09X	Cold- rolled	420	250	32	125

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

Work hardened by cold rolling (Typical values)



At high temperatures (Typical values)



Corrosion Resistance

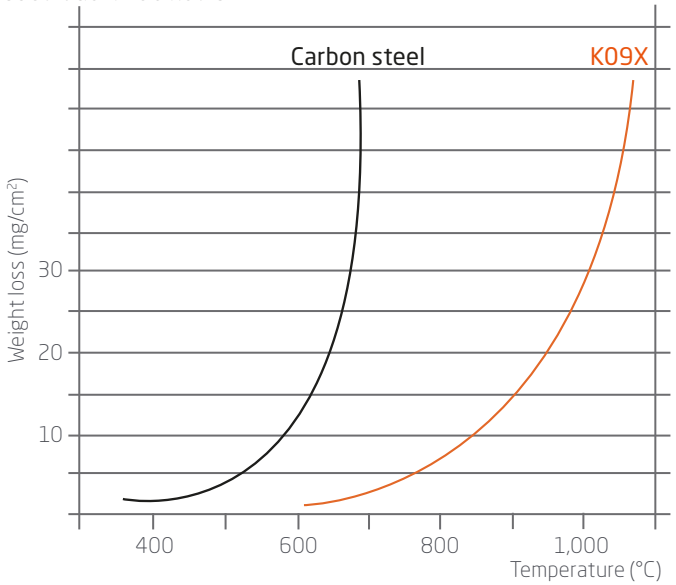
Like all ferritic stainless steels:

- K09X grade is not susceptible to stress corrosion cracking
- K09X grade resists corrosion by acid condensates in gasoline or diesel engine exhaust systems (in car manufacturer simulation tests).

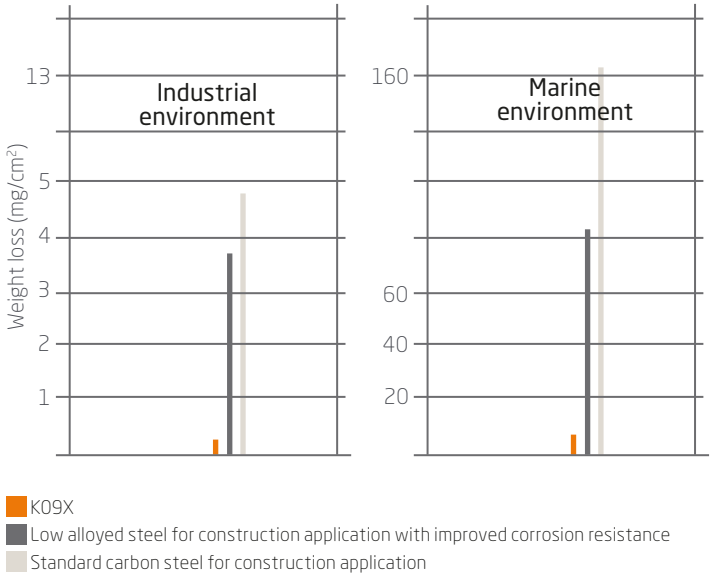
The corrosion resistance of welds and heat affected zones is similar to that of the base metal.
When exposed to the atmosphere, K09X's corrosion rate is lower than 1 µm per year, (i.e. 100 times less than low-alloyed metals).
However, the superficial deterioration of the material will result in the formation of a brown layer, if the aesthetics are of concern, then a paint application is required.

High temperature oxidation

Test duration: 100 hours



Exposition trial: 2 years duration



K09X
Low alloyed steel for construction application with improved corrosion resistance
Standard carbon steel for construction application

Forming

K09X can be readily cold formed using standard processes (folding, bending, drawing, etc.).
Strain ratio = 1.2 (typical value).

Erichsen trial (stretching trial)

Grade	European designation	AISI	Erichsen deflection*(mm)
K09X	1.4512	409	11.6

Typical values – 1.5 mm thick sheet

Bending of butt seam tube

K09X 's permissible bending ratios are provided in the table below and are based on laboratory results for a bending angle of 90°, where D is the diameter and R is the radius.

Bending	Ra=R/Dmini
Tube Ø 40 mm x 1.5mm	1.1
Tube Ø 50 mm x 1.5mm	1.1

Typical values - Ra = bending ratio, D = tube diameter, R = bending radius

Welding

Our K09X grade can be resistance welded using both spot and seam techniques. Good results are obtained without post treatment so long as the weld is sufficiently forged.

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	W / G 19 9 L [1] or 18L Nb [1] ER 308 L [2] or 430 LNb 1.4316 or 1.4511 [5]	W / G 19 9 L [1] or 18L Nb [1] ER 308 L [2] or 430 LNb 1.4316 or 1.4511 [5]	Ar Ar + He
PLASMA	< 1.5 mm	> 0.5 mm		G 19 9LSi [1] or 18 L Nb [1] ER 308 LSi [2] or 430 LNb 1.4316 or 1.4511 [5]	Ar Ar + He
MIG		> 0.8 mm		G 19 9 LSi [1] or 18 L Nb [1] ER 308 LSi [2] or 430 LNb 1.4316 or 1.4511 [5]	Ar + 2% CO_2 Ar + 2% O_2 Ar + 2% CO_2 + He
SAW		≤ 2 mm		ER 308 L	
Electrode		Repairs	E 199 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 since these gases decrease the ductility of the welds. For the same reason, nitrogen shielding must not be employed, while CO_2 additions must be limited to 3 %.

In order to restrict grain growth in the HAZ, the use of high welding powers 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. Pulsed MIG/MAG welding has a lower power input than conventional MIG welding and enables better control of both bead geometry and grain size.

K09X has a excellent medium and high frequency induction weldability.

Post-weld heat treatment is generally not necessary.

The welds must be mechanically or chemically descaled, then passivated and decontaminated.

Oxyacetylene torch welding is prohibited.

Heat Treatment and Finishing

Annealing

- At 850°C, followed by air cooling (never exceed 925°C)
- Parts must be thoroughly degreased prior to any heat treatment operation