KARA Ferritic Stainless Steel

K36X

18% Chromium, Niobium stabilized with added Molybdenum

KARA key for value

"X" marks the spot for exhaust applications. K36X guarantees:

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

Key Features

- Good resistance to pitting corrosion
- Great performance in industrial and salt spray environments
- Good formability, free from "roping"
- Excellent polishability
- Enhanced mechanical properties at high temperatures
- Resistance to high temperature oxidation (up to 950°C)
- Good corrosion resistance in exhaust gas atmospheres

Applications

- Various parts of exhaust systems (manifold, catalytic converter shell, connecting pipe, silencer)
- Automotive exhaust tailpipe

Chemical Composition

Elements (%)	C	N	Si	Mn	Cr	Nb	Mo
K36X	0.02	0.015	0.40	0.25	17.5	0.50	1.25

Typical values

European designation	American designation	IMDS
X6CrMoNb17-1/1.4526 [1]	Type 436 [2]	336850497

[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

Product Range

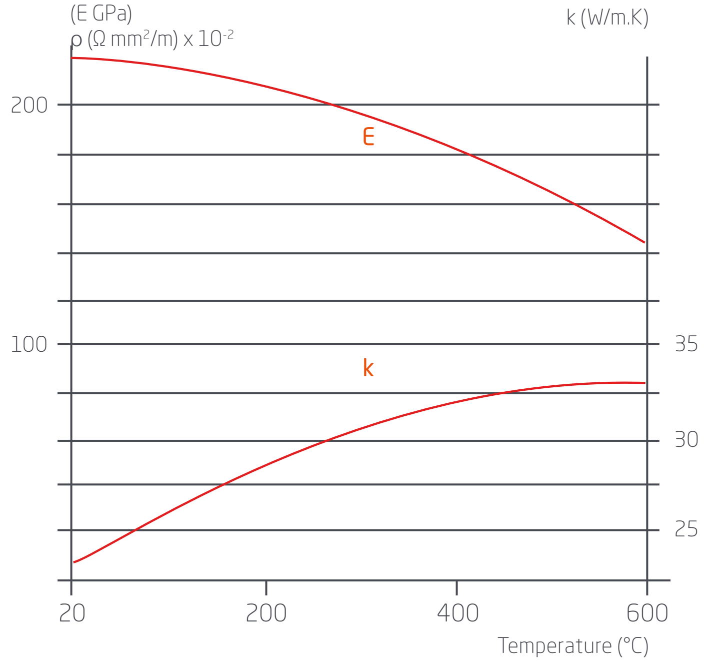
	Coils
Thickness (mm)	0.40 up to 4
Width (mm)	up to 1,500
Finish	2R / 2B / 2D

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	Liquidus	1,480
Specific heat	c	J/kg.K	20°C	440
Thermal conductivity	k	W/m.K	20°C	30
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	0.70
Magnetic resistivity	μ	at 0.8 kA/m DC or AC	20°C	550
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)

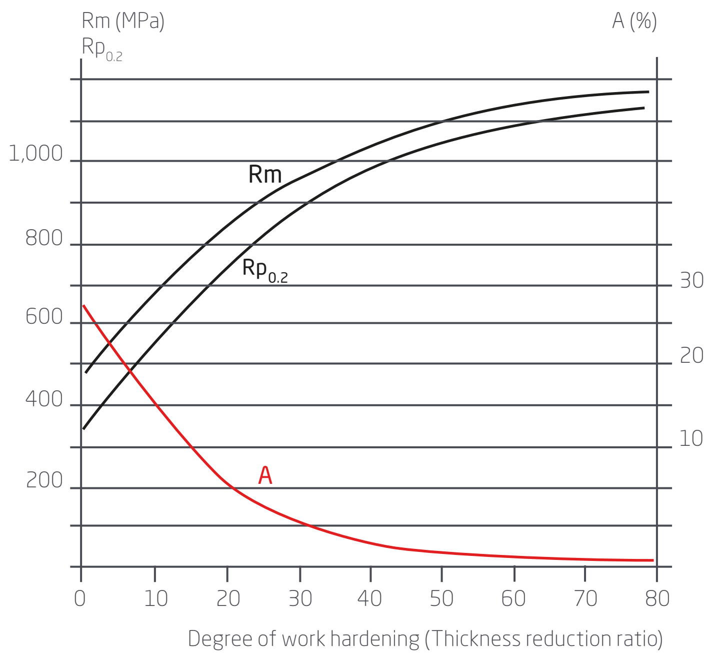
In the annealed condition

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

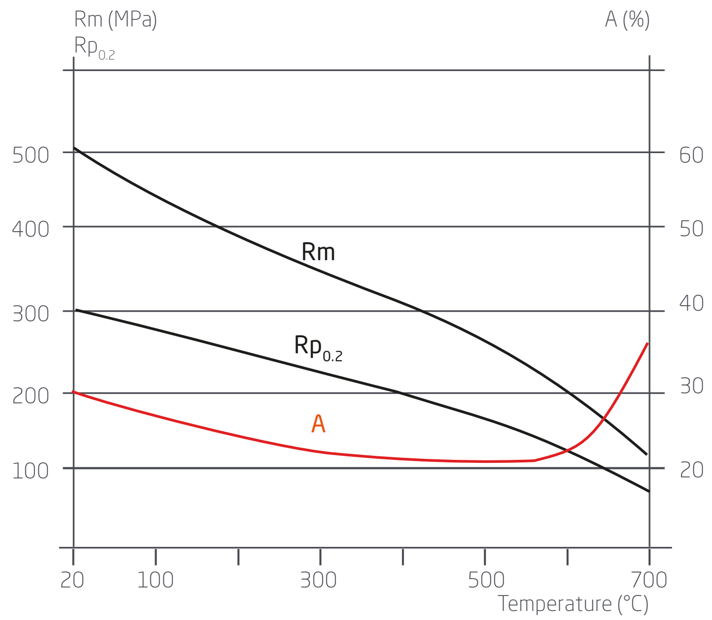
Grade	Condition	Rm[1] (MPa)	$Rp_{0.2}$[2] (MPa)	A[3] %	HRB
K36X	Cold- rolled	500	350	29	78

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

The addition of molybdenum gives this grade good resistance to pitting corrosion and extends its field of application.
Our K36X grade is also resistant to corrosion by acid condensates in exhaust systems.

K36X grade offers good performance in a salt spray environment, as well as in the various cosmetic corrosion tests encountered in the automotive industry.

Like all ferritic grades, this steel is not susceptible to stress corrosion cracking.

Resistance to condensate corrosion

Accelerated "DIP-DRY" simulation tests - Cyclic tests in synthetic condensate furnace at 300°C, pH4

Grades [1]	Maximum depth of corrosion (µm)						
	Free sheet surface		Crevice corrosion		Under deposit corrosion		
	500 hrs	1000 hrs	30 days	90 days	30 days	30 days+ $FeCl_3$ 6%	5 days+ pH1.6 +$FeCl_3$ 6%
K09X	6	18	180	500	18	108	500
K39M [1]	6	12	36	350	12.5	96	270
K41X	-	-	18	42	-	-	-
K36X	2	4	6	20	0	101	200

[1] EN 1.4510, Type 430 Ti

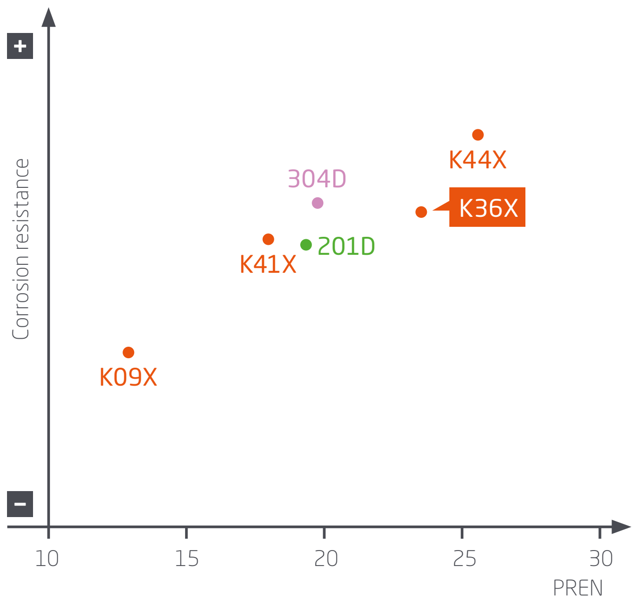
Resistance to localised corrosion

Grades	Norms		
	ASTM	UNS	EN
K09X	409	S40910	1.4512
K41X	441 [1]	S43932	1.4509
K36X	436	S43600	1.4526
K44X	444	S44400	1.4521
201D	201.1	S20100 [3]	1.4618 [2]
304D	304	S30400	1.4301

[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

K36X can be cold formed using all common processes (folding, contour forming, bending, deep drawing, slitting).
Thicknesses less than 0.7 mm can be folded sharply through 180° . For greater thicknesses, the minimum bend radius will be: r > 0.5t (thickness).
Deep drawing operations can be facilitated by the production of a large-radius preform.

Bending of welded tubes

The bending ratios permissible with K36X are given in the table to the right, based on laboratory tests for a bending angle of 90°, where D is the tube diameter and R is the bending radius.

Bending of butt seam tube

Bending (laboratory results)	Ra = R/D mini
Tube Ø 40 mm x 1.5 mm	1.3
Tube Ø 50 mm x 1.5 mm	1.3

Ra = bending ratio - D = tube diameter - R = bend radius
Angle 90°

Welding

Our K36X 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	G 19 12 3L (1) ER 316L (2) 1.4430 (3)	G 19 12 3L (1) ER 316L (2) 1.4430 (3)	Ar Ar + He
PLASMA	< 1.5 mm	> 0.5 mm		G 19 12 3L (1) ER 316L (2) 1.4430 (3)	Ar Ar + He
MIG		> 0.8 mm		G 19 12 3L (1) ER 316L (2) 1.4430 (3)	Ar + 2 % CO_2 Ar + 2 % O_2 Ar + 2% CO_2 + He
Electrode		Repairs	G 19 12 3L (4) ER 316L (5) 1.4430 (3)		
Laser	< 5 mm				He Under certain conditions: Ar

(1) According to EN ISO 14343 - (2) According to AWS A5.9 - (3) According to VDEH - (4) According to EN 1600 - (5) According to AWS A5.4

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. As a further example, pulsed MIG/MAG welding has a lower power input than conventional MIG welding and enables better control of both bead geometry and grain size.

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

Heat treatment

Parts must be thoroughly descaled 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