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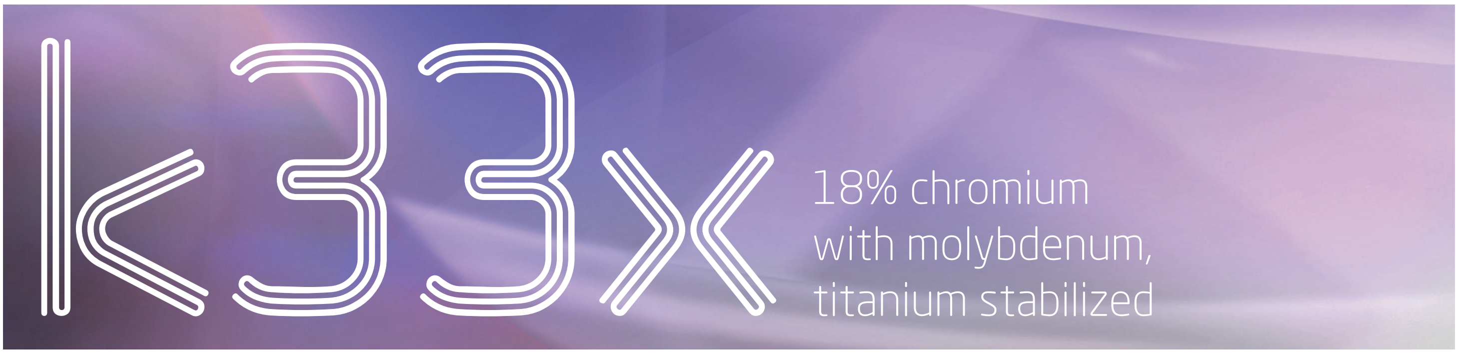
KARA ferritic stainless steel offer

grade K33X



Chemical composition

Elements	C	N	Si	Mn	Cr	Ti	Mo
%	0.015	0.015	0.50	0.25	17.30	0.35	0.90

Typical values

European designation	IMDS n°
X2CrMoTi17-1	336837226
1. 4513 [1]	

[1] According to EN 10088-2

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 to Annex II dated 27 June 2002.

"X" for exhaust means the warranty for:

- Just in time deliveries
- Reliable quality
- Continuous improvement as required by the automotive market

Applications

- The muffler of the exhaust system in substitute to the 1.4301 to increase the life time.
- Various after-treatment systems (particulate filter system, Urea SCR)

General characteristics

The principal features of our K33X grade are:

- Its excellent corrosion results in exhaust gas environment
- Its high level of pitting corrosion resistance, similar to the austenitic 1.4301
- Its absence of sensitivity to stress corrosion and intergranular corrosion
- Low thermal expansion coefficient thanks to its ferritic structure
- Its high thermal conductivity guaranteeing an homogenous aspect
- Good oxidation resistance up to 850°C
- Ease of forming
- Good weldability

Product range

Forms: sheets, blanks, coils, strips, circles
Thicknesses: 0.4 to 2.0 mm
Width: according to the thickness, consult us
Finishes: cold rolled depending on the thickness

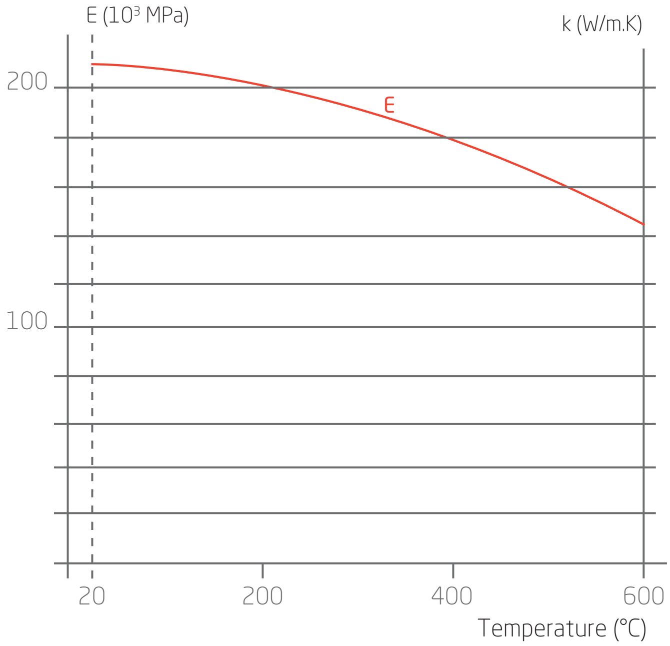
KARA key for value

Physical properties

Cold rolled sheet Annealed condition*

Density	d	kg/dm³	20 °C	7.7
Melting temperature		°C	Liquidus	1480
Specific heat	c	J/kg.K	20 °C	440
Thermal conductivity	k	W/m.K	20 °C 500 °C	30 26.3
Mean coefficient of thermal expansion	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 permeability	μ	at 0.8 kA/m DC or AC	20 °C	550
Young's modulus	E	MPa.10³	20 °C	220

(Typical values)

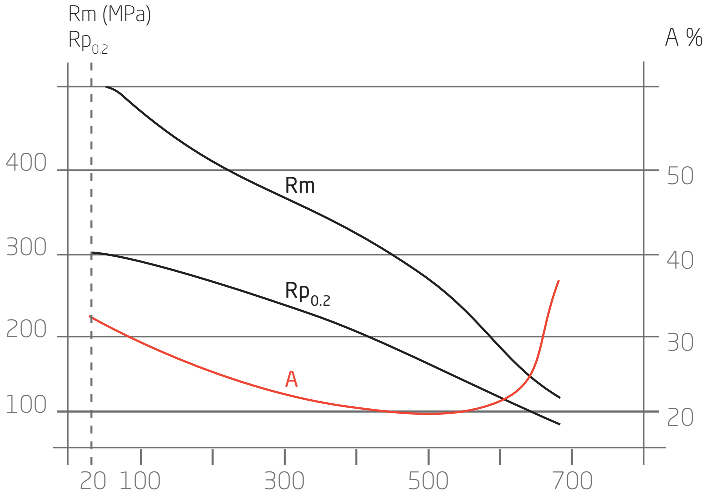


Mechanical properties

In the annealed condition
In accordance with ISO 6892-1 part 1,
test specimen perpendicular to the rolling direction

Test specimen
L = 80 mm (thickness < 3 mm)
L = 5.65 √So (thickness ≥ 3 mm)

At high temperatures*



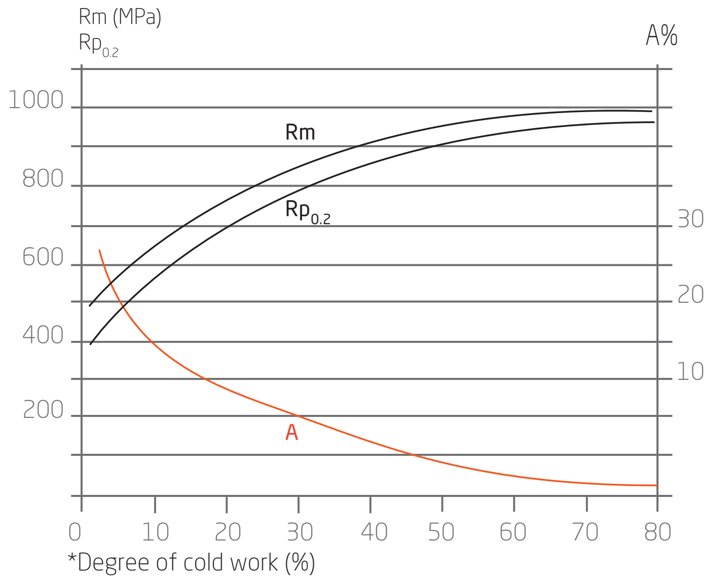
* Typical values

Présentation	Rm[1] (MPa)	$Rp_{0.2}$ [2] (MPa)	A[3] (%)	HRB
Cold-rolled*	470	300	32	76

1 Mpa = 1 N/mm². *Typical values

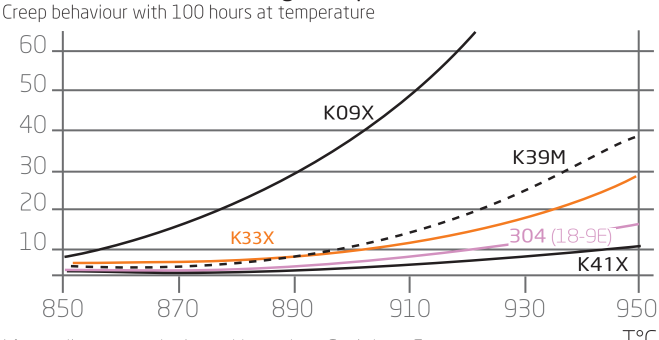
[1] Ultimate Tensile Strengh (UTS) [2] Yield Strengh (YS) [3] Elongation (A%).

Effect of cold rolling



Creep properties

Grade characteristics at high temperatures
Creep behaviour with 100 hours at temperature



*According to analysis and based on Stainless Europe process.

Our **K33X** grade has good creep resistance compared to our K09X grade (1.4512)

The additional molybdenum content provides the **K33X** a better hardness at high temperature which gives it a better creep resistance than the K39M (1.4510)

Creep resistance:
Deflection measurement in mm on a sample of: 200x25x1.5 mm positioned at the extremity between 2 sides and subjected at different temperatures during 100 hours.

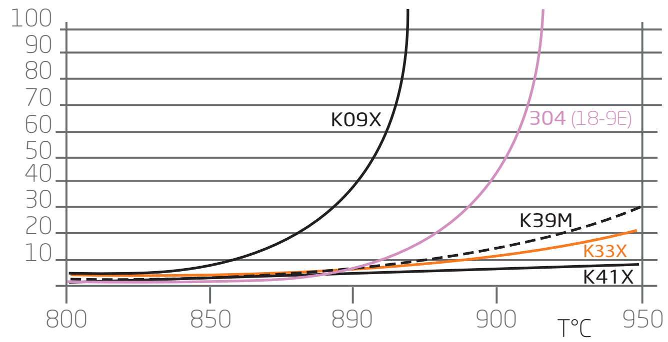
Oxidation resistance

As with our other Ferritic grades, the **K33X** holds a low coefficient of thermal expansion which makes it less sensitive to the oxide layer scaling off in comparison with an austenitic 1.4301.

Our **K33X** is titanium stabilised enabling it to retain its Ferritic structure whatever the temperature and proves to be insensitive to all phenomenon of carbide and chromium precipitations during thermal cycles.

Grades	Norms		
	ASTM	**UNS**	**EN**
K09X	409	S40900	1.4512
K39M	430Ti	S43036	1.4510
K33X			**1.4513**
K41X	441	S43932	1.4509
304D (18-9ED)	304	S30400	1.4301

Its oxidation resistance is limited to 870°C.
Its oxidation resistance is greater than that of 1.4301 austentic grade and that of K09X ,EN 1.4512. It is also slightly greater than the one of K39M, EN 1.4510.
Its resistance to oxidation turns out to be limited compared to the K41X, EN 1.4509 niobium and titanium stabilised.

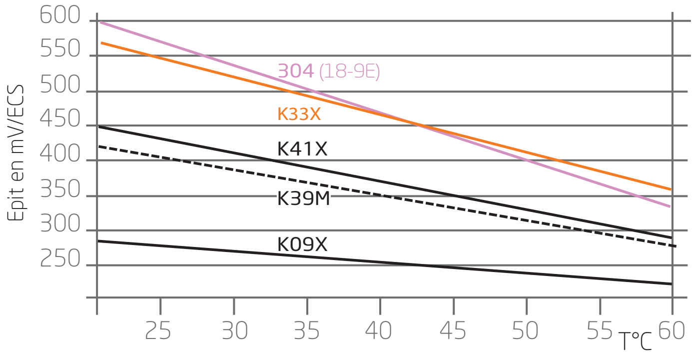


Cyclic oxidation: Temperature influence on oxidation (oxide metal loss)

Corrosion resistance

Pitting Corrosion Resistance

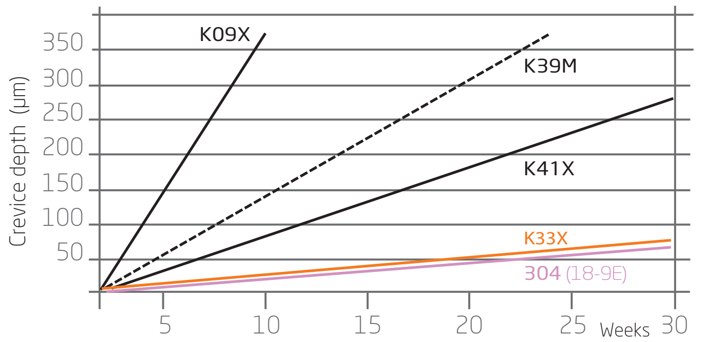
Our **K33X** grade is insensitive to stress corrosion. The molybdenum contained in the **K33X** offers an improved pitting corrosion resistance compared to K39M, 1.4510. The pitting corrosion resistance of stainless steel decreases according to the temperatures, greater amongst the austenitic grades than for the Ferritic.
The **K33X** grade records a good pitting corrosion resistance with high temperature, for this reason, the **K33X** can be readily compared with the austenitic 1.4301.



Pitting potential according to the T°.Neutral PH solution, 700 ppm of NaCl.

Condensates corrosion resistance

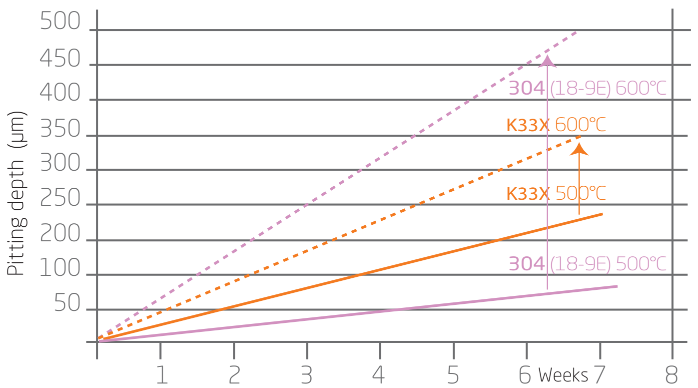
The good resistance to condensates corrosion is a key point of the material qualification in exhaust system. The **K33X** grade has been optimized to satisfy these properties and to offer a Ferritic substitute to the costly 1.4301 solution.
In the exhaust, the qualification of resistance to condensates corrosion is done by successive immersion/emersion phases or 'Drip & Dry' testing in chosen condensates with regular passing into the oven to simulate an automotive cycle. Our **K33X** offers a good compromise between costs and techniques.



Pitting depth depending on time. Dip and Dry trial with 100 ppm of Cl

Temperature influence on condensates corrosion resistance

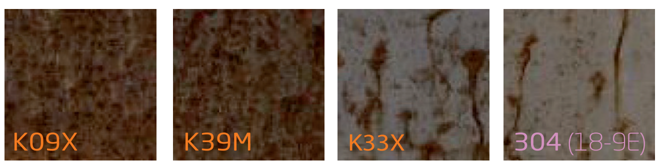
Arrivals of new after-treatment such as particulate filters and NOX traps increase the temperatures in the downstream exhaust. The use of our **K33X** is perfectly adapted to this evolution thanks to its low thermal expansion and its stabilising elements. The stabilizers enable the avoidance of the intergranular corrosion phenomenon, particularly present on the 1.4301 as soon as the temperature exceeds 500°C.



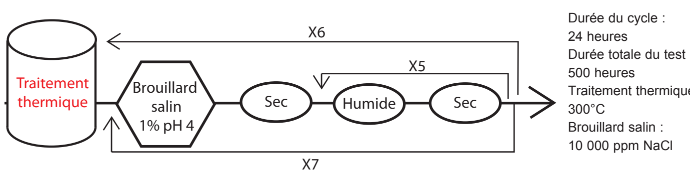
Pitting depth depending on time. Dip and Dry trial with 100 ppm of Cl

Resistance to external corrosion by salt

In addition to the durability criteria, car manufacturers are more and more sensitive to the aspect of the exhaust system. For this reason we have built a test simulating the external aggressions on the exhaust system by successive sequences of wetting and drying in a salty atmosphere with regular heating at 300°C. Samples are classified depending on oxidation and corrosion. Our **K33X** shows a corrosion resistance close to austenitic grade 1.4301.



Essais de corrosion en chambre climatique pour simuler les phénomènes de corrosion externe. Illustration des échantillons exposés après 4 semaines de test.



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Grades classifications with regards to the cosmetic corrosion

Grades	Insufficient	Acceptable	Medium	Good	Very good
K09X					
K39M					
304D (18-9ED)					
K41X					
K33X					
K09X Al[(1)]					
K44X[(2)]					

[(1)] EN 1.4512 Alusi®, type 409Al, [(2)] EN 1.4521, Type 444

Forming

K33X can be readily cold formed by standard processes (folding, bending, drawing, etc.).

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

Grades	European designation	Erichsen deflection*(mm)	LDR (mm)
K33X	1.4513	10.2	2.31

*Typical values – 1.0 mm thick sheet

Welded tube bending

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

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

Welding

K33X can be resistance welded by spot or seam techniques. Good results are obtained without the need for post treatment provided that forging of the weld is sufficient.

Welding process	No filler metal	With filler metal			Shielding gas*
	Typical thicknesses	Thicknesses	Filler metal		Hydrogen and nitrogen forbidden in all cases
			Rod	Wires	
Resistance: spot, seam	≤ 2 mm				
TIG	< 1.5 mm	> 0.5 mm	G 19 12 3L [(1)] ER 316L [(2)] n°1.4430 [(3)]		Argon Argon + Helium
PLASMA	< 1.5 mm	> 0.5 mm		G 19 12 3L [(1)] ER 316L [(2)] 1.4430 [(3)]	Argon Argon + Helium
MIG		> 0.8 mm		G 19 12 3L [(1)] ER 316L [(2)] 1.4430 [(3)]	Argon + 2% CO_2 Argon + 2% O_2 Argon + 2% CO_2 + Helium
Electrode		Repair	G 19 12 3L [(4)] ER 316L [(5)] 1.4430 [(3)]		
Laser	< 5 mm				Helium Under conditions: Argon

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

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 additions of CO2 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. K33X 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 must be avoided.

Heating treatment and finishing

Annealing At 950°C followed by air cooling. Do not exceed 1000°C. Parts must be thoroughly degreased prior to any heat treatment operation.

Pickled : Fluonitric mix (10% HNO_3 + 2% HF) Descaling pastes for weld zone
Passivation : 20-25% cold nitric acid bath Passivating pastes for passive weld beads

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