

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

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:

- > Stainless Europe Materials Safety Data Sheet No. 1: stainless steels (European Directive 2001/58/EC)
- > European Directive 2000/53/EC relating to end-of-life vehicles and Annex II, dated 27 June 2002

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

Product Range

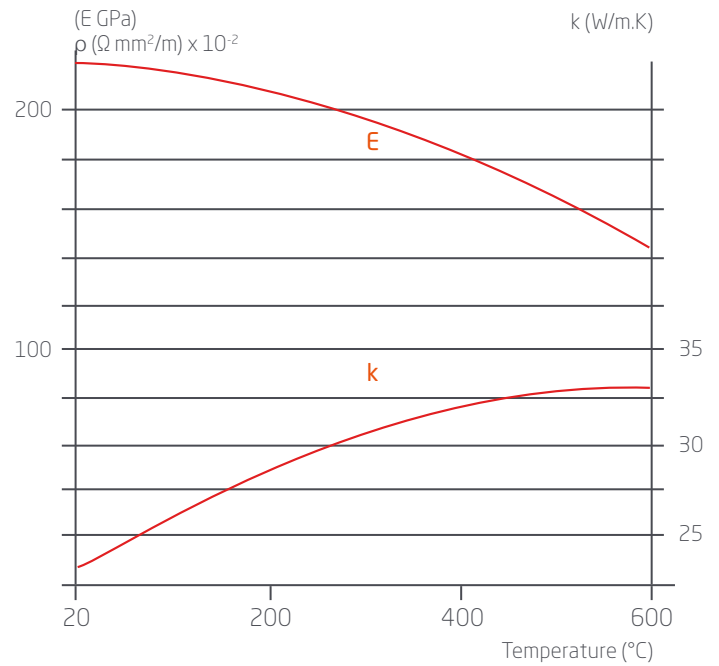
| | Coils |
|----------------|--------------|
| Thickness (mm) | 0.40 up to 4 |
| Width (mm) | up to 1,500 |
| Finish | 2R / 2B / 2D |

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

Physical Properties

Cold rolled and annealed sheet

| | | | | |
|------------------------------------|---|-------------------------|----------|-------|
| Density | d | kg/dm ³ | 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 | 11.7 |
| | | | 20-400°C | 12.1 |
| | | | 20-600°C | 12.7 |
| | | | 20-800°C | 14.2 |
| Electric resistivity | ρ | Ω mm ² /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

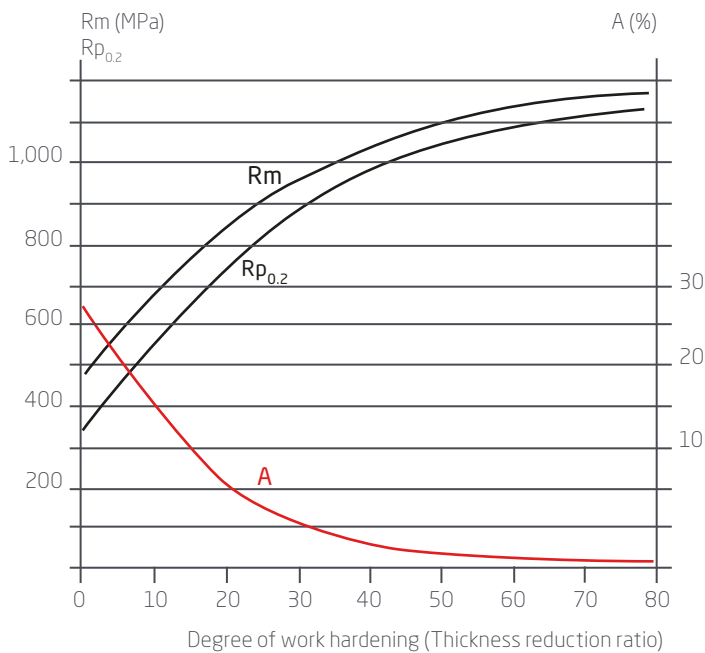
Test piece

Length = 80 mm (thickness < 3 mm)
Length = 5.65 √ S₀ (thickness ≥ 3 mm)

In the annealed condition

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

Work-hardened by cold rolling (Typical values)

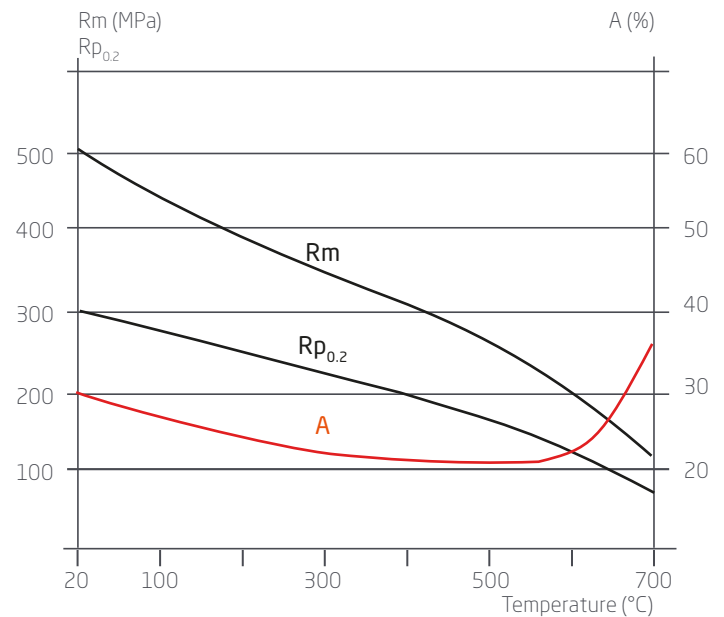


| Grade | Condition | Rm ⁽¹⁾ (MPa) | Rp _{0.2} ⁽²⁾ (MPa) | A ⁽³⁾ (%) | HRB |
|-------|-------------|----------------------------|---|-------------------------|-----|
| K36X | Cold-rolled | 500 | 350 | 29 | 78 |

1 MPa = 1 N/mm² - Typical values

⁽¹⁾ Ultimate Tensile Strength (UTS) - ⁽²⁾ Yield Strength (YS) - ⁽³⁾ Elongation (A)

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 | | |
| | | | Rod | Wire | * Hydrogen and nitrogen forbidden in all cases |
| 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 CO₂ 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% HNO₃ + 2% HF)
- > Use descaling pastes for weld zones

Passivation

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

