KARA ferritic stainless steel offer grade K41

18% chromium, titanium and niobium stabilized

Chemical composition

<table>
<thead>
<tr>
<th>Elements</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Ti+Nb</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>0.015</td>
<td>0.60</td>
<td>0.30</td>
<td>17.80</td>
<td>0.65</td>
</tr>
</tbody>
</table>

Typical values

European designation  X2CrTiNb18  1.4509 (1)

(1) According to EN 10088-2

American designation  S43932 / S43940, type 441 (2)

(2) According to ASTM A 240.

This grade complies with:
- 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 the requirements of the FDA (United States Food and Drug Administration) regarding materials used in contact with foodstuffs.
- 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".

General characteristics

The principal characteristics of our K41 grade are:
- Good weldability.
- Ease of forming.
- Its suitability for surface finishing (polishing, brushing, scotch brite).
- Good resistance to pitting corrosion.
- Elevated hot mechanical properties without risk of \( \sigma \) 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 than austenitics and a lower coefficient of expansion.

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

Forms: sheets, blanks, coils, strip, discs.
Thicknesses: 0.4 to 2.0 mm (from 2 to 6.5 mm consult us).
Width: according to thickness, consult us.
Finishes: cold-rolled, hot-rolled according to thickness.
**Physical properties**

On cold-rolled sheet. In the annealed condition.*

- **Density** $d$ kg/dm³: 20 °C 7.7
- **Melting temperature** °C: 1505
- **Specific heat** $c$ J/kgK: 20 °C 460
- **Thermal conductivity** $k$ W/mK: 20 °C 25, 500 °C 26.3
- **Mean coefficient of thermal expansion $\alpha$ 10⁻⁶/K**: 20-200 °C 11.0, 20-400 °C 11.5, 20-600 °C 11.6, 20-800 °C 12.1, 20-1000 °C 12.8
- **Electric resistivity $\rho$ Ω mm/m**: 20 °C 0.6
- **Magnetic permeability $\mu$ at 0.8 kA/m DC or AC**: 20 °C 850
- **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)
- $L = 5.65 \sqrt{S_0}$ (thickness ≥ 3 mm)

**At high temperatures***

- $Rm$ (MPa)
- $R_{p0.2}$ (MPa)
- $A$ (%)
- HRB

<table>
<thead>
<tr>
<th>Condition</th>
<th>$Rm$ (MPa)</th>
<th>$R_{p0.2}$ (MPa)</th>
<th>$A$ (%)</th>
<th>HRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold-rolled*</td>
<td>480</td>
<td>310</td>
<td>30</td>
<td>78</td>
</tr>
</tbody>
</table>

* Typical values 1 MPa = 1 N/mm²

(1) Ultimate tensile strength (UTS) (2) Yield strength (YS) (3) Elongation

**Effect of cold rolling***

- $Rm$ (MPa)
- $R_{p0.2}$ (MPa)
- $A$
- HRB

<table>
<thead>
<tr>
<th>Degree of cold work (%)</th>
<th>$Rm$ (MPa)</th>
<th>$R_{p0.2}$ (MPa)</th>
<th>$A$</th>
<th>HRB</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>20</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>80</td>
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<tr>
<td>30</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>40</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>50</td>
<td>800</td>
<td>120</td>
<td>30</td>
<td>80</td>
</tr>
<tr>
<td>60</td>
<td>750</td>
<td>110</td>
<td>40</td>
<td>70</td>
</tr>
<tr>
<td>70</td>
<td>700</td>
<td>100</td>
<td>50</td>
<td>70</td>
</tr>
<tr>
<td>80</td>
<td>650</td>
<td>90</td>
<td>60</td>
<td>70</td>
</tr>
</tbody>
</table>

* Typical values
Creep properties

Resistance to corrosion

Our K41 grade has resistance to pitting corrosion close 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. In particular, dual stabilisation with titanium and niobium affords K41 excellent resistance to grain boundary corrosion.

Resistance to localised corrosion

Cyclic oxidation

At high temperatures, K41 exhibits high resistance to oxidation and in particular cyclic oxidation, enabling its use up to 980°C. This property is particularly useful for heating or 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.
**Welding**

Our K41 grade is weldable by these processes: resistance (spot, seam), electrical arc, high frequency, LASER and electron beam. Good results are obtained without post treatment provided that the weld is sufficiently forged. Its dual stabilisation with titanium and niobium enables elimination of any risk of grain boundary corrosion, grain growth and embrittlement at high temperature.

### Welding process

<table>
<thead>
<tr>
<th>Welding process</th>
<th>Without filler metal</th>
<th>With filler metal</th>
<th>Shielding gas*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Typical thicknesses</td>
<td>Thicknesses:</td>
<td></td>
</tr>
<tr>
<td>Resistance:</td>
<td>≤ 2 mm</td>
<td>Rod</td>
<td></td>
</tr>
<tr>
<td>spot, seam</td>
<td></td>
<td>Wire</td>
<td></td>
</tr>
<tr>
<td>TIG</td>
<td>&lt; 1.5 mm</td>
<td>G 19 9L (1) or 18L Nb (1) ER 308L (2) or 430Nb 1.4316 or 1.4511 (5)</td>
<td>Argon Argon + Helium</td>
</tr>
<tr>
<td>PLASMA</td>
<td>&gt; 0.5 mm</td>
<td>Argon Argon + Helium</td>
<td></td>
</tr>
<tr>
<td>MIG</td>
<td>&gt; 0.8 mm</td>
<td>G 19 9LSi (1) or 18L Nb (1) ER 308LSi (2) or 430LNb 1.4316 or 1.4511 (5)</td>
<td>Argon + 2% CO₂ Argon + 2% O₂ Argon + 2% CO + Helium</td>
</tr>
<tr>
<td>Electrode</td>
<td>Repair</td>
<td>E 19 9 L (8) E 308 L (4)</td>
<td>Argon + 2% CO₂ Argon + 2% O₂ Argon + 2% CO + Helium</td>
</tr>
<tr>
<td>Laser</td>
<td>&lt; 5 mm</td>
<td>Helium Under certain conditions: Argon</td>
<td></td>
</tr>
</tbody>
</table>

*In accordance with EN ISO 14343, (1) In accordance with AWS A5.9, (2) In accordance with EN 1600, (3) In accordance with AWS A5.4, (4) 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 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.

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 1000°C. Parts must be degreased prior to any heat treatment operation.

- **Pickling**
  Nitric-hydrofluoric acid mixture (10% HNO₃ + 2% HF). Descaling pastes for weld zones.

- **Passivation**
  20-25% cold nitric acid bath. Passivating pastes for weld beads.

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**Forming**

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

### Bending of welded tubes

<table>
<thead>
<tr>
<th>Folding</th>
<th>Ra = R/D mini*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube ø 50 mm x 1.5 mm</td>
<td>1.2</td>
</tr>
</tbody>
</table>

*Tests performed on typical values using 2 mm thickness.

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

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**Erichsen (cupping) test**

<table>
<thead>
<tr>
<th>Grades</th>
<th>European designation</th>
<th>ASTM A 240</th>
<th>Erichsen test* (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K41</td>
<td>14509</td>
<td>543932/543940</td>
<td>11.8</td>
</tr>
</tbody>
</table>

*Tests performed on typical values using 2 mm thickness.