

UGINOX

18-11ML 18-12ML

18-12MS 18-13MS

Very low carbon molybdenum containing austenitic stainless steels

UGINOX 18-11ML	UGINOX 18-12ML	UGINOX 18-12MS	UGINOX 18-13MS
European designation ⁽¹⁾	European designation ⁽¹⁾	European designation ⁽¹⁾	European designation ⁽¹⁾
X5CrNiMo17-12-2/ X2CrNiMo17-12-2	X5CrNiMo17-12-2/ X2CrNiMo17-12-2	X2CrNiMo17-12-3	X2CrNiMo18-14-3
1.4401 / 1.4404	1.4401 / 1.4404	1.4432	1.4435
American designation ⁽²⁾	American designation ⁽²⁾	American designation ⁽²⁾	American designation ⁽²⁾
AISI 316 / 316L	AISI 316 / 316L	AISI 316 L	AISI 316 L

(1) According to NF EN 10088-2
(2) According to ASTM A 240

These grades are in accordance with:

- UGINE & ALZ Material Safety Data Sheet n°1: stainless steels (European Directive 2001/58/EC).
- European Commission Directive 2000/53/EC for end-of-life vehicles, and to the annexe II dated 27 June 2002.
- PED (Pressure Equipment Directive) according to EN 10028-7 and AD2000W2 according to VD TÜV W494.
- Lloyd's Register of Shipping.
- NFA 36 711 Standard «Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption» (non packaging steel)..

Chemical composition

Mean values

Elements (%)	C	Si	Mn	Cr	Ni	Mo
UGINOX 18-11ML	< 0,030	0,50	1,50	16,80	10,30	2,10
UGINOX 18-12ML	< 0,030	0,50	1,50	17,50	11,20	2,10
UGINOX 18-12MS	< 0,030	0,50	1,50	16,80	11,10	2,60
UGINOX 18-13MS	< 0,030	0,50	1,50	17,80	12,70	2,60

General characteristics

The principal features of **UGINOX 18-11ML**, **UGINOX 18-12ML**, **UGINOX 18-12MS** and **UGINOX 18-13MS** are:

- good resistance to corrosion in acids and chloride containing media
- excellent resistance to intergranular corrosion, even after welding
- excellent weldability
- high ductility
- excellent polishability.

Typical applications

- Chemical engineering equipment: tanks, tubes
- Food industry equipment: tanks, tubes, pumps
- Marine engineering
- Road transport tanks
- Building industry: architectural components, roofing, etc...

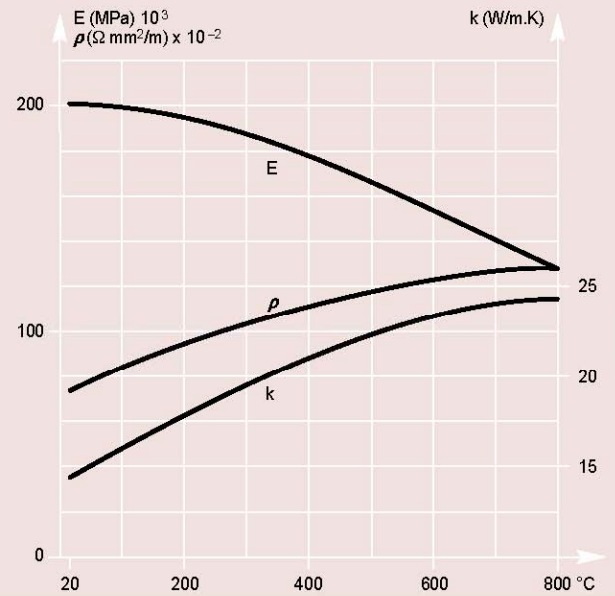
Product range

Forms: sheets, blanks, coils, strips, circles
Thicknesses: 0.4 to 14 mm
Width: according to thickness, consult us
Finish: cold rolled or hot rolled, depending on the thickness

Physical properties (cold rolled sheet)

Density	d	—	20 °C	8.0
Melting temperature		°C		1440
Specific heat	c	J/kg.K	20 °C	500
Thermal conductivity	k	W/m.K	20 °C	15
Mean coefficient of Thermal expansion	α	$10^{-6}/K$	20 - 100 °C 20 - 300 °C 20 - 500 °C	16.0 17.0 18.0
Electric resistivity	ρ	$\Omega \cdot \text{mm}^2/\text{m}$	20 °C	0.75
Magnetic permeability	μ	at 0.8 kA/m DC or AC	20 °C	1.005
Young's modulus	E	$\text{Mpa} \cdot 10^3$	20 °C	200

Ferrite content (Delon diagram): <10%
Poisson's ratio: 0.30



Tensile properties

Delivery condition
According to NF EN 10002-1 (july 2001),
specimen perpendicular to the rolling direction

Specimen
Lo = 80 mm (thickness < 3 mm)
Lo = $5,65 \sqrt{S_0}$ (thickness ≥ 3 mm)

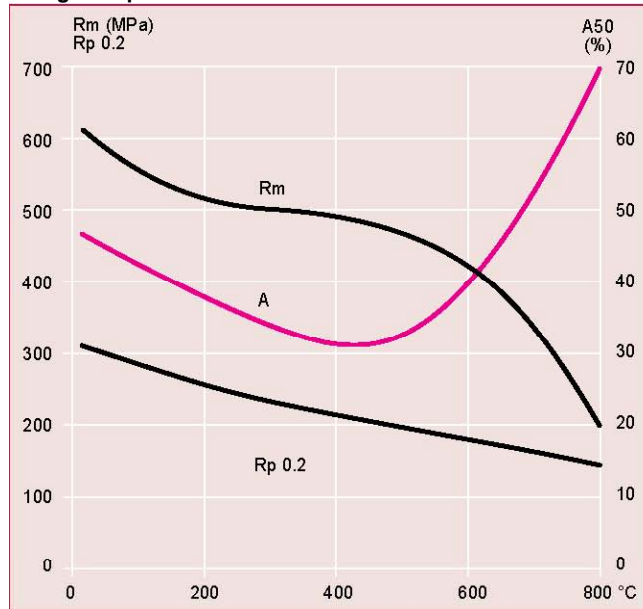
1 MPa = 1 N/mm²

	$R_m^{(1)}$ (MPa)	$Rp_{0.2}^{(2)}$ (MPa)	$A^{(3)}$ (%)
UGINOX 18-11ML	620	340	48
UGINOX 18-12ML	610	320	48
UGINOX 18-12MS	590	310	48
UGINOX 18-13MS	610	310	48

* mean values

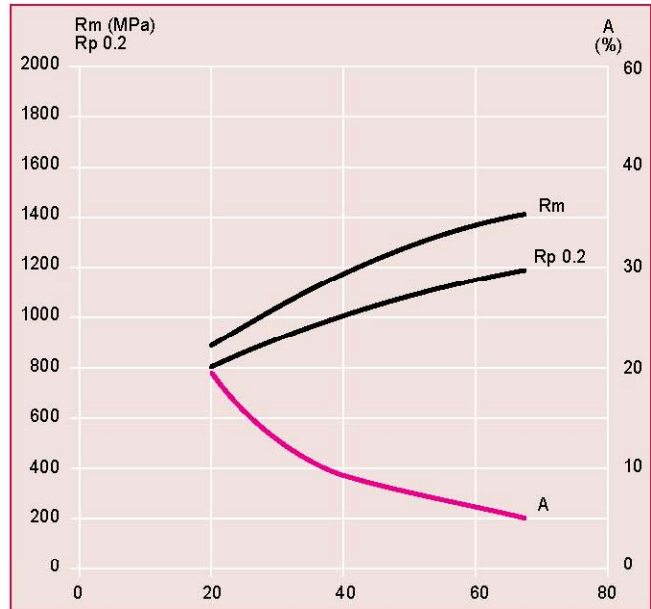
(1) Ultimate Tensile Strength (UTS) (2) Yield Strength (YS) (3) Elongation (EI)

At high temperature



Typical values

Effect of cold work



Degree of cold work (%)

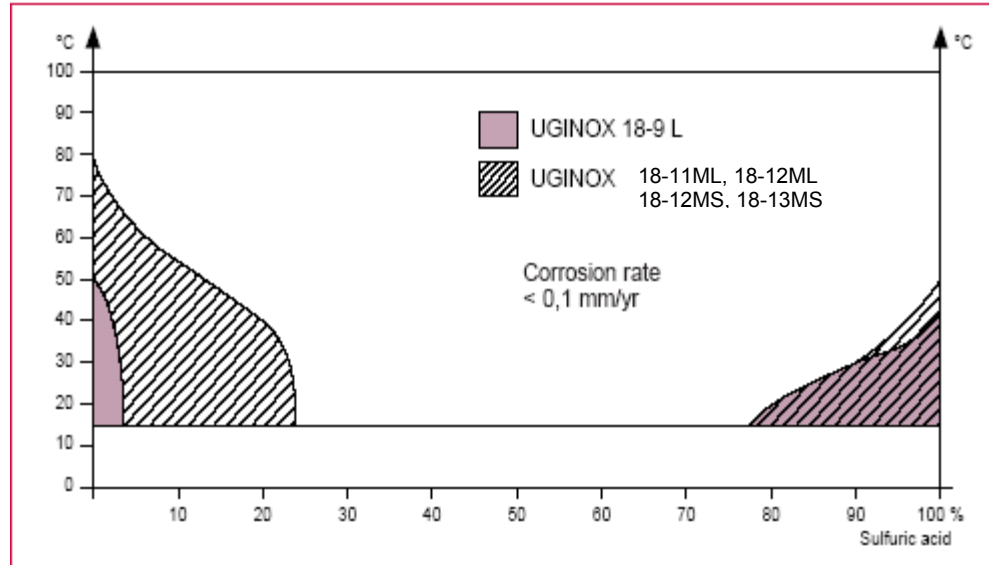
Corrosion resistance

As shown in the diagrams below, **UGINOX 18-11ML, UGINOX 18-12ML, UGINOX 18-12MS** and **UGINOX 18-13MS** have excellent corrosion resistance in acid solutions, and also show good resistance in chloride containing media. They are therefore used for the manufacture of domestic hot water tanks, and for parts in contact with seawater at low temperatures.

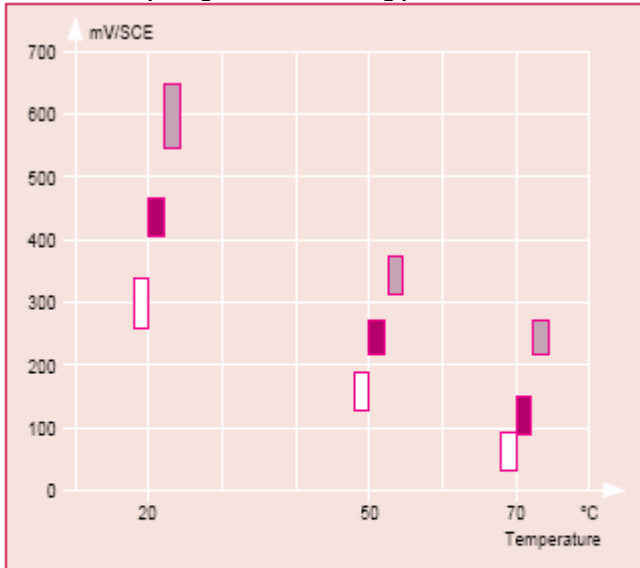
UGINOX 18-11ML, UGINOX 18-12ML, UGINOX 18-12MS and **UGINOX 18-13MS** meet the requirements of standard intergranular corrosion tests:

- EN ISO 3651-2 (sensitizing treatments T1 and T2)
- ASTM A 262
- ex DIN 50914.

Corrosion resistance of stainless steels in sulfuric acid



Resistance to pitting corrosion. Pitting potential



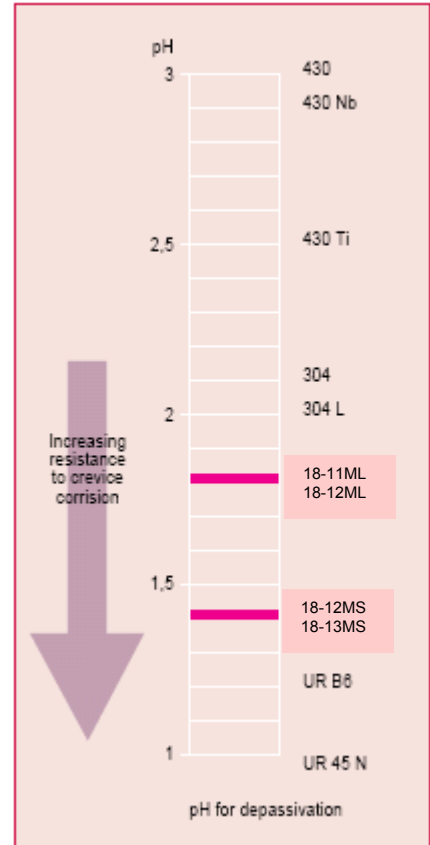
- UGINOX 18-11ML
18-12ML
- UGINOX 18-12MS
18-13MS
- UGINOX 18-9 E

30 g/l (0.5 M) NaCl solution, pH = 6.6

Resistance to crevice corrosion

The resistance of crevice corrosion is evaluated in terms of pH for depassivation (electrochemical method).

Medium: 2M NaCl.



Welding

Welding process	No filler metal	With filler metal		Shielding gas*	
	Typical thicknesses	Thickness	Filler metal		*Hydrogen and nitrogen forbidden in all cases
			Rod	Wire	
Resistance Spot Seam	≤ 2 mm ≤ 2 mm				
TIG	< 1.5 mm	> 0.5 mm	ER 316 L (Si) ER 317 L (Si)	ER 316 L (Si) ER 317 L (Si)	Argon Argon + 5% hydrogen Argon + helium
PLASMA	< 1.5 mm	> 0.5 mm		ER 316 L (Si) ER 317 L (Si)	Argon Argon + 5% hydrogen Argon + helium
MIG		> 0.8 mm		ER 316 L (Si) ER 317 L (Si)	Argon + 2% CO ₂ Argon + 2% O ₂ Argon + 2% CO ₂ + 1% H ₂ Argon + 2% CO ₂ + helium
S.A.W		> 2 mm		ER 316 L ER 317 L	
Electrode		Repairs	ER 316 L ER 317 L		
Laser	< 5 mm				Helium. In certain conditions: argon, nitrogen

No heat treatment is necessary after welding.

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

For use at temperatures above 500°C, filler metals must be chosen to ensure that the ferrite content in the weld does not exceed 8%.

Forming

In the annealed condition, **UGINOX 18-11ML**, **UGINOX 18-12ML**, **UGINOX 18-12MS** and **UGINOX 18-13MS** can be readily cold formed by all standard processes (bending, contour forming, drawing, etc.).

Grade	European designation	AISI	Erichsen deflection* (expansion test)
UGINOX 18-11ML	1.4401/4404	316/316L	11-11.5 (mm)
UGINOX 18-12ML	1.4401/1.4404	316/316L	11-11.5 (mm)
UGINOX 18-12MS	1.4432	316L	11-11.5 (mm)
UGINOX 18-13MS	1.4435	316L	11-11.5 (mm)

* on 0.8 mm thick sheet

Heat treatment and finishing

Annealing

Water quench or air cool from 1050°C ± 25°C.

Pickling

Nitric-hydrofluoric acid mixture (10% HNO₃ + 2% HF), at RT or 60°C.
Sulfuric-nitric acid mixture (10% H₂SO₄ + 0,5% HNO₃) at 60°C.
Descaling pastes for weld zones.

Passivation

20-25 % HNO₃ solution at 20°C.
Passivating pastes for weld zones.

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