

# UGINOX

## R24-13S

### Heat resisting austenitic stainless steel

European designation <sup>(1)</sup>
X12CrNi23-13
1.4833
American designation <sup>(2)</sup>
AISI 309S

(1) According to NF EN 10095

(2) According to ASTM A 240

This grade is 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 Annex II dated 27 June 2002.

#### Chemical composition

Mean values

Elements	C	Si	Mn	Cr	Ni
%	0.06	0.35	1.30	22.20	13.60

#### General characteristics

The principal features of **UGINOX R24-13S** are:

- excellent resistance to oxidation and corrosion at temperatures up to about 1050 °C
- good mechanical strength up to 1000 °C
- good weldability and formability

For use at higher temperature in oxidizing atmospheres, the UGINOX R25-20 grade should be preferred.

#### Typical applications

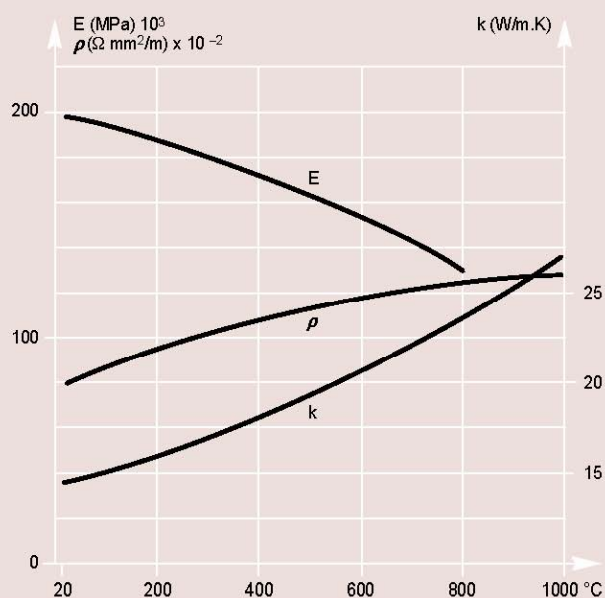
- Industrial furnace and boiler components
- Annealing bells
- Heat exchangers
- Salt bath heat treatment systems
- Calrods

#### Product range

Forms: sheets, blanks, coils, strips, circles  
Thicknesses: 0.40 à 14 mm  
Width: according to thickness, consult us  
Finish: cold rolled or hot rolled, depending on the thickness

## Physical properties (cold rolled sheet - annealed)

Density	d	–	4 °C	7.9
Melting temperature		°C		1420
Specific heat	c	J/kg.K	20 °C	500
Thermal conductivity	k	W/m.K	20 °C 500 °C	15 19
Mean coefficient of Thermal expansion	$\alpha$	$10^{-6}/K$	20 - 200 °C 20 - 400 °C 20 - 600 °C 20 - 800 °C 20 - 1000 °C	16.0 17.5 18.0 18.5 19.5
Electric resistivity	$\rho$	$\Omega \cdot \text{mm}^2/\text{m}$	20 °C	0.78
Magnetic permeability	$\mu$	at 0.8 kA/m DC or AC	20 °C	1.02
Young's modulus	E	$\text{MPa} \cdot 10^3$	20 °C	195



## Tensile properties

### Annealed condition

According to NF EN 10002-1 (July 2001),  
Specimen perpendicular to the rolling direction

### Specimen

$L_0 = 80 \text{ mm}$  (thickness < 3 mm)  
 $L_0 = 5,65 \sqrt{S_0}$  (thickness  $\geq 3 \text{ mm}$ )

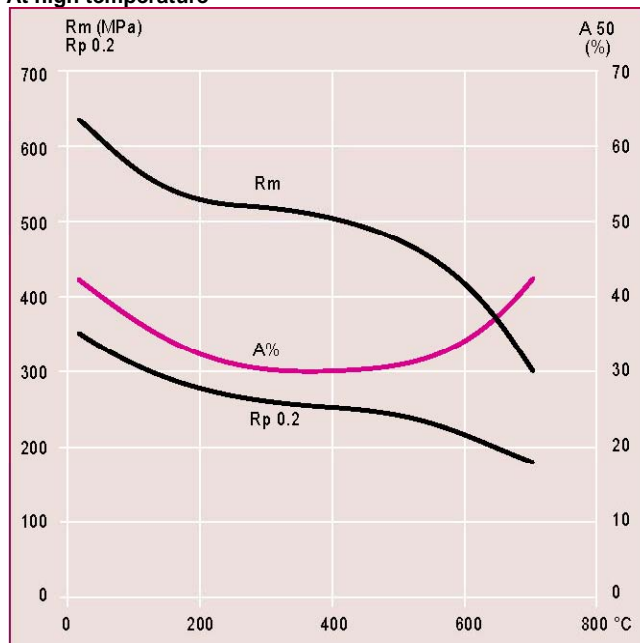
$$1 \text{ MPa} = 1 \text{ N/mm}^2$$

	$R_m^{(1)}$ (MPa)	$Rp_{0.2}^{(2)}$ (MPa)	$A^{(3)}$ (%)
Cold rolled	590	310	45

Mean values

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

### At high temperature



Typical values

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## Creep properties (MPa)

(typical values)

Mean stresses (MPa) for different rupture lives as a function of temperature

Temperature (°C)	100 h	10 000 h	100 000 h
600	190	120	65
700	75	36	16
800	35	18	7.5
900	15	8.5	3
1000	9	4	1.5

Mean stresses (MPa) for 1% elongation in different times as a function of temperature

Temperature (°C)	1 000 h	10 000 h	100 000 h
600	100	70	60
700	40	25	20
800	18	10	5.5
900	8	5	2
1000	5.5	2.5	1

*Note: Prolonged holding between 650 and 850°C decreases the low temperature ductility of UGINOX R24-13S.*

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## High temperature oxidation and corrosion resistance

In general, depending on the type of atmosphere, the maximum temperatures for the use of **UGINOX R24-13S** in continuous service are as follows:

Atmosphere	
Oxidizing	1 050°C
Oxidizing, sulfur-containing	1 000°C
Reducing, carburizing	950°C
Reducing, sulfidizing	850°C

When the atmosphere is not continuously oxidizing, the limiting service temperatures are lower than those indicated above, and depend on the frequency of the cycles. In no circumstances must temperatures then exceed 950°C.

**UGINOX R24-13S** has satisfactory resistance to temperature cycling, but where there is a risk of severe thermal shocks UGINOX R25-20 is to be preferred.

**UGINOX R24-13S** behaves well in carburizing atmospheres. It is also used in contact with molten salt baths, even in certain cases where the salt is contaminated with fuel ash.

*Note:*

*These indications are general in nature and usually refer to the behavior in impurity-free media. They must therefore be used only as rough guidelines for material selection purposes.*

## Welding

Welding process	No filler metal	With filler metal		Shielding gas
	Typical thicknesses	Thickness	Filler metal	
			Rod	Wire
Resistance Sport Seam	≤ 2 mm ≤ 2 mm			
TIG	< 1.5 mm	> 0.5 mm	ER 309 L (Si) ER Ni Cr 3 <sup>(1)</sup>	ER 309 L (Si) ER Ni Cr 3 <sup>(1)</sup> Argon Argon + 5% H <sub>2</sub> Argon + Helium
PLASMA	< 1,5 mm	> 0.5 mm		ER 309 L (Si) ER Ni Cr 3 <sup>(1)</sup> Argon Argon + 5% H <sub>2</sub> Argon + Helium
MIG		> 0.8 mm		ER 309 L (Si) ER Ni Cr 3 <sup>(1)</sup> Argon + 2% CO <sub>2</sub> Argon + 2% O <sub>2</sub> Argon + 3% CO <sub>2</sub> + 1%H <sub>2</sub> Argon + 2% CO <sub>2</sub> + Helium
S.A.W		> 2 mm		ER 309 L ER Ni Cr 3 <sup>(1)</sup>
Electrode		Repairs		E 309 L E NI Cr Fe 2 <sup>(1)</sup>
Laser	< 5 mm			Helium Possibly argon or nitrogen

(1) For service temperatures (not commended) between 550 and 900°C

In general, **UGINOX R 24-13S** is slightly more difficult to weld than UGINOX 18-8 type austenitic grades. It is recommended to reduce the welding power, and where necessary to increase the number of passes, limiting the interpass temperature to a maximum of 150°C.

It can be useful to preheat the parts to be joined for large thicknesses or complex assemblies. No post-weld heat treatment is required.

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

## Forming

**UGINOX R24-13S** can be drawn and can be readily cold and hot formed

## Heat treatment and finishing operations

### Annealing

Water quench or air cool from 1075 ± 25°C.

### Polishing – brushing – buffing – satin finishing

No particular difficulty.

### Pickling

Nitric-hydrofluoric acid mixture  
(10% HNO<sub>3</sub> + 2% HF) at RT 60°C.  
Sulphuric-nitric acid mixture  
(10% H<sub>2</sub>SO<sub>4</sub> + 0,5% HNO<sub>3</sub>) at 60°C.  
Descaling pastes for weld zones.

### Note :

*For high temperature applications, pickling is generally of no utility.*

### Passivation

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

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