Heat Resisting Austenitic Stainless Steel

Aperam 310S

Chemical Composition

Elements (%)	C	Si	Mn	Cr	Ni
310S	0.05	0.6	1.3	25	19.2

Typical values

Grade designation	European designation	American designation
310S	1.4845 (1)	UNS S31008 (2)
	(1) According to EN 10095	(1) According to ASTM A 240

This grade complies with:

- Aperam Stainless Europe 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

Key features

- Grade with high carbon content for high temperature application
- Excellent resistance to corrosion and oxidation
- Very good creep resistance
- Maximum in-service temperature of 1,050°C
- Excellent resistance to carburizing
- Good weldability and formability
- Wet corrosion properties are moderate

Applications

- Industrial furnace and boiler components
- Tubes and expansions bellows
- Heat exchangers
- Automotive exhaust systems and manifolds

Product Range

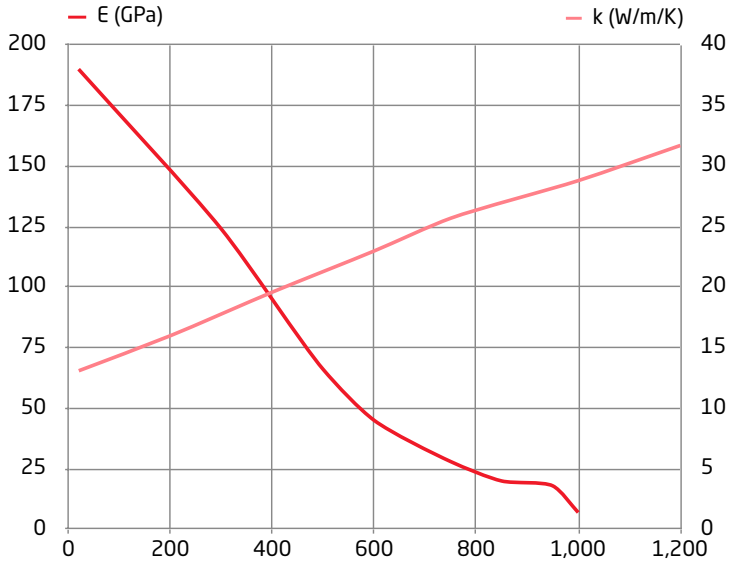
	Coils	Sheets / Blanks
Thickness (mm)	0.4 up to 12	0.4 up to 12
Width (mm)	up to 1,524	up to 1,524
Finish	2B / 2D / 2E / 1D	2B / 2D / 2E / 1D

Physical Properties

Cold rolled and annealed sheet

Density	d	kg/dm³	20°C	7.8
Melting temperature		°C	Liquidus	1410
Specific heat	c	J/kg·K	20°C	480
Thermal conductivity	k	W/m·K	20°C	13
Mean thermal expansion coefficient	α	10^{-6}/K	20-200°C 20-400°C 20-600°C 20-800°C 20-1,000°C	16.5 17.2 17.6 18 18.3
Electric resistivity	ρ	Ω mm²/m	20°C	0.86
Young's modulus	E	GPa	20°C	195

Poisson's coefficient: 0.30



Mechanical Properties

In the annealed condition

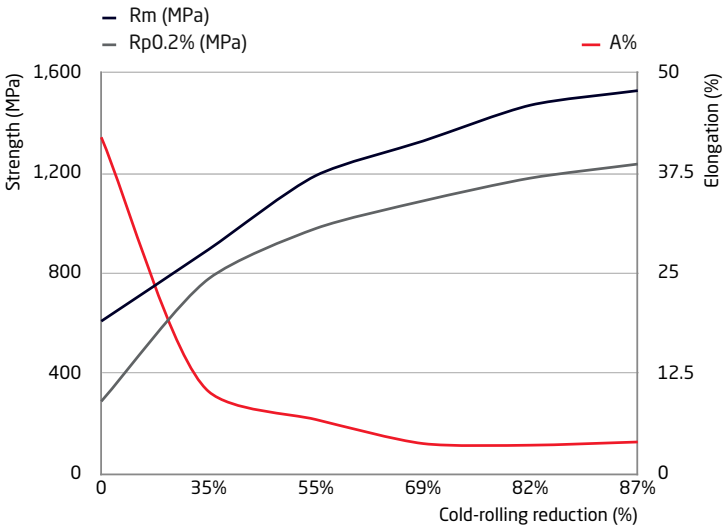
Length = 50 mm (thickness < 3 mm)
Length = 5.65 √ So (thickness ≥ 3 mm)

Grades	European designation	ASTM A240	Rm(1) (MPa)	$Rp_{0.2}$(2) (MPa)	A(3) %
310S	1.4845	S31008	610	290	42
309N	1.4835	S30815	750	410	48
309	1.4828	-	640	310	52
316Ti	1.4571	S31635	600	290	50
321	1.4541	S32100	620	290	52
K41X	1.4509	S423932 S43940	500	350	29
K44X	1.4521	S44400	540	370	29

1 MPa = 1 N/mm² - Typical values
(1) Ultimate Tensile Strength (UTS) - (2) Yield Strength (YS) - (3) Elongation (A)

In the tempered conditions

Typical values

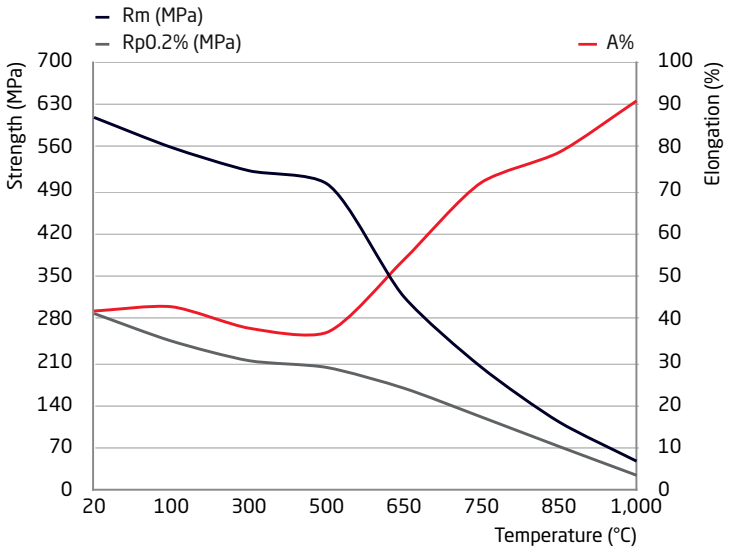


High Temperatures Properties

Grade AISI 310S is mainly used at high temperature due to its corrosion resistance. The typical working temperatures for an atmosphere with maximum Sulfur content of 2g/m³ are 1,050 °C (continuous service) and 1,100°C (peak temperature). Sulfur contents higher than 2g/m³ decrease maximum temperature to 950 °C.

At high temperatures

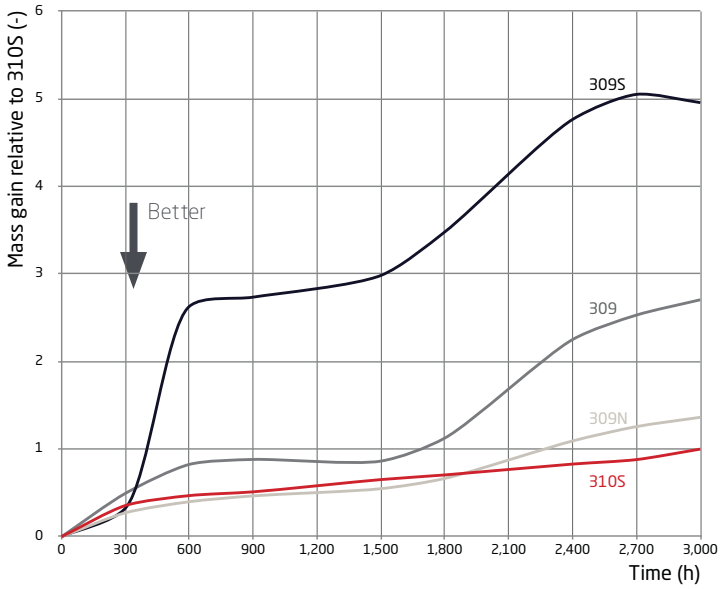
Tested in rolling direction – Typical values



Cyclic Oxidation

Environment: 1,000°C air
Thermal cycle between 600-1,000 °C with a dwell time of 33h in order to obtain 3,000 h of total dwell time at 1,000 °C.

310S exhibited very high oxidation resistance thanks to its high chromium and nickel content.



Corrosion

310S grade is primarily used at elevated temperature to take advantage of its oxidation resistance and its mechanical properties at high temperature. However, this grade is also resistant to aqueous corrosion due to its high chromium and nickel contents. After a long period of exposure to high temperature, grade AISI 310S can be susceptible to intergranular corrosion due to precipitation of chromium carbides.

Pitting potential (mV/SCE)

309N has a superior pitting resistance compared to 316L and 309.

Grades	European. designation	NaCl 0.02M 23°C	NaCl 0.02M 50°C	NaCl 0.5M 23°C	NaCl 0.5M 50°C	PREN
310S	1.4835	No-pit	No-pit	619	383	27
309N	1.4845	No-pit	No-pit	974	574	25
309	1.4828	No-pit	549	421	239	20
316L	1.4571	630	500	455	270	24
K41X	1.4509	419	252	304	47	19
K44X	1.4521	775	555	550	310	25

Forming

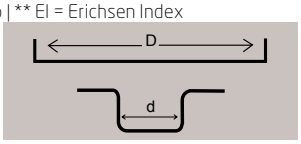
In the annealed condition, the 310S grade can be readily formed by all standard processes such as bending, contour forming, drawing, etc.

Typical values – 1.5 mm thick sheet with lubricant Mobilux EP00.

Grades	European Designation	LDR* (mm)
310S	1.4835	2.08
309N	1.4828	2.13
309	1.4828	2.16
K41X	1.4509	2.05
K44X	1.4521	2.08

* LDR = Limit Drawing Ratio | ** EI = Erichsen Index

$$LDR = \frac{D_{max}}{d}$$



Welding

Welding process	No filler material	With filler metal		Shielding gas*
	Typical thicknesses	Thicknesses	Filler material	* Hydrogen and nitrogen forbidden in all cases
TIG	< 1.5 mm	> 0.5 mm	EN ISO 14343-B 310 AWS 5.9 ER310	Ar Ar + He
PLASMA	< 1.5 mm	> 0.5 mm	EN ISO 14343-B 310 AWS 5.9 ER310	Ar Ar + He
MIG-MAG		> 0.8 mm	EN ISO 14343-B 310 AWS 5.9 ER310	Ar Ar + He Ar (+ He) + 1-2% CO_2 Ar + 1-2% O_2
SAW		> 3 mm	EN ISO 14343-B 310 AWS 5.9 ER310	-
SMAW		Repairs	EN ISO 3581 E 25 20 AWS 5.4 E310	-

310S is weldabale using standard arc welding processes. Heat treatment is usually not necessary before and after welding. The welds must be mechanically descaled and cleaned.

310S and equivalent filler wire present a primary austenitic solidification and are somewhat susceptible to hot cracking. Usual recommendation regarding this phenomena must be followed :

- Welding interpass temperature must be kept below 150°C
- Heat input must be low

Heat Treatment and Finishing

Annealing

After cold forming (work hardening) and welding, using an annealing treatment for a couple of minutes at 1,050 °C ±25 °C, followed by air cooling or water quenching, restores the microstructure (recrystallisation and dissolution of carbides) and eliminates internal stresses.

Pickling

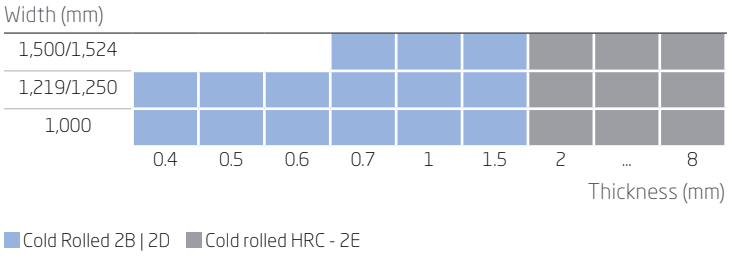
- Nitric-Hydrofluoric acid mixture (10 % HNO_3 + 2% HF) at ambient temperature or up to 60 °C
- Sulfuric-nitric acid mixture (10 % H_2SO_4 + 0.5 % HNO_3) at 60 °C
- Use descaling pastes for weld areas

Passivation

- 20-25% HNO_3 solution (36° Baumé) at 20°C
- Use passivating pastes for weld zones

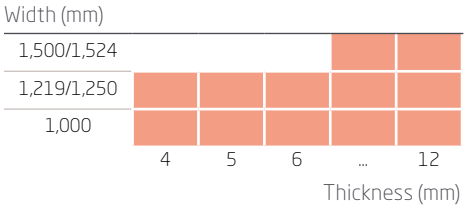
Size Range

Cold Rolled



Cold Rolled 2B | 2D Cold rolled HRC - 2E

Hot Rolled



Hot rolled HRAP 1D