Austenitic Stainless Steel

Aperam 304 304 - 304H - 304D - 304ED

Chemical Composition

Elements (%)	C	Si	Mn	Cr	Ni
304	0.05	0.40	1.10	18.20	8.05
304H	0.05*	0.40	1.10	18.20	8.05
304D	0.04	0.40	1.20	18.20	8.10
304ED	0.045	0.40	1.10	18.20	9.10

Typical values . * C mini = 0.04

Grade designation	European designation	American designation	IMDS Nr
304 standard level grade	X5CrNi18-10 / 1.4301[1]	UNS 30400/ Type 304[2]	1846756
304H	X6CrNi18-10 / 1.4948[3]	UNS 30409/ Type 304[2]	1845846
304D deep drawing grade	X5CrNi18-10 / 1.4301[1]	UNS 30400/ Type 304[2]	1846756
304ED severe deep drawing grade	X5CrNi18-10 / 1.4301[1]	UNS 30400/ Type 304[2]	1846756

[1] According to EN 10088-2

[2] According to ASTM A 240

[3] According to EN 10088-1, 2005 / EN10028-7, 2007

These grades comply with:

- REACH Regulation (EC) 1907/2006 article 32
- European Regulation (EC) 1272/2008 on the Classification, Labelling, and Packaging of substances and mixtures (CLP)
- European Directive 2000/53/EC on end-of-life vehicles and later modifications
- NFA 36 711 standard "Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non-packaging steel)"
- NSF/ANSI 51 Standard for "Food Equipment Materials" (United States Food and Drug Administration) regarding materials used for food contact
- French Decree No. 92-631, dated 8 July 1992, and Regulation No. 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food
- French regulatory paper dated 13 January 1976 relating to materials and articles made of stainless steel in contact with foodstuffs
- Italian Decree of 21 March 1973: a list of stainless steel types appropriate to "Regulations on the hygiene of packaging, receptacles and tools intended to come into contact with substances for food use or with substances for personal use"
- PED (Pressure Equipment Directive), according to EN 10028-7 and AD2000 Merkblatt W2 and W10

Key Features

Our 304 grades of stainless steel (304, 304H, 304D, 304ED) are a general purpose grade offering:

- Excellent resistance to pitting and crevice corrosion
- Good ductility
- Can easily de welded and polished
- Good polish ability
- 304D and 304ED have very good drawability

Applications

- Domestic appliances
- Sink units
- Metallic frames for the building industry
- Serving trays and cutlery
- Domestic cooking and catering equipment
- Dairy equipment
- Welded structures
- Decorative tubes
- Exhaust systems

Product Range

	Coils	Sheets / Blanks	Discs	Precision Strip	Precision Sheet	Tubes	Flat Bars
Thickness (mm)	0.30 up to 13	0.15 up to 13	0.38 up to 2.50	0.06 up to 2.5	0.20 up to 2.5	0.80 up to 2.5	2 up to 20
Width (mm)	up to 2,000	80 up to 2,000	Ø 15 up to 1,000	3 up to 700	40 up to 670	Ø 8 up to 80	10 up to 300
Finish	2R / 2B / 2D / 1D	2R / 2B / 2D / 1D	2R / 2B / 2D / 1D	2R / 2B / 2D / 2H / 2F	2R / 2B / 2D / 2H / 2F	2B / 2D / 1D	1D / Polished

Physical Properties

Cold rolled and annealed sheet

Density	d	kg/dm³	20°C	7.9
Melting temperature		°C	Liquidus	1,450
Specific heat	c	J/kg.K	20°C	500
Thermal conductivity	k	W/m.K	20°C	15
Mean thermal expansion coefficient	α	10^{-6}/K	20-100°C 20-200°C 20-400°C 20-600°C 20-800°C	16.0 16.5 17.0 17.5 18.0
Electric resistivity	ρ	Ω mm²/m	20°C	0.73
Magnetic resistivity	μ	at 0.8 kA/m DC or AC	20°C	1.02
Young's modulus	E	GPa	20°C	200

Poisson's coefficient: 0.30

Mechanical Properties

Test piece

Length = 50 mm (thickness < 3 mm)
Length = 5.65 √ S_o (thickness ≥ 3 mm)
Cold rolled

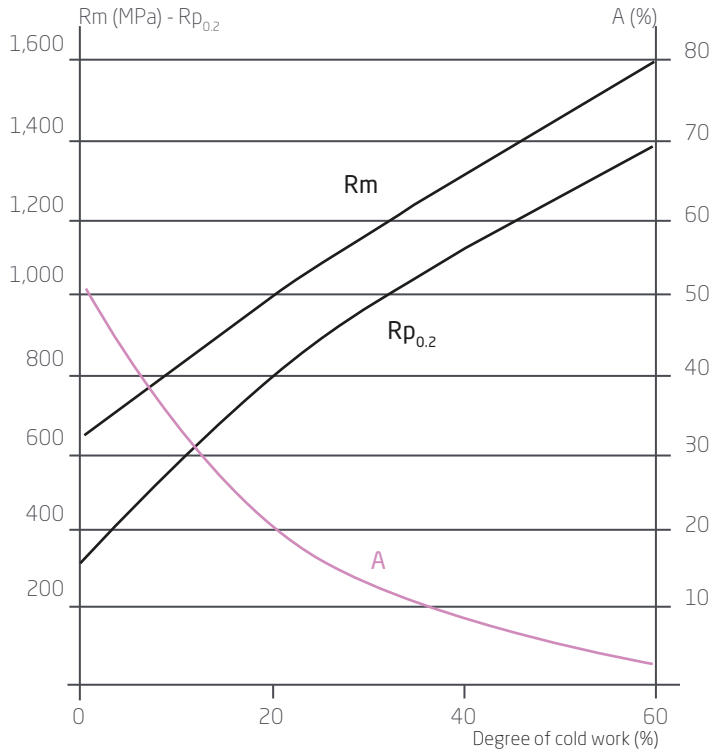
In the annealed condition

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

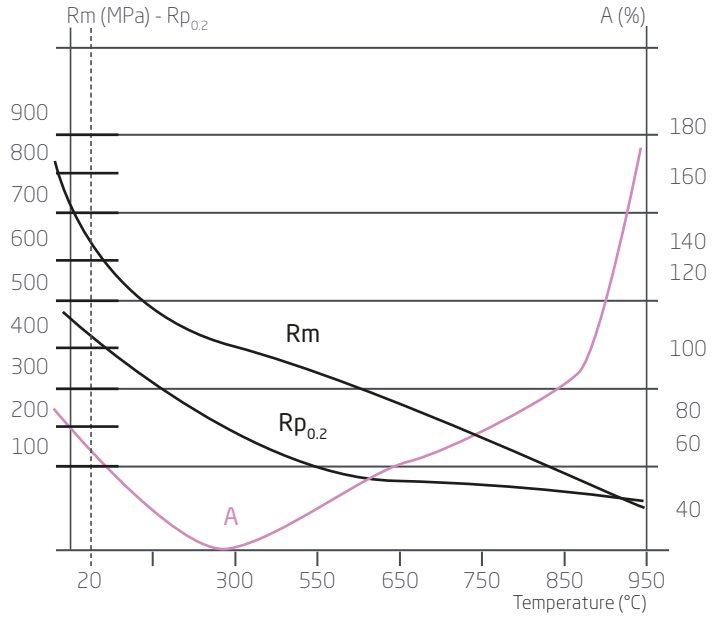
Grades	European designation	ASTM A240	Rm(1) (MPa)	$Rp_{0.2}$(2) (MPa)	A(3) %
304	1.4301	304	650	300	54
304H	1.4948	304	670	320	52
304D	1.4301	304	630	285	57
304ED	1.4301	304	610	270	57
201D	1.4618	201.1	665	320	52
K41	1.4509	441(a)	480	310	30
K45	1.4621(b)	445(a)	510	360	29

1 MPa = 1 N/mm² - Typical values
(1) Ultimate Tensile Strength (UTS) - (2) Yield Strength (YS) - (3) Elongation (A)
(a) Common designation - (b) Pending update of the standard

In the tempered condition (Typical values)



At high temperatures (Typical values)



Creep Properties

Creep is the slow deformation of a metal caused by the a long term exposure to a certain level of stress below the yield strength. Together with duration, temperature is a significant factor for determining the mean stress (MPa) for rupture.

Temperature (°C)	100 h	10 000 h	100 000 h
400	240	185	135
500	185	130	90
650	125	85	55

Typical values for 304 - MPa

Corrosion Resistance

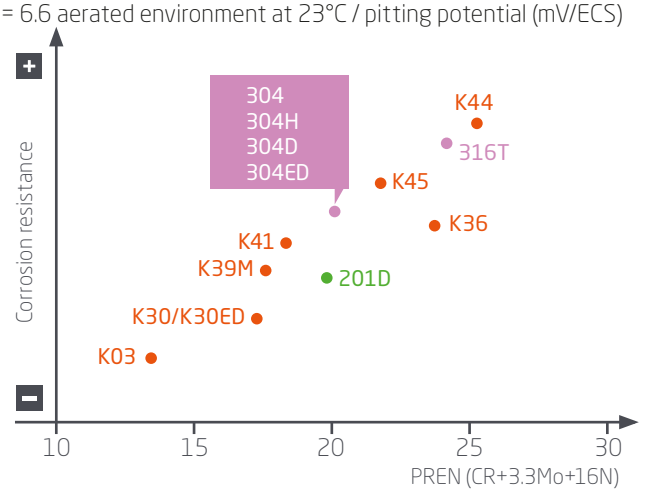
Although our 304, 304H, 304D, 304ED grades offer good resistance to common corrosion, they are not recommended when there is a risk of intergranular corrosion. They are, however, well adapted for exposure to fresh water and urban and rural atmospheres. In all cases, exposed external surfaces must be regularly cleaned to conserve the grade's appearance.
Our 304, 304H, 304D, 304ED grades also have good resistance against various acids, including:

- phosphoric acid in all concentrations at ambient temperature
- nitric acid up to 65% (40° Baumé), between 20 and 50°C
- formic and lactic acids at room temperature
- acetic acid between 20 and 50°C

This resistance makes these grades particularly well suited for applications that come into contact with cold or hot foodstuffs,such as wine, beer, milk (curdled or otherwise), natural fruit juices, syrups, molasses, etc.

Pitting corrosion

Pitting potential in a NaCl 0.02M,
pH = 6.6 aerated environment at 23°C / pitting potential (mV/ECS)



Pitting potential

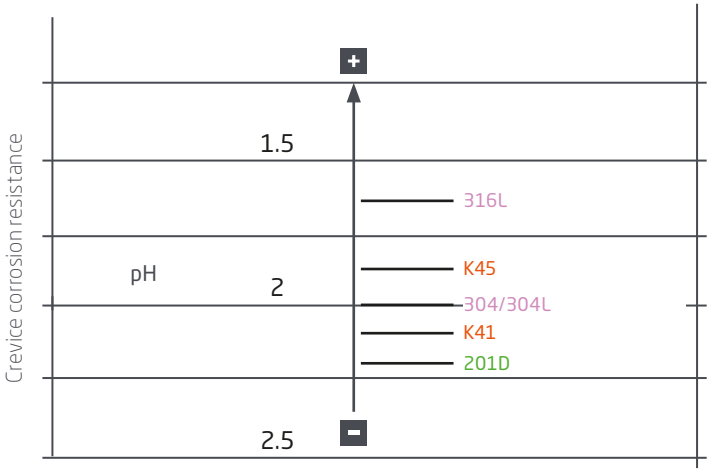
In variations following the temperature and the chloride concentration.

Grades	NaCl 0.02/23°C	NaCl 0.02/50°C	NaCl 0.05/23°C	NaCl 0.05/50°C
304 304H 304D 304ED	540 mV	385 mV	305 mV	175 mV

Typical values

Crevice corrosion

Depassivation pH in a deaerated NaCl 2M environment at 23°C



Crevice corrosion occurs in two stages. During the first stage (initiation), chloride accumulates and acidification begins. This eventually causes depassivation within the crevice region. A depassivation pH is the critical condition for passivity breakdown.

The metal begins to dissolve during the second stage (propagation). This process can be slowed down using grades that contain molybdenum and nickel as both elements are known to decrease the speed of propagation.

Forming

In the annealed condition, our 304, 304H, 304D, 304ED grades can be readily cold formed using all standard processes (bending, contour forming, drawing, flow turning, etc.). However, some forming operations are more readily performed hot. Regardless of the type of forming operation used, subsequent pickling is necessary. For severe forming operations, our 304, 304H, 304D, 304ED grades are preferred.

Deep drawing (Swift test)

The Swift test is used to determine the Limiting Drawing Ration (LDR). LDR is defined by the maximum ratio between the blank diameter (variable) and the punch diameter (fixed) that drawing can be successfully performed in one step.

Stretching (Erichsen test)

The stretching behaviour is characterized by the dome height (h) of the Erichsen test, is also known as Index ' EI '.

Bending

Our 304, 304H, 304D, 304ED grades have good bending capacity up to 180°, with very small bending radii for thicknesses below 0.8 mm. For thicker gauges, a bending radius of at least half the thickness of the sheet is recommended. When bending the material, the elastic springback must always be taken into consideration.

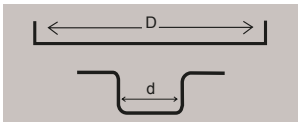
Flow turning

Our 304, 304H, 304D, 304ED (1.4301) are the most suitable grades for this application.

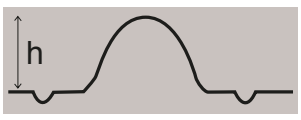
Grades	European designation	ASTM A240	LDR*	EI** (mm)
304	1.4301	304	1.96	11.6
304D	1.4301	304	1.98	11.8
304ED	1.4301	304	2.02	12.0
201D	1.4618	201.1	1.92	11.9
K41	1.4509	441	2.29	9.4
K45	1.4621	445	2.28	9.5

* Limiting Drawing Ratio
** Erichsen Index - Lubricant = Mobilux EP00 - Typical values tests done on 0.8 mm thickness.

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



EI =



Welding

Welding process	No filler material	With filler metal			Shielding gas*
	Typical thicknesses	Thicknesses	Filler material		* Hydrogen and nitrogen forbidden in all cases
			Rod	Wire	
Resistance: spot, seam	< 2 mm				
TIG	< 1.5 mm	> 0.5 mm	ER 308 L[1] ER 347L [1] [2]	ER 308 L[1] ER 347L [1] [2]	Ar Ar + 5% H Ar + He
PLASMA	< 1.5 mm	> 0.5 mm		ER 308 L[1] ER 347L [1] [2]	Ar Ar + 5% H Ar + He
MIG		> 0.8 mm		ER 308 L[1] ER 347L [1] [2]	Ar + 2% CO_2 Ar + 2% O_2 Ar + 2% CO_2 + 1% H Ar + He
SAW		> 2 mm		ER 308 L[1]	
Electrode		Repairs	E 308 L[1] E 308L E 347[1] [2]		
Laser	< 5 mm				He Under certain circumstances: Ar N

[1] ER 308L (AWS A5.9) = G 19 9 L (NF EN ISO 14343) - [2] ER 347 (AWS A5.9) = G 19 9 Nb (NF EN ISO 14343) - [3] E308L (AWS A5.4) = E 19 9 L (EN1600) - [4] 4 E347 (AWS A5.4) = E 19 9 Nb (EN1600)

In general, heat treatment is not required after welding. However, to fully restore the metal's corrosion resistance, the welds must be mechanically or chemically descaled, then passivated and decontaminated. If there is a risk of intergranular corrosion, a solution annealing treatment at 1,075 ±25°C must be carried out. However, in such cases, we recommend using either a low carbon grade, such as our 304, or titanium stabilized grades, such as our 321 (Type 321).

Heat Treatment and Finishing

Annealing

After cold forming (work hardening) and welding (risk of intergranular corrosion in the weld joint), using an annealing treatment for a couple of minutes at 1,075 ±25°C, followed by air cooling, will restore the microstructure (recrystallisation and dissolution of carbides) and eliminates internal stresses. After annealing, pickling, followed by passivation, is necessary.

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

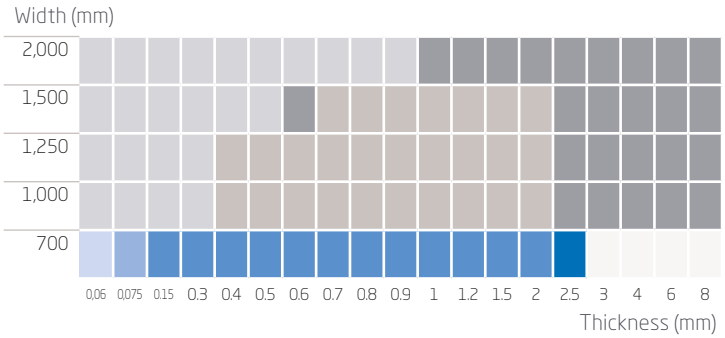
Polishing

The surface of our 304ED is suitable for all kinds of polishing (grit, scotch-brite, electro polishing).

Size Range

Our size range is based on our production capabilities. Please contact us for the latest information per grades on offer.

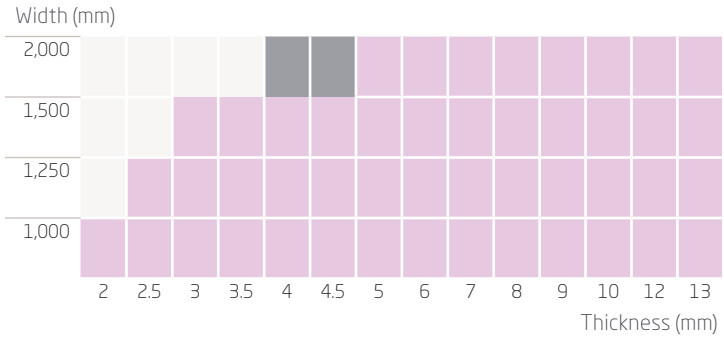
Cold Rolled



2D - 2B | 2R (BA) - 2D - 2B | 2R(BA) for 304 & 304D only
2H - 2F | 2H - 2R - 2F | 2H - 2R - 2D - 2B - 2F | 2H - 2D - 2B - 2F

For 2 mm thick under 1,000 wide: only available for 304 and 304D, not for 304ED.
For > 1,500 mm wide: only available for 304.

Hot Rolled and HRC



Hot rolled HRAP - 1D | Cold rolled HRC - 2E

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