Super Austenitic Stainless Steel

904L

Chemical Composition

Elements	C	Cr	Ni	Mo	Cu	N
%	0.015	20	25	4.5	1.5	≤ 0.1

Typical values
PREN ≥ 34 (Pitting Resistance Equivalent Number – % Cr+3.3x% Mo+16x% N)

Aperam 904L super austenitic stainless steel is characterized by a high PREN (minimum 34%) and the ability to meet the most demanding applications.

European designation [1]	American designation [2]
X1NiCrMoCu25-20-5 / 1.4539	UNS N08904/Type 904L
[1] According to EN 10088-1	[2] According to ASTM A240

This grade complies with:
- Aperam Stainless Europe - Safety Information Sheet for Stainless Steel
- European directive 2000/53/EC on end-of-life vehicles and later modifications
- PED 2014/68/EU (Pressure Equipment Directive)
- NF A36-711 standard "Stainless Steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non packaging steel)"
- ISO 15156-3 / NACE MR 0175
- ISO 17945 / NACE MR 0103
- EN10088-4 with CE marking , according to CPD 305/2011/EU is available (DoP.Nr.GNK.22.01 REV.0)
- VdTüV WB 421

Key Features

- **High PREN:** ≥ 34 – pitting and crevice corrosion resistance in the presence of chlorides
- **High corrosion resistance:** phosphoric and sulphuric acid resistance
- **High temperature resistance:** for chimneys and exhaust systems
- **Cryogenic service resistance:** for liquefied gases

Applications & Equipment

- (Petro)chemical, Oil & Gas
- Energy, Geothermal
- Water, Fertilisers, Chemistry
- Hydrometallurgy, Minerals processing
- Pollution control
- Exhaust
- Chimneys
- Piping & tubing
- Heat exchangers
- Storage tanks, Reactors

Product Range

Forms: coils, sheets and strips
Thicknesses: from 0.15 mm and up to 10 mm

Width: up to 1,524 mm / 60 in (depending on thickness)
Finishes: hot and cold rolled

	Coils	Sheets / Blanks	Precision Strip		Precision Sheet	
Thickness (mm)	0.40 up to 10	0.40 up to 10	0.30 up to 2.5	0.15 up to 2.5	0.30 up to 2.5	0.15 up to 2.5
Width (mm)	up to 1,524 (60 in)	up to 1,524 (60 in)	5 up to 680		100 up to 680	
Finish	2B / 2E / 2D / 1D	2B / 2E / 2D / 1D	2B / 2D	2R	2B / 2D	2R

For any other dimensions and for 2H finish, please consult us.

Physical Properties

Density	d	kg/dm³	20°C	8.0
Melting temperature	-	°C	–	1,383
Specific heat	c	J/kg.K	20°C	460
Thermal conductivity	k	W/m.K	20°C	11.9
Mean coefficient of thermal expansion	α	10^{-6}/K	20-200°C 20-400°C 20-600°C 20-800°C 20-1,000°C	18.4 18.0 18.0 18.2 18.5
Electric resistivity	ρ	Ω mm²/m	20°C	$9.35 \cdot 10^{-7}$
Magnetic permeability	μ	at 0.8 kA/m DC or AC	20°C	< 1.05
Young's modulus	E	GPa	20°C	200

Mechanical Properties

In annealed condition at 20°C

According to ISO 6892-1, transverse direction. Gauge length: 50 mm

Grade	European designation	UNS designation	Rm (1) (MPa)	$Rp_{0.2}$ (2) (MPa)	A (3) %
904L	1.4539	N08904	610	295	41
DX1803	1.4462	S31803	800	620	30
DX2205		S32205			
316L	1.4401/4404	S31603	620	300	52

1 MPa= 1 N/mm² / Typical values

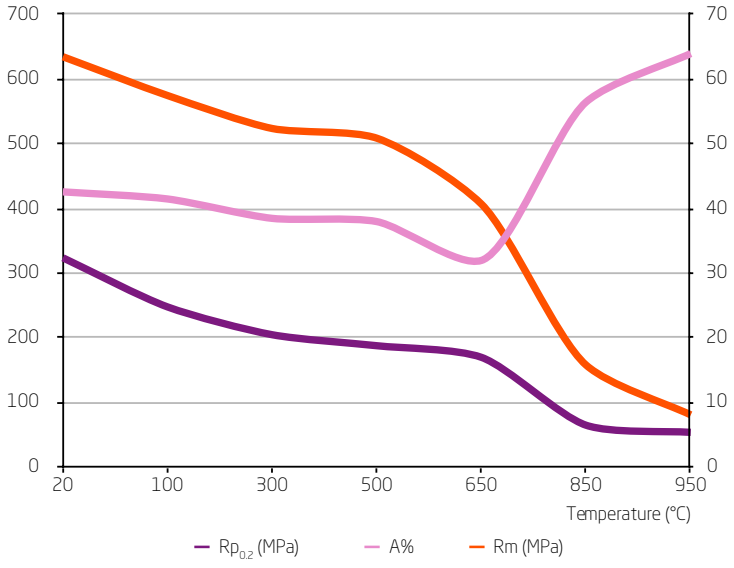
(1) Ultimate Tensile Strength (UTS) / (2) Yield Strength (YS) / (3) Elongation (A)

Typical impact toughness

Temperature (°C)	Kv typical* (J)
20	250
-40	200
-196	150

*Kv_2 transversal

At high temperatures



Corrosion Resistance

Uniform corrosion

Thanks to its high chromium, copper and molybdenum content, Aperam 904L has a uniform corrosion resistance, similar to that of standard duplex grades.

Intergranular corrosion

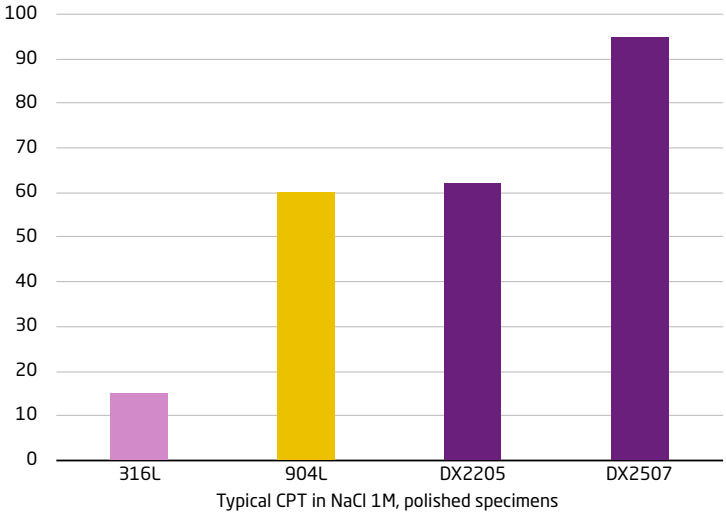
Aperam 904L exhibits high intergranular corrosion resistance - the result of having a low carbon and high chromium content and the addition of molybdenum.
Aperam 904L is resistant to intergranular corrosion and satisfies both the Strauss and Huey tests (according to ASTM A262E and A262C respectively).

Pitting corrosion

Aperam 904L's 20% chromium, 4.5% molybdenum and 0.06% nitrogen content, means the grade has a pitting corrosion resistance as high as duplex stainless steels and even higher than some nickel-based alloys.

To compare relative corrosion resistance, ASTM G150 Critical Pitting Temperatures (CPT) are plotted on the following graph:

Critical Pitting Temperature (°C)
as determined by ASTM G150



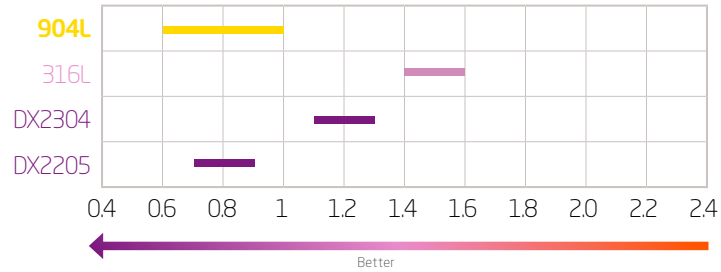
Typical CPT in NaCl 1M, polished specimens

Crevice Corrosion

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 using grades that contain molybdenum and nickel as both elements are known to decrease the speed of propagation.

Depassivation pH, 2M NaCl, 23°C



For further information about corrosion testing results, please contact the Technical Customer Support Team.

Forming

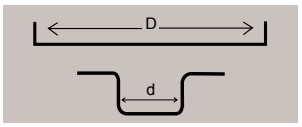
This grade can be used for forming applications.

Aperam 904L tolerates severe cold forming conditions, even with higher mechanical properties than standard austenitic stainless steels.

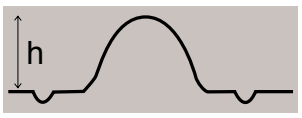
Grades	European designation	ASTM A240	LDR*	EI** (mm)
904L	**1.4539**	**UNS N08904**	**2.10**	**12.5**
304L	1.4307	304L	1.91	11.4
316L	1.4401/1.4404	316/316L	2.01	11.5
DX2205	1.4462	2205	1.9 - 1.95	9.5

* Limiting Drawing Ratio
** Erichsen Index - Lubricant = Mobilux EP00 - Typical values | Tests performed on 0.8 mm thickness.

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



EI =



A bending test is commonly used to evaluate a steel's forming ability. The minimum bending radius is equal to the thickness of the base metal.

Welding

Aperam 904L can be welded using all conventional welding processes typically applied to standard austenitic stainless steels. A matching filler wire or a nickel-based wire can be used. Welding without filler material is also possible. However, due to the fully austenitic microstructure of the alloy, specific precautions must be taken:

- Minimise heat input: use stringer beads and avoid weaving,
- Interpass temperature should not exceed 100°C,
- No preheating or postheating is required,
- Post-weld heat treatment is generally not necessary, although hyper-quenching annealing may be mandated by applicable standards.

After welding, all welds must be mechanically and/or chemically descaled, followed by passivation and decontamination. The following table illustrates different welding conditions for different welding processes:

Welding process	No filler material	With filler material			Shielding gas Backing gas
	Typical thicknesses	Typical thicknesses	Filler material		
			Rod[1]	Wire[2]	
Resistance: spot, seam	≤ 2 mm				
TIG	≤ 1.5 mm	> 0.5 mm		20 25 5 Cu L/ER 385 Ni Cr 22 Mo 9 Nb/ E(R)NiCrMo-3	Ar Ar + 5% H_2 Ar + He
PLASMA	≤ 1.5 mm	> 0.5 mm		20 25 5 Cu L/ER 385 Ni Cr 22 Mo 9 Nb/ E(R)NiCrMo-3	Ar Ar + 5% H_2 Ar + He
MIG-MAG		> 0.8 mm		20 25 5 Cu L/ER 385 Ni Cr 22 Mo 9 Nb/ E(R)NiCrMo-3	Ar + 2% CO_2 Ar + 2% O_2 Ar + 2% CO_2 + He
SAW		> 2 mm		20 25 5 Cu L/ER 385 Ni Cr 22 Mo 9 Nb/ E(R)NiCrMo-3	
Electrode		Repairs	20 25 5 Cu L/ER 385 Ni Cr 22 Mo 9 Nb/ E(R)NiCrMo-3		
Laser	≤ 5 mm				He or Ar

[1] EN ISO 3581 / AWS A5.4 EN ISO 14172 | [2] EN ISO 14343 / AWS A5.9 EN ISO 18274

Heat Treatment and Finishing

Heat treatment

After cold forming, applying an annealing treatment for a few minutes at 1,100 ±25°C, followed by air cooling, will restore the structure and eliminate internal stresses. After heat treatment, pickling, followed by passivation, must be carried out.

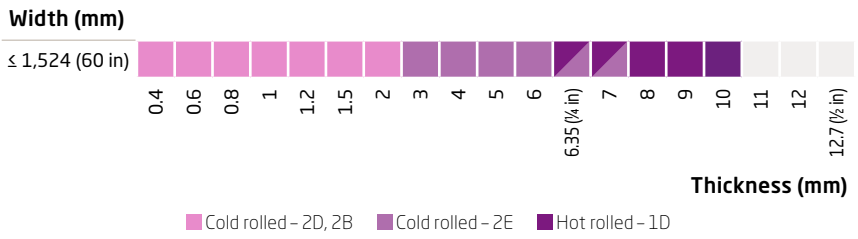
Pickling

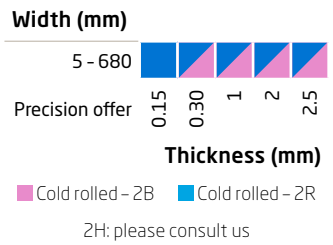
By acid mix (20% HNO_3 + 2% HF) at room temperature or at 60°C. By sulphuric-nitric bath (10% H_2SO_4 + 0.5% HNO_3) at room temperature or at 60°C. Use pickling pastes for welds.

Passivation

Nitric acid bath (10 – 25%) at 20°C. Use passivating pastes for welds.

Size Range





2H: please consult us

Please contact us about sizes and finishes outside this range.