Alleima

Sanmac® 304/304L

Bar

Datasheet

General description

Sanmac® 304/304L is an austenitic chromium-nickel steel with improved machinability.

Standards

- ASTM: 304, 304L
- UNS: S30400, S30403
- EN Number: 1.4301, 1.4307
- EN Name: X 5 CrNi 18-10, X 2 CrNi 18-9
- W.Nr.: 1.4301
- JIS: SUS304

Standards

Product standards

- EN 10088-3, EN 10088-5 (dimensions up to 250 mm)
- EN 10272, EN 10222-5, (dimensions ≥ 180 mm), AD-2000-W2
- ASTM A479, A276
- Chemical composition and mech. properties acc. ASTM A182

Approvals

- TÜV AD-Merkblatt W0/TRD 100
- Pressure Equipment Directive (2014/68/EU)
- Ü-Zeichen
- JIS Approval for Stainless Steel Bars

Certificate

- Status according to EN 10 204/3.1

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Chemical composition (nominal)

Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni
≤0.030	0.3	1.8	≤0.040	≤0.030	18.5	8.5

Applications

SANMAC® 304/304L is used for a wide range of industrial applications.

Industrial categories	Typical applications
Chemical industry	Flanges
Food industry	Valves
Petrochemical industry	Fittings
Pulp & paper industry	Couplings
Nuclear industry	Rings
	Seals
	Bolts and Nuts
	Shafts
	Forgings
	Discs

Corrosion resistance

General corrosion

Sanmac® 304/304L has good resistance in:

organic acids at moderate temperatures
salt solutions, e.g. sulfates, sulfides and sulfites
caustic solutions at moderate temperatures
oxidizing acids like nitric acid

Stress corrosion cracking

Austenitic steels are susceptible to stress corrosion cracking. This may occur at temperatures above about 60°C (140°F) if the steel is subjected to tensile stresses and at the same time comes into contact with certain solutions, particularly those containing chlorides.

In applications demanding high resistance to stress corrosion cracking we recommend the austenitic-ferritic steel Sanmac® SAF 2205, see datasheet S-8702-ENG.

Intergranular corrosion

Sanmac® 304/304L has a low carbon content and therefore good resistance to intergranular corrosion.

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Pitting and crevice corrosion

The Sanmac® 304/304L grade is relatively low alloyed and therefore it may be sensitive to pitting and crevice corrosion even in solutions of relatively low chloride content. Molybdenum-alloyed steels have better resistance and the resistance improves with increasing molybdenum content.

Gas corrosion

Sanmac® 304/304L can be used in

air up to 850°C (1560°F)
steam up to 750°C (1380°F
synthesis gas (ammonia synthesis) up to about 550°C (1020°F)

Creep behavior should also be taken into account when using the steel in the creep range. In flue gases containing sulphur, the corrosion resistance is reduced. In such environments the steel can be used at temperatures up to 600–750°C (1110–1380°F) depending on service conditions. Factors to consider are whether the atmosphere is oxidizing or reducing, i.e. the oxygen content, and whether impurities such as sodium and vanadium are present.

Forms of supply

Finishes and dimensions

Sanmac® 304/304L bar steel is stocked in a large number of sizes. The standard size range for stock comprises 20-450 mm and in inch sizes 3/4-14", see pocket card S-02909. Round bar is supplied in solution annealed and peel turned condition.

Lengths

Bars are delivered in random lengths of 3-7 m, depending on diameter.

Diameter	Height of arch, Typical value
mm	mm/m
20 - 70	1
> 70	2

Tolerances, mm-sizes

Diameter	Tolerances
mm	mm
20-35	-0/+0.15
40-45	-0/+0.16
50-95	-0/+0.19
75-95	-0/+1.00
100-265	-0/+1.50
290-350	-0/+2.00

Tolerances for the inch-sizes are in accordance with ASTM A-484

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Surface conditions	Ra, Typical value	Size, diameter
	µm	mm
Peeled and polished	1	20-300
Peel turned	2	>300

Heat treatment

Sanmac® 304/304L bars are delivered in solution annealed condition. Billets are delivered in hot-worked condition. If another heat treatment is needed after further processing the following is recommended.

Solution annealing

1040–1100°C (1900–2010°F), rapid cooling in air or water.

Hot working

Hot working should be carried out at a material temperature of 900-1200°C (1650-2190°F), cooling in air or in water. If additional heat treatment is needed it should be carried out in accordance with the recommendations given for heat treatment.

Mechanical properties

Bar steel is tested in delivery condition.

At 20°C (68°F)

Metric units

Proof strength		Tensile strength	Elong.	Contr.	HB
$R_{p0.2}$ a)	$R_{p1.0}$ a)	R_m	A b)	Z	
MPa	MPa	MPa	%	%	
≥205	≥230	515-680	≥45	≥50	≤215

Imperial units

Proof strength		Tensile strength	Elong.	Contr.	HB
$R_{p0.2}$ a)	$R_{p1.0}$ a)	R_m	A b)	Z	
ksi	ksi	ksi	%	%	
≥29.5	≥33.5	74.5-98.5	≥45	≥50	≤215

1 MPa = 1 N/mm^2
a) $R_{p0.2}$ and $R_{p1.0}$ corresponds to 0.2% offset and 1.0% offset yield strength, respectively.
b) Based on $L_0 = 5.65\sqrt{S_0}$, where L_0 is the original gauge length and S_0 the original cross-section area.

Impact strength

Due to its austenitic microstructure, SANMAC® 304/304L has very good impact strength both at room temperature and at cryogenic temperatures.

Tests have demonstrated that the steel fulfils the requirements (60 J (44 ft-lb) at -196 °C (-320 °F)) according

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to the European standards EN 13445-2 (UFPV-2) and EN 10272.

At high temperatures

Metric units

Temperature	Proof strength		Tensile strength
	$R_{p.02}$	$R_{p1.0}$	R_m
°C	MPa	MPa	MPa
	min.	min.	min.
100	155	190	450
200	127	155	400
300	110	135	380
400	98	125	380
500	92	120	360

Imperial units

Temperature	Proof strength		Tensile strength
	$R_{p.02}$	$R_{p1.0}$	R_m
°F	ksi	ksi	ksi
	min.	min.	min.
200	23.1	28.1	66.1
400	18.3	22.4	57.9
600	15.7	19.3	55.1
800	14.0	17.9	54.3
1000	13.1	17.4	48.9

Physical properties

Relative magnetic permeability < 2,5

Density: 7.9 g/cm^3, 0.29 lb/in^3

Thermal conductivity

Temperature		Temperature	
°C	W/m °C	°F	Btu/ft h °F
20	15	68	8.5
100	16	200	9.5
200	18	400	10.5
300	20	600	12
400	22	800	13

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500	23	1000	14
600	25	1200	15
700	26	1300	15

Specific heat capacity

Temperature		Temperature	
°C	J/kg °C	°F	Btu/lb °F
20	475	68	0.11
100	500	200	0.12
200	530	400	0.13
300	560	600	0.13
400	580	800	0.14
500	600	1000	0.14
600	615	1200	0.15
700	625	1300	0.15

Thermal expansion [1)]

Temperature		Temperature	
°C	Per °C	°F	Per °F
30-100	16.5	86-200	9.5
30-200	17	86-400	9.5
30-300	17.5	86-600	10
30-400	18	86-800	10
30-500	18.5	86-1000	10
30-600	18.5	86-1200	10.5
30-700	19	86-1400	10.5

1) Mean values in temperature ranges ($x10^{-6}$)

Modulus of elasticity [1)]

Temperature		Temperature	
°C	MPa	°F	ksi
20	200	68	29.0
100	194	200	28.2
200	186	400	26.9
300	179	600	25.8
400	172	800	24.7

500	165	1000	23.5

1) x10[3]

Machining

Sanmac is our trademark for the Alleima machinability concept. In Sanmac materials, machinability has been improved without jeopardizing properties such as corrosion resistance and mechanical strength.

The improved machinability is owing to:

- optimized non-metallic inclusions
- optimal chemical composition
- optimized process and production parameters

Detailed recommendations for the choice of tools and cutting data regarding turning, thread cutting, parting/grooving, drilling, milling and sawing are provided in the brochure S-029-ENG.

The diagram shows the ranges within data should be chosen in order to obtain a tool life of minimum 10 minutes when machining austenitic Sanmac materials (304/304L, 316/316L). The ranges are limited in the event of low feeds because of unacceptable chip breaking. In the case of high cutting speeds, plastic deformation is the most dominant cause of failure. When feed increases and the cutting speed falls, edge frittering (chipping) increases significantly. The diagram is applicable for short cutting times. For long, continuous cuts, the cutting speeds should be reduced somewhat.

[bild]   Figure 1. Machining chart Sanmac® 304/304L.

The lowest recommended cutting speed is determined by the tendency of the material to stick to the insert (built-up-edge), although the integrity of insert clamping and the stability of the machine are also of great significance.

It is important to conclude which wear mechanism is active, in order to optimize cutting data with the aid of the diagram.

Turning of Sanmac® 304/304L, 316/316L

Recommended insert and cutting data (starting values)

Insert Geometry	Grade	Cutting data Feed	Cutting speed	Application
		mm/rev	m/min	
MF	GC2015	0.15	250	Finishing, copy turning
MM	GC2015	0.30	225	Medium machining
MM	GC2025	0.30	195	Medium-to-rough machining under less stable conditions

Welding

The weldability of SANMAC® 304/304L is good. Suitable methods of fusion welding are manual metal-arc welding (MMA/SMAW) and gas-shielded arc welding, with the TIG/GTAW method as first choice.

Since this material is alloyed in such a way to improve its machinability, the amount of surface oxides on the welded beads might be higher compared to that of the standard 304/304L steels. This may lead to arc instability during TIG/GTAW welding, especially welding without filer material. However, the welding behavior

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of this material is the same as for standard 304/304L steels when welding with filler material.

For SANMAC® 304/304L, heat input of <2.0 kJ/mm and interpass temperature of <150°C (300°F) are recommended. Preheating and post-weld heat treatment are normally not necessary.

Recommended filler metals

TIG/GTAW or MIG/GMAW welding

ISO 14343 S 19 9 L / AWS A5.9 ER308L (e.g. Exaton 19.9.L)

MMA/SMAW welding

ISO 3581 E 19 9 L R / AWS A5.4 E308L-17(e.g. Exaton 19.9.LR)

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