Alleima

Sanmac® 304/304L

Hollow bar

Datasheet

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

Standards

- ASTM: MT 304, MT 304L
- UNS: S30400, S30403
- EN Number: 1.4301, 1.4307
- EN Name: X5CrNi18-10, X2CrNi18-9
- JIS: SUS304TKA

Product standards in applicable parts

- EN 10216-5*, EN 10297-2, EN 10294-2
- ASTM A511
- JIS G3446

* The leakage test is deferred to the finished component

Approval

JIS Approval No. SE9402 for Stainless Steel Tubes

Chemical composition (nominal) %

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C	Si	Mn	P	S	Cr	Ni
≤0.030	0.4	1.3	≤0.040	≤0.030	18.5	9

Applications

Sanmac® 304/304L is used for a wide range of industrial applications. Typical examples are: Machined parts for tube and pipe fittings, valves, components for pumps, heat exchangers and vessels, different tubular shafts in chemical, petrochemical, fertilizer, pulp and paper and power industries as well as in the production of pharmaceuticals, foods and beverages.

Corrosion resistance

General corrosion

Sanmac® 304/304L has good resistance to:

- Organic acids at moderate temperatures, with the exception of formic acid
- Sulphates, sulphides and sulphites
- 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, the austenitic-ferritic steels SAF™ 2304, Alleima® 10RE51 or Sanmac® SAF™ 2205 have higher resistance to stress corrosion cracking than 304L.

Intergranular corrosion

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

Pitting and crevice corrosion

The steel 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

Datasheet last updated 2023-11-09 14:39:10 (supersedes all previous editions)

content.

Forms of supply

Hollow bar- Finishes, dimensions and tolerances

Hollow bar in Sanmac® 304L is stocked in various sizes in the solution annealed and white-pickled condition. See catalogues S-110-ENG or S-02909-ENG.

Dimensions are given as outside and inside diameters with guaranteed component sizes after machining, see catalogues.

Outside diameter tolerance is +2/-0%, but minimum +1/-0mm
Inside diameter tolerance is +0/-2%, but minimum +0/-1mm
Straightness +/-1.5mm/m
Other tolerances can be supplied against special order

Other forms of supply

Bar

Steel with improved machinability, Sanmac®, is also available in bar.

Heat treatment

Hollow bar is delivered in heat treated condition. If further heat treatment is needed after further processing the following is recommended:

Stress relieving
850–950°C (1560–1740°F), cooling in air.

Solution annealing
1000–1100°C (1830–2010°F), rapid cooling in air or water.

Mechanical properties

For hollow bar with wall thicknesses greater than 10 mm (0.4 in.) the proof strength may fall short of the stated values by about 10 MPa (1.4 ksi).

At 20°C (68°F)

Metric units

Proof strength		Tensile strength	Elong.		Hardness
$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m	A[b]	$A_{2"}$	HRB
MPa	MPa	MPa	%	%	

≥210	≥240	515-680	≥45	≥35	≤90

Imperial units

Proof strength		Tensile strength	Elong.		Hardness
$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m	A[b]	$A_{2"}$	HRB
ksi	ksi	ksi	%	%	
≥30	≥35	75-99	≥45	≥35	≤90

1 MPa = $1 N/mm^2$
a) $R_{p0.2}$ and $R_{p1.0}$ correspond to 0.2% offset and 1.0% offset yield strength, respectively.
b) Based on L_0 = 5.65 ÖS_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 to the European standards EN 13445-2 (UFPV-2) and EN 10216-5.

At high temperatures

Metric units

Temperature	Proof strength		Tensile strength
°C	$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m
	MPa	MPa	MPa
	min.	min.	min.
50	190	215	480
100	165	195	450
150	150	175	425
200	140	165	400
250	130	155	390
300	125	150	380
350	120	145	370
400	115	140	365
450	110	135	355
500	105	130	345

550	100	125	325
600	95	120	305

Imperial units

Temperature	Proof strength		Tensile strength
°F	$R_{p0.2}$[a]	$R_{p1.0}$[a]	R_m
	ksi	ksi	ksi
	min.	min.	min.
200	24	29	66
400	20	24	58
600	18	21	55
800	16	19	52
1000	15	18	48

Physical properties

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

Thermal Conductivity

Temperature, °C	W/m °C	Temperature, °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
500	23	1000	14
600	25	1200	15
700	26	1300	15

Specific heat capacity

Temperature, °C	J/kg °C	Temperature, °F	Btu/lb °F
20	475	68	0.11
100	500	200	0.12
200	530	400	0.13
300	560	600	0.13

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400	580	800	0.14
500	600	1000	0.14
600	615	1200	0.15
700	625	1300	0.15

Thermal expansion, mean values in temperature ranges ($x10^{-6}$)

Temperature, °C	Per °C	Temperature, °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

Modulus of elasticity, ($x10^{3}$)

Temperature, °C	MPa	Temperature, °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

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 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)

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-02909-ENG.

The diagram shows the ranges within which data should be chosen in order to obtain a tool life of minimum 10 minutes when machining austenitic Sanmac materials (304/304L, 316/316L).

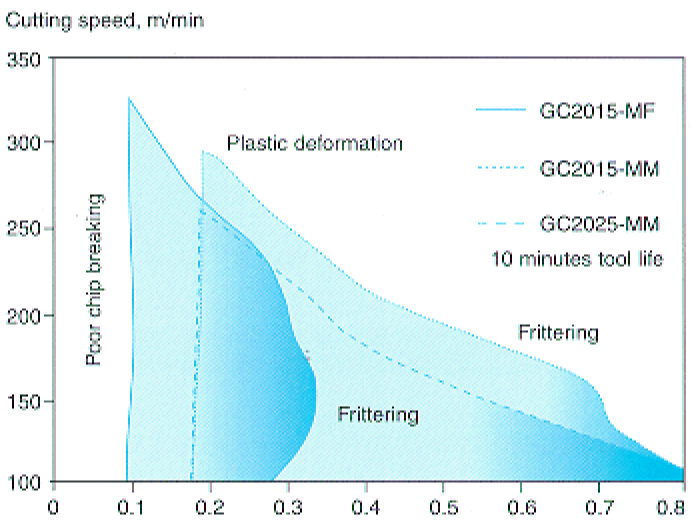

Figure 1. Machining chart Sandvik Sanmac 304L and 316L.

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.

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.

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