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Sandvik 304L

(Plate and sheet)

Sandvik 304L is an austenitic chromium-nickel steel with a low carbon content.

STANDARDS

- ASTM TP304L
- UNS S30403
- EN number 1.4306*
- W.Nr. 1.4306
- DIN X 2 CrNi 19 11
- SS 2352
- AFNOR Z 2 CN 18.10
- BS 304S11
- JIS SUS304L

Product standards
ASTM A240, A480

Approval
* Valid for sheet/plate, strip, semifinished products, bars, rods and sections for general purposes (not for pressure purposes).

CHEMICAL COMPOSITION (NOMINAL) %

C	Si	Mn	P	S	Cr	Ni
max.			max.	max.		
0.030	0.5	1.3	0.030	0.015	18.5	10

Subject to agreement, material with extra low Co content can be supplied.

FORMS OF SUPPLY-FINISHES AND DIMENSIONS

Plate & sheet
Plate & sheet are delivered in the solution annealed and pickled condition.

Sheet may be supplied as annealed and pickled, polished or in the bright-annealed condition

The size ranges available are given below in Sizes in stock section.

MECHANICAL PROPERTIES

METRIC UNITS

Proof strength				Tensile Strength		Elong.	
$R_{p0.2}$ a)		$R_{p1.0}$ a)		R_m		A b)	$A_{2"}$
MPa	ksi	MPa	ksi	MPa	ksi	%	%
min	min	min	min			min	min
170	25	240	35	485	70	40	35

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.

The hardness 201(Brinell) 92 (Rockwell B)

The **impact strength** (Charpy V) at -60 °C (-75 °F) is min. 150 J (110 ft-lb).

At high temperatures

METRIC UNITS

Temperature	Proof strength	
°C	$R_{p0.2}$	$R_{p1.0}$
	MPa	MPa
	min.	min.
50	190	215
100	165	190
150	150	175
200	140	165
250	130	155
300	125	150
350	120	145
400	115	140
450	110	135
500	105	130
550	100	125
600	95	120

IMPERIAL UNITS

Temperature	Proof strength	
°F	$R_{p0.2}$	$R_{p1.0}$
	ksi	ksi
	min.	min.
200	24	28
400	20	24
600	18	22
800	16	20
1000	15	18

CREEP STRENGTH

Temperature		Creep-rupture strength			
°C	°F	10 000 h	(ISO-values)	100 000 h	
		MPa	ksi	MPa	ksi
		approx.	approx.	approx.	approx.
550	1020	195	28.3	115	16.6
575	1065	147	21.3	93	13.5
600	1110	122	17.6	74	10.7
625	1155	100	14.5	58	8.4
650	1200	79	11.5	45	6.5
675	1245	64	9.2	33	4.8
700	1290	48	7.0	23	3.3

PHYSICAL PROPERTIES

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

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

THERMAL EXPANSION [1)]

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

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

MODULUS OF ELASTICITY [1)]

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

1) $x10^3$

CORROSION RESISTANCE

General corrosion
Sandvik 304L has good resistance in

- Organic acids at moderate temperatures
- Salt solutions, e.g. sulphates, sulphides and sulphites.
- Caustic solutions at moderate temperatures

Sandvik 304L has better resistance than normal type AISI 304 to oxidising agents, such as nitric acid. Figure 2 shows isocorrosion in nitric acid for Sandvik 304L.

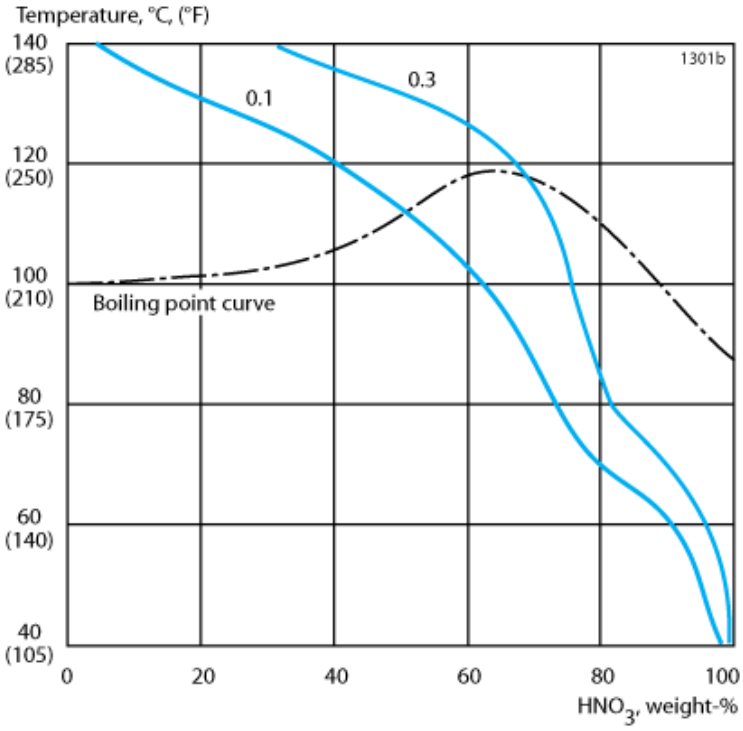

Figure 2. Diagram showing isocorosion in nitric acid for Sandvik 304L at the corrosion rates of 0.1 mm/year (4mpy) and 0.3 mm/year (12 mpy).

Intergranular corrosion

Sandvik 304L has a low carbon content and therefore better resistance to intergranular corrosion than steels of type AISI 304.

The TTC-diagram, Figure 3, which shows the result of testing for 24 hour in boiling Strauss solution (12% sulphuric acid, 6% copper sulphate) confirms the superior resistance of Sandvik 304L. This is an advantage in complicated welding operations.

The good resistance against intergranular attack of Sandvik 304L is also demonstrated in the Huey test (boiling in 65% nitric acid for 5x48h). A maximum corrosion rate of 0.40 mm/year in the annealed condition and 0.60 mm/year in the sensitised (675°C) condition can be met.

Sandvik 304L with its controlled and low impurity level, shows better results than ordinary AISI 304 or 321.

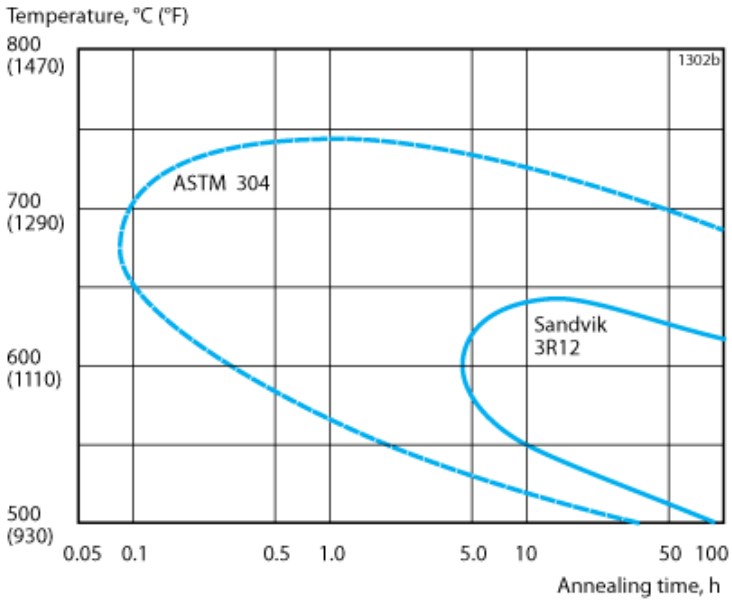

Figure 3. TTC-diagram for Sandvik 3R12 (AISI 304L) and AISI 304.

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 improves with

increasing molybdenum content.

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. Such service conditions should therefore be avoided. Conditions when plants are shut down must also be considered, as the condensates which are then formed can develop conditions that leads to both stress corrosion cracking and pitting.

In applications demanding high resistance to stress corrosion cracking we recommend the austenitic-ferritic steel Sandvik SAF 2304. See data sheet S-1871-ENG.

Gas corrosion
Sandvik 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 behaviour 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 oxidising or reducing, i.e. the oxygen content, and whether impurities such as sodium and vanadium are present.

HEAT TREATMENT

Plates are normally delivered in heat treated condition. If additional 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.

WELDING

The weldability of Sandvik 304L is good. Suitable welding methods are manual metal-arc welding with covered electrodes and gas-shielded arc welding with the TIG and MIG methods as first choice. Preheating and post-weld heat treatment are not normally necessary.

Since the material has low thermal conductivity and high thermal expansion, welding must be carried out with a low heat input and with welding plans well thought out in advance so that the deformation of the welded joint can be kept under control. If, despite these precautions, it is foreseen that the residual stresses might impair the function of the weldment, we recommend that the entire structure be stress relieved. See under Heat treatment.

As filler material for gas-shielded arc welding we recommend wire electrodes and rods Sandvik 19.9.L or 19.9.LSi. In manual metal-arc welding covered electrodes Sandvik 19.9.LR or 19.9.LRHD are recommended. If flux cored arc welding is preferred, electrodes Sandvik 19.9.LT or 19.9.LVT should be used.

BENDING

Annealing after cold bending is not normally necessary, but this point must be decided with regard to the degree of bending and the operating conditions. Heat treatment, if any, should take the form of stress relieving or solution annealing, see under heat treatment.

Hot bending is carried out at 1100-850°C (2010-1560°F) and should be followed by solution annealing.

APPLICATIONS

Sandvik 304L is used for a wide range of industrial applications. Typical examples are: Tanks and reactors in the chemical, petrochemical, fertilizer, pulp and paper and nuclear power industries, as well as in the production of pharmaceuticals, foods and beverages.

DISCLAIMER:
Recommendations are for guidance only, and the suitability of a material for a specific application can be confirmed only when we know the actual service conditions. Continuous development may necessitate changes in technical data without notice. This datasheet is only valid for Sandvik materials.