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Sandvik Bioline 3R12

(Tube and pipe, seamless)

Sandvik Bioline 3R12 is an austenitic stainless chromium-nickel steel with a low carbon content used for medical and dental instruments. The grade is characterized by:

- Good corrosion resistance
- Excellent toughness
- Good welding properties

STANDARDS

- ASTM TP304, TP304L
- UNS S30400, S30403
- EN number 1.4301, 1.4306
- W.Nr. 1.4301, 1.4306
- DIN X5 CrNi 18 10, X2CrNi 19 11
- SS 2333, 2352
- AFNOR Z 2 CN 18.10
- BS 304S11, 304S31
- JIS SUS304L, SUS304LTB, SUS304TP

Product standards

- ASTM F899, A213, A269, A312
- ISO 16061
- JIS G3459, G3463
- EN 10216-5
- BS 3605, 3606
- DIN 17456, 17458
- NFA 49-117, 49-217
- SS 14 23 52, 14 23 33

Approval

JIS approval for Stainless Steel Tubes

APPLICATIONS

Thick wall tubes applications :

Sandvik Bioline 3R12 is used for medical and dental tools.

Thin wall tubes applications :

Sandvik Bioline 3R12 can be used for biopsy punches, mammography machine, brooches, suspension for oxygen tank for hospital mobile beds, surgical and dental tools.

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.

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.

CORROSION RESISTANCE

General corrosion

Sandvik Bioline 3R12 has good resistance in

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

Sandvik Bioline 3R12 has better resistance than normal type AISI 304 to oxidising agents, such as nitric acid. Figure 1 shows isocorrosion in nitric acid for Sandvik Bioline 3R12.

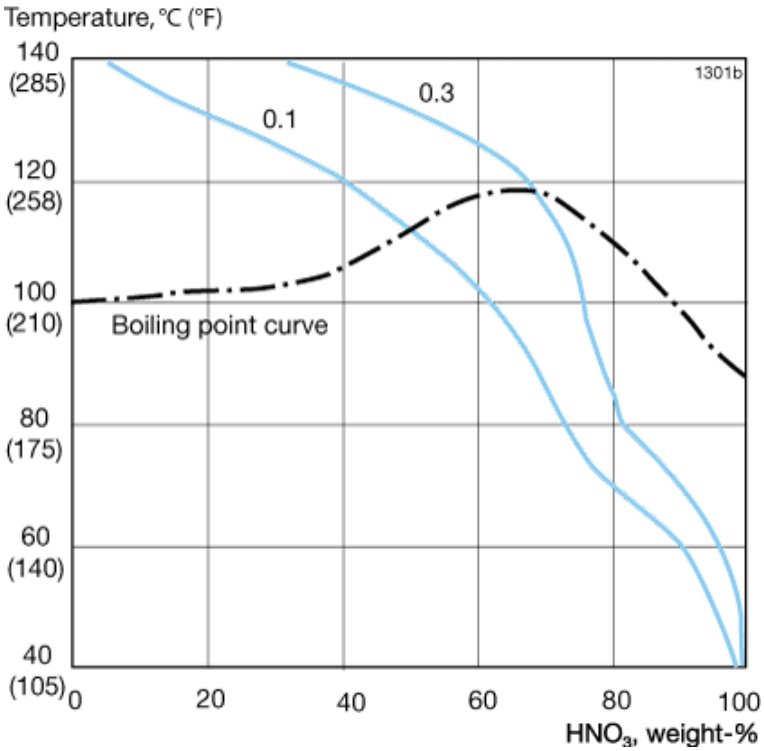

Figure 1. Diagram showing isocorosion in nitric acid for Sandvik Bioline 3R12 at the corrosion rates of 0.1 mm/year (4mpy) and 0.3 mm/year (12 mpy).

Intergranular corrosion
Sandvik Bioline 3R12 has a low carbon content and therefore better resistance to intergranular corrosion than steels of type AISI 304.

The TTC-diagram, Figure 2, 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 Bioline 3R12. This is an advantage in complicated welding operations.

The good resistance against intergranular attack of Sandvik Bioline 3R12 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 Bioline 3R12 with its controlled and low impurity level, shows better results than ordinary AISI 304L or 321.

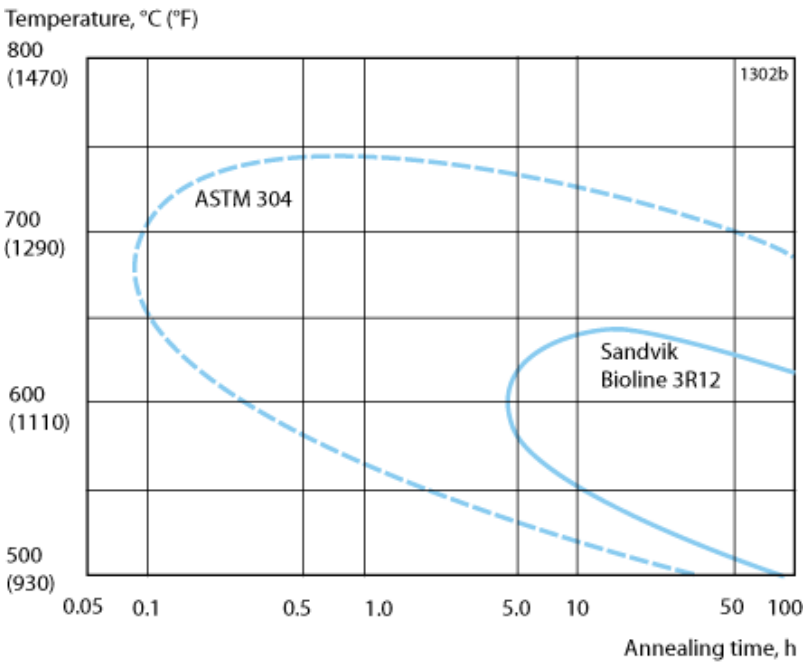

Figure 2. TTC-diagram for Sandvik Bioline 3R12 (AISI 304L) and AISI 304.

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.

Gas corrosion
Sandvik Bioline 3R12 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.

FORMS OF SUPPLY

Dimension range for tubes, thick wall
Seamless tube and pipe in Sandvik Bioline 3R12 is supplied in dimensions up to 260 mm outside diameter in the solution annealed and white-pickled condition or solution annealed in a bright-annealing process.

U-tubes can be delivered on request.

Sandvik Bioline 3R12 is stocked in a wide range of sizes according to ISO and ANSI.
Details of our manufacturing and stock programme are given in catalogue S-110-ENG.

Dimension range for tubes, thin wall
OD : 0.5 - 50.80 mm
thickness : 0.1 - 3 mm
Fine tube tolerances :

- Thickness tolerance : +/- 10%
- OD tolerance : +/- 0.75% with a minimum of +/-0.02 mm
- Roughness

for OD> 5mm Ra (outside) < 0.4 (by polishing)
for ID>3.2mm Ra (inside)< 0.4 - this possibility depends on thickness/diameter ratio
Specific roughness can be done on request

- Internal cleaning can not be done for inside diameter below 4 mm

All products supplied either in the annealed and cold worked condition to provide mechanical properties as required

HEAT TREATMENT

The tubes 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.

MECHANICAL PROPERTIES

Thin wall tubes
Sandvik Bioline 3R12 can be supplied in bright annealed or cold worked condition with a R_m : 860-1100 MPa

Thick wall tubes
For tube and pipe with wall thickness greater than 10 mm (0.4 in.) the proof strength may fall short of the stated value by about 10 MPa (1.4 ksi).

At 20°C (68°F)
Mechanical properties can be set according to your demands.

	Tensile strength		Proof strength				Elong.		Hardness
	R_m		$R_{p0.2}$[a]		$R_{p1.0}$[a]		A[b]	A_2[-]	
	MPa	ksi	MPa	ksi	MPa	ksi	%	%	HRB
			min.	min.	min.	min.	min.	min.	max.
Annealed	515-660	75-100	210	30	240	35	45	35	90
Cold worked (min)	700	101	600	80			18		

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, Sandvik 3R12 has very good impact strength both at room temperature and at cryogenic temperatures.

Tests have demonstrated that the steel fulfils the requirements according to the European standards EN 13445-2 (UFPV-2) ((min. 60 J (44 ft-lb) at -270 °C (-455 °F)) and EN 10216-5 (min. 60 J (44 ft-lb) at -196 °C (-320°F).

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 (ISO- values)			
°C	°F	10 000 h		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

THERMAL CONDUCTIVITY

Temperature			
°C	**°F**	**W/m °C**	**Btu/ft h °F**
20	68	15	8.5
100	200	16	9.5
200	400	18	10.5
300	600	20	12
400	800	22	13
500	1000	23	14
600	1200	25	15
700	1300	26	15

SPECIFIC HEAT CAPACITY

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

THERMAL EXPANSION [1)]

Temperature, °C	Per °C	Temperature, °F	Per °F
30-100	16.5	86-200	9
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

Temperature			
°C	**°F**	**MPa**	**ksi**
20	68	200	29.0
100	200	194	28.2
200	400	186	26.9
300	600	179	25.8
400	800	172	24.7
500	1000	165	23.5

WELDING

The weldability of Sandvik Bioline 3R12 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.

DISCLAIMER:
Sandvik is not providing any products or services that are intended or may be construed to be recommending or otherwise advising on, in any manner, the design, suitability, appropriateness or effectiveness, from a medical/biological/safety perspective, of any medical material, instrument and/or medical device.