Datasheet updated 2013-03-22 15:22:08 (supersedes all previous editions)

Sandvik Bioline 3R65

(Tube and pipe, seamless)

Sandvik Bioline 3R65 is a molybdenum-alloyed austenitic stainless chromium-nickel steel with a low carbon content. The grade is characterized by:

- Good resistance to general corrosion and better resistance to pitting than ASTM TP304, because of the alloying with molybdenum (Mo).
- High tensile strength

Sandvik Bioline 3R65 is used for medical tools.

STANDARDS

- ASTM TP316L, TP316
- UNS S31603, S31600
- EN number 1.4404, 1.4401
- EN name X2CrNiMo17-12-2, X5CrNiMo17-12-2
- W.Nr. 1.4404, 1.4401
- DIN X 2 CrNiMo 17 13 2, X 5 CrNiMo 17 12 2
- SS 2348
- AFNOR Z 2 CND 17.12, Z 6 CND 17.11
- BS 316S11

Product standards
- ASTM F899, A213, A269, A312
- ISO 16061
- EN 10216-5
- BS 3605, BS 3606
- DIN 17456, 17458
- NFA 49-117, 49-217
- SS 14 23 48

APPLICATIONS

Thick wall tubes applications:
Sandvik Bioline 3R65 is used in a wide variety of industrial applications. For medical industry, Sandvik Bioline 3R65 is used for medical tools.

Thin wall tubes applications:
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	Mo
max.			max.	max.			
0.030	0.4	1.7	0.040	0.015	17	11.5	2.1

CORROSION RESISTANCE

General corrosion
Sandvik Bioline 3R65 has good resistance to:

- Organic acids at high concentrations and temperatures, with the exception of formic acid and acids with corrosive contaminants
- Inorganic acids, e.g. phosphoric acid, at moderate concentrations and temperatures, and sulphuric acid below 20% at moderate temperatures. The steel can also be used in sulphuric acid of concentrations above 90% at low temperature
- Salt solutions, e.g. sulphates, sulphides and sulphites

Intergranular corrosion
Sandvik Bioline 3R65 has a low carbon content and therefore better resistance to intergranular corrosion than other steels of type AISI 316.

Pitting and crevice corrosion
Resistance of these types of corrosion improves with molybdenum content. Sandvik Bioline 3R65 has substantially higher resistance to attack than steels of type AISI 304.

Stress corrosion cracking
Austenitic steels are susceptible to stress corrosion cracking. Stress corrosion cracking may occur if the steel is simultaneously exposed to the following:

- Tensile stresses
- Certain solutions, particularly those containing chlorides
- Temperatures above 60°C (140°F)

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 a chloride content that leads to both stress corrosion cracking and pitting.

In applications demanding high resistance to stress corrosion cracking, austenitic-ferritic steels, e.g. Sandvik SAF 2304 or SAF 2205 are recommended.

Gas corrosion
Sandvik Bioline 3R65 can be used in

- Air up to 850°C (1560°C)
- Steam up to 750°C (1380°F)

In flue gases containing sulphur, the corrosion resistance is reduced. In such environments Sandvik Bioline 3R65 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

Seamless tube and pipe- Finishes and dimensions
Seamless tube and pipe in Sandvik Bioline 3R65 are supplied in dimensions up to 260 mm outside diameter in the solution annealed and white-pickled condition or in the bright-annealed condition.

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

- Wall 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 wall 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 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), 10-15 minutes, cooling in air.

Solution annealing
1000-1100°C (1830-2010°F), 5-20 minutes, rapid cooling in air or water.

MACHINING

Sandvik Bioline 3R65 has good machining properties. However the machining of Sandvik Bioline 3R65, as with other stainless steels, requires an adjustment of tooling data and machining method, in order to achieve satisfactory results. Compared to

Sanmac 316/316L, the cutting speed must be reduced by approximately 30-40 % when turning Sandvik Bioline 3R65 with coated, cemented carbide tools. Much the same applies to other operations.

Feeds should only be reduced slightly and with care.

Detailed recommendations for the choice of tools and cutting data are provided in the brochure S-02909-ENG. Data should be selected as for steel grade Sanmac 316/316L, while taking into account the provisions above.

MECHANICAL PROPERTIES

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

Thick wall tubes
For tube and pipe 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)
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	515-690	75-100	220	32	250	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 $L_0 = 5.65\sqrt{S_0}$ where L_0 is the original gauge length and S_0 the original cross-section area.

Impact strength
Due to its austenitic microstructure, Sandvik Bioline 3R65 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

Temperature	Proof strength	Proof strength	Temperature	Proof strength	Proof strength
	$R_{p0.2}$	$R_{p1.0}$		$R_{p0.2}$	$R_{p1.0}$
°C	MPa	MPa	°F	ksi	ksi
	min.	min.		min.	min.
50	200	230	200	27	32
100	180	215	400	22	26
150	165	195	600	18	24
200	150	180	800	17	21
250	140	170	1000	16	20
300	130	160			
350	120	150			
400	115	145			
450	115	145			
500	110	140			
550	110	140			
600	95	120			

PHYSICAL PROPERTIES

Density: 8.0 g/cm^3 , 0.29 lb/in^3

THERMAL CONDUCTIVITY

Temp. °C	Thermal conductivity W/m °C	Specific heat capacity J/kg °C	Modulus of elasticity (x10^3) MPa	Temp. °F	Thermal conductivity Btu/ft h °F	Specific heat capacity Btu/lb °F	Modulus of elasticity (x10^3) ksi
20	14	485	200	68	8	0.11	29.0
100	15	500	194	200	8.5	0.12	28.2
200	17	515	186	400	10	0.12	26.9
300	18	525	179	600	10.5	0.13	25.8
400	20	540	172	800	11.5	0.13	24.7
500	21	555	165	1000	12.5	0.13	23.5
600	23	575		1100	13	0.14	

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	86-1000	10
30-600	18.5	86-1200	10.5
30-700	18.5	86-1400	10.5

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

WELDING

The weldablity of Sandvik Bioline 3R65 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.

As filler material for **gas-shielded arc welding** we recommend wire electrodes and rods Sandvik 19.12.3.L, 19.12.3.LSi or, when a ferritic-free weld metal is required, 25.22.2.LMn. In **manual metal-arc welding** covered electrodes Sandvik 19.12.3.LR or 19.12.3.LRHD are recommended and as a ferrite free alternative 25.22.2.LMnB.

DISCLAIMER:
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