



# SANDVIK 3R64

## TUBE AND PIPE, SEAMLESS

### DATASHEET

Sandvik 3R64 is an austenitic stainless steel with a high molybdenum content. The grade is characterized by improved resistance to general and pitting corrosion in comparison with ASTM 316L.

#### STANDARDS

- ASTM: TP317L
- UNS: S31703
- SS: 2367

#### Product standards

##### Seamless tube and pipe

ASTM A213, A312

SS 142367

#### CHEMICAL COMPOSITION (NOMINAL) %

##### Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo
≤0.030	0.4	1.7	≤0.030	≤0.015	18.5	14.5	3.1

#### FORMS OF SUPPLY

##### Seamless tube and pipe

Seamless tube and pipe in 3R64 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.

##### Other forms of supply

Sandvik 3R64 is also supplied in forms of:

- Welded tube and pipe
- Wire electrodes and filler wire/rods
- Covered electrodes
- Fittings and flanges

Further details concerning sizes and finishes are available on request.

#### MECHANICAL PROPERTIES

For tube and pipe with a wall thickness 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 <sub>p0.2</sub> <sup>a</sup>	R <sub>p1.0</sub> <sup>a</sup>	R <sub>m</sub>		A <sup>b</sup>	Vickers
MPa	MPa	MPa		%	
					approx.
≥220	≥250	515-690		≥35	155

### Imperial units

Proof strength		Tensile strength		Elong.	Hardness
R <sub>p0.2</sub> <sup>a</sup>	R <sub>p1.0</sub> <sup>a</sup>	R <sub>m</sub>		A <sup>b</sup>	Vickers
ksi	ksi	ksi		%	
					approx.
≥32	≥36	75-100		≥35	155

1 MPa = 1 N/mm<sup>2</sup>

a) R<sub>p0.2</sub> and R<sub>p1.0</sub> correspond to 0.2% offset and 1.0% offset yield strength, respectively.

b) Based on L<sub>0</sub> = 5.65 S<sub>0</sub> where L<sub>0</sub> is the original gauge length and S<sub>0</sub> the original cross-section area.

### Impact strength

Due to its austenitic microstructure, Sandvik 3R64 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	
	R <sub>p0.2</sub> <sup>a</sup>	R <sub>p1.0</sub> <sup>a</sup>
°C	MPa	MPa
	min.	min.
50	196	221
100	172	197
150	155	180
200	144	169
250	136	161
300	129	154
350	123	148
400	119	144
450	115	140
500	110	135

#### Imperial units

Temperature	Proof strength	
	R <sub>p0.2</sub> <sup>a</sup>	R <sub>p1.0</sub> <sup>a</sup>
°F		

	MPa	ksi
	min.	min.
200	25.4	29.0
400	20.8	24.4
600	18.4	22.1
800	17.0	20.6
1000	15.4	19.0

### PHYSICAL PROPERTIES

Density: 8.0 g/cm<sup>3</sup>, 0.29 lb/in<sup>3</sup>

#### Thermal conductivity

Temperature, °C	W/m °C	Temperature, °F	Btu/ft h °F
20	14	68	8
100	15	200	8.5
200	17	400	10
300	18	600	10.5
400	20	800	11.5
500	21	1000	12.5
600	23	1100	13

#### Specific heat capacity

Temperature, °C	J/kg °C	Temperature, °F	Btu/lb °F
20	485	68	0.11
100	500	200	0.12
200	515	400	0.12
300	525	600	0.13
400	540	800	0.13
500	555	1000	0.13
600	575	1100	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	86-1200	10.5
30-700	18.5	86-1400	10.5

1) Mean values in temperature ranges (x10<sup>-6</sup>)

## 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<sup>3</sup>)

## CORROSION RESISTANCE

Owing to its high molybdenum content Sandvik 3R64 possesses improved resistance compared to ASTM 316/316L in a majority of chloride and acidic environments.

### General corrosion

Sandvik 3R64 has good resistance in:

- Organic acids at high concentrations and moderate temperatures
- Inorganic acids, e.g. phosphoric and sulphuric acids at moderate concentrations and 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 caustic environments

The following data illustrate the improved resistance of Sandvik 3R64 vs ASTM 316, although the corrosion rates at the majority of temperatures are unacceptably high for both grades.

Table 1. General corrosion resistance of Sandvik 3R64 and ASTM 316 in boiling formic acid.

Formic acid, wt-%	Corrosion rate, mm/year	
	Sandvik 3R64	ASTM 316
5	0.12	0.18
10	0.20	0.3
25	0.35	0.6
50	0.45	0.6
80	1.0	1.5
90	0.8	1.8
100	0.4	0.6

### Intergranular corrosion

Owing to its low carbon content Sandvik 3R64 possesses a low risk for intergranular corrosion after e.g. welding operations.

### Pitting and crevice corrosion

The pitting corrosion resistance of stainless steels is primarily determined by the contents chromium, molybdenum and nitrogen. The Pitting Resistance Equivalent can be used for ranking different stainless steels with regard to their pitting resistance. The PRE number is defined as:

$$\text{PRE} = \% \text{Cr} + 3.3 \times \% \text{Mo} + 16 \times \% \text{N}$$

Table 2. PRE values for Sandvik 3R64 and some other alloys. Typical values unless otherwise stated

Alloy	3R64	ASTM 316L <sup>1)</sup>	Alloy 825	904L	SAF 2205
PRE	29	24	31	34	>35

1) 2.1 % Mo

Thus Sandvik 3R64 is resistant against pitting corrosion at higher temperatures and/or higher chloride concentrations than is the case for ASTM 316L.

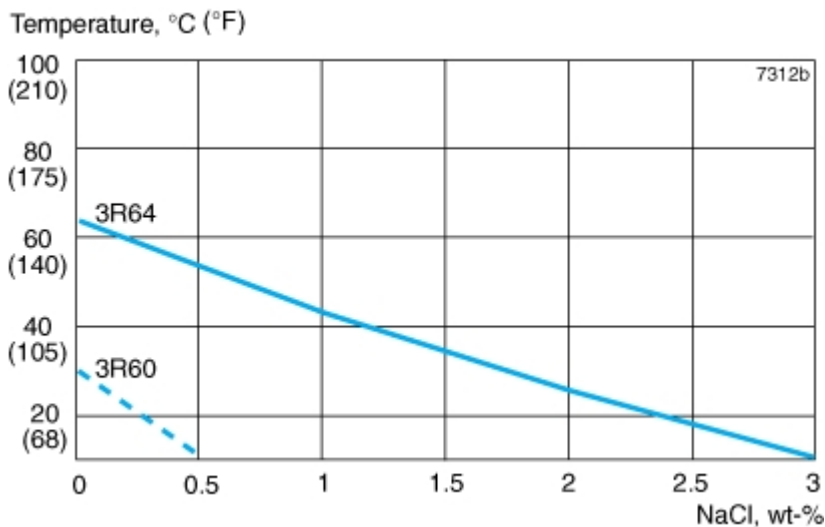


Figure 1. Crevice corrosion resistance of Sandvik 3R64 and 3R60.

The same ranking of alloys can be applied for the crevice corrosion resistance. However, crevice corrosion is to be expected at significantly lower temperatures, than is the case for pitting corrosion. Figure 1 demonstrates the better crevice corrosion resistance of Sandvik 3R64 vs. 3R60 (ASTM 316L with 2.6% Mo, EN 1.4435) after 2 months exposure in chloride solutions.

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

In applications demanding high resistance to stress corrosion cracking, austenitic-ferritic steels, such as Sandvik SAF 2304 or Sandvik SAF 2205 are recommended. See data sheets S-1871-ENG or S-1874-ENG.

### 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 min, cooling in air.

#### Solution annealing

1000–1100°C (1830–2010°F), 10-30 min, cooling in air or water.

### WELDING

The weldability of Sandvik 3R64 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 metals for **gas-shielded arc welding** we recommend wire electrodes and rods Sandvik 19.13.4.L. In **shielded metal-arc welding (SMAW)** covered electrodes Sandvik 19.13.4.LR are recommended.

### APPLICATIONS

Sandvik 3R64 can be used for a wide range of industrial applications where steels of type ASTM 304 and 304L or even ASTM 316L have insufficient corrosion resistance. Typical examples are heat exchangers, condensers, pipelines, cooling and heating coils in the chemical, petrochemical, pulp and paper and food industries.

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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.