



# SANDVIK 3R60™ UREA GRADE TUBE AND PIPE, SEAMLESS

## DATASHEET

Sandvik 3R60™ Urea Grade is a high-purity variant of ASTM 316L, specially developed for the urea industry. The grade has a guaranteed maximum ferrite content of 0.6%. Sandvik 3R60™ Urea Grade is characterized by:

- High resistance to corrosion in ammonium carbamate
- High resistance to intergranular corrosion
- Good weldability

### STANDARDS

- ASTM: TP316L
- UNS: S31603
- EN Number: 1.4435
- EN Name: X 2 CrNiMo 18-14-3
- W.Nr.: 1.4435
- DIN: X 2 CrNiMo 18 14 3
- SS: 2353
- BS: 316S13

**Urea specifications** issued by  
Stamicarbon  
Snamprogetti  
Urea Casale  
Kellogg

**Product standards**  
ASTM A213, A312  
EN 10216-5  
DIN 17458

### CHEMICAL COMPOSITION (NOMINAL) %

#### Chemical composition (nominal) %

C	Si	Mn	P	S	Cr	Ni	Mo
≤0.020	0.4	1.7	≤0.015	≤0.010	17.5	14	2.6

### FORMS OF SUPPLY

#### Seamless tube and pipe- finishes and dimensions

Seamless tube and pipe in Sandvik 3R60™ Urea Grade is supplied in dimensions up to 260 mm outside diameter in the solution annealed and white pickled condition, or solution annealed by a bright annealing process.

U-tubes can be supplied on request.

**Other forms of supply**

- Urea high pressure pipe fittings and flanges

**Filler metals for welding**

The sizes listed below are Sandvik stock standard. Local market stocks comprise sizes in common demand. For technical information on the filler metal please refer to brochures S-2361-ENG, S-2362-ENG and S-2366-ENG.

**MECHANICAL PROPERTIES**

For 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). (1 N/mm<sup>2</sup> = 1 MPa)

**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>	A <sub>2</sub> "	HRB	
MPa	MPa	MPa	%	%		
≥190	≥235	490-690	≥40	≥35	≤90	

**At 68°F 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>	A <sub>2</sub> "	HRB	
ksi	ksi	ksi	%	%		
≥28	≥34	71-100	≥40	≥35	≤90	

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.

The impact energy (Charpy V) at -60 °C (-75 °F) is minimum 150 J (110 ft-lb)

**At high temperatures**

**Metric units**

Temperature	Proof strength		Tensile strength
	R <sub>p0.2</sub>	R <sub>p1.0</sub>	R <sub>m</sub>
°C	MPa	MPa	MPa
	min.	min.	min.
50	180	225	470
100	165	200	450
150	150	180	430
200	140	165	415
250	130	155	410
300	120	145	400
350	115	140	395
400	110	135	390

## Imperial units

Temperature	Proof strength		Tensile strength
	R <sub>p0.2</sub>	R <sub>p1.0</sub>	R <sub>m</sub>
°F	ksi	ksi	ksi
	min.	min.	min.
200	25	29	66
400	20	24	60
600	17	21	58
800	16	19	56

## 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 <sup>1)</sup>

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<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

The low ferrite and impurity contents of Sandvik 3R60™ Urea Grade make it highly resistant to general and intergranular corrosion in the process solutions occurring in the manufacture of urea.

Sandvik 3R60™ Urea Grade easily meets the Huey test and selective attack requirements specified by Stamicarbon, Snamprogetti and Urea Casale. The general corrosion rate is normally set at 0.6 mm/year maximum for unsensitized material (24mpy, 3.3um/48h).

### HEAT TREATMENT

Tubes are delivered in the heat treated condition. If additional heat treatment is needed after further processing the following is recommended.

#### Solution annealing

1050-1100°C (1920-2010°F), 5-20 minutes, rapid cooling in water.

### WELDING

The weldability of Sandvik 3R60™ Urea grade is good. Welding must be carried out without preheating and subsequent heat treatment is normally not required. 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.

For Sandvik 3R60™ Urea grade, heat input of <1.5 kJ/mm and interpass temperature of <100°C (210°F) are recommended.

#### Recommended filler metals

TIG/GTAW or MIG/GMAW welding

ISO 14343 S 25 22 2 N L (e.g. Exaton 25.22.2.LMn)

MMA/SMAW welding

ISO 3581 E 25 22 2 N L B (e.g. Exaton 25.22.2.LMnB)

### FABRICATION

#### Bending

Annealing after cold bending is not normally necessary, but the decision must be made after taking account of degree of bending and the operating conditions. Heat treatment, if any, should take the form of 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.

#### Machining

The mechanical machining of stainless steels always requires an adjustment to cutting to data and machining method to give satisfactory results. When turning is undertaken with carbide tipped tools, the cutting speed should be reduced by 30% for finish machining and 60% for rough machining, compared with the cutting speeds applied for AISI 316. Much the same applies to other operations. If high speed steel tools are used, approximately the same cutting speed can be used as for AISI 316.

Detailed recommendations for the choice of tools and cutting data are provided in brochure S-1,462-ENG. Select data as for grade 5R60 (AISI 316), taking into account the above comments.

## APPLICATIONS

Typical urea plant applications of Sandvik 3R60™ Urea Grade are:

- Carbamate condensers
- Scrubbers
- Decomposers
- High pressure piping.

---

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.