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Sandvik 3R60 Urea Grade

(Tube and pipe, seamless)

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) %

C max	Si	Mn	P max	S max	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
- Welding wire and filler wire/rods
- Covered electrodes
- Strip electrodes and flux for surfacing

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.

Welding wire and filler wire/rods
Sandvik 25.22.2.LMn: 1.20, 1.60 and 2.40 mm

Covered electrodes
Sandvik 25.22.2.LMnB: 2.5, 3.25 and 4.0 mm

Strip electrodes
Sandvik 25.22.2.LMn in 0.5 mm (0.02 in.) thickness. Widths by agreement.

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^2 = 1 MPa)

AT 20°C (68°F) METRIC UNITS

Proof strength		Tensile strength	Elong.		Hardness
$R_{p0.2}$ [a)]	$R_{p1.0}$ [a)]	R_m	A [b)]	$A_{2"}$	HRB
MPa	MPa	MPa	%	%	
min.	min.		min.	min.	max.
190	235	490-690	40	35	90

AT 68°F IMPERIAL UNITS

Proof strength		Tensile strength	Elong.		Hardness
$R_{p0.2}$ [a)]	$R_{p1.0}$ [a)]	R_m	A [b)]	$A_{2"}$	HRB
ksi	ksi	ksi	%	%	
min.	min.		min.	min.	max.
28	34	71-100	40	35	90

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.

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
	$R_{p0.2}$	$R_{p1.0}$	R_m
°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
	$R_{p0.2}$	$R_{p1.0}$	R_m
°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^3, 0.29 lb/in^3

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	18.5	86-1200	10.5
30-700	18.5	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

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

Weldability of Sandvik 3R60 Urea Grade is good. Suitable fusion 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 is solution annealed. See under "Heat treatment".

The welded joint will be ferrite-free, which is essential for good resistance in corrosive urea solutions. To achieve maximum corrosion resistance, oxides and slag residuals must be removed from the weldment.

Recommended filler metals

Gas-shielded arc welding: Wire Sandvik 25.22.2.LMn.
Manual metal-arc welding: Covered electrodes Sandvik 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.