



UREA™ 316L

UREA™ 316L: A 316L modified - low Si, high Mo stainless steel for urea plants

The UREA™ 316L grade has been specially developed for urea plant applications. It is a 316L modified stainless steel with extra - low silicon content and substantial higher molybdenum contents. The low carbon content, combined with a well balanced chemistry (low silicon and nickel content close to 14%) makes the alloy fully austenitic, free of intermetallic phase precipitations. The ferrite level is kept under 0.5% in the solution annealing and water quenched conditions. The alloy is designed for improved corrosion resistance properties in urea - carbonate environments.

PROPERTIES

STANDARDS

> EURONORM:	EN 1.4435	X2 Cr Ni Mo 18-14-3
> ASTM:	316L Modified	UNS S31603

CHEMICAL ANALYSIS - WEIGHT %

Typical values

C	Cr	Ni	Mo	Others
< .03	18	13.5	2.6	Si < 0.5, 1 ≤ Mn ≤ 2

PHYSICAL PROPERTIES

Density: 7.9 kg/dm³

Interval temperature (°C)	Thermal expansion ($\alpha \times 10^{-6} K^{-1}$)	T °C (°F)	Resistivity ($\mu\Omega \cdot cm$)	Thermal conductivity ($W \cdot m^{-1} \cdot K^{-1}$)	Specific heat ($J \cdot kg^{-1} \cdot K^{-1}$)	Young modulus E (GPa)	Shear modulus G (GPa)
20 - 100	16	20 (68)	74	15	500	200	75
20 - 300	16.5	200 (392)	90	17	550	185	70
20 - 500	17.5	400 (752)	100	20	590	170	64

MECHANICAL PROPERTIES

Typical tensile properties after solution annealing heat treatment

°C	°F	Y.S. 0.2%		Y.S. 1%		UTS		Elongation
		MPa	ksi	MPa	ksi	MPa	ksi	%
20	68	250	36	280	41	530	77	55
100	212	190	27	210	30	490	71	55
200	392	160	23	180	26	460	67	55
300	572	135	19	155	22	420	61	55
400	752	125	18	140	20	390	56	55

Impact value:

- > KCV \geq 120 J/cm² (room temperature)
- > Minimum yield strength: 190 MPa (27 ksi) at room temperature (th < 20 mm)
- > Minimum tensile strength: 490 MPa (71 ksi) at room temperature (th < 20 mm)

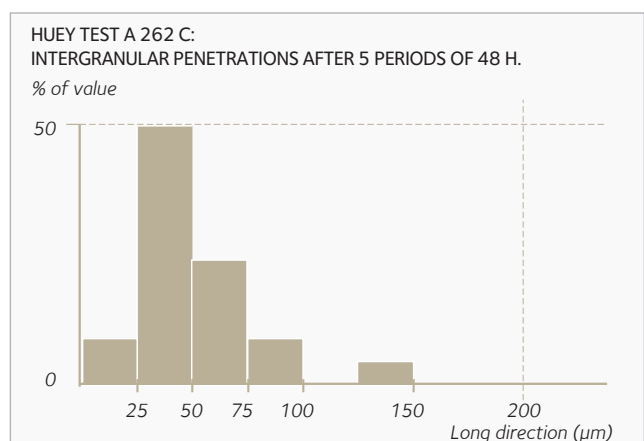
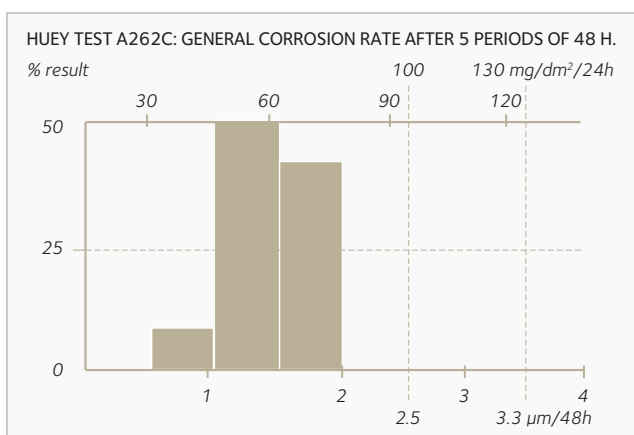
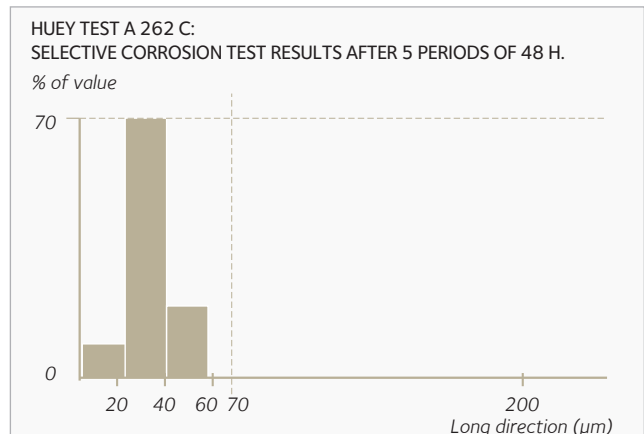
STRUCTURE

The UREA™ 316L grade is a fully austenitic stainless steel which ferrite content is guaranteed less than 0.5% after solution annealing heat treatment 1120 - 1180°C (2048 - 2156°F) / water quenched. The carbon content is kept low while the steel making is optimised in order to improve the cleanliness properties of the steel. The alloy is designed for urea applications.

IN SERVICE CONDITIONS

CORROSION RESISTANCE

Typical maximum corrosion results required following different specifications after Huey tests (ASTM A262 C - five periods of 48 h.) are: maximum weight loss lower than 3,3 µm/48 h (130 mg/dm² per 24 h.), with a maximum depth for microcracks of 200 µm in the long direction and 70 µm in the transverse direction. The UREA™ 316L grade behaves much better than those maximum values as indicated on the following graphs where 100 test results performed on a 2 years production period are reported:



DELIVERY CONDITIONS

SIZE RANGE

	Hot rolled plates	Clad plates
Thickness	5 to 150 mm 3/16" to 6"	6 up to 150mm 1/4" to 6"
Width	Up to 3300 mm Up to 130"	Up to 3300 mm Up to 130"
Length	Up to 12000 mm Up to 39.3 ft	Up to 14000 mm Up to 45.9 ft

Other sizes are available on request, including 4100 mm (161,4") width plates

PLATE PROCESSING

HOT FORMING

Hot forming should be carried out in a temperature range of 1200 – 950°C (2732 – 1742°F) after the piece has been uniformly heat treated. Final full annealing temperature is required to obtain the requested microstructure. It will be performed at 1120 – 1180°C (2048 – 2156°F) followed by water quenching.

COLD FORMING

Due to its fully austenitic microstructure, the alloy can be cold formed without any problem. The higher molybdenum content and cold hardening behaviour of the steel explains that it may require more powerful equipments than 304 stainless steel.

PICKLING

The UREA™ 316L grade must be used in the as pickled and passivated conditions. Pickling treatment may be performed with a nitro – hydrofluoric acid bath (10 – 20% HNO₃ – 1.5 – 5% HF) at room temperature (few hours) or 20 minutes approx. at 60°C (140°F). 10 – 20% H₂SO₄ – 1.5 – 5% HF pickling bath may also be used.

WELDING

The UREA™ 316L grade can be welded with most of the welding processes: TIG, Plasma, MIG welding, as well as SMAW, SAW or FCAW processes. The alloy is sensitive to hot cracking phenomenon due to its fully austenitic microstructure. Weld should be performed in order to obtain extra – low ferrite contents, no carbide or nitrides precipitations, low silicon contents as well as no intermetallic phases precipitations. Higher manganese content products should be considered.

Typical chemistry of filler materials to be used is as follow:

C	Ni	Mo	Mn	N
20%	16%	3%	6.5%	.2%

Use basic coated electrodes or fluxes in order to decrease the hot cracking susceptibility. The heat input should be limited to 1,5 kJ/mm and interpass temperature kept below 150°C (302°F). Typical corrosion test results in Huey test solution – ASTM A262 – C are as follow: maxi weight loss 3.3µm/48h – 0,54 g/m² h with selective attack lower than 200 µm.



MACHINING

Operation	Tool	Lubrication	CONDITIONS			
			Depth mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)	
Turning	High speed steel	Cutting oil	6 (0.23)	0.5 (0.019)	11 - 16 (36.1 - 52.5)	
			3 (0.11)	0.4 (0.016)	18 - 23 (59.1 - 75.5)	
			1 (0.04)	0.2 (0.008)	25 - 30 (82 - 98.4)	
	Carbide	Dry or cutting oil	6 (0.23)	0.5 (0.019)	70 - 80 (229.7 - 262.5)	
			3 (0.11)	0.4 (0.016)	85 - 95 (278.9 - 312.7)	
			1 (0.04)	0.2 (0.008)	100 - 110 (328.1 - 360.9)	
			Depth of cut mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)	
Parting off	High speed steel	Cutting oil	1.5 (0.06)	0.03 (0.0012)	17 - 22 (55.8 - 72.2)	
			3 (0.11)	0.04 (0.0016)	18 - 23 (59.1 - 75.5)	
			6 (0.23)	0.05 (0.0020)	19 - 24 (62.3 - 78.7)	
			Drill Ø mm (inch)	Feed mm/t (inch/t)	Speed m/min (feet/min)	
Drilling	High speed steel	Cutting oil	1.5 (0.06)	0.025 (0.0010)	10 - 14 (32.8 - 45.9)	
			3 (0.11)	0.06 (0.0024)	11 - 15 (36.1 - 49.2)	
			6 (0.23)	0.08 (0.0031)	11 - 15 (36.1 - 49.2)	
			12 (0.48)	0.10 (0.0039)	11 - 15 (36.1 - 49.2)	
					Feed mm/t (inch/t)	Speed m/min (feet/min)
Milling profiling	High speed steel	Cutting oil			0.05 - 0.10 (0.002 - 0.0039)	10 - 20 (32.8 - 65.6)

APPLICATIONS

The UREA™ 316L grade is designed for the fabrication of lining interiors in urea units or complementary products (pipes, fittings...). The alloy is not designed for nitric acid application.

YOUR CONTACTS

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