

# UREA 316L mod

A 316 L modified - low Si, high Mo stainless steel for Urea plants

The UREA 316L Modified 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.

## STANDARDS

EN 10088 / EN 10028..... X2 Cr Ni Mo 18-14-3 - 1.4435  
AFNOR..... Z3 CND 18.14.03  
DIN..... W.Nr 1.4435  
ASTM..... 316L modified

## CHEMICAL ANALYSIS

### Typical values (Weight %)

C	Cr	Ni	Mo	Others
< 0.03	18	13.5	2.6	Si < 0.5 ; 1 ≤ Mn ≤ 2

## MECHANICAL PROPERTIES

### Typical tensile properties after solution annealing heat treatment

°C	Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	°F	YS 0.2% KSI	YS 1.0% KSI	UTS KSI	El%
20	250	280	530	68	36	41	77	55
100	190	210	490	212	27	30	71	55
200	160	180	460	392	23	26	67	55
300	135	155	420	572	19	22	61	55
400	125	140	390	752	18	20	56	55

**Impact value** : KCV ≥ 120 J/cm<sup>2</sup> (room temperature)

Minimum yield strength : 190 Mpa at room temperature (th < 20 mm)

Minimum tensile strength : 490 MPa at room temperature (th < 20 mm)

## PHYSICAL PROPERTIES

**Density** : 7,9 kg/m<sup>3</sup>

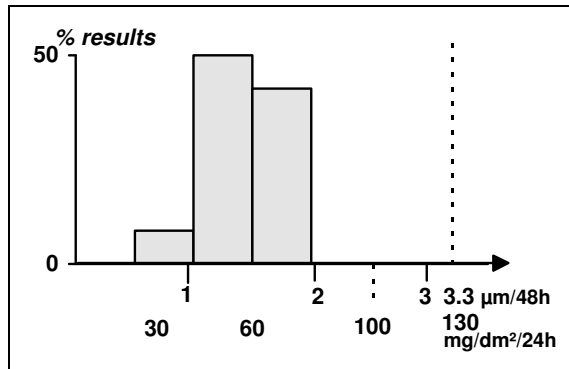
Interval Temper °C	Thermal expansion ax10 <sup>-6</sup> K <sup>-1</sup>	°C	°F	Resistivity (μΩ cm)	Thermal conductivity (W.m <sup>-1</sup> .K <sup>-1</sup> )	Specific heat (J.kg <sup>-1</sup> .K <sup>-1</sup> )	Young modulus E (GPa)	Shear modulus G (GPa)
20-100	16	20	68	74	15	500	200	75
20-300	16.5	200	392	90	17	550	185	70
20-500	17.5	400	752	100	20	590	170	64

## STRUCTURE

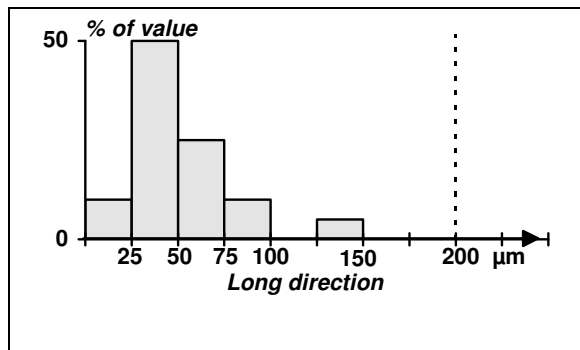
The UREA 316L Modified grade is a fully austenitic stainless steel which ferrite content is guaranteed less than 0.5% after solution annealing heat treatment (1120°-1180°C (2048-2156°F) /water quenched). The carbon content is kept low while the steel making is optimised in order to improve the cleanliness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

## CORROSION RESISTANCE

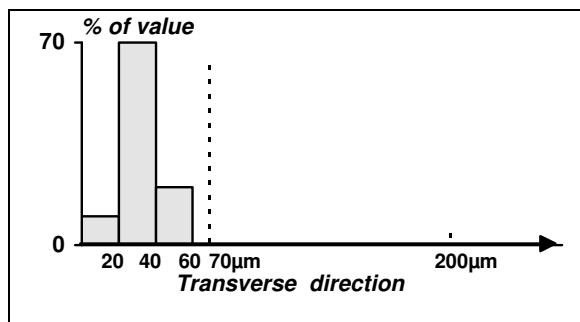
The alloy is designed for urea applications (low carbon and silicon contents). Typical maximum corrosion results required following different specifications after Huey tests (ASTM A262 C - five periods of 48 h.) are : maximum weight loss lower than 3,3 μm/48 h (≈ 130 mg/dm<sup>2</sup> per 24 h.), with a maximum depth for microcracks of 200 μm in the long direction and 70 μm in the transverse direction. The UREA 316L Modified grade behaves much better than those maximum values as indicated on the following graphs where 100 test results performed between 1994 and 1996 are reported :



Huey test A 262 C :  
General corrosion rate  
after 5 periods of 48 h.



Huey test A 262 C :  
Selective corrosion  
test results  
after 5 periods of 48 h



Huey test A 262 C :  
Selective corrosion  
test results  
after 5 periods of 48 h

## 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 Modified grade must be used in the as pickled and passivated conditions. Pickling treatment may be performed with a nitro-hydrofluoric acid bath (10-20 % HNO<sub>3</sub> - 1.5-5% HF) at room temperature (few hours) or 20 minutes approx. at 60°C (140°F).

10-20% H<sub>2</sub>SO<sub>4</sub> - 1.5-5% HF pickling bath may also be used.

## WELDING

The UREA 316L Modified 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

Cr	Ni	Mo	Mn	N
20%	16%	3%	6.5%	0.2%

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 3.3 µm/48h - 0,54 g/m<sup>2</sup> h with selective attack lower than 200 µm.

## MACHINING

Operation	Tool	Lubrication	CONDITIONS					
			Depth of cut		Feed		Speed	
			(mm)	(inch)	(mm)	(inch)	(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
Parting off	High speed steel	Cutting oil	Blade width		Feed		Speed	
			mm	inch	mm	inch	(m/min)	(feet/min)
			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
Drilling	High speed steel	Cutting oil	Drill Ø		Feed		Speed	
			mm	inch	mm	inch	(m/min)	(feet/min)
			1.5	0.06	0.25	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
Milling profiling	High speed steel	Cutting oil	Feed		Speed			
			mm	inch	(m/min)	(feet/min)		
			.05/0.10	.002/.0039	10-20	32.8-65.6		

## APPLICATIONS

The UREA 316L Modified 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 applications.

## SIZE RANGE

	Hot rolled plates	Cold rolled plates	Clad plates
Thickness	5 to 150 mm 3/16" to 6"	2 to 14 mm 5/64" to 5/8"	6 to 150 mm 1/4" to 6"
Width	Up to 3300 mm Up to 130"	Up to 2300 mm Up to 90.5"	Up to 3300 mm Up to 130"
Length	Up to 12000 mm Up to 472"	Up to 8250 mm Up to 325"	Up to 14000 mm Up to 551"

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

### NOTA

This technical data and information represents our best knowledge at the time of printing. However, it may be subject to some slight variations due to our ongoing research programme on corrosion resistant grades.

We therefore suggest that information be verified at time of enquiry or order.

Furthermore, in service, real conditions are specific for each application. The data presented here is only for the purpose of description, and may only be considered as guarantees when our company has given written formal approval.

Further information may be obtained from the following address.

#### For all information :

#### **INDUSTEEL Creusot**

56 Rue Clemenceau – BP19

71201 LE CREUSOT CEDEX - FRANCE

#### Sales

Tel +33 3 85 80 55 31

Fax +33 3 85 80 51 77

#### **INDUSTEEL Belgium**

266, rue de Châtelet

B- 6030 MARCHIENNE AU PONT

Tel +32 71 44 16 99

Fax +32 71 44 19 56