

URANUS^ò 45 N⁺

a 22 % Cr austenitic-ferritic duplex stainless steel

URANUS 45N⁺ (UR 45N⁺) is a nitrogen alloyed austenitic-ferritic Duplex stainless steel (22.05), with a minimum PREN value guaranteed of 36 due to over-alloying in Molybdenum and Chromium. This alloy presents higher mechanical and corrosion resistance properties than duplex 22 Cr stainless steels.

Its yield strength is about twice that of standard austenitic grades and well in excess of that of nitrogen alloyed austenitics.

Operation temperature of UR 45 N⁺ is generally limited from -50°C to 280°C (-58°F to 536°F). Lower temperature used particularly for welded structures may also be considered, but needs technical background.

STANDARDS

EURONORM.....1.4462 - X2 Cr Ni Mo N 22.5.3
AFNORZ3 CND 22.05.AZ
WERKSTOFFNr 1.4462
ASTM.....UNS S 31803/S 32205

CHEMICAL ANALYSIS

Typical values (%)

C	Cr	Ni	Mo	N	Others
.020	22.6	6	3.4	.18	S = .001
PREN = [Cr %] + 3.3 [Mo %] + 16 [N %] ³ 36					

MECHANICAL PROPERTIES

Tensile properties - Minimum guaranteed values

°C	Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	°F	YS 0.2% KSI	YS 1.0% KSI	UTS KSI	A/Elong %
20	510	540	720	68	74	78	104	25
Plates th £ 50 mm (2 inches)								
50	460	500	670	122	67	72	97	
100	420	450	640	212	61	65	93	25
150	380	420	620	302	55	61	90	
200	350	390	600	392	51	56	87	20
250	320	350	600	482	46	51	87	
300	310	340	600	572	45	49	87	20

PHYSICAL PROPERTIES

CORROSION RESISTANCE

FABRICATION

Plates th \geq 50 mm (2 inches)

°C	Rp 0.2 MPa	Rp 1.0 MPa	Rm MPa	°F	YS 0.2% KSI	YS 1.0% KSI	UTS KSI	A/Elong %
50	440	480	650	122	64	70	94	
100	400	430	620	212	58	62	90	
150	360	400	600	30	52	58	87	
200	330	370	580	392	48	64	84	
250	300	330	580	482	44	48	84	
300	290	320	580	572	42	46	84	

UR 45 N⁺ should not be used over 280°C (536°F) for long periods.

Impact values

KCV + 20°C	+ 68° F	120 J/cm ² average 90 J/cm ² mini	87 Ft.lbs 65 Ft.lbs
KCV - 50°C	- 58° F	90 J/cm ² average 75 J/cm ² mini	65 Ft.lbs 54 Ft.lbs

Specific mass 7800 kg/m³

Interval Temper °C	Thermal expansion ? $\times 10^{-6}K^{-1}$	°C	°F	Resistivity (μW cm)	Thermal conductivity (W.m ⁻¹ .K ⁻¹)	Specific heat (J.kg ⁻¹ .K ⁻¹)	Young modulus E (GPa)	Shear modulus G (GPa)
20-100	12	20	68	80	17	450	200	75
20-200	12.5	100	212		18	450	194	73
20-300	13	200	392		19	500	186	70
		300	572		20	550	180	67

Structure

The UR45 N⁺ alloy is a two-phase microstructure containing, 50% α , 50% γ

General corrosion

UR 45N⁺ has a general corrosion resistance better than a 316 L steel (Z3 CND 17.12.03) and equivalent or better than a 904 L alloy (UR B6)

Pitting corrosion

	PREN Value
316 L	\geq 23
URANUS 45N	\geq 33
URANUS 45N ⁺	\geq 36
URANUS B6 (20 Cr/25 Ni/4.5 Mo/Cu)	\geq 32

Crevice corrosion

Better than 316L ; equivalent to UR B6 / 904L

Stress corrosion cracking

Duplex structure gives to UR45 N⁺ a definite advantage over austenitic steels (chloride containing media at temperatures up to 280°C (536°F).

Intergranular corrosion

UR 45N⁺ is resistant to Strauss test (A262E) as delivered and as welded conditions

Heat treatment

The heat treatment for delivery is 1040-1100°C (1904/2012°F)

Air cooling for thicknesses < 8 mm is agreed, but water quenching is advised. For thicknesses of 8 mm and above, water quenching is necessary. Special precautions must be taken during heat treatment to avoid deformation.

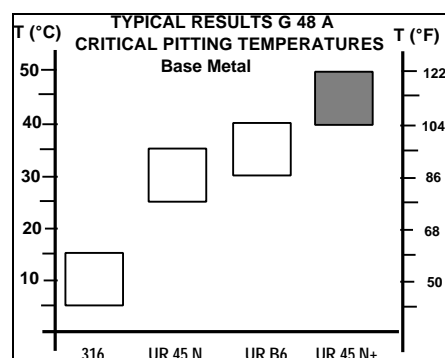
Cold forming

Due to its higher mechanical properties, UR 45 N⁺ requires more strength than a classical austenitic stainless steel. Deformation higher than 20% requires an intermediate heat treatment.

Hot forming

Recommended between 1150°C and 1000°C (2102 and 1832°F)

After forming, a new heat treatment is necessary to obtain optimal mechanical properties and microstructure stability



Pickling

Pickling solution acceptable for 316L may be used, but the pickling time required is at least twice that of 316L.

Machining

Machining is yet another example of a fabrication process in which the employed techniques (eg. tools and lubricants) are very similar to those used for conventional stainless steels).

Machining characteristics of UR 45N⁺ are better than those of Z3 CND 17.12.02 (316 L grade).

Oper.	Tool	Lubri- cation	Depth of cut mm (inch)	Feed mm (inch)	SPEED (m/min) -SPEED (feet/min)			
					m/min	feet/min	m/min	feet/min
Turning	High speed steel	Cutting oil	6-0.23	0.5-0.19	Ur B6		Ur 45 N ⁺	
			3-0.11	0.4-.016	6-11	19.7-36.1	15-20	49.2-65.6
			1-0.04	0.2-.008	9-14	29.5-45.9	23-28	75.5-91.9
	Carbide	Dry or cutting oil	6-0.23	0.5-.019	15-20	49.2-65.6	30-35	98.4-114.8
			3-0.11	0.4-.016	25-35	82-114.8	75-85	246.1/278.9
			1-0.04	0.2-.008	45-55	147.6-180.4	90-100	295.3-328.1
Parting off	High Speed steel	Cutting oil	Blade width					
			1.5-0.06	0.03 -0.0012	10-13	32.8-42.7	23-28	75.5-91.9
			3-0.11	0.04 -0.0016	11-14	36.1-45.9	24-29	78.7-95.1
			6-0.23	0.05 -.0020	12-15	39.4-49.2	25-30	82.-98.4
Drilling	High speed steel	Cutting oil	Drill Ø					
			1.5-0.06	0.25 -0.0010	6-10	19.7-32.8	10-14	32.8-45.9
			3-0.11	0.06 -0.0024	7-11	23.-26.1	11-15	36.1-49.2
			6-0.23	0.08 -0.0031	7-11	23.-26.1	11-15	36.1-49.2
			12-0.48	0.10- 0.0039	7-11	23.-26.1	11-15	36.1-49.2
Milling profiling	High speed steel	Cutting oil		.05/0.10 .002/.0039	10-20	32.8-65.6	12-22	39.4-72.2

WELDING

UR 45N⁺ is an austenitic-ferritic Duplex grade, and the ferrite/austenite ratio is controlled by :

- its chemical analysis, designed to obtain between 45 and 55 % of ferrite and the complement austenite after heat treatment at 1050/1080°C (1922/1976°F),
- the thermal cycle undergone by the alloy, a higher heat treatment temperature (>1100°C is 2020°F) resulting in a higher amount of ferrite.

After thermal cycle (heat at high temperature and rapid cooling), HAZ structure is enriched by ferrite compared to the heat treated structure. Nevertheless, the high nitrogen level of UR 45N⁺ allows an excellent control of the structure in HAZ. The chemical composition of UR 45N⁺ has been calculated so that ferrite does not exceed 75 % to guarantee a good corrosion resistance and a good ductility. Austeno-ferritic structure of UR 45N⁺ steel (primary solidification) excludes all risk of hot cracking.

UR 45 N⁺ is easily welded by the following processes :

- TIG welding, both manual and automatic	- MIG welding
- Plasma welding	- Manual arc welding with covered electrodes
- Flux Cored Arc Welding (FCAW)	- Submerged Arc Welding (SAW)

Special care must be taken in controlling the ferrite content of the weld deposit, which is usually between 20 and 60 %, and, depending on the application, a low ferrite content will be recommended (20-40 % of ?) i.e. for SMAW, SAW and FCAW

Chemical composition has to be adapted to stabilise austenite (generally, nickel or nitrogen overalloying compared to the base metal). Using of a Cr and Mo overalloyed filler metals is recommended.

Welding in several passes helps to limit ferrite content.

As for austenitic grades :

- No preheat is necessary prior to welding,
- The heat input must be controlled (10 to 25 KJ/cm is generally counselled).
- Interpass temperature must be limited to 150°C (302°F)
- No post weld heat treatment is necessary, except if, in particular cases, or for a particular welding, a lower ferrite content is necessary. Treatment will be realised at a sufficient temperature to avoid any transformation in phase. A higher temperature can be required when using welding products on alloyed steels 1080/1100°C (1976/2012°F).

- Usual precautions including cleaning and degreasing of weld area, protection against weld spatters must be taken to ensure corrosion resistance of finished product.
- Careful final descaling and/or cleaning of the weld is highly recommended.

1. Plasma + TIG welding

- Typically used for thicknesses 5 to 12 mm.
- Normal 22.09 wire, or overalloyed wire (25.10.4 type) will be used for plasma pass.
- If no filler metal is used for the plasma arc, Ar + (2-3)% N₂ will be used as shielding gas.
- Ferrite content will be between 30 and 60 %. Complementary TIG welding will also be realised with normal 22.09 wire or overalloyed wire. The ferrite content will also be between 30 and 60 %.
- Nitrogen addition (2-3%) to the shielding gas can be recommended to improve corrosion behaviour and stabilize the microstructure. Technical assistance is available for special cases. In each case, contamination of shielding gas by hydrogen must be avoided.

2. Manual metal arc welding

A standard 22.09 wire or 25-10-4 grade allowing overalloy of deposit metal will be used. The ferrite content is between 20 and 40 %. For more information, please contact us.

3. Submerged arc welding

This process can be used for single pass or multipass welds for high thicknesses (≥ 10mm) or to complete a plasma pass. The filler metal is a duplex wire and basic fluxes should be preferred. Ferrite content will be controlled between 20 and 40% in order to avoid cold cracking risks ; use only well dried fluxes to avoid hydrogen pick-up.

APPLICATIONS

Gas transportation on- offshore	Other uses
- tubes for platforms	- Bulk tankers for transportation of chemical products
- tubes for transportation of acid gas to refining stations	- acid areas (H ₂ SO ₄ diluted, phosphoric acid, production and storage of phosphates)
- wet carbonic gases collecting unit	- urea production
	- truck, lorries
	- pollution control industry
	- pulp and paper industry
	- plastic industry
	- food industry
	- chloride areas

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

NOTE

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.

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