



## UR™ 4565

### UR™ 4565: A high N super austenitic stainless steel, with PREN ≥ 45

UR™ 4565 is a 17% Ni, 24% Cr, 4.5% Mo super austenitic stainless steel grade with 0.4 % nitrogen additions, particularly designed for mechanical and high corrosion resistance properties.

The 17% nickel and 0.4 % nitrogen additions make the steel austenitic. The 24% chromium combined with 4.5% molybdenum and 0.4% nitrogen additions improve the behaviour of the steel in many corrosive solutions encountered for example in chemical and petrochemical processes.

The alloy behaves particularly well in chloride containing solutions and is well considered for pollution control equipments (scrubbers...). The alloy is also resistant to seawater and is used in offshore industries.

The austenitic microstructure obtained by nickel and high nitrogen additions explains its high toughness properties, obtained even down to -200°C (-28°F).

## PROPERTIES

### STANDARDS

> EURONORM: EN 1.4565 X2 Cr Ni Mn Mo N 25-20-7

> ASTM: UNS S34565

### CHEMICAL ANALYSIS - WEIGHT %

C	Cr	Ni	Mo	N (min)	S	Others
0.01	24	17	4.5	0.4	0.001	Mn = 4.5

$$\text{PREN} = [\text{Cr} \text{ \%}] + 3.3 [\text{Mo} \text{ \%}] + 16 [\text{N} \text{ \%}] \geq 45$$

### PHYSICAL PROPERTIES

Density: 8.1 kg/dm<sup>3</sup> - 0.29 lb/in<sup>3</sup>

Temperature interval °C (°F)	Thermal expansion ( $\alpha \times 10^{-6} \text{ K}^{-1}$ )	T °C (°F)	Resistivity ( $\mu\Omega \cdot \text{cm}$ )	Thermal conductivity ( $\text{W m}^{-1} \text{ K}^{-1}$ )	Specific heat ( $\text{J kg}^{-1} \text{ K}^{-1}$ )	Young modulus E (GPa)	Shear modulus G (GPa)
20 - 100 (68 - 212)	15	20 (68)	92	13	450	195	75
20 - 300 (68 - 572)	16.5	200 (392)	105	14	550	182	70
20 - 500 (68 - 932)	17.3	400 (752)	110	15	620	166	66

## MECHANICAL PROPERTIES

### Tensile properties - minimum values

°C	R <sub>p0.2</sub>	R <sub>p1.0</sub>	R <sub>m</sub>	°F	YS 0.2%	YS 1.0%	UTS	A/Elongation
	MPa				ksi			%
20	420	440	800	68	61	64	109	45
100	350	380	730	212	51	55	106	45
200	280	300	670	392	41	43	97	45
300	240	260	630	572	35	38	91	45

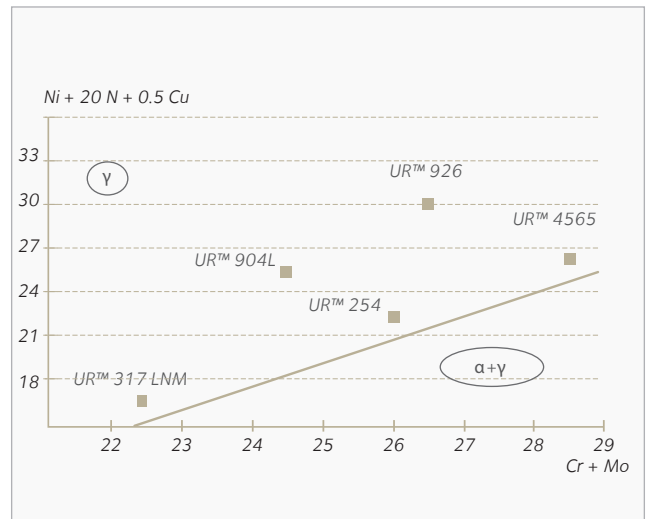
**Impact toughness:** KCV > 100J/cm<sup>2</sup> (70ft.lbs) at -196°C (-320°F)

**Hardness values:** HV<sub>10</sub>: [180-220]

## STRUCTURE

The chemical analysis of UR™ 4565 (17 Ni, 0.4 N - in order to increase its structure stability), is particularly well balanced to obtain an austenitic stainless steel microstructure. Some ferrite islands may be observed in the mid-thickness of the plates. The alloy remains very ductile down to -196°C (-321°F) (KCV>100 J/cm<sup>2</sup>).

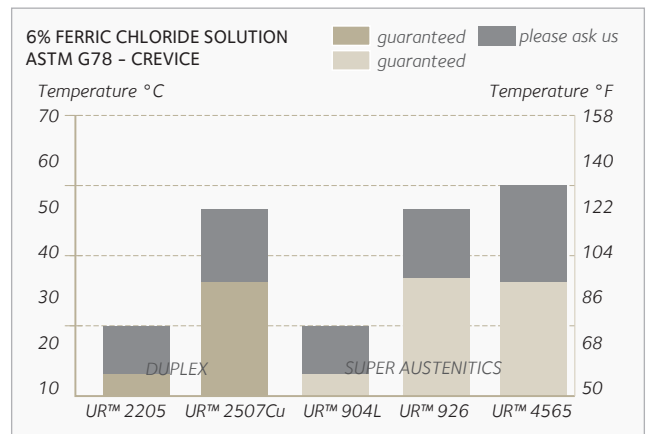
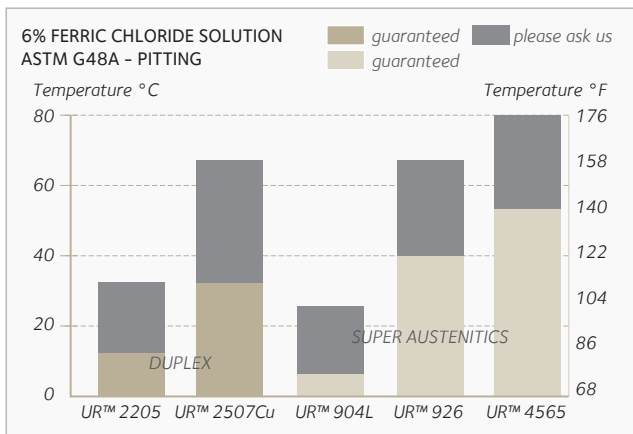
Due to the high chromium and molybdenum contents, the UR™ 4565 alloy must be water-quenched to avoid the intermetallic phase transformations which may occur in the 800 - 1100°C (1472 - 2012°F) temperature interval. Due to the high chromium and molybdenum contents, it must be water-quenched to avoid intermetallic phase transformations which may occur in the 800 - 1100°C (1472 - 2012°F) temperature interval.



## IN SERVICE CONDITIONS

## CORROSION RESISTANCE

### Pitting and crevice corrosion resistance



The high chromium, molybdenum and nitrogen contents of alloy UR™ 4565 (PREN ≥ 45) explain why the grade is very resistant to localized corrosion in seawater as well as in acidified oxidizing environments.

## IN SERVICE CONDITIONS

### Pitting corrosion resistance

Chloride level		1 g/l			5 g/l			30 g/l			300 g/l		
F <sup>-</sup> (ppm)		0	400	1000	0	400	1000	0	400	1000	0	400	1000
pH	6	316L						UR™ 2507Cu UR™ 4565			UR™ 66 or UR™ 22 / UR™ 276		
	4	UR™ 2205											
	2				UR™ 926			UR™ 926					
	1	UR™ 22 / UR™ 276											

Selection grid for the selection of materials for FGD applications at 60°C (140°F) based on corrosion test results and cost effectiveness considerations.

The balance between nickel content and high chromium molybdenum and nitrogen additions explains why UR™ 4565 alloy is a typical multipurpose grade for very severe conditions of use. It generally behaves better than superduplex stainless steels and is less expensive than nickel based alloys. It may be used in acidified solutions polluted by chloride or fluoride additions as observed on the selection grid of material selection for FGD applications.

## DELIVERY CONDITIONS

### SIZE RANGE

	Plates	Clad plates
Thickness	5 to 150 mm 3/16" to 6"	6 to 150 mm 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 472"	Up to 14000 mm Up to 551"

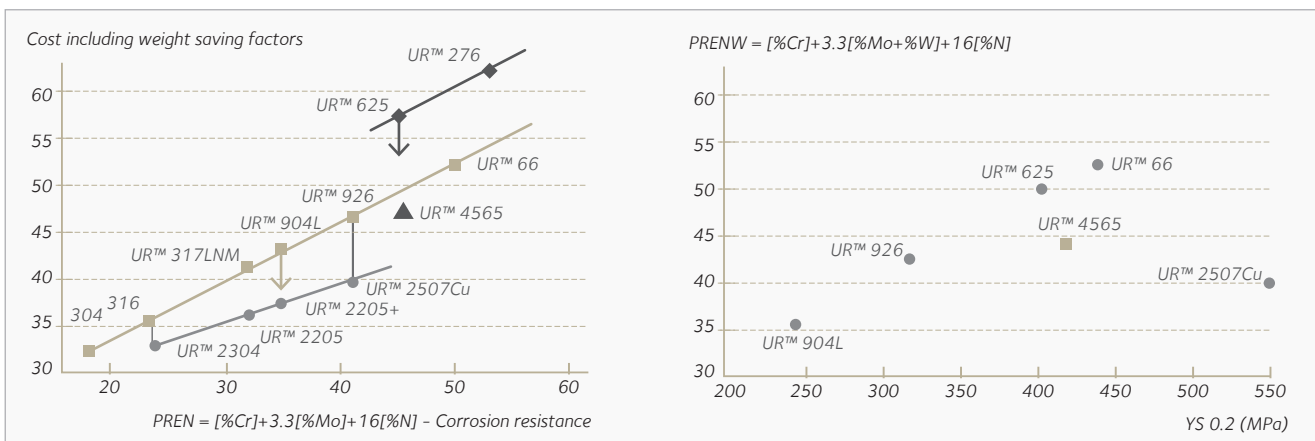
Other sizes are available on request, including 4100 mm (161,4") width plates.

## PLATE PROCESSING

### DESIGN

UR™ 4565 has a unique position in the stainless steel family when comparing the combined PRENw value and mechanical properties. The use of the high mechanical properties allows the designer to reduce the costs. Another cheaper way to design vessels is the use of cladded UR™ 4565 grade.

### Cost effectiveness aspects



## HOT FORMING

Furnace atmosphere must be slightly oxidising and free of sulphur contaminations. Load the plate in the furnace at specified temperature. Temperature range for hot forming: 1200°C to 900°C (2190°F to 1650°F). Reheat as often as necessary to reduce hardening and structural effects. Solution annealing is necessary after hot working:

- > **Temperature: 1120 - 1170°C (2050 - 2138°F)**
- > **Soaking time: 1 to 2 min per mm of thickness at annealing temperature**
- > **Cooling: water quench.**

## COLD FORMING

The cold formability of UR™ 4565 is excellent, but due to its high Mo and N contents, the work hardening rate is higher than for 316 L. Intermediate annealing may be necessary. To remove forming stresses, or in case of SCC risks (chloride or caustic media), an annealing heat treatment may be necessary (see heat treatment).

## PICKLING

The cleanliness of the surface is very important to maintain the high corrosion resistance of this alloy. The following solution is recommended:

- > **Nitric acid: 15 to 20 % (weight)**
- > **Hydrofluoric acid: 2 % to 5 % (weight)**
- > **Temperature: 40 to 60°C (105 to 140°F)**

## WELDING

UR™ 4565 can be welded by the following processes: TIG/GTAW, PLASMA/PAW, MIG/GMAW, SMAW with covered electrodes. This grade must be welded with filler metal: welds without filler have lower ductility and a low corrosion resistance. Keep the dilution of parent metal below 50% (more filler metal than parent metal).

Due to the fully austenitic structure, the following precautions must be taken:

- > **Minimise the heat input (string beads, no oscillation, diameter of covered electrodes limited to 3,2 mm). The heat input should preferably be limited to 1.2 kJ/mm.**
- > **Interpass temperature must be controlled to less than 140°C (284°F).**
- > **No preheating for PWHT.**
- > **Careful cleaning and degreasing of weld area and descaling and cleaning of finished weld are highly recommended. Carefully grind strike marks and other welding defects.**
- > **Use run-on and run-off plates and anti-spatter protection where possible.**
- > **Dry electrodes according to manufacturer's instructions.**



UR™ 4565 may be welded with ER Ni.Cr.Mo-7 or EN Ni.Cr.Mo-10 (AWS A5.14) wire, and E Ni.Cr.Mo-7 or E.Ni.Cr.Mo-10 (AWS A 5.11) electrodes or filler metal as EL Ni.Cr.19 Mo-15 or SG Ni.Cr.20 Mo-15; EL Ni.Cr.23.Mo-16 or SG Ni.Cr.23 Mo-16 (DIN 1736) electrodes or filler metal can also be used.

Suitable electrodes and welding wire are available from various manufacturers. Technical assistance is available on request.

## APPLICATIONS

- > Natural and treated seawater systems, desalination plants
- > **Pollution control:** flue gas desulphurisation (absorbers)
- > **Chemical industries:** chloride containing media - Fine chemical production



## YOUR CONTACTS

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*Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we 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 are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.*