



## 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 addition, 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 equipment (marine 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 (-328°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)	Others
0.01	24	17	4.5	0.4	Mn > 5

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

### 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

PROPERTIES

MECHANICAL PROPERTIES

Tensile properties - minimum values

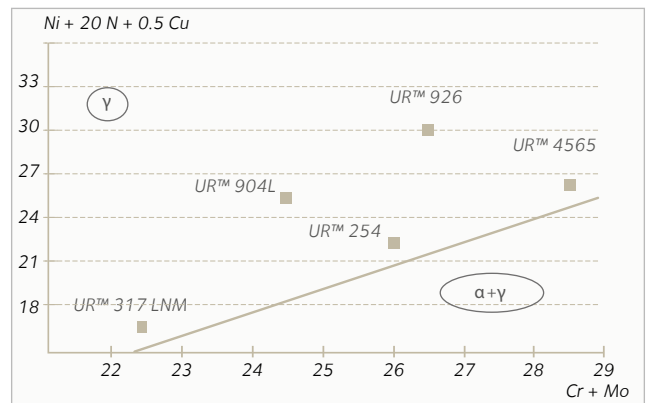
°C	R <sub>p0.2</sub>	R <sub>p1.0</sub>	R <sub>m</sub>	°F	YS 0.2%	YS 1.0%	UTS	A/Elongation
	MPa				ksi			%
20	420	460	800	68	61	66	116	30

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

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.

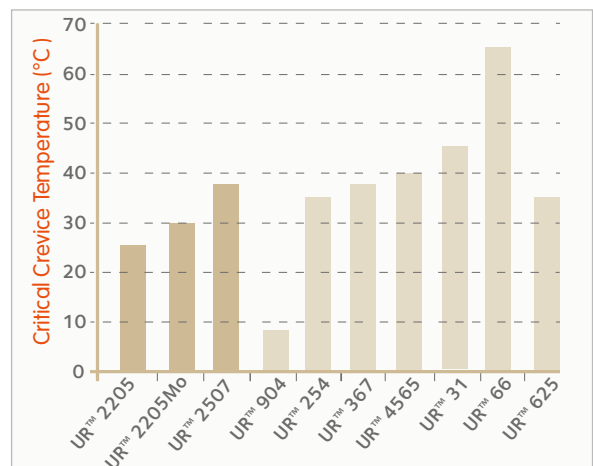
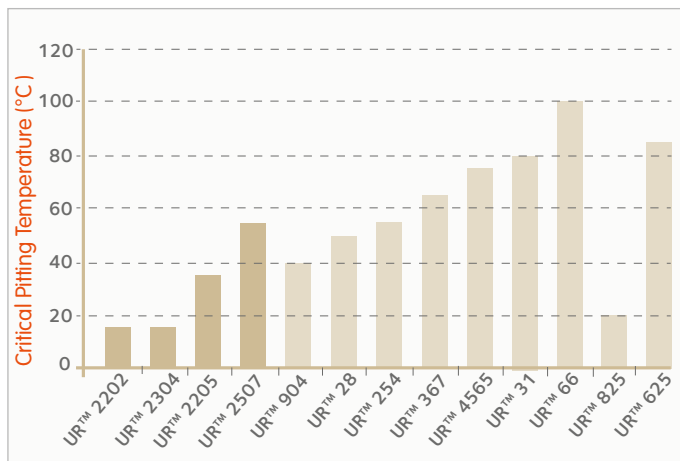
The alloy remains very ductile down to -196°C (-321°F) (KCV>100 J/cm<sup>2</sup>). Due to the high chromium and molybdenum contents, UR™ 4565 alloy must be water-quenched to avoid intermetallic phase transformations which may occur in the 800 - 1100°C (1472 - 2012°F) temperature interval.



IN SERVICE CONDITIONS

CORROSION RESISTANCE

Pitting and crevice corrosion resistance (ASTM G48)



## IN SERVICE CONDITIONS

Thanks to its chromium, molybdenum, and nitrogen contents, UR™ 4565 presents a good resistance to localized corrosion, better than conventional 6%Mo grades when tested according to the most common standards.

Grades	CPT °C (ASTM G48E)	CCT °C (ASTM G48D)
UR™ 4565	75	40
UR™ 367	65	35
UR™ 254	55	35

*Typical pitting and crevice results.*

### Environments

#### Phosphoric acid

Phosphoric acid is a weak acid, mainly used in the fertilizer industry and as food additive. This acid is generally produced using a wet process route where phosphate rock is converted by reaction with concentrated sulfuric acid into phosphoric acid and calcium sulfate. Impurities contained in the phosphate rock increase the corrosivity of the phosphoric acid production process.

In environments representative of phosphoric acid production\*, UR™ 4565 is resistant up to 80°C (176 °F).

\*41% H<sub>3</sub>PO<sub>4</sub> + 2% H<sub>2</sub>SO<sub>4</sub> + 1.5% H<sub>2</sub>SiF<sub>6</sub> + 0.2% HF + 0.3% Fe<sup>3+</sup> + 0.3% Al<sup>3+</sup> + 1000 ppm Cl<sup>-</sup>

#### Sulfuric acid

Sulfuric acid concentration	Max temperature (°C)
< 10%	90
20%	70
40%	60
60%	40

*Temperature limits in industrial sulfuric acid without any impurity*

Please ask for data with chloride contamination.

#### Water and Seawater

In fresh water, UR™ 4565 is almost not susceptible to corrosion.

Long-term immersion of UR™ 4565 coupons have demonstrated that it is very resistant to pitting and crevice corrosion in renewed seawater up to 30°C (86 °F), even if 0.5 ppm of free chlorine are added.

#### Pollution control

UR™ 4565 presents an excellent resistance to localized corrosion in environments representative of the courses of marine open loop scrubbers, above the wet/dry interface.

## IN SERVICE CONDITIONS

### Sour environments

UR™ 4565 has proven to be resistant in a solution containing 150 000 ppm of chlorides at pH 4.5 and 150°C up to at least a H<sub>2</sub>S partial pressure of 7 bar. This environment is representative of aggressive conditions encountered in Oil & Gas production units, and is much more aggressive than the current NACE MR0175 / ISO15156 limits. In these conditions, standard 6%Mo grades suffer from stress corrosion cracking.



UR™ 4565 after 720 hours (7 bar H<sub>2</sub>S, 250 g/l NaCl, pH 4.5, 150°C) at 90%AYS

## DELIVERY CONDITIONS

### SIZE RANGE

	Plates
Thickness	5 to 30 mm 3/16" to 2"
Width	Up to 2500 mm Up to 98"
Length	Up to 12000 mm Up to 472"

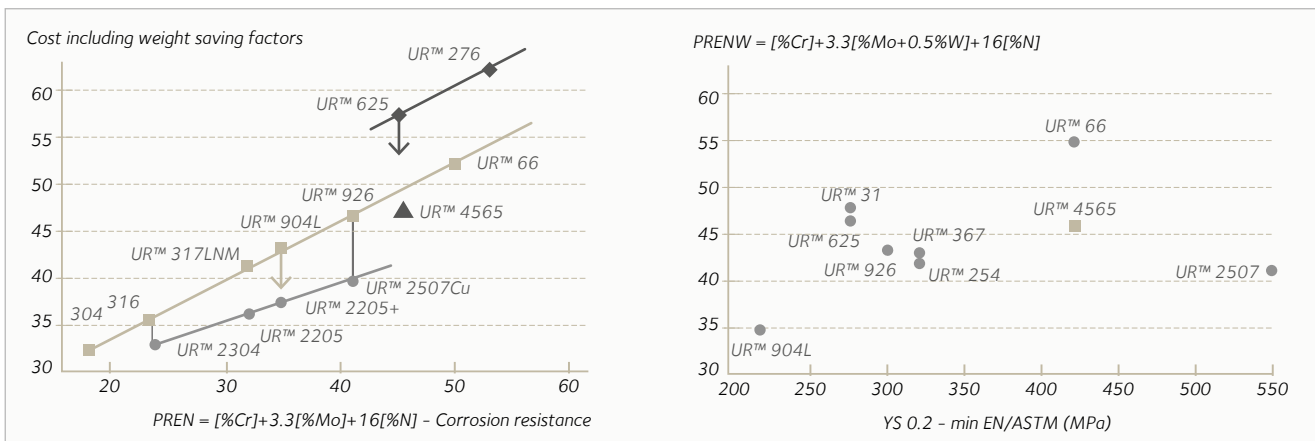
Other sizes are available on request.

## PLATE PROCESSING

### DESIGN

UR™ 4565 has a unique position in the stainless steel family when comparing the combined PREN value and mechanical properties. The use of the high mechanical properties allows the designer to reduce the costs.

### Cost effectiveness aspects



## HOT FORMING

Furnace atmosphere must be slightly oxidising and free from 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: 1150 - 1180°C (2050 - 2138°F)**
- > **Soaking time: 1.5 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, 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 properties of this alloy. Use 6 Mo super austenitic pickling conditions. Please ask for pickling recommendations.

## 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 because 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:

- > **Minimize 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 when possible.**
- > **Dry electrodes according to manufacturer's instructions.**



UR™ 4565 can be welded with niobium free base filler material 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 suppliers. Technical assistance is available upon request.

## APPLICATIONS

- > **Seawater applications**
- > **Pollution control:** flue gas desulphurisation (absorbers), marine scrubbers
- > **Chemical industries**



## 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.*