



UR™ 31

UR™ 31: A high nickel super austenitic stainless steel

UR™ 31 is a super austenitic stainless steel with high contents of nickel, chromium and molybdenum. The alloy is designed to give properties in-between super austenitic and nickel base alloys for very demanding applications from the corrosion aspect. The high content of chromium and molybdenum gives an excellent resistance to localized corrosion. The high nickel content provides a very good resistance to stress corrosion cracking.

PROPERTIES

STANDARDS

- > EURONORM: EN 1.4562
- > ASTM: UNS N08031

CHEMICAL ANALYSIS - WEIGHT %

C	Ni	Cr	Mo	N	Mn
<.015	31	26.5	6.3	.2	< 2

$$\text{PREN} = [\text{Cr}\%] + 3.3 ([\text{Mo}\%] + 16 [\text{N}\%]) \geq 48$$

PHYSICAL PROPERTIES

Density: 8.0 kg/dm³

Temperature interval °C (°F)	Thermal expansion ($\alpha \times 10^{-6} \text{ K}^{-1}$)	T °C (°F)	Resistivity ($\mu\Omega$. cm)	Thermal conductivity ($\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$)	Specific heat ($\text{J}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$)	Young modulus E (GPa)
		20 (68)	103	11.7	450	198
20 - 100 (68 - 212)	14.3	100 (212)	106	13.2	463	189
20 - 200 (68 - 392)	14.7	200 (392)	110	15	474	183
20 - 300 (68 - 572)	15.1	300 (572)	113	16.8	483	176
20 - 400 (68 - 752)	15.5	400 (752)	116	18.5	491	170
20 - 500 (68 - 932)	15.7	500 (932)	118	20.2	500	163

MECHANICAL PROPERTIES

Tensile properties - minimum values

°C	R _{p0.2}	R _{p1.0}	R _m	°F	YS 0.2%	YS 1.0%	UTS	A/Elongation %
	MPa				ksi			
20	280	310	650	68	40.6	45	94.6	> 40%

STRUCTURE

UR™ 31 shows a completely austenitic microstructure thanks to its high nickel and nitrogen contents. The alloy is sensitive to precipitation of intermetallic phase in the temperature region 700 - 1100°C. After the final solution heat treatment, it is recommended that the alloy be water quenched.

IN SERVICE CONDITIONS

CORROSION RESISTANCE

Pitting and crevice corrosion resistance

Thanks to its chromium and molybdenum contents, UR™ 31 presents an excellent resistance to localized corrosion, much better than conventional 6% Mo grades and relatively close to 625 alloy when tested according to the most common standards.

Corrosion data for UR™ 31 in some typical test solutions.

Grades	CPT °C (ASTM G48E)	CPT °C (green death)	CCT °C (ASTM G48D)
UR™ 66	> 100	> 100	55
UR™ 625	85	70	35
UR™ 31	80	65	40
UR™ 254	55	-	35

Typical pitting and crevice results.

The high nickel content contributes to an enhanced resistance to stress corrosion cracking. It can be used for a variety of very demanding applications.

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™ 31 is resistant up to 110°C (230°F) even if fluorhydric acid is present.

*41% H₃PO₄ + 2% H₂SO₄ + 1.5% H₂SiF₆ + 0.2% HF + 0.3% Fe³⁺ + 0.3% Al³⁺ + 1000 ppm Cl⁻

Sulfuric acid

UR™ 31 has excellent resistance in pure and contaminated sulfuric acid over a broad range of concentrations up to 80 °C (176° F).

IN SERVICE CONDITIONS

Water and Seawater

In fresh water, UR™ 31 is almost not susceptible to corrosion.

Long-term immersions of UR™ 31 coupons have demonstrated that it is very resistant to pitting and crevice corrosion in renewed seawater up to 50°C (122°F), even if 0.5 ppm of free chlorine are added.

Pollution control

UR™ 31 has proven to be a good candidate for open loop marine scrubbers, above the wet/dry interface.

Sour environments

UR™ 31 has proven to be resistant in a solution containing 150 000 ppm of chlorides at pH 4.5 and 150°C under a H₂S partial pressure of 14 bar. This environment is representative of very 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.

DELIVERY CONDITIONS

SIZE RANGE

	Hot rolled plate	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.

PLATE PROCESSING

HOT FORMING

Furnace atmosphere must be slightly oxidising and free from sulphur contaminations. Load the plate in the furnace at specified temperature. Temperature range is 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°C to 1180°C (2100°F to 2150°F)**
- > **Soaking time: 1.5 min /mm of thickness at annealing temperature**
- > **Cooling: water quench.**

COLD FORMING

The cold formability of UR™ 31 is good, but due to high Mo content, the work hardening rate is higher than for 316L. Intermediate annealing may be necessary. Remove forming stresses by annealing heat treatment.

WELDING

The following processes can be used to weld UR™ 31: 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).

Welding conditions

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 120°C (248°F)
- > No necessity for preheating or post weld heat treatment
- > Careful cleaning and degreasing of weld area. 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



Filler metals

UR™ 31 may be welded with:

- > ER NiCrMo-7 or EN NiCrMo-10 (AWS A5.14) wire
- > EL NiCrMo-7 or EL NiCrMo-10 (AWS A5.11) electrodes
- > SG NiCr20Mo-15 or SG NiCr23Mo-16 (DIN 1736) filler metals
- > EL NiCr23Mo-16 or EL NiCr19Mo-15 (DIN 1736) electrodes

Suitable electrodes and welding wires are available from a variety of suppliers. Technical assistance is available upon request.

APPLICATIONS

- > **Flue gas cleaning systems:** inland and marine scrubbers
- > **Pulp and paper industry:** bleaching equipment
- > **Oil and Gas applications**
- > **Chemical industries**



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