

UR™ 904L

A multipurpose Austenitic stainless steel with PREN \geq 34

UR™ 904L is a multipurpose 20 Cr - 4.3 Mo high corrosion resistance austenitic stainless steel developed 40 years ago by Industeel.

Due to combined additions of chromium (20%), molybdenum (4.3%), copper (1.5%) combined with its high nickel content, the grade is recommended for most applications dealing with medium to severe corrosive solutions. UR™904L has improved stress corrosion resistance properties.

UR™ 904L alloy is particularly used in sulphuric and phosphoric acids applications.

Standard

EN 10088 - EN 10028.7:	X1 Ni Cr Mo Cu 25.20.5 - 1.4539
AFNOR:	Z2 NCDU 25.20 (AZ)
DIN:	W. Nr 1.4539
ASTM:	B 625 - UNS N 08904

Chemical analysis

Typical values (%)

C	Cr	Ni	Mo	Others
0.020	20	25	4.3	Cu = 1.5

$$\text{PREN} = [\text{Cr} \%] + 3.3 [\text{Mo} \%] + 16 [\text{N} \%] \geq 34$$

Mechanical properties

Tensile properties - Minimum values

°C	R _{p0.2} MPa	R _{p1.0} MPa	R _m MPa	°F	YS 0.2% KSI	YS 1.0% KSI	UTS KSI	A/EI%
20	313	275	520	68	45	39	75	40
100	205	230	520	212	30	33	75	40
300	145	170	490	572	21	26	71	40
500	125	150	410	932	18	22	35	40

Values for hot rolled 10 mm thick plates

Impact: KCV > 100J/cm² (70 ft lbs) at -196°C (-319°F)

Hardness: HV₁₀: [180-220]

Physical properties

Density: 8.050 kg/m³ - 0.29 lb/in³

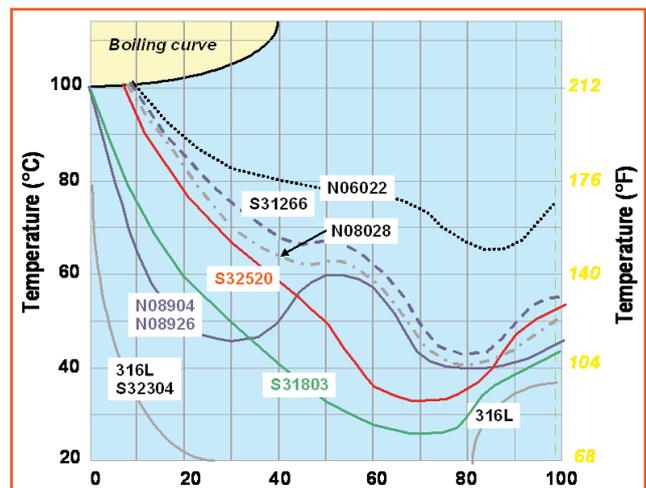
Temperature interval °C	Thermal expansion $\alpha \times 10^{-6} \text{ K}^{-1}$	T °C	T °F	Resistivity ($\mu\Omega \text{ cm}$)	Thermal conductivity ($\text{W m}^{-1} \text{ K}^{-1}$)	Specific heat ($\text{J kg}^{-1} \text{ K}^{-1}$)	Young's modulus E (GPa)	Shear modulus G (GPa)
20 - 100	15	20	68	80	17	500	190	75
20 - 300	16	300	572	100	13	550	180	70
20 - 500	17	500	932	120	14	650	165	66

Corrosion resistance

General corrosion

Sulfuric acid:

In sulfuric acid environments, the range of concentrations and temperatures in which URTM 904L can be used is much wider than the one of most of the other high corrosion resistant grades (such as URTM 317L and URTM 2205). This is partially explained by high content of nickel, chromium, molybdenum and also its copper addition.

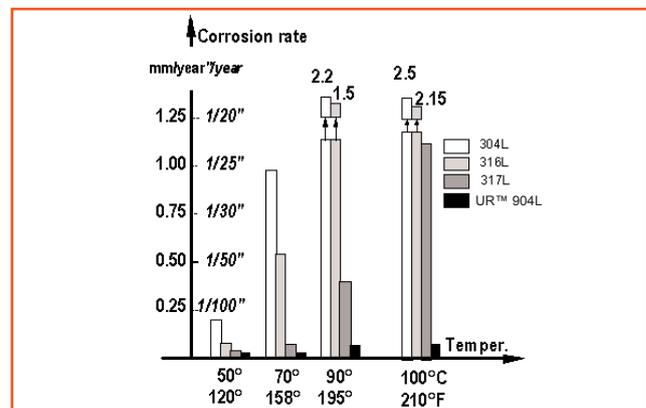


ISO – Corrosion diagram in industrial H₂SO₄ (0,2mm/y)

Phosphoric acid:

General corrosion resistance properties of alloy URTM 904L in industrial phosphoric acid solutions is excellent and much better than the one of the austenitic grades 316L and 317L. At higher temperatures, the alloy behaves also better than the duplex grade URTM 2205.

URTM 904L is today commonly used for phosphoric acid applications. The corrosion resistance in this environment is strongly influenced by the presence of impurities (chlorides, fluorides, ...).

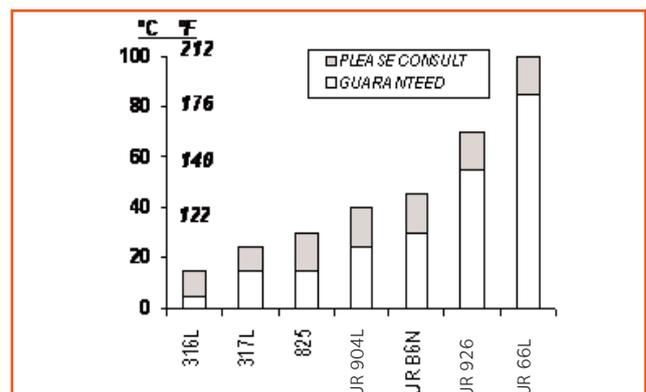


Corrosion rate of different types of stainless steels in industrial phosphoric acid (P2O5=48%, SO3=2.7%, F= 0.44%)

Localized corrosion

The high chromium and molybdenum contents of URTM 904L make its resistance to pitting and crevice corrosion superior to 316L and 317L. This has been demonstrated by laboratory tests and field experience.

In the most severe conditions such as stagnant sea water, the use of super-duplex grade (URTM 2507Cu) or a super-austenitic alloy (URTM 926, URTM 66) is recommended.



ASTM G48A - PITTING in Fe Cl₃ solution

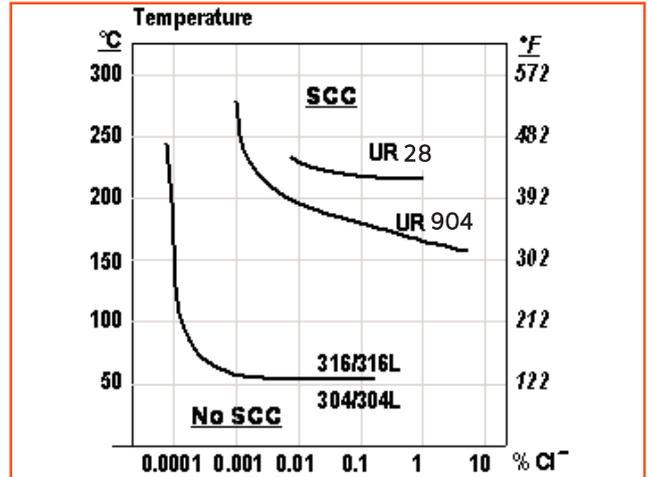
Intergranular corrosion

The very low carbon content of UR™ 904L makes this alloy resistant to this type of corrosion.

Stress corrosion cracking

Due to its high nickel and molybdenum content, UR™ 904L is more resistant to stress corrosion cracking than other standard austenitic materials.

Field experience and laboratory tests show that UR™ 904L performs much better than 304L and 316L grades. This is particularly true in high temperature chloride containing solutions where early failures are often reported for 304L and 316L.



Practical experience and laboratory results of SCC in stainless steels

Welding

UR™ 904L can be welded by the following processes: TIG/GTAW, MIG/GMAW, SMAW, PAW and SAW.

This grade must be welded with matching filler metal or with Ni based alloys. Basic electrodes and fluxes should be used preferably to rutile ones.

Due to the fully austenitic microstructure, precautions shall be taken when welding UR™ 904L:

- Minimize heat input (string bead, limitation of the diameter electrodes or ods). The heat input should be preferably limited to 1.5 kJ/mm.
- Interpass temperature must be controlled to less than 140°C (284°F).
- No preheating nor postheating. PWHT is not necessary except if required.
- Protection against weld spatter, 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 as practicable.
- Dry electrodes according to manufacturer's instructions.

UR™ 904L must be welded with matching filler metal (type E 20 25 5 L Cu B) or nickel alloyed filler metal such as type E(R)NiCrMo-3 or PHYWELD NCW (Nb free 625). Suitable electrodes and welding wire are available from various manufacturers.

Machining

Operation	Tool	Lubrication	Depth of cut (mm) (inch)	Feed (mm) (inch)	CONDITIONS		
					18/8	18/12 Mo	UR™ 904L
Parting off	High speed steel	Cutting oil	Blade width mm - inch	Feed mm -inch	SPEED (m/min) SPEED (feet/min)		
			1.5 0.06	0.03 0.0012	21-26 68.9-85.3	17-22 55.8-72.2	10-13 32.8-42.7
			3 0.11	0.04 0.0016	22-27 59.1-75.5	18-23 59.1-75.5	11-14 36.1-45.9
			6 0.23	0.05 0.0020	23-28 75.5-91.9	19-24 62.3-78.7	12-15 39.4-49.2
			Drilling	High speed steel	Cutting oil	Drill dia. mm - inch	Feed mm -inch
Milling profiling	High speed steel	Dry or Cutting oil	1.5 0.06	0.25 0.0010	10-14 32.8-45.9	10-14 32.8-45.9	6-10 19.7-32.8
			3 0.11	0.06 0.0024	11-15 36.1-49.2	11-15 36.1-49.2	7-11 23-26.1
			6 0.23	0.08 0.0031	11-15 36.1-49.2	11-15 36.1-49.2	7-11 23-26.1
			12 0.48	0.10 0.0039	11-15 36.1-49.2	11-15 36.1-49.2	7-11 23-26.1
			Feed mm -Inch	SPEED (m/min) SPEED (feet/min)			
0.05-0.10 0.002-0.0039	12-22 39.4-72.2	10-20 32.8-65.6	10-20 32.8-65.6				

Size range

	Plates	Cold rolled plates	Clad plates
Thickness	5 to 120mm <i>3/16" to 4.7"</i>	6 to 14mm <i>5/64" to 5/8"</i>	6 to 126mm <i>1/4" to 5"</i>
Width	Up to 3300mm <i>Up to 130"</i>	Up to 2300mm <i>Up to 90.5"</i>	Up to 3200mm <i>Up to 126"</i>
Length	Up to 12000mm <i>Up to 472"</i>	Up to 8250mm <i>Up to 325"</i>	Up to 14000mm * <i>Up to 551"</i>

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

* Indicative dimensional program. Maximum width depends on thickness. For wider and thicker plates or other specific request, please consult. Prefabrication pieces according to drawing.

Applications

- Phosphoric acid, fertilizers, phosphate industries,
- Sulphuric acid solutions and hydrometallurgy,
- Saline solutions and, with some restrictions, seawater applications,
- Sour gas applications (separators...),
- Pollution control equipments,
- Chemical plants (medium to severe conditions)

For any information

Industeel France

56 rue Clemenceau
F-71201 Le Creusot Cedex
Tel + 33 3 85 80 53 02
Fax + 33 3 85 80 54 11

Industeel Belgium

266 rue de Chatelet
B-6030 Charleroi
Tel + 32 71 44 15 00
Fax + 32 71 44 19 56

www.industeel.info
www.arcelormittal.com

**transforming
tomorrow**

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.