Alloy 28: A high nickel super austenitic stainless steel.

Alloy 28 is a super austenitic stainless steel with very high nickel (31%) and chromium (27%) contents. The molybdenum content is about 3.5%. The alloy is designed for specific purposes, including sulphuric and phosphoric acid applications. It behaves particularly well in sulphuric and phosphoric acid environments, even when contaminated by chlorides and fluorides species.

The high nickel content improves its stress corrosion cracking resistance. The combined chromium and molybdenum additions contribute to drastically increase the localized corrosion resistance. UR™ 28 behaves much better than alloy 825 and could be considered in some applications (sour gas) to replace the more expensive 625 grade.

The alloy is extensively used in chemical and offshore applications including very sour gas fields.

STANDARDS

- EURONORM: EN 1.4563 X1NiCrMoCu31-27-4
- ASTM: UNS N08028

CHEMICAL ANALYSIS - WEIGHT %
Typical values

C	<0.020
Cr	27
Cr	31
Mo	3.5
Mo	0.05
Others	Cu = 1

CHEMICAL ANALYSIS - WEIGHT %
Typical values

PREN = [Cr%] + 3.3 [Mo%] + 16 [N%] ≥ 39

PHYSICAL PROPERTIES

Density: 8.0 kg/dm3 - 0.29lb/in3

Interval temperature °C (°F)	Thermal expansion (α x10 - 6 K - 1)	T °C (°F)	Resistivity (μΩ.cm)	Thermal conductivity (W .m - 1 .K - 1)	Specific heat (J .kg - 1 .K - 1)	Young modulus E (Gpa)	Shear modulus G (Gpa)
20 - 200 (68 - 392)	15.8	20 (68)	100	12	450	195	75
20 - 300 (68 - 572)	16.5	100 (212)	-	-	-	182	70
20 - 500 (68 - 932)	17.3	400 (752)	-	-	-	-	166

MECHANICAL PROPERTIES

Tensile properties - minimum values

° C	Mpa			° F	ksi			A/Elongation
	Rp0.2	Rp1.0	Rm		YS 0.2%	YS 1.0%	UTS	%
20	220	250	500	68	32	36	72	40
100	190	220	460	212	28	32	67	40
200	160	190	430	392	23	28	62	40
300	150	180	400	572	22	26	58	35
300	135	165	380	752	19	24	52	35

HARDNESS:

HV10: 250 - 310

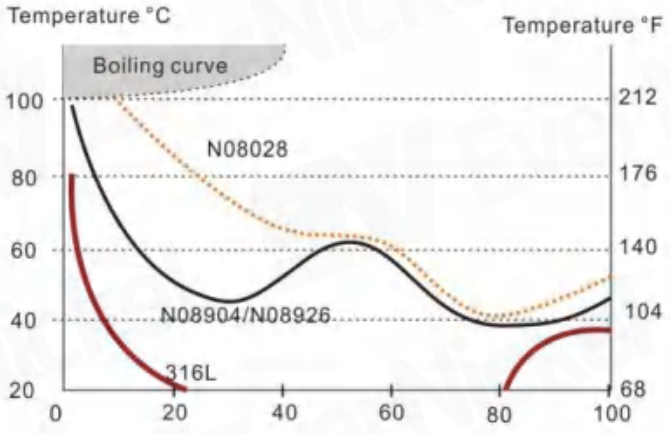
Impact properties - minimum guaranteed values:

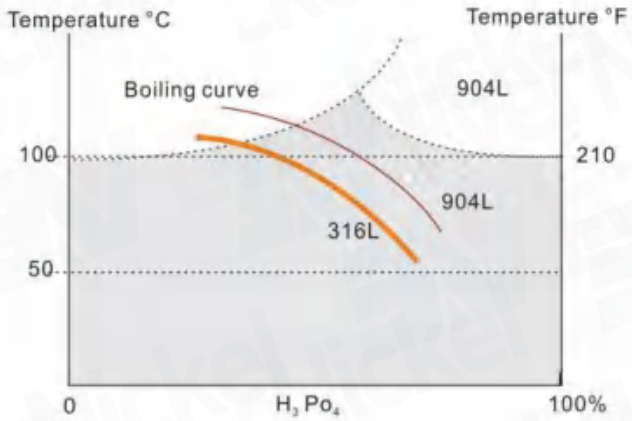
Alloy 28 retains a very good impact strength at low temperature: - 196°C (- 319°F) > 100J/cm^2

STRUCTURE

Alloy 28 has an entirely austenitic structure due to its very high nickel content.
The alloy is sensitive to intermetallic phase precipitation when heat treated between 700 and 1100°C (1292 and 2012°F).
The alloy must be water quenched after final solution annealing treatment.
The alloy is designed for a maximum service temperature of about 450°C (842°F).

CORROSION RESISTANCE



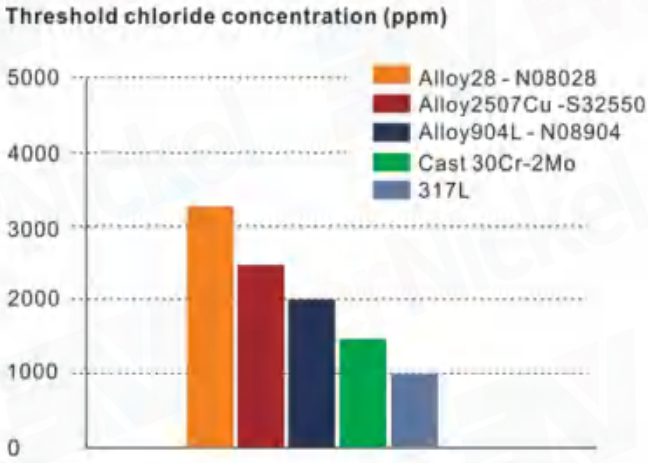


In most of the corrosive solutions, alloy 28 is more corrosion resistant than alloy 904L (N08904). The alloy is extensively used in phosphoric acid applications and some sulphuric solutions. Alloy 28 may also be used in caustic solutions since its molybdenum content remains low comparing with the nickel and chromium additions.

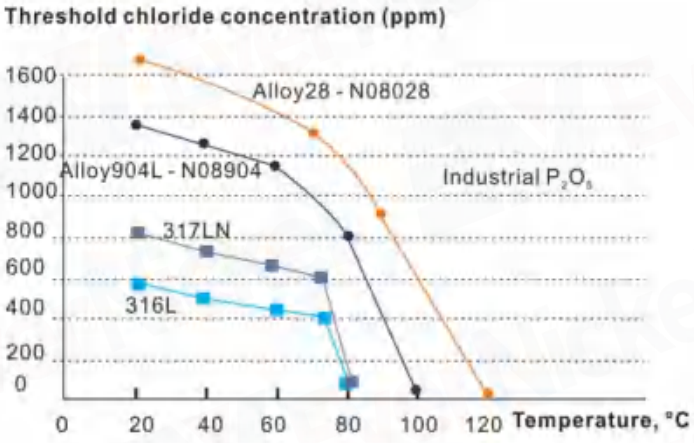
Pitting and crevice corrosion resistance

High chromium and moderate molybdenum additions contribute to improve the local corrosion resistance of alloy 28. The grade performs much better than alloy 825 and better than alloy N08904 (UR™ 904L) in acidic chloride containing solutions.

Threshold chloride level for use in 30% p205 solutions at 80°c Corrosion rate 0.2mm/yearthreshold chloride level for use In 30% p205 solutions at 80°c corrosion rate 0.2mm/year



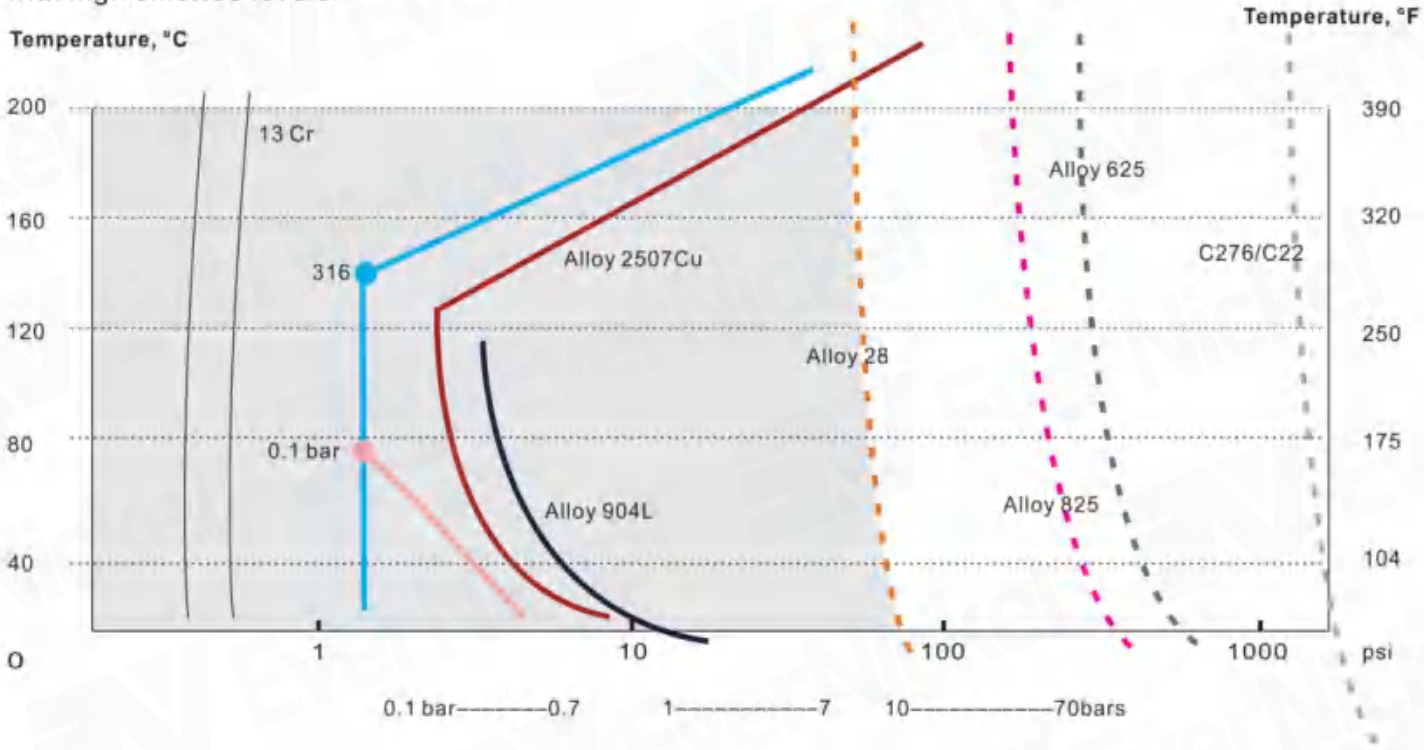
Max temperature and threshold chloride level for use in 54% p205 solution



Isocorrosion chart -0.1 mm/year (4mpy) in contaminated H_3PO_4 solutions

Pitting and crevice corrosion resistance

The high nickel and molybdenum contents give alloy 28 an excellent resistance to stress corrosion cracking phenomena. This is particularly the case for high temperature applications (140 - 400°C = 284 - 752°F) and chloride containing environments. Alloy 28 is particularly well designed for sour gas applications and has been successfully tested at 230°C (446°F) with 3 bars H2S and 50 bar CO_2 with high chloride levels.



HOT FORMING

See precautions for heating. Load into furnace at temperature (1100 - 1150°C = 2012 - 2102°F) with 0.5 to 1 min/mm thickness soaking time - Finish forming above 850°C (1562°F). Air or preferably activated air cooling after forming.

COLD FORMING AND MACHINING

Similar to alloy 904L.

HEATING AND HEAT TREATMENT

Degrease, remove contaminants such as sulphur, low melting point metals, Zn rich paints, etc... Heat at 1100 - 1180°C (2012 - 2156°F), followed by rapid cooling - water preferable - (soaking time = 1 - 2 min/mm thickness). A neutral or oxidizing sulphur free atmosphere is preferred.

WELDING

Alloy 28 is readily welded by GMAW, GTAW, SMAW. Due to its austenitic primary solidification, precautions must be taken when welding alloy28 to prevent the risk of "hot cracking".

- no preheat
- low heat input, stringer bead
- interpass temperature < 120°C (248°F)

Filler metal: SANDVIK 27.31.4.L Cu wire. Over matching filler materials such as ER Ni Cr Mo.3 or E Ni Cr Mo.3 (AWS) or PHYWELD NCM (Nb free 625) can also be used.

Alloy 28 has been used with success in the following applications:

- Production, concentration and use of phosphoric acid reactors tanks, impellers, piping systems, cyclone evaporators, surface coolers, circulation pumps, agitators, super phosphoric acid storage, shell/tubes for heat exchangers

- **Production and use of sulphuric acid:** heating equipments, reactor tanks, agitators, inlet pipe in reactors...
- **Oil and gas production:** sour gas application, tubing, separators...
- Several offshore platform equipments
- Chemical industry (acetic acid, vinyl chlorides)




Size Ranges

BILLET AND BAR PRODUCTS

Billet and Bar
Diameters 0.5 in. to 15 in. (12.7 mm to 381 mm) and weights up to ca. 22,000 lb. (10,000 kg)

Round Cornered Squares
4 in. to 14 in. (102 mm to 356 mm) across flats and weights up to approx. 20,000 lb. (9,000 kg)

Hot Rolled Rod
Diameters 0.5 in. to 2.36 in. (13 mm to 60 mm) and lengths up to ca. 20 ft. (6 m). Longer lengths on application

Hot Rolled Wire Rod
Diameters 0.217 in. to 0.59 in. (5.51 mm to 15 mm) in coil form

Cold Drawn Rounds
Diameters 0.5 in. to 4 in. (13 mm to 102 mm) and lengths up to approx. 32 ft. (10 m)

Cold Drawn Hexagons
0.5 in. to 4 in. (13 mm to 101.6 mm) across flats and lengths up to ca. 20 ft. (6 m)

Cold Drawn Wire
Diameters from 0.004 in. to 0.2 in. (0.2 mm to 5 mm) available in coil, on reels and in "pay-off packs"

Ingot
Diameter up to 44 in.

TUBULAR PRODUCTS

Cold Worked Seamless Pipe and Tube
0.75 in. to 26 in. (19.1 mm to 660 mm) O.D. range
Hot Worked (Extruded) Seamless Pipe and Tube
3.5 in. to 8.625 in. (88.9 mm to 219.1 mm) O.D. range

FLAT PRODUCTS

Hot Rolled Plate
Thickness from 0.187 in. to 4 in. (4.76 mm to 102 mm) and widths from 48 in. to 98 in.(1,220 mm to 2,500 mm)

Cold Rolled Sheet
Thickness from 0.008 in. to 0.25 in. (0.20 mm to 6.4 mm) and widths to 48 in. (1,219 mm)

Cold Rolled Strip
Thickness from 0.008 in. to 0.125 in. (0.20 mm to 3.2 mm) and widths down to 12.6 in. (320 mm)

Minimum Mill Quantities
Small batch quantities, 300 or 500 kg, can be offered for most bar & tube sizes, for flat products, the minimum order quantity is 2 metric tons.

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