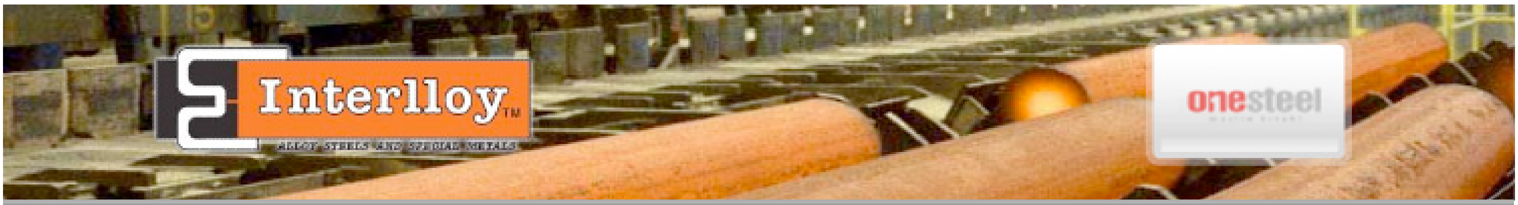


Download a pdf version of this data sheet for printing and future reference. (right click and select save to disk)

316 Austenitic Stainless Steel Bar

316 is a chromium-nickel-molybdenum austenitic stainless steel with good strength and excellent corrosion resistance, as supplied in the annealed condition with a typical brinell hardness of 175.

Characterised by high corrosion resistance in marine and industrial atmospheres, it exhibits excellent resistance to chloride attack and against complex suphur compounds employed in the pulp and paper processing industries. The addition of 2% to 3% of molybdenum increases its resistance to pitting corrosion and improves its creep resistance at elevated temperatures. Also it displays good oxidation resistance at elevated temperatures and has excellent weldability.

316 cannot be hardened by thermal treatment, but strength and hardness can be increased substantially by cold working, with susequent reduction in ductility.

It is now available with improved machinability (by calcium injection treatment), which has little effect on corrosion resistance and weldability while greatly increasing feeds and/or speeds, plus extending tool life.

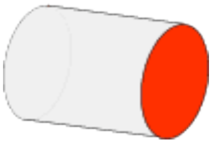
It is used extensively by the Marine, Chemical, Petrochemical, Pulp and Paper, Textile, Transport, Manufacturing and allied industries.

Typical uses are:
Architectural Components, Textile Equipment, Pulp and Paper Processing Equipment, Marine Equipment and Fittings, Photographic Equipment and X-Ray Equipment etc..

Material non magnetic in the annealed condition, but can become mildly magnetic following heavy cold working. Annealing is required to rectify if necessary.

N.B. Optimum corrosion resistance is achieved in the annealed condition.

Colour Code



Red
(Bar end)

Stocked Sizes	Rounds	3.18 mm to 325 mm diameter.
	Hexagons	7.94 mm to 63.5 mm A/F
	Squares	6.35 mm to 50 mm A/F
	Hollow Bar	32 mm - 250 mm OD
Bar Finish	Peeled, Cold Drawn Turned and Polished, and Centreless Ground.	

Related Specifications

Australia	AS 2837-1986-316
Germany	W.Nr 1.4401 X5CrNiMo17 12 2 W.Nr 1.4436 X5CrNiMo 17 13 3
Great Britain	Bs970 Part 3 1991 316S31/316S33 Bs970 1955 EN58J
Japan	JIS G4303 SuS 316
USA	ASTM A276-98b 316 SAE 30316 AISI 316 UNS S31600

Chemical Composition	Min. %	Max. %
Carbon	0	0.08
Silicon	0	1.00
Manganese	0	2.00
Nickel	10.00	14.00
Chromium	16.00	18.00
Molybdenum	2.00	3.00
Nitrogen	0	0.10
Phosphorous	0	0.045
Sulphur	0	0.03

Mechanical Property Requirements - Annealed to ASTM A276-98b 316

Finish	Dia. Or Thickness mm	Tensile Strength Mpa Min.	Yield Strength Mpa Min.	Elongation in 50mm % Min.
Hot Finished	All	515	205	40
Cold Finished	up to 12.7	620	310	30
	over 12.7	515	205	30

Typical Mechanical Properties At Room Temperature - Annealed

Finish	Tensile Strength Mpa	Yield Strength Mpa	Elongation in 50 mm %	Impact Charpy V J	Hardness	
					HB	Rc
Cold Drawn	680	500	42	190	195	13
Other	590	280	55	180	155	

Elevated Temperature Properties

316 displays good oxidation resistance in continuous service up to 930 ^{o}C, and in intermittent service up to 870 ^{o}C.

NB. Continuous service however between 430 ^{o}C and 870 ^{o}C is not recommended, nor is slow cooling through this range due to the problem of intergranular corrosion. 316L (low carbon type) can be employed to overcome this problem.

Mechanical properties are reduced as temperature increases.

Typical Mechanical Properties - Annealed at Elevated Temperatures

Temperature ^{o}C	Short - Time Tensile Test Tensile Strength Mpa	Creep Tests Stress for 1% Creep in 10,000 Hours Mpa
20	590	
550	500	170
600	480	120
650	460	90
700	450	55
750	355	35
850	260	20

Low Temperature Properties

316 has excellent low temperature properties, with increased tensile and yield strength without loss of toughness in the annealed condition.

Typical Mechanical Properties - Annealed at Zero and Sub-Zero Temperatures

Temperature ^{o}C	Tensile Strength Mpa	Yield Strength Mpa	Elongation in 50 mm %	Impact Charpy J
0	650	310	67	190
-70	750	350	65	190
-130	990	470	62	183
-180	1200	530	60	183
-240	1450	600	56	183

The combination of high strength and toughness at low temperatures allows this grade to be used in extremely cold climates or high altitudes, also for storage of liquified gasses etc. at very low temperatures.

N.B. 316 even when cold worked will still have good high strength and ductility at sub-zero temperatures.

Cold Bending

316 has good cold bending properties and cold bending can generallybe carried out without too much difficulty, after cold working it may be mildly magnetic. Annealing is recommended following cold working, causing more than 15% deformation.

Hot Bending

Hot bending should be performed at 950 ^{o}C - 1100 ^{o}C, followed by annealing to restore optimum corrosion resistance.

Corrosion Resistance

General Corrosion

316 has better resistance to general corrosion in most media than 310, 304, 321, 302 and 303 grades.

Pitting Corrosion/Crevice Corrosion

316 has higher resistance to both pitting and crevice corrosion than the non molybdenum bearing grades such as 304, 321, 310 and 303 etc..

Stress Corrosion Cracking

316 has a better resistance to stress corrosion cracking in chloride solutions than 302 or 304 grades, however it can also fail if subjected to high stresses in an environment conducive to stress corrosion.

Intergranular Corrosion

316 has better resistance to intergranular corrosion than the higher carbon grades 303, 310 or 302 but not as good as the low carbon grades 316L and 304L, or the titanium stabilised grade 321.

N.B. It is most important that oxygen is always allowed to circulate freely on all stainless steel surfaces to ensure that a chrome oxide film is always present to protect it. If this is not the case, rusting will occur as with other types of non stainless steel.

For optimum corrosive resistance surfaces must be free of scale and foreign particles.
Finished parts should be passivated.

Forging

Heat uniformly to 1150 ^{o}C - 1200 ^{o}C, hold until temperature is uniform throughout the section.

Do not forge below 900 ^{o}C

Finished forgings should be air cooled.

Finally forgings will require to be annealed in order to obtain optimum corrosion resistance.

Heat Treatment

Annealing

Heat to 1020 ^{o}C - 1100 ^{o}C, hold until temperature is uniform throughout the section. *Soak as required. Quench in water to obtain optimum corrosion resistance.

*Actual soaking time should be long enough to ensure that the part is heated thoroughly throughout its section to the required temperature, 30 minutes per 25 mm of section may be used as a guide.

Please consult your heat treater for best results.

Machining

316 improved machinability is slightly more difficult to machine than improved machinability 304 grade. More difficult to machine than 303 free machining grade and most of the 400 series stainless steels. It has a typical machinability rating around 50% - 55% of free machining (S1214) mild steel.

Due to the high work hardening rate of this grade, cutting or drilling tools etc. must be kept sharp at all times and not cause unnecessary work hardening of the surface etc..

All machining should be carried out as per machine maunfacturers recommendations for suitable tool type, feeds and speeds.

Welding

316 is readily weldable by shielded fusion and resistance welding processes, followed by air cooling giving good toughness.

Oxcyacetylene welding is not recommended due to possible carbon pick up in the weld area.

Small sections may be welded without loss of corrosion resistance due to intergranular carbide precipitation, but larger sections, or for service in the more extreme conditions post weld annealing is recommended.

Welding Procedure

Welding should be carried out using 316, 316L or *similar electrodes or rods (depending upon application). No pre heat or post heat is generally required.

*Please consult your welding consumables supplier.