Stainless Steel - Grade 304

Chemical Formula

Fe, <0.08% C, 17.5-20% Cr, 8-11% Ni, <2% Mn, <1% Si, <0.045% P, <0.03% S

Topics Covered

Background

Grade 304 is the standard "18/8" stainless; it is the most versatile and most widely used stainless steel, available in a wider range of products, forms and finishes than any other. It has excellent forming and welding characteristics. The balanced austenitic structure of Grade 304 enables it to be severely deep drawn without intermediate annealing, which has made this grade dominant in the manufacture of drawn stainless parts such as sinks, hollow-ware and saucepans. For these applications it is common to use special "304DDQ" (Deep Drawing Quality) variants. Grade 304 is readily brake or roll formed into a variety of components for applications in the industrial, architectural, and transportation fields. Grade 304 also has outstanding welding characteristics. Post-weld annealing is not required when welding thin sections.

Grade 304L, the low carbon version of 304, does not require post-weld annealing and so is extensively used in heavy gauge components (over about 6mm). Grade 304H with its higher carbon content finds application at elevated temperatures. The austenitic structure also gives these grades excellent toughness, even down to cryogenic temperatures.

Key Properties

These properties are specified for flat rolled product (plate, sheet and coil) in ASTM A240/A240M. Similar but not necessarily identical properties are specified for other products such as pipe and bar in their respective specifications.

Composition

Typical compositional ranges for grade 304 stainless steels are given in table 1.

Table 1. Composition ranges for 304 grade stainless steel

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
304	min.	-	-	-	-	-	18.0	-	8.0	-
	max.	0.08	2.0	0.75	0.045	0.030	20.0		10.5	0.10
304L	min.	-	-	-	-	-	18.0	-	8.0	-
	max.	0.030	2.0	0.75	0.045	0.030	20.0		12.0	0.10
304H	min.	0.04	-	-	-0.045	-	18.0	-	8.0	-
	max.	0.10	2.0	0.75		0.030	20.0		10.5	

Mechanical Properties

Typical mechanical properties for grade 304 stainless steels are given in table 2.

Table 2. Mechanical properties of 304 grade stainless steel

Grade	Tensile Strength (MPa) min	Yield Strength 0.2% Proof (MPa) min	Elongation (% in 50mm) min	Hardness	
				Rockwell B (HR B) max	Brinell (HB) max
304	515	205	40	92	201
304L	485	170	40	92	201
304H	515	205	40	92	201
304H also has a requirement for a grain size of ASTM No 7 or coarser.					

Physical Properties

Typical physical properties for annealed grade 304 stainless steels are given in table 3.

Table 3. Physical properties of 304 grade stainless steel in the annealed condition

Grade	Density (kg/m^3)	Elastic Modulus (GPa)	Mean Coefficient of Thermal Expansion (µm/m/°C)			Thermal Conductivity (W/m.K)		Specific Heat 0-100°C (J/kg.K)	Electrical Resistivity (nΩ.m)
			0-100°C	0-315°C	0-538°C	at 100°C	at 500°C		
304/L/H	8000	193	17.2	17.8	18.4	16.2	21.5	500	720

Grade Specification Comparison

Approximate grade comparisons for 304 stainless steels are given in table 4.

Table 4. Grade specifications for 304 grade stainless steel

Grade	UNS No	Old British		Euronorm		Swedish	Japanese JIS
		BS	En	No	Name	SS	
304	S30400	304S31	58E	1.4301	X5CrNi18-10	2332	SUS 304
304L	S30403	304S11	-	1.4306	X2CrNi19-11	2352	SUS 304L
304H	S30409	304S51	-	1.4948	X6CrNi18-11	-	-
These comparisons are approximate only. The list is intended as a comparison of functionally similar materials **not** as a schedule of contractual equivalents. If exact equivalents are needed original specifications must be consulted.							

Possible Alternative Grades

Possible alternative grades to grade 304 stainless steels are given in table 5.

Table 5. Possible alternative grades to 304 grade stainless steel

Grade	Why it might be chosen instead of 304
301L	A higher work hardening rate grade is required for certain roll formed or stretch formed components.
302HQ	Lower work hardening rate is needed for cold forging of screws, bolts and rivets.
303	Higher machinability needed, and the lower corrosion resistance, formability and weldability are acceptable.
316	Higher resistance to pitting and crevice corrosion is required, in chloride environments
321	Better resistance to temperatures of around 600-900°C is needed…321 has higher hot strength.
3CR12	A lower cost is required, and the reduced corrosion resistance and resulting discolouration are acceptable.
430	A lower cost is required, and the reduced corrosion resistance and fabrication characteristics are acceptable.

Corrosion Resistance

Excellent in a wide range of atmospheric environments and many corrosive media. Subject to pitting and crevice corrosion in warm chloride environments, and to stress corrosion cracking above about 60°C. Considered resistant to potable water with up to about 200mg/L chlorides at ambient temperatures, reducing to about 150mg/L at 60°C.

Heat Resistance

Good oxidation resistance in intermittent service to 870°C and in continuous service to 925°C. Continuous use of 304 in the 425-860°C range is not recommended if subsequent aqueous corrosion resistance is important. Grade 304L is more resistant to carbide precipitation and can be heated into the above temperature range.

Grade 304H has higher strength at elevated temperatures so is often used for structural and pressure-containing applications at temperatures above about 500°C and up to about 800°C. 304H will become sensitised in the temperature range of 425-860°C; this is not a problem for high temperature applications, but will result in reduced aqueous corrosion resistance.

Heat Treatment

Solution Treatment (Annealing) - Heat to 1010-1120°C and cool rapidly. These grades cannot be hardened by thermal treatment.

Welding

Excellent weldability by all standard fusion methods, both with and without filler metals. AS 1554.6 pre-qualifies welding of 304 with Grade 308 and 304L with 308L rods or electrodes (and with their high silicon equivalents). Heavy welded sections in Grade 304 may require post-weld annealing for maximum corrosion resistance. This is not required for Grade 304L. Grade 321 may also be used as an alternative to 304 if heavy section welding is required and post-weld heat treatment is not possible.

Machining

A "Ugima" improved machinability version of grade 304 is available in bar products. "Ugima" machines significantly better than standard 304 or 304L, giving higher machining rates and lower tool wear in many operations.

Dual Certification

It is common for 304 and 304L to be stocked in "Dual Certified" form, particularly in plate and pipe. These items have chemical and mechanical properties complying with both 304 and 304L specifications. Such dual certified product does not meet 304H specifications and may be unacceptable for high temperature applications.

Applications

Typical applications include:

- Food processing equipment, particularly in beer brewing, milk processing & wine making.
- Kitchen benches, sinks, troughs, equipment and appliances
- Architectural panelling, railings & trim
- Chemical containers, including for transport
- Heat Exchangers
- Woven or welded screens for mining, quarrying & water filtration
- Threaded fasteners
- Springs

Source: Atlas Steels Australia