North American Stainless

Long Products Stainless Steel Grade Sheet

AISI 304
UNS S30400
EN 1.4301

AISI 304L
UNS S30430
EN 1.4307

INTRODUCTION:

Types 304 and 304L are the most versatile and widely used of all the stainless steels. Their chemical composition, mechanical properties, weldability and corrosion/oxidation resistance provides the best all-round performance at relatively lower cost.

These have excellent low-temperature properties and respond well to hardening by cold working. The carefully controlled chemical compositions of various sub-grades provide a large range of cold work hardenability, enabling them to suit for various applications by direct drawing without intermediate annealing. Contact us to suggest a suitable NAS grade to satisfy your specification.

The 304 types SS have good welding characteristics. Post-weld annealing is not normally required to restore the excellent performance of these grades in a wide range of mildly corrosive conditions. Type 304L SS does not require post-weld annealing and finds extensive use in heavy-gauge components where freedom from carbide precipitation is often required.

PROUDCTS AVAILABLE

Wire Rod, Round Bars and equal leg length Angles. *See product sheet for dimensions, tolerances, finishes available and other details.*

Standard Chemical Composition:

Elements			C	MN	P	S	SI	CR	NI
UNS S30400	AISI 304	Min						18.00	8.00
		Max	.08	2.0	0.045	.030	1.00	20.00	10.50
UNS S30403	AISI 304L	Min						18.00	8.00
		Max	.03	2.0	0.045	.030	1.00	20.00	12.00

Nominal Mechanical Properties (annealed condition)

Tensile Strength ksi[MPa]	**Yield Strength** ksi[MPa]	**% Elong** 4d	**% Reduction in Area**	**Hardness** HB
85[585]	35[240]	40	50	150

Nominal Physical Properties: The values are at room temperature, unless otherwise specified.

Density	7.9 kg/m^3	Mean Co-efficient of Thermal Expansion 0-100°C	17.2 um/mK
Modulus of Elasticity	193		
Specific Heat Capacity	500J/kgK	Melting Range	1400-1450°C
Thermal Conductivity @100°C	16.2W/mK	Relative Permeability*	1.02

*Note: *This grade is non-magnetic in annealed condition but becomes slightly magnetic after cold working.*

PROPERTIES AT ELEVATED TEMPERATURE

The properties quoted below are typical of annealed 304 only, as strength values for 304L fall rapidly at temperatures above 425°C. These values are given as a guideline only, and should not be used for design purposes.

SHORT TIME ELEVATED TEMPERATURE TENSILE PROPERTIES

		Temperature (°C)								
Property	Type	100	300	500	600	700	800	900	1 000	1 100
Tensile Strength (MPa)	304	510	435	410	360	245	135	75	40	20
	321	525	405	380	335	265	175	100	60	25
0.2% Proof Stress (MPa)	304	220	145	125	110	95	70			
	321	210	165	140	130	115	95			
Elongation (% in 50mm)	304	52	40	36	35	35	37	42	73	96
	321	50	43	37	37	48	68	62	62	87

MAXIMUM RECOMMENDED SERVICE TEMPERATURE

(In oxidising conditions)

Operating Conditions	Temperature (°C)	
Type	304	321
Continuous	830	830
Intermittent	800	800

PROPERTIES AT SUB-ZERO TEMPERATURES

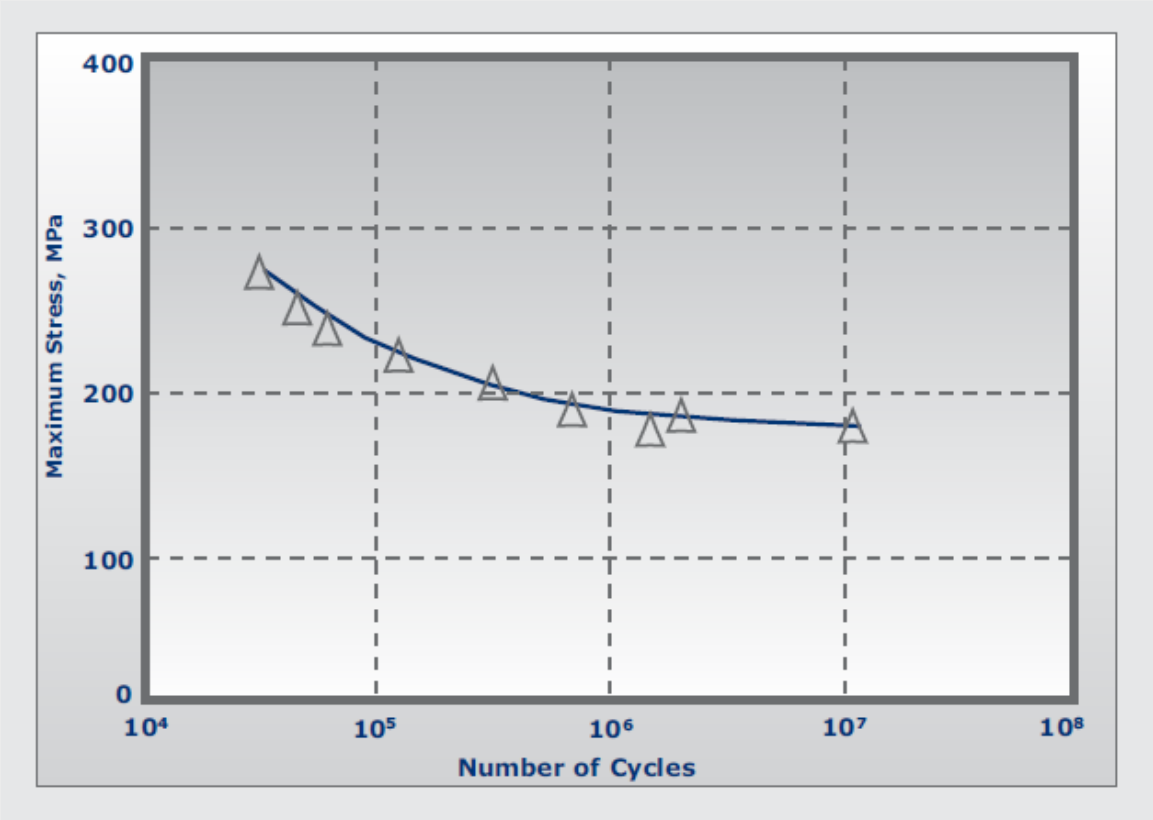
The properties quoted below are typical of annealed CS304 only

Temperature (°C)	20	0	-10	-50	-100	-140	-196
Tensile Strength (MPa)	616	885	976	1101	1281	1368	1609
0.2% Proof Stress (MPa)	255	242	240	236	222	246	231
Elongation (%)	70	64	55	50	42	41	38
Impact Energy (J)	217	204	194	194	168	160	168

FATIGUE PROPERTIES

When looking into the fatigue properties of austenitic stainless steels, it is important to note that design and fabrication—not material are the major contributors to fatigue failure. Design codes (e.g., ASME) use data from low-cycle fatigue tests carried out on machined specimens to produce conservative S-N curves used with stress concentration factors (k1c) or fatigue strength reduction factors (kt). In essence, the fatigue strength of a welded joint should be used for design purposes, as the inevitable flaws (even only those of cross-sectional change) within a weld will control the overall fatigue performance of the structure.

The curve below shows a typical S-N curve for 304 stainless steel.



ANNEALING

Annealing of types SS304 and SS304L is achieved by heating to above 1900°F for 60 minutes per inch thickness followed by water quenching. The best corrosion resistance is achieved when the final annealing temperature is above 1900°F. Controlled atmospheres are recommended in order to avoid excessive oxidation of the surface.

STRESS RELIEVING

The lower-carbon grade (304L) can be stress relieved at 850°F to 1100°F for 60 minutes with little danger of sensitization. A lower stress-relieving temperature of 750°F maximum must be used with 304 SS with longer soaking times. If stress relieving is carried out above 1100°F, there is a serious threat of grain boundary sensitization occurring with a concomitant loss in corrosion resistance.

HEAT TREATMENT

Annealing: Parts can be annealed at 1900°F–2050°F held for minimum 60 minutes per inch of thickness and water quenched. Prolonged exposure between 800°F–1500°F must be avoided to prevent embrittlement and loss of corrosion properties.
This grade does not harden with heat treatment.

COLD WORKABILITY

304/304L can be readily cold worked. Strain-hardening rate will vary depending on chemistry. Operations such as drawing, forging, upsetting and bending are common. Severe forming may require intermediate annealing.

MACHINABILITY

Like most other austenitic steels, these grades machine with rough and stringy chips; therefore, chip curlers can be beneficial. NAS provides a special chemistry balance for bars with improved machinability. Contact NAS for details.

WELDING

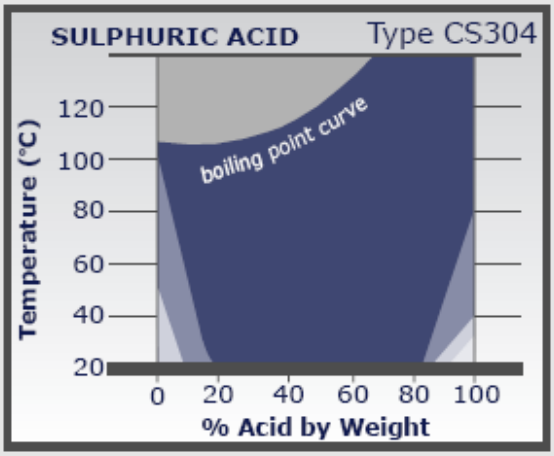
304/304L SS types have good welding characteristics and are suited to all standard welding methods. Either matching or slightly over-alloyed filler wires should be used. For maximum corrosion resistance, the higher carbon type SS304 should be annealed after welding to dissolve any chromium carbides which may have precipitated. The weld discoloration should be removed by pickling and passivation to restore maximum corrosion resistance.

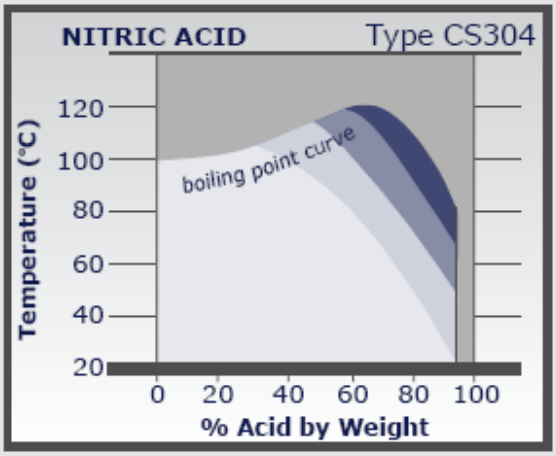
CORROSION RESISTANCE

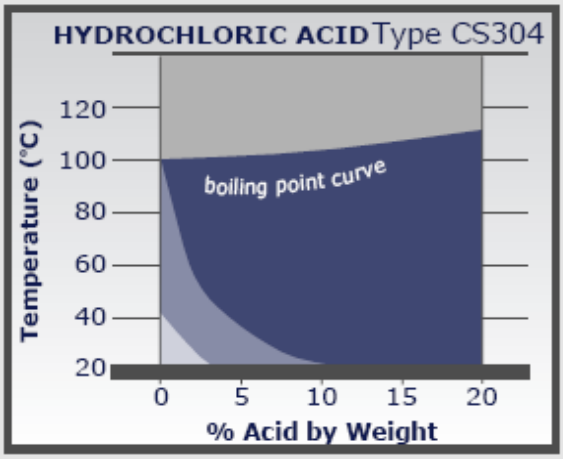
304/304L SS have excellent corrosion resistance in a wide variety of corrosive media, including foodstuffs, sterilizing solutions, most organic chemicals and dyes and a wide variety of inorganic chemicals. Iso-corrosion diagrams for 304 in sulfuric, nitric, hydrochloric, phosphoric and acetic acids are shown below.

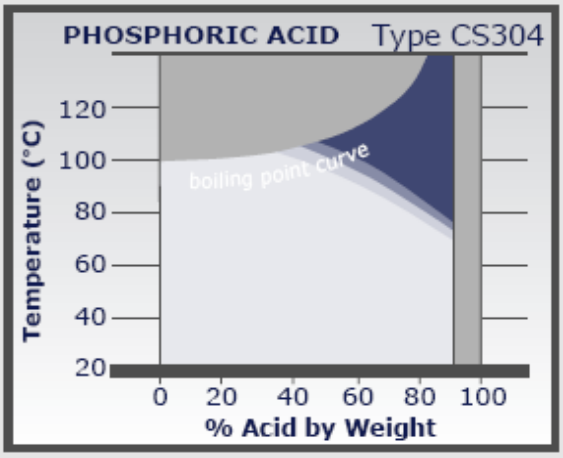
In service, acid corrosion may be either inhibited or accelerated by the presence of other chemicals or contaminants. The reaction of a material to all the possible service variables

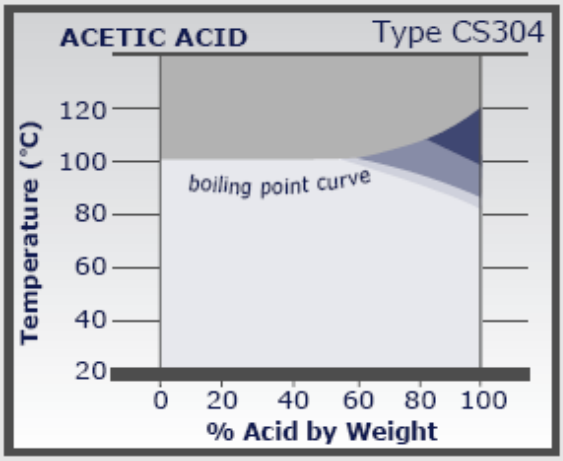
can not be fully assessed in the laboratory. Consequently, tests have been carried out in pure acid solutions and are intended only to provide a guide to general uniform corrosion in this media. In situ testing will provide more reliable data for material selection.

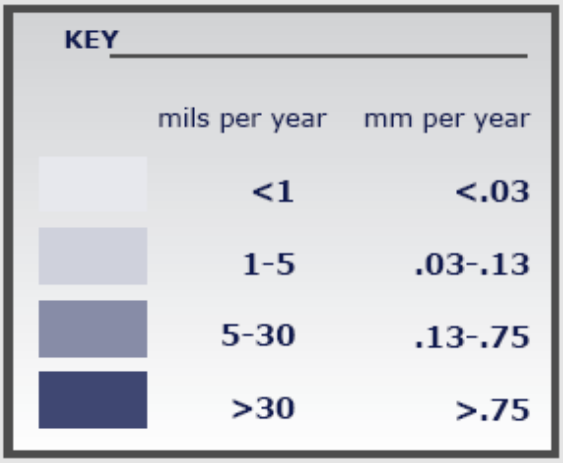








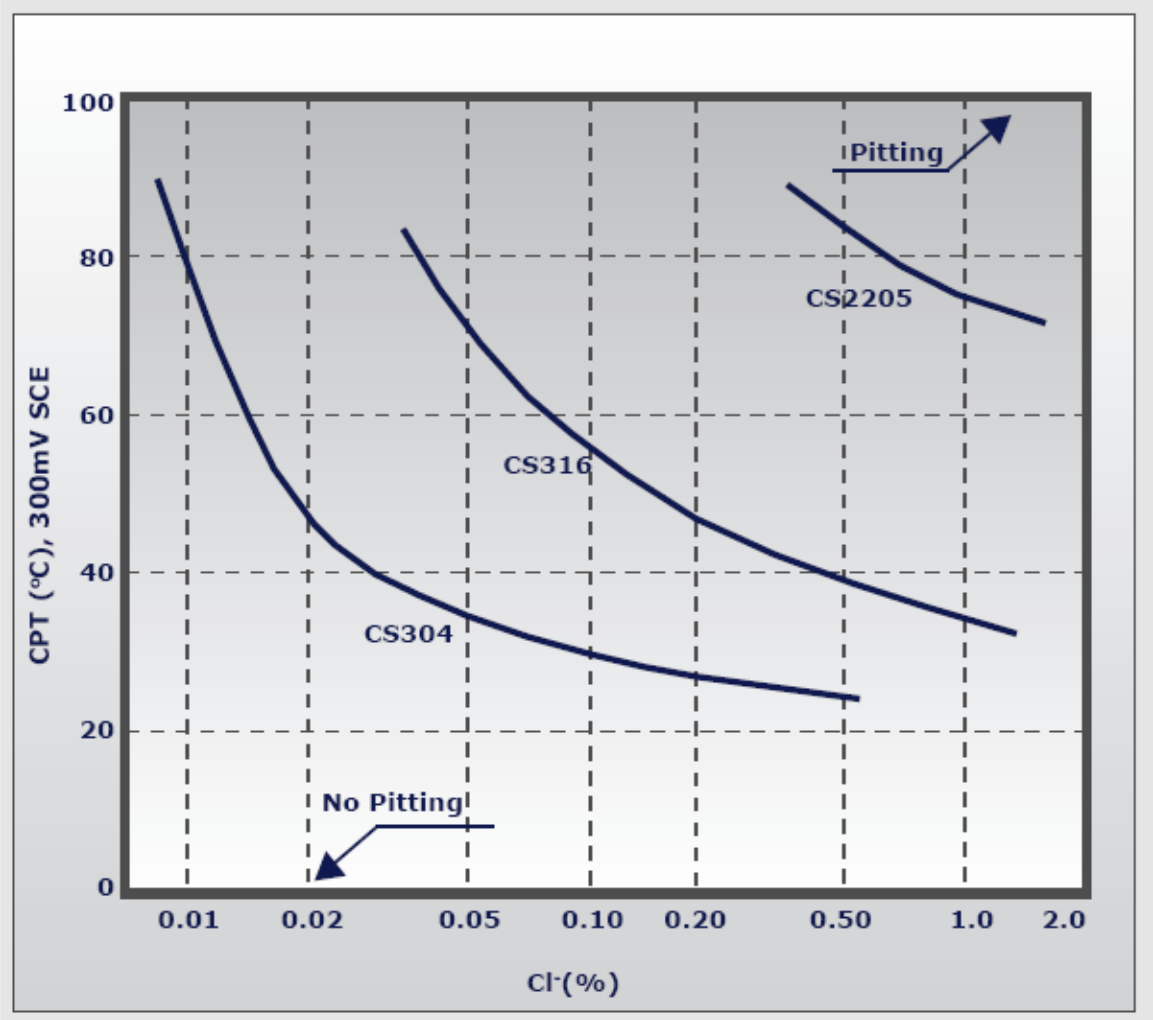




PITTING RESISTANCE

Pitting resistance is important, mainly in applications involving contact with chloride solutions, particularly in the presence of oxidizing media. These conditions may be conducive to localized penetration of the passive surface film on the steel and a single deep pit may well be more damaging than a much greater number of relatively shallow pits. Where pitting corrosion is anticipated, steels containing molybdenum (such as 316L) should be considered.

The diagram below shows the critical temperature for initiation of pitting (CPT) at different chloride contents for SS304, SS316 and SS2205 types.



Pitting resistance equivalent numbers (PREN) are a theoretical way of comparing the pitting corrosion resistance of various types of stainless steels, based on their chemical compositions. The PREN (or PRE) numbers are useful for ranking and comparing the different grades, but cannot be used to predict whether a particular grade will be suitable for a given application, where pitting corrosion may be a hazard.

INTERGRANULAR CORROSION

Sensitization may occur when the heat-affected zones of welds in some austenitic stainless steels are cooled through the sensitizing temperature range of between 850°F and 1550°F. At these temperatures, a compositional change may occur at and near the grain boundaries. If a sensitized material is then subjected to a corrosive environment, intergranular attack may be experienced. This corrosion takes place preferentially in the heat-affected zone away from and parallel to the weld. Susceptibility to this form of attack, often termed “weld decay”, may be assessed by testing per ASTM A262, Practice A & E.

In the more severe nitric acid test, some weldments in 304 may exhibit slight intergranular corrosion. For service in the as-welded condition in severe chemical environments, 304L would be recommended over 304.

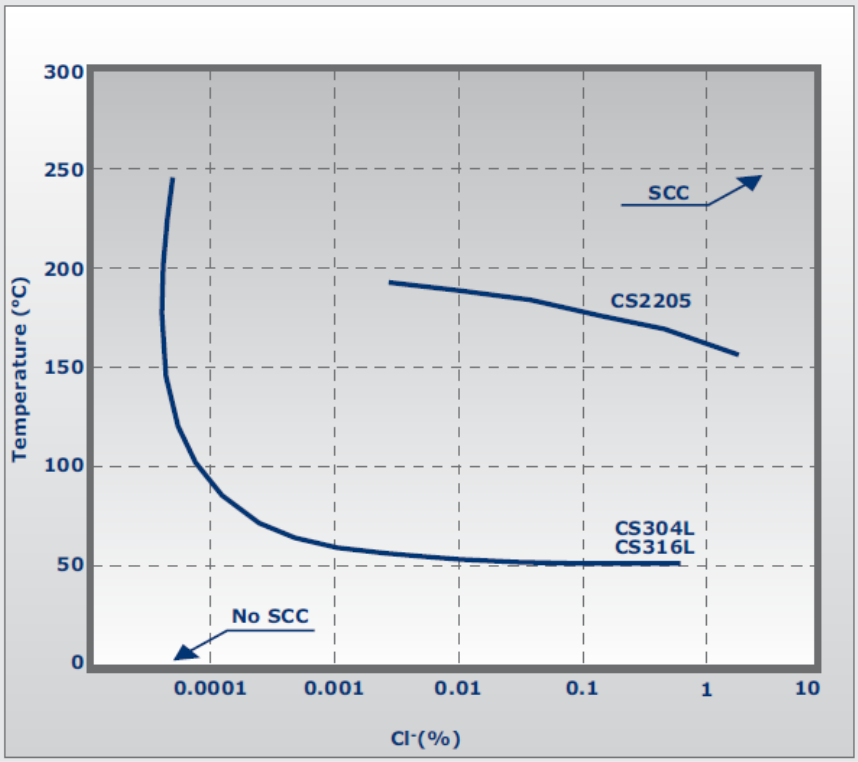
ATMOSPHERIC CORROSION

The atmospheric corrosion resistance of austenitic stainless steel is unequalled by virtually all other uncoated engineering materials. Stainless steel develops maximum resistance to staining and pitting with the addition of molybdenum. For this reason, it is common practice to use the molybdenum-bearing 316 SS grade in areas where the atmosphere is highly polluted with chlorides, sulfur compounds and solids, either singly or in combination. However, in urban and rural areas, 304 SS generally performs satisfactorily.

STRESS CORROSION CRACKING

Stress corrosion cracking (SCC) can occur in austenitic stainless steels when they are stressed in tension in chloride environments at temperatures in excess of about 140°F. The stress may be applied, as in a pressure system, or it may be residual arising from cold-working operations or welding. Additionally, the chloride ion concentration need not be very high initially, if locations exist in which concentrations of salt can accumulate. Assessment of these parameters and accurate prediction of the probability of SCC occurring in service is therefore difficult.

Where there is a likelihood of SCC occurring, a beneficial increase in life can be easily obtained by a reduction in operating stress and temperature. Alternatively, specially designed alloys, such as duplex stainless steels, should be used.



Resistance to stress corrosion Cracking (laboratory results) for SS304L, SS316L and SS2205.

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