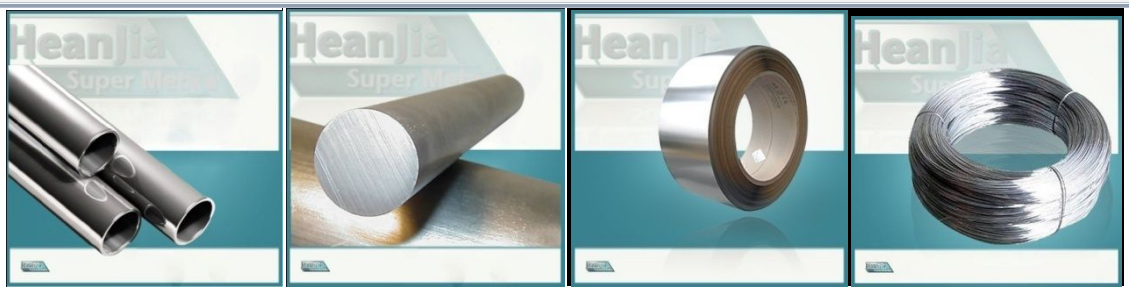
Stainless Steel 310/310S (UNS S31000/ UNS S31008)



Austenitic Stainless Steel 310/310S offers excellent resistance to oxidation up to 2000oF. It is a low grade steel that prevents embrittlement and sensitization. It offers medium strength and hardness at the very low temperature even below -450oF. Outstanding heat resistant alloy. It offers superior corrosion resistance properties however poor than Inconel 600 and Incoloy 800. Steel 310 is commonly employed in power reactors, thermal treatment and food processing applications.

It is utilized at temperature 1150oC in the continuous operations and 1035oC in the intermittent operations. 310S grade is a steel comprising of low concentration of carbon.

Chemical Composition 310/310S

Element	SS 310	SS 310S
Chromium (Cr)	24 to 26 %	24 to 26 %
Nickel (Ni)	19.2 to 22 %	19.2 to 22 %
Carbon (C)	0.25 %	0.08 %
Silicon (Si)	1.50 %	1.50 %
Manganese (Mn)	2 %	2 %
Phosphorous (P)	0.045 %	0.045 %
Sulfur (S)	.03 %	.03 %
Molybdenum (Mo)	0.75 %	0.75 %
Copper (Cu)	0.50 %	0.50 %
Iron (Fe)	Rem %	Rem %

Stainless Steel 310/310S Service Temperature

Condition	Regular Service	Max temperature
Oxidizing (sulfur 2gm/cm3)	1922oF or 1050oC	2012oF or 1100oC
Oxidizing (sulfur > 2gm/cm3)	1742oF or 950oC	
Slight oxygen (Sulfur 2 gm/cm3	1832oF or 1000oC	
Nitridation or carburization	1562 oF to 1742oF or 850oC to 950oC	

Physical Properties

Density	0.285 lbs/inch3	7.89 gm/cm3
Specific heat	0.12 BTU/lb-°F at 32 to 212oF	502 J/kg-oK at 0 to 100oC
Modulus of elasticity	28.5 x 10(6) psi	196 GPa
Thermal conductivity	8 BTU/hr/ft^2/ft/°F at 212oF	10.8 W/m-°K at 100oC
Melting Point	2470 to 2555oF	1354 to 1402oC
Electric resistivity	30.7 Microhm-in at 68oC	78 Microhm-cm at 20°C

Thermal Conductivity

212oF	100 oC	8.2 BTU/hr/sq ft/ft/oF	0.099 W/m.K
932 of	500 oC	10.8 BTU/hr/sq ft/ft/oF	0.130 W/m.K

Mean Coefficient of Thermal Expansion, per oF, oC, (x 10(6))

32 of to 212 oF	0 oC to 100 oC	8.8	15.9
32 of to 600 of	0 oC to 315 oC	9	16.2
32 of to 1000 of	0 oC to 538 oC	9.4	17
32 of to 1200 of	0 oC to 649 oC	9.7	17.5
32 of to 1800 of	0 oC to 981 oC	10.6	19.1

Modulus of Elasticity

oF	oC	Modulus	Psi x 10(6)	GPa
80 oF	27 oC	Tension	29 Psi x 10(6)	200 GPa
200 oF	93 oC	Tension, shear	28.2 Psi x 10(6), 10.9 Psi x 10(6)	194 GPa, 75 GPa
300 oF	149 oC	Tension, shear	27.5 Psi x 10(6), 10.6 Psi x 10(6)	190 GPa, 73 GPa
400 oF	204 oC	Tension, shear	26.8 Psi x 10(6), 10.3 Psi x 10(6)	185 GPa, 71 GPa
500 oF	260 oC	Tension, shear	26.2 Psi x 10(6), 10 Psi x 10(6)	181 GPa, 69 GPa
600 oF	316 oC	Tension, shear	25.5 Psi x 10(6), 9.7 Psi x 10(6)	176 GPa, 67 GPa
700 oF	371 oC	Tension, shear	24.9 Psi x 10(6), 9.4 Psi x 10(6)	172 GPa, 65 GPa
800 oF	427 oC	Tension, shear	24.2 Psi x 10(6), 9.1 Psi x 10(6)	167 GPa, 63 GPa
900 oF	482 oC	Tension, shear	23.6 Psi x 10(6), 8.8 Psi x 10(6)	163 GPa, 61 GPa
1000 oF	538 oC	Tension , shear	23 Psi x 10(6), 8.5 Psi x 10(6)	159 GPa, 59 GPa
1100 oF	593 oC	Tension, shear	22.4 Psi x 10(6), 8.2 Psi x 10(6)	154 GPa, 57 GPa
1200 oF	649 oC	Tension, shear	21.8 Psi x 10(6), 7.9 Psi x 10(6)	150 GPa, 54 GPa
1300 oF	704 oC	Tension, shear	21.2 Psi x 10(6), 7.6 Psi x 10(6)	146 GPa, 52 GPa
1400 oF	760 oC	Tension, shear	20.5 Psi x 10(6), 7.2 Psi x 10(6)	141 GPa, 50 GPa
1500 oF	816 oC	Tension, shear	19 Psi x 10(6), 6.9 Psi x 10(6)	131 GPa, 48 GPa
1600 oF	871 oC	Tension, shear	19.2 Psi x 10(6), 6.6 Psi x 10(6)	132 GPa, 46 GPa

Mechanical Properties

Annealed sheet

temperature		Yield strength		Tensile strength		Elongation,	Reduction of area, %	Hardness Rockwell B
oF	oC	Ksi	Mpa	Ksi	Mpa	%		
80 oF	27 oC	45 Ksi	310 Mpa	95 Ksi	655 Mpa	45 %	-	85
300 oF	149 oC	34.9 Ksi	241 Mpa	82.1 Ksi	566 Mpa	38 %	69 %	-
500 oF	260 oC	32.5 Ksi	224 Mpa	77.6 Ksi	535 Mpa	35 %	63 %	-
700 oF	371 oC	29.6 Ksi	204 Mpa	75.5 Ksi	521 Mpa	35 %	57 %	-
900 oF	482 oC	26.3 Ksi	181 Mpa	69.5 Ksi	479 Mpa	35 %	53 %	-

1100 oF	593 oC	22.7 Ksi	157 Mpa	61.5 Ksi	424 Mpa	38 %	47 %	-
1300 oF	704 oC	19 Ksi	131 Mpa	45.5 Ksi	314 Mpa	31 %	42 %	-
1500 oF	816 oC	15 Ksi	103 Mpa	29.5 Ksi	203 Mpa	30 %	38 %	-
1700 oF	927 oC			17 Ksi	117 Mpa	49 %	48 %	-
1900 oF	1038 oC			11 Ksi	76 Mpa	56 %	46 %	-
2000 oF	1093 oC			7 Ksi	48 Mpa	57 %	48 %	-

High temperature tensile properties

Temp	Tensile strength, MPa	0.2 % Proof stress	Elongation
100 oC	600 MPa	265 MPa	41 %
300 oC	530 MPa	225 MPa	35 %
500 oC	475 MPa	175 MPa	35 %
600 oC	420 MPa	155 MPa	38 %
700 oC	315 MPa	130 MPa	31 %
800 oC	215 MPa	110 MPa	30 %
900 oC	135 MPa		45 %
1000 oC	85 MPa		54 %
1100 oC	45 MPa		57 %

Creep and rupture properties

Temp, oC	Stress to create 1% strain		Stress to create rupture	
	10,00 hours	100,00 hours	1000 hours	10,000 hours
450 oC	180 MPa	115 MPa	-	-
500 oC	145 MPa	95 MPa	-	-
550 oC	115 MPa	75 MPa	240 MPa	205 MPa
600 oC	85 MPa	60 MPa	150 MPa	130 MPa
650 oC	55 MPa	40 MPa	90 MPa	75 MPa
700 oC	35 MPa	25 MPa	60 MPa	50 MPa
750 oC	20 MPa	15 MPa	45 MPa	35 MPa
800 oC	10 MPa	10 MPa	35 MPa	25 MPa
850 oC	5 MPa	5 MPa	25 MPa	20 MPa

Grade 310/310S Tensile Properties

Temp, oF	Tensile strength	Yield strength	Elongation
70 of	80 ksi	35 ksi	52 %
1000 of	67.8 ksi	20.8 ksi	47 %
1200 of	54.1 ksi	20.7 ksi	43 %
1400 of	35.1 ksi	19.3 ksi	46 %
1600 of	19.1 ksi	12.2 ksi	48 %

Creeping Properties

Temperature, of	Lowest creep 0.0001 %, ksi	10 (5) hours, rupture strength, ksi
12000 of	14.9 ksi	14.4 ksi
1400 of	3.3 ksi	4.5 ksi
1600 of	1.1 ksi	1.5 ksi
1800 of	0.28 ksi	0.66 ksi

Standard Creep strain properties

Temperature		Creep Strain (MPa)			Creep Rupture (MPa)		
oC	oF	1000 hours	10000 hours	100000 hours	1000 hours	10000 hours	100000 hours
600 oC	1112 of	120 MPa	100 MPa	40 MPa	200 MPa	140 MPa	80 MPa
700 oC	1292 of	50 MPa	35 MPa	20 MPa	80 MPa	45 MPa	20 MPa
800 oC	1472 of	20 MPa	10 MPa	8 MPa	35 MPa	20 MPa	8 MPa
900 oC	1652 of	10 MPa	6 MPa	3 MPa	15 MPa	10 MPa	5 MPa
1000 oC	1832 of	5 MPa	3 MPa	1.5 MPa	9 MPa	4 MPa	2 MPa

Effect of prolong exposure at high temperatures

10,000 hours		Yield strength		Tensile strength		Elongation in 2 inch	Reduction of area
oF	oC	Ksi	Mpa	Ksi	Mpa	%	%
900 oF	482 oC	37.2	256	90.2	622	54	69
1050 oF	566 oC	42.3	292	93.5	645	46	54
1200 oF	649 oC	58.1	401	117.9	813	4	4

Corrosion Resistance

Stainless steel 310S alloy is made of 25% chromium and 20% nickel that make it widely resistant to oxidation and corrosion. The nominal carbon magnitude makes it less inclined to embrittlement and sensitization while in use. The high magnitude of chromium and nickel makes steel suitable for the operation in the reducing sulfur. Stainless steel 310S grade is extensively used in carburizing conditions as found in petrochemical conditions. In the rigorous carburizing environments other heat resistant alloys are chosen. Steel grade 310S is preferred for using in rapid liquid cooling as it may get the heat stroke. It is commonly used in the cryogenic applications for its stiffness and lower magnetic permeability.

Just like other stainless steel alloys, **310S steel** cannot be toughened by heat processing. It can be toughened by cold processing, though this method is rarely used.

Heat Resistance

Steel 310/310S offers excellent oxidation resistance property while intermittent service at temperatures 1035oC and at 1050oC while in regular use in the presence of air. It is superiorly resistant to carburization, oxidation and sulphidation.

Fabrication

For fabrication stainless steel 310S is forged at temperature up to 975oC to 1175oC. The heavy processing is performed at 1050oC and light finishing is done to the end of range. Subsequent to forging, annealing is preferred to remove the stress from the forming process. The alloy can be readily cold processed by the standard methods and systems.

Heat Processing

Austenitic stainless steel 310/310S is solution annealed through heating up from 1040oC to 1065oC, kept at this temperature for completely bathe then water cooling is done.

Machining

The machinability of stainless steel 310S alloy is identical to the machining of 304L steel. The process of toughening may cause an issue and it is easy to remove the work hardened surface through nominal speeds and massive cuts with the sharp systems and better lubrication. The strong machines and robust tools are utilized.

Welding of Stainless Steel 310S

Stainless steel grade 310/310S are welded through similar electrodes and filler metals. These are readily weldable through SMAW, GMAW, GTAW and SAW. The preferred electrodes are AWS A5.4 E310-XX and A 5.22 E310T-X and filler metal is AWS A5.9 ER310. Argon is used as a shielding gas. Preheating and post heating are not essential, however for performance in the corrosive liquids, complete post solution annealing processing is required. Pickling and passivation of metal are required to eradicate the elevated temperature metal oxides and make the steel fully corrosion resistant subsequent to welding. This processing is not essential for elevated temperature functions, but welding slag should be completely eradicated.

Available Forms

Wire, Mesh, Strip, Foil, Plate, Sheet, Rod, Bar, Tubing, Pipe, Flanges