Hastelloy X (UNS N06002)

Nickel Based Super alloy Hastelloy X offers elevated service temperature up to 220oF, high strength and great oxidation resistance. It resists chloride induced stress corrosion cracking, carburization and oxidation. Outstanding fabrication characteristics. Alloy X is used in industrial gas turbine engine components, petrochemical processing, spray bars, chemical processing plants, furnace baffles and tubes, furnace trays etc.

Hastelloy X is preferred for diverse furnace applications as it offers excellent resistance to oxidation, reduction and neutral conditions. It is utilized in the jet engines, afterburner parts, cabin heaters and other aircraft components. It is also utilized as a corrosion resistance alloy in the petrochemical operations. It attains highly ductile character even after it is subjected into the extended exposure at temperature ranges of 1200oF, 1400oF, 1600oF for over 10,000 hours.

Chemical Composition

Nickel (Ni)	Rem %
Molybdenum (Mo)	8 to 10 %
Chromium (Cr)	20.5 to 23 %
Iron (Fe)	17 to 20 %
Tungsten (W)	0.2 to 1 %
Cobalt (Co)	0.5 to 2.5 %
Manganese (Mo)	1 %
Carbon (C)	0.05 to 0.15 %
Phosphorous (P)	0.04 %
Sulfur (S)	0.03 %
Silicon (Si)	1 %
Aluminum (Al)	0.50 %
Titanium (Ti)	0.15 %

Boron (B)	0.01 %
Copper (Cu)	0.50 %

Mechanical Properties

Tensile Properties

Form	Aging temp, oF, oC		Aging period, hours	Ultimate tensile strength		Yield strength 0.2 % offset		Elongation % in 2 inch
	oF	oC		Ksi	Mpa	Ksi	Mpa	
Sheet	1200 oF	649 oC	1000	125 Ksi	862 Mpa	61 Ksi	421 Mpa	35 %
			4000	143 Ksi	991 Mpa	76.2 Ksi	525 Mpa	19 %
			8000	148 Ksi	1020 Mpa	78.6 Ksi	542 Mpa	19 %
			16000	149 Ksi	1020 Mpa	78.1 Ksi	538	15 %
Sheet	1400 oF	760 oC	1000	137 Ksi	945 Mpa	65.3 Ksi	450 Mpa	23 %
			4000	134.6 Ksi	928 Mpa	64.3 Ksi	443 Mpa	18 %
			8000	131 Ksi	903 Mpa	61.3 Ksi	423 Mpa	19 %
			16000	126.1 Ksi	869 Mpa	59.3 Ksi	409 Mpa	17 %
Sheet	1600 oF	871 oC	1000	123 Ksi	848 Mpa	53.2 Ksi	369 Mpa	26 %
			4000	117.9 Ksi	813 Mpa	49.3 Ksi	340 Mpa	29 %
			8000	115 Ksi	793 Mpa	48.2 Ksi	332 Mpa	30 %
			16000	111.1 Ksi	766 Mpa	46.1 Ksi	318 Mpa	29 %
Plate	1200 oF	649 oC	1000	121.4 Ksi	837 Mpa	56.5 Ksi	392 Mpa	33 %
			4000	142.5 Ksi	983 Mpa	73.4 Ksi	506 Mpa	18 %
			8000	143.6 Ksi	990 Mpa	73 Ksi	503 Mpa	18 %
Plate	1400 oF	760 oC	1000	129.4 Ksi	892 Mpa	56.9 Ksi	390 Mpa	23 %
			4000	129.9 Ksi	896 Mpa	56.9 Ksi	390 Mpa	21 %
			8000	129.2 Ksi	891 Mpa	56.3 Ksi	388 Mpa	20 %
Plate	1600 oF	871 oC	1000	119 Ksi	820 Mpa	47.6 Ksi	328 Mpa	31 %
			4000	116.7 Ksi	805 Mpa	44.9 Ksi	310 Mpa	28 %
			8000	113.7 Ksi	784 Mpa	43.9 Ksi	303 Mpa	26 %
			16000	109 Ksi	752 Mpa	42.7 Ksi	294 Mpa	26 %

Mechanical Properties

Rupture life strength									
Temperature,		Rupture life strength for following time							
oF	oC	10 hours		100 hours		1000 hours		10000 hours	
		Ksi	Mpa	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa
1200 of	649 oC	72 Ksi	496 Mpa	47.9 Ksi	330 Mpa	34 Ksi	234 Mpa	24 Ksi	165 Mpa
1350 of	732 oC	36 Ksi	248 Mpa	25 Ksi	172 Mpa	18 Ksi	124 Mpa	12.5 Ksi	86 Mpa
1500 of	816 oC	21 Ksi	145 Mpa	14 Ksi	96 Mpa	10 Ksi	69 Mpa	6.8 Ksi	47 Mpa
1650 of	899 oC	12 Ksi	83 Mpa	7.5 Ksi	52 Mpa	4.7 Ksi	32 Mpa	3 Ksi	21 Mpa
1800 of	982 oC	7 Ksi	48 Mpa	4.2 Ksi	29 Mpa	2.4 Ksi	17 Mpa	1.4 Ksi	10 Mpa
1950 of	1066 oC	3.7 Ksi	26 Mpa	1.9 Ksi	13 Mpa	1 Ksi	7 Mpa	-	-
2100 of	1149 oC	1.7 Ksi	12 Mpa	0.7 Ksi	5 Mpa	0.3 Ksi	2 Mpa	-	-
Creeping rate									
Temperature		Stress for given % per hour smallest creep rate							
		0.0001		**0.001**		**0.01**		**0.1**	
oF	oC	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa

1200 oF	649 oC	14.7 Ksi	101 Mpa	21 Ksi	145 Mpa	31 Ksi	21.4 Mpa	44 Ksi	303 Mpa
1400 oF	760 oC	7.2 Ksi	50 Mpa	10 Ksi	69 Mpa	14 Ksi	97 Mpa	19.5 Ksi	134 Mpa
1600 oF	871 oC	2.7 Ksi	19 Mpa	4.1 Ksi	28 Mpa	6.2 Ksi	43 Mpa	9.2 Ksi	63 Mpa
1800 oF	982 oC	0.7 Ksi	5 Mpa	1.3 Ksi	9 Mpa	2.2 Ksi	15 Mpa	3.7 Ksi	26 Mpa
2000 oF	1093 oC	-	-	-	-	-	-	0.9 Ksi	6 Mpa

Creeping properties

Temperature	Creep %	Stress, required to create mentioned Creep in:							
		10 hours		100 hours		1000 hours		10,000 hours	
		Ksi	Mpa	Ksi	Mpa	Ksi	Mpa	Ksi	Mpa
1200 oF or 649 oC	0.5 %	40 Ksi	276 Mpa	27 Ksi	186 Mpa	17.5 Ksi	121 Mpa	-	-
	1 %	44 Ksi	303 Mpa	30 Ksi	207 Mpa	21 Ksi	145 Mpa	-	-
	2 %	48 Ksi	321 Mpa	33 Ksi	221 Mpa	22.5 Ksi	155 Mpa	-	-
1400 oF or 760 oC	0.5 %	16.5 Ksi	114 Mpa	10.5 Ksi	72 Mpa	6.5 Ksi	45 Mpa	-	-
	1 %	19 Ksi	131 Mpa	13 Ksi	90 Mpa	9 Ksi	62 Mpa	6.2 Ksi	4.3 Mpa
	2 %	21 Ksi	145 Mpa	15 Ksi	103 Mpa	10.8 Ksi	74 Mpa	7.6 Ksi	52 Mpa
1600 oF or 871 oC	0.5 %	7.8 Ksi	54 Mpa	4.9 Ksi	34 Mpa	3.1 Ksi	21 Mpa	-	-
	1 %	9 Ksi	62 Mpa	6.1 Ksi	42 Mpa	3.6 Ksi	25 Mpa	2.1 Ksi	14
	2 %	10.5 Ksi	72 Mpa	7.2 Ksi	50 Mpa	4.3 Ksi	30 Mpa	2.3 Ksi	16
1800 oF or 982 oC	0.5 %	3.1 Ksi	21 Mpa	1.7 Ksi	12 Mpa	0.9 Ksi	6 Mpa	-	-
	1 %	3.6 Ksi	25 Mpa	1.9 Ksi	13 Mpa	1 Ksi	7 Mpa	-	-
	2 %	4.2 Ksi	29 Mpa	2.2 Ksi	15 Mpa	1.1 Ksi	8 Mpa	-	-

Aged Hardness

Form	Aged temp,		Aging time, hours	Hardness, rockwell
	oF	oC		
Sheet	1200 oF	649 oC	1000	54
			4000	56
			8000	62
	1400 oF	760 oC	1000	63
			4000	62
			8000	61
	1600 oF	871 oC	1000	61
			4000	58
			8000	55
Plate	1200 oF	649 oC	1000	57
			4000	62
			8000	63
	1400 oF	760 oC	1000	60
			4000	59
			8000	58
	1600 oF	871 oC	1000	56
			4000	56
			8000	54

Fabrication

An easily fabricable Hastelloy X offers superior forging and welding features. It can be easily forged and offers high ductility. It can be cold treated. Alloy X can be easily welded by following the manual and automatic techniques such as shielded metal arc and gas tungsten arc and gas metal arc. It can also be resistance welded.

Heat Processing

The wrought forms of Hastelloy X are provided in the solution heat processing condition. It is solution heat processed at temperature of 2150oF and then quenched quickly. The lustrous products are quenched through hydrogen.

Welding Precautions

Welding of Hastelloy X is performed safely. People involved in the welding processes are familiar with the significant harms of the welding gases, heat, electric shocks and burns. The federal laws that are approved by OSHA in correspondence of welding and cutting methods are followed. The Nickel-Cobalt-Iron alloys contain different content of elements such as aluminum, cobalt, chromium, copper, iron, manganese, molybdenum, nickel and tungsten. Intake of metal dust produced through welding, crushing, grinding, melting or other processes put adverse effects on humans like lung cancer.

Extended contact in welding dust may cause eye irritation, skin problems and other problems. The application and maintenance of welding and cutting machines are performed by following the latest ANSI standards. The mechanical aeration is essential under the specific environments like in limited area during welding, cutting applications to avoid exposure to the toxic fumes and dust.

Applications

Hastelloy X is purposeful in aircrafts, furnace and chemical processing. It is used in gas turbine engines, transition ducts, combustor cans, spray bars and flame holders and cabin heating equipments.

Hastelloy X is purposeful in the commercial furnace operations due to its excellent resistance to oxidation, reduction and neutral conditions. The furnace parts that are made of Hastelloy X alloy show stabilized nature even after exposure at temperature of 2150oF for 8700 hours. It is also employed in the chemical processing for catalyst support grids, furnace baffles, tubing for pyrolysis and others.

Available Forms

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