HASTELLOY® X alloy

Welding

HASTELLOY® X alloy is readily welded by Gas Tungsten Arc Welding (GTAW), Gas Metal Arc Welding (GMAW), Shielded Metal Arc Welding (SMAW), and resistance welding techniques. Submerged Arc Welding (SAW) is not recommended as this process is characterized by high heat input to the base metal and slow cooling of the weld. These factors can increase weld restraint and promote cracking.

Base Metal Preparation

The welding surface and adjacent regions should be thoroughly cleaned with an appropriate solvent prior to any welding operation. All greases, oils, cutting oils, crayon marks, machining solutions, corrosion products, paint, scale, dye penetrant solutions, and other foreign matter should be completely removed. It is preferable, but not necessary, that the alloy be in the solution- annealed condition when welded.

Filler Metal Selection

HASTELLOY® X filler wire (AWS A5.14, ERNiCrMo-2) is recommended for joining X alloy by Gas Tungsten Arc or Gas Metal Arc welding. Coated electrodes of X alloy are also available for Shielded Metal Arc welding in non-ASME code construction. For dissimilar metal joining of X alloy to nickel-, cobalt-, or iron- base materials, X filler wire, HAYNES® 556® alloy (AWS A5.9 ER3556, AMS 5831) , HASTELLOY® S alloy (AMS 5838) or HASTELLOY® W alloy (AMS 5786, 5787) welding products may all be considered, depending upon the particular case. Please click here or the Haynes Welding SmartGuide for more information.

Preheating, Interpass Temperatures, and Post- Weld Heat Treatment

Preheat is not required. Preheat is generally specified as room temperature (typical shop conditions). Interpass temperature should be maintained below 200°F (93°C). Auxiliary cooling methods may be used between weld passes, as needed, providing that such methods do not introduce contaminants. Post-weld heat treatment is not generally required for X alloy. For further information, please click here.

Nominal Welding Parameters

Details for GTAW, GMAW and SMAW welding are given here. Nominal welding parameters are provided as a guide for performing typical operations and are based upon welding conditions used in our laboratories.

Mechanical Properties of Welded Material
Room Temperature Hardness of Welded Sheet

Weld Method	Test Area	HRBW
Shielded Metal Arc (covered electrodes)	Weld Area	92
	Heat-Affected Zone	93
	Base Metal	91
Gas Tungsten Arc (TIG)	Weld Area	89
	Heat-Affected Zone	93
	Base Metal	91

Gas Metal Arc (MIG)	Weld Area	90
	Heat-Affected Zone	93
	Base Metal	91

Note: Sheet was solution heat-treated prior to welding. Hardness was determined at room temperature in the as-welded condition.
HRBW = Hardness Rockwell “B”, Tungsten Indentor.

Average Short-term Tensile Data, Cold-reduced and Welded 0.109 in. (2.8mm) Sheet

Condition	Form	0.2% Yield Strength		Ultimate Tensile Strength	
-	-	ksi	MPa	ksi	MPa
As Cold-reduced	Reduced 5%	82.0	565	123.0	848
	Reduced 15%	106.0	731	137.0	945
	Reduced 30%	137.0	945	161.0	1110
Cold-reduced and Welded, As Welded	Reduced 5%	68.0	469	114.9	792
	Reduced 15%	72.1	497	113.1	780
	Reduced 30%	69.9	482	112.9	778

NOTE: All cold-reduced sheet and the various weld samples were produced from material which had been solution heat-treated prior to cold reduction or welding. All data were obtained at room temperature and are the result of a limited number of tests.

Average Tensile Data, Weldments

Condition	Weld Method	Material	0.2% Yield Strength		Ultimate Tensile Strength		Elongation
-	-	-	ksi	MPa	ksi	MPa	%
As-Welded	Shielded Metal Arc (covered electrodes)	Sheet, 0.125 in. (3.2mm)	55.2	381	110.2	760	26
		Plate, 0.250 in. (6.4mm)	56.7	391	109.8	757	26
		Plate, 0.375 in. (9.5mm)	55.4	382	110.2	760	26
As-Welded	Gas Tungsten Arc (TIG)	Sheet, 0.125 in. (3.2mm)	59.1	407	110.2	759	26
		Plate, 0.250 in. (6.4mm)	53.1	365	107.1	738	25
		Plate, 0.375 in. (9.5mm)	54.9	379	107.6	742	22
As-Welded	Gas Metal Arc (MIG)	Sheet, 0.125 in. (3.2mm)	53.1	366	103.7	715	22
		Plate, 0.250 in. (6.4mm)	55.0	379	110.8	764	33
		Plate, 0.375 in. (9.5mm)	57.0	393	106.4	734	24

All Weld Metal

Test Temperature		0.2% Yield Strength		Ultimate Tensile Strength		Elongation	
°F	°C	ksi	MPa	ksi	MPa	%	
RT	RT	66.4	458	98.6	680	28	in 1 inch
600	316	52.1	359	80.4	554	27	in 1.125 inches
1000	538	49.2	339	76.3	526	28	in 1.125 inches
1500	816	38.2	263	56.7	391	45	in 1.125 inches

RT= Room Temperature

Average Welded and Aged Tensile Data, Room Temperature*

Form	Aging Temperature		Aging Time	0.2% Yield Strength		Ultimate Tensile Strength		Elongation
-	°F	°C	h	ksi	MPa	ksi	MPa	%
Plate 1/2 in (12.7mm) thick	1600	871	8000	47.9	330	109.0	752	22
Gas Tungsten Arc Welded Plate, 1/2 in. (12.7mm) thick	1200	649	1000	66.0	455	126.9	875	33
			4000	86.5	596	150.1	1035	19
			8000	82.9	572	145.5	1003	18
	1400	760	1000	58.2	401	128.2	884	19
			4000	62.3	430	127.4	878	18
			8000	62.3	430	125.2	863	15
	1600	871	4000	49.7	343	105.3	726	15
			8000	46.9	323	98.0	676	16
All Weld Metal**	1200	649	1000	87.5	603	123.0	848	8
			4000	86.0	593	139.3	960	8
			8000	86.8	598	131.8	909	9
	1400	760	1000	62.7	432	113.5	783	12
			4000	60.6	418	110.5	762	6
			8000	59.8	412	97.7	674	7
	1600	871	1000	48.3	330	92.8	640	9
			8000	46.3	319	92.7	639	11

*Test data for each form are from a single heat.

**Single test data.

Gas tungsten arc welded.