

Haynes Hastelloy® C-2000® Nickel Alloy Synergic Gas Metal Arc Welded (GMAW) Plate

Category : Metal , Nonferrous Metal , Nickel Alloy

Material Notes:

Nickel-chromium-molybdenum (Ni-Cr-Mo) C-type alloys have a long history of use in the Chemical Process Industries and are known for their versatility. Not only do they resist all acids (especially hydrochloric, sulfuric, and hydrofluoric) over large temperature ranges, but they also resist the insidious types of attack induced by chlorides and other halide solutions, specifically pitting, crevice attack, and stress corrosion cracking. HASTELLOY® C-2000® alloy has greater versatility than traditional Ni-Cr-Mo alloys. This was accomplished by use of a high chromium content, a high molybdenum content, and a small but effective addition of copper. The copper provides enhanced temperature capability in sulfuric acid, hydrofluoric acid, and dilute hydrochloric acid. C-2000 alloy is available in plate, sheet, strip, billet, bar, wire, covered electrodes, pipe, and tubing. Applications: Chemical process industry reactors, heat exchangers, columns, and piping. Pharmaceutical industry reactors and dryers. Flue gas desulfurization systems. C-2000 alloy is covered by ASME, ASTM, AWS, DIN, and T&E specifications. Welding: The weldability of C-2000 alloy is similar to that of C-276 alloy. To weld the C-type alloys, three processes are commonly used. For sheet welds and plate root passes, gas tungsten arc (GTAW) welding is favored. For plate welds, the gas metal arc (GMAW) process is preferred. For field welding, the shielded metal arc process, using coated electrodes, is favored. Submerged arc welding is not recommended as this process is characterized by high heat input to the base metal and slow cooling of the weld. To minimize the precipitation of second phases in regions affected by the heat of welding, a maximum interpass temperature of 93°C (200°F) is recommended for the C-type alloys. Welding of cold-worked materials is strongly discouraged, since they sensitize more quickly and induce residual stresses. A full solution anneal, followed by water quenching, is recommended for cold-worked structures prior to welding. Base Metal Preparation: The joint surface and adjacent area should be thoroughly cleaned before welding. All grease, oil, crayon marks, sulfur compounds, and other foreign matter should be removed. Filler Metal Selections: For gas tungsten arc and gas metal arc welding, C-2000 filler wire (ERNiCrMo-17) is suggested. For shielded metal arc welding, C-2000 covered electrodes (ENiCrMo-17) are suggested. Heat Treatment: The standard solution annealing treatment consists of heating to 1135°C (2075°F) followed by rapid air-cooling or water quenching. Parts which have been hot formed should be solution annealed prior to final fabrication or installation. Forming: C-2000 alloy has excellent forming characteristics, and cold forming is the preferred method of shaping. The alloy can be easily cold worked due to its good ductility. The alloy is generally stiffer than the austenitic stainless steels so more energy is required during cold forming. Tensile and impact properties reported are for transverse welded samples. Other properties are typical of the alloy. Data provided by the manufacturer, Haynes International, Inc.

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Physical Properties	Metric	English	Comments
Density	8.50 g/cc	0.307 lb/in ³	

Mechanical Properties	Metric	English	Comments
Tensile Strength, Ultimate	582 MPa @Thickness 12.7 mm, Temperature 538 °C	84400 psi @Thickness 0.500 in, Temperature 1000 °F	

Mechanical Properties	654 MPa Metric	94900 psi English	Comments
	@Thickness 12.7 mm, Temperature 260 Å°C	@Thickness 0.500 in, Temperature 500 Å°F	
	783 MPa	114000 psi	
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	
Tensile Strength, Yield	301 MPa	43700 psi	0.2% offset
	@Thickness 12.7 mm, Temperature 538 Å°C	@Thickness 0.500 in, Temperature 1000 Å°F	
	352 MPa	51100 psi	0.2% offset
	@Thickness 12.7 mm, Temperature 260 Å°C	@Thickness 0.500 in, Temperature 500 Å°F	
	456 MPa	66100 psi	0.2% offset
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	
Elongation at Break	42.1 %	42.1 %	
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	
	43.1 %	43.1 %	
	@Thickness 12.7 mm, Temperature 260 Å°C	@Thickness 0.500 in, Temperature 500 Å°F	
	45.6 %	45.6 %	
	@Thickness 12.7 mm, Temperature 538 Å°C	@Thickness 0.500 in, Temperature 1000 Å°F	
Modulus of Elasticity	162 GPa	23500 ksi	
	@Temperature 649 Å°C	@Temperature 1200 Å°F	
	171 GPa	24800 ksi	
	@Temperature 538 Å°C	@Temperature 1000 Å°F	
	177 GPa	25700 ksi	
	@Temperature 427 Å°C	@Temperature 801 Å°F	
	190 GPa	27600 ksi	
	@Temperature 316 Å°C	@Temperature 601 Å°F	
	207 GPa	30000 ksi	
	@Temperature 25.0 Å°C	@Temperature 77.0 Å°F	

Mechanical Properties	Metric	English	Comments
Charpy Impact	106 J	78.2 ft-lb	Mid-Weld
	@Thickness 12.7 mm, Temperature -196 Å°C	@Thickness 0.500 in, Temperature -321 Å°F	
	142 J	105 ft-lb	Mid-Weld
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	
Heat Affected Zone	203 J	150 ft-lb	Heat Affected Zone
	@Thickness 12.7 mm, Temperature -196 Å°C	@Thickness 0.500 in, Temperature -321 Å°F	
Heat Affected Zone	240 J	177 ft-lb	Heat Affected Zone
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	

Thermal Properties	Metric	English	Comments
CTE, linear	12.4 Åµm/m-Å°C	6.89 Åµin/in-Å°F	
	@Temperature 25.0 - 100 Å°C	@Temperature 77.0 - 212 Å°F	
	12.4 Åµm/m-Å°C	6.89 Åµin/in-Å°F	
	@Temperature 25.0 - 200 Å°C	@Temperature 77.0 - 392 Å°F	
	12.6 Åµm/m-Å°C	7.00 Åµin/in-Å°F	
	@Temperature 25.0 - 300 Å°C	@Temperature 77.0 - 572 Å°F	
	12.9 Åµm/m-Å°C	7.17 Åµin/in-Å°F	
@Temperature 25.0 - 400 Å°C	@Temperature 77.0 - 752 Å°F		
Specific Heat Capacity	13.2 Åµm/m-Å°C	7.33 Åµin/in-Å°F	
	@Temperature 25.0 - 500 Å°C	@Temperature 77.0 - 932 Å°F	
	13.3 Åµm/m-Å°C	7.39 Åµin/in-Å°F	
@Temperature 25.0 - 600 Å°C	@Temperature 77.0 - 1110 Å°F		
Specific Heat Capacity	0.428 J/g-Å°C	0.102 BTU/lb-Å°F	
	@Temperature 25.0 Å°C	@Temperature 77.0 Å°F	
Specific Heat Capacity	0.434 J/g-Å°C	0.104 BTU/lb-Å°F	
	@Temperature 100 Å°C	@Temperature 212 Å°F	

Thermal Properties	0.443 J/g-Â°C Metric	0.106 BTU/lb-Â°F English	Comments
	@Temperature 200 Â°C	@Temperature 392 Â°F	
	0.455 J/g-Â°C	0.109 BTU/lb-Â°F	
	@Temperature 300 Â°C	@Temperature 572 Â°F	
	0.468 J/g-Â°C	0.112 BTU/lb-Â°F	
	@Temperature 400 Â°C	@Temperature 752 Â°F	
	0.486 J/g-Â°C	0.116 BTU/lb-Â°F	
	@Temperature 500 Â°C	@Temperature 932 Â°F	
	0.536 J/g-Â°C	0.128 BTU/lb-Â°F	
	@Temperature 600 Â°C	@Temperature 1110 Â°F	
Thermal Conductivity	9.10 W/m-K @Temperature 25.0 Â°C	63.2 BTU-in/hr-ftÂ²- Â°F @Temperature 77.0 Â°F	
	10.8 W/m-K @Temperature 100 Â°C	75.0 BTU-in/hr-ftÂ²- Â°F @Temperature 212 Â°F	
	12.6 W/m-K @Temperature 200 Â°C	87.4 BTU-in/hr-ftÂ²- Â°F @Temperature 392 Â°F	
	14.1 W/m-K @Temperature 300 Â°C	97.9 BTU-in/hr-ftÂ²- Â°F @Temperature 572 Â°F	
	16.1 W/m-K @Temperature 400 Â°C	112 BTU-in/hr-ftÂ²-Â°F @Temperature 752 Â°F	
	18.0 W/m-K @Temperature 500 Â°C	125 BTU-in/hr-ftÂ²-Â°F @Temperature 932 Â°F	
	21.6 W/m-K @Temperature 600 Â°C	150 BTU-in/hr-ftÂ²-Â°F @Temperature 1110 Â°F	
Melting Point	1328 - 1358 Â°C	2422 - 2476 Â°F	
Solidus	1328 Â°C	2422 Â°F	
Liquidus	1358 Â°C	2476 Â°F	

Component Elements Properties	Metric	English	Comments
Aluminum, Al	<= 0.50 %	<= 0.50 %	
Carbon, C	<= 0.010 %	<= 0.010 %	
Chromium, Cr	23 %	23 %	
Copper, Cu	1.6 %	1.6 %	
Iron, Fe	<= 3.0 %	<= 3.0 %	
Manganese, Mn	<= 0.50 %	<= 0.50 %	
Molybdenum, Mo	16 %	16 %	
Nickel, Ni	>= 57 %	>= 57 %	as balance
Silicon, Si	<= 0.080 %	<= 0.080 %	

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.000128 ohm-cm	0.000128 ohm-cm	
	@Temperature 25.0 Â°C	@Temperature 77.0 Â°F	
	0.000129 ohm-cm	0.000129 ohm-cm	
	@Temperature 100 Â°C	@Temperature 212 Â°F	
	0.000130 ohm-cm	0.000130 ohm-cm	
	@Temperature 200 Â°C	@Temperature 392 Â°F	
	0.000131 ohm-cm	0.000131 ohm-cm	
	@Temperature 300 Â°C	@Temperature 572 Â°F	
0.000132 ohm-cm	0.000132 ohm-cm		
@Temperature 400 Â°C	@Temperature 752 Â°F		
0.000134 ohm-cm	0.000134 ohm-cm		
@Temperature 500 Â°C	@Temperature 932 Â°F		
0.000135 ohm-cm	0.000135 ohm-cm		
@Temperature 600 Â°C	@Temperature 1110 Â°F		

Processing Properties	Metric	English	Comments
Annealing Temperature	1135 - 1150 Â°C	2075 - 2100 Â°F	followed by rapid air-cooling or water quenching

Descriptive Properties	Value	Comments
Thermal Diffusivity (cm ² /s)	at 100Å°C	
	at 200Å°C	
	at 25Å°C	
	at 300Å°C	
	at 400Å°C	
	at 500Å°C	
	at 600Å°C	

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