Haynes HastelloyÂ® C-2000Â® Nickel Alloy Gas Tungsten Arc Welded (GTAW) All Weld Cruciform

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. HASTELLOYÂ® C-2000Â® 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 TÃœV 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 93Â°C (200Â°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 1135Â°C (2075Â°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 properties reported are for 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/inÂ³	

Mechanical Properties	Metric	English	Comments
Tensile Strength, Ultimate	528 MPa @Diameter 12.7 mm, Temperature 538 Â°C	76600 psi @Diameter 0.500 in, Temperature 1000 Â°F	

Mechanical Properties	Metric	English	Comments
	614 MPa @Diameter 12.7 mm, Temperature 260 Â°C	89100 psi @Diameter 0.500 in, Temperature 500 Â°F	
	733 MPa @Diameter 12.7 mm, Temperature 25.0 Â°C	106000 psi @Diameter 0.500 in, Temperature 77.0 Â°F	
Tensile Strength, Yield	365 MPa @Diameter 12.7 mm, Temperature 538 Â°C	52900 psi @Diameter 0.500 in, Temperature 1000 Â°F	0.2% offset
	391 MPa @Diameter 12.7 mm, Temperature 260 Â°C	56700 psi @Diameter 0.500 in, Temperature 500 Â°F	0.2% offset
	493 MPa @Diameter 12.7 mm, Temperature 25.0 Â°C	71500 psi @Diameter 0.500 in, Temperature 77.0 Â°F	0.2% offset
Elongation at Break	44 % @Diameter <=12.7 mm, Temperature 25.0 Â°C	44 % @Diameter <=0.500 in, Temperature 77.0 Â°F	
	46.6 % @Diameter <=12.7 mm, Temperature 538 Â°C	46.6 % @Diameter <=0.500 in, Temperature 1000 Â°F	
	47.7 % @Diameter <=12.7 mm, Temperature 260 Â°C	47.7 % @Diameter <=0.500 in, Temperature 500 Â°F	
Modulus of Elasticity	162 GPa @Temperature 649 Â°C	23500 ksi @Temperature 1200 Â°F	
	171 GPa @Temperature 538 Â°C	24800 ksi @Temperature 1000 Â°F	
	177 GPa @Temperature 427 Â°C	25700 ksi @Temperature 801 Â°F	
	190 GPa @Temperature 316 Â°C	27600 ksi @Temperature 601 Â°F	
	207 GPa @Temperature 25.0 Â°C	30000 ksi @Temperature 77.0 Â°F	

Thermal Properties	Metric	English	Comments
CTE, linear	12.4 Âµm/m-Â°C @Temperature 25.0 - 100 Â°C	6.89 Âµin/in-Â°F @Temperature 77.0 - 212 Â°F	
	12.4 Âµm/m-Â°C @Temperature 25.0 - 200 Â°C	6.89 Âµin/in-Â°F @Temperature 77.0 - 392 Â°F	
	12.6 Âµm/m-Â°C @Temperature 25.0 - 300 Â°C	7.00 Âµin/in-Â°F @Temperature 77.0 - 572 Â°F	
	12.9 Âµm/m-Â°C @Temperature 25.0 - 400 Â°C	7.17 Âµin/in-Â°F @Temperature 77.0 - 752 Â°F	
	13.2 Âµm/m-Â°C @Temperature 25.0 - 500 Â°C	7.33 Âµin/in-Â°F @Temperature 77.0 - 932 Â°F	
	13.3 Âµm/m-Â°C @Temperature 25.0 - 600 Â°C	7.39 Âµin/in-Â°F @Temperature 77.0 - 1110 Â°F	
Specific Heat Capacity	0.428 J/g-Â°C @Temperature 25.0 Â°C	0.102 BTU/lb-Â°F @Temperature 77.0 Â°F	
	0.434 J/g-Â°C @Temperature 100 Â°C	0.104 BTU/lb-Â°F @Temperature 212 Â°F	
	0.443 J/g-Â°C @Temperature 200 Â°C	0.106 BTU/lb-Â°F @Temperature 392 Â°F	
	0.455 J/g-Â°C @Temperature 300 Â°C	0.109 BTU/lb-Â°F @Temperature 572 Â°F	
	0.468 J/g-Â°C @Temperature 400 Â°C	0.112 BTU/lb-Â°F @Temperature 752 Â°F	
	0.486 J/g-Â°C @Temperature 500 Â°C	0.116 BTU/lb-Â°F @Temperature 932 Â°F	
	0.536 J/g-Â°C @Temperature 600 Â°C	0.128 BTU/lb-Â°F @Temperature 1110 Â°F	

Thermal Properties	Metric	English	Comments
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 @Temperature 25.0 Â°C	0.000128 ohm-cm @Temperature 77.0 Â°F	
	0.000129 ohm-cm @Temperature 100 Â°C	0.000129 ohm-cm @Temperature 212 Â°F	
	0.000130 ohm-cm @Temperature 200 Â°C	0.000130 ohm-cm @Temperature 392 Â°F	
	0.000131 ohm-cm @Temperature 300 Â°C	0.000131 ohm-cm @Temperature 572 Â°F	
	0.000132 ohm-cm @Temperature 400 Â°C	0.000132 ohm-cm @Temperature 752 Â°F	
	0.000134 ohm-cm @Temperature 500 Â°C	0.000134 ohm-cm @Temperature 932 Â°F	
	0.000135 ohm-cm @Temperature 600 Â°C	0.000135 ohm-cm @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 (cm2/s)	at 100Â°C	
	at 200Â°C	
	at 25Â°C	
	at 300Â°C	
	at 400Â°C	
	at 500Â°C	
	at 600Â°C	

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