

## Haynes Hastelloy® Hybrid-BC1® Nickel Alloy Gas Tungsten Arc Welded (GTAW) Plate

Category : Metal , Nonferrous Metal , Nickel Alloy

### Material Notes:

HASTELLOY® HYBRID-BC1® alloy possesses much higher resistance to hydrochloric and sulfuric acids than the nickel-chromium-molybdenum (C-type) alloys, and can tolerate the presence of oxidizing species. The alloy also exhibits extremely high resistance to pitting and crevice corrosion. HYBRID-BC1 alloy is available in the form of plate, sheet, strip, billet, bar, wire, pipe, and tube. HYBRID-BC1 alloy is suitable for the following applications in the chemical processing, pharmaceutical, agricultural, food, petrochemical, and power industries: Reaction vessels Heat exchangers Valves Pumps Piping Storage tanks The alloy is suitable for use at temperatures up to approximately 427°C (800°F). HYBRID-BC1 alloy excels in reducing acids and acid mixtures (with or without halides) open to oxygen and other oxidizing residuals/contaminants. Heat Treatment: Wrought forms of HYBRID-BC1 alloy are furnished in the solution annealed condition, unless otherwise specified. The standard solution annealing treatment consists of heating to 1149°C (2100°F) followed by rapid air-cooling or (preferably) water quenching. Parts which have been hot formed should be solution annealed prior to final fabrication or installation. The minimum hot forming temperature of the alloy is 954°C (1750°F). Forming: HYBRID-BC1 alloy has excellent forming characteristics, and cold forming is the preferred method of shaping. The alloy can be easily cold worked due to its high ductility; however, the alloy is stronger than the austenitic stainless steels and therefore requires more energy during cold forming. Tensile properties reported are for transverse GTAW (TIG) 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	8.83 g/cc	0.319 lb/in <sup>3</sup>	

Mechanical Properties	Metric	English	Comments
Tensile Strength, Ultimate	685 MPa	99400 psi	
	@Thickness 12.7 mm, Temperature 371 °C	@Thickness 0.500 in, Temperature 700 °F	
	692 MPa	100000 psi	
	@Thickness 12.7 mm, Temperature 427 °C	@Thickness 0.500 in, Temperature 801 °F	
	696 MPa	101000 psi	
@Thickness 12.7 mm, Temperature 316 °C	@Thickness 0.500 in, Temperature 601 °F		
716 MPa	104000 psi		
@Thickness 12.7 mm, Temperature 260 °C	@Thickness 0.500 in, Temperature 500 °F		
723 MPa	105000 psi		

Mechanical Properties	Metric	English	Comments
	@Thickness 12.7 mm, Temperature 204 Å°C	@Thickness 0.500 in, Temperature 399 Å°F	
	756 MPa	110000 psi	
	@Thickness 12.7 mm, Temperature 149 Å°C	@Thickness 0.500 in, Temperature 300 Å°F	
	789 MPa	114000 psi	
	@Thickness 12.7 mm, Temperature 93.0 Å°C	@Thickness 0.500 in, Temperature 199 Å°F	
	841 MPa	122000 psi	
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	
Tensile Strength, Yield	324 MPa	47000 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 371 Å°C	@Thickness 0.500 in, Temperature 700 Å°F	
	351 MPa	50900 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 316 Å°C	@Thickness 0.500 in, Temperature 601 Å°F	
	354 MPa	51300 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 260 Å°C	@Thickness 0.500 in, Temperature 500 Å°F	
	355 MPa	51500 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 427 Å°C	@Thickness 0.500 in, Temperature 801 Å°F	
	391 MPa	56700 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 204 Å°C	@Thickness 0.500 in, Temperature 399 Å°F	
	400 MPa	58000 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 149 Å°C	@Thickness 0.500 in, Temperature 300 Å°F	
	419 MPa	60800 psi	0.2% Offset
	@Thickness 12.7 mm, Temperature 93.0 Å°C	@Thickness 0.500 in, Temperature 199 Å°F	
	478 MPa	69300 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	36.2 %	36.2 %	
	@Thickness 12.7 mm, Temperature 204 Å°C	@Thickness 0.500 in, Temperature 399 Å°F	

Mechanical Properties	Metric	English	Comments
	@Thickness 12.7 mm, Temperature 93.0 Å°C	@Thickness 0.500 in, Temperature 199 Å°F	
	39 %	39 %	
	@Thickness 12.7 mm, Temperature 316 Å°C	@Thickness 0.500 in, Temperature 601 Å°F	
	40.2 %	40.2 %	
	@Thickness 12.7 mm, Temperature 260 Å°C	@Thickness 0.500 in, Temperature 500 Å°F	
	40.9 %	40.9 %	
	@Thickness 12.7 mm, Temperature 25.0 Å°C	@Thickness 0.500 in, Temperature 77.0 Å°F	
	41.1 %	41.1 %	
	@Thickness 12.7 mm, Temperature 427 Å°C	@Thickness 0.500 in, Temperature 801 Å°F	
	41.3 %	41.3 %	
	@Thickness 12.7 mm, Temperature 371 Å°C	@Thickness 0.500 in, Temperature 700 Å°F	
	70.1 %	70.1 %	
	@Thickness 12.7 mm, Temperature 149 Å°C	@Thickness 0.500 in, Temperature 300 Å°F	
Modulus of Elasticity	188 GPa	27300 ksi	Dynamic
	@Temperature 600 Å°C	@Temperature 1110 Å°F	
	191 GPa	27700 ksi	Dynamic
	@Temperature 500 Å°C	@Temperature 932 Å°F	
	197 GPa	28600 ksi	Dynamic
	@Temperature 400 Å°C	@Temperature 752 Å°F	
	200 GPa	29000 ksi	Dynamic
	@Temperature 300 Å°C	@Temperature 572 Å°F	
	205 GPa	29700 ksi	Dynamic
	@Temperature 200 Å°C	@Temperature 392 Å°F	
	211 GPa	30600 ksi	Dynamic
	@Temperature 100 Å°C	@Temperature 212 Å°F	
	217 GPa	31500 ksi	

Mechanical Properties	@Temperature 25.0 Metric °C	@Temperature 77.0 °F English °F	Dynamic Comments
<b>Thermal Properties</b>	<b>Metric</b>	<b>English</b>	<b>Comments</b>
CTE, linear	11.5 $\mu\text{m}/\text{m}\cdot\text{Å}^\circ\text{C}$	6.39 $\mu\text{in}/\text{in}\cdot\text{Å}^\circ\text{F}$	
	@Temperature 25.0 - 100 $\text{Å}^\circ\text{C}$	@Temperature 77.0 - 212 $\text{Å}^\circ\text{F}$	
	11.9 $\mu\text{m}/\text{m}\cdot\text{Å}^\circ\text{C}$	6.61 $\mu\text{in}/\text{in}\cdot\text{Å}^\circ\text{F}$	
	@Temperature 25.0 - 200 $\text{Å}^\circ\text{C}$	@Temperature 77.0 - 392 $\text{Å}^\circ\text{F}$	
	12.2 $\mu\text{m}/\text{m}\cdot\text{Å}^\circ\text{C}$	6.78 $\mu\text{in}/\text{in}\cdot\text{Å}^\circ\text{F}$	
	@Temperature 25.0 - 300 $\text{Å}^\circ\text{C}$	@Temperature 77.0 - 572 $\text{Å}^\circ\text{F}$	
	12.5 $\mu\text{m}/\text{m}\cdot\text{Å}^\circ\text{C}$	6.94 $\mu\text{in}/\text{in}\cdot\text{Å}^\circ\text{F}$	
@Temperature 25.0 - 400 $\text{Å}^\circ\text{C}$	@Temperature 77.0 - 752 $\text{Å}^\circ\text{F}$		
12.7 $\mu\text{m}/\text{m}\cdot\text{Å}^\circ\text{C}$	7.06 $\mu\text{in}/\text{in}\cdot\text{Å}^\circ\text{F}$		
@Temperature 25.0 - 500 $\text{Å}^\circ\text{C}$	@Temperature 77.0 - 932 $\text{Å}^\circ\text{F}$		
12.7 $\mu\text{m}/\text{m}\cdot\text{Å}^\circ\text{C}$	7.06 $\mu\text{in}/\text{in}\cdot\text{Å}^\circ\text{F}$		
@Temperature 25.0 - 600 $\text{Å}^\circ\text{C}$	@Temperature 77.0 - 1110 $\text{Å}^\circ\text{F}$		
Specific Heat Capacity	0.403 $\text{J}/\text{g}\cdot\text{Å}^\circ\text{C}$	0.0963 $\text{BTU}/\text{lb}\cdot\text{Å}^\circ\text{F}$	
	@Temperature 25.0 $\text{Å}^\circ\text{C}$	@Temperature 77.0 $\text{Å}^\circ\text{F}$	
	0.416 $\text{J}/\text{g}\cdot\text{Å}^\circ\text{C}$	0.0994 $\text{BTU}/\text{lb}\cdot\text{Å}^\circ\text{F}$	
	@Temperature 100 $\text{Å}^\circ\text{C}$	@Temperature 212 $\text{Å}^\circ\text{F}$	
	0.429 $\text{J}/\text{g}\cdot\text{Å}^\circ\text{C}$	0.103 $\text{BTU}/\text{lb}\cdot\text{Å}^\circ\text{F}$	
	@Temperature 200 $\text{Å}^\circ\text{C}$	@Temperature 392 $\text{Å}^\circ\text{F}$	
	0.439 $\text{J}/\text{g}\cdot\text{Å}^\circ\text{C}$	0.105 $\text{BTU}/\text{lb}\cdot\text{Å}^\circ\text{F}$	
@Temperature 300 $\text{Å}^\circ\text{C}$	@Temperature 572 $\text{Å}^\circ\text{F}$		
0.449 $\text{J}/\text{g}\cdot\text{Å}^\circ\text{C}$	0.107 $\text{BTU}/\text{lb}\cdot\text{Å}^\circ\text{F}$		
@Temperature 400 $\text{Å}^\circ\text{C}$	@Temperature 752 $\text{Å}^\circ\text{F}$		
0.457 $\text{J}/\text{g}\cdot\text{Å}^\circ\text{C}$	0.109 $\text{BTU}/\text{lb}\cdot\text{Å}^\circ\text{F}$		
@Temperature 600 $\text{Å}^\circ\text{C}$	@Temperature 1110 $\text{Å}^\circ\text{F}$		

Thermal Properties	0.461 J/g-Â°C Metric	0.110 BTU/lb-Â°F English	Comments
	@Temperature 500 Â°C	@Temperature 932 Â°F	
Thermal Conductivity	9.30 W/m-K	64.5 BTU-in/hr-ftÂ²- Â°F	
	@Temperature 25.0 Â°C	@Temperature 77.0 Â°F	
	10.5 W/m-K	72.9 BTU-in/hr-ftÂ²- Â°F	
	@Temperature 100 Â°C	@Temperature 212 Â°F	
	11.9 W/m-K	82.6 BTU-in/hr-ftÂ²- Â°F	
	@Temperature 200 Â°C	@Temperature 392 Â°F	
	13.5 W/m-K	93.7 BTU-in/hr-ftÂ²- Â°F	
	@Temperature 300 Â°C	@Temperature 572 Â°F	
	14.9 W/m-K	103 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 400 Â°C	@Temperature 752 Â°F	
	16.4 W/m-K	114 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 500 Â°C	@Temperature 932 Â°F	
	17.5 W/m-K	121 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 600 Â°C	@Temperature 1110 Â°F	
Maximum Service Temperature, Air	427 Â°C	800 Â°F	

Component Elements Properties	Metric	English	Comments
Aluminum, Al	<= 0.50 %	<= 0.50 %	
Carbon, C	<= 0.010 %	<= 0.010 %	
Chromium, Cr	15 %	15 %	
Iron, Fe	<= 1.25 %	<= 1.25 %	
Manganese, Mn	0.25 %	0.25 %	
Molybdenum, Mo	22 %	22 %	
Nickel, Ni	60.91 %	60.91 %	as balance
Silicon, Si	<= 0.080 %	<= 0.080 %	

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.000126 ohm-cm	0.000126 ohm-cm	
	@Temperature 25.0 Å°C	@Temperature 77.0 Å°F	
	0.000127 ohm-cm	0.000127 ohm-cm	
	@Temperature 100 Å°C	@Temperature 212 Å°F	
	0.000127 ohm-cm	0.000127 ohm-cm	
	@Temperature 200 Å°C	@Temperature 392 Å°F	
	0.000128 ohm-cm	0.000128 ohm-cm	
	@Temperature 300 Å°C	@Temperature 572 Å°F	
0.000128 ohm-cm	0.000128 ohm-cm		
@Temperature 400 Å°C	@Temperature 752 Å°F		
0.000129 ohm-cm	0.000129 ohm-cm		
@Temperature 500 Å°C	@Temperature 932 Å°F		
0.000131 ohm-cm	0.000131 ohm-cm		
@Temperature 600 Å°C	@Temperature 1110 Å°F		

Descriptive Properties	Value	Comments
Consumable Diameter	3.2	
Thermal Diffusivity	0.0264 cm <sup>2</sup> /s	23Å°C
	0.0291 cm <sup>2</sup> /s	at 100Å°C
	0.0319 cm <sup>2</sup> /s	at 200Å°C
	0.0352 cm <sup>2</sup> /s	at 300Å°C
	0.0382 cm <sup>2</sup> /s	at 400Å°C

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