

## Haynes Hastelloy® C-2000® Bar, Annealed at 2100°F (1149°C)

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 TÜV 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. 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 <sup>3</sup>	

Mechanical Properties	Metric	English	Comments
Tensile Strength, Ultimate	554 MPa	80400 psi	
	@Temperature 649 °C	@Temperature 1200 °F	
	585 MPa	84800 psi	
	@Temperature 482 °C	@Temperature 900 °F	

Mechanical Properties	586 MPa Metric	85000 psi English	Comments
	@Temperature 538 °C	@Temperature 1000 °F	
	605 MPa	87700 psi	
	@Temperature 371 °C	@Temperature 700 °F	
	609 MPa	88300 psi	
	@Temperature 427 °C	@Temperature 801 °F	
	616 MPa	89300 psi	
	@Temperature 316 °C	@Temperature 601 °F	
	641 MPa	93000 psi	
	@Temperature 260 °C	@Temperature 500 °F	
	676 MPa	98000 psi	
	@Temperature 204 °C	@Temperature 399 °F	
	684 MPa	99200 psi	
	@Temperature 149 °C	@Temperature 300 °F	
	724 MPa	105000 psi	
	@Temperature 93.0 °C	@Temperature 199 °F	
	724 MPa	105000 psi	
	@Diameter 50.8 mm, Temperature 25.0 °C	@Diameter 2.00 in, Temperature 77.0 °F	
	738 MPa	107000 psi	
	@Diameter 88.9 mm, Temperature 25.0 °C	@Diameter 3.50 in, Temperature 77.0 °F	
	738 MPa	107000 psi	
	@Diameter 19.1 mm, Temperature 25.0 °C	@Diameter 0.752 in, Temperature 77.0 °F	
	745 MPa	108000 psi	
	@Diameter 9.70 mm, Temperature 25.0 °C	@Diameter 0.382 in, Temperature 77.0 °F	
	758 MPa	110000 psi	
	@Diameter 25.4 mm, Temperature 25.0 °C	@Diameter 1.00 in, Temperature 77.0 °F	
Tensile Strength, Yield	331 MPa	48000 psi	0.2% offset
	@Diameter 9.70 mm, Temperature 25.0 °C	@Diameter 0.382 in, Temperature 77.0 °F	

Mechanical Properties	345 MPa Metric	50000 psi English	Comments
	@Diameter 19.1 mm, Temperature 25.0 °C	@Diameter 0.752 in, Temperature 77.0 °F	
	<b>379 MPa</b>	<b>55000 psi</b>	
	@Diameter 25.4 mm, Temperature 25.0 °C	@Diameter 1.00 in, Temperature 77.0 °F	0.2% offset
	<b>379 MPa</b>	<b>55000 psi</b>	
	@Diameter 50.8 mm, Temperature 25.0 °C	@Diameter 2.00 in, Temperature 77.0 °F	0.2% offset
	<b>386 MPa</b>	<b>56000 psi</b>	
	@Diameter 88.9 mm, Temperature 25.0 °C	@Diameter 3.50 in, Temperature 77.0 °F	0.2% offset
	<b>209 MPa</b>	<b>30300 psi</b>	
	@Strain 0.200 %, Temperature 649 °C	@Strain 0.200 %, Temperature 1200 °F	
	<b>214 MPa</b>	<b>31000 psi</b>	
	@Strain 0.200 %, Temperature 538 °C	@Strain 0.200 %, Temperature 1000 °F	
	<b>216 MPa</b>	<b>31300 psi</b>	
	@Strain 0.200 %, Temperature 427 °C	@Strain 0.200 %, Temperature 801 °F	
	<b>223 MPa</b>	<b>32300 psi</b>	
	@Strain 0.200 %, Temperature 482 °C	@Strain 0.200 %, Temperature 900 °F	
	<b>234 MPa</b>	<b>33900 psi</b>	
	@Strain 0.200 %, Temperature 371 °C	@Strain 0.200 %, Temperature 700 °F	
	<b>243 MPa</b>	<b>35200 psi</b>	
	@Strain 0.200 %, Temperature 316 °C	@Strain 0.200 %, Temperature 601 °F	
	<b>260 MPa</b>	<b>37700 psi</b>	
	@Strain 0.200 %, Temperature 260 °C	@Strain 0.200 %, Temperature 500 °F	
	<b>283 MPa</b>	<b>41000 psi</b>	
	@Strain 0.200 %, Temperature 204 °C	@Strain 0.200 %, Temperature 399 °F	
	<b>308 MPa</b>	<b>44700 psi</b>	
	@Strain 0.200 %, Temperature 149 °C	@Strain 0.200 %, Temperature 300 °F	

Mechanical Properties	Metric	English	Comments
	@Strain 0.200 %, Temperature 93.0 °C	@Strain 0.200 %, Temperature 199 °F	
Elongation at Break	67.9 %	67.9 %	
	@Temperature 260 °C	@Temperature 500 °F	
	68.8 %	68.8 %	
	@Temperature 149 °C	@Temperature 300 °F	
	69.3 %	69.3 %	
	@Temperature 204 °C	@Temperature 399 °F	
	69.8 %	69.8 %	
	@Temperature 371 °C	@Temperature 700 °F	
	70.3 %	70.3 %	
	@Temperature 93.0 °C	@Temperature 199 °F	
	70.7 %	70.7 %	
	@Temperature 649 °C	@Temperature 1200 °F	
	72.6 %	72.6 %	
	@Temperature 482 °C	@Temperature 900 °F	
	72.7 %	72.7 %	
	@Temperature 316 °C	@Temperature 601 °F	
	73 %	73 %	
	@Temperature 427 °C	@Temperature 801 °F	
	75.3 %	75.3 %	
	@Temperature 538 °C	@Temperature 1000 °F	
	67 %	67 %	
	@Diameter 9.70 mm, Temperature 25.0 °C	@Diameter 0.382 in, Temperature 77.0 °F	
	68 %	68 %	
	@Diameter 25.4 mm, Temperature 25.0 °C	@Diameter 1.00 in, Temperature 77.0 °F	
	69 %	69 %	
	@Diameter 19.1 mm, Temperature 25.0 °C	@Diameter 0.752 in, Temperature 77.0 °F	
	71 %	71 %	

Mechanical Properties	Metric	English	Comments
	@Diameter 50.8 mm, Temperature 25.0 °C	@Diameter 2.00 in, Temperature 77.0 °F	
	71 %	71 %	
	@Diameter 88.9 mm, Temperature 25.0 °C	@Diameter 3.50 in, Temperature 77.0 °F	
Modulus of Elasticity	162 GPa	23500 ksi	
	@Temperature 649 °C	@Temperature 1200 °F	
	171 GPa	24800 ksi	
	@Temperature 538 °C	@Temperature 1000 °F	
	177 GPa	25700 ksi	
	@Temperature 427 °C	@Temperature 801 °F	
	190 GPa	27600 ksi	
	@Temperature 316 °C	@Temperature 601 °F	
	207 GPa	30000 ksi	
	@Temperature 25.0 °C	@Temperature 77.0 °F	

Thermal Properties	Metric	English	Comments
CTE, linear	12.4 µm/m-°C	6.89 µin/in-°F	
	@Temperature 25.0 - 100 °C	@Temperature 77.0 - 212 °F	
	12.4 µm/m-°C	6.89 µin/in-°F	
	@Temperature 25.0 - 200 °C	@Temperature 77.0 - 392 °F	
	12.6 µm/m-°C	7.00 µin/in-°F	
	@Temperature 25.0 - 300 °C	@Temperature 77.0 - 572 °F	
	12.9 µm/m-°C	7.17 µin/in-°F	
	@Temperature 25.0 - 400 °C	@Temperature 77.0 - 752 °F	
	13.2 µm/m-°C	7.33 µin/in-°F	
	@Temperature 25.0 - 500 °C	@Temperature 77.0 - 932 °F	
	13.3 µm/m-°C	7.39 µin/in-°F	
	@Temperature 25.0 - 600 °C	@Temperature 77.0 - 1110 °F	

Thermal Properties	Metric	English	Comments
	0.428 J/g-°C	0.102 BTU/lb-°F	
	@Temperature 25.0 °C	@Temperature 77.0 °F	
	0.434 J/g-°C	0.104 BTU/lb-°F	
	@Temperature 100 °C	@Temperature 212 °F	
	0.443 J/g-°C	0.106 BTU/lb-°F	
	@Temperature 200 °C	@Temperature 392 °F	
	0.455 J/g-°C	0.109 BTU/lb-°F	
	@Temperature 300 °C	@Temperature 572 °F	
	0.468 J/g-°C	0.112 BTU/lb-°F	
	@Temperature 400 °C	@Temperature 752 °F	

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

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