Haynes Hastelloy® G-35® Nickel Alloy Bar, Annealed at 2075°F (1135°C)

Category : Metal , Nonferrous Metal , Nickel Alloy

Material Notes:

Known for its corrosion performance, HASTELLOY® G-35® alloy was designed to resist "wet process" phosphoric acid, which is widely used in the production of fertilizers. Tests indicate that it is far superior to HASTELLOY® G-30® alloy and stainless steels, in this chemical. It was also designed to resist localized attack in the presence of chlorides, since under-deposit attack is a potential problem in evaporators used to concentrate "wet process" phosphoric acid. As a result of its high-chromium content, G-35 alloy is extremely resistant to other oxidizing acids, such as nitric, and mixtures containing nitric acid. It possesses moderate resistance to reducing acids, as a result of its appreciable molybdenum content, and, unlike other nickel-chromium-molybdenum alloys, it is very resistant to "caustic dealloying" in hot sodium hydroxide. Finally, G-35 alloy is much less susceptible to chloride-induced stress corrosion cracking than the high chromium stainless steels and nickel-chromium-iron alloys traditionally used in "wet process" phosphoric acid. G-35 alloy is available in the form of plate, sheet, strip, billet, bar, wire, covered electrodes, pipe, and tubing. Potential Applications: "Wet process" phosphoric acid evaporators. Pickling in nitric and hydrofluoric acids. Chemical process industry systems involving nitric and chlorides. Caustic neutralizing systems. Systems requiring resistance to high temperature corrosion at 800-1200°F.G-35 alloy is covered by ASME, ASTM, and DIN specifications. Welding: The weldability of G-35 alloy is similar to that of C-276 alloy. To weld G-35 alloy, 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 G-35 alloy. Also, 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. Joining 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, G-35 filler wire is suggested. For shielded metal arc welding, G-35 covered electrodes are suggested. Heat Treatment: Wrought forms of HASTELLOY G-35 alloy are furnished in the solution annealed condition, unless otherwise specified. The standard solution annealing treatment consists of heating to 1121°C (2050°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: G-35 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; therefore, 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	8.22 g/cc	0.297 lb/in³	

Mechanical Properties	Metric	English	Comments
Tensile Strength, Ultimate	483 MPa @Temperature 649 °C	70100 psi @Temperature 1200 °F	

Mechanical Properties	Metric	English	Comments
	@Temperature 593 °C	@Temperature 1100 °F	
	521 MPa @Temperature 538 °C	75600 psi @Temperature 1000 °F	
	543 MPa @Temperature 482 °C	78800 psi @Temperature 900 °F	
	561 MPa @Temperature 427 °C	81400 psi @Temperature 801 °F	
	570 MPa @Temperature 371 °C	82700 psi @Temperature 700 °F	
	583 MPa @Temperature 316 °C	84600 psi @Temperature 601 °F	
	600 MPa @Temperature 260 °C	87000 psi @Temperature 500 °F	
	623 MPa @Temperature 204 °C	90400 psi @Temperature 399 °F	
	656 MPa @Temperature 149 °C	95100 psi @Temperature 300 °F	
	692 MPa @Temperature 93.0 °C	100000 psi @Temperature 199 °F	
	689 MPa @Thickness 63.5 mm, Temperature 25.0 °C	99900 psi @Thickness 2.50 in, Temperature 77.0 °F	
	710 MPa @Thickness 25.4 mm, Temperature 25.0 °C	103000 psi @Thickness 1.00 in, Temperature 77.0 °F	
Tensile Strength, Yield	319 MPa @Thickness 25.4 mm, Temperature 25.0 °C	46300 psi @Thickness 1.00 in, Temperature 77.0 °F	0.2% Offset
	338 MPa @Thickness 63.5 mm, Temperature 25.0 °C	49000 psi @Thickness 2.50 in, Temperature 77.0 °F	0.2% Offset
	184 MPa	26700 psi	

Mechanical Properties	Metric	English	Comments
	@Strain 0.200 %, Temperature 649 °C	@Strain 0.200 %, Temperature 1200 °F	
	185 MPa @Strain 0.200 %, Temperature 593 °C	26800 psi @Strain 0.200 %, Temperature 1100 °F	
	194 MPa @Strain 0.200 %, Temperature 538 °C	28100 psi @Strain 0.200 %, Temperature 1000 °F	
	204 MPa @Strain 0.200 %, Temperature 482 °C	29600 psi @Strain 0.200 %, Temperature 900 °F	
	215 MPa @Strain 0.200 %, Temperature 427 °C	31200 psi @Strain 0.200 %, Temperature 801 °F	
	217 MPa @Strain 0.200 %, Temperature 371 °C	31500 psi @Strain 0.200 %, Temperature 700 °F	
	219 MPa @Strain 0.200 %, Temperature 316 °C	31800 psi @Strain 0.200 %, Temperature 601 °F	
	232 MPa @Strain 0.200 %, Temperature 260 °C	33600 psi @Strain 0.200 %, Temperature 500 °F	
	248 MPa @Strain 0.200 %, Temperature 204 °C	36000 psi @Strain 0.200 %, Temperature 399 °F	
	278 MPa @Strain 0.200 %, Temperature 149 °C	40300 psi @Strain 0.200 %, Temperature 300 °F	
	313 MPa @Strain 0.200 %, Temperature 93.0 °C	45400 psi @Strain 0.200 %, Temperature 199 °F	
Elongation at Break	67.9 % @Temperature 260 °C	67.9 % @Temperature 500 °F	
	68.2 % @Temperature 149 °C	68.2 % @Temperature 300 °F	
	68.8 %	68.8 %	

Mechanical Properties	Metric	English	Comments
	@Temperature 316 °C	@Temperature 601 °F	
	69.3 % @Temperature 93.0 °C	69.3 % @Temperature 199 °F	
	69.5 % @Temperature 204 °C	69.5 % @Temperature 399 °F	
	70.2 % @Temperature 649 °C	70.2 % @Temperature 1200 °F	
	71 % @Temperature 482 °C	71 % @Temperature 900 °F	
	72 % @Temperature 593 °C	72 % @Temperature 1100 °F	
	72.3 % @Temperature 371 °C	72.3 % @Temperature 700 °F	
	72.7 % @Temperature 538 °C	72.7 % @Temperature 1000 °F	
	72.8 % @Temperature 427 °C	72.8 % @Temperature 801 °F	
	66 % @Thickness 25.4 mm, Temperature 25.0 °C	66 % @Thickness 1.00 in, Temperature 77.0 °F	
	68 % @Thickness 63.5 mm, Temperature 25.0 °C	68 % @Thickness 2.50 in, Temperature 77.0 °F	
Modulus of Elasticity	170 GPa @Temperature 649 °C	24700 ksi @Temperature 1200 °F	Dynamic
	177 GPa @Temperature 538 °C	25700 ksi @Temperature 1000 °F	Dynamic
	183 GPa @Temperature 427 °C	26500 ksi @Temperature 801 °F	Dynamic
	189 GPa @Temperature 316 °C	27400 ksi @Temperature 601 °F	Dynamic
	204 GPa	29600 ksi	

Mechanical Properties	Metric	English	Comments
	@Temperature 25.0 °C	@Temperature 77.0 °F	Dynamic

Thermal Properties	Metric	English	Comments
CTE, linear	12.3 µm/m-°C @Temperature 21.0 - 100 °C	6.83 µin/in-°F @Temperature 69.8 - 212 °F	
	12.6 µm/m-°C @Temperature 21.0 - 200 °C	7.00 µin/in-°F @Temperature 69.8 - 392 °F	
	13.2 µm/m-°C @Temperature 21.0 - 300 °C	7.33 µin/in-°F @Temperature 69.8 - 572 °F	
	13.4 µm/m-°C @Temperature 21.0 - 400 °C	7.44 µin/in-°F @Temperature 69.8 - 752 °F	
	13.6 µm/m-°C @Temperature 21.0 - 500 °C	7.56 µin/in-°F @Temperature 69.8 - 932 °F	
	14.4 µm/m-°C @Temperature 21.0 - 600 °C	8.00 µin/in-°F @Temperature 69.8 - 1110 °F	
Specific Heat Capacity	0.450 J/g-°C @Temperature 25.0 °C	0.108 BTU/lb-°F @Temperature 77.0 °F	
	0.470 J/g-°C @Temperature 100 °C	0.112 BTU/lb-°F @Temperature 212 °F	
	0.490 J/g-°C @Temperature 200 °C	0.117 BTU/lb-°F @Temperature 392 °F	
	0.510 J/g-°C @Temperature 300 °C	0.122 BTU/lb-°F @Temperature 572 °F	
	0.530 J/g-°C @Temperature 400 °C	0.127 BTU/lb-°F @Temperature 752 °F	
	0.530 J/g-°C @Temperature 500 °C	0.127 BTU/lb-°F @Temperature 932 °F	
	0.600 J/g-°C	0.143 BTU/lb-°F	

Thermal Properties	Metric	English	Comments
	@Temperature 600 °C	@Temperature 1110 °F	
Thermal Conductivity	10.0 W/m-K	69.4 BTU-in/hr-ft²-°F	
	@Temperature 25.0 °C	@Temperature 77.0 °F	
	12.0 W/m-K	83.3 BTU-in/hr-ft²-°F	
	@Temperature 100 °C	@Temperature 212 °F	
	14.0 W/m-K	97.2 BTU-in/hr-ft²-°F	
	@Temperature 200 °C	@Temperature 392 °F	

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.000118 ohm-cm	0.000118 ohm-cm	
	@Temperature 25.0 °C	@Temperature 77.0 °F	
	0.000119 ohm-cm	0.000119 ohm-cm	
	@Temperature 100 °C	@Temperature 212 °F	
	0.000120 ohm-cm	0.000120 ohm-cm	
	@Temperature 200 °C	@Temperature 392 °F	
	0.000121 ohm-cm	0.000121 ohm-cm	
	@Temperature 300 °C	@Temperature 572 °F	
	0.000122 ohm-cm	0.000122 ohm-cm	
	@Temperature 400 °C	@Temperature 752 °F	
	0.000124 ohm-cm	0.000124 ohm-cm	
	@Temperature 500 °C	@Temperature 932 °F	
	0.000125 ohm-cm	0.000125 ohm-cm	
	@Temperature 600 °C	@Temperature 1110 °F	

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