

## Haynes Hastelloy® G-35® Nickel Alloy Plate, Annealed at 2025°F (1107°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/in <sup>3</sup>	

Mechanical Properties	Metric	English	Comments

Mechanical Properties Modulus of Elasticity	170 GPa Metric	24700 ksi English	Comments Dynamic
	@Temperature 649 Å°C	@Temperature 1200 Å°F	
	177 GPa	25700 ksi	Dynamic
	@Temperature 538 Å°C	@Temperature 1000 Å°F	
	183 GPa	26500 ksi	Dynamic
	@Temperature 427 Å°C	@Temperature 801 Å°F	
	189 GPa	27400 ksi	Dynamic
	@Temperature 316 Å°C	@Temperature 601 Å°F	
	204 GPa	29600 ksi	Dynamic
	@Temperature 25.0 Å°C	@Temperature 77.0 Å°F	
Charpy Impact	>= 358 J	>= 264 ft-lb	Annealed
	@Thickness 19.1 mm	@Thickness 0.752 in	
	104 J	76.7 ft-lb	Annealed, aged for 2000h
	@Treatment Temp. 649 Å°C, Thickness 19.1 mm	@Treatment Temp. 1200 Å°F, Thickness 0.752 in	
	>= 358 J	>= 264 ft-lb	Annealed, aged for 2000h
	@Treatment Temp. 427 Å°C, Thickness 19.1 mm	@Treatment Temp. 801 Å°F, Thickness 0.752 in	
	>= 358 J	>= 264 ft-lb	Annealed, aged for 2000h
	@Treatment Temp. 482 Å°C, Thickness 19.1 mm	@Treatment Temp. 900 Å°F, Thickness 0.752 in	
	>= 358 J	>= 264 ft-lb	Annealed, aged for 2000h
	@Treatment Temp. 538 Å°C, Thickness 19.1 mm	@Treatment Temp. 1000 Å°F, Thickness 0.752 in	
	>= 358 J	>= 264 ft-lb	Annealed, aged for 2000h
	@Treatment Temp. 593 Å°C, Thickness 19.1 mm	@Treatment Temp. 1100 Å°F, Thickness 0.752 in	

Thermal Properties	Metric	English	Comments
CTE, linear	12.3 Åµm/m-Å°C	6.83 Åµin/in-Å°F	
	@Temperature 21.0 -	@Temperature 69.8 -	

Thermal Properties	100 °C Metric	212 °F English	Comments	
	12.6 Åµm/m-Å°C	7.00 Åµin/in-Å°F		
	@Temperature 21.0 - 200 Å°C	@Temperature 69.8 - 392 Å°F		
	13.2 Åµm/m-Å°C	7.33 Åµin/in-Å°F		
	@Temperature 21.0 - 300 Å°C	@Temperature 69.8 - 572 Å°F		
	13.4 Åµm/m-Å°C	7.44 Åµin/in-Å°F		
	@Temperature 21.0 - 400 Å°C	@Temperature 69.8 - 752 Å°F		
	13.6 Åµm/m-Å°C	7.56 Åµin/in-Å°F		
	@Temperature 21.0 - 500 Å°C	@Temperature 69.8 - 932 Å°F		
	14.4 Åµm/m-Å°C	8.00 Åµin/in-Å°F		
	@Temperature 21.0 - 600 Å°C	@Temperature 69.8 - 1110 Å°F		
Specific Heat Capacity	0.450 J/g-Å°C	0.108 BTU/lb-Å°F		
	@Temperature 25.0 Å°C	@Temperature 77.0 Å°F		
	0.470 J/g-Å°C	0.112 BTU/lb-Å°F		
	@Temperature 100 Å°C	@Temperature 212 Å°F		
	0.490 J/g-Å°C	0.117 BTU/lb-Å°F		
	@Temperature 200 Å°C	@Temperature 392 Å°F		
	0.510 J/g-Å°C	0.122 BTU/lb-Å°F		
	@Temperature 300 Å°C	@Temperature 572 Å°F		
Specific Heat Capacity	0.530 J/g-Å°C	0.127 BTU/lb-Å°F		
	@Temperature 400 Å°C	@Temperature 752 Å°F		
	0.530 J/g-Å°C	0.127 BTU/lb-Å°F		
	@Temperature 500 Å°C	@Temperature 932 Å°F		
	0.600 J/g-Å°C	0.143 BTU/lb-Å°F		
	@Temperature 600 Å°C	@Temperature 1110 Å°F		
	Thermal Conductivity	10.0 W/m-K	69.4 BTU-in/hr-ftÅ²-Å°F	
		@Temperature 25.0 Å°C	@Temperature 77.0 Å°F	

Thermal Properties	Metric	English	Comments
	@Temperature 100 Â°C	@Temperature 212 Â°F	
	14.0 W/m-K	97.2 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 200 Â°C	@Temperature 392 Â°F	
	16.0 W/m-K	111 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 300 Â°C	@Temperature 572 Â°F	
	18.0 W/m-K	125 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 400 Â°C	@Temperature 752 Â°F	
	19.0 W/m-K	132 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 500 Â°C	@Temperature 932 Â°F	
	23.0 W/m-K	160 BTU-in/hr-ftÂ²-Â°F	
	@Temperature 600 Â°C	@Temperature 1110 Â°F	
Melting Point	1332 - 1361 Â°C	2430 - 2482 Â°F	
Solidus	1332 Â°C	2430 Â°F	
Liquidus	1361 Â°C	2482 Â°F	

Component Elements Properties	Metric	English	Comments
Aluminum, Al	<= 0.40 %	<= 0.40 %	
Carbon, C	<= 0.050 %	<= 0.050 %	
Chromium, Cr	33 %	33 %	
Iron, Fe	<= 2.0 %	<= 2.0 %	
Manganese, Mn	<= 0.50 %	<= 0.50 %	
Molybdenum, Mo	8.0 %	8.0 %	
Nickel, Ni	55.5 %	55.5 %	as balance
Silicon, Si	<= 0.60 %	<= 0.60 %	

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.000118 ohm-cm	0.000118 ohm-cm	
	@Temperature 25.0 Â°C	@Temperature 77.0 Â°F	

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

Processing Properties	Metric	English	Comments
Annealing Temperature	1120 Å°C	2050 Å°F	Followed by rapid air cooling or water quench

Descriptive Properties	Value	Comments
Thermal Diffusivity	0.028 cm <sup>2</sup> /s	25Å°C
	0.031 cm <sup>2</sup> /s	100Å°C
	0.034 cm <sup>2</sup> /s	200Å°C
	0.038 cm <sup>2</sup> /s	300Å°C
	0.042 cm <sup>2</sup> /s	400Å°C
	0.045 cm <sup>2</sup> /s	500Å°C
	0.048 cm <sup>2</sup> /s	600Å°C

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