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

Categories: 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.

Vendors: **Click here to view all available suppliers for this material.**

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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	745 MPa @Thickness 3.20 mm	108000 psi @Thickness 0.126 in	
Tensile Strength, Yield	348 MPa @Strain 0.200 %, Thickness 3.20 mm	50500 psi @Strain 0.200 %, Thickness 0.126 in	
Elongation at Break	59 % @Thickness 3.20 mm	59 % @Thickness 0.126 in	
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 @Temperature 25.0 °C	29600 ksi @Temperature 77.0 °F	Dynamic

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

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

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 @Temperature 600 °C	0.143 BTU/lb-°F @Temperature 1110 °F	
Thermal Conductivity	10.0 W/m-K @Temperature 25.0 °C	69.4 BTU-in/hr-ft²-°F @Temperature 77.0 °F	
	12.0 W/m-K @Temperature 100 °C	83.3 BTU-in/hr-ft²-°F @Temperature 212 °F	
	14.0 W/m-K @Temperature 200 °C	97.2 BTU-in/hr-ft²-°F @Temperature 392 °F	
	16.0 W/m-K @Temperature 300 °C	111 BTU-in/hr-ft²-°F @Temperature 572 °F	
	18.0 W/m-K @Temperature 400 °C	125 BTU-in/hr-ft²-°F @Temperature 752 °F	
	19.0 W/m-K @Temperature 500 °C	132 BTU-in/hr-ft²-°F @Temperature 932 °F	
	23.0 W/m-K @Temperature 600 °C	160 BTU-in/hr-ft²-°F @Temperature 1110 °F	
Melting Point	1332 - 1361 °C	2430 - 2482 °F	
Solidus	1332 °C	2430 °F	
Liquidus	1361 °C	2482 °F	

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

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 %	

Descriptive Properties

Descriptive Properties		
Thermal Diffusivity	0.028 cm²/s	at 25°C
	0.031 cm²/s	at 100°C
	0.034 cm²/s	at 200°C
	0.038 cm²/s	at 300°C
	0.042 cm²/s	at 400°C
	0.045 cm²/s	at 500°C
	0.048 cm²/s	at 600°C