

## Haynes Hastelloy® C-22HS™ Nickel Alloy Sheet, Cold-rolled, Solution Annealed

Categories: [Metal](#); [Nonferrous Metal](#); [Nickel Alloy](#)

**Material Notes:** Outstanding Corrosion Resistance, High Strength

HASTELLOY® C-22HSTM alloy is corrosion-resistant, nickel-chromium-molybdenum alloy which can be heat treated to obtain a strength approximately double that of other C-type alloys. Importantly, the corrosion resistance and ductility of the alloy remain excellent when in the high strength condition. In addition to its high uniform corrosion resistance in oxidizing as well as reducing environments, the as-heat treated C-22HS alloy possesses high resistance to chloride-induced pitting and crevice corrosion attack.

C-22HS alloy is available in the form of plate, sheet, strip, billet, bar, wire, pipe, and tube.

Heat Treatment: The high strength of C-22HS alloy is derived from the formation of strengthening particles of Ni<sub>2</sub>(Mo,Cr) which form during the patented two-step age-hardening heat treatment. The approximately 48 hour heat treatment, 1300°F (705°C) FC to 1125°F (605°C)/32 hours/AC, is described in more detail on page 14.

Solution Annealed and Filler Wire Applications: C-22HS alloy may also be considered for applications which do not require the high strength imparted by the heat treatment. In the annealed condition, C-22HS alloy has even higher corrosion-resistance, particularly with regard to localized corrosive attack. This localized attack resistance also makes the alloy an attractive candidate as a general-purpose filler metal or weld overlay.

Applications:

- Agitators and blenders
- Shafting
- Fan blades and hubs
- Fasteners
- Springs
- Valves
- Dies
- Screws
- Wellhead parts
- Rings and gaskets

Heat Treatment: Wrought forms of C-22HS alloy are furnished in the solution annealed condition, unless otherwise specified. The standard solution annealing treatment consists of heating to 1975°F (1080°C) followed by rapid air-cooling or water quenching. Parts which have been hot formed should be solution annealed prior to final fabrication or installation. To use the alloy in the high-strength condition, it is necessary to age-harden using a two step treatment of 1300°F (705°C) for 16 hours, furnace cooling to 1125°F (605°C) and holding at that temperature for 32 hours, followed by an air cool. Cold or hot-worked structures should normally be given a full solution anneal prior to performing the age-hardening treatment.



Forming: C-22HS 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. For further information on the fabrication of C-type alloys, please consult publication H-2010.

Machining: C-22HS alloy may be machined in either the solution annealed or age-hardened condition. Carbide or ceramic tools are recommended. For use in the age-hardened condition, it is suggested to rough machine in the annealed condition. After performing the age-hardening heat treatment, light machining may be performed to achieve desired final dimensions.

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	8.60 g/cc	0.311 lb/in <sup>3</sup>	annealed
	8.64 g/cc	0.312 lb/in <sup>3</sup>	age-hardened
Mechanical Properties	Metric	English	Comments
Hardness, Rockwell B	90	90	Mill-annealed
Tensile Strength, Ultimate 	665 MPa	96500 psi	
	@Temperature 600 °C	@Temperature 1110 °F	
	691 MPa	100000 psi	
	@Temperature 500 °C	@Temperature 932 °F	
	718 MPa	104000 psi	
	@Temperature 400 °C	@Temperature 752 °F	
	734 MPa	106000 psi	
	@Temperature 300 °C	@Temperature 572 °F	
	754 MPa	109000 psi	
	@Temperature 200 °C	@Temperature 392 °F	
	807 MPa	117000 psi	
	@Temperature 100 °C	@Temperature 212 °F	
	837 MPa	121000 psi	
	@Temperature 25.0 °C	@Temperature 77.0 °F	
Tensile Strength, Yield 	288 MPa	41800 psi	



	@Strain 0.200 %, Temperature 600 °C	@Strain 0.200 %, Temperature 1110 °F
	296 MPa @Strain 0.200 %, Temperature 500 °C	42900 psi @Strain 0.200 %, Temperature 932 °F
	308 MPa @Strain 0.200 %, Temperature 400 °C	44700 psi @Strain 0.200 %, Temperature 752 °F
	316 MPa @Strain 0.200 %, Temperature 300 °C	45800 psi @Strain 0.200 %, Temperature 572 °F
	343 MPa @Strain 0.200 %, Temperature 200 °C	49700 psi @Strain 0.200 %, Temperature 392 °F
	394 MPa @Strain 0.200 %, Temperature 100 °C	57100 psi @Strain 0.200 %, Temperature 212 °F
	439 MPa @Strain 0.200 %, Temperature 25.0 °C	63700 psi @Strain 0.200 %, Temperature 77.0 °F

Elongation at Break	57.3 % @Temperature 25.0 °C	57.3 % @Temperature 77.0 °F
	58.6 % @Temperature 200 °C	58.6 % @Temperature 392 °F
	59.9 % @Temperature 100 °C	59.9 % @Temperature 212 °F
	66.8 % @Temperature 300 °C	66.8 % @Temperature 572 °F
	67.8 % @Temperature 500 °C	67.8 % @Temperature 932 °F
	69.6 % @Temperature 400 °C	69.6 % @Temperature 752 °F
	69.9 % @Temperature 600 °C	69.9 % @Temperature 1110 °F

Modulus of Elasticity	181 GPa @Temperature 600 °C	26300 ksi @Temperature 1110 °F	Dynamic
	195 GPa @Temperature 500 °C	28300 ksi @Temperature 932 °F	Dynamic
	205 GPa @Temperature 400 °C	29700 ksi @Temperature 752 °F	Dynamic
	209 GPa @Temperature 300 °C	30300 ksi @Temperature 572 °F	Dynamic
	211 GPa @Temperature 200 °C	30600 ksi @Temperature 392 °F	Dynamic
	218 GPa @Temperature 100 °C	31600 ksi @Temperature 212 °F	Dynamic
	223 GPa @Temperature 25.0 °C	32300 ksi @Temperature 77.0 °F	Dynamic

Electrical Properties	Metric	English	Comments
Electrical Resistivity	0.0000980 ohm-cm @Temperature 25.0 °C	0.0000980 ohm-cm @Temperature 77.0 °F	
	0.000100 ohm-cm @Temperature 100 °C	0.000100 ohm-cm @Temperature 212 °F	
	0.000104 ohm-cm @Temperature 200 °C	0.000104 ohm-cm @Temperature 392 °F	
	0.000108 ohm-cm @Temperature 300 °C	0.000108 ohm-cm @Temperature 572 °F	
	0.000112 ohm-cm @Temperature 400 °C	0.000112 ohm-cm @Temperature 752 °F	
	0.000115 ohm-cm @Temperature 500 °C	0.000115 ohm-cm @Temperature 932 °F	
	0.000117 ohm-cm @Temperature 600 °C	0.000117 ohm-cm @Temperature 1110 °F	

Thermal Properties	Metric	English	Comments
CTE, linear	11.6 µm/m-°C @Temperature 25.0 - 100 °C	6.44 µin/in-°F @Temperature 77.0 - 212 °F	
	12.0 µm/m-°C @Temperature 25.0 - 200 °C	6.67 µin/in-°F @Temperature 77.0 - 392 °F	
	12.4 µm/m-°C @Temperature 25.0 - 300 °C	6.89 µin/in-°F @Temperature 77.0 - 572 °F	
	12.7 µm/m-°C @Temperature 25.0 - 400 °C	7.06 µin/in-°F @Temperature 77.0 - 752 °F	

	@Temperature 25.0 - 400 °C	@Temperature 77.0 - 752 °F
	13.1 µm/m-°C	7.28 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
Specific Heat Capacity 	0.412 J/g-°C	0.0985 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
	0.451 J/g-°C	0.108 BTU/lb-°F
	@Temperature 200 °C	@Temperature 392 °F
	0.465 J/g-°C	0.111 BTU/lb-°F
	@Temperature 300 °C	@Temperature 572 °F
	0.477 J/g-°C	0.114 BTU/lb-°F
	@Temperature 400 °C	@Temperature 752 °F
	0.488 J/g-°C	0.117 BTU/lb-°F
	@Temperature 500 °C	@Temperature 932 °F
	0.504 J/g-°C	0.120 BTU/lb-°F
	@Temperature 600 °C	@Temperature 1110 °F
Thermal Conductivity 	11.8 W/m-K	81.9 BTU-in/hr-ft²-°F
	@Temperature 25.0 °C	@Temperature 77.0 °F
	13.5 W/m-K	93.7 BTU-in/hr-ft²-°F
	@Temperature 100 °C	@Temperature 212 °F
	15.4 W/m-K	107 BTU-in/hr-ft²-°F
	@Temperature 200 °C	@Temperature 392 °F
	17.1 W/m-K	119 BTU-in/hr-ft²-°F
	@Temperature 300 °C	@Temperature 572 °F
	18.6 W/m-K	129 BTU-in/hr-ft²-°F
	@Temperature 400 °C	@Temperature 752 °F
	20.5 W/m-K	142 BTU-in/hr-ft²-°F
	@Temperature 500 °C	@Temperature 932 °F
	22.4 W/m-K	155 BTU-in/hr-ft²-°F
	@Temperature 600 °C	@Temperature 1110 °F
Melting Point	1304 - 1368 °C	2379 - 2494 °F
Solidus	1304 °C	2379 °F
Liquidus	1368 °C	2494 °F

Processing Properties	Metric	English	Comments
Annealing Temperature	1079 °C	1975 °F	

Component Elements Properties	Metric	English	Comments
Aluminum, Al	<= 0.50 %	<= 0.50 %	
Boron, B	<= 0.0060 %	<= 0.0060 %	
Carbon, C	<= 0.010 %	<= 0.010 %	
Chromium, Cr	21 %	21 %	
Cobalt, Co	<= 1.0 %	<= 1.0 %	
Iron, Fe	<= 2.0 %	<= 2.0 %	
Manganese, Mn	<= 0.80 %	<= 0.80 %	
Molybdenum, Mo	17 %	17 %	
Nickel, Ni	57 %	57 %	as balance
Silicon, Si	<= 0.080 %	<= 0.080 %	
Tungsten, W	<= 1.0 %	<= 1.0 %	

#### Descriptive Properties

Thermal Diffusivity	0.0334 cm²/s	at 25°C
	0.0362 cm²/s	at 100°C
	0.0398 cm²/s	at 200°C
	0.0427 cm²/s	at 300°C
	0.0454 cm²/s	at 400°C
	0.0489 cm²/s	at 500°C
	0.0517 cm²/s	at 600°C

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