

## Haynes Hastelloy® S alloy, gas tungsten arc welded, aged 1300 hours

Category : Metal , Nonferrous Metal , Nickel Alloy , Superalloy

### Material Notes:

Nickel-based, high temperature alloy. Excellent thermal stability, low thermal expansion, excellent oxidation resistance to 1093°C, good high temperature and thermal fatigue strength. Applications include seal rings in gas turbine engines, and severe cyclical heating conditions where it retains strength, ductility, and integrity. Data provided by the manufacturer, Haynes International, Inc.

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Physical Properties	Metric	English	Comments
Density	8.75 g/cc	0.316 lb/in <sup>3</sup>	

Mechanical Properties	Metric	English	Comments
Tensile Strength, Ultimate	964 MPa	140000 psi	
Tensile Strength, Yield	678 MPa @Strain 0.200 %	98300 psi @Strain 0.200 %	
Elongation at Break	25 %	25 %	in 50.8 mm
Reduction of Area	24 %	24 %	
Modulus of Elasticity	132 GPa @Temperature 1093 °C	19100 ksi @Temperature 1999 °F	Heat treated at 1066°C, air cooled
	151 GPa @Temperature 927 °C	21900 ksi @Temperature 1700 °F	Heat treated at 1066°C, air cooled
	161 GPa @Temperature 813 °C	23400 ksi @Temperature 1500 °F	Heat treated at 1066°C, air cooled
	166 GPa @Temperature 760 °C	24100 ksi @Temperature 1400 °F	Heat treated at 1066°C, air cooled
	174 GPa @Temperature 649 °C	25200 ksi @Temperature 1200 °F	Heat treated at 1066°C, air cooled
	182 GPa @Temperature 538 °C	26400 ksi @Temperature 1000 °F	Heat treated at 1066°C, air cooled

Mechanical Properties	Metric <sup>SI</sup>	English <sup>SI</sup>	Comments
	@Temperature 357 Â°C	@Temperature 675 Â°F	Heat treated at 1888Â°C, air cooled
	212 GPa	30700 ksi	
	@Temperature 24.0 Â°C	@Temperature 75.2 Â°F	

Thermal Properties	Metric	English	Comments
CTE, linear	11.5 Âµm/m-Â°C	6.39 Âµin/in-Â°F	
	@Temperature 20.0 - 93.0 Â°C	@Temperature 68.0 - 199 Â°F	
	12.2 Âµm/m-Â°C	6.78 Âµin/in-Â°F	
	@Temperature 20.0 - 204 Â°C	@Temperature 68.0 - 399 Â°F	
	12.8 Âµm/m-Â°C	7.11 Âµin/in-Â°F	
	@Temperature 20.0 - 316 Â°C	@Temperature 68.0 - 601 Â°F	
	13.1 Âµm/m-Â°C	7.28 Âµin/in-Â°F	
	@Temperature 20.0 - 427 Â°C	@Temperature 68.0 - 801 Â°F	
	13.3 Âµm/m-Â°C	7.39 Âµin/in-Â°F	
	@Temperature 20.0 - 538 Â°C	@Temperature 68.0 - 1000 Â°F	
14.4 Âµm/m-Â°C	8.00 Âµin/in-Â°F		
@Temperature 20.0 - 760 Â°C	@Temperature 68.0 - 1400 Â°F		
14.9 Âµm/m-Â°C	8.28 Âµin/in-Â°F		
@Temperature 20.0 - 871 Â°C	@Temperature 68.0 - 1600 Â°F		
15.5 Âµm/m-Â°C	8.61 Âµin/in-Â°F		
@Temperature 20.0 - 982 Â°C	@Temperature 68.0 - 1800 Â°F		
16.0 Âµm/m-Â°C	8.89 Âµin/in-Â°F		
@Temperature 20.0 - 1093 Â°C	@Temperature 68.0 - 1999 Â°F		
Specific Heat Capacity	0.398 J/g-Â°C	0.0951 BTU/lb-Â°F	
	@Temperature 0.000 Â°C	@Temperature 32.0 Â°F	

Thermal Properties	0.414 J/g-Â°C Metric	0.0989 BTU/lb-Â°F English	Comments
	@Temperature 50.0 Â°C	@Temperature 122 Â°F	
	0.440 J/g-Â°C	0.105 BTU/lb-Â°F	
	@Temperature 150 Â°C	@Temperature 302 Â°F	
	0.456 J/g-Â°C	0.109 BTU/lb-Â°F	
	@Temperature 250 Â°C	@Temperature 482 Â°F	
	0.473 J/g-Â°C	0.113 BTU/lb-Â°F	
	@Temperature 350 Â°C	@Temperature 662 Â°F	
	0.481 J/g-Â°C	0.115 BTU/lb-Â°F	
	@Temperature 450 Â°C	@Temperature 842 Â°F	
	0.494 J/g-Â°C	0.118 BTU/lb-Â°F	
	@Temperature 550 Â°C	@Temperature 1020 Â°F	
	0.502 J/g-Â°C	0.120 BTU/lb-Â°F	
	@Temperature 650 Â°C	@Temperature 1200 Â°F	
	0.590 J/g-Â°C	0.141 BTU/lb-Â°F	
	@Temperature 800 Â°C	@Temperature 1470 Â°F	
	0.594 J/g-Â°C	0.142 BTU/lb-Â°F	
	@Temperature 850 Â°C	@Temperature 1560 Â°F	
	0.594 J/g-Â°C	0.142 BTU/lb-Â°F	
	@Temperature 900 Â°C	@Temperature 1650 Â°F	
	0.594 J/g-Â°C	0.142 BTU/lb-Â°F	
	@Temperature 700 Â°C	@Temperature 1290 Â°F	
	0.594 J/g-Â°C	0.142 BTU/lb-Â°F	
	@Temperature 750 Â°C	@Temperature 1380 Â°F	
	0.598 J/g-Â°C	0.143 BTU/lb-Â°F	
	@Temperature 1000 Â°C	@Temperature 1830 Â°F	
	0.598 J/g-Â°C	0.143 BTU/lb-Â°F	

Thermal Properties	Metric @ Temperature 1050 °C	English @ Temperature 1920 °F	Comments
	0.598 J/g-°C	0.143 BTU/lb-°F	
	@Temperature 950 °C	@Temperature 1740 °F	
	0.603 J/g-°C	0.144 BTU/lb-°F	
	@Temperature 1100 °C	@Temperature 2010 °F	
Thermal Conductivity	14.0 W/m-K	97.2 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 200 °C	@Temperature 392 °F	
	16.1 W/m-K	112 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 300 °C	@Temperature 572 °F	
	17.9 W/m-K	124 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 400 °C	@Temperature 752 °F	
	19.5 W/m-K	135 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 500 °C	@Temperature 932 °F	
	21.0 W/m-K	146 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 600 °C	@Temperature 1110 °F	
	26.1 W/m-K	181 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 700 °C	@Temperature 1290 °F	
	26.1 W/m-K	181 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 800 °C	@Temperature 1470 °F	
	26.1 W/m-K	181 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 900 °C	@Temperature 1650 °F	
	27.1 W/m-K	188 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 950 °C	@Temperature 1740 °F	
	28.0 W/m-K	194 BTU-in/hr-ft <sup>2</sup> -°F	
	@Temperature 1000 °C	@Temperature 1830 °F	
Melting Point	1335 - 1380 °C	2435 - 2520 °F	

<b>Solidus Thermal Properties</b>	<b>1335 Å°C Metric</b>	<b>2435 Å°F English</b>	<b>Comments</b>
Liquidus	1380 Å°C	2520 Å°F	
Maximum Service Temperature, Air	1093 Å°C	1999 Å°F	

<b>Component Elements Properties</b>	<b>Metric</b>	<b>English</b>	<b>Comments</b>
Aluminum, Al	0.10 - 0.50 %	0.10 - 0.50 %	
Boron, B	<= 0.015 %	<= 0.015 %	
Carbon, C	<= 0.020 %	<= 0.020 %	
Chromium, Cr	14.5 - 17 %	14.5 - 17 %	
Cobalt, Co	<= 2.0 %	<= 2.0 %	
Copper, Cu	<= 0.35 %	<= 0.35 %	
Iron, Fe	<= 3.0 %	<= 3.0 %	
Lanthanum, La	0.010 - 0.10 %	0.010 - 0.10 %	
Manganese, Mn	0.30 - 1.0 %	0.30 - 1.0 %	
Molybdenum, Mo	14 - 16.5 %	14 - 16.5 %	
Nickel, Ni	67 %	67 %	
Phosphorous, P	<= 0.020 %	<= 0.020 %	
Silicon, Si	0.20 - 0.75 %	0.20 - 0.75 %	
Sulfur, S	<= 0.015 %	<= 0.015 %	
Tungsten, W	<= 1.0 %	<= 1.0 %	

<b>Electrical Properties</b>	<b>Metric</b>	<b>English</b>	<b>Comments</b>
Electrical Resistivity	0.000128 ohm-cm @Temperature 25.0 Å°C	0.000128 ohm-cm @Temperature 77.0 Å°F	specimen aged 16000 hours at 650Å°C (1200Å°F)

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