

Haynes Hastelloy® S alloy, flat products

Categories: [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.


Key Words: UNS N06635, AMS 5711, AMS 5838, AMS 5873

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| Physical Properties | Metric | English | Comments |
|--|---|---|----------|
| Density | 8.75 g/cc | 0.316 lb/in ³ | |
| Mechanical Properties | Metric | English | Comments |
| Hardness, Rockwell A  | 52 @Thickness 1.45 mm | 52 @Thickness 0.0571 in | |
| | 57 @Thickness 12.7 mm | 57 @Thickness 0.500 in | |
| Tensile Strength, Ultimate  | 110 MPa @Thickness 1.10 - 1.60 mm, Temperature 1093 °C | 16000 psi @Thickness 0.0433 - 0.0630 in, Temperature 1999 °F | |
| | 117 MPa @Thickness 9.50 - 25.4 mm, Temperature 1093 °C | 17000 psi @Thickness 0.374 - 1.00 in, Temperature 1999 °F | |
| | 193 MPa @Thickness 1.10 - 1.60 mm, Temperature 982 °C | 28000 psi @Thickness 0.0433 - 0.0630 in, Temperature 1800 °F | |
| | 228 MPa @Thickness 9.50 - 25.4 mm, Temperature 982 °C | 33100 psi @Thickness 0.374 - 1.00 in, Temperature 1800 °F | |
| | 341 MPa @Thickness 1.10 - 1.60 mm, Temperature 871 °C | 49500 psi @Thickness 0.0433 - 0.0630 in, Temperature 1600 °F | |
| | 363 MPa @Thickness 9.50 - 25.4 mm, Temperature 871 °C | 52600 psi @Thickness 0.374 - 1.00 in, Temperature 1600 °F | |
| | 547 MPa @Thickness 9.50 - 25.4 mm, Temperature 760 °C | 79300 psi @Thickness 0.374 - 1.00 in, Temperature 1400 °F | |
| | 574 MPa @Thickness 1.10 - 1.60 mm, Temperature 760 °C | 83300 psi @Thickness 0.0433 - 0.0630 in, Temperature 1400 °F | |
| | 683 MPa @Thickness 9.50 - 25.4 mm, Temperature 649 °C | 99100 psi @Thickness 0.374 - 1.00 in, Temperature 1200 °F | |
| | 720 MPa @Thickness 1.10 - 1.60 mm, Temperature 649 °C | 104000 psi @Thickness 0.0433 - 0.0630 in, Temperature 1200 °F | |
| | 727 MPa @Thickness 9.50 - 25.4 mm, Temperature 538 °C | 105000 psi @Thickness 0.374 - 1.00 in, Temperature 1000 °F | |
| | 751 MPa @Thickness 9.50 - 25.4 mm, Temperature 427 °C | 109000 psi @Thickness 0.374 - 1.00 in, Temperature 801 °F | |
| | 756 MPa @Thickness 9.50 - 25.4 mm, Temperature 316 °C | 110000 psi @Thickness 0.374 - 1.00 in, Temperature 601 °F | |
| | 773 MPa @Thickness 1.10 - 1.60 mm, Temperature 538 °C | 112000 psi @Thickness 0.0433 - 0.0630 in, Temperature 1000 °F | |
| | 789 MPa @Thickness 9.50 - 25.4 mm, Temperature 204 °C | 114000 psi @Thickness 0.374 - 1.00 in, Temperature 399 °F | |
| 814 MPa @Thickness 9.50 - 25.4 mm, Temperature 93.0 °C | 118000 psi @Thickness 0.374 - 1.00 in, Temperature 199 °F | | |
| 844 MPa @Thickness 1.10 - 1.60 mm, | 122000 psi @Thickness 0.0433 - 0.0630 in, | | |


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|--|--|---|-------------|
| | Temperature 20.0 °C | Temperature 68.0 °F | |
| | 849 MPa @Thickness 9.50 - 25.4 mm, Temperature 20.0 °C | 123000 psi @Thickness 0.374 - 1.00 in, Temperature 68.0 °F | |
| | 864 MPa @Thickness 12.7 mm, Temperature 20.0 °C | 125000 psi @Thickness 0.500 in, Temperature 68.0 °F | |
| | 887 MPa @Thickness 1.45 mm, Temperature 20.0 °C | 129000 psi @Thickness 0.0571 in, Temperature 68.0 °F | |
| Tensile Strength, Yield  | 52.0 MPa @Thickness 1.10 - 1.60 mm, Temperature 1093 °C | 7540 psi @Thickness 0.0433 - 0.0630 in, Temperature 1999 °F | 0.2% offset |
| | 61.0 MPa @Thickness 9.50 - 25.4 mm, Temperature 1093 °C | 8850 psi @Thickness 0.374 - 1.00 in, Temperature 1999 °F | 0.2% offset |
| | 110 MPa @Thickness 1.10 - 1.60 mm, Temperature 982 °C | 16000 psi @Thickness 0.0433 - 0.0630 in, Temperature 1800 °F | 0.2% offset |
| | 135 MPa @Thickness 9.50 - 25.4 mm, Temperature 982 °C | 19600 psi @Thickness 0.374 - 1.00 in, Temperature 1800 °F | 0.2% offset |
| | 218 MPa @Thickness 1.10 - 1.60 mm, Temperature 871 °C | 31600 psi @Thickness 0.0433 - 0.0630 in, Temperature 1600 °F | 0.2% offset |
| | 233 MPa @Thickness 9.50 - 25.4 mm, Temperature 871 °C | 33800 psi @Thickness 0.374 - 1.00 in, Temperature 1600 °F | 0.2% offset |
| | 271 MPa @Thickness 9.50 - 25.4 mm, Temperature 760 °C | 39300 psi @Thickness 0.374 - 1.00 in, Temperature 1400 °F | 0.2% offset |
| | 274 MPa @Thickness 9.50 - 25.4 mm, Temperature 649 °C | 39700 psi @Thickness 0.374 - 1.00 in, Temperature 1200 °F | 0.2% offset |
| | 283 MPa @Thickness 9.50 - 25.4 mm, Temperature 538 °C | 41000 psi @Thickness 0.374 - 1.00 in, Temperature 1000 °F | 0.2% offset |
| | 291 MPa @Thickness 9.50 - 25.4 mm, Temperature 316 °C | 42200 psi @Thickness 0.374 - 1.00 in, Temperature 601 °F | 0.2% offset |
| | 297 MPa @Thickness 9.50 - 25.4 mm, Temperature 427 °C | 43100 psi @Thickness 0.374 - 1.00 in, Temperature 801 °F | 0.2% offset |
| | 311 MPa @Thickness 1.10 - 1.60 mm, Temperature 760 °C | 45100 psi @Thickness 0.0433 - 0.0630 in, Temperature 1400 °F | 0.2% offset |
| | 322 MPa @Thickness 1.10 - 1.60 mm, Temperature 649 °C | 46700 psi @Thickness 0.0433 - 0.0630 in, Temperature 1200 °F | 0.2% offset |
| | 331 MPa @Thickness 9.50 - 25.4 mm, Temperature 204 °C | 48000 psi @Thickness 0.374 - 1.00 in, Temperature 399 °F | 0.2% offset |
| | 338 MPa @Thickness 1.10 - 1.60 mm, Temperature 538 °C | 49000 psi @Thickness 0.0433 - 0.0630 in, Temperature 1000 °F | 0.2% offset |
| | 365 MPa @Thickness 9.50 - 25.4 mm, Temperature 93.0 °C | 52900 psi @Thickness 0.374 - 1.00 in, Temperature 199 °F | 0.2% offset |
| | 365 MPa @Thickness 12.7 mm, Temperature 20.0 °C | 52900 psi @Thickness 0.500 in, Temperature 68.0 °F | 0.2% offset |
| | 383 MPa @Thickness 9.50 - 25.4 mm, Temperature 20.0 °C | 55500 psi @Thickness 0.374 - 1.00 in, Temperature 68.0 °F | 0.2% offset |
| | 434 MPa @Thickness 1.45 mm, Temperature 20.0 °C | 62900 psi @Thickness 0.0571 in, Temperature 68.0 °F | 0.2% offset |
| | 444 MPa @Thickness 1.10 - 1.60 mm, Temperature 20.0 °C | 64400 psi @Thickness 0.0433 - 0.0630 in, Temperature 68.0 °F | 0.2% offset |
| Elongation at Break  | 46 % @Thickness 1.10 - 1.60 mm, Temperature 982 °C | 46 % @Thickness 0.0433 - 0.0630 in, Temperature 1800 °F | in 50.8 mm |
| | 47 % @Thickness 1.10 - 1.60 mm, Temperature 871 °C | 47 % @Thickness 0.0433 - 0.0630 in, Temperature 1600 °F | in 50.8 mm |

| | temperature 071 °C | temperature 1000 °F | |
|--|---|---|---|
| | 49 % @Thickness 1.10 - 1.60 mm, Temperature 20.0 °C | 49 % @Thickness 0.0433 - 0.0630 in, Temperature 68.0 °F | in 50.8 mm |
| | 50 % @Thickness 1.10 - 1.60 mm, Temperature 538 °C | 50 % @Thickness 0.0433 - 0.0630 in, Temperature 1000 °F | in 50.8 mm |
| | 54 % @Thickness 12.7 mm, Temperature 20.0 °C | 54 % @Thickness 0.500 in, Temperature 68.0 °F | in 50.8 mm |
| | 55 % @Thickness 9.50 - 25.4 mm, Temperature 20.0 °C | 55 % @Thickness 0.374 - 1.00 in, Temperature 68.0 °F | in 50.8 mm |
| | 56 % @Thickness 1.10 - 1.60 mm, Temperature 649 °C | 56 % @Thickness 0.0433 - 0.0630 in, Temperature 1200 °F | in 50.8 mm |
| | 57 % @Thickness 9.50 - 25.4 mm, Temperature 871 °C | 57 % @Thickness 0.374 - 1.00 in, Temperature 1600 °F | in 50.8 mm |
| | 58 % @Thickness 1.45 mm, Temperature 20.0 °C | 58 % @Thickness 0.0571 in, Temperature 68.0 °F | in 50.8 mm |
| | 59 % @Thickness 9.50 - 25.4 mm, Temperature 204 °C | 59 % @Thickness 0.374 - 1.00 in, Temperature 399 °F | in 50.8 mm |
| | 59 % @Thickness 9.50 - 25.4 mm, Temperature 649 °C | 59 % @Thickness 0.374 - 1.00 in, Temperature 1200 °F | in 50.8 mm |
| | 60 % @Thickness 9.50 - 25.4 mm, Temperature 93.0 °C | 60 % @Thickness 0.374 - 1.00 in, Temperature 199 °F | in 50.8 mm |
| | 61 % @Thickness 9.50 - 25.4 mm, Temperature 538 °C | 61 % @Thickness 0.374 - 1.00 in, Temperature 1000 °F | in 50.8 mm |
| | 62 % @Thickness 9.50 - 25.4 mm, Temperature 427 °C | 62 % @Thickness 0.374 - 1.00 in, Temperature 801 °F | in 50.8 mm |
| | 62 % @Thickness 9.50 - 25.4 mm, Temperature 982 °C | 62 % @Thickness 0.374 - 1.00 in, Temperature 1800 °F | in 50.8 mm |
| | 63 % @Thickness 9.50 - 25.4 mm, Temperature 316 °C | 63 % @Thickness 0.374 - 1.00 in, Temperature 601 °F | in 50.8 mm |
| | 69 % @Thickness 9.50 - 25.4 mm, Temperature 760 °C | 69 % @Thickness 0.374 - 1.00 in, Temperature 1400 °F | in 50.8 mm |
| | 69 % @Thickness 9.50 - 25.4 mm, Temperature 1093 °C | 69 % @Thickness 0.374 - 1.00 in, Temperature 1999 °F | in 50.8 mm |
| | 70 % @Thickness 1.10 - 1.60 mm, Temperature 760 °C | 70 % @Thickness 0.0433 - 0.0630 in, Temperature 1400 °F | in 50.8 mm |
| | 75 % @Thickness 1.10 - 1.60 mm, Temperature 1093 °C | 75 % @Thickness 0.0433 - 0.0630 in, Temperature 1999 °F | in 50.8 mm |
| 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 |
| | 194 GPa @Temperature 357 °C | 28100 ksi @Temperature 675 °F | Heat treated at 1066°C, air cooled |
| | 212 GPa @Temperature 24.0 °C | 30700 ksi @Temperature 75.2 °F | |
| Charpy Impact | 190 J | 140 ft-lb | V Notch; solution heat-treated, not aged |
| Electrical Properties | Metric | English | Comments |
| Electrical Resistivity | 0.000128 ohm-cm | 0.000128 ohm-cm | specimen aged 16000 hours at 650°C (1200°F) |

@Temperature 25.0 °C

@Temperature 77.0 °F

Thermal Properties

CTE, linear 

Metric

English

Comments

| | |
|--|--|
| 11.5 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 93.0 °C | 6.39 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 199 °F |
| 12.2 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 204 °C | 6.78 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 399 °F |
| 12.8 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 316 °C | 7.11 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 601 °F |
| 13.1 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 427 °C | 7.28 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 801 °F |
| 13.3 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 538 °C | 7.39 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 1000 °F |
| 14.4 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 760 °C | 8.00 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 1400 °F |
| 14.9 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 871 °C | 8.28 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 1600 °F |
| 15.5 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 982 °C | 8.61 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 1800 °F |
| 16.0 $\mu\text{m}/\text{m}\cdot\text{°C}$ @Temperature 20.0 - 1093 °C | 8.89 $\mu\text{in}/\text{in}\cdot\text{°F}$ @Temperature 68.0 - 1999 °F |

Specific Heat Capacity 

| | |
|---------------------------------------|--|
| 0.398 J/g·°C @Temperature 0.000 °C | 0.0951 BTU/lb·°F @Temperature 32.0 °F |
| 0.414 J/g·°C @Temperature 50.0 °C | 0.0989 BTU/lb·°F @Temperature 122 °F |
| 0.440 J/g·°C @Temperature 150 °C | 0.105 BTU/lb·°F @Temperature 302 °F |
| 0.456 J/g·°C @Temperature 250 °C | 0.109 BTU/lb·°F @Temperature 482 °F |
| 0.473 J/g·°C @Temperature 350 °C | 0.113 BTU/lb·°F @Temperature 662 °F |
| 0.481 J/g·°C @Temperature 450 °C | 0.115 BTU/lb·°F @Temperature 842 °F |
| 0.494 J/g·°C @Temperature 550 °C | 0.118 BTU/lb·°F @Temperature 1020 °F |
| 0.502 J/g·°C @Temperature 650 °C | 0.120 BTU/lb·°F @Temperature 1200 °F |
| 0.590 J/g·°C @Temperature 800 °C | 0.141 BTU/lb·°F @Temperature 1470 °F |
| 0.594 J/g·°C @Temperature 850 °C | 0.142 BTU/lb·°F @Temperature 1560 °F |
| 0.594 J/g·°C @Temperature 900 °C | 0.142 BTU/lb·°F @Temperature 1650 °F |
| 0.594 J/g·°C @Temperature 700 °C | 0.142 BTU/lb·°F @Temperature 1290 °F |
| 0.594 J/g·°C @Temperature 750 °C | 0.142 BTU/lb·°F @Temperature 1380 °F |
| 0.598 J/g·°C @Temperature 950 °C | 0.143 BTU/lb·°F @Temperature 1740 °F |
| 0.598 J/g·°C @Temperature 1000 °C | 0.143 BTU/lb·°F @Temperature 1830 °F |
| 0.598 J/g·°C @Temperature 1050 °C | 0.143 BTU/lb·°F @Temperature 1920 °F |
| 0.603 J/g·°C @Temperature 1100 °C | 0.144 BTU/lb·°F @Temperature 2010 °F |

Thermal Conductivity 

| | |
|-----------------------------------|---|
| 14.0 W/m-K @Temperature 200 °C | 97.2 BTU-in/hr-ft ² ·°F @Temperature 392 °F |
| 16.1 W/m-K @Temperature 300 °C | 112 BTU-in/hr-ft ² ·°F @Temperature 572 °F |
| 17.9 W/m-K @Temperature 400 °C | 124 BTU-in/hr-ft ² ·°F @Temperature 752 °F |
| 19.5 W/m-K @Temperature 500 °C | 135 BTU-in/hr-ft ² ·°F @Temperature 932 °F |
| 21.0 W/m-K @Temperature 600 °C | 146 BTU-in/hr-ft ² ·°F @Temperature 1110 °F |
| 26.1 W/m-K @Temperature 700 °C | 181 BTU-in/hr-ft ² ·°F @Temperature 1290 °F |
| 26.1 W/m-K @Temperature 800 °C | 181 BTU-in/hr-ft ² ·°F @Temperature 1470 °F |
| 26.1 W/m-K @Temperature 900 °C | 181 BTU-in/hr-ft ² ·°F @Temperature 1650 °F |
| 27.1 W/m-K @Temperature 950 °C | 188 BTU-in/hr-ft ² ·°F @Temperature 1740 °F |

| | | |
|----------------------------------|------------------------------------|---|
| | 28.0 W/m-K @Temperature 1000 °C | 194 BTU-in/hr-ft ² -°F @Temperature 1830 °F |
| Melting Point | 1335 - 1380 °C | 2435 - 2520 °F |
| Solidus | 1335 °C | 2435 °F |
| Liquidus | 1380 °C | 2520 °F |
| Maximum Service Temperature, Air | 1093 °C | 1999 °F |

| Component Elements Properties | Metric | English | Comments |
|-------------------------------|----------------|----------------|----------|
| 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 % | |

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