HAYNES® 718 alloy

An age-hardenable Ni-Fe-Cr-Cb-Mo-Ti-Al alloy that combines excellent strength to 1200°F (650°C) with good ductility, formability, and weldability.
**PRINCIPAL FEATURES**

**Excellent High-Temperature Strength Up to 1200°F (650°C), Good Ductility, Formability, and Weldability**

HAYNES® 718 alloy is an age-hardenable nickel-iron-chromium-columbium-molybdenum-titanium-aluminum alloy designed to combine excellent strength with good fabrication characteristics in the annealed condition. While limited to applications below 1200°F (650°C), it is significantly stronger at these lower temperatures than such materials as Waspaloy alloy, R-41 alloy, or X-750 alloy. It is also much easier to weld than these alloys, and is less susceptible to the strain age cracking problems common for gamma prime strengthened materials.

HAYNES 718 alloy is normally only used for component applications up to 1200°F (650°C); however, its oxidation resistance is comparable to that for other gamma-prime strengthened superalloys.

**Fabrication**

HAYNES 718 alloy has very good forming and welding characteristics. The hot working temperature range for the alloy is approximately 1700 to 2100°F (985-1150°C). The alloy has very good ductility in the annealed condition, and thus may also be formed by cold working. Intermediate annealing in the temperature range from 1700 to 1850°F (925 to 1010°C) may be needed for complex component forming operations. All hot- or cold-worked parts should be annealed and rapidly cooled in order to restore the best balance of properties.

HAYNES 718 alloy can be welded by both manual and automatic welding methods, including gas tungsten arc (TIG), gas metal arc (MIG), electron beam, and resistance welding. Matching composition filler wire is available and is generally used for welding 718 alloy.

**Heat Treatment**

Wrought HAYNES 718 alloy is furnished in the solution heat-treated condition unless otherwise specified. The alloy is normally solution heat-treated at 1700 to 1850°F (925 to 1010°C) and rapidly cooled or water quenched for optimal properties. Following solution heat treatment, the alloy is normally age-hardened by a two step treatment consisting of 1325°F (720°C) for 8 hours, furnace cooling to 1150°C (620°C), holding for an additional 8 hours, and then air cooling.

**Available in Convenient Forms**

HAYNES 718 alloy is produced in the form of sheet, strip, plate, bar, billet, wire, and tubular products.

**Applications**

HAYNES 718 alloy combines properties which make it suitable for a variety of fabricated component applications in both aircraft turbine engines and land-based turbines. These include rings, casings, and many types of formed sheet metal components. It is also used for fasteners and instrumentation parts. The alloy also is used in various applications for oil/gas well down hole and well head components.

**Applicable Specifications**

HAYNES 718 alloy is covered by the following specifications: AMS 5596/5597 (sheet, strip and plate), AMS 5662/5664 (bar and billet), AMS 5832 (wire), AMS 5589/5590 (seamless tubulars); NACE MR-01-75 (oil field equipment); and ASTM B-626 (welded tubing). The UNS number for this material is N07718.

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### Nominal Chemical Composition, Weight Percent

<table>
<thead>
<tr>
<th></th>
<th>Ni</th>
<th>Co</th>
<th>Fe</th>
<th>Cr</th>
<th>Cb+Ta</th>
<th>Mo</th>
<th>Mn</th>
<th>Si</th>
<th>Ti</th>
<th>Al</th>
<th>C</th>
<th>B</th>
<th>Cu</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>52²</td>
<td>1*</td>
<td>19</td>
<td>18</td>
<td>5</td>
<td>3</td>
<td>0.35*</td>
<td>0.35*</td>
<td>0.9</td>
<td>0.5</td>
<td>0.05</td>
<td>0.009</td>
<td>0.1*</td>
</tr>
</tbody>
</table>

²As Balance  
* Maximum

---

HAYNES 718 alloy
## CREEP AND STRESS-RUPTURE STRENGTHS

**Cold-Rolled, Solution-Treated and Aged**

### Approximate Initial Stress, Ksi (MPa)

<table>
<thead>
<tr>
<th>Test Temperature</th>
<th>Creep, Percent</th>
<th>10 Hours</th>
<th>100 Hours</th>
<th>1,000 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 °F 540 °C</td>
<td>0.5</td>
<td>157 (1080)</td>
<td>146 (1005)</td>
<td>132 (910)</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>160 (1105)</td>
<td>150 (1035)</td>
<td>138 (950)</td>
</tr>
<tr>
<td></td>
<td>Rupture</td>
<td>-</td>
<td>165 (1140)</td>
<td>144 (995)</td>
</tr>
<tr>
<td>1100 °F 595 °C</td>
<td>0.5</td>
<td>140 (965)</td>
<td>126 (870)</td>
<td>108 (745)</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>143 (985)</td>
<td>130 (895)</td>
<td>112 (770)</td>
</tr>
<tr>
<td></td>
<td>Rupture</td>
<td>-</td>
<td>150 (1035)</td>
<td>115 (795)</td>
</tr>
<tr>
<td>1200 °F 650 °C</td>
<td>0.5</td>
<td>121 (835)</td>
<td>101 (695)</td>
<td>75 (515)</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>124 (855)</td>
<td>103 (710)</td>
<td>78 (540)</td>
</tr>
<tr>
<td></td>
<td>Rupture</td>
<td>-</td>
<td>130 (895)</td>
<td>87 (600)</td>
</tr>
<tr>
<td>1300 °F 705 °C</td>
<td>0.5</td>
<td>95 (655)</td>
<td>64 (440)</td>
<td>25 (175)</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>98 (675)</td>
<td>66 (455)</td>
<td>33 (230)</td>
</tr>
<tr>
<td></td>
<td>Rupture</td>
<td>-</td>
<td>102 (705)</td>
<td>43 (295)</td>
</tr>
<tr>
<td>1400 °F 760 °C</td>
<td>0.5</td>
<td>58 (400)</td>
<td>22 (150)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>60 (415)</td>
<td>26 (180)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Rupture</td>
<td>70 (485)</td>
<td>36 (250)</td>
<td>14 (97)</td>
</tr>
</tbody>
</table>

*Limited data

### Comparison of Stress to Produce 1% Creep in 1000 Hours

HAYNES® 718 alloy has stress-rupture strength up to 1200°F (650°C) which is superior to most other age-hardenable, wrought nickel-base superalloys. At temperatures above 1200°F (650°C), materials such as Waspaloy alloy and R-41 alloy provide higher strength.
## TYPICAL TENSILE PROPERTIES

**Cold-Rolled, Solution-Treated and Aged* (Sheet)**

<table>
<thead>
<tr>
<th>Test Temperature</th>
<th>Ultimate Tensile Strength</th>
<th>Yield Strength at 0.2% Offset</th>
<th>Elongation in 2 in. (50.8 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>°F</td>
<td>°C</td>
<td>Ksi</td>
<td>MPa</td>
</tr>
<tr>
<td>Room</td>
<td>Room</td>
<td>202.3</td>
<td>1395</td>
</tr>
<tr>
<td>1000</td>
<td>540</td>
<td>164.1</td>
<td>1130</td>
</tr>
<tr>
<td>1200</td>
<td>650</td>
<td>167.6</td>
<td>1155</td>
</tr>
<tr>
<td>1400</td>
<td>760</td>
<td>124.1</td>
<td>855</td>
</tr>
<tr>
<td>1600</td>
<td>870</td>
<td>43.9</td>
<td>305</td>
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<tr>
<td>1800</td>
<td>980</td>
<td>20.9</td>
<td>145</td>
</tr>
<tr>
<td>2000</td>
<td>1095</td>
<td>11.2</td>
<td>77</td>
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</table>

*Limited data

## DYNAMIC MODULUS OF ELASTICITY

<table>
<thead>
<tr>
<th>Temperature, °F</th>
<th>British Units</th>
<th>Temperature, °C</th>
<th>Metric Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Room</td>
<td>29.0 x 10⁶ psi</td>
<td>Room</td>
<td>200 GPa</td>
</tr>
<tr>
<td>200</td>
<td>28.4 x 10⁶ psi</td>
<td>100</td>
<td>195 GPa</td>
</tr>
<tr>
<td>400</td>
<td>27.6 x 10⁶ psi</td>
<td>200</td>
<td>191 GPa</td>
</tr>
<tr>
<td>600</td>
<td>26.7 x 10⁶ psi</td>
<td>300</td>
<td>185 GPa</td>
</tr>
<tr>
<td>800</td>
<td>25.8 x 10⁶ psi</td>
<td>400</td>
<td>179 GPa</td>
</tr>
<tr>
<td>1000</td>
<td>24.8 x 10⁶ psi</td>
<td>500</td>
<td>173 GPa</td>
</tr>
<tr>
<td>1200</td>
<td>23.7 x 10⁶ psi</td>
<td>600</td>
<td>167 GPa</td>
</tr>
<tr>
<td>1400</td>
<td>22.3 x 10⁶ psi</td>
<td>700</td>
<td>159 GPa</td>
</tr>
<tr>
<td>1600</td>
<td>20.2 x 10⁶ psi</td>
<td>800</td>
<td>149 GPa</td>
</tr>
<tr>
<td>1800</td>
<td>17.4 x 10⁶ psi</td>
<td>900</td>
<td>134 GPa</td>
</tr>
<tr>
<td>1000</td>
<td></td>
<td>1000</td>
<td>117 GPa</td>
</tr>
<tr>
<td><strong>Physical Property</strong></td>
<td><strong>British Units</strong></td>
<td><strong>Metric Units</strong></td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td><strong>Density</strong></td>
<td>Room</td>
<td>0.297 lb/in³</td>
<td>Room</td>
</tr>
<tr>
<td><strong>Melting Range</strong></td>
<td>2300-2435</td>
<td>1260-1335</td>
<td></td>
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<tr>
<td><strong>Electrical Resistivity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room</td>
<td>47.5 microhm-in.</td>
<td>Room</td>
<td>121 microhm-cm</td>
</tr>
<tr>
<td>200</td>
<td>48.0 microhm-in.</td>
<td>100</td>
<td>122 microhm-cm</td>
</tr>
<tr>
<td>400</td>
<td>49.4 microhm-in.</td>
<td>200</td>
<td>125 microhm-cm</td>
</tr>
<tr>
<td>600</td>
<td>50.3 microhm-in.</td>
<td>300</td>
<td>127 microhm-cm</td>
</tr>
<tr>
<td>800</td>
<td>50.7 microhm-in.</td>
<td>400</td>
<td>129 microhm-cm</td>
</tr>
<tr>
<td>1000</td>
<td>51.6 microhm-in.</td>
<td>500</td>
<td>130 microhm-cm</td>
</tr>
<tr>
<td>1200</td>
<td>52.0 microhm-in.</td>
<td>600</td>
<td>132 microhm-cm</td>
</tr>
<tr>
<td>1400</td>
<td>52.2 microhm-in.</td>
<td>700</td>
<td>132 microhm-cm</td>
</tr>
<tr>
<td>1600</td>
<td>52.1 microhm-in.</td>
<td>800</td>
<td>132 microhm-cm</td>
</tr>
<tr>
<td>1800</td>
<td>52.4 microhm-in.</td>
<td>900</td>
<td>133 microhm-cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000</td>
<td>133 microhm-cm</td>
</tr>
<tr>
<td><strong>Thermal Conductivity</strong></td>
<td></td>
<td>Room</td>
<td>11.4 W/m-K</td>
</tr>
<tr>
<td>Room</td>
<td>79 Btu-in./ft² hr.°F</td>
<td>Room</td>
<td>11.4 W/m-K</td>
</tr>
<tr>
<td>200</td>
<td>87 Btu-in./ft² hr.°F</td>
<td>100</td>
<td>12.6 W/m-K</td>
</tr>
<tr>
<td>400</td>
<td>100 Btu-in./ft² hr.°F</td>
<td>200</td>
<td>14.3 W/m-K</td>
</tr>
<tr>
<td>600</td>
<td>112 Btu-in./ft² hr.°F</td>
<td>300</td>
<td>15.9 W/m-K</td>
</tr>
<tr>
<td>800</td>
<td>124 Btu-in./ft² hr.°F</td>
<td>400</td>
<td>17.5 W/m-K</td>
</tr>
<tr>
<td>1000</td>
<td>136 Btu-in./ft² hr.°F</td>
<td>500</td>
<td>19.0 W/m-K</td>
</tr>
<tr>
<td>1200</td>
<td>148 Btu-in./ft² hr.°F</td>
<td>600</td>
<td>20.6 W/m-K</td>
</tr>
<tr>
<td>1400</td>
<td>161 Btu-in./ft² hr.°F</td>
<td>700</td>
<td>22.2 W/m-K</td>
</tr>
<tr>
<td>1600</td>
<td>173 Btu-in./ft² hr.°F</td>
<td>800</td>
<td>23.8 W/m-K</td>
</tr>
<tr>
<td>1800</td>
<td>186 Btu-in./ft² hr.°F</td>
<td>900</td>
<td>25.4 W/m-K</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000</td>
<td>27.1 W/m-K</td>
</tr>
<tr>
<td><strong>Mean Coefficient of Thermal Expansion</strong></td>
<td></td>
<td>25-100</td>
<td>12.8 µm/m-°C</td>
</tr>
<tr>
<td>70-200</td>
<td>7.1 microinches/in-°F</td>
<td>25-200</td>
<td>13.5 µm/m-°C</td>
</tr>
<tr>
<td>70-400</td>
<td>7.5 microinches/in-°F</td>
<td>25-300</td>
<td>13.8 µm/m-°C</td>
</tr>
<tr>
<td>70-600</td>
<td>7.7 microinches/in-°F</td>
<td>25-400</td>
<td>14.1 µm/m-°C</td>
</tr>
<tr>
<td>70-800</td>
<td>7.9 microinches/in-°F</td>
<td>25-500</td>
<td>14.3 µm/m-°C</td>
</tr>
<tr>
<td>70-1000</td>
<td>8.0 microinches/in-°F</td>
<td>25-600</td>
<td>14.8 µm/m-°C</td>
</tr>
<tr>
<td>70-1200</td>
<td>8.4 microinches/in-°F</td>
<td>25-700</td>
<td>15.5 µm/m-°C</td>
</tr>
<tr>
<td>70-1400</td>
<td>8.9 microinches/in-°F</td>
<td>25-800</td>
<td>16.3 µm/m-°C</td>
</tr>
<tr>
<td>70-1600</td>
<td>9.4 microinches/in-°F</td>
<td>25-900</td>
<td>17.2 µm/m-°C</td>
</tr>
</tbody>
</table>
HAYNES® 718 alloy has very good forming and welding characteristics. It may be hot-worked at temperatures in the range of about 1700-2100°F (925-1150°C) provided the entire piece is soaked for a time sufficient to bring it uniformly to temperature. Initial breakdown is normally performed at the higher end of the range, while finishing is usually done at the lower temperatures to afford grain refinement.

As a consequence of its good ductility, 718 alloy is also readily formed by cold-working. All hot- or cold-worked parts should normally be annealed at 1700 to 1850°F (925 to 1010°C) and cooled by air cool or faster rate before aging in order to develop the best balance of properties.

The alloy can be welded by a variety of processes, including gas tungsten arc, gas metal arc, electron beam and resistance welding. High heat input processes such as submerged arc and oxyacetylene welding are not recommended.

**Welding Procedures**
Welding procedures common to most high-temperature, nickel-base alloys are recommended. These include use of stringer beads and an interpass temperature less than 200°F (95°C). Preheat is not required. Cleanliness is critical, and careful attention should be given to the removal of grease, oil, crayon marks, shop dirt, etc. prior to welding. Because of the alloy’s high nickel content, the weld puddle will be somewhat “sluggish” relative to steels. To avoid lack of fusion and incomplete penetration defects, the root opening and bevel should be sufficiently open.

**Filler Metals**
HAYNES 718 alloy should be joined using matching filler metal. For welding 718 alloy to other alloys, HASTELLOY® alloys S or W filler wires are suggested.

**Post-Weld Heat Treatment**
HAYNES 718 alloy is normally used in the fully-aged condition. Following forming and welding, a full solution anneal prior to aging is often employed in order to develop the best joint and overall fabrication properties. The best practice is dependent upon the specific condition of the fabrication prior to aging. Contact Haynes International, Inc. for further information.

**HEALTH AND SAFETY INFORMATION**
Welding can be a safe occupation. Those in the welding industry, however, should be aware of the potential hazards associated with welding fumes, gases, radiation, electric shock, heat, eye injuries, burns, etc. Also, local, municipal, state, and federal regulations (such as those issued by OSHA) relative to welding and cutting processes should be considered.

Nickel-, cobalt-, and iron-base alloy products may contain, in varying concentrations, the following elemental constituents: aluminum, cobalt, chromium, copper, iron, manganese, molybdenum, nickel and tungsten. For specific concentrations of these and other elements present, refer to the Materials Safety Data Sheets (MSDS), H3095 and H1072 for the product.

Inhalation of metal dust or fumes generated from welding, cutting, grinding, melting, or dross handling of these alloys may cause adverse health effects such as reduced lung function, nasal and mucous membrane irritation. Exposure to dust or fumes which may be generated in working with these alloys may also cause eye irritation, skin rash and effects on other organ systems.

The operation and maintenance of welding and cutting equipment should conform to the provisions of American National Standard ANSI/AWS Z49.1, “Safety in Welding and Cutting”. Attention is especially called to Section 7 (Protection of Personnel) and 8 (Health Protection and Ventilation) of ANSI/AWS Z49.1. Mechanical ventilation is advisable and, under certain conditions such as a very confined space, is necessary during welding or cutting operations, or both, to prevent possible exposure to hazardous fumes, gases, or dust that may occur.
STANDARD PRODUCTS

By Brand or Alloy Designation:

**HASTELLOY® Family of Corrosion-Resistant Alloys**

B-2, B-3®, C-4, C-22®, C-276, C-2000®, D-205™, G-3, G-30®, G-50® and N

**HASTELLOY Family of Heat-Resistant Alloys**

S, W, and X

**HAYNES® Family of Heat-Resistant Alloys**


**Corrosion-Wear Resistant Alloy**

ULTIMET®

**Wear-Resistant Alloy**

6B

**HAYNES Titanium Alloy Tubular**

Ti-3Al-2.5V

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**Standard Forms:**
Bar, Billet, Plate, Sheet, Strip, Coils, Seamless or Welded Pipe & Tubing, Pipe Fittings, Flanges, Fittings, Welding Wire and Coated Electrodes

**Properties Data:**

The data and information in this publication are based on work conducted principally by Haynes International, Inc. and occasionally supplemented by information from the open literature, and are believed to be reliable. However, we do not make any warranty or assume any legal liability or responsibility for its accuracy, completeness or usefulness, nor do we represent that its use would not infringe upon private rights. Any suggestions as to uses and applications for specific alloys are opinions only and Haynes International, Inc. makes no warranty of results to be obtained in any particular situation. For specific concentrations of elements present in a particular product and a discussion of the potential health effects thereof, refer to the Material Safety Data Sheet supplied by Haynes International, Inc.

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