Stainless Steel 316 has superior corrosion resistance properties as well as elevated temperature prolong performance potential. It offers good resistance to pitting and crevice corrosion in the various chemical conditions. Excellent aqueous corrosion resistance. High oxidation resistance up to 870°C. SS 316 is used in digesters, containers, evaporating systems, fabric production equipments, spacejet engine parts, mining and medical apparatus and in welding applications.

The nominal carbon content of 316L paired with an inclusion of nitrogen empowers 316L to fulfill the mechanical properties need of 316. Steel 316L offers resistance to atmospheric corrosion and moderate reducing and oxidizing conditions. It also offers resistance to corrosion in polluted marine applications. Steel 316L offers resistance to intergranular corrosion in the welded form. It has high strength and hardness at cryogenic temperatures. It is non magnetic in the annealed condition and becomes slightly magnetic by cold processing or welding. It can be conveniently welded and worked by normal fabrication methods.

### Chemical Composition

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon (C)</td>
<td>0.03 %</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>2 %</td>
</tr>
<tr>
<td>Silicon (Si)</td>
<td>.75 %</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>0.045 %</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>0.03 %</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>16 to 18 %</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>2 to 3 %</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>10 to 14 %</td>
</tr>
<tr>
<td>Nitrogen (N)</td>
<td>0.10 %</td>
</tr>
</tbody>
</table>

### Physical Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>7.87 to 8.07 Mg/m³ or 491.308 lb/ft³ to 503.794 lb/ft³</td>
</tr>
<tr>
<td>Bulk Modulus</td>
<td>134 to 152 GPA or 19.435 to 22.0457 x 10⁶ psi</td>
</tr>
</tbody>
</table>
Compressive strength: 170 to 310 Mpa or 24.6 to 44.9617 ksi
Ductility: 0.3 to 0.51
Elastic limit: 170 to 310 Mpa or 24.6 to 45 ksi
Endurance limit: 256 to 307 Mpa or 37.1 to 44.53 ksi
Hardness: 1700 to 2200 Mpa or 246.5 to 319 ksi
Rupture modulus: 170 to 310 Mpa or 24.7 to 44.96 ksi
Poisson ratio: 0.265 to 0.275
Shear modulus: 74 to 82 Gpa or 10.7 to 11.8 x 10(6) psi
Tensile strength: 480 to 620 Mpa or 69.6 to 89.92 ksi
Young Modulus: 190 to 205 Gpa or 27.56 to 29.73 x 10(6) psi
Latest heat of fusion: 260 to 285 kj/kg or 111.7 to 122.5 BTU/lb
Highest operation temperature: 1023 to 1198 K or 1381 to 1696°F
Melting temperature: 1648 to 1673 K or 2506 to 2551°F
Lowest operation temperature: -459.7°F
Specific heat: 490 to 530 J/Kg.K or 0.38 to 0.41 BTU/lb°F
Thermal conductivity: 13 to 17 W/m.K or 24.3364 to 31.82 BTU.ft/h.ft.°F
Thermal expansion: 15 to 18 x 10^-6/K or 27 to 32.4 x 10^-6/°F
Electric resistivity: 69 to 81 x 10^-8 ohm.m

### Modulus of Elasticity

<table>
<thead>
<tr>
<th>°F</th>
<th>°C</th>
<th>Modulus</th>
<th>Psi x 10(6)</th>
<th>GPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>27</td>
<td>Tension</td>
<td>28.1 x 10(6), 11 Psi x 10(6)</td>
<td>194 GPa, 76 GPa</td>
</tr>
<tr>
<td>200</td>
<td>93</td>
<td>Tension, shear</td>
<td>27.5 Psi x 10(6), 10.6 Psi x 10(6)</td>
<td>190 GPa, 73 GPa</td>
</tr>
<tr>
<td>300</td>
<td>149</td>
<td>Tension, shear</td>
<td>26.9 Psi x 10(6), 10.3 Psi x 10(6)</td>
<td>185 GPa, 71 GPa</td>
</tr>
<tr>
<td>500</td>
<td>260</td>
<td>Tension, shear</td>
<td>26.3 Psi x 10(6), 10 Psi x 10(6)</td>
<td>181 GPa, 69 GPa</td>
</tr>
<tr>
<td>600</td>
<td>316</td>
<td>Tension, shear</td>
<td>25.6 Psi x 10(6), 9.7 Psi x 10(6)</td>
<td>177 GPa, 67 GPa</td>
</tr>
<tr>
<td>700</td>
<td>371</td>
<td>Tension, shear</td>
<td>24.9 Psi x 10(6), 9.4 Psi x 10(6)</td>
<td>172 GPa, 65 GPa</td>
</tr>
<tr>
<td>800</td>
<td>427</td>
<td>Tension, shear</td>
<td>24.2 Psi x 10(6), 9.1 Psi x 10(6)</td>
<td>167 GPa, 63 GPa</td>
</tr>
<tr>
<td>900</td>
<td>482</td>
<td>Tension, shear</td>
<td>23.5 Psi x 10(6), 8.8 Psi x 10(6)</td>
<td>162 GPa, 61 GPa</td>
</tr>
<tr>
<td>1000</td>
<td>538</td>
<td>Tension, shear</td>
<td>22.8 Psi x 10(6), 8.5 Psi x 10(6)</td>
<td>157 GPa, 59 GPa</td>
</tr>
<tr>
<td>1100</td>
<td>593</td>
<td>Tension, shear</td>
<td>22.2 Psi x 10(6), 8.3 Psi x 10(6)</td>
<td>153 GPa, 57 GPa</td>
</tr>
<tr>
<td>1200</td>
<td>649</td>
<td>Tension, shear</td>
<td>21.5 Psi x 10(6), 8.1 Psi x 10(6)</td>
<td>148 GPa, 56 GPa</td>
</tr>
<tr>
<td>1300</td>
<td>704</td>
<td>Tension, shear</td>
<td>20.8 Psi x 10(6), 7.6 Psi x 10(6)</td>
<td>143 GPa, 54 GPa</td>
</tr>
<tr>
<td>1400</td>
<td>760</td>
<td>Tension, shear</td>
<td>20 Psi x 10(6), 7.9 Psi x 10(6)</td>
<td>138 GPa, 53 GPa</td>
</tr>
<tr>
<td>1500</td>
<td>816</td>
<td>Tension, shear</td>
<td>19.1 Psi x 10(6), 7.5 Psi x 10(6)</td>
<td>132 GPa, 52 GPa</td>
</tr>
</tbody>
</table>

### Mechanical Properties

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Tensile strength</th>
<th>Yield strength</th>
<th>Elongation, %</th>
<th>Hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>316</td>
<td>75 ksi</td>
<td>30 ksi</td>
<td>40%</td>
<td>95 HRB</td>
</tr>
<tr>
<td>316</td>
<td>70 ksi</td>
<td>25 ksi</td>
<td>40%</td>
<td>95 HRB</td>
</tr>
<tr>
<td>1.4404</td>
<td>75 ksi</td>
<td>34.81 ksi</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>1.4401</td>
<td>75 ksi</td>
<td>34.81 ksi</td>
<td>40%</td>
<td></td>
</tr>
</tbody>
</table>

### Annealed sheet mechanical properties

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Yield strength</th>
<th>Tensile strength</th>
<th>Elongation, %</th>
<th>Reduction of area, %</th>
<th>Hardness</th>
<th>Rockwell</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Temp</th>
<th>Tensile strength, MPa</th>
<th>0.2 % Proof stress</th>
<th>Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 °C</td>
<td>540 Mpa</td>
<td>235 Mpa</td>
<td>52 %</td>
</tr>
<tr>
<td>300 °C</td>
<td>500 Mpa</td>
<td>165 Mpa</td>
<td>48 %</td>
</tr>
<tr>
<td>500 °C</td>
<td>480 Mpa</td>
<td>145 Mpa</td>
<td>47 %</td>
</tr>
<tr>
<td>600 °C</td>
<td>450 Mpa</td>
<td>140 Mpa</td>
<td>44 %</td>
</tr>
<tr>
<td>700 °C</td>
<td>350 Mpa</td>
<td>130 Mpa</td>
<td>43 %</td>
</tr>
<tr>
<td>800 °C</td>
<td>205 Mpa</td>
<td>115 Mpa</td>
<td>42 %</td>
</tr>
<tr>
<td>900 °C</td>
<td>100 Mpa</td>
<td>-</td>
<td>63 %</td>
</tr>
<tr>
<td>1000 °C</td>
<td>50 Mpa</td>
<td>-</td>
<td>62 %</td>
</tr>
<tr>
<td>1100 °C</td>
<td>25 Mpa</td>
<td>-</td>
<td>76 %</td>
</tr>
</tbody>
</table>

**Creep and rupture properties**

<table>
<thead>
<tr>
<th>Temp, °C</th>
<th>Stress to create 1% strain</th>
<th>Stress to create rupture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10,000 hours</td>
<td>100,000 hours</td>
</tr>
<tr>
<td>550 °C</td>
<td>225 Mpa</td>
<td>125 Mpa</td>
</tr>
<tr>
<td>600 °C</td>
<td>145 Mpa</td>
<td>80 Mpa</td>
</tr>
<tr>
<td>650 °C</td>
<td>95 Mpa</td>
<td>55 Mpa</td>
</tr>
<tr>
<td>700 °C</td>
<td>65 Mpa</td>
<td>35 Mpa</td>
</tr>
<tr>
<td>750 °C</td>
<td>40 Mpa</td>
<td>20 Mpa</td>
</tr>
<tr>
<td>800 °C</td>
<td>30 Mpa</td>
<td>15 Mpa</td>
</tr>
<tr>
<td>850 °C</td>
<td>20 Mpa</td>
<td>10 Mpa</td>
</tr>
</tbody>
</table>

**Sub zero temperature properties**

<table>
<thead>
<tr>
<th>Temp</th>
<th>Tensile strength</th>
<th>0.2 % Proof stress</th>
<th>Elongation</th>
<th>Impact energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 °C</td>
<td>584 Mpa</td>
<td>235 Mpa</td>
<td>61 %</td>
<td>170 J</td>
</tr>
<tr>
<td>0 °C</td>
<td>680 Mpa</td>
<td>260 Mpa</td>
<td>70 %</td>
<td>191 J</td>
</tr>
<tr>
<td>-10 °C</td>
<td>832 Mpa</td>
<td>336 Mpa</td>
<td>69 %</td>
<td>186 J</td>
</tr>
<tr>
<td>-50 °C</td>
<td>1105 Mpa</td>
<td>380 Mpa</td>
<td>65 %</td>
<td>183 J</td>
</tr>
<tr>
<td>-140 °C</td>
<td>1136 Mpa</td>
<td>417 Mpa</td>
<td>61 %</td>
<td>155 J</td>
</tr>
<tr>
<td>-196 °C</td>
<td>1360 Mpa</td>
<td>444 Mpa</td>
<td>58 %</td>
<td>166 J</td>
</tr>
</tbody>
</table>

**Prolong High temperature exposure effect on mechanical properties**

<table>
<thead>
<tr>
<th>Temp</th>
<th>Yield strength</th>
<th>Tensile strength</th>
<th>Elongation in 2 inch</th>
<th>Reduction of area</th>
</tr>
</thead>
<tbody>
<tr>
<td>10,000 hours</td>
<td>of</td>
<td>oC</td>
<td>Ksi</td>
<td>MPa</td>
</tr>
<tr>
<td>900 °F</td>
<td>482 °C</td>
<td>45 Ksi</td>
<td>310 MPa</td>
<td>91.9 Ksi</td>
</tr>
<tr>
<td>1050 °F</td>
<td>566 °C</td>
<td>41.8 Ksi</td>
<td>288 MPa</td>
<td>97.2 Ksi</td>
</tr>
</tbody>
</table>
In different operations, alloy 316/316L has excellent corrosion resistance over steel 304/304L. The process conditions that do not corrode alloy 304/304L do not cause corrosion of this steel type except oxidizing acids like nitric acid however stainless steels comprising of molybdenum are minor resistant. Steel grade 316L offers good performance in the sulfur conditions that occur in the pulp and paper commerce. It can be utilized in high contents at temperatures about 120°F. It offers excellent resistance to pitting corrosion in phosphoric and acetic acid. It can be utilized in the food and medical processing industries to handle hot organic and fatty acids to reduce contamination.

### Corrosion rate in hydrofluoric acid

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Concentration %</th>
<th>Temperature °C</th>
<th>°F</th>
<th>Time</th>
<th>Corrosion rate Mm/y</th>
<th>mpy</th>
</tr>
</thead>
<tbody>
<tr>
<td>316</td>
<td>10 %</td>
<td>16</td>
<td>60</td>
<td>30 days</td>
<td>.002</td>
<td>.1 mpy</td>
</tr>
<tr>
<td>316</td>
<td>38 %</td>
<td>110</td>
<td>230</td>
<td>2 days</td>
<td>51 Mm/y</td>
<td>2000 mpy</td>
</tr>
<tr>
<td>316</td>
<td>40 %</td>
<td>20</td>
<td>68</td>
<td>-</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>316</td>
<td>70 %</td>
<td>21</td>
<td>70</td>
<td>42 days</td>
<td>1.24 Mm/y</td>
<td>49 mpy</td>
</tr>
<tr>
<td>316</td>
<td>98 %</td>
<td>34 to 44</td>
<td>95 to 110</td>
<td>3.5 days</td>
<td>.05 Mm/y</td>
<td>2 mpy</td>
</tr>
<tr>
<td>316</td>
<td>60 % to 65 %</td>
<td>-1.1 to 26</td>
<td>30 to 80</td>
<td>28 days</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>316</td>
<td>72 %</td>
<td>176</td>
<td>350</td>
<td>14 days</td>
<td>6 Mm/y</td>
<td>240 mpy</td>
</tr>
<tr>
<td>316</td>
<td>72 %</td>
<td>176</td>
<td>350</td>
<td>14 days</td>
<td>10 Mm/y</td>
<td>380 mpy</td>
</tr>
<tr>
<td>316</td>
<td>12 %</td>
<td>83</td>
<td>182</td>
<td>7.2 days</td>
<td>18 Mm/y</td>
<td>700 mpy</td>
</tr>
<tr>
<td>316</td>
<td>50 %</td>
<td>176</td>
<td>350</td>
<td>7 days</td>
<td>2.6 Mm/y</td>
<td>103 mpy</td>
</tr>
<tr>
<td>316</td>
<td>50 %</td>
<td>176</td>
<td>350</td>
<td>7 days</td>
<td>28 Mm/y</td>
<td>113 mpy</td>
</tr>
<tr>
<td>316</td>
<td>50 %</td>
<td>RT to 60</td>
<td>140</td>
<td>4 days</td>
<td>2.5 Mm/y</td>
<td>100 mpy</td>
</tr>
<tr>
<td>316</td>
<td>37 %</td>
<td>75</td>
<td>167</td>
<td>9.3 days</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>316</td>
<td>29 %</td>
<td>60</td>
<td>140</td>
<td>10.3 days</td>
<td>2.5 Mm/y</td>
<td>100 mpy</td>
</tr>
<tr>
<td>316</td>
<td>70 %</td>
<td>21</td>
<td>70</td>
<td>42 days</td>
<td>12 Mm/y</td>
<td>490 mpy</td>
</tr>
<tr>
<td>316</td>
<td>6 %</td>
<td>135</td>
<td>275</td>
<td>226 days</td>
<td>0.3 Mm/y</td>
<td>12 mpy</td>
</tr>
<tr>
<td>316</td>
<td>46.5 %</td>
<td>98 to 104</td>
<td>210 to 220</td>
<td>49 days</td>
<td>0.03 Mm/y</td>
<td>1 mpy</td>
</tr>
<tr>
<td>316</td>
<td>38 %</td>
<td>110</td>
<td>230</td>
<td>2 days</td>
<td>50 Mm/y</td>
<td>2000 mpy</td>
</tr>
</tbody>
</table>

Stainless steel type 316 offers good functionality in fresh water service in fact in the presence of concentrated chlorides. It has superior corrosion resistance in the seawater conditions. The high concentration of molybdenum ensures the outstanding pitting resistance in the chloride conditions. In several cases, the corrosion resistance steel 316 and 316L show similar performance. But to avoid intergranular corrosion attack of welds and heat affected zone, alloy 316L should be utilized that has lower content of carbon. Steel type 316/316L can be conveniently welded and processed through standard fabrication.

### Fabrication

**Hot Forging:** The processing temperature of 1700°F to 2200°F is preferred for common hot processing operations. For highest corrosion resistance, the alloy should be annealed at 1900°F at least and water cooling or quickly cooled through other ways subsequent to hot processing.
Cold Forging: Steel 316/316L is highly ductile and formable. The cold processing enhances its strength and toughness and provides magnetic features.

Welding: Steel 316L can be easily welded through common methods. The post weld heat processing is not essential.

Machining: 316L steel type is subjected to work toughening while deformation and it is subjected to chip breaking. The superior machining outcomes are obtained with slow speed, large feed rate, superior lubrication, sharp tooling and strong devices.

**Available Forms**

Wire, Mesh, Flanges, Pipe, Strip, Foil, Plate, Sheet, Rod, Bar