

## Haynes Hastelloy® C-22® alloy, 6.4-19.1 mm thick plate, solution heat treated

Category : Metal , Nonferrous Metal , Nickel Alloy , Superalloy

### Material Notes:

HASTELLOY® C-22® alloy is a nickel-chromium-molybdenum-tungsten alloy with excellent overall corrosion resistance compared to other Ni-Cr-Mo alloys, including HASTELLOY C-276 and C-4 alloys and alloy 625. C-22 alloy has outstanding resistance to pitting, crevice corrosion, and stress corrosion cracking. It has excellent resistance to oxidizing aqueous media including wet chlorine and mixtures containing nitric acid or oxidizing acids with chloride ions. C-22 alloy offers optimum resistance to environments where reducing and oxidizing conditions are encountered in process streams. Because of such versatility it can be used where “upset” conditions are likely to occur or in multi-purpose plants. C-22 alloy has exceptional resistance to a wide variety of chemical process environments, including strong oxidizers such as ferric and cupric chlorides, chlorine, hot contaminated solutions (organic and inorganic), formic and acetic acids, acetic anhydride, and seawater and brine solutions. C-22 alloy resists the formation of grain-boundary precipitates in the weld heat-affected zone, thus making it suitable for most chemical process applications in the as-welded condition. Product Forms: C-22 alloy is available in most common product forms: plate, sheet, strip, billet, bar, wire, covered electrodes, pipe, and tubing. Applications: Acetic Acid/Acetic Anhydride Acid Etching Cellophane Manufacturing Chlorination Systems Complex Acid Mixtures Electro-Galvanizing Rolls Expansion Bellows Flue Gas Scrubber Systems Geothermal Wells HF Furnace Scrubbers Incineration Scrubber Systems Nuclear Fuel Reprocessing Pesticide Production Phosphoric Acid Production Pickling Systems Plate Heat Exchangers Selective Leaching Systems SO2 Cooling Towers Sulfonation Systems Tubular Heat Exchangers Weld Overlay-Valves Data provided by the manufacturer, Haynes International, Inc.

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[http://www.lookpolymers.com/polymer\\_Haynes-Hastelloy-C-22-alloy-64-191-mm-thick-plate-solution-heat-treated.php](http://www.lookpolymers.com/polymer_Haynes-Hastelloy-C-22-alloy-64-191-mm-thick-plate-solution-heat-treated.php)

| Physical Properties | Metric    | English                  | Comments |
|---------------------|-----------|--------------------------|----------|
| Density             | 8.69 g/cc | 0.314 lb/in <sup>3</sup> |          |

| Mechanical Properties      | Metric               | English              | Comments |
|----------------------------|----------------------|----------------------|----------|
| Hardness, Rockwell B       | 93                   | 93                   |          |
|                            | @Temperature 23.0 °C | @Temperature 73.4 °F |          |
|                            | 95                   | 95                   |          |
|                            | @Temperature 23.0 °C | @Temperature 73.4 °F |          |
| Tensile Strength, Ultimate | 786 MPa              | 114000 psi           |          |
|                            | 524 MPa              | 76000 psi            |          |
|                            | @Temperature 760 °C  | @Temperature 1400 °F |          |
|                            | 572 MPa              | 83000 psi            |          |
|                            | @Temperature 649 °C  | @Temperature 1200 °F |          |
|                            | 607 MPa              | 88000 psi            |          |

| Mechanical Properties   | @Temperature 538 °C<br>Metric           | @Temperature 1000 °F<br>English         | Comments   |
|-------------------------|---|---|------------|
|                         | 634 MPa                                 | 92000 psi                               |            |
|                         | @Temperature 427 °C                     | @Temperature 801 °F                     |            |
|                         | 655 MPa                                 | 95000 psi                               |            |
|                         | @Temperature 316 °C                     | @Temperature 601 °F                     |            |
|                         | 676 MPa                                 | 98000 psi                               |            |
|                         | @Temperature 204 °C                     | @Temperature 399 °F                     |            |
|                         | 738 MPa                                 | 107000 psi                              |            |
|                         | @Temperature 93.0 °C                    | @Temperature 199 °F                     |            |
| Tensile Strength, Yield | 372 MPa                                 | 54000 psi                               |            |
|                         | @Strain 0.200 %                         | @Strain 0.200 %                         |            |
|                         | 214 MPa                                 | 31000 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 760 °C  | @Strain 0.200 %,<br>Temperature 1400 °F |            |
|                         | 221 MPa                                 | 32100 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 649 °C  | @Strain 0.200 %,<br>Temperature 1200 °F |            |
|                         | 234 MPa                                 | 33900 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 538 °C  | @Strain 0.200 %,<br>Temperature 1000 °F |            |
|                         | 241 MPa                                 | 35000 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 427 °C  | @Strain 0.200 %,<br>Temperature 801 °F  |            |
|                         | 248 MPa                                 | 36000 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 316 °C  | @Strain 0.200 %,<br>Temperature 601 °F  |            |
|                         | 283 MPa                                 | 41000 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 204 °C  | @Strain 0.200 %,<br>Temperature 399 °F  |            |
|                         | 338 MPa                                 | 49000 psi                               |            |
|                         | @Strain 0.200 %,<br>Temperature 93.0 °C | @Strain 0.200 %,<br>Temperature 199 °F  |            |
| Elongation at Break     | 62 %                                    | 62 %                                    | in 50.8 mm |
|                         | 65 %                                    | 65 %                                    | in 50.8 mm |
|                         | @Temperature 93.0 °C                    | @Temperature 199 °F                     |            |

| Mechanical Properties        | Metric              | English              | Comments  |
|------------------------------|---------------------|----------------------|---|
|                              | @Temperature 204 °C | @Temperature 399 °F  | in 50.8 mm  |
|                              | 67 %                | 67 %                 | in 50.8 mm  |
|                              | @Temperature 538 °C | @Temperature 1000 °F |   |
|                              | 68 %                | 68 %                 | in 50.8 mm  |
|                              | @Temperature 316 °C | @Temperature 601 °F  |   |
|                              | 68 %                | 68 %                 | in 50.8 mm  |
|                              | @Temperature 427 °C | @Temperature 801 °F  |   |
|                              | 68 %                | 68 %                 | in 50.8 mm  |
|                              | @Temperature 760 °C | @Temperature 1400 °F |   |
|                              | 69 %                | 69 %                 | in 50.8 mm  |
|                              | @Temperature 649 °C | @Temperature 1200 °F |   |
| <b>Modulus of Elasticity</b> | <b>206 GPa</b>      | <b>29900 ksi</b>     | <b>heat-treated at 1121°C (2050°F), rapid quenched, plate</b> |
|                              | 145 GPa             | 21000 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 982 °C | @Temperature 1800 °F |   |
|                              | 154 GPa             | 22300 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 871 °C | @Temperature 1600 °F |   |
|                              | 163 GPa             | 23600 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 760 °C | @Temperature 1400 °F |   |
|                              | 171 GPa             | 24800 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 649 °C | @Temperature 1200 °F |   |
|                              | 177 GPa             | 25700 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 538 °C | @Temperature 1000 °F |   |
|                              | 183 GPa             | 26500 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 427 °C | @Temperature 801 °F  |   |
|                              | 190 GPa             | 27600 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 316 °C | @Temperature 601 °F  |   |
|                              | 196 GPa             | 28400 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |
|                              | @Temperature 204 °C | @Temperature 399 °F  |   |
|                              | 203 GPa             | 29400 ksi            | heat-treated at 1121°C (2050°F), rapid quenched, plate        |

| Mechanical Properties | @Temperature 93.0 °C<br>Metric | @Temperature 199 °F<br>English | Comments  |
|-----------------------|--------------------------------|--------------------------------|---|
| Charpy Impact         | 353 J                          | 260 ft-lb                      | heat treated at 1121 °C (2050 °F) then rapid quenched |
|                       | 351 J                          | 259 ft-lb                      | heat treated at 1121 °C (2050 °F) then rapid quenched |
|                       | @Temperature -196 °C           | @Temperature -321 °F           |   |

| Thermal Properties         | Metric                      | English                     | Comments |
|----------------------------|-----------------------------|-----------------------------|----------|
| CTE, linear                | 12.4 µm/m-°C                | 6.89 µin/in-°F              |          |
|                            | @Temperature 24.0 - 93.0 °C | @Temperature 75.2 - 199 °F  |          |
|                            | 12.4 µm/m-°C                | 6.89 µin/in-°F              |          |
|                            | @Temperature 24.0 - 204 °C  | @Temperature 75.2 - 399 °F  |          |
|                            | 12.6 µm/m-°C                | 7.00 µin/in-°F              |          |
|                            | @Temperature 24.0 - 316 °C  | @Temperature 75.2 - 601 °F  |          |
|                            | 13.3 µm/m-°C                | 7.39 µin/in-°F              |          |
|                            | @Temperature 24.0 - 427 °C  | @Temperature 75.2 - 801 °F  |          |
|                            | 13.9 µm/m-°C                | 7.72 µin/in-°F              |          |
|                            | @Temperature 24.0 - 538 °C  | @Temperature 75.2 - 1000 °F |          |
| 14.6 µm/m-°C               | 8.11 µin/in-°F              |                             |          |
| @Temperature 24.0 - 649 °C | @Temperature 75.2 - 1200 °F |                             |          |
| 15.3 µm/m-°C               | 8.50 µin/in-°F              |                             |          |
| @Temperature 24.0 - 760 °C | @Temperature 75.2 - 1400 °F |                             |          |
| 15.8 µm/m-°C               | 8.78 µin/in-°F              |                             |          |
| @Temperature 24.0 - 871 °C | @Temperature 75.2 - 1600 °F |                             |          |
| 16.2 µm/m-°C               | 9.00 µin/in-°F              |                             |          |
| @Temperature 24.0 - 982 °C | @Temperature 75.2 - 1800 °F |                             |          |
| Specific Heat Capacity     | 0.414 J/g-°C                | 0.0989 BTU/lb-°F            |          |
|                            | @Temperature 52.0 °C        | @Temperature 126 °F         |          |
|                            | 0.423 J/g-°C                | 0.101 BTU/lb-°F             |          |

| Thermal Properties   | @Temperature 100 °C<br>Metric | @Temperature 212 °F<br>English     | Comments |
|----------------------|-------------------------------|------------------------------------|----------|
|                      | 0.444 J/g-°C                  | 0.106 BTU/lb-°F                    |          |
|                      | @Temperature 200 °C           | @Temperature 392 °F                |          |
|                      | 0.460 J/g-°C                  | 0.110 BTU/lb-°F                    |          |
|                      | @Temperature 300 °C           | @Temperature 572 °F                |          |
|                      | 0.476 J/g-°C                  | 0.114 BTU/lb-°F                    |          |
|                      | @Temperature 400 °C           | @Temperature 752 °F                |          |
|                      | 0.489 J/g-°C                  | 0.117 BTU/lb-°F                    |          |
|                      | @Temperature 500 °C           | @Temperature 932 °F                |          |
|                      | 0.514 J/g-°C                  | 0.123 BTU/lb-°F                    |          |
|                      | @Temperature 600 °C           | @Temperature 1110 °F               |          |
| Thermal Conductivity | 10.1 W/m-K                    | 70.1 BTU-in/hr-ft <sup>2</sup> -°F |          |
|                      | @Temperature 48.0 °C          | @Temperature 118 °F                |          |
|                      | 11.1 W/m-K                    | 77.0 BTU-in/hr-ft <sup>2</sup> -°F |          |
|                      | @Temperature 100 °C           | @Temperature 212 °F                |          |
|                      | 13.4 W/m-K                    | 93.0 BTU-in/hr-ft <sup>2</sup> -°F |          |
|                      | @Temperature 200 °C           | @Temperature 392 °F                |          |
|                      | 15.5 W/m-K                    | 108 BTU-in/hr-ft <sup>2</sup> -°F  |          |
|                      | @Temperature 300 °C           | @Temperature 572 °F                |          |
|                      | 17.5 W/m-K                    | 121 BTU-in/hr-ft <sup>2</sup> -°F  |          |
|                      | @Temperature 400 °C           | @Temperature 752 °F                |          |

| Electrical Properties  | Metric               | English              | Comments |
|------------------------|----------------------|----------------------|----------|
| Electrical Resistivity | 0.000114 ohm-cm      | 0.000114 ohm-cm      |          |
|                        | @Temperature 24.0 °C | @Temperature 75.2 °F |          |
|                        | 0.000123 ohm-cm      | 0.000123 ohm-cm      |          |
|                        | @Temperature 100 °C  | @Temperature 212 °F  |          |
|                        | 0.000124 ohm-cm      | 0.000124 ohm-cm      |          |
|                        | @Temperature 200 °C  | @Temperature 392 °F  |          |
|                        | 0.000125 ohm-cm      | 0.000125 ohm-cm      |          |
|                        | @Temperature 300 °C  | @Temperature 572 °F  |          |

| Electrical Properties | 0.000126 ohm-cm<br>Metric | 0.000126 ohm-cm<br>English | Comments |
|-----------------------|---------------------------|----------------------------|----------|
|                       | @Temperature 400 °C       | @Temperature 752 °F        |          |
|                       | 0.000127 ohm-cm           | 0.000127 ohm-cm            |          |
|                       | @Temperature 500 °C       | @Temperature 932 °F        |          |
|                       | 0.000128 ohm-cm           | 0.000128 ohm-cm            |          |
|                       | @Temperature 600 °C       | @Temperature 1110 °F       |          |

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