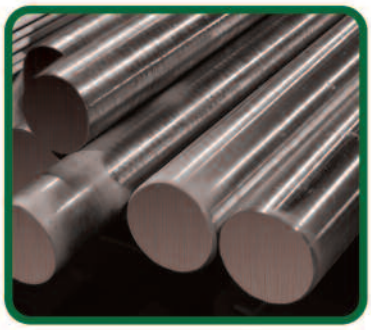
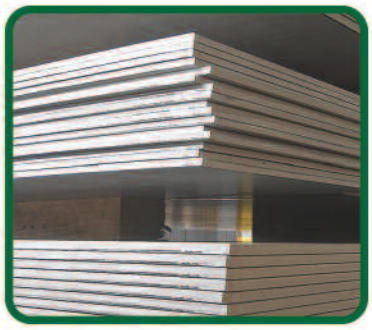
# Alloy 416 Specifications: UNS S41600





## ALLOY 416 (UNS S41600)

Penn Stainless inventory now includes Alloy 416 (UNS S41600) in plate and round bar products.

## GENERAL PROPERTIES

Alloy 416 is a martensitic, free-machining, chromium steel alloy that is generally considered to be the first free-machining stainless steel. It has the highest machinability of any stainless steel at about 85% of that of a free-machining carbon steel. Martensitic stainless steels were designed to be hardenable by heat treatment and also corrosion resistant. Although Alloy 416 and other martensitic stainless steels are not as resistant as austenitic or ferritic stainless, it still demonstrates good corrosion and oxidation resistance plus high strength in the hardened and tempered condition. Alloy 416 responds well to heat treating, is easily machined, is always magnetic, and has low frictional properties that reduce galling and seizing.

## APPLICATIONS

Alloy 416 is generally used for parts that are extensively machined and require the corrosion resistance of a 13% chromium stainless steel. Applications that generally use Alloy 416 include:

- Electrical motors
- Nuts and bolts
- Pumps
- Valves
- Automatic screw machine parts
- Washing machine components
- Studs
- Gears

## STANDARDS ALLOY 416

ASTM/ASME .....UNS S41600
EURONORM .....FeMi35Cr20Cu4Mo2
DIN .....2.4660

**Alloy 416 (UNS S41600) can be processed by Penn Stainless utilizing the following methods:**

- Shear Cutting
- Dynamic Water Jet Cutting
- Laser Cutting
- Saw Cutting
- Machine Cutting

**Product Offering:**

- Sheet
- Plate
- Round bar
- Square bar
- Hex Bar
- Rolled flat bar

## CORROSION RESISTANCE

- Demonstrates corrosion resistance to natural food acids, waste products, basic and neutral salts, natural waters, and most atmospheric conditions
- Less resistant that the austenitic grades of stainless steel and also the 17% chromium ferritic alloys
- High sulfur, free-machining grades like Alloy 416 are unsuitable for marine or other chloride exposure
- Maximum corrosion resistance is achieved in the hardened condition, with a smooth surface finish

## HEAT RESISTANCE

- Fair resistance to scaling in intermittent service up to 1400°F (760°C) and up to 1247°F (675°C) in continuous service
- Not recommended for use in temperatures above the relevant tempering temperature if maintenance of mechanical properties is important

## WELDING CHARACTERISTICS

- Poor weldability
- If welding is necessary use Alloy 410 low hydrogen electrodes
- Pre-heat to 392 to 572°F (200-300°C)
- Follow immediately with annealing or re-hardening, or a stress relief at 1202 to 1247°F (650 to 675°C)

## MACHINABILITY

- Has outstanding machinability
- Best machinability is in the sub-critical annealed condition.

## CHEMICAL PROPERTIES

| Type | C | Mn | Si | P | S | Cr |
|---|---|---|---|---|---|---|
| **416** | 0.15 max | 1.25 max | 1.00 max | 0.06 max | 0.15 max | min: 12.00 max: 14.00 |

## MECHANICAL PROPERTIES

| Tempering Temperature (°C) | Tensile Strength (MPa) | Yield Strength 0.2% Proof (MPa) | Elongation (% in 50mm) | Hardness Brinell (HB) | Impact Charpy V (J) |
|---|---|---|---|---|---|
| Annealed * | 517 | 276 | 30 | 262 | – |
| Condition T ** | 758 | 586 | 18 | 248-302 | – |
| 204 | 1340 | 1050 | 11 | 388 | 20 |
| 316 | 1350 | 1060 | 12 | 388 | 22 |
| 427 | 1405 | 1110 | 11 | 401 | # |
| 538 | 1000 | 795 | 13 | 321 | # |
| 593 | 840 | 705 | 19 | 248 | 27 |
| 650 | 750 | 575 | 20 | 223 | 38 |

* Annealed properties are typical for Condition A of ASTM A582.
** Hardened and tempered Condition T of ASTM A582 - Brinell Hardness is specified range, other properties are typical only.
# Due to associated low impact resistance this steel should not be tempered in the range 400-

## PHYSICAL PROPERTIES

| | Alloy 416 |
|---|---|
| **Density** | 7750 Kg/ $m^3$ |
| **Specific Gravity** | 7.7 |
| **Specific Heat –** at 32 - 212°F (0 - 100°C) | 460 J/kg.K |
| **Electrical Resitivity –** at 68°F (20°C) | 43 **Microhm-cm** |
| **Elastic Modulus** | 200 **GPa** |
| **Mean Coefficient of Thermal Expansion** | |
| at 32 - 212°F (0 - 100°C) | 9.9 µm/m/°C |
| at 32 - 599°F (0 - 315°C) | 11.0 µm/m/°C |
| at 32 - 1000°F (0 - 538°C) | 11.6 µm/m/°C |
| **Thermal Conductivity** | **W/mK** |
| at 212°F (100°C) | 24.9 |
| at 932°F (500°C) | 28.7 |



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