
416 Free Machining Stainless Steel – Technical Material Specification

1.0 Material Overview & Common Uses

416 stainless steel is a martensitic, free-machining stainless steel alloy that contains added sulfur or selenium to improve machinability. It is magnetic and offers moderate corrosion resistance, primarily used in applications requiring high production rates and tight tolerances.

Common industrial applications include automatic screw machine parts, valve components, pump shafts, gears, fasteners, and fittings in the automotive, aerospace, and general manufacturing sectors.

2.0 Core Technical Properties & Sizing

- Density: 7.75 g/cm³ (0.280 lb/in³)
- Melting point: 1420–1510°C (2590–2750°F)
- Tensile strength (annealed): 517 MPa (75 ksi) minimum
- Yield strength (0.2% offset, annealed): 275 MPa (40 ksi) minimum
- Elongation in 2 inches (annealed): 30% minimum
- Hardness (annealed): Rockwell B 85–95
- Hardness (heat treated): Rockwell C 35–45 typical
- Modulus of elasticity: 200 GPa (29 × 10⁶ psi)
- Thermal conductivity: 24.9 W/m·K at 100°C
- Electrical resistivity: 57 µΩ·cm at room temperature
- Standard forms: round bar (1/8" to 12" diameter), hex bar, square bar, flat bar, and plate
- Diameter tolerance for cold-finished round bar: ±0.002" for sizes up to 1", ±0.003" for 1–2"
- Length tolerance: +1/8" / -0" for random mill lengths

3.0 Processing, Machinability & Application

416 stainless steel is the most machinable of all stainless steels, with a machinability rating of approximately 85% compared to AISI B1112 free-cutting steel. It is typically supplied in the annealed condition for optimal machining.

- Recommended cutting speed (HSS tooling): 30–40 m/min (100–130 SFM) for turning; 20–30 m/min (65–100 SFM) for drilling
- Carbide tooling recommended for high-volume production: 60–90 m/min (200–300 SFM) for turning
- Use positive rake geometry and sharp tools to reduce work hardening
- Flood coolant with water-soluble oil (5–10% concentration) is mandatory to control heat and chip evacuation
- Chip breakers recommended due to stringy chip formation
- Welding is not recommended due to sulfur content causing hot cracking; if required, use 309L filler and preheat to 200–300°C (400–575°F)

- Heat treatment: Austenitize at 925–1010°C (1700–1850°F), oil quench, temper at 150–370°C (300–700°F) for desired hardness
- Annealing: Heat to 730–790°C (1350–1450°F), furnace cool at 20°C/hr (35°F/hr) to 600°C (1100°F), then air cool

4.0 Common Defects & Quality Control

- Reject if surface cracks or seams exceed 0.005" depth on cold-finished bar
- Reject if surface pits or porosity exceed 0.003" depth or 0.010" diameter
- Reject if out-of-roundness exceeds 50% of diameter tolerance
- Reject if straightness deviation exceeds 1/16" in any 4-foot length
- Reject if decarburization depth exceeds 0.005" per side on finished parts
- Reject if sulfur stringers (visible at 100x magnification) exceed ASTM E45 Plate A rating of 2.0
- Reject if hardness varies more than ± 3 HRC across a single bar
- Reject if magnetic permeability is below 1.02 (fully magnetic expected)

5.0 Storage, Handling & WHMIS Guidelines

- Store indoors in a dry, climate-controlled environment below 60% relative humidity to prevent surface rust
- Shelf life: indefinite if stored properly; FIFO recommended for traceability
- Separate from carbon steel to avoid galvanic corrosion and contamination
- WHMIS classification: Not classified as a hazardous material in solid form; dust or fines may be classified as a nuisance particulate
- Mandatory PPE during machining: safety glasses with side shields, hearing protection, cut-resistant gloves when handling sharp edges
- When grinding or producing airborne dust: use local exhaust ventilation and wear N95 respirator
- No special storage segregation required under WHMIS for solid bar stock
- Wash hands after handling to avoid metal dust ingestion

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