CNC-Inconel 625

Nickel-based alloy

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Product Description

Inconel 625 is a solid-solution strengthened nickel-based superalloy known for its outstanding resistance to pitting, crevice corrosion, stress corrosion cracking, and high-temperature oxidation. With its superior strength and corrosion resistance across a wide range of extreme environments—from seawater to acidic chemical processing—the alloy performs reliably from cryogenic temperatures up to 980°C (1800°F).

Chemical Composition (ASTM B446)

Element	Composition Range (wt.%)	Key Role
Nickel (Ni)	58.0 min.	Base metal; corrosion resistance and thermal stability
Chromium (Cr)	20.0–23.0	Improves oxidation and corrosion resistance
Molybdenum (Mo)	8.0–10.0	Increases pitting resistance and mechanical strength
Niobium (Nb + Ta)	3.15–4.15	Enhances creep and fatigue strength
Iron (Fe)	≤5.0	Balance element
Cobalt (Co)	≤1.0	Residual element
Carbon (C)	≤0.10	Controlled to prevent carbide precipitation
Manganese (Mn)	≤0.50	Improves hot workability
Silicon (Si)	≤0.50	Enhances oxidation resistance
Sulfur (S)	≤0.015	Minimizes cracking risk

Physical Properties

Property	Value (Typical)	Test Standard/Condition
Density	8.44 g/cm³	ASTM B311
Melting Range	1290–1350°C	ASTM E1268 (DTA)
Thermal Conductivity	9.8 W/m·K at 100°C	ASTM E1225
Electrical Resistivity	1.30 μΩ·m at 20°C	ASTM B193
Thermal Expansion	12.8 μm/m·°C (20–1000°C)	ASTM E228
Specific Heat Capacity	427 J/kg·K at 20°C	ASTM E1269
Elastic Modulus	207 GPa at 20°C	ASTM E111

Mechanical Properties (Annealed Condition – ASTM B446)

Tensile Strength	827–960 MPa	ASTM E8/E8M
Yield Strength (0.2%)	414–517 MPa	ASTM E8/E8M
Elongation	≥30% (50mm gauge)	ASTM E8/E8M
Hardness	200–240 HB	ASTM E10

CNC Machining Challenges and Solutions for Inconel 625

Machining Challenges
Work Hardening
High strain hardening index (~0.45) leads to a hardened surface layer during machining.

Increases cutting forces and tool wear if not properly managed.

Low Thermal Conductivity
Poor heat dissipation results in localized tool tip temperatures exceeding 900°C, causing thermal fatigue and crater wear.

Toughness and Ductility
Generates long, continuous chips with high shear strength, leading to poor chip control and potential surface galling.

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Tool Selection

Parameter	Recommendation	Rationale
Tool Material	Carbide with AlTiN or TiAlN coating	Withstands high heat and abrasion
Coating	Thickness 2–5 μm, PVD applied	Reduces wear and thermal cracking
Geometry	Positive rake (10°), sharp edge, honed flank	Minimizes deformation and improves finish

Cutting Parameters (ISO 3685)

Operation	Speed (m/min)	Feed (mm/rev)
Roughing	20–30	0.20–0.30
Finishing	40–55	0.05–0.10

Operation	DOC (mm)	Coolant Pressure (bar)
Roughing	2.0–3.0	80–120
Finishing	0.5–1.0	100–150