
H13 Hot Work Tool Steel – Technical Material Specification

1.0 Material Overview & Common Uses

H13 is a chromium-molybdenum-vanadium alloyed hot work tool steel, known for its excellent toughness, high hardenability, and resistance to thermal fatigue and erosion at elevated temperatures. It is air-hardening and retains high strength up to 540°C (1000°F).

Common industrial applications include die casting dies (aluminum, magnesium, zinc), extrusion dies and mandrels, forging dies, hot punches, shear blades, plastic injection molds, and core pins. It is also used for hot work tooling in the automotive, aerospace, and general manufacturing sectors.

2.0 Core Technical Properties & Sizing

- Density: 7.80 g/cm³ (0.282 lb/in³)
- Melting point: Approximately 1427°C (2600°F)
- Hardness (as supplied): Typically 180–230 HB (annealed); after heat treatment: 44–56 HRC depending on tempering temperature
- Tensile strength (annealed): 700–850 MPa (101,500–123,300 psi)
- Yield strength (annealed): 350–450 MPa (50,800–65,300 psi)
- Elongation in 50 mm (annealed): 15–25%
- Thermal conductivity: 24.3 W/m·K at 20°C
- Coefficient of thermal expansion: 11.5 µm/m·°C (20–100°C)
- Standard available forms: Round bar (diameter 6 mm to 500 mm), flat bar (thickness 3 mm to 200 mm, width up to 600 mm), square bar, plate, and block
- Length tolerances: Cut lengths ±3 mm for bars up to 6 m; longer lengths by agreement
- Diameter tolerance for round bar (ground): h8 to h9; for black bar: ±0.5 mm up to 100 mm diameter, ±1.0 mm above
- Flatness tolerance for plate: ≤ 0.5 mm per 300 mm length
- Straightness tolerance: ≤ 1 mm per 1000 mm for bars

3.0 Processing, Machinability & Application

H13 is machinable in the annealed condition (180–230 HB) using conventional tooling. In the hardened condition (44–56 HRC), machining requires carbide or ceramic tooling with rigid setups and ample coolant. The material is suitable for EDM, grinding, and polishing.

- Recommended cutting speed for turning (annealed, HSS tooling): 15–20 m/min; for carbide tooling: 60–90 m/min
- Feed rate for turning (roughing): 0.3–0.6 mm/rev; finishing: 0.1–0.2 mm/rev
- Drilling: Use cobalt or carbide drills; peck cycle recommended for depths > 3x diameter; speed 8–12 m/min, feed 0.05–0.15 mm/rev
- Milling (annealed): Use carbide end mills with 4–6 flutes; cutting speed 50–80 m/min; chip load 0.05–0.15 mm/tooth

- Grinding: Use aluminum oxide or CBN wheels; avoid overheating to prevent surface cracking; use flood coolant
- Welding: Preheating to 315–540°C (600–1000°F) is mandatory; use H13 filler metal (e.g., ER H13); post-weld stress relieve at 540–650°C for 1 hour per 25 mm thickness
- Heat treatment: Austenitize at 1010–1065°C (1850–1950°F); quench in air or forced gas; double temper at 540–620°C (1000–1150°F) for 2 hours each cycle
- EDM: Use dielectric fluid with filtration; avoid excessive current to prevent recast layer cracking; post-EDM stress relief recommended
- Polishing: Can achieve surface finish down to 0.05 µm Ra with diamond compounds

4.0 Common Defects & Quality Control

- Reject if surface cracks or seams exceed 0.1 mm depth on ground bars; for black bars, reject if cracks exceed 0.5 mm depth
- Reject if decarburization depth exceeds 0.5 mm per side on annealed bars (measured per ASTM E1077)
- Reject if non-metallic inclusions exceed ASTM E45 rating of 2.0 for Type A (sulfide) or Type D (oxide) in the worst field
- Reject if hardness variation exceeds ±5 HRC across a single piece after heat treatment
- Reject if out-of-roundness exceeds 50% of diameter tolerance for ground bars
- Reject if straightness deviation exceeds 1 mm per 1000 mm for bars or 0.5 mm per 300 mm for plates
- Reject if surface pitting or porosity exceeds 0.2 mm depth on any surface
- Reject if ultrasonic inspection reveals any internal flaw larger than 1.5 mm equivalent flat-bottom hole (per ASTM A388)
- Reject if microstructure shows excessive carbide segregation (banding > 2.0 per ASTM E1268)
- Reject if material fails to meet specified chemical composition per ASTM A681 (e.g., C 0.32–0.45%, Cr 4.75–5.50%, Mo 1.10–1.75%, V 0.80–1.20%)

5.0 Storage, Handling & WHMIS Guidelines

- Store in a dry, indoor environment with relative humidity below 60% to prevent surface corrosion
- Maintain temperature between 10°C and 30°C; avoid condensation on cold material
- Apply rust-preventive oil or VCI paper on machined surfaces if storage exceeds 30 days
- Implement FIFO (First-In, First-Out) inventory rotation; shelf life is indefinite if stored properly, but re-inspect after 12 months
- WHMIS 2015 Classification: Not classified as hazardous in solid form. Dust, fume, or mist from machining may be hazardous.
- Hazard statements for dust/fume: H335 (May cause respiratory irritation), H373 (May cause damage to lungs through prolonged or repeated inhalation)
- Precautionary statements: P261 (Avoid breathing dust/fume/mist), P271 (Use only outdoors or in a well-ventilated area), P280 (Wear protective gloves/protective clothing/eye protection)
- Mandatory PPE during machining: Safety glasses with side shields, hearing protection, cut-resistant gloves (e.g., ANSI A4 level), and respiratory protection (N95 mask or half-face respirator with P100 filter if airborne dust exceeds exposure limits)
- Local exhaust ventilation required for grinding, welding, or EDM operations to control airborne particulates
- Wash hands thoroughly after handling; do not eat, drink, or smoke in work areas
- Spill procedure for fines/dust: Vacuum with HEPA-filtered vacuum; do not sweep dry. Collect in sealed container for disposal per local regulations.
- First aid: For eye contact, flush with water for 15 minutes. For skin contact, wash with soap and water. For inhalation, move to fresh air. Seek medical attention if irritation persists.

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