
A2 Air Hardening Tool Steel – Technical Material Specification

1.0 Material Overview & Common Uses

A2 is a medium-alloy, air-hardening tool steel that offers an excellent balance of wear resistance, toughness, and dimensional stability during heat treatment. It is a cold work tool steel containing chromium, molybdenum, and vanadium as primary alloying elements, which provide deep hardenability and minimal distortion during air quenching.

Common industrial applications include blanking dies, forming dies, punches, shear blades, slitter knives, injection mold components, and gauges. A2 is widely specified in Canadian tool and die shops, stamping facilities, and plastic mold manufacturing due to its predictable response to heat treatment and good machinability in the annealed condition.

2.0 Core Technical Properties & Sizing

- Density: 7.86 g/cm³ (0.284 lb/in³)
- Hardness (annealed): 200–230 HB (max 248 HB per ASTM A681)
- Hardness (hardened & tempered): 57–62 HRC typical
- Melting point: approximately 1420°C (2590°F)
- Modulus of elasticity: 200 GPa (29 × 10⁶ psi)
- Thermal conductivity: 26 W/m·K at 20°C
- Coefficient of thermal expansion: 11.5 × 10⁻⁶ /°C (20–200°C)
- Standard stock forms: round bar (1/4" to 12" diameter), flat bar (1/8" to 6" thickness, up to 24" width), and plate (up to 8" thick)
- Length tolerances: ±1/8" on random mill lengths (10–12 ft); precision ground lengths ±0.005"
- Diameter tolerance for centerless ground rounds: +0.000" / -0.001" for sizes up to 2"; +0.000" / -0.002" for 2"–4"
- Flatness tolerance for ground flat stock: 0.001" per inch of width, maximum 0.005" total
- Surface finish (as supplied): typically 125 RMS or better for precision ground stock

3.0 Processing, Machinability & Application

A2 is supplied in the annealed condition (200–230 HB) for optimal machinability. It machines similarly to O1 tool steel but requires slightly more attention to tool sharpness due to its higher chromium content. Carbide tooling is recommended for high-production runs, while high-speed steel (HSS) tools can be used for lower volumes with appropriate feeds and speeds.

- Recommended cutting speed for HSS tools: 60–80 SFM (surface feet per minute) for turning and milling
- Recommended cutting speed for carbide tools: 200–300 SFM for turning; 150–250 SFM for milling
- Feed rate for turning: 0.005–0.015 inches per revolution (IPR) for roughing; 0.002–0.005 IPR for finishing
- Feed rate for milling: 0.002–0.006 inches per tooth (IPT) for HSS; 0.003–0.008 IPT for carbide
- Depth of cut: 0.050–0.150" for roughing; 0.010–0.030" for finishing
- Use positive rake tool geometry to reduce cutting forces and built-up edge

- Flood coolant (water-soluble oil at 5–10% concentration) is mandatory to prevent work hardening and tool wear
- Grinding: use aluminum oxide or CBN wheels; avoid overheating to prevent surface cracking
- Welding: not recommended for load-bearing applications; if necessary, preheat to 315–425°C (600–800°F) and use AWS ER312 filler, followed by slow cooling in still air
- Heat treatment: preheat at 650–700°C (1200–1300°F), austenitize at 925–980°C (1700–1800°F), air quench (still air or forced air), then double temper at 175–540°C (350–1000°F) depending on target hardness
- Dimensional change during hardening: typically +0.0005 to +0.0015 inches per inch of section; A2 is one of the most dimensionally stable air-hardening grades

4.0 Common Defects & Quality Control

- Reject if surface decarburization exceeds 0.010" depth on any surface (per ASTM A681 decarb limits)
- Reject if visible cracks, seams, or laps are present under 5x magnification
- Reject if surface pitting exceeds 0.005" depth or 0.010" diameter on precision ground surfaces
- Reject if out-of-roundness exceeds 50% of the diameter tolerance band
- Reject if flat bar exhibits twist greater than 0.005" per foot of length
- Reject if hardness in annealed condition exceeds 248 HB (per ASTM A681)
- Reject if microstructural carbide banding exceeds ASTM E112 grain size 2 (severe banding)
- Reject if non-metallic inclusions exceed ASTM E45 rating of 2.0 for Type A, B, C, or D
- Reject if material fails to achieve minimum 57 HRC after proper heat treatment per supplier's recommended cycle
- Acceptance criteria: material must be free of scale, rust, and oil contamination on precision ground surfaces

5.0 Storage, Handling & WHMIS Guidelines

A2 tool steel is not classified as a hazardous material under WHMIS 2015 in its solid form. However, dust, chips, and fumes generated during machining, grinding, or welding may present health hazards and are subject to WHMIS requirements for the resulting by-products.

- Store in a dry, indoor environment with relative humidity below 60% to prevent surface rust
- Temperature range: 10–35°C (50–95°F); avoid condensation by allowing cold stock to acclimate before unwrapping
- Shelf life: indefinite if stored properly with protective oil coating; reapply rust inhibitor every 6 months
- FIFO protocol: use first-in, first-out rotation for coated stock to prevent oil degradation
- WHMIS classification for solid: not a hazardous product (per HPR Schedule 1 exclusion for manufactured items)
- WHMIS classification for grinding dust: may contain chromium (VI) compounds; treat as carcinogenic (Category 1A) per WHMIS 2015
- Mandatory PPE during machining/grinding: NIOSH-approved N95 respirator (or better), safety glasses with side shields, cut-resistant gloves (ANSI A4 or higher), and hearing protection if noise exceeds 85 dBA
- Welding fume PPE: supplied-air respirator required if welding in confined space; local exhaust ventilation mandatory
- First aid: for skin contact with chips, wash with soap and water; for eye contact, flush with water for 15 minutes; for inhalation of dust/fumes, move to fresh air and seek medical attention
- Spill procedure: sweep up chips and dust using HEPA vacuum or wet methods; avoid dry sweeping to prevent airborne dust
- Disposal: scrap A2 steel can be recycled as ferrous scrap; grinding dust must be disposed of as hazardous waste if chromium content exceeds regulatory thresholds

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