

D2 Air Hardening Tool Steel – Technical Material Specification

1.0 Material Overview & Common Uses

D2 is a high-carbon, high-chromium air-hardening tool steel (AISI D2, UNS T30402) known for excellent wear resistance, high compressive strength, and good dimensional stability during heat treatment. It contains approximately 1.5% carbon and 12% chromium, placing it in the cold work tool steel family. D2 is not stainless but offers moderate corrosion resistance due to its chromium content.

Common industrial applications include blanking dies, forming dies, stamping dies, shear blades, slitter knives, punches, thread rolling dies, gauges, and wear-resistant components. It is widely used in automotive stamping, metal packaging, and general tool and die manufacturing across Canadian fabrication shops.

2.0 Core Technical Properties & Sizing

- Density: 7.70 g/cm³ (0.278 lb/in³)
- Hardness (annealed): 200–240 HB (Brinell)
- Hardness (hardened & tempered): 58–62 HRC (Rockwell C)
- Melting point: 1420°C (2588°F)
- Modulus of elasticity: 210 GPa (30.5 × 10⁶ psi)
- Thermal conductivity: 20.0 W/m·K at 20°C
- Coefficient of thermal expansion: 10.5 × 10⁻⁶ /°C (20–200°C)
- Standard stock forms: round bar (diameter 1/4" to 12"), flat bar (thickness 1/8" to 6", width up to 24"), and plate (thickness up to 8")
- Length tolerances: ±1/8" on standard 12' lengths; custom lengths available with ±1/16" tolerance
- Straightness tolerance: 1/16" in any 4' length for annealed condition
- Surface finish: typically supplied in annealed condition with a ground or turned finish (Ra 3.2 µm max)

3.0 Processing, Machinability & Application

D2 is machinable in the annealed condition (200–240 HB) but becomes very difficult to machine after hardening (58–62 HRC). Carbide tooling is recommended for all operations. Use positive rake angles and rigid setups to minimize chatter. Flood coolant with high-pressure delivery is essential to control heat and prevent work hardening.

- Turning: Use C2 or C3 carbide inserts with a 5–10° positive rake; cutting speed 60–90 SFM (18–27 m/min) for roughing, 90–120 SFM (27–37 m/min) for finishing; feed rate 0.005–0.015 in/rev (0.13–0.38 mm/rev)
- Milling: Use 4-flute carbide end mills with 30° helix; cutting speed 50–80 SFM (15–24 m/min); chip load 0.002–0.005 in/tooth (0.05–0.13 mm/tooth); depth of cut 0.050–0.150 in (1.3–3.8 mm)
- Drilling: Use cobalt or carbide twist drills with 118° point angle; peck drilling cycle recommended; cutting speed 30–50 SFM (9–15 m/min); feed rate 0.002–0.006 in/rev (0.05–0.15 mm/rev)
- Grinding: Use aluminum oxide or CBN wheels; frequent dressing required to prevent loading; use copious coolant to avoid burning

- Welding: Not recommended for hardened D2 due to cracking risk. In annealed condition, preheat to 315–425°C (600–800°F) and use austenitic stainless steel filler (e.g., ER309L). Post-weld slow cool in lime or vermiculite. Stress relieve at 650°C (1200°F) for 1 hour per inch of thickness.
- Heat treatment: Austenitize at 980–1040°C (1800–1900°F); air cool or positive pressure quench (2 bar minimum); temper immediately at 200–540°C (400–1000°F) depending on desired hardness; double tempering recommended for full transformation
- EDM (Electrical Discharge Machining): Suitable for hardened D2; use roughing and finishing passes; expect recast layer of 0.001–0.003 in (0.025–0.076 mm) which should be removed by grinding or polishing

4.0 Common Defects & Quality Control

- Reject if surface cracks or seams are visible under 5x magnification or detectable by magnetic particle inspection (MPI).
- Reject if decarburization depth exceeds 0.010 in (0.25 mm) per side for ground stock, or 0.030 in (0.76 mm) for hot-rolled stock.
- Reject if carbide segregation (banding) exceeds ASTM E45 Plate D severity level 3.
- Reject if hardness in annealed condition exceeds 240 HB or is below 200 HB.
- Reject if out-of-straightness exceeds 1/16" in any 4' length for annealed bars.
- Reject if surface pitting or scale exceeds 0.005 in (0.13 mm) depth on ground surfaces.
- Reject if dimensional tolerance exceeds ± 0.005 in (0.13 mm) for precision ground stock.
- Reject if non-metallic inclusions exceed ASTM E45 Plate A severity level 2.
- Reject if material exhibits excessive center porosity or pipe (visible on cut cross-section).

5.0 Storage, Handling & WHMIS Guidelines

- Store in a dry, indoor environment with relative humidity below 60% to prevent surface rust. D2 is not stainless and will corrode if exposed to moisture.
- Apply a light rust-preventive oil (e.g., LPS-3 or equivalent) on all machined surfaces if storing longer than 30 days.
- Shelf life: Indefinite when stored properly; however, FIFO (First-In, First-Out) rotation is recommended to avoid prolonged storage of surface-ground stock.
- WHMIS 2015 Classification: Not classified as a hazardous product in solid form. Dust, fume, or swarf generated during machining may contain chromium (VI) compounds and respirable crystalline silica. Refer to Safety Data Sheet (SDS) for specific hazards.
- Mandatory PPE during machining: Safety glasses with side shields, hearing protection, cut-resistant gloves (ANSI A4 or higher), and steel-toed boots. When grinding, use a NIOSH-approved N95 respirator or local exhaust ventilation to control airborne particulates.
- Do not use compressed air to clean swarf; use a brush or vacuum to avoid airborne dust generation.
- Wash hands thoroughly after handling, especially before eating or smoking. Do not eat or drink in work areas where D2 dust or swarf is present.
- Dispose of D2 scrap as ferrous metal waste. Swarf and grinding sludge may be classified as hazardous waste depending on local regulations due to chromium content; consult your environmental compliance officer.

Regulatory Disclaimer: This document is a generic technical material specification provided for educational purposes. The end-user assumes all liability for reviewing, adapting, and validating all tolerances, properties, and safety protocols against specific OEM data sheets and local regulations before deployment.