H13 Tool Steel Properties, Machining Guide, and Applications Explained

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What Is H13 Tool Steel?

H13 is regarded as an “all-round performer” in the field of hot work tool steels. Through a multi-alloy system of carbon, chromium, molybdenum, and vanadium, it achieves an optimal balance between hardness, toughness, and thermal stability. It is widely used in aluminum die casting, hot forging, and other core industrial applications, with mold service life exceeding 100,000 cycles.

As a professional mold steel processing team, Moldsteells summarizes key properties and application guidelines of H13 based on our practical experience and material data, helping you select materials accurately and improve machining efficiency.

Main Characteristics of H13 Tool Steel

- **Balanced Strength and Toughness:** Quenched hardness HRC 42–50, impact toughness 15–35 J/cm², tensile strength around 1000 MPa at 600°C.
- **Excellent Hardenability and Thermal Stability:** Synergistic effect of Cr/Mo/V ensures through-hardening and stable tempering hardness.
- **High Thermal Fatigue and Oxidation Resistance:** Dense oxide film formed by Cr/Si resists cracking under thermal cycling.
- **Good Machinability:** Annealed hardness ≤229 HBW, suitable for mass production.
- **Clear Performance Limitations:** Insufficient cold-work hardness, poor polishability, and weak corrosion resistance.

Chemical Composition of H13 (ASTM A681)

Element	Range (wt%)	Function
C	0.32–0.45	Ensures hardness and wear resistance
Cr	4.75–5.50	Improves hardenability and oxidation resistance
Mo	1.10–1.75	Enhances tempering stability
V	0.80–1.20	Refines grains and improves wear resistance
Si	0.80–1.20	Improves thermal fatigue resistance
Mn	0.20–0.50	Assists hardenability
P	≤0.030	Impurity control
S	≤0.030	Impurity, affects toughness
Ni+Cu	≤0.75	Residual element control

Physical Properties of H13

Property	Value	Unit	Remarks
Density	7.85	g/cm³	ASTM A681
Elastic Modulus	210	GPa	Temperature dependent
Thermal Expansion	9.1–13.5	×10⁻⁶/°C	20–700°C
Thermal Conductivity	28.8–32.2	W/(m·K)	25–650°C

Ac_1	860	°C	Austenite start
Ms	340	°C	Martensite start

Mechanical Properties of H13

Category	Parameter	Value	Unit	Condition
Tensile	Tensile Strength	1800–2200	MPa	Q&T, RT
	Yield Strength	1500–1800	MPa	Q&T, RT
	Elongation	≥8	%	Q&T, RT
Compression	Compressive Strength	≥2500	MPa	Q&T, RT
Impact	Room Temp Impact	15–35	J/cm²	20°C
	Low Temp Impact	≥20	J/cm²	-40°C
Hardness	Annealed	≤229	HBW	RT
	Q&T	42–50	HRC	RT
High Temp	600°C Tensile	~1000	MPa	600°C
	600°C Yield	~850	MPa	600°C
	600°C Hardness	35–38	HRC	600°C
Fatigue	Rotating Bending Limit	600–800	MPa	RT

Typical Applications of H13 Tool Steel

- Aluminum and magnesium die casting molds
- Automotive crankshaft and connecting rod forging dies
- Aluminum extrusion dies
- High-temperature plastic molds
- Precision hot forming molds
- Cost-optimized composite molds

Non-Recommended Applications

- Cold forging and cold heading dies
- Ultra-high hardness molds (HRC ≥58)
- Mirror-finish plastic molds
- Corrosive environments (PVC, sulfur/chlorine media)
- Long-term service above 650°C
- Low-volume economical molds

H13 Selection Reference Table

Category	Recommended	Not Recommended
Hot Work	Die casting, hot forging, extrusion, hot stamping	Long-term >650°C, ceramic/glass forming
Plastic Mold	GF reinforced plastics, high-temp plastics	Mirror polish molds, PVC molds
Cold Work	Low-load cold stamping	High-strength cold extrusion, deep drawing
Special	Mass production, thermal cycling molds	Small batch, strong corrosion, micro molds

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Recommended Cutting Tools for H13 Machining

Stage	Tool Type	Coating	Parameters	Recommende

				d Brands
Roughing	Micro-grain Carbide	AlCrN / TiSiN	8–12% Co	Sandvik, Kennametal, ZCC, Xiamen Golden Egret
Semi-Finishing	Coated Carbide	TiAlN+AlCrN	45° Helix	Kyocera, Iscar, TaeguTec
Finishing	CBN	None	≥90% CBN	Element Six, Kyocera, Sumitomo
Mirror	PCD	None	R0.1–0.2	Element Six, Sumitomo

Machining Parameter Selection Guide

Cutting Speed

Annealed: 120–150 m/min
Pre-hardened: 80–120 mmin
Hardened: 50–90 m/min

Feed Rate

Roughing: 0.15–0.3 mm/r
Finishing: 0.05–0.15 mmr

Depth of Cut

Roughing: 1–3 mm
Finishing: 0.1–0.3 mm

Spindle Speed

Φ6mm: 3000–5000 rpm
Φ10mm: 1500–3000 rpm
Φ20mm: 800–1500 rpm

Cooling

High-pressure coolant, oil mist, EP cutting oil

Tool Path

Contour milling, spiral milling, trochoidal milling

Common Problems and Solutions

1. Rapid Tool Chipping After Quenching

Use CBN tools (BN-S20), vc=80–100 m/min, oil-based coolant.

2. Chatter Marks on Cavity Surface

Use shrink-fit holders, reduce feed, increase spindle speed.

3. Chip Entanglement in Deep Cavities

Use long-neck tools, internal coolant, and peck milling.

4. Scratches in Mirror Machining

Use PCD tools, high speed, shallow depth.

5. Micro Cracks After CNC Machining

Low-temperature aging, small feed, and depth.

6. Spindle Vibration in High-Speed Milling

Avoid resonance, use balanced tools.

7. Dimensional Deviation in Mass Production

Temperature compensation and tool wear control.

8. Drill Breakage in Deep Holes

Use Co-HSS drills, peck drilling, internal cooling.

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