Technical Data Sheet: D2 Tool Steel

Introduction

D2 tool steel is a versatile, high-carbon, high-chromium, air-hardening tool steel characterized by its relatively high attainable hardness and numerous, large, chromium-rich alloy carbides in the microstructure. These carbides provide good resistance to wear from sliding contact with other metals and abrasive materials. D2 steel offers excellent dimensional stability during heat treatment and is widely employed in cold work applications requiring high wear resistance and moderate toughness. This document outlines the typical chemical composition and key properties of D2 tool steel.

Chemical Composition

The performance characteristics of D2 tool steel are primarily derived from its chemical composition. While exact percentages may vary slightly depending on specific manufacturing standards and heat treatments, the typical elemental composition falls within the following ranges:

- **Carbon (C):** 1.50% - 1.60%
  - *Significance:* High carbon content is crucial for forming hard carbides, contributing significantly to wear resistance and hardness.
- **Chromium (Cr):** 11.50% - 12.50%
  - *Significance:* High chromium content promotes the formation of abundant Cr-rich carbides (primarily M7C3 type), which are essential for the steel's excellent abrasion and wear resistance. It also contributes to hardenability and corrosion resistance (though D2 is not considered stainless).
- **Molybdenum (Mo):** 0.70% - 0.90%
  - *Significance:* Molybdenum acts as a strong carbide former, enhances hardenability (particularly for air hardening), contributes to secondary hardening during tempering, and improves toughness compared to simpler high-carbon steels.
- **Vanadium (V):** 0.80% - 1.10%
  - *Significance:* Vanadium forms very hard MC-type carbides, further enhancing wear resistance and contributing to grain refinement and secondary hardening potential. It also improves toughness.
- **Manganese (Mn):** 0.25% - 0.45%
  - *Significance:* Contributes to hardenability and deoxidation during steelmaking.
- **Silicon (Si):** 0.25% - 0.45%
  - *Significance:* Primarily acts as a deoxidizer during steel production and

slightly increases strength.

(Note: Specific analyses often show values such as C 1.55%, Cr 12.00%, Mo 0.80%, V 0.90%, Mn 0.35%, Si 0.30%)

Key Properties

The specific combination of alloying elements results in the following characteristic properties for D2 tool steel:

- **High Wear Resistance:** Primarily due to the high volume fraction of hard chromium and vanadium carbides. Ideal for applications involving abrasion and sliding wear.
- **High Hardness:** Typically achieves a working hardness of 60–62 HRC after proper heat treatment. Specialized surface treatments like ion nitriding can achieve even higher surface hardness (e.g., 61-64 HRC core).
- **Good Dimensional Stability:** Exhibits minimal distortion during heat treatment, especially when air quenched (typical size change: +/- 0.0005 in/in or mm/mm).
- **Air Hardening Capability:** High hardenability allows for hardening by air cooling, reducing the risk of distortion and cracking associated with liquid quenching.
- **Moderate Toughness:** While superior to some high-carbon steels, its toughness is lower than that of lower-alloy, shock-resisting tool steels.
- **Machinability:** Considered relatively poor (approx. 45% of a 1% carbon steel) due to its hardness and abrasive carbides. Requires appropriate tooling and machining parameters.
- **Weldability:** Generally difficult to weld using conventional methods due to high carbon and alloy content, increasing susceptibility to cracking. Specialized procedures are required.

Typical Applications

Based on its properties derived from the composition, D2 tool steel is particularly suitable for:

- Cold work applications
- Blanking and forming dies
- Demanding tooling applications within the tool and die industry requiring high wear resistance and dimensional stability.

Conclusion

D2 tool steel remains a standard choice in the industry for cold work tooling applications where high wear resistance and dimensional stability are paramount. Its

unique composition, centered around high carbon and chromium levels augmented by molybdenum and vanadium, provides a reliable and cost-effective solution for demanding manufacturing operations.

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