

M2 Molybdenum High Speed Tool Steel (UNS T11302)

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Sep 13 2012

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Introduction

Molybdenum high speed steels are designated as Group M steels according to the AISI classification system. Over 95% of high-speed steels manufactured in the US are group M steels. Tungsten is present in all types from M1 to M10, except M6, and cobalt is not present in any these steels. Molybdenum high speed steels have similar performance when compared to tungsten high-speed steels. However, the initial cost of molybdenum tool steels is lower. Titanium nitride, titanium carbide and several other coatings can be used in the tools made of this kind of steels through physical vapor deposition process to improve the performance and life span of the tool.

This article will provide an overview of M2 molybdenum high speed tool steel, which has high carbon content and better wear resistance than M1 molybdenum high speed tool steel.

Chemical Composition

The following table shows the chemical composition of M2 molybdenum high speed tool steels.

Element	Content (%)
C	0.78-1.05
Mn	0.15-0.40
Si	0.20-0.45
Cr	0.20-0.45
Ni	0.3
Mo	4.50-5.50
W	5.50-6.75
V	1.75-2.20
Cu	0.25
P	0.03
S	0.03

Physical Properties

The physical properties of M2 molybdenum high speed tool steel are given in the following table.

Physical properties	Metric	Imperial
Density	8.16 g/cm ³	0.294 lb/in ³
Melting point	4680°C	2600°F

Mechanical Properties

The mechanical properties of M2 molybdenum high speed tool steel are tabulated below.

Mechanical properties	Metric	Imperial
Hardness, Rockwell C (tempered at 1150°F, quenched at 2200°F)	62	62
Hardness, Rockwell C (as hardened, quenched at 2200°F)	65	65
Compressive yield strength (when tempered at 300°F)	3250 MPa	471000 psi
Izod impact unnotched (when tempered at 300°F)	67 J	49.4 ft-lb
Abrasion (loss in mm ³ , as-hardened; ASTM G65)	25.8	25.8
Abrasion (loss in mm ³ , tempered at 1275°F; ASTM G65)	77.7	77.7
Poisson's ratio	0.27-0.30	0.27-0.30
Elastic modulus	190-210 GPa	27557-30458 ksi

Thermal Properties

The following table shows the thermal properties of M2 molybdenum high speed tool steels.

Thermal properties	Metric	Imperial
CTE, linear (@20.0 - 100°C/ 68.0 - 212°F)	10 $\mu\text{m}/\text{m}^\circ\text{C}$	5.56 $\mu\text{in}/\text{in}^\circ\text{F}$
CTE, linear (@20.0 - 500°C/68.0 - 932°F)	12.2 $\mu\text{m}/\text{m}^\circ\text{C}$	6.78 $\mu\text{in}/\text{in}^\circ\text{F}$
CTE, linear (@20.0 - 850°C/68.0 - 1560°F)	12.6 $\mu\text{m}/\text{m}^\circ\text{C}$	7 $\mu\text{in}/\text{in}^\circ\text{F}$

Other Designations

Other designations that are equivalent to M2 molybdenum high speed tool steels include:

- AFNOR 06-05-04-02
- DIN 1.3343
- UNI KU
- JIS SKH9
- SS 2722
- B.S. BM 2
- FED QQ-T-590
- ASTM A597 (CM-2)
- ASTM A600
- SAE J437
- SAE J438
- UNS T11302

Fabrication and Heat Treatment

Machinability

Shaping of M2 tool steels can be carried out using grinding methods. However, they have poor grinding capability and hence they are regarded as "medium" machinability tool steel under annealed conditions. The machinability of these steels is only 50% of that of the easily machinable W group or water hardening tool steels.

Heat Treatment

M2 tool steels are pre-heated prior to hardening at 2610°C (4730°F) followed by rapid heating from 2610°C (4730°F) to 3960°C (7160°F). These steels are then cooled for 3 to

5 min and quenched in air, salt bath or oil.

Annealing

M2 tool steels are annealed at 1204°C (2200°F) and cooled at 72°C (162°F) per hour or even less.

Tempering

M2 steels are tempered at 552°C (1025°F) to obtain Rockwell C hardness from 60 to 65.

Hardening

Finally, M2 steels are hardened by heat treatment and quenching.

Applications

M2 tool steels are suitable for making cutting tools.