Technical Datasheet

# CarTech® M4

## Identification

UNS Number

• T11304

AISI Number

• Type M4

## Type Analysis

*Single figures are nominal except where noted.*

| | | | |
|---|---|---|---|
| **Carbon** | 1.30 % | **Manganese** | 0.30 % |
| **Silicon** | 0.30 % | **Chromium** | 4.50 % |
| **Molybdenum** | 4.50 % | **Vanadium** | 4.00 % |
| **Tungsten** | 5.50 % | **Iron** | Balance |

## General Information

Description

CarTech M4, a molybdenum-tungsten high-speed tool steel possessing high carbon and vanadium content, provides a very high degree of wear resistance coupled with high strength.

Applications

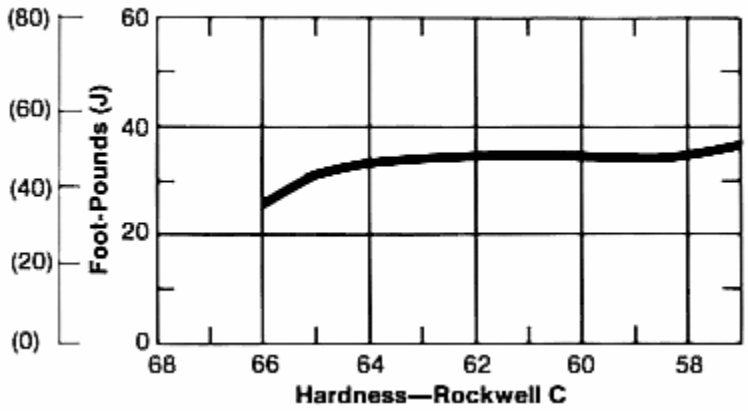
CarTech M4 has found application in:

Lathe tools
Planer tools
Drills
Taps
Reamers
Broaches
Milling cutters
Form cutters
Thread chasers
Hobs
Counterbores
Inserts-heading dies

## Properties

### Typical Mechanical Properties

**Typical Unnotched Izod Impact Properties—Carpenter Four Star**



**Typical Hot Hardness—Carpenter Four Star**
Hardened 2225°F (1218°C) 5 minutes in salt, oil quenched, tempered 1050°F (566°C), 2 + 2 hours.

| Testing Temperature | | Rockwell C Hardness at Temperature |
|---|---|---|
| °F | °C | |
| 600 | 316 | 61/62 |
| 700 | 371 | 60/61 |
| 800 | 427 | 59/60 |
| 900 | 482 | 58/59 |
| 1000 | 538 | 56/57 |
| 1100 | 593 | 53/54 |
| 1200 | 649 | 44 |
| 1300 | 704 | 20 |

## Heat Treatment

### Decarburization

While Four Star is somewhat susceptible to decarburization in hardening, means of preventing this are well known. If proper control of atmosphere is maintained, Four Star will present no difficulty with decarburization.

### Normalizing

Normalizing is not recommended.

### Annealing

Pack in a suitable container with clean cast iron borings. Heat uniformly to 1550/1600°F (843/871°C) and cool slowly in the furnace to 1100°F (593°C) at a rate of 20/40°F (11/22°C) per hour. Average Brinell hardness 207/248.

To relieve machining stresses for greater accuracy in hardening, first rough machine, then anneal below the critical (from 1250/1300°F [677/704°C]) and cool slowly. Finish machine parts after cooling.

### Hardening

Four Star should be heat treated from neutral salt baths or properly adjusted controlled atmosphere furnaces. A dew point of +10°F (-12°C) is suggested for the high-heat furnace when using controlled atmosphere.

First, preheat to 1400/1500°F (760/816°C), then transfer to a superheating furnace with a temperature maintained at 2200/2225°F (1204/1218°C). When neutral salt baths are used for hardening, the temperature should be dropped 25°F (14°C) as compared to other furnace temperatures.

If the usual controls over temperature and atmosphere are employed, there should be no difficulty with decarburization.

Quench in oil, ensuring that tools are cooled below 200°F (93°C) before tempering (cool enough to hold in your hand).

Small sizes (under about 1" [25.4 mm] in diameter) or delicate sections may be hardened by cooling in still air. It is also acceptable to quench in molten salt at temperatures of 1000/1100°F (538/593°C), equalizing for 5 minutes per inch followed by air cooling.

### Deformation (Size Change) in Hardening

Four Star changes size only slightly in hardening. A 1" (25.4 mm) cube will expand about 0.0005" (0.013 mm) in hardening at 2225°F (1218°C) and will expand a like amount when tempered at 1050°F (556°C).

Cutters and form tools will open up slightly in the hole and expand slightly on the OD.

### Tempering

Be sure to allow sufficient time for the tools to reach the proper temperature and then start timing the tempering operation.

Tools should be tempered immediately after the completion of the quench. For best results with most tools, a range of 1000/1200°F (538/649°C) is suitable. For cutting tools, double or triple temper at 1000/1050°F (538/566°C) where maximum wear resistance is desired.

The effect of various tempering temperatures on the Rockwell hardness of Four Star is shown in the following chart:

**Effect of Tempering Temperature on Hardness—Carpenter Four Star**
Hardening temperature 2225°F (1218°C), 5 minutes in salt and oil quenched

| Tempering Temperature 2 Hours at Heat | | Average Values — Rockwell C Scale |
|---|---|---|
| °F | °C | |
| As Hardened | | 64/65 |
| 800 | 427 | 59/60 |
| 900 | 482 | 61/62 |
| 1000 | 538 | 66 |
| 1050 | 566 | 66 |
| 1100 | 593 | 65/66 |
| 1200 | 649 | 59/61 |

## Workability

### Forging

Preheat very slowly to 1400/1500°F (760/816°C), then increase furnace temperature to full heat of 2050°F (1121°C).

Do not forge under 1700°F (927°C); reheat as often as necessary.

Forgings should be cooled slowly in lime or ashes. Cool to at least 400°F (204°C) before reheating to anneal.

### Machinability

Four Star is carefully annealed to produce the highest degree of machinability possible in this type of tool steel. It machines somewhat better than the 18-4-1 type.

For further comparison, its machinability rating is about 45% of a 1% carbon tool steel or 33% of AISI B1112 screw stock.

Following are typical feeds and speeds for Annealed Four Star.

Turning—Single Point and Box Tools

| Depth of Cut, In. | High-Speed Tools | | | Carbide Tools | | | |
|---|---|---|---|---|---|---|---|
| | | | | Speed, fpm | | | |
| | Speed, fpm | Feed, ipr | Tool Material | Brazed | Throw Away | Feed, ipr | Tool Material |
| .150 | 60 | .015 | M-42 | 220 | 250 | .015 | C-6 |
| .025 | 65 | .007 | M-47 | 250 | 300 | .007 | C-7 |

Turning—Cut-Off and Form Tools

| Speed, fpm | Feed, ipr | | | | | | | Tool Material |
|---|---|---|---|---|---|---|---|---|
| | Cut-Off Tool Width, Inches | | | Form Tool Width, Inches | | | | |
| | 1/16 | 1/8 | 1/4 | 1/2 | 1 | 1-1/2 | 2 | |
| 55 | .001 | .001 | .0015 | .0015 | .001 | .0007 | .0007 | M-2 |
| 190 | .002 | .003 | .0045 | .003 | .002 | .0015 | .0015 | C-6 |

Drilling

| Speed, fpm | Feed, ipr | | | | | | | | Tool Material |
|---|---|---|---|---|---|---|---|---|---|
| | Nominal Hole Diameter, Inches | | | | | | | | |
| | 1/16 | 1/8 | 1/4 | 1/2 | 3/4 | 1 | 1-1/2 | 2 | |
| 35 | .001 | .002 | .003 | .005 | .007 | .008 | .011 | .013 | M-1;M-10 |

Reaming

| High-Speed Tools | | | | | | | | Carbide Tools | |
|---|---|---|---|---|---|---|---|---|---|
| Speed, fpm | Feed, Inches per Rev | | | | | | Tool Material | Speed, fpm | Tool Material |
| | Reamer Diameter, Inches | | | | | | | | |
| | 1/8 | 1/4 | 1/2 | 1 | 1-1/2 | 2 | | | |
| 30 | .003 | .005 | .008 | .012 | .015 | .018 | M-7 | 100 | C-2 |

Tapping

| Speed, fpm | Tool Material |
|---|---|
| 20 | M-1; M-7; M-10 |

Die Threading

| Speed, fpm | | | | Tool Material |
|---|---|---|---|---|
| 7 or Less | 8 to 15 | 16 to 24 | 25 and up, T.P.I. | |
| 8-12 | 12-18 | 18-25 | 20-30 | M-1; M-2; M-7; M-10 |

Milling—End Peripheral

| Depth of Cut, In. | High-Speed Tools | | | | | | Carbide Tools | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Speed, fpm | Feed—Inches per Tooth, Cutter Diameter, Inches | | | | Tool Material | Speed, fpm | Feed—Inches per Tooth, Cutter Diameter, Inches | | | | Tool Material |
| | | 1/4 | 1/2 | 3/4 | 1-2 | | | 1/4 | 1/2 | 3/4 | 1-2 | |
| .050 | 60 | .001 | .002 | .003 | .004 | M-42 | 225 | .0015 | .0025 | .004 | .005 | C-6 |
| | 55 | .001 | .002 | .003 | .004 | | 220 | .0015 | .0025 | .004 | .005 | |

Broaching

| Speed, fpm | Chip Load, Inches per Tooth | Tool Material |
|---|---|---|
| 5 | .002 | M-42 |

Sawing—Power Hack Saw

| Pitch—Teeth per Inch, Material Thickness, Inches | | | | Speed | Feed |
|---|---|---|---|---|---|
| Under 1/4 | 1/4-3/4 | 3/4-2 | Over 2 | Strokes/Minute | Inches/Stroke |
| 10 | 10 | 6 | 4 | 60 | .006 |

Additional Machinability Notes

Figures used for all metal removal operations covered are average. On certain work, the nature of the part may require adjustment of speeds and feeds. Each job has to be developed for best production results with optimum tool life. Speeds and feeds should be increased or decreased in small steps.

## Other Information

### Applicable Specifications

- ASTM A600
- QQ-T-590

### Forms Manufactured

- Bar-Rounds



Edition Date: 11/01/1988