# PM-M48 – Technical Data

## General Descriptions:

PM-M48 is a superior PM (Particle Metallurgy) high speed steel with high carbon, vanadium and cobalt. It has an excellent combination of high red hardness, high abrasion resistance and good toughness.

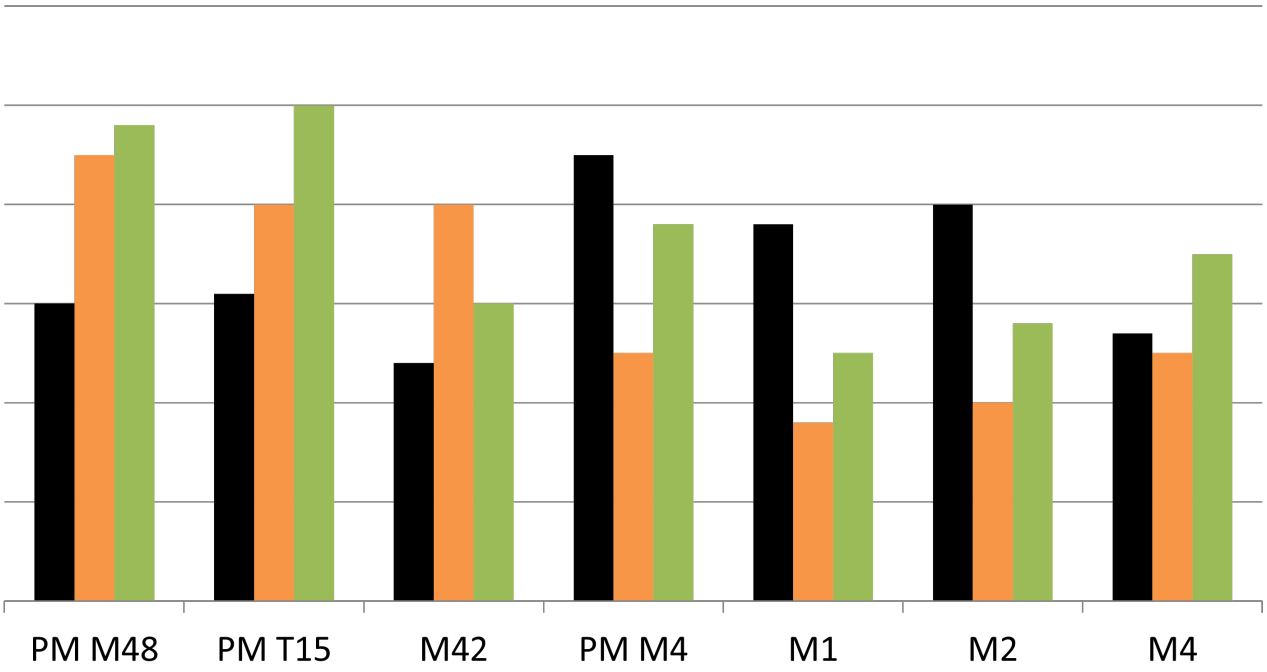
## Examples of applications:

End mills, form tool, gear hobs, milling cutters, shaper cutter, broaching tools, tool bits, special taps.

## Chemical Composition

| Carbon | Manganese | Chromium | Vanadium | Molybdenum | Cobalt | Tungsten |
|---|---|---|---|---|---|---|
| 1.42-1.52% | 0.15-0.40% | 3.50-4.00% | 2.75-3.25% | 4.75-5.50% | 8.00-10.00% | 9.50-10.50% |

## Comparison Chart




## Typical Heat Treat Response

| Tempering Temp °F | Hardening Temp °F /HRC 2100 | 2125 | 2150 | 2175 | 2190 |
|---|---|---|---|---|---|
| As Quenched | 68 | 68 | 67 | 66.5 | 65.5 |
| 1000 | 67 | 67.5 | 68 | 68.5 | 69 |
| 1025 | 66.5 | 67 | 67.5 | 68 | 68.5 |
| 1050 | 65.5 | 66.5 | 67 | 67.5 | 68 |
| 1100 | 63 | 64 | 65 | 66 | 66.5 |
| 1150 | 59 | 60 | 61.5 | 63 | 64 |
| 1200 | 53 | 55 | 57 | 59 | 60 |

## Size Changes During Hardening

| Hardening Temp °F | Tempering Temp | HRC | Longitudinal Size Change % |
|---|---|---|---|
| 2175 | 1025 | 68 | +0.22 |

## Surface Treatment

PM-M48 can be nitrided, or titanium-nitride if desired

If the CVD-TiN treatment is used, care is required in vacuum hardening.

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## Heat Treatment

### Forging

2000-2100 °F. Do not forge below 1700 °F. Slow cool after forging.

### Annealing

Heat to 1600 °F, hold two hours.
Slow cool 30 °F/hour to 1000 °F.
Then air or furnace cool to room temperature. Annealed hardness is 285-311 BHN.

### Stress Relieving

After machining to minimize distortion in heat treating.
1100-1300 °F, hold for two hours, then air cool to room temperature.

### Hardening

Salt bath, protective atmosphere, or vacuum furnace equipment preferred.

### High Heat (Austenitizing)

Preheat 1500-1550 °F, equalize. Then second preheat at 1850-1900 °F, let parts equalize.
2100-2190 °F for 3 to 10 minutes depending upon furnace type being used and austenitizing temperature.

### Quench

Salt, oil or atmosphere quench to 1000-1100 °F, equalize, then air cool to below 125 °F.
Vacuum or atmosphere quench rate through 1850-1300 °F range critical to achieve optimum heat treat response.

### Tempering

Minimum 1000 °F tempering temperature recommended.
Triple tempering required, quadruple tempering recommended.

## Physical Properties

| | | | |
|---|---|---|---|
| **Modulus of Elasticity** | 31 x $10^6$ psi (207 GPa) | **Density** | 0.298 lb/$in^3$ |
| **Annealed Hardness** | 285-311 BHN | **Machinability** | 40% of O1 |