M4 – Technical Data

General Descriptions:

M4 is a special purpose high speed steel designed to give high wear resistance in tools. Its high vanadium and carbon content provide for superior resistance to cratering and wear in cold work punches, die inserts, and cutting applications involving high speed and light cuts. It is designed to give maximum performance working with abrasive material, exhibiting better wear resistance than M2 or M3.

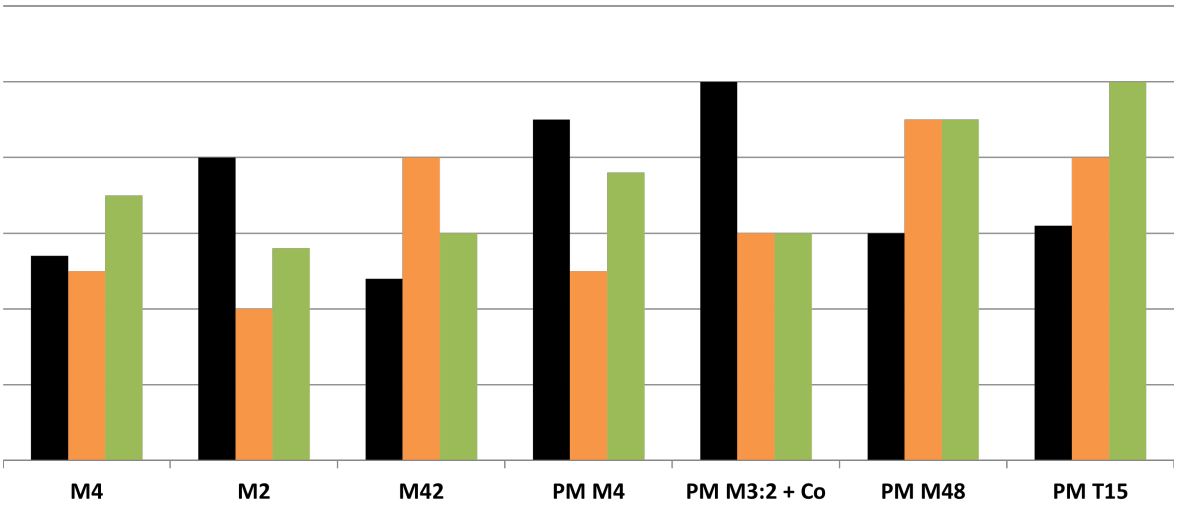
Examples of applications:

Broach inserts, end mills, form tools, taps, spade drills, punches, dies, rolls.

Chemical Composition

Carbon	Manganese	Silicon	Chromium	Vanadium	Tungsten	Molybdenum
1.25-1.40%	0.15-0.40%	0.20-.45%	3.75-4.75%	3.75-4.50%	5.25-6.50%	4.25-5.50%

Comparison Chart



Typical Heat Treat Response

Tempering Temp °F	Hardening Temp °F /HRC 1875	1975	2050	2100	2150	2200	Charpy C-Notch Ft.-lbs
As Quenched	59.5	62.5	64.5	65	65	63.5	
1000	58.5	61	62.5	63.5	65	66	
1025	58	60.5	62	63	64.5	65.5	8.5 (2200°)
1050	57.5	59.5	61	62	63.5	64.5	11 (2150°)
1100	54	56	58.5	60	61.5	62.5	
1150	50	53	55	56	58	59	
1200	44	48	51	52	54	55	
Minimum time at austenitizing temperature (minutes)							
	45	30	20	15	10	5	
Min # of tempers:	2	2	2	3	3	3	

Size Changes During Hardening

Hardening Temp °F	Tempering Temp	HRC	Longitudinal Size Change %
2200	1025	65	+0.20

Surface Treatment

M4 can be nitrided or titanium-nitride coated if desired
If the CVD TiN treatment is used, care is required in vacuum hardening.

Note

Lowering the hardening temperature (under hardening) reduces the grain size and increases toughness.

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Heat Treatment

Forging

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

Annealing

1600 °F, hold 2 hours, slow cool (30 °F/hour maximum) to 1000 °F.
Then air or furnace cool.
Resulting Hardness is 225-255 BHN.

Stress Relieving

Stress relieve after machining.1100-1300 °F, hold two hours at temperature then air or furnace cool to room temperature.
To stress relieve hardened parts: Temper 30 °F below original tempering temperature.

Hardening

Preheat to 1500-1550 °F, equalize.
Second preheat stage at 1850-1900 °F suggested for high temperature hardening in vacuum.

High Heat (Austenitizing)

1875-2225 °F.
2150-2200 °F recommended for cutting tools.
1875-2125 recommended for cold work applications.

Quench

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

Tempering

1000 °F minimum recommended.
Double tempering required and triple tempering recommended when hardening from 2100 °F or higher.
Air cool to room temperature between tempers.

Physical Properties

Modules of Elasticity	31 x 10^6 psi (214 GPa)	**Density**	0.288 lbs/in^3
Annealed Hardness	225-255 BHN	**Machinability**	70% of O1