Powder metallurgy HSS

M4 PM

Cincinnati Tool Steel Co.

CHEMICAL COMPOSITION

C	Cr	Mo	W	V
1.40	4.2	5.0	5.8	4.1

STANDARDS

- Europe: HS 6-5-4
- USA: M4

DELIVERY HARDNESS

Soft annealed	max. 260 HB
Cold drawn	max. 300 HB

DESCRIPTION

M4 PM is a high vanadium alloyed grade with high wear resistance and toughness suitable for cold work applications.

APPLICATIONS

- Punches
- Dies
- Rolls
- Rotating multi-edge cutting tools
- Milling cutters
- Taps
- Broaches

FORM SUPPLIED

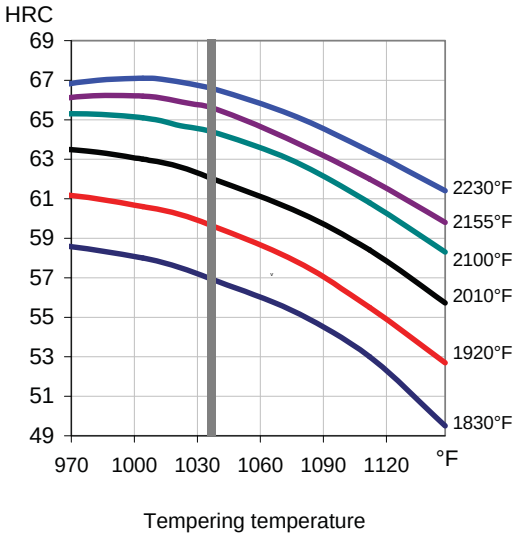
- Coils
- Round bars
- Flat & square bars
- Forged blanks

Available surface conditions : drawn, ground, hot worked, peeled, rough machined, hot rolled.

HEAT TREATMENT

- Soft annealing in a protective atmosphere at 1560-1650°F for 3 hours, followed by slow cooling at 20°F/h down to 1290°F, then air cooling.
- Stress-relieving at 1110°F to 1290°F for approximately 2 hours, slow cooling down to 930°F.
- Hardening in a protective atmosphere with pre-heating in 2 steps at 840-930°F and 1560-1650°F and austenitising at a temperature suitable for chosen working hardness. Cooling down to 100-120°F.
- Tempering at 1040°F three times for at least 1 hour each time. Cooling to room temperature (77°F) between temperings.

GUIDELINES FOR HARDENING



Hardness after hardening, quenching and tempering 3x1 hour

PROCESSING

M4 PM can be worked as follows :

- machining (grinding, turning, milling)
- polishing
- plastic forming
- electrical discharge machining
- welding (special procedure including preheating and filler materials of base material composition).

GRINDING

During grinding, local heating of the surface, which may alter the temper, must be avoided. Grinding wheel makers can furnish advice on the choice of grinding wheels.

SURFACE TREATMENT

The steel grade is a good substrate material for PVD and CVD coating. If nitriding is demanded a small zone of 2-15 µm is recommended. The steel grade can also be steam-tempered if so desired.

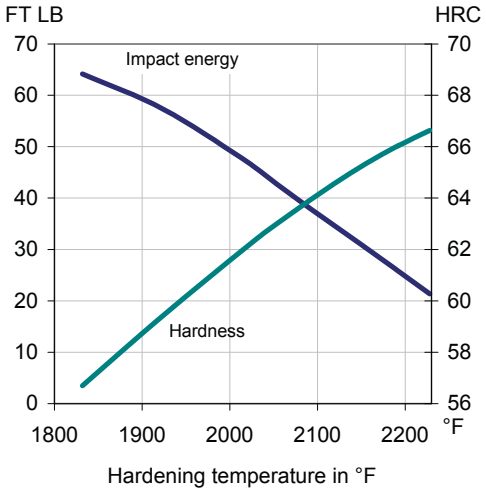
PROPERTIES

PHYSICAL PROPERTIES

	Temperature		
	68°F	**750°F**	**1110°F**
Density lb/in³ *(1)*	0.29	0.29	0.28
Modulus of elasticity psi *(2)*	$3.5x10^7$	$3.1 x10^7$	$2.7 x10^7$
Specific heat Btu/lb °F *(2)*	0.10	0.12	0.14

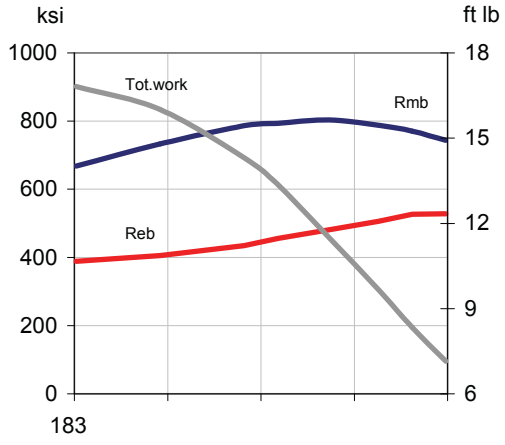
(1)=Soft annealed
(2)=Hardened 2155°F and tempered 1040°F, 3x1 hour

IMPACT STRENGTH



Original dimension 1/3x1/2 mm
Tempering 3 x 1 hour at 1040° F
Unnotched test piece 9/32 x13/32 x 25/32 inch

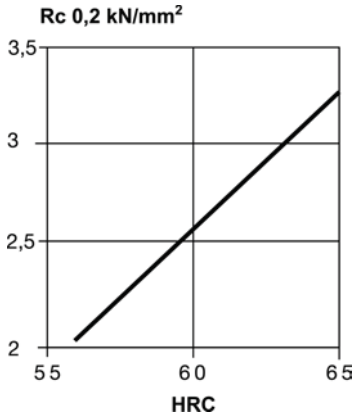
4-POINT BEND STRENGTH



Original dimension ∅ 1/4 inch
Tempering 3 x 1 hour at 1040° F
Dimension of test piece ∅1/5 inch

Rmb = Ultimate bend strength in kN/mm²
Reb = Bend yield strength in kN/mm²
Tot. work = Total work in Nm

COMPRESSION YIELD STRESS



Test piece : hour glass with 2/5 inch ∅ waist

COMPARATIVE PROPERTIES