CRUCIBLE

DATA SHEET

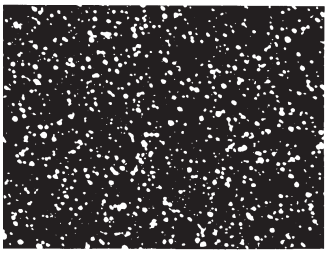
CRUCIBLE CPM® 9V®

Issue #1

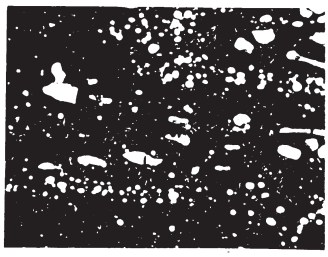
CPM 9V is made by the Crucible Particle Metallurgy process. Its composition is a modification of CPM 10V with lower carbon and vanadium to improve toughness and heat check resistance. These enhanced properties permit CPM 9V to perform well in problem applications where high carbon, high chromium tool steels, such as CPM 10V or the high speed steels, lack sufficient toughness or heat check resistance, or where lower alloy tool steels and hot work tool steels lack sufficient wear resistance.

The CPM process produces very homogeneous, high quality steel characterized by superior dimensional stability, grindability, and toughness compared to steels produced by conventional processes.

Carbon	**1.90%**
Chromium	**5.25%**
Vanadium	**9.10%**
Molybdenum	**1.30%**

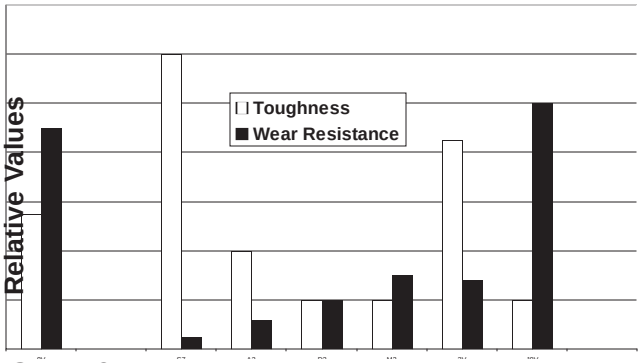


CPM Steel



Conventional Steel

Tool Steel Comparagraph



	CPM 9V	S7	A2	D2	M2	CPM 3V	CPM 10V
HRC	54	55	60	60	62	58	60

Physical Properties

Elastic Modulus 32 X 10^6 psi (221 GPa)
Density .269 lbs./in^3 (7.455 g/cm^3)

Thermal Conductivity

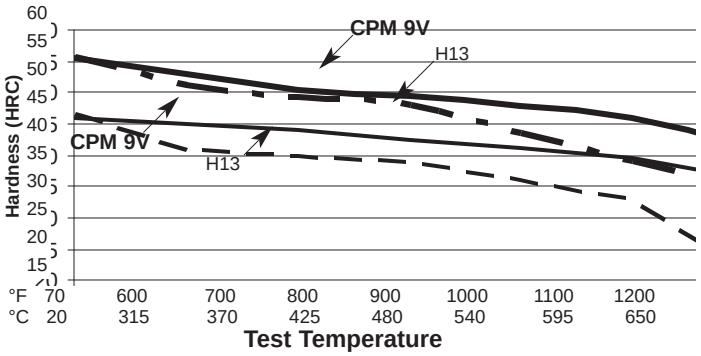
		BTU/hr-ft-°F	W/m-°K	cal/cm-s-°C
72°F	22°C	11.83	20.48	4.89 X 10^{-2}
212°F	100°C	12.48	21.60	5.16 X 10^{-2}
392°F	200°C	13.35	23.10	5.52 X 10^{-2}
572°F	300°C	14.59	25.25	6.03 X 10^{-2}
932°F	500°C	14.91	25.81	6.16 X 10^{-2}
1004°F	540°C	15.07	26.08	6.23 X 10^{-2}

Coefficient of Thermal Expansion

°F	°C	in/in/°F	mm/mm/°C
70 - 200	(20 - 90)	6.15X10^{-6}	(11.07X10^{-6})
70 - 400	(20 - 200)	6.21X10^{-6}	(11.18X10^{-6})
70 - 800	(20 - 430)	6.45X10^{-6}	(11.61X10^{-6})
70 -1200	(20 - 650)	6.59X10^{-6}	(11.86X10^{-6})

Mechanical Properties

Hot Hardness vs. H13 (Hardness at Indicated Temperature)



Heat Check Resistance (Warm Work Applications)

Grade	Hardness HRC	Number of Cycles[A]
D2	**50**	**3,000**
10V	**51**	**5,000**
9V	**48**	**15,000**
H13	**48**	**20,000**
H19	**50**	**60,000**

[A]One cycle consists of immersing the test specimen in 1250°F molten lead for 4 sec., cooling in 180°F water for 2 sec. followed by 8 sec. of air cooling.

Typical Applications

Forming Rolls	Punches
Rolling Mill Rolls	Dies
Header Tooling	Slitter Knives
Extrusion Tooling	Shear Blades
Pelletizer Blades	Granulator Blades

Plasticizing Components: Non-return Valves and Screws

Note: These are some typical applications. Your specific application should not be undertaken without independent study and evaluation for suitability.

Machinability and Grindability

In the annealed condition, the machinability of CPM 9V is comparable to that of M2. Similar grinding equipment and practices used for high speed steels are recommended. "SG" type alumina wheels or CBN wheels have generally given the best performance with CPM steels.

Crucible Industries LLC

Thermal Treatments

Critical Temperature: 1590°F (865°C)
Forging: 2000-2100°F (1095-1150°) Do not forge below 1700°F (930°C). Slow Cool.
Annealing: Heat to 1650°F (900°C), hold 2 hours, slow cool no faster than 30°F (15°C) per hour to 1000°F (540°C), then furnace cool or cool in still air to room temperature.
Annealed Hardness: About BHN 223-255

Stress Relieving

Annealed Parts: Heat to 1100-1300°F (595-700°C), hold 2 hours, then furnace cool or cool in still air.
Hardened Parts: Heat to 25-30°F (15°C) below original tempering temperature, hold 2 hours, then furnace cool or cool in still air.
Straightening: Best done warm 400-800°F (200-430°C)

Hardening

Preheat: Heat to 1550-1600°F (845-870°C) Equalize. Second pre-heat stage at 1850-1900°F (1010-1040°C) suggested for vacuum or atmosphere hardening.
Austenitize: 1850-2150°F (1025-1175°C), hold time at temperature 30-45 minutes.
Quench: Air or positive pressure quench (2 bar minimum) to below 125°F (50°C), or salt or interrupted oil quench to about 1000°F (540°C), then air cool to below 125°F (50°C). Salt bath treatment, if practical, will ensure maximum attainable toughness for a given hardening treatment. Vacuum or atmosphere quench rate through 1850-1300°F (1010-705°C) range is critical to achieve optimum heat treat response.
Temper: Double temper at 1000°F (540°C) minimum. 2 hours minimum each time. (See Table)
Size Change: +0.01%

Recommended Heat Treatment:

For the best combination of toughness and wear resistance, austenitize 9V at 2050°F (1120°C), hold 30-45 minutes, and quench. Temper 3 times at 1025°F (550°C).
Aim hardness: 54-56 HRC. Higher austenitizing temperatures can be used to obtain higher hardness, at a slight decrease in impact resistance. The lower austenitizing temperatures provide the best impact toughness.

Surface Treatments

Because of its high tempering temperatures (>1000°F) CPM 9V is suitable for nitriding, PVD coating or similar surface treatments. CVD coating processes generally exceed the critical temperature and may result in non-predictable dimensional changes.

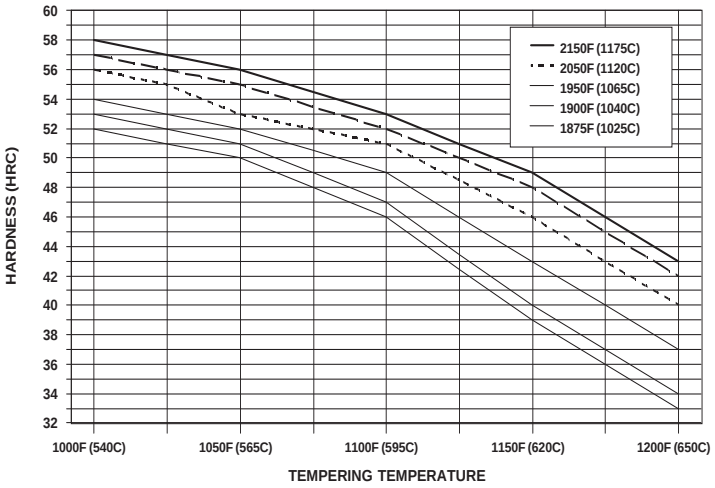
Heat Treat Response

Hardness HRC

Tempering Temperature	Austenitizing Temperature 1875°F (1025°C)	1900°F (1040°C)	1950°F (1065°C)	2050°F (1120°C)	2100°F (1150°C)	2150°F (1175°C)
As Quenched	53	54	56	58	59	61
1000°F (540°C)	52	53	54	56	57	58
Optimum for Maximum Toughness and Effective Stress Relieving						
1025°F (550°C)	51	52	53	55	56	57
1050°F (565°C)	50	51	52	53	55	56
1100°F (595°C)	46	47	49	51	52	53
1150°F (620°C)	39	40	43	46	48	49
1200°F (650°C)	33	34	37	40	42	43

Results may vary with hardening method and section size. Salt or oil quenching will give maximum response. Vacuum or atmosphere cooling may result in up to 1-2 HRC points lower.

Minimum Time at Aust. Temp.	60 min.	45 min.	30 min.	20 min.	15 min.	10 min.
Minimum Number of Tempers	2	2	2	2	3	3



Toughness

Depending on the hardness requirement, lowering the hardening temperature (underhardening) increases toughness.

Hardening Temperature	Tempering Temperature	Hardness HRC	Charpy C-Notch ft-lb	Charpy C-Notch (J)	Bend Fracture Strength ksi	Bend Fracture Strength (MPa)
2150°F (1175°C)	1025°F (550°C)	57	26	35	606	4177
2100°F (1150°C)	1025°F (550°C)	56	36	48	-	-
2050°F (1120°C)	1000°F (540°C)	56	47	63	600	4136
1950°F (1065°C)	1100°F (595°C)	49	74	99	-	-

Note: Properties shown throughout this data sheet are typical values. Normal variations in chemistry, size and heat treat conditions may cause deviations from these values. For additional data or metallurgical engineering assistance, consult your local Crucible Service Center.

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