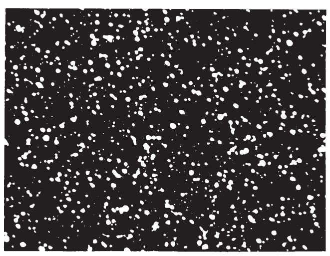
CRUCIBLE

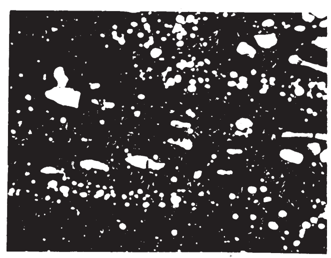
DATA SHEET

CPM 10V was the first in the family of high vanadium tool steels made by the Crucible Particle Metallurgy process. Crucible engineers optimized the vanadium content to provide superior wear resistance while maintaining toughness and fabrication characteristics comparable to D2 and M2. Since its introduction in 1978, CPM 10V has become recognized world-wide and sets the standard for highly wear resistant industrial tooling. Its exceptional wear resistance and good toughness make it an excellent candidate to replace carbide and other highly wear resistant materials in cold work tooling applications, particularly where tool toughness is a problem or where cost effectiveness can be demonstrated.

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

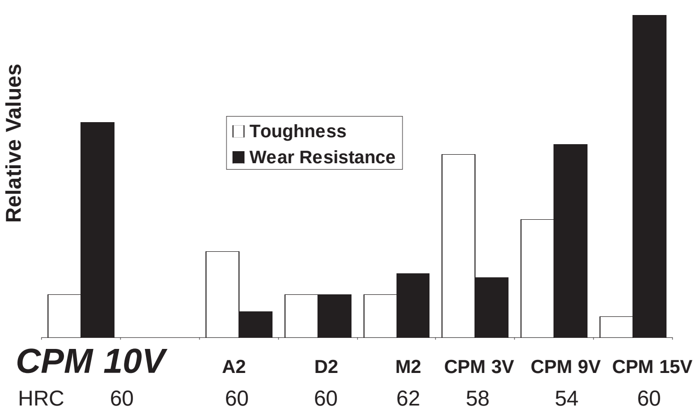


CPM Steel



Conventional Steel

Tool Steel Comparagraph



Typical Applications

- Stamping or Forming Tools
- Powder Compaction Tooling
- Industrial Knives and Slitters
- Plastic Mold Inserts
- Wear Parts
- Punches and Dies
- Blanking and Piercing Dies
- Woodworking Tools
- Plastic Injection Barrels

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

CRUCIBLE CPM® 10V® (AISI A11)

Issue #1

Carbon	**2.45%**
Chromium	**5.25%**
Vanadium	**9.75%**
Molybdenum	**1.3%**

Physical Properties

Elastic Modulus	32 X 10^6 psi	(221 GPa)
Density	0.268 lbs./in^3	(7.418 g/cm^3)

Thermal Conductivity

	BTU/hr-ft-°F	W/m-°K	cal/cm-s-°C
70°F (21°C)	11.78	20.39	0.0487
212°F (100°C)	12.44	21.54	0.0514
572°F (300°C)	14.36	24.85	0.0593
932°F (500°C)	15.19	26.30	0.0628

Coefficient of Thermal Expansion

°F	°C	in/in/°F	mm/mm/°C
70-200	(21- 93)	5.96X10^{-6}	(10.7X10^{-6})
70-500	(21-260)	6.18X10^{-6}	(11.1X10^{-6})
70-800	(21-427)	6.54X10^{-6}	(11.8X10^{-6})
70-1100	(21-593)	6.82X10^{-6}	(12.3X10^{-6})

Mechanical Properties

Impact Toughness

Depending upon the application requirement for hardness, lowering the hardening temperature (underhardening) increases the toughness.

Hardening Temperature		Tempering Temperature		Hard-ness	Charpy C-Notch Impact Strength		Bend Fracture Strength	
°F	°C	°F	°C	HRC	ft.-lb.	(J)	ksi	(MPa)
2150	1175	1000	540	64	15	20	627	4322
2100	1150	1000	540	63	16	22	615	4239
2050	1120	1025	550	61	23	30	635	4377
1950	1065	1025	550	59	26	35	-	-

Machinability and Grindability

Machinability in the annealed condition is similar to T15 high speed steel. 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.

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Thermal Treatments

Critical Temperature: 1540°F (840°C)

Forging: 2000-2100°F (1095-1150°) Do not forge below 1700°F (930°C). Slow Cool.

Annealing: Heat to 1600°F (870°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 255-277

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 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 1500-1550°F (815-845°C) Equalize. Second pre-heat stage at 1850-1900°F (1010-1040°C) suggested for vacuum or atmosphere hardening.

Austenitize: 1850-2150°F (1010-1175°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: +0.03/0.05%

Recommended Heat Treatment: For the best combination of toughness and wear resistance, austenitize CPM 10V at 2050°F (1120°C), hold 30-45 minutes, and quench. Temper 3 times at 1025°F (550°C).

Aim hardness: HRC 60. 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.

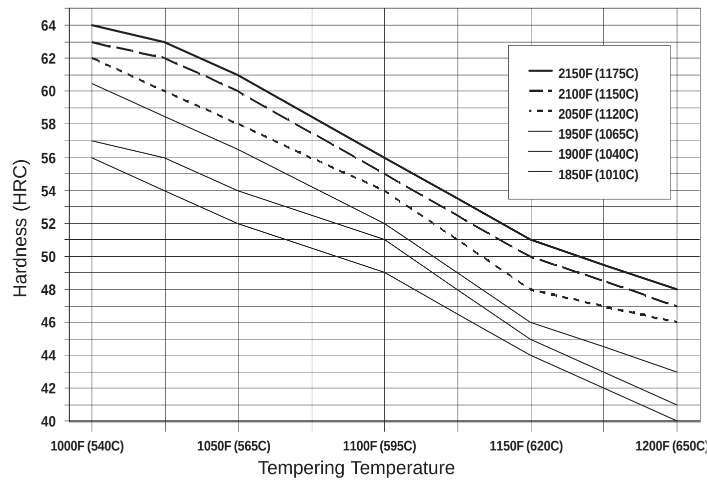
Heat Treat Response

Hardness HRC

Tempering Temperature	Austenitizing Temperature 1850°F (1010°C)	1900°F (1040°C)	1950°F (1065°C)	2050°F (1120°C)	2100°F (1150°C)	2150°F (1175°C)
As Quenched	61	63	65	65	64.5	63.5
1000°F (540°C)	56	57	60.5	62	63	64
Optimum for Maximum Toughness and Effective Stress Relieving						
1025°F (550°C)	54	56	58.5	60	62	63
1050°F (565°C)	52	54	56.5	58	60	61
1100°F (595°C)	49	51	52	54	55	56
1150°F (620°C)	44	45	46	48	50	51
1200°F (650°C)	40	41	43	46	47	48

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



Surface Treatments

Because of its high tempering temperatures (>1000°F) CPM 10V 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.

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.

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