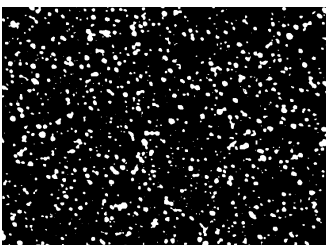


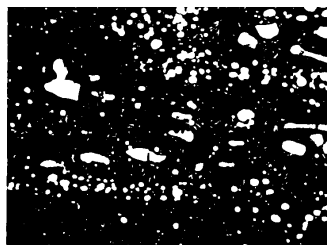
# CRUCIBLE

CPM Rex 45 is an 8% cobalt modification of M3 high speed steel made by the CPM (Crucible Particle Metallurgy) Process. It has red hardness comparable to that of M42 but offers abrasion resistance even better than that of M3. With its excellent red hardness, good wear resistance and good toughness, CPM Rex 45 is suitable for difficult machining applications or high cutting speed applications.

The CPM process results in a homogeneous microstructure with a finer, more uniform carbide distribution imparting superior dimensional stability, grindability and toughness when compared to steels produced by conventional processes. The CPM process also allows the design of more highly alloyed grades which cannot be produced by conventional steelmaking.

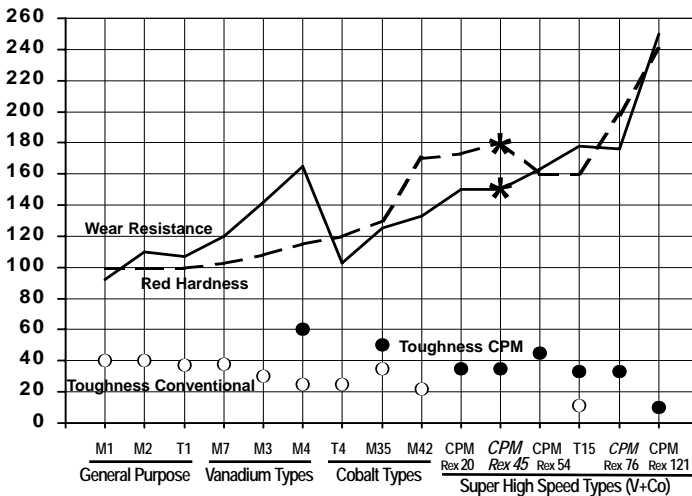


CPM Steel



Conventional Steel

## High Speed Steel Comparagraph



## Typical Applications

- |            |                   |
|------------|-------------------|
| Gear Hobs  | Milling Cutters   |
| End Mills  | Extrusion Punches |
| Form Tools | Shaper Cutters    |
| Broaches   | Taps              |

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

# Crucible...

## The Tool Steel Pros<sup>®</sup>

Crucible, CPM, Rex, 20, 45, 54, 76 and 121 are trademarks or service marks of Crucible Materials Corporation, Syracuse, NY.

# DATA SHEET

## CRUCIBLE CPM<sup>®</sup> Rex<sup>®</sup> 45<sup>®</sup> (HS)\* High Speed Steel

Issue #6

<b>Carbon</b>	<b>1.30%</b>
<b>Chromium</b>	<b>4.05%</b>
<b>Vanadium</b>	<b>3.05%</b>
<b>Tungsten</b>	<b>6.25%</b>
<b>Molybdenum</b>	<b>5.00%</b>
<b>Cobalt</b>	<b>8.00%</b>
<b>Sulfur</b>	<b>0.06 (0.22%)*</b>

\*Sulfur is added to improve the machinability of larger diameter rounds (e.g. 2-9/16" and over). The higher sulfur content benefits the toolmaker by increasing the ease of manufacture, and benefits the tool user by increasing the ease of resharping. The CPM process permits the use of sulfur without affecting the tool's performance.

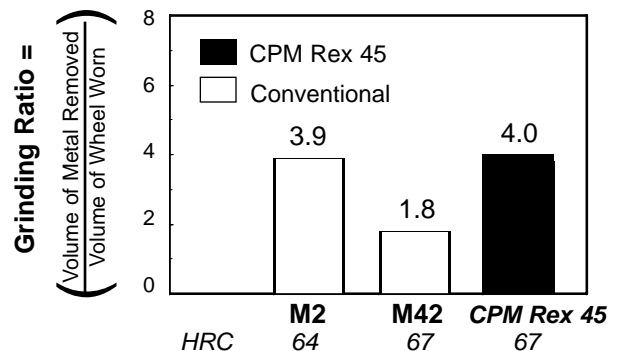
## Physical Properties

<b>Elastic Modulus</b>	31 X10 <sup>6</sup> psi	214 GPa
<b>Specific Gravity</b>	8.05	
<b>Density</b>	0.291 lbs/in <sup>3</sup>	8.05 g/cm <sup>3</sup>
<b>Coefficient of Thermal Expansion</b>		
°F	°C	
70-750	20-400	6.3 X 10 <sup>-6</sup>
70-1100	20-595	6.4 X 10 <sup>-6</sup>
		in/in/°F
		mm/mm/°C
		11.4 X 10 <sup>-6</sup>
		11.5 X 10 <sup>-6</sup>

## Machinability and Grindability

**Machinability** of CPM Rex 45 in the annealed condition is approximately 30% of W1 Tool Steel (1%C).

**Grindability** of CPM Rex 45 compares favorably with regular high speed steels because of its fine, uniformly distributed carbides. Conventional grinding wheels designed for high speed steels can be used. In special cases, the advice of a grinding wheel manufacturer should be sought.



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.

## Thermal Treatments

**Critical Temperature:** 1500°F (815°C)

**Forging:** 2000-2100°F (1095-1150°C). Do not forge below 1700°F (925°C). Slow cool after forging.

### Annealing

Heat to 1600°F (870°C), hold 2 hours, slow cool no faster than 25°F (15°C) per hour to 1000°F (540°C), then furnace cool or cool in still air to room temperature.

**Annealed Hardness:** Approx. BHN 255/285

### Stress Relieving

**Annealed parts:** Heat to 1100-1300°F (595-705°C), hold 2 hours, then furnace cool or cool in still air.

**Hardened parts:** Heat to 25°F (15°C) below original tempering temperature, or 1000°F (540°C) minimum, hold 2 hours, then furnace cool or cool in still air.

### Hardening (Salt or High Pressure Vacuum preferred)

**Pre-heat:** Heat to 1500-1550°F (815-845°C), hold long enough to soak through. For vacuum heat treating, an additional pre-heat at 1850-1900°F (1010-1040°C) is recommended to minimize hold time needed at austenitizing temperature.

**Austenitize:** 2100-2190°F (1150-1200°C)

Standard recommendation to achieve HRC 66-68 is 2175°F (1190°C).

**Quench:** Quench rapidly to below 1100°F (595°C), equalize, then air cool to hand warm, below 125°F (50°C). Salt or interrupted oil quenching usually gives the best heat treat response for high speed steels. A fast quench rate from hardening temperature to below 1100°F (595°C) is critical to achieve optimum heat treat response.

**Temper:** 1000°F (540°C) minimum. Triple tempering is required, hold 2 hr. minimum at temperature. Cool to room temperature between tempts.

**Straightening:** Best done warm 400°F minimum (205°C). Straightening after salt quenching and before cooling to below 400°F (205°C) is preferred.

### Size Change During Hardening

Hardening Temp.	Tempering Temp.	HRC	Longitudinal Size Change
2175°F (1190°C)	1025°F (550°C)	67	+0.002 in/in (+0.051 mm/mm)

### Service Center Locations

Location	Phone	Toll Free	FAX
Auburn, MA	508-832-5353	800-365-1101	508-832-2217
Charlotte, NC	704-372-3073	800-365-1160	704-342-0985
Chicago, IL	630-378-0093	800-365-1151	630-378-1965
Cincinnati, OH	513-771-1310	800-365-1163	513-771-0119
Cleveland, OH	330-562-3131	800-365-1132	330-562-7818
Columbus, OH	614-262-4959	800-365-1131	614-262-7850
Dallas, TX	817-649-2800	800-365-1168	817-633-8142
Detroit, MI	248-528-0332	800-365-1133	248-528-1977
Grand Rapids, MI	616-554-9699	800-365-1137	616-554-9328
Huntsville, AL	256-772-0201	800-365-1161	256-772-3361
Indianapolis, IN	317-638-4501	800-365-1146	317-634-7375
Los Angeles, CA	714-632-1131	800-365-1179	714-632-1181

**Crucible Service Centers**

A Division of Crucible Materials Corporation

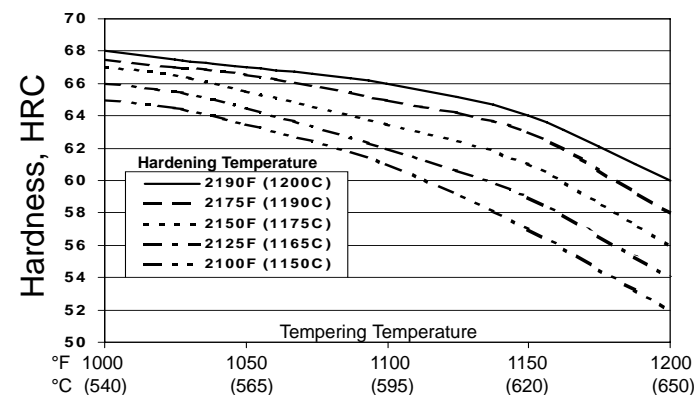
## Heat Treat Response

Hardness (HRC) - Oil or Salt Quench (Note A)

Tempering Temperature °F (°C)	2100°F (1150°C)	2125°F (1165°C)	2150°F (1175°C)	2175°F (1190°C)	2190°F (1200°C)
As-Quenched	66	67	67	66	65.5
1000 (540)	65	66	67	67.5	68
Optimum For Maximum Toughness and Effective Stress Relieving					
1025 (550)	64.5	65.5	66.5	67	67.5
1050 (565)	63.5	64.5	65.5	66.5	67
1100 (595)	61	62	63.5	65	66
1150 (620)	57	59	61	63	64
1200 (650)	52	54	56	58	60

NOTE A: RESULTS MAY VARY WITH HARDENING METHOD AND SECTION SIZE. SALT OR OIL QUENCHING WILL GIVE MAXIMUM RESPONSE. VACUUM OR ATMOSPHERE COOLING MAY RESULT IN  $\pm$  POINT HRC LOWER.

Minimum time at Austenitizing temp. minutes	10	10	5	5	3
Minimum number of tempts	3	3	3	3	3



**Toughness:** Lower hardening temperatures (underhardening) provide finer grain size and increased toughness.

Hardening Temp. °F (°C)	Tempering Temp. °F (°C)	Hardness HRC	Charpy Impact C-Notch ft.lb. (J)	Bend Fracture Strength ksi (MPa)
2175 (1190)	1025 (550)	67	15 20	702 4826
2150 (1175)	1025 (550)	66.5	18 24	712 4895
2125 (1165)	1040 (560)	65	20 27	685 4709

## Surface Treatments

CPM Rex 45 can be nitrided or PVD coated if desired. If a CVD treatment is used, subsequent hardening is required and may result in undesirable distortion.

Location	Phone	Toll Free	FAX
Meadville, PA	814-337-8804	800-365-0530	814-337-8808
Milwaukee, WI	262-781-6710	800-242-0948	262-781-6743
Minneapolis, MN	612-331-6320	800-365-1153	612-331-4137
St. Louis, MO	636-272-7220	877-201-4049	636-978-9559
<b>Canada</b>			
Wallaceburg, ONT	519-627-2245	800-265-5293	519-627-2247 (Toll-free FAX: 888-701-4287)
<b>Mexico (SISA)</b>			
Monterrey, N.L.	52-81-8351-7220		52-81-8351-2981
Naucalpan, E de M	52-55-5576-4011		52-55-5360-1865

### CRUCIBLE SERVICE CENTERS DIVISIONAL HEADQUARTERS:

Camillus, NY 315-487-0800 800-365-1185 315-487-4028  
[www.crucibleservice.com](http://www.crucibleservice.com) email: [crucible@crucibleservice.com](mailto:crucible@crucibleservice.com)