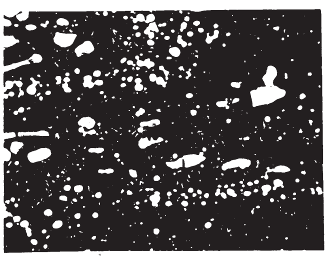
CRUCIBLE

DATA SHEET

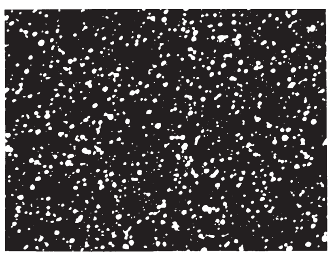
CRUCIBLE CPM® Rex® 121®

CPM Rex 121 is a high vanadium cobalt-bearing tool steel designed to offer the highest combination of wear resistance, attainable hardness, and red hardness available in a high speed steel. Its superior red hardness permits higher cutting speeds compared to other high speed steels. Its superior wear resistance, owing to its high vanadium content, helps to maintain a sharp cutting edge at increased cutting speeds. CPM Rex 121 also bridges the performance gap between high alloy tool steels and carbide materials. It may be used for cutting tools, where high cutting speeds demand higher heat resistance, but carbide is too brittle, or for high wear tooling applications (punches and dies) where carbide tools are too fragile.

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.

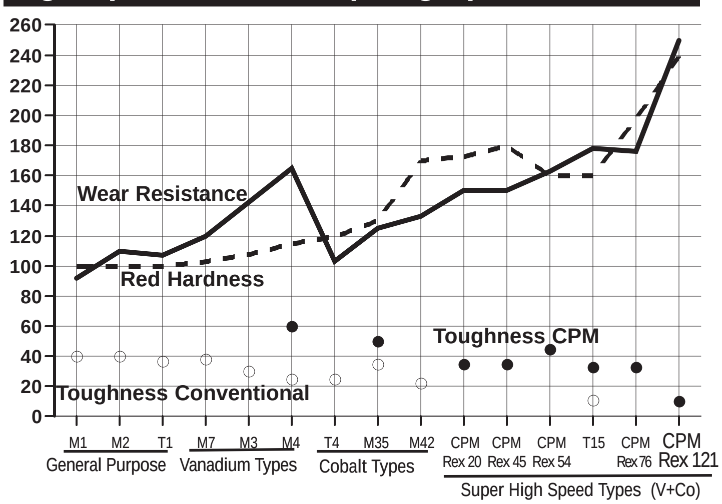


Conventional High Speed Steel



CPM High Speed Steel

High Speed Steel Comparagraph



Typical Applications

Hobs	**Powder Compaction Tooling**	
Broaches	**Milling Cutters**	
Die Inserts	**Wear Parts**	**Guide Rolls**

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

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Issue #1

Carbon	**3.4%**
Chromium	**4.0%**
Vanadium	**9.5%**
Tungsten	**10.0%**
Molybdenum	**5.0%**
Cobalt	**9.0%**
Sulfur	**0.03% (0.10%)***

**Because of the extremely fine and uniform microstructure provided by the CPM (Crucible Particle Metallurgy) process, sulfur may be added if desired to improve the machinability. The higher sulfur content benefits the toolmaker by allowing ease of manufacture, and the tool user by allowing easier resharpening. The CPM process ensures that the additional sulfur will not detrimentally affect the tool's toughness.*

Physical Properties

Elastic Modulus	31×10^6 psi	214 GPa
Specific Gravity	8.26	
Density	0.298 lbs/in^3	8.255g/cm^3

Coefficient of Thermal Expansion

°F	°C	in/in/°F	mm/mm/°C
70-400	20-200	6.0×10^{-6}	10.8×10^{-6}
70-600	20-315	6.15×10^{-6}	11.1×10^{-6}
70-800	20-425	6.33×10^{-6}	11.4×10^{-6}
70-1000	20-540	6.52×10^{-6}	11.7×10^{-6}
70-1200	20-650	6.75×10^{-6}	12.1×10^{-6}

Relative Mechanical Properties

Wear Resistance

Depending on the application, the wear resistance of CPM Rex 121 is approximately 50-100% better than CPM Rex T15, CPM Rex 76 or CPM 10V.

Impact Toughness

Depending on the heat treatment, the impact toughness of CPM Rex 121 is approximately comparable to that of CPM 15V or conventionally melted T15.

Red Hardness

The red hardness of CPM Rex 121 is higher than that of CPM Rex 76. CPM Rex 121 can retain a room temperature hardness of HRC 60 even after tempering at 1200°F (650°C). Its high red hardness may be particularly useful for high cutting speed operations. When CPM Rex 121 is used in place of conventional cobalt-bearing high speed steels in cutting tools, cutting speeds may be increased by approximately 25%-50%, depending on application experience.

Thermal Treatments

Annealing

Heat to 1650° F (900°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 360/410 (HRC 38/44)

Stress Relieving

Annealed parts: Heat to 1100-1300° F (595-705°C), hold 2 hours, then air cool or furnace cool.
Hardened parts: Heat to 25-50°F (15-30°C) below original tempering temperature, hold 2 hours, then air cool or furnace cool.

Hardening (Salt Bath or Vacuum Furnace preferred.)

Pre-heat: 1500-1550°F (815-845°C), hold long enough to soak through. A second pre-heat at 1850-1950°F (1010-1065°C) is recommended when hardening from over 2100°F (1150°C)

Austenitize: 1875-2200° F (1025-1205° C) Hold time at temperature: 5-30 minutes depending on temperature.

Quench: Quench rapidly to below 1100° F (595° C), equalize then air cool to hand warm, 125°F (50°C). Salt or interrupted oil quench usually gives the best heat treat response for high speed steels. Vacuum hardening may result in slightly lower hardness for larger tools. The quench rate from the hardening temperature to below 1100° F (595°C) is critical to achieve optimum results. The cooling rate below 1000°F (540°C) may be slower to minimize distortion if desired.

Temper: Temper 2 to 4 times at 1000°F (540°C) or higher. Hold at least 2 hours at temperature for each temper. (From 2 to 4 tempers are required, depending on exact hardening temperature.) Air cool to room temperature between tempers.

Straightening: Best when done warm 500-1000°F (260-540°C). Straightening after salt quenching, before cooling to below 500°F (260°C) is preferred if possible. This grade has limited toughness; straightening may present a risk of cracking.

Heat Treat Response (HRC) - Oil or Salt Quench (Note A)

Tempering Temperature °F (°C)	1875°F (1025°C)	2050°F (1120°C)	2150°F (1175°C)	2200°F (1205°C)
as-quenched	71	69	67	65
1000 (540)	68.5	70	70.5	70.5
Optimum For Maximum Toughness and Effective Stress Relieving				
1025 (550)	67.5	69.5	70.5	70.5
1050 (565)	66.5	68.5	70	69
1100 (595)	63	66	67.5	68
1200 (650)	55	56	58	59
Minimum time at Aust. temp. (mins)	**30**	**20**	**15**	**10**
Minimum number of tempers	**2**	**3**	**3**	**4**

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 ≅ 1 POINT HRC LOWER.

Recommended Austenitizing Temperatures:
2150-2200°F (aim 70-71 HRC) for high speed cutting tools.
1875-2050°F (aim 68-69 HRC) for metalforming tools.

Surface Treatments

CPM Rex 121 can be nitrided or PVD coated if desired. If a CVD treatment is used, subsequent hardening is required and may result in undesirable distortion. The high red hardness of CPM Rex 121 makes it a particularly good substrate for TiAlN or similar coatings designed for higher temperature exposure.

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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