CRUCIBLE

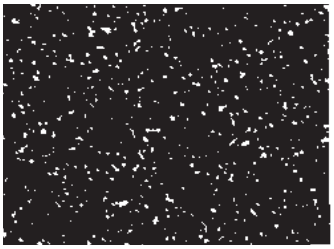
DATA SHEET

CRUCIBLE CPM® Rex® 54™HS

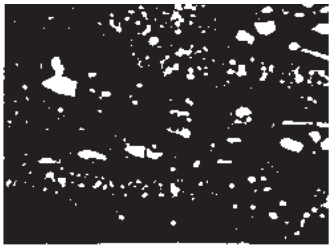
Issue #1

CPM Rex 54 is a cobalt-bearing high speed steel designed to offer an improvement in the red hardness of the popular M4 grade, while maintaining wear properties equivalent to M4. CPM Rex 54 has a chemical anlysis very similar to M4 to which cobalt has been added for superior red hardness which allows for higher cutting speeds. It contains higher vanadium (4%) than either M35 (2%) or CPM Rex 45 (3%), and therefore offers improved wear resistance over these two grades, while maintaining a similar red hardness level.

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.

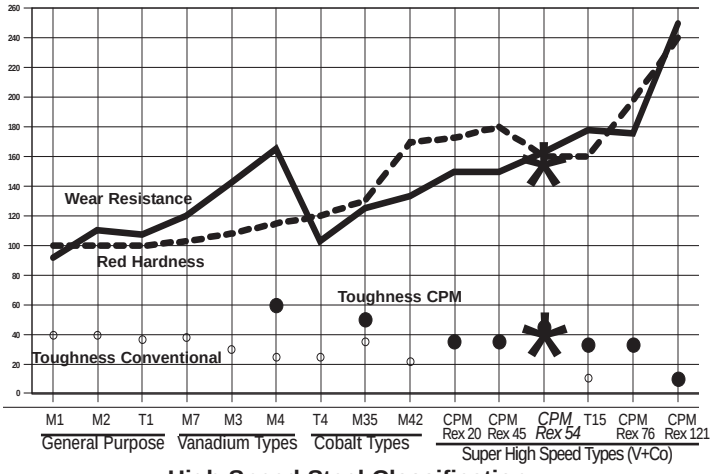


CPM Steel



Conventional Steel

High Speed Steel Comparagraph



High Speed Steel Classification

Typical Applications

Hobs	Punches & Dies	Form Tools
Broaches	Milling Cutters	End Mills
Tool Bits	Counter Bores	Taps

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

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Carbon	**1.48%**
Chromium	**4.0%**
Vanadium	**3.75%**
Tungsten	**5.5%**
Molybdenum	**5.0%**
Cobalt	**5.0%**
Sulfur	**0.22%***

**Sulfur is added to improve the machinability. The higher sulfur content benefits the toolmaker by increasing the ease of manufacture, and benefits the tool user by increasing the ease of resharpening. The extrmely fine and uniform CPM microstructure ensures that the additional sulfur will not detrimentally affect the tool's toughness.*

Physical Properties

Elastic Modulus	30 X10^6 psi	207 GPa
Specific Gravity	8.14	
Density	0.294 lbs/in^3	8.144 g/cm^3

Coefficient of Thermal Expansion

°F	°C	in/in/°F	mm/mm/°C
70-500	20-260	6.4 X 10^{-6}	11.5 X 10^{-6}
70-800	20-425	6.58 X10^{-6}	11.8 X 10^{-6}
70-1000	20-540	6.72X10^{-6}	12.1 X 10^{-6}

Mechanical Properties

Wear Resistance: The wear resistance of CPM Rex 54 is similar to CPM M4HC, and better than CPM Rex 45.
Toughness: The impact toughness of CPM Rex 54 is similar to CPM M35HCHS and better than CPM Rex 45 or CPM T15.
Red Hardness: The red hardness of CPM Rex 54 is similar to CPM T15 between CPM M35 and CPM Rex 45.

CPM Rex 54 as an Upgrade:

CPM Rex 54 provides higher attainable hardness and better heat resistance than M4. CPM Rex 54 is also an upgrade to M35 for improved wear resistance. It has a chemistry similar to M35, but with increased vanadium and carbon, for greater wear resistance. CPM Rex 54 may be substituted for M35 in nearly any application for better performance. It may also be substituted for CPM Rex 45 in most applications where higher wear resistance is desired. CPM Rex 54 offers the same cobalt level as M35, T15 and other cobalt-bearing high speed steels. (For applications requiring red hardness greater than that of CPM Rex 54, consider CPM Rex 76.)

Thermal Treatments

Annealing

Heat to 1600-1650°F (870-900°C), hold 2 hours, slow cool no faster than 25°F (15°C) per hour to 1100°F (595°C), then furnace cool or cool in still air to room temperature.
Annealed Hardness: Approx. BHN 225/255

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 25-50°F (15-30°C) below original tempering temperature, 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 1850-1950°F (1010-1065°C) is recommended to minimize hold time needed at austenitizing temperature.
Austenitize: 2100-2200° F (1150-1205°C)
Hold time at temperature: 5-15 minutes

Quench: Quench rapidly to below 1100°F (595°C), equalize, then air cool to hand warm, below 150°F (65°C). Salt or interrupted oil quenching usually gives the best heat treat response for high speed steels. Vacuum hardening may result in 1-1.5 points HRC lower hardness for larger tools. A fast quench rate from hardening temperature to below 1100°F (595°C) is critical to achieve optimum results.

Temper: Three tempers each for at least 2 hrs. at temperature at 1000°F (540°C) or higher, is recommended. Air cool to room temperature between tempers.

Straightening: Best done warm 400-900°F (205-485°C). Straightening after salt quenching before cooling to below 400°F(205°C) is preferred if possible.

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)	2200°F (1205°C)
as-quenched		65.5	65.5	65	65	64.5
1000	(540)	65	66	66	66.5	67
Optimum For Maximum Toughness and Effective Stress Relieving						
1025	(550)	64.5	65	65.5	66	66.5
1050	(565)	63.5	64	64.5	65	66
1100	(595)	61	62	62.5	63	64
1150	(620)	57	58	58.5	59	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 ≦1 POINT HRC LOWER.

Minimum time at Austenitizing temp.	15 **minutes**	10 **minutes**	10 **minutes**	5 **minutes**	5 **minutes**
Minimum number of tempers	**3**	**3**	**3**	**3**	**3**

Surface Treatments: CPM Rex 54 can be nitrided or PVD coated if desired. If a CVD treatment is used, subsequent hardening is required and may result in undesirable distortion.

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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