CRUCIBLE

CPM 1V is a medium carbon, high alloy tool steel which exhibits high toughness combined with high heat resistance. It is suited for both hot or cold applications which demand high impact toughness and also require moderate wear resistance.

The CPM (Crucible Particle Metallurgy) 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

Relative Values

CPM 1V H13 S7 H19 A2 M2
HRC 56 46 57 54 60 62
Impact Toughness ft-lbs 115 130 125 60 40 20

Typical Applications

Hot (Warm) Work
- Hot and Warm Forming Dies Hot
- Shear Dies
- Hot Heading Dies Extrusion Dies
- Forging Dies and Punches

Cold Work
- Cold Heading Dies High Impact
- Blanking Dies Punches
- Thread Rolling Dies

Relative Mechanical Properties

Impact Toughness and Wear Resistance
With its 1% vanadium content, CPM 1V has wear resistance slightly better than A2. Because of its CPM microstructure, 1V has high impact toughness approaching that of the shock-resistant tool steels such as S7.

Temper Resistance
Because of its high alloy composition, CPM 1V has temper resistance similar to high speed steel (M2) and much better than most typical hot work tool steels as shown in the comparative temper curves below.

Elastic Modulus 30 X 10^6 psi (207 GPa)
Density 0.284 lbs./in^3 (7.85 g/cm^3)
Thermal Conductivity BTU/hr-ft-°F W/m-°K cal/cm-s-°C
72°F (22°C) 12.64 21.88 5.23X10^-2
212°F (100°C) 13.80 23.88 5.70X10^-2
572°F (300°C) 14.90 25.80 6.16X10^-2
752°F (400°C) 15.46 26.76 6.39X10^-2
1004°F (540°C) 16.23 28.09 6.71X10^-2

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

Crucible Industries LLC

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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: About BHN 187

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
Preheat: Heat to 1550-1600°F (840-870°C) Equalize.

Austenitize: 1950-2000°F (1065-1120°C), hold time at temperature 10-15 minutes. The lower austenitizing temperature of 1950°F (1065°C) provides the best impact toughness.

Quench: 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.

Temper: Three times at 1000-1025°F (540-550°C), 2 hours minimum each time.

Aim hardness 57-59 HRC.

Surface Treatments
CPM 1V can be nitrided or PVD coated. Due to its high tempering temperature, it will retain its hardness after such processes, making it a more suitable substrate than A2 or S7. As for most tool steels, higher temperature face treatments, such as CVD, may result in dimensional 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.

Machinability and Grindability
The machinability and grindability of CPM 1V in the annealed condition is similar to that of A2.

Thermal Fatigue
The results of thermal fatigue tests show that CPM 1V offers an improvement over premium quality H13 and CPM 9V. Thermal fatigue tests are used to predict performance in die casting or other applications involving cyclic high temperature exposures.

Thermal Treatments

<table>
<thead>
<tr>
<th></th>
<th>HRC</th>
<th>Austenitize</th>
<th>Quench</th>
<th>Temper</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPM 1V</td>
<td>60</td>
<td>2000°F/10 min.</td>
<td>Air</td>
<td>1000°F/2+2hrs.</td>
</tr>
<tr>
<td>CPM 1V</td>
<td>59</td>
<td>1950°F/30 min.</td>
<td>Air</td>
<td>1000°F/2+2hrs.</td>
</tr>
<tr>
<td>Premium H13</td>
<td>45</td>
<td>1875°F/30 min.</td>
<td>Oil</td>
<td>1130°F/2+2hrs.</td>
</tr>
<tr>
<td>CPM 9V</td>
<td>55</td>
<td>2050°F/30 min.</td>
<td>Air</td>
<td>1000°F/2+2hrs.</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Heat Treatment (1)</th>
<th>Impact (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temper</td>
<td>Austenitizing</td>
</tr>
<tr>
<td>CPM 1V</td>
<td>1875°F (1025°C)</td>
</tr>
<tr>
<td>CPM 1V</td>
<td>1950°F (1065°C)</td>
</tr>
<tr>
<td>CPM 9V</td>
<td>2000°F (1085°C)</td>
</tr>
<tr>
<td>CPM 1V</td>
<td>2025°F (1110°C)</td>
</tr>
</tbody>
</table>

(1) Heat Treatment: Austenitize as indicated and temper to hardness
(2) Charpy C-Notch Impact Test

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