Technical Information: PD#1

PD#1 is a cold work tool steel produced using (powdered metal) steel making process. The grade has excellent wear resistance and toughness combined with moderate hardness. PD#1 is ideal for cold work applications needing a high degree of toughness.

Typical Chemical Composition

<table>
<thead>
<tr>
<th>Element</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>1.10%</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>1.60%</td>
</tr>
<tr>
<td>Vanadium</td>
<td>2.35%</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.03%</td>
</tr>
<tr>
<td>Chromium</td>
<td>7.75%</td>
</tr>
<tr>
<td>Silicon</td>
<td>1.20%</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.25%</td>
</tr>
</tbody>
</table>

PM Steel Properties Comparison

- Relative Wear Resistance
- Chipping Resistance

Physical Properties

- Modulus of Elasticity: $30 \times 10^6$ psi (207 GPa)
- Density: 0.277 lb/in$^3$
- Annealed Hardness: 225-255 Brinell Hardness (BHN)
- Machinability: Similar to M4 High Speed Steel
Technical Information: PD#1

HEAT TREATMENT

ANNEALING
Heat to 1600°F, hold two hours
Slow cool 20°F/hour to 600°F
Then air or furnace cool to room temperature

STRESS RELIEVING
Performed prior or after machining to minimize distortion in heat treating
1100/1200°F, hold two hours
Then air cool to room temperature

HARDENING
Salt bath, protective atmosphere, or vacuum furnace equipment preferred.

HIGH HEAT (AUSTENITIZING)
1950/2050°F for 20 to 30 minutes at heat.
Higher Austenitizing temperatures require less time at heat

QUENCH
Salt bath quench to 1000-1100°F, equalize, then air cool to 150°F.
Vacuum or atmosphere quench rate of a minimum 50 degrees F per minute down to 1200F is
critical to achieve best heat treat response.
Temper immediately following quench

TEMPERING
Minimum 950°F tempering temperature required.
Double tempering is required, triple tempering recommended.
Air cool to room temperature between tempers.

TYPICAL HEAT TREAT RESPONSE

<table>
<thead>
<tr>
<th>Tempering Temp °F</th>
<th>Hardening Temp 1950°F</th>
<th>Hardening Temp 2050°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>As Quenched</td>
<td>62</td>
<td>61</td>
</tr>
<tr>
<td>950</td>
<td>63</td>
<td>64</td>
</tr>
<tr>
<td>1000</td>
<td>60.5</td>
<td>64</td>
</tr>
<tr>
<td>1050</td>
<td>55</td>
<td>59.5</td>
</tr>
<tr>
<td>1100</td>
<td>47.5</td>
<td>52.5</td>
</tr>
</tbody>
</table>

LONGITUDINAL SIZE CHANGE
Approximately: plus 0.10%