### CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>Element</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon</td>
<td>2.45 %</td>
</tr>
<tr>
<td>Chromium</td>
<td>5.25 %</td>
</tr>
<tr>
<td>Vanadium</td>
<td>9.75 %</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>1.30 %</td>
</tr>
<tr>
<td>Manganese</td>
<td>0.50 %</td>
</tr>
<tr>
<td>Silicon</td>
<td>0.90 %</td>
</tr>
</tbody>
</table>

### DESCRIPTION

Z-A10 PM is a high vanadium cold work tool steel produced by powder metallurgy methods. Its highly alloyed, air hardening composition offers exceptional wear resistance along with good strength and toughness. This combination of properties can provide outstanding edge retention and extended tool life tool compared to standard tool steels grades such as D2 and M2. It is suitable for use in demanding applications involving long run, high production tools and abrasive part materials. The powder metallurgy processing utilized provides well known benefits including more consistent machinability, grindability, heat treat response, and dimensional stability when compared to conventionally produced, high alloy grades.

### TYPICAL APPLICATIONS

- punches and dies
- powder compaction tooling
- cold forming tools
- industrial knives
- slitter blades
- plastic processing components
- granulator and pelletizer blades
- woodworking tools
- wear parts

### PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus of elasticity E [psi x 10^6]</td>
<td>32</td>
</tr>
<tr>
<td>Density [lb/in³]</td>
<td>0.268</td>
</tr>
<tr>
<td>Coefficient of thermal expansion [in/in/ °F]</td>
<td>6.82 x 10^-6</td>
</tr>
<tr>
<td>over temperature range of 100 - 1100 °F</td>
<td></td>
</tr>
</tbody>
</table>
THERMAL PROCESSING

ANNEALING
Heat uniformly in a protective atmosphere (or vacuum) to 1600°F (870°C) and soak for 2 hours. Slow cool 30°F (15°C) per hour until 1000°F (540°C). Parts can then be cooled in air or furnace as desired. Hardness expected is BHN 255-277.

STRESS RELIEVING (SOFT)
Heat uniformly to 1100-1300°F (595-700°C), soak for 2 hours, and cool in air or furnace.

HARDENING
Vacuum, salt, or protective atmosphere methods are generally used. Care must be taken to prevent decarburization.

PREHEAT
Heat to 1550-1600°F (845-870°C) until temperature is equalized. Additional preheat steps including 1250-1300°F (680-700°C) and 1850-1900°F (1010-1040°C) are suggested when using programmed control during vacuum processing.

AUSTENITIZING
Temperatures in the range of 1950°F (1040°C) to 2150°F (1180°C) are commonly used with the specific temperature and soak time determined by the hardness required. Higher hardening temperatures will provide maximum wear resistance and hardness while temperatures lower in the range will provide increased toughness. Refer to chart for further information.

QUenchING
Methods include use of high pressure gas (minimum 5 bar preferred), salt bath, or oil. Quench rate through the temperature range of 1900°F (1040°C) to 1300°F (700°C) is critical to the development of optimum structure and properties. Part temperature can then be equalized at 1000-1100°F (540-595°C) after which cooling can continue to below 150°F (66°C) or “hand warm”. Step quenching in this manner will help to minimize distortion in larger section sizes.

TEMPERING
Tempering should be performed immediately after quenching. Temperatures in the range of 1000°F (540°C) to 1100°F (595°C) are generally used depending on the hardness required. Heat uniformly to the selected temperature and soak for 2 hours. Double tempering is absolutely necessary while triple tempering is highly recommended when hardening at 2100°F (1150°F) and over. Tempering temperatures of less than 1000°F (540°C) should not be used, and care must be taken to cool parts fully to room temperature between each temper.

HEAT TREATMENT INSTRUCTIONS

<table>
<thead>
<tr>
<th>Required hardness HRC</th>
<th>Austenitizing soak temp [°F]</th>
<th>Austenitizing soak time [min]*</th>
<th>Tempering temperature [°F]**</th>
</tr>
</thead>
<tbody>
<tr>
<td>58-60 (max toughness)</td>
<td>1950</td>
<td>30</td>
<td>1000/1025</td>
</tr>
<tr>
<td>60-62</td>
<td>2050</td>
<td>20</td>
<td>1000/1025</td>
</tr>
<tr>
<td>62-64 (max wear)</td>
<td>2150</td>
<td>10</td>
<td>1000/1025</td>
</tr>
</tbody>
</table>

* Process variation and part section size can affect results. Soak times should be based on actual part temperatures. Use of load thermocouples is highly recommended during batch processing.
** An increase in tempering temperature by 25°F can be used to reduce hardness 1 to 2 points HRC.
Tempering temperatures less than 1000°F should not be used.
STRESS RELIEVING
Heat to 25 °F (15 °C) less than the temperature of the last temper and soak for 1 hour.

CRITICAL TEMPERATURE
1540 °F (838 °C)

SIZE CHANGE DURING HARDENING
+.0004 in/in (at HRc 60)

STRAIGHTENING
Should be done warm (or during quench) using temperatures in the range of 400°F (200°C) to 800°F (430°C).

SURFACE TREATMENT
This grade is an excellent substrate material for use with the various commercially available PVD coating processes. Conventional nitriding (.001” maximum depth) and steam tempering can also be used. Coating vendors should be consulted to select the optimum process for a given application. Care must be exercised during CVD and other surface treatment processes that can alter the original heat treatment of the tool.

Further information regarding our products and locations are available in our image brochure and under www.zapp.com

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