CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>C</th>
<th>Cr</th>
<th>Mo</th>
<th>W</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.40</td>
<td>4.2</td>
<td>5.0</td>
<td>5.8</td>
<td>4.1</td>
</tr>
</tbody>
</table>

STANDARDS
- Europe: HS 6-5-4
- USA: M4

DELIVERY HARDNESS
- Soft annealed: max. 260 HB
- Cold drawn: max. 300 HB

DESCRIPTION
M4 PM is a high vanadium alloyed grade with high wear resistance and toughness suitable for cold work applications.

APPLICATIONS
- Punches
- Milling cutters
- Dies
- Taps
- Rolls
- Broaches
- Rotating multi-edge cutting tools

FORM SUPPLIED
- Coils
- Forged blanks
- Round bars
- Flat & square bars

Available surface conditions: drawn, ground, hot worked, peeled, rough machined, hot rolled.

HEAT TREATMENT
- Soft annealing in a protective atmosphere at 1560-1650°F for 3 hours, followed by slow cooling at 20°F/h down to 1290°F, then air cooling.
- Stress-relieving at 1110°F to 1290°F for approximately 2 hours, slow cooling down to 930°F.
- Hardening in a protective atmosphere with pre-heating in 2 steps at 840-930°F and 1560-1650°F and austenitising at a temperature suitable for chosen working hardness. Cooling down to 100-120°F.
- Tempering at 1040°F three times for at least 1 hour each time. Cooling to room temperature (77°F) between temperings.

GUIDELINES FOR HARDENING

PROCESSING
M4 PM can be worked as follows:
- Machining (grinding, turning, milling)
- Polishing
- Plastic forming
- Electrical discharge machining
- Welding (special procedure including preheating and filler materials of base material composition)

GRINDING
During grinding, local heating of the surface, which may alter the temper, must be avoided. Grinding wheel makers can furnish advice on the choice of grinding wheels.

SURFACE TREATMENT
The steel grade is a good substrate material for PVD and CVD coating. If nitriding is demanded a small zone of 2-15 μm is recommended. The steel grade can also be steam-tempered if so desired.
**PROPERTIES**

**PHYSICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Property</th>
<th>Temperature</th>
<th>68°F</th>
<th>750°F</th>
<th>1110°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, lb/in³ (1)</td>
<td></td>
<td>0.29</td>
<td>0.29</td>
<td>0.28</td>
</tr>
<tr>
<td>Modulus of elasticity, psi (2)</td>
<td></td>
<td>3.5x10⁷</td>
<td>3.1x10⁷</td>
<td>2.7x10⁷</td>
</tr>
<tr>
<td>Specific heat, Btu/lb °F (2)</td>
<td></td>
<td>0.10</td>
<td>0.12</td>
<td>0.14</td>
</tr>
</tbody>
</table>

(1)=Soft annealed
(2)=Hardened 2155°F and tempered 1040°F, 3x1 hour

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**IMPACT STRENGTH**

![Impact Strength Diagram]

**COMPRESSION YIELD STRESS**

![Compression Yield Stress Graph]

Rmb = Ultimate bend strength in kN/mm²
Reb = Bend yield strength in kN/mm²
Tot. work = Total work in Nm

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**COMPARATIVE PROPERTIES**

<table>
<thead>
<tr>
<th>Machineability</th>
<th>Wear resistance</th>
<th>Toughness</th>
<th>Hot hardness</th>
<th>Grindability</th>
</tr>
</thead>
<tbody>
<tr>
<td>E M2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E M6</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>E M12</td>
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</tr>
<tr>
<td>C8</td>
<td></td>
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</tr>
<tr>
<td>E M3.2</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>M12</td>
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</tr>
<tr>
<td>E M01</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>E T1</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>WKE 42</td>
<td></td>
<td></td>
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<tr>
<td>WKE 45</td>
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01/03