CHEMICAL COMPOSITION

<table>
<thead>
<tr>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Mo</th>
<th>W</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.60</td>
<td>1.0</td>
<td>0.3</td>
<td>4.0</td>
<td>2.0</td>
<td>2.1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

STANDARDS

- Europe: HS 2.2.2
- Germany: 1.3397

DELIVERY HARDNESS

- Typical soft annealed hardness is 230 HB

DESCRIPTION

ASP®2012 is the best in class for high toughness up to 58 HRC in cold-, warm- and hot applications.

APPLICATIONS

- Cold work tools: Powder compacting tools, cold extrusion tools, cold-heading dies, fine blanking tools.
- Plastic injection moulders, broaches and injector pins.
- Machine components and rolls.
- Warm- and hot-work applications: extrusion dies, forging dies and punches, hot forming dies.

FORM SUPPLIED

- Round bars
- Flat bars
Available surface conditions: drawn, peeled, rough machined.

HEAT TREATMENT

- Soft annealing in a protective atmosphere at 850-900°C for 3 hours, followed by slow cooling at 10°C/h down to 700°C, then air cooling.
- Stress-relieving at 600-700°C for approximately 2 hours, slow cooling down to 500°C.
- Hardening in a protective atmosphere with pre-heating in 2 steps at 450-500°C and 850-900°C and austenitising at a temperature suitable for chosen working hardness. Cooling down to 40-50°C.
- Tempering at 560°C three times for at least 1 hour each time. Cooling to room temperature (25°C) between temperings.

GUIDELINES FOR HARDENING

Hardness after hardening, quenching and tempering: 3x1 hour

PROCESSING

ASP®2012 can be worked as follows:

- machining (grinding, turning, milling)
- polishing
- hot 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 manufacturers can provide advice on the choice of grinding wheels.

SURFACE TREATMENT

The steel grade is a perfect substrate material for PVD coating. If nitriding is requested, a small diffusion zone is recommended but avoid compound and oxidized layers.
**PROPERTIES**

**PHYSICAL PROPERTIES**

<table>
<thead>
<tr>
<th>Temperature</th>
<th>20°C</th>
<th>400°C</th>
<th>600°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density g/cm³</td>
<td>7.8</td>
<td>7.7</td>
<td>7.6</td>
</tr>
<tr>
<td>Modulus of elasticity kN/mm²</td>
<td>220</td>
<td>195</td>
<td>175</td>
</tr>
<tr>
<td>Coefficient of thermal expansion from 20°C, per °C</td>
<td>- 12.1x10⁻⁶</td>
<td>12.7x10⁻⁶</td>
<td></td>
</tr>
<tr>
<td>Thermal conductivity W/m°C</td>
<td>26</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Specific heat J/kg °C</td>
<td>420</td>
<td>510</td>
<td>600</td>
</tr>
</tbody>
</table>

(1)=Soft annealed
(2)=Hardened 1100°C and tempered 560°C, 3x1 hour

**IMPACT TOUGHNESS**

- Impact energy
- Hardness

Hardening temperature in °C
Original dimension Ø 118 mm
Tempering 3 x 1 hour at 560°C
Unnotched test piece 7 x 10 x 55 mm

**WEAR RESISTANCE**

<table>
<thead>
<tr>
<th>Test Piece</th>
<th>Wear resistance (min/gram)</th>
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<tbody>
<tr>
<td>H13</td>
<td>52 HRC</td>
</tr>
<tr>
<td>ASP2012</td>
<td>58 HRC</td>
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</tbody>
</table>

Wear resistance is measured as the time needed for removal of one-gram material from a test piece.
Technique: Pin-on-cylinder, dry SiO₂-paper of grade 00,
sliding rate 0.3m/s, load 9N and size of specimen 2 x 5 x 30mm.

**TENSILE STRENGTH**

- \( Rm \)
- \( Rp0.2 \)
- Elongation at rupture (%)

- Test temperature in °C
- Size of blank Ø15mm
- Test piece dimensions are given below.
- Hardness 58 HRC

**COMPRESSION YIELD STRESS**

- \( Rc 0.2 \) kN/mm²
- \( HRC \)

**TEMPERING RESISTANCE**

- \( HR \)
- Time (hours) at 550°C

**COMPARATIVE PROPERTIES**

<table>
<thead>
<tr>
<th></th>
<th>Machinability</th>
<th>Wear resistance</th>
<th>Toughness</th>
<th>Hot hardness</th>
<th>Grindability</th>
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</thead>
<tbody>
<tr>
<td>EM2</td>
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<td>AISI H13</td>
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<td>ASP2053</td>
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