RAW MATERIALS

QUALITY NEEDS TO BE CHECKED
We carry out in-house spectral analyses, strength tests and ultrasonic tests. Only flawless steel will pass these quality control measures.

HIGH-QUALITY RAW MATERIAL
Not all steel is the same. This is why we select the best-known steelworks as our suppliers. Only the best raw materials ensure exceptionally good products. It is ultimately you as the customer who benefits from this quality.
STRESS-RELIEVING HEAT TREATMENT

THREE FURNACES FOR 240 TONNES OF STEEL

During the production of steel plates tension grows in the material from various machining processes - caused, for example, by irregular temperature.

At Meusburger all steel plates are heat-treated for stress relief in one of the three furnaces for 24 hours. The daily capacity is 240 tonnes.

LOWERING TENSION

With stress-relieving heat treatment, the tension in the material is minimised without changes to the microstructure or strength. This is a great advantage during subsequent machining. If there was still tension in the material, it would, for example, cause deformation during sawing or milling. During stress relieving it is important to heat the plates slowly and consistently and then maintain this temperature for 6 hours. This guarantees that thick plates are also heated through to the core.

COOLING FOR 14 HOURS

The subsequent slow, regular cooling period of 14 hours in the furnace is even more important. Here the plates are cooled by approximately 35°C per hour. If they were cooled more quickly, tension - and even the formation of cracks - could once more occur in the material.
# Not All Steel is the Same

## Material Grades

<table>
<thead>
<tr>
<th>Unalloyed steel</th>
<th>Steel for case-hardening</th>
<th>Pre-toughened steel</th>
<th>Corrosion resistant steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0577</td>
<td>1.2162</td>
<td>1.2311</td>
<td>1.2083</td>
</tr>
<tr>
<td>1.1730</td>
<td>1.7131</td>
<td>1.2312</td>
<td>1.2083ESU</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Steel for through hardening</th>
<th>Steel for through hardening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold-work steel</td>
<td>Hot-work steel</td>
</tr>
<tr>
<td>1.2083</td>
<td>1.2343</td>
</tr>
<tr>
<td>1.2083 ESU</td>
<td>1.2343 ESU</td>
</tr>
<tr>
<td>1.2210</td>
<td>1.2344</td>
</tr>
<tr>
<td>1.2363</td>
<td>1.2344 ESU</td>
</tr>
<tr>
<td>1.2379</td>
<td>1.2714</td>
</tr>
<tr>
<td>1.2767</td>
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<tr>
<td>1.2842</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HSS</th>
<th>HSS high speed / powder steel</th>
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</thead>
<tbody>
<tr>
<td>High-speed steel</td>
<td></td>
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<tr>
<td>1.3343</td>
<td>1.3343PM</td>
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<tr>
<td></td>
<td>MV10PM</td>
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<tr>
<td></td>
<td>MW10PM</td>
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</table>

<table>
<thead>
<tr>
<th>Quenched and tempered alloy steel</th>
<th>Carbides</th>
<th>Unalloyed steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7225</td>
<td>CF-H40S+</td>
<td>3.3547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4365</td>
</tr>
</tbody>
</table>
COLD-WORK STEEL
Cold-work steels are used for moulds which generally don’t reach temperatures higher than 200°C while in operation.

HOT-WORK STEEL
The continuous operating temperature of hot-work steel is over 200°C, which is why hot-work steel offers the best properties for die casting moulds as well as moulds with which high performance plastics are processed.

STEEL FOR CASE-HARDENING
Due to the low carbon content of steels for case-hardening, they are “inserted” into an atmosphere with high carbon content and heated. The result is a piece with high core toughness and surface hardness.

TEMPERED STEEL
These steels are delivered already quenched and tempered. High tensile and fatigue strength are the distinguishing features of this material.

STEEL FOR THROUGH HARDENING
Steels for through hardening are delivered in a soft condition. They are good for further hardening processes, in order to change the mechanical properties of the steel.

HIGH-SPEED STEEL
High-speed steels, or HSS for short, are high-alloy tool steels with large amounts of alloying elements such as tungsten, molybdenum, chrome, and vanadium. They offer high resistance to adhesive and abrasive wear with high toughness as well as high resistance to pressure and high temperatures.
<table>
<thead>
<tr>
<th>Element</th>
<th>Melting point</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium (Al)</td>
<td>658 °C</td>
<td>This is the strongest and very frequently used deoxidation and denitriding compound which supports the steel during its ageing. Since Aluminium nitrides with Nitrogen to produce a very hard compound, it is usually used as an alloy in nitriding steel.</td>
</tr>
<tr>
<td>Carbon (C)</td>
<td>3450 °C</td>
<td>Carbon is the most important and indispensable steel alloying elements.</td>
</tr>
<tr>
<td>Cobalt (Co)</td>
<td>1492 °C</td>
<td>Cobalt is always used together with other alloying elements such as Chromium and Tungsten. It increases the hot hardness and wear resistance in high speed steel.</td>
</tr>
<tr>
<td>Chromium (Cr)</td>
<td>1920 °C</td>
<td>Chromium forms hard carbides, which increases the wear resistance and the durability of cutting edges. At the same time it facilitates through hardening.</td>
</tr>
<tr>
<td>Copper (Cu)</td>
<td>1084 °C</td>
<td>Copper is used as an alloying element for only a few steel grades because it accumulates below the scale layer and can penetrate the grain boundary of the steel causing very fragile surfaces in hot forming processes. It is sometimes considered to have a damaging effect on steel.</td>
</tr>
<tr>
<td>Manganese (Mn)</td>
<td>1221 °C</td>
<td>Manganese binds Sulphur to Manganese Sulphides and thereby reduces the adverse effects of the Iron Sulphide. All steel grades contain small amounts of Manganese in order to facilitate casting, rolling and forging. It is considered an alloying element only if its content is greater than 0.5%.</td>
</tr>
<tr>
<td>Molybdenum (Mo)</td>
<td>2623 °C</td>
<td>Molybdenum is usually used together with other alloying elements. It works like Chromium but is stronger. In combination with Chromium it results in a higher hot hardness.</td>
</tr>
<tr>
<td>Nickel (Ni)</td>
<td>1453 °C</td>
<td>Nickel gives cold work steels a higher toughness. Engineering steels contain Nickel in combination with Chromium and Molybdenum in order to improve their strength.</td>
</tr>
<tr>
<td>Phosphor (P)</td>
<td>44 °C</td>
<td>This strong alloying element usually has a damaging effect on steel.</td>
</tr>
<tr>
<td>Sulphur (S)</td>
<td>118 °C</td>
<td>Sulphur has a low solubility in Iron but forms stable Sulphides with some other alloying elements. Manganese Sulphides are favourable because they have a positive effect on machining.</td>
</tr>
<tr>
<td>Silicon (Si)</td>
<td>1414 °C</td>
<td>This is included in all steel grades in order to facilitate the processing of the steel. It is considered an alloying element only if its content is greater than 0.5%.</td>
</tr>
<tr>
<td>Vanadium (V)</td>
<td>1726 °C</td>
<td>Vanadium is a good Carbide former. It binds Nitrogen and has a refining effect on the crystals. The result is a finer structure. The hard carbides increase the heat resistance, wear resistance and resistance to tempering.</td>
</tr>
<tr>
<td>Tungsten (W)</td>
<td>3380 °C</td>
<td>Tungsten forms hard carbides with very good cutting properties and also provides a high hot hardness. The tensile strength, yield strength, wear resistance and toughness can be increased with Tungsten.</td>
</tr>
<tr>
<td>Material Grades</td>
<td>Material no.</td>
<td>Designation</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
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<tr>
<td></td>
<td>1.0577</td>
<td>DIN: S 355 J2 (St 52-3)</td>
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<tr>
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<td>AFNOR: A 52 FP</td>
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<td>1.1730</td>
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<td>DIN: X 40 Cr 14</td>
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<td>Z 40 C 14</td>
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<td>1.2162</td>
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<td>1.2210</td>
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<td>Z 35 CD 17</td>
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<td>Indicatory analysis</td>
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<tr>
<td>1.2363</td>
<td>DIN: X 100 CrMoV 5</td>
<td>C 1.00, Si 0.30, Mn 0.50, Cr 5.20, Mo 1.10, V 0.20</td>
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<tr>
<td>1.2379</td>
<td>DIN: X 153 CrMoV 5-1 KU</td>
<td>C 1.53, Si 0.35, Mn 0.80, Cr 12.00, Mo 0.80</td>
</tr>
<tr>
<td>1.2714</td>
<td>DIN: 56 NiCrMoV 7</td>
<td>C 0.56, Si 1.70, Mo 0.50, Ni 0.10</td>
</tr>
<tr>
<td>1.2714 HH</td>
<td>DIN: 56 NiCrMoV 7</td>
<td>C 0.56, Si 1.70, Mo 0.50, Ni 0.10</td>
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<tr>
<td>1.2738</td>
<td>DIN: 45 CrMo 16</td>
<td>C 0.45, Si 0.25, Mn 0.80, Cr 1.35, Mo 0.25, Ni 4.00</td>
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<td>1.2767</td>
<td>DIN: 45 MnNiMo 8-6-4</td>
<td>C 0.26, Mn 1.45, Cr 1.25, Mo 0.50, Ni 1.05, V 0.12</td>
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<td>1.2738 TSHH</td>
<td>DIN: Sonderlegierung</td>
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<td>1.2767</td>
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<td>DIN: H5 6-5-2 C</td>
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<td>1.3344 PM</td>
<td>DIN: PM 6-5-3</td>
<td>C 0.90, Si 0.30, Mn 0.30, Cr 1.00, Mo 0.50, V 1.90, W 6.20</td>
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<tr>
<td>1.7131</td>
<td>DIN: 16 MnCr 5</td>
<td>C 0.16, Si 0.25, Mn 1.15, Cr 0.95</td>
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<tr>
<td>1.7225</td>
<td>DIN: 42 CrMo 4</td>
<td>C 0.42, Si 0.25, Mn 0.75, Cr 1.00, Mo 0.22</td>
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<tr>
<td>CF-H40S+</td>
<td>ISO: K40</td>
<td>WC 86.6, Co 11.8</td>
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<tr>
<td>Material no.</td>
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<td>Indicatory analysis</td>
</tr>
<tr>
<td>-------------</td>
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<tr>
<td>3.3547</td>
<td>(AW-5083)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Si 0.40, Fe 0.40, Cu 0.10, Mn 0.70, Mg 4.40, Cr 0.15, Zn 0.25, Ti 0.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤ 540 N/mm² (depending on thickness)</td>
</tr>
<tr>
<td>3.4365</td>
<td>(AW-7075)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Si 0.40, Fe 0.50, Cu 1.60, Mn 0.30, Mg 2.40, Cr 0.23, Zn 5.60, Ti 0.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C 2.45, Si 0.90, Mn 0.30, Cr 5.20, Mo 1.30, V 9.75</td>
</tr>
<tr>
<td>M V10 PM</td>
<td>AISI: A11</td>
<td>C 2.45, Si 0.90, Mn 0.30, Cr 5.20, Mo 1.30, V 9.75</td>
</tr>
<tr>
<td></td>
<td>HS 10-2-5-8</td>
<td>C 1.6, Cr 4.8, Mo 2.0, V 5.0, W 10.5, Co 8.0</td>
</tr>
</tbody>
</table>

This general information is only a recommendation for anyone to apply freely. For individual cases the buyer must make sure they purchase for the right application. If in doubt, a specialist (e.g. steel manufacturer, hardening shop) should be consulted. Liability does not lie with Meusburger Georg GmbH & Co KG.
<table>
<thead>
<tr>
<th>Material No.:</th>
<th>1.0577</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>DIN: S 355 J2 (St 52-3)</td>
</tr>
<tr>
<td></td>
<td>AFNOR: A S2 FP</td>
</tr>
<tr>
<td></td>
<td>UNI: -</td>
</tr>
<tr>
<td></td>
<td>AISI: A738</td>
</tr>
</tbody>
</table>

| Indicatory analysis: | C ≤ 0.22 |
|                     | Si ≤ 0.55 |
|                     | Mn ≤ 1.60 |

| Strength: | ≈ 550 N/mm² |
| Thermal conductivity at 20 °C: | 40 $\frac{W}{m \cdot K}$ |

| Character: | unalloyed structural steel with good weldability |
| Application: | for common applications in tool, mould and machine construction |

| Treatment by | Welding: very good weldability due to its low carbon content |
|             | Polishing: |
|             | Etching: |
|             | EDM: not usual |
|             | Nitriding: |
|             | Hard chroming: |

| Heat treatment: | Soft annealing: 650 to 700 °C for about 2 to 5 hours |
|                | slow controlled cooling of 10 to 20 °C per hour to about 600 °C; further cooling in air, max. 180 HB |

**Technical Tip**
- If no welding is required, we recommend 1.1730 → better machinability in spite of higher strength.
Material No.: 1.1730

Designation
- DIN: C 45 U
- AFNOR: XC 48
- UNI: -
- AISI: 1045

Indicatory analysis:
- C: 0.45
- Si: 0.30
- Mn: 0.70

Strength: $\approx 640$ N/mm²

Thermal conductivity at 20 °C: $50 \text{ W m}^{-1} \text{ K}^{-1}$

Character: unalloyed tool steel with excellent machinability; chilled cast steel, suitable for flame and inductive hardening

Application: unhardened parts for mould, die and jig construction or plates and frames for tools and dies

Treatment by
- Polishing:
- Etching:
- EDM:
- Nitriding:
- Hard chroming: not usual

Heat treatment:
- Soft annealing: 680 to 710 °C for about 2 to 5 hours slow controlled cooling of 10 to 20 °C per hour to about 600 °C; further cooling in air, max. 190 HB
- Hardening: 800 to 830 °C quenching in water obtainable hardness: 58 HRC hardening depth: 3–5 mm max. 15 mm through-hardening thickness
- Tempering: slow heating to tempering temperature immediately after hardening, to 180 to 300 °C depending on desired hardness 1 hour per 20 mm: min. 2 hours

Tempering chart:
Material No.: 1.2083 / 1.2083 ESR*

**Designation**
- DIN: X 40 Cr 14
- AFNOR: Z 40 C 14
- UNI: -
- AISI: 420 / 420 ESR

**Indicatory analysis:**
- C 0.40
- Si 0.40
- Mn 0.30
- Cr 13.00

**Strength:**
- ≈ 720 N/mm²

**Thermal conductivity at 100°C:**
- 18 \(\frac{W}{m \cdot K}\)

**Character:**
- low corrosion, high-alloy, low warpage steel for through hardening with excellent properties for mirror polishing as well as good photo etching, good machinability, high wear resistance and high dimensional stability

**Application:**
- Cavity plates and inserts for working with chemically aggressive plastics; because of excellent polishability, suitable for optical and medical products

**Treatment by**
- Polishing:
  - can be polished in the annealed and hardened state; good preliminary surface preparation work is decisive for a good polish
- Etching:
  - good photo etching (graining)
- Spark eroding:
  - in the hardened and tempered condition, treat again for stress relief about 20°C below the last temperature
- Nitriding:
- Hard chroming:
  - not usual

**Heat treatment:**
- Soft annealing:
  - 750 to 800°C for about 2 to 5 hours
  - slow controlled cooling of 10 to 20°C per hour to about 650°C;
  - further cooling in air, max. 200 HB
- Hardening:
  - 1000 to 1050°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/compressed gas/hot bath
  - obtainable hardness: 53 - 56 HRC
- Tempering:
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 2 hours per 20 mm part thickness;
  - twice tempering is recommended

**Technical Tip**
- cold-work steel
- must be tempered several times after hardening (max. 52HRC).
- The demand for “max. hardness” often ends in material breakage.
- mould temperature max. 200°C
- not corrosion-resistant until after hardening
- The ESR quality guarantees an extremely pure and homogeneous microstructure.

---

**Technical Tip**

- Soft annealing:
  - 750 to 800°C for about 2 to 5 hours
  - slow controlled cooling of 10 to 20°C per hour to about 650°C;
  - further cooling in air, max. 200 HB

- Hardening:
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  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/compressed gas/hot bath
  - obtainable hardness: 53 - 56 HRC

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<table>
<thead>
<tr>
<th>HRC</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td>52</td>
<td>300</td>
</tr>
<tr>
<td>48</td>
<td>500</td>
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<tr>
<td>44</td>
<td>700</td>
</tr>
<tr>
<td>40</td>
<td>900</td>
</tr>
<tr>
<td>36</td>
<td>1100</td>
</tr>
</tbody>
</table>

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**Technical Tip**

- Soft annealing:
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</tr>
<tr>
<td>40</td>
<td>900</td>
</tr>
<tr>
<td>36</td>
<td>1100</td>
</tr>
</tbody>
</table>

---

**Technical Tip**

- Soft annealing:
  - 750 to 800°C for about 2 to 5 hours
  - slow controlled cooling of 10 to 20°C per hour to about 650°C;
  - further cooling in air, max. 200 HB

- Hardening:
  - 1000 to 1050°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/compressed gas/hot bath
  - obtainable hardness: 53 - 56 HRC

- Tempering:
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 2 hours per 20 mm part thickness;
  - twice tempering is recommended

**Tempering chart:**

<table>
<thead>
<tr>
<th>HRC</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td>52</td>
<td>300</td>
</tr>
<tr>
<td>48</td>
<td>500</td>
</tr>
<tr>
<td>44</td>
<td>700</td>
</tr>
<tr>
<td>40</td>
<td>900</td>
</tr>
<tr>
<td>36</td>
<td>1100</td>
</tr>
</tbody>
</table>

---

**Technical Tip**

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**Tempering chart:**

<table>
<thead>
<tr>
<th>HRC</th>
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</tr>
<tr>
<td>40</td>
<td>900</td>
</tr>
<tr>
<td>36</td>
<td>1100</td>
</tr>
</tbody>
</table>

---

**Technical Tip**

- Soft annealing:
  - 750 to 800°C for about 2 to 5 hours
  - slow controlled cooling of 10 to 20°C per hour to about 650°C;
  - further cooling in air, max. 200 HB

- Hardening:
  - 1000 to 1050°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/compressed gas/hot bath
  - obtainable hardness: 53 - 56 HRC

- Tempering:
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 2 hours per 20 mm part thickness;
  - twice tempering is recommended

**Tempering chart:**

<table>
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<tr>
<th>HRC</th>
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<tr>
<td>44</td>
<td>700</td>
</tr>
<tr>
<td>40</td>
<td>900</td>
</tr>
<tr>
<td>36</td>
<td>1100</td>
</tr>
</tbody>
</table>
Material No.: 1.2085

**Designation**
- **DIN:** X 33 CrS 16
- **AFNOR:** Z 35 CD 17.S
- **UNI:** -
- **AISI:** ≈ 422 + S

**Indicatory analysis:**
- C 0.33
- Si 0.30
- Mn 0.80
- Cr 16.00
- S 0.06
- Ni 0.30

**Strength:**
- ≈ 1080 N/mm²

**Thermal conductivity at 100 °C:**
- 18 W m⁻¹ K⁻¹

**Character:** corrosion resistant, high-alloy, pre-toughened tool steel with good machinability due to Sulphur (S) additive

**Application:** plates for corrosion resistant mould tools and die sets; moulds for corrosive plastics; the expense for protection and care of mould tools is reduced thanks to increased corrosion resistance; not suitable for mould inserts

**Treatment by**
- Polishing:
- Etching:
- EDM:
- Nitriding:
- Hard chroming:

**Heat treatment:** Usually no heat treatment is required.
- **Soft annealing:**
  - 850 to 880 °C for about 2 to 5 hours
  - slow controlled cooling inside the furnace; annealing hardness: max. 240 HB
- **Hardening:**
  - 1000 to 1030 °C
  - keep curing temperature for 30 minutes
  - quenching in oil is preferable
  - obtainable hardness: 48 HRC
- **Tempering:**
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 2 hours per 20 mm part thickness;
  - tempering twice is recommended

**Tempering chart:**

![Tempering chart](image-url)
<table>
<thead>
<tr>
<th>Material No.:</th>
<th>1.2162</th>
<th>Technical Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>DIN: 21 MnCr 5 AFNOR: 20 MC 5 UNI: 5120</td>
<td></td>
</tr>
<tr>
<td>Indicatory analysis:</td>
<td>C 0.21</td>
<td>- For mirror polishing we recommend the steel for through hardening 1.2767.</td>
</tr>
<tr>
<td>Strength:</td>
<td>≈ 660 N/mm²</td>
<td></td>
</tr>
<tr>
<td>Thermal conductivity at 100 °C:</td>
<td>38.5 W/m K</td>
<td></td>
</tr>
<tr>
<td>Character:</td>
<td>standard steel for case-hardening with good machinability; high surface hardness with tough core</td>
<td></td>
</tr>
<tr>
<td>Application:</td>
<td>machine parts and moulding plates with a high surface hardness; synthetic resin press moulds for the processing of thermoplastics and thermosets</td>
<td></td>
</tr>
<tr>
<td>Treatment by</td>
<td>Polishing:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Etching:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EDM:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nitriding:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Usually, hardened parts are not nitrided → loss of hardness.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hard chroming:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>recommended, results in increased wear and corrosion resistance</td>
<td></td>
</tr>
<tr>
<td>Heat treatment:</td>
<td>Soft annealing: 670 to 710 °C for about 2 to 5 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>slow controlled cooling inside the furnace, further cooling in air, max. 205 HB</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carburising: 900 to 950 °C. The choice of the carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case hardening: 870 to 930 °C in powder/salt bath, cooling in oil/hot bath at 160 to 250 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intermediate heat treatment: 630 to 650 °C, for about 2 to 4 hours with slow furnace cooling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Preheating: 350 °C depending on dimensions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hardening: curing temperature 810 to 840 °C in warmed oil of ~ 60 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooling: in to about 100 °C oil, then in air to about 50 °C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tempering: 1 hour per 20 mm part thickness, min. 2 hours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tempering chart:</td>
<td></td>
</tr>
</tbody>
</table>

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![Tempering chart](image-url)
### Material No. 1.2210

#### Designation
- **DIN:** 115 CrV 3
- **AFNOR:** 100 C3
- **UNI:** 107 CrV 3 KU
- **AISI:** L2

#### Indicatory analysis:
- **C:** 1.18
- **Si:** 0.25
- **Mn:** 0.30
- **Cr:** 0.70
- **V:** 0.10

#### Strength:
- $\approx 740 \text{ N/mm}^2$

#### Thermal conductivity at 100 °C:
- $33 \text{ W/m K}$

#### Character:
Chrome-Vanadium alloyed **cold-work steel** with high resistance; also known as silver steel.

#### Application:
- Small turned parts, core pins, punches and engraving tools

#### Treatment by
- Polishing:
- Etching:
- EDM: $\Rightarrow$ not usual
- Nitriding:
- Hard chroming:

#### Heat treatment:
- **Soft annealing:**
  - 710 to 740 °C for about 2 to 5 hours
  - Slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C further cooling in air, **max. 220 HB**
- **Hardening:**
  - 780 to 840 °C
  - Keep curing temperature for 15 to 30 minutes
  - Quenching in water/oil
  - Obtainable hardness: **64–66 HRC**
- **Tempering:**
  - Slow heating to tempering temperature immediately after hardening;
  - Minimum time in furnace: 1 hour per 20 mm part thickness;
  - Min. 2 hours/cooling in air

#### Tempering chart:

![Tempering chart](image-url)
Material No.: 1.2311

Designation
- DIN: 40 CrMnMo 7
- AFNOR: 40 CMD 8
- UNI: 35 CrMo 8 KU
- AISI: P20

Indicatory analysis:
- C: 0.40
- Si: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20

Strength: $\approx 1080 \text{ N/mm}^2$

Thermal conductivity at 100 °C: $35 \frac{W}{m \cdot K}$

Character: alloyed and pre-toughened tool steel, especially suitable for polishing; high dimensional stability

Application: Cavity plates, inserts and high-tensile machine parts

Treatment by
- Polishing: good suitability for polishing; at 580 °C (Meusburger standard) is recommended.
- Etching: possible
- EDM: possible
- Nitriding: increases the steel’s wear resistance
- Hard chroming: particularly increases the steel’s wear resistance and corrosion resistance

Heat treatment: already pre-toughened; usually no heat treatment required
- Nitriding: before nitriding, stress-relief annealing is recommended at 580 °C. (Meusburger standard)
- Hard chrome plating: after the hard chroming the mould must be annealed about 3 to 4 hours at 180 °C to avoid brittle fractures from hydrogen.
- Hardening: 840 to 860 °C
- Cooling: to 180 °C/220 °C in oil/hot bath, then in air to about 100 °C
- Obtainable hardness: 52 HRC
- Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 25 mm part thickness

Heat treatment chart:

![Heat treatment chart](image-url)
Material No.: 1.2312

Indicatory analysis:

<table>
<thead>
<tr>
<th>Element</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.40</td>
</tr>
<tr>
<td>Si</td>
<td>0.40</td>
</tr>
<tr>
<td>Mn</td>
<td>1.50</td>
</tr>
<tr>
<td>Cr</td>
<td>1.90</td>
</tr>
<tr>
<td>Mo</td>
<td>0.20</td>
</tr>
<tr>
<td>S</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Strength: ≈ 1080 N/mm²

Thermal conductivity at 100 °C: 35 W m⁻¹ K⁻¹

Character: alloyed and pre-toughened tool steel, with excellent machinability in the hardened condition because of the Sulphur additive; high dimensional stability

Application: plates for mould tools and dies with increased requirements on strength; high-tensile machine parts

Treatment by

Polishing: technical polishing possible; for higher surface requirements we recommend 1.2311 or 1.2738
Etching: not recommended
EDM: Nitriding: increases the steel's wear resistance

Heat treatment: already pre-toughened, usually no heat treatment required

Nitriding: before nitriding, stress-relief annealing at 580 °C (Meusburger standard) is recommended
Hardening: 840 to 860 °C
Cooling: to 180 °C/220 °C in oil/hot bath

obtainable hardness: 52 HRC

Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 25 mm part thickness.

Tempering chart:
Material No.: 1.2316

Designation

DIN: X 38 CrMo 16
AFNOR: Z 35 CD 17
UNI: X 38 CrMo 16 KU
AISI: ≈ 422

Indicatory analysis:

C 0.36
Cr 16.00
Mo 1.20

Strength: ≈ 1010 N/mm²

Thermal conductivity at 100 °C: 18 W/m K

Character: corrosion resistant, high-alloy, polishable, pre-toughened tool steel

Application: moulds for processing corrosive plastics

Treatment by

Polishing: good suitability
Etching: possible
EDM:
Nitriding: reduces the corrosion resistance

Heat treatment:

already pre-toughened; usually no heat treatment required

Soft annealing:
760 bis 800 °C, for about 4 to 5 hours
slow controlled cooling of 10 to 20 °C per hour to about 650 °C
further cooling in air, max. 230 HB

Hardening:
1030 to 1050 °C
keep curing temperature for 15 to 30 minutes
quenching in water/oil
obtainable hardness: 49 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:
Material No.: 1.2343 / 1.2343 ESR*  

**Designation**  
DIN: X 38 CrMoV 5-1  
AFNOR: Z 38 CdV 5  
UNI: X 37 CrMoV 5-1 KU  
AISI: H11 / H11 ESR

<table>
<thead>
<tr>
<th>Indicator Analysis</th>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>0.38</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>1.00</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>0.40</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cr</td>
<td>5.30</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mo</td>
<td>1.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Strength:**  
≈ 780 N/mm²

**Thermal conductivity at 200 °C:**  
27 W/m K

**Character:**  
High-alloy hot-work steel with high toughness and heat resistance, hot cracks resistance and good thermal conductivity; for very high requirements available in grade *ESR* (Electro-Slag Remelted)

**Application:**  
Cavity plates and inserts for plastic injection moulds; *ESR* for die casting applications (Al, Mg, Zn)

**Treatment by**  
Polishing: highly suitable  
Etching: very easily feasible (graining)  
EDM: in the hardened and tempered condition, treat again for stress relief about 20 °C below the last tempering temperature  
Nitriding: increases the wear resistance and prevents the bonding of casting material  
Hard chroming: in special cases

**Heat treatment:**  
Soft annealing:  
750 to 800 °C, about 4 to 5 hours  
slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C; further cooling in air, max. 205 HB  
Nitriding:  
before nitriding, stress-relief annealing at 580 °C (Meusburger standard) is recommended.  
A treatment at 525 °C in ammonia gas results in a surface hardness of approx. 55 HRC.  
Hardening:  
1000 to 1040 °C  
keep curing temperature for 15 to 30 minutes  
quenching in water/oil/air  
obtainable hardness: 50–56 HRC  
Tempering:  
slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 20 mm part thickness; repeated tempering is recommended

**Tempering chart:**

**High temperature strength chart:**

- susceptible to corrosion; during machining, continuous corrosion protection has to be ensured (especially during wire EDM)

- 1.2343 ESR is highly suitable for mirror polishing
<table>
<thead>
<tr>
<th>Material No.:</th>
<th>1.2344 / 1.2344 ESR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>DIN: X 40 CrMoV 5-1</td>
</tr>
<tr>
<td></td>
<td>AFNOR: Z 40 CDV 5</td>
</tr>
<tr>
<td></td>
<td>UNI: X 40 CrMoV 5-1 KU</td>
</tr>
<tr>
<td></td>
<td>AISI: H13 / H13 ESR</td>
</tr>
<tr>
<td>Indicatory analysis:</td>
<td>C 0.40</td>
</tr>
<tr>
<td></td>
<td>Si 1.00</td>
</tr>
<tr>
<td></td>
<td>Cr 5.30</td>
</tr>
<tr>
<td></td>
<td>Mo 1.40</td>
</tr>
<tr>
<td></td>
<td>V 1.00</td>
</tr>
<tr>
<td>Strength:</td>
<td>≈ 780 N/mm²</td>
</tr>
<tr>
<td>Thermal conductivity at 100 °C:</td>
<td>26 W/m K</td>
</tr>
<tr>
<td>Character:</td>
<td>high-alloy <strong>hot-work steel</strong>, high heat resistance, high wear resistance, good toughness, thermal conductivity and hot cracks resistance, limited use for water cooling; for very high requirements available in grade <em>ESR</em> (Electro-Slag Remelted)</td>
</tr>
<tr>
<td>Application:</td>
<td>standard material for hot-work tools, extrusion moulds, dies, tools for plastic processing</td>
</tr>
<tr>
<td>Treatment by</td>
<td>Polishing:</td>
</tr>
<tr>
<td></td>
<td>Etching:</td>
</tr>
<tr>
<td></td>
<td>EDM:</td>
</tr>
<tr>
<td></td>
<td>Nitriding:</td>
</tr>
<tr>
<td></td>
<td>Hard chrome plating: in special cases</td>
</tr>
<tr>
<td>Heat treatment:</td>
<td>Soft annealing: 750 to 800 °C for about 4 to 5 hours</td>
</tr>
<tr>
<td></td>
<td>slow controlled cooling inside the furnace; 10 to 20 °C per hour to about 600 °C further cooling in air, <em>max. 230 HB</em></td>
</tr>
<tr>
<td></td>
<td>Hardening: 1020 to 1060 °C</td>
</tr>
<tr>
<td></td>
<td>keep curing temperature for 15 to 30 minutes</td>
</tr>
<tr>
<td></td>
<td>quenching in water/oil</td>
</tr>
<tr>
<td></td>
<td>obtainable hardness: 54 HRC</td>
</tr>
<tr>
<td></td>
<td>Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 20 mm part thickness</td>
</tr>
<tr>
<td>Technical Tip</td>
<td>- susceptible to corrosion; during machining, continuous corrosion protection has to be ensured (especially during wire EDM)</td>
</tr>
<tr>
<td></td>
<td>- 1.2344 ESR is highly suitable for mirror polishing</td>
</tr>
</tbody>
</table>

**Technical Tip**: 1.2344 ESR is highly suitable for mirror polishing.
Material No.: 1.2363

Designation: DIN: X 100 CrMoV 5  
AFNOR: Z 100 CDV 5  
UNI: X 100 CrMoV 5-1 KU  
AISI: A2

Indicatory analysis:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.00</td>
</tr>
<tr>
<td>Si</td>
<td>0.30</td>
</tr>
<tr>
<td>Mn</td>
<td>0.50</td>
</tr>
<tr>
<td>Cr</td>
<td>5.20</td>
</tr>
<tr>
<td>Mo</td>
<td>1.10</td>
</tr>
<tr>
<td>V</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Strength: ≈ 810 N/mm²

Thermal conductivity at 100°C: \( \frac{19}{mK} \)

Character: Steel for through hardening with good machinability, high wear resistance and low warpage; very good dimensional stability, toughness and through hardenability

Application: Cavity plates and inserts as well as cutting punches, wear plates and cutting dies with high requirements on toughness

Treatment by:

Polishing:
Etching:
Nitrering:
Hard chroming: possible

Heat treatment:

Soft annealing: 800 to 840°C for about 4 - 5 hours  
slow controlled cooling inside the furnace: 10 to 20°C per hour to about 650°C  
further cooling in air, max. 230 HB

Hardening: 950 to 980°C  
quenching in calm air  
obtainable hardness: 62 HRC

Tempering:  
slow heating to tempering temperature immediately after hardening;  
tempering twice is recommended; rapid cooling following the tempering improves the dimensional stability;  
maximum hardness achievable after tempering: 58 – 60 HRC

Tempering chart:
Material No.: 1.2379

<table>
<thead>
<tr>
<th>Designation</th>
<th>DIN: X 153 CrMoV 12</th>
<th>AFNOR: Z 160 CDV 12</th>
<th>UNI:</th>
<th>AISI: ≈ D2</th>
</tr>
</thead>
</table>

Indicatory analysis:
- C: 1.53
- Si: 0.30
- Mn: 0.35
- Cr: 12.00
- Mo: 0.80
- V: 0.80

Thermal conductivity at 100 °C: 21 W/m K

Strength: ≈ 850 N/mm²

Character:
- high-alloy steel for through-hardening with moderate machinability;
- extremely wear resistant and low warpage, good dimensional stability, toughness and through hardenability

Application:
- mould plates and inserts as well as cutting punches, wear plates and cutting dies with high requirements for wear resistance

Treatment by
- Polishing: possible when hardened
- Nitriding: very well suited, due to the fact that the hardness of the base material will not fall below 60 HRC
- EDM: possible, Structure eroding not possible
- Hard chroming: possible
- Etching: not possible, coarse carbides are washed out

Heat treatment:
- Soft annealing: 800 to 850 °C for about 2 to 5 hours
- slow controlled cooling of 10 to 20 °C per hour to about 600 °C
- further cooling in air, max. 235 HB

- Hardening:
  - curing temperature: see tempering chart
  - quenching in oil/air/hot bath
  - obtainable hardness: 63–65 HRC

- Tempering:
  - slow heating to tempering temperature (to avoid forming of cracks)
  - immediately after hardening;
  - triple tempering at max. secondary hardening temperature is recommended;
  - rapid cooling following the tempering improves the dimensional stability;
  - maximum hardness achievable after tempering: 60–62 HRC

Tempering chart:
Material No.: 1.2714

Designation

- DIN: 56 NiCrMoV 7
- AFNOR: 55 NCDV 7
- UNI: 
- AISI: L6

Indicatory analysis:
- C: 0.56
- Cr: 1.10
- Mo: 0.50
- Ni: 1.70
- V: 0.10

Strength: \( \approx 850 \text{ N/mm}^2 \)

Thermal conductivity at 100 °C: \( 36 \frac{W}{m \cdot K} \)

Character: Steel for through hardening with good heat resistance, high temperature resistance, through hardenability and toughness

Application: Extrusion dies, hot-forging tools, dies for processing tin, lead and zinc alloys

Treatment by
- Polishing: technical polishing possible
- Etching:
- EDM:
- Nitriding:
- Hard chroming: possible

Heat treatment:
- Soft annealing: 650 to 700 °C for about 4 to 5 hours
- Slow controlled cooling inside the furnace: 10 to 20 °C per hour to about 600 °C
- Further cooling in air, max. 248 HB

- Hardening: 950 to 980 °C
- Keep curing temperature for 15 to 30 minutes
- Quenching in water/oil
- Obtainable hardness: 56 HRC

- Tempering:
- Slow heating to tempering temperature immediately after hardening;
- Minimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:

![Tempering Chart](chart.png)
Material No.: 1.2714 HH

Designation:
- DIN: 56 NiCrMoV 7
- AFNOR: 55 NCDV 7
- UNI: -
- AISI: L6

Indicatory analysis:
- C: 0.56
- Cr: 1.10
- Mo: 0.50
- Ni: 1.70
- V: 0.10

Strength: through-hardened to 1320 N/mm² (≈ 42HRC)

Thermal conductivity at 100 °C: 36 W/m K

Character: steel for through hardening, quenched and tempered, with good heat resistance, hardenability and toughness

Application: mould inserts, cores and slides for injection moulds

Treatment by:
- Polishing: technical polishing possible
- Etching: possible
- EDM: possible
- Nitriding: possible
- Hard chroming: possible

Heat treatment:
- Soft annealing: 650 to 700°C for about 4 to 5 hours, slow controlled cooling of 10 to 20 °C per hour to about 600 °C, further cooling in air, max. 248 HB
- Hardening: 950 to 980 °C, keep curing temperature for 15 to 30 minutes, quenching in water/oil
- Obtainable hardness: 56 HRC
- Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 20 mm part thickness

Tempering chart:
Material No.: 1.2738

Designation in:
- DIN: 40 CrMnNiMo 8-6-4
- AFNOR: 40 CMND 8
- UNI: -
- AISI: ≈ P20 + Ni / ≈ P20 + Ni mod.

Indicatory analysis:
- C: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20
- Ni: 1.10
- Si: 0.30

Strength:
≈ 1080 N/mm²

Thermal conductivity at 100°C:
33.5 W/m K

Character:
low-sulfer mould steel, supplied in quenched condition; because of the nickel-content constant strength with maximum dimensions

Application:
large mould tools with high loads at core, moulds for bumpers, dashboards, moulding frames

Treatment by:
- Polishing:
- Etching:
- Spark eroding: > is recommended
- Nitriding:
- Hard chroming: > suitable

Heat treatment:
already pre-toughened, generally no heat treatment required
Annealing:
710 to 740°C for about 2 - 5 hours
slow controlled cooling of 10 to 20°C per hour to about 600°C
further cooling in air, max. 235 HB

Hardening:
840 to 870°C
15 to 30 minutes keeping curing temperature
quenching in oil/heat bath /air 180 to 220°C
obtainable hardness: 53 HRC

Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 1 hour per 20 mm part thickness;
tempering twice is recommended

Tempering chart:
## Technical Tip

- uniform hardness over the entire cross section
- improved weldability
- higher toughness than 1.2738

### Material No.

**1.2738 TSHH**

### Designation in

- DIN: Special alloy
- AFNOR: -
- UNI: -
- AISI: -

### Indicatory analysis:

<table>
<thead>
<tr>
<th>Element</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.26</td>
</tr>
<tr>
<td>Mn</td>
<td>1.45</td>
</tr>
<tr>
<td>Cr</td>
<td>1.25</td>
</tr>
<tr>
<td>Mo</td>
<td>0.50</td>
</tr>
<tr>
<td>Ni</td>
<td>1.05</td>
</tr>
<tr>
<td>V</td>
<td>0.12</td>
</tr>
</tbody>
</table>

### Strength:

Tempered to $\approx 1200 \text{ N/mm}^2$  
(\(\approx 38 \text{ HRC}\))

### Thermal conductivity at 250°C:

$41.3 \ \frac{W}{m \cdot K}$

### Character:

Modified, pre-toughened steel for plastic moulds, which is characterised by excellent polishability and grainability; high thermal conductivity and wear resistance

### Application:

Cavity plates without dimension restrictions, with deep cavities and high core loads

### Treatment by

- Polishing: highly suitable
- Etching:
- EDM:
- Nitriding:
- Hard chrome plating: is possible

### Heat treatment:

Already pre-toughened; usually no heat treatment required

- **Soft annealing:**
  - $720^\circ C$ 1 hour per 25 mm part thickness
  - slow controlled cooling inside the furnace
  - **max. 245 HB**

- **Hardening:**
  - $880 ^\circ C$
  - keep curing temperature for 15 to 30 minutes
  - cooling in hot bath/oil/compressed gas
  - obtainable hardness: **50 HRC**

- **Tempering:**
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 1 hour per 25 mm part thickness

### Heat Treatment Chart:

![Heat Treatment Chart](image-url)

---

**Übersicht**
Material No.: 1.2767

Designation in:
- DIN: 45 NiCrMo 16
- AFNOR: 45 NCD 16
- UNI: 40 NiCrMoV 16 KU
- AISI: ≈ 6F7

Indicatory analysis:
- C: 0.45
- Si: 0.25
- Mn: 0.40
- Cr: 1.35
- Mo: 0.25
- Ni: 4.00

Strength: ≈ 830 N/mm²

Thermal conductivity at 100°C: 30 W/m K

Character: Nickel alloyed steel for through hardening, moderate machinability, very high resistance against bending and compressive strength, very high toughness and good through hardenability, also with bigger sections.

Application: difficult mould plates and inserts for the processing of plastics with high surface requirements (mirror polishing); stamping, forming, bending dies for particularly high pressure and bending stresses

Treatment by:
- Polishing: best metallurgical properties for mirror polishing
- Etching: is possible
- Spark eroding: very well suited
- Nitriding: not usual
- Hard chroming: in addition to wear resistance especially the corrosion resistance increases

Heat treatment:
- Soft annealing: 610 to 650°C for about 2 - 5 hours
  slow controlled cooling of 10 to 20°C per hour to about 600°C
  further cooling in air, max. 260 HB
- Hardening: 840 to 870°C
  quenching in oil/warm bath/air
  obtainable hardness: 53 - 58 HRC
- Tempering: slow heating to tempering temperature immediately after hardening;
  minimum time in furnace: 1 hour per 20 mm part thickness;
  tempering twice is recommended

Tempering chart:

Technical Tip
- To avoid undesirable distortion in spraying of plastics, the tempering temperature after hardening must be 50°C over operation temperature.
Material No.: 1.2842

**Designation**

- DIN: 90 MnCrV 8
- AFNOR: 90 MV 8
- UNI: 90 MnVCr 8 KU
- AISI: O2

**Indicatory analysis:**

- C: 0.90
- Si: 0.20
- Mn: 2.00
- Cr: 0.40
- V: 0.10

**Strength:** ≈ 760 N/mm²

**Thermal conductivity at 100 °C:** 33 W/mK

**Character:**

- steel for through-hardening with good machinability and high wear resistance; low warping and high dimensional stability; with high toughness and through hardenability (uniform hardness for cross sections up to 40 mm)

**Application:**

- cavity plates and inserts exposed to abrasive stress; cutting punches;
- wear plates, cutting dies and guiding plates; pressure pads and guiding rails

**Treatment by**

- Polishing: not usual → 1.2379
- Etching:
- Nitriding:
- EDM: is possible
- Hard chrome plating:

**Heat treatment:**

- **Soft annealing:** 680 to 720 °C for about 2 to 5 hours
- slow controlled cooling of 10 to 20 °C per hour to about 600 °C
- further cooling in air, max. 220 HB

- **Hardening:** 790 to 820 °C
- quenching in oil/hot bath (200 to 250 °C)
- obtainable hardness: 63−65 HRC

- **Tempering:**
  - slow heating (to avoid forming of cracks) to tempering temperature immediately after hardening;
  - twice tempering with intermediate cooling down to 20 °C increases the steel’s toughness
  - max. obtainable hardness after tempering: 58−60 HRC

- **Tempering chart:**

  ![Tempering chart](image-url)

**Technical Tip**

- Steel grade 1.2510 is an adequate alternative with regards to its properties, machinability and dimensional stability after heat treatment.
### Material No.: 1.3343 (HSS)

**Designation**
- DIN: HS 6-5-2 C
- AFNOR: Z 85 WDCV 6
- UNI: X 82 WMoV 6 5
- AISI: M 2 reg. C

**Indicatory analysis:**
- C: 0.9
- Si: 0.3
- Mn: 0.3
- Cr: 4.0
- Mo: 5.0
- V: 1.9
- W: 6.2

**Strength:**
≈ 920 N/mm²

**Thermal conductivity at 100°C:**
27.4 \( \frac{W}{m \cdot K} \)

**Character:**
high-speed steel featuring high resistance to adhesive and abrasive wear in combination with high toughness and compressive strength.

**Application:**
blocks for eroding, cold forming tools such as cutting, fine blanking and impact extrusion punches and dies
inserts with a very high wear resistance

**Treatment by**
- Polishing: suitable
- Nitriding: highly suitable
- EDM: highly suitable for EDM
- Coating: highly suitable

**Heat treatment:**
- Soft annealing: 820 to 850 °C, about 2 to 5 hours
  slow controlled cooling inside the furnace: 10 to 20°C per hour to about 55°C; then further cooling in air. max. 270 HB
- Hardening: 1190 - 1230 °C
  quenching in oil/compressed gas/air/hot bath
  obtainable hardness: 66 HRC
- Tempering:
  slow heating to tempering temperature (to avoid forming of cracks)
  immediately after hardening;
  triple tempering is recommended

**Tempering chart:**

---

**Technical Tip**
- excellent for PVD and CVD coating;
  highest dimensional stability because the steel was tempered at more than 520 °C.
Material No.: 1.3344 PM (PM23)

Designation
DIN: PM 6-5-3
AFNOR: X 130 WMoCrV 6-5-4-3
UNI: W 6 Mo 5 Cr 4 V 3
AISI: M 3-2 (PM)

Indicatory analysis:
- C 1.25
- Si 0.30
- Mn 0.30
- Cr 4.0
- Mo 5.0
- V 3.0
- W 6.2

Strength: ≈ 870 N/mm²

Thermal conductivity at 100 °C: 24 \( \frac{W}{m\ K} \)

Character:
- powder metallurgy high-speed steel with good machinability, high resistance to adhesive and abrasive wear, with optimal toughness due to the uniform and fine carbide structure, very good through hardenability and high dimensional stability

Application:
- blocks for eroding, cutting punches and dies with particularly durable edges,
- inserts with excellent wear resistance

Treatment by
Polishing:
- best metallurgical properties for mirror finish
Nitriding:
- highly suited for nitriding
EDM:
- highly suited for EDM
Coating:
- highly suited for coating

Heat treatment:
Soft annealing:
- at 860 to 880 °C, for approx. 2 to 5 hours
- slow controlled cooling of 10 to 20 °C per hour to about 600 °C;
- further cooling in air, max. 260 HB

Hardening:
- curing temperature: see tempering chart
- quenching in oil/compressed gas/air/hot bath
- obtainable hardness: 64–66 HRC

Tempering:
- slow heating to tempering temperature (in order to avoid formation of cracks)
- immediately after hardening;
- tempering three times is recommended

Technical Tip
- excellent for PVD and CVD coating;
- highest dimensional stability because the steel was tempered at more than 520 °C.

Tempering chart:
Material No.: 1.7131

Designation
DIN: 16 MnCr 5
AFNOR: 16 MC 5
UNI: -
AISI: 5115

Indicatory analysis:
C 0.16
Si 0.25
Mn 1.15
Cr 0.95

Strength:
≈ 600 N/mm²

Thermal conductivity at 20 °C:
44 W/m K

Character:
steel for case hardening for parts requiring a core strength of 800 to 1000 N/mm² and high wear resistance

Application:
guiding elements, cores and machine parts with high surface hardness; synthetic resin press moulds for processing thermoplastics and thermosetting plastics

Treatment by
Polishing:
Etching:
EDM: possible
Nitriding:
Usually, hardened parts are not nitrided → loss of hardness.
Hard chroming: recommended, increases wear and corrosion resistance

Heat treatment:
Soft annealing:
670 to 710 °C for about 2 to 5 hours
slow controlled cooling, further cooling in air, max. 205 HB

Carburising:
900 to 950 °C. The choice of the carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.

Case hardening:
870 to 930 °C in powder/salt bath, cooling in oil/hot bath at 160 to 250 °C

Intermediate heat treatment:
630 to 650 °C, for about 2 to 4 hours with slow cooling inside the furnace

Preheating:
350 °C depending on dimensions

Hardening:
curing temperature 810 to 840 °C - harden in 60 °C hot oil

Cooling:
down to about 100 °C in oil, then in air to about 50 °C

Tempering:
1 hour per 20 mm part thickness, min. 2 hours
Tempering: 150 °C - 200 °C
Material No.: **1.7225**

**Designation:**
- DIN: 42 CrMo 4
- AFNOR: 42 CD 4
- UNI: 42 CrMo 4
- AISI: 4140

**Indicatory analysis:**
- C 0.42
- Si 0.25
- Mn 0.75
- S <0.035
- Cr 1.10
- Mo 0.22

**Strength:**
- ~720 N/mm²

**Tensile strength:**
- heat treated max. 720 N/mm²

**Thermal conductivity at 20°C:**
- 42.6 W/mK

**Character:**
alloyed steel, suitable for quenching and tempering, with high resistance and high toughness;
universally useable in engineering when toughened and pre-hardened

**Application:**
machine construction, base plates, axes, gear shafts, gear wheels

**Treatment by**
- Nitriding: suitable
- Welding: not recommended
- EDM: suitable for EDM
- Coating: suitable

**Heat treatment:**
- Normalizing: 840 to 880 °C afterwards air cooling
- some components need tempering afterwards
- Soft annealing: 680 to 720 °C, about 2 to 5 hours
  - slow controlled cooling of 10 to 20 °C per hour to about 600 °C
  - then further cooling in air; **max. 217 HB**
- Toughening:
  - max. 1.600 N/mm²
- Hardening: 820 to 880 °C
  - quenching in oil or water
  - oil hardening for thin and complex,
  - water hardening for large and simple components
  - obtainable hardness: **53–61 HRC**
- Tempering:
  - slow heating to temperature (to avoid forming of cracks)
  - immediately after hardening; at least 60 minutes
  - cooling in air

**Tempering chart:**

![Tempering Chart](image-url)
<table>
<thead>
<tr>
<th>Material No.:</th>
<th>CF-H40S+</th>
<th>Technical Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Designation</td>
<td>ISO: K40</td>
<td>- Excellent corrosion resistance in connection with the mechanical and physical characteristics required in die making.</td>
</tr>
<tr>
<td></td>
<td>US Industry: C11/C12</td>
<td></td>
</tr>
<tr>
<td>Material composition (%):</td>
<td>WC 86.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Co (Binder) 11.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Other 1.6</td>
<td></td>
</tr>
<tr>
<td>Physical and mechanical characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average WC grit size:</td>
<td>fine</td>
<td></td>
</tr>
<tr>
<td>Density (ISO 3369):</td>
<td>14.15 g/cm³</td>
<td></td>
</tr>
<tr>
<td>Hardness (ISO 3878):</td>
<td>1400 HV10</td>
<td></td>
</tr>
<tr>
<td>Flexural strength (ISO 3327):</td>
<td>3200 MPa</td>
<td></td>
</tr>
<tr>
<td>Compressive strength:</td>
<td>4900 MPa</td>
<td></td>
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<tr>
<td>Elastic modulus:</td>
<td>551 GPa</td>
<td></td>
</tr>
<tr>
<td>Fracture toughness:</td>
<td>12.5 MPa m¹/²</td>
<td></td>
</tr>
<tr>
<td>Thermal conductivity at 100 °C:</td>
<td>90 W/mK</td>
<td></td>
</tr>
<tr>
<td>Coefficient of thermal expansion (20-400°C):</td>
<td>5.4 10⁻⁶/K</td>
<td></td>
</tr>
<tr>
<td>Corrosion resistance:</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Character:</td>
<td>The universal carbide grade - the ideal compromise between hardness and fracture toughness with high edge stability.</td>
<td></td>
</tr>
<tr>
<td>Applications:</td>
<td>Blocks for eroding, cutting punches, and dies with maximum wear resistance; active parts for stamping, embossing, bending, and forming</td>
<td></td>
</tr>
<tr>
<td>Treatment by</td>
<td>Polishing: well-suitable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EDM: suitable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coating: suitable</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Laser cutting: suitable</td>
<td></td>
</tr>
<tr>
<td>Typical microstructure view:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Material No.: 3.3547

#### Designation
- **DIN:** AlMg4,5Mn / ISO 5083
- **AFNOR:** A - G4,5MC
- **UNI:** 7790
- **AISI:** -

#### Indicatory analysis:
- **Si:** 0.40
- **Fe:** 0.40
- **Cu:** 0.10
- **Mn:** 0.40 – 1.00
- **Mg:** 4.00 – 4.90
- **Cr:** 0.05 – 0.25
- **Zn:** 0.25
- **Ti:** 0.15

#### Strength:
- ■ 230 – 290 N/mm² (casting-hard)
- ● ≥ 270 N/mm²

#### Thermal conductivity at 100 °C:
- 110 – 140 \( \frac{W}{m \cdot K} \)

#### Character:
- not hardenable, homogenised, annealed aluminium alloy with particularly good machining and welding properties; excellent dimensional stability; ideally suited for anodising, hard chromium plating and chemical nickel plating; very high resistance to corrosion

  - **Density:** 2.66 kg/dm³
  - **Thermal expansion coefficient:** 24.2 \( \times 10^{-6} m/mK \)
  - **Max. temperature permanent/short term:** 90/110 °C

#### Application:
plates for mould tools, rotary tables, machined components for machine and jig construction, moulds for prototypes and foamed parts

#### Treatment by
- **Polishing:** suitable
- **EDM:**
- **Etching:**
- **Milling:** ideally suited
- **Welding:**

#### Heat treatment:
**Note:**
Subsequent heat treatment may lead to a deterioration of the mechanical properties!
Material No.: 3.4365

Designation
- DIN: AlZnMgCu 1.5 / ISO 7075
- AFNOR: A - Z5GU
- UNI: 9007 / 2
- AISI: 

Indicatory analysis:
- Si: 0.40
- Fe: 0.50
- Cu: 1.20–2.00
- Mn: 0.30
- Mg: 2.10–2.90
- Cr: 0.18–0.28
- Zn: 5.10–6.10
- Ti: 0.20

Strength: depending on the thickness of the plate

<table>
<thead>
<tr>
<th>plate thickness [mm]</th>
<th>10</th>
<th>20</th>
<th>50</th>
<th>60</th>
<th>80</th>
<th>90</th>
<th>100</th>
<th>120</th>
<th>150</th>
<th>200</th>
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</thead>
<tbody>
<tr>
<td>tensile strength $R_m$ [N/mm²]</td>
<td>540</td>
<td>540</td>
<td>530</td>
<td>525</td>
<td>495</td>
<td>490</td>
<td>460</td>
<td>410</td>
<td>360</td>
<td>360</td>
</tr>
<tr>
<td>yield point $R_{p02}$ [N/mm²]</td>
<td>470</td>
<td>470</td>
<td>460</td>
<td>440</td>
<td>420</td>
<td>390</td>
<td>360</td>
<td>300</td>
<td>260</td>
<td>240</td>
</tr>
</tbody>
</table>

Thermal conductivity at 100 °C: 130–160 $\frac{W}{m\cdot K}$

Character: hardened, high-strength aluminium zinc alloy with good properties for structure-etching, as well as good machinability, EDM and polishing properties
- Density: 2.8 kg/dm³
- Thermal expansion coefficient: 23.4 $10^{-6}$ m/mK
- Max. temperature permanent/short term: 90/120 °C

Application: plates for mould tools and dies with increased requirements on strength; components for machine and jig construction

Treatment by
- Polishing: possible
- Machining:
- EDM:
- Etching: suitable for structure-etching
- Repair welding: not suitable for welding

Heat treatment: Note: Subsequent heat treatment may lead to a deterioration of the mechanical properties.
**Material No.:** M V10 PM

**Designation**

AISI: A11 (PM)

**Indicatory analysis:**

<table>
<thead>
<tr>
<th>Element</th>
<th>Content</th>
</tr>
</thead>
<tbody>
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<td>C</td>
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<tr>
<td>Si</td>
<td>0.90</td>
</tr>
<tr>
<td>Mn</td>
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</tr>
<tr>
<td>Cr</td>
<td>5.20</td>
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<tr>
<td>Mo</td>
<td>1.30</td>
</tr>
<tr>
<td>V</td>
<td>9.75</td>
</tr>
</tbody>
</table>

**Strength:**

$\approx 950 \text{ N/mm}^2$

**Thermal conductivity at 100 °C:**

$20 \frac{W}{m \cdot K}$

**Character:**

Powder metallurgical high-speed steel with optimal dimensional accuracy after the heat treatment. Highest abrasive wear resistance and excellent toughness. Good machinability through a homogeneous microstructure.

**Application:**

Blocks for eroding, dies and cutting punches with extreme requirements, fine blanking punches, pressing punches for sinter press tools.

**Treatment by**

- Polishing: best metallurgical properties for mirror polishing
- Nitriding: highly suitable for nitriding
- EDM: highly suitable for EDM
- Coating: highly suitable

**Heat treatment:**

Soft annealing:

880 to 900 °C, about 2 to 5 hours
slow controlled cooling of 10 to 20 °C per hour
to about 600 °C; further cooling in air, max. 280 HB

Hardening:

Curing temperature: see tempering chart
quenching in oil/compressed gas/air/hot bath
obtainable hardness: 60-63 HRC

Tempering:

slow heating to tempering temperature (to avoid forming of cracks)
immediately after hardening;
triple tempering is recommended

**Tempering chart:**

![Tempering chart](image-url)
Material No.: M W10 PM
Designation EN: HS 10-2-5-8

Indicatory analysis:
- C 1.6
- Cr 4.8
- Mo 2.0
- V 5.0
- W 10.5
- Co 8.0

Strength:
Thermal conductivity at 100 °C: $26 \, \frac{W}{m \cdot K}$

Character:
High-speed steel produced by powder metallurgy with highest compressive strength. High adhesive wear resistance and excellent toughness. Very high working hardness possible.

Application:
Blocks for eroding, dies, cutting punches and cutting tools for extremely high requirements, fine blanking punches, embossing tools, cold solid forming

Treatment by
- Polishing: best metallurgical properties for mirror polishing
- Nitriding: highly suited for nitriding
- EDM: highly suited
- Coating: highly suited

Heat treatment:
Soft annealing:
870 to 900°C for about 2 to 5 hours
slow controlled cooling inside the furnace 10 to 12°C per hour to about 550°C, further cooling in air, max. 300 HB

Hardening:
curing temperature: see tempering chart
quenching in oil/compressed gas/air/hot bath
obtainable hardness: 68 HRC

Tempering:
slow heating to tempering temperature (in order to avoid formation of cracks)
immediately after hardening;
keep at tempering temperature for at least 1 hour
four tempering cycles are recommended, with cooling to room temperature in between

Tempering chart:

- Retains hardness at high temperatures due to high cobalt content
- Excellent for PVD and CVD coating without risk of dimensional changes, as the steel is tempered at more than 520°C
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