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.

QUALITY NEEDS TO BE CHECKED

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.
Cold-work steels are used for moulds which generally don’t reach temperatures higher than 200°C while in operation.

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.

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.

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

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 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.

### MATERIAL GRADES

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<th>Unalloyed steel</th>
<th>Steel for case-hardening</th>
<th>Pre-toughened steel</th>
<th>Corrosion resistant steel</th>
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<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>
<tr>
<td></td>
<td></td>
<td>1.2714HH</td>
<td>1.2085</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2738</td>
<td>1.2316</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2985</td>
<td>1.2738TSHH</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2316</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2738TSHH</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Steel for through hardening</th>
<th>Hot-work steel</th>
<th>HSS High-speed / powder steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2083</td>
<td>1.2343</td>
<td>1.3343PM</td>
</tr>
<tr>
<td>1.2083ESU</td>
<td>1.2344</td>
<td>MV10PM</td>
</tr>
<tr>
<td>1.2363</td>
<td>1.2344ESU</td>
<td>MW10PM</td>
</tr>
<tr>
<td>1.2379</td>
<td>1.2714</td>
<td></td>
</tr>
<tr>
<td>1.2767</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2842</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quenched and tempered alloy steel</th>
<th>Carbides</th>
<th>Non-ferrous metals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7225</td>
<td>CF-H405+</td>
<td>3.3547</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.4365</td>
</tr>
<tr>
<td>Element</td>
<td>Melting point</td>
<td>Importance</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<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 alloying element in steel.</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>Silicon 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>
</tbody>
</table>
### Overview of material grades

<table>
<thead>
<tr>
<th>Material no.</th>
<th>Designation</th>
<th>Indicator analysis</th>
<th>Strength</th>
<th>Character</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0577</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.45</td>
<td>132 - 185 HB</td>
<td>Unalloyed, with good workability for hot forming</td>
</tr>
<tr>
<td>1.1730</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.45</td>
<td>160 - 195 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2083</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.45</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2085</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.35</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2162</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.21</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2120</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2312</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2316</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2433</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2343</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2344</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2363</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</td>
</tr>
<tr>
<td>1.2379</td>
<td>DIN EN 1008</td>
<td>C</td>
<td>0.18</td>
<td>280 - 325 HB</td>
<td>Unalloyed, suitable for flame hardening and making dies and machine parts.</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. (e.g. die casting, a specialist in steel manufacturer, hardening shop) should be consulted. Liability does not lie with Meusburger Georg GmbH & Co KG.
MATERIAL NO.: 1.0577

DESIGNATION:
- DIN: S 355 J2 (St 52-3)
- AFNOR: A 52 FP
- UNI: A738
- AISI: A5278

TECHNICAL TIP:
- If no welding is required, we recommend 1.1730 - better machinability in spite of higher strength

INDICATORY ANALYSIS:
- C ≤ 0.22
- Si ≤ 0.55
- Mn ≤ 1.60

STRENGTH:
- 132 - 185 HB
  (= 450 - 630 N/mm²)

THERMAL CONDUCTIVITY AT 20°C:
- 40 W/mK

CHARACTER:
- Unalloyed structural steel with good weldability

APPLICATION:
- For common applications in mould, die, and jigs and fixtures construction

TREATMENT BY:
- Welding:
  - very good weldability due to its low carbon content
- Polishing, etching, EDM, nitriding, hard chroming:
  - not usual

HEAT TREATMENT:
- Soft annealing:
  - 650 to 700°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. 180 HB

MATERIAL NO.: 1.1730

DESIGNATION:
- DIN: C 45 U
- AFNOR: X 48
- UNI: 1045
- AISI: 1045

INDICATORY ANALYSIS:
- C 0.45
- Si 0.30
- Mn 0.70

STRENGTH:
- 180 - 195 HB
  (= 610 - 660 N/mm²)

THERMAL CONDUCTIVITY AT 20°C:
- 50 W/mK

CHARACTER:
- Unalloyed tool steel with excellent machinability; chilled cast steel, suitable for flame and inductive hardening

APPLICATION:
- Unhardened parts for mould and jig construction or plates and frames for mould bases and die sets

TREATMENT BY:
- Polishing, etching, EDM, nitriding, hard chrome plating:
  - 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**

**TECHNICAL TIP:**
- Cold-work steel
- Must be tempered several times after hardening (max. 52 HRC). 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.

**INDICATORY ANALYSIS:**

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>0.40</td>
<td>0.40</td>
<td>0.30</td>
<td>13.00</td>
</tr>
</tbody>
</table>

**STRENGTH:**
- max. 240 HB
- (≈ max. 800 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
- 23.5 W m K⁻¹

**CHARACTER:**
- Low corrosion, high-alloy, low wearage 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:**
- Mould plates and inserts for working with chemically aggressive plastics; because of excellent polishing, 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)
- EDM:
  - in the hardened and tempered condition, treat again for stress relief about 20°C below the last temperature
- Nitriding, hard chroming:
  - not recommended

**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
  - double tempering is recommended

**TEMPERING CHART:**

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**MATERIAL NO.: 1.2085**

**TECHNICAL TIP:**
- Corrosion resistant, high-alloy, pre-toughened tool steel with good machinability due to sulphur (S) additive.

**APPLICATION:**
- Plates for corrosion resistant mould bases and die sets; moulds for corrosive plastics; better corrosion resistance reduces the amount of mould maintenance required; not suitable for mould inserts.

**TREATMENT BY:**
- Polishing, etching, EDM, nitriding, hard chrome plating:
  - not usual

**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
  - double tempering is recommended

**TEMPERING CHART:**
MATERIAL NO.: 1.2162

DESIGNATION: 21 MnCr 5
AFNOR: 20 MC 5
UNI: AISI: 5120

**INDICATORY ANALYSIS:**
- C: 0.21
- Si: 0.25
- Mn: 1.25
- Cr: 1.20

**STRENGTH:**
max. 210 HB
(≈ max. 710 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
38.5 W/mK

**CHARACTER:**
- Standard steel for case-hardening with good machinability, high surface hardness with tough core

**APPLICATION:**
- Machine parts and mould plates with a high surface hardness; synthetic resin press moulds for the processing of thermoplastics and thermostets

**TREATMENT BY:**
- Polishing, etching, EDM: possible
- Nitriding: usually, hardened parts are not nitrided - loss of hardness.
- Hard chroming: recommended, results in increased wear and corrosion resistance

**HEAT TREATMENT:**
- Soft annealing: 670 to 710°C for about 2 to 5 hours
  slow controlled cooling inside the furnace, further cooling in air, max. 205 HB
- Carburising: 870 to 950°C. The choice of carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.
- Intermediate heat treatment:
  - 630 to 650°C, about 2 to 4 hours with slow cooling inside the furnace
- Hardening:
  - 810 to 840°C
  quenching in oil/hot bath (160 to 250°C)
- Tempering:
  - 1 hour per 20 mm part thickness, min. 2 hours

**TEMPERING CHART:**

---

MATERIAL NO.: 1.2210

DESIGNATION: 115 CrV 3
AFNOR: 100 C3
UNI: AISI: L2

**INDICATORY ANALYSIS:**
- C: 1.18
- Si: 0.25
- Mn: 0.30
- Cr: 0.70
- V: 0.10

**STRENGTH:**
max. 220 HB
(≈ max. 750 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
33 W/mK

**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, nitriding, hard chrome plating: not usual

**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:**

---
**MATERIAL NO.:** 1.2311

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

**TECHNICAL TIP:**
- The core strength decreases with increasing plate thickness: for thickness >300 we recommend 1.2738.

**INDICATORY ANALYSIS:**
- C: 0.40
- Si: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20

**STRENGTH:**
- 280 - 325 HB
- (= 950 - 1100 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
- 35 W/m 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:
  - Technical polishing possible; for higher surface requirements we recommend 1.2311 or 1.2738
- Etching, EDM:
  - Possible
- Nitriding:
  - Increases the steel's wear resistance
  - Hard chrome plating particularly increases the steel's wear resistance and corrosion resistance

**HEAT TREATMENT:**
- Already pre-toughened; usually no heat treatment required
- Soft annealing:
  - 720 to 740°C for about 2 to 4 hours
  - Slow controlled cooling inside the furnace
- Nitriding:
  - Before nitriding, stress-relieving heat treatment at 580°C (meusburger standard) is recommended.
- Hardening:
  - 840 to 860°C
  - Quenching in oil/heat bath (180 to 220°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

**TEMPERING CHART:**

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**MATERIAL NO.:** 1.2312

**DESIGNATION:**
- DIN: 40 CrMnMoS 8-6
- AFNOR: 40 CMD 8.S
- UNI: P20 + S
- AISI: P20 + S

**TECHNICAL TIP:**
- For increased surface quality requirements use material grade 1.2311.

**INDICATORY ANALYSIS:**
- C: 0.40
- Si: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20
- S: 0.06

**STRENGTH:**
- 280 - 325 HB
- (= 950 - 1100 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
- 35 W/m K

**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 bases 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, EDM:
  - Recommended
  - Nitriding:
  - Increases the steel's wear resistance

**HEAT TREATMENT:**
- Already pre-toughened; usually no heat treatment required
- Soft annealing:
  - 720 to 740°C for about 2 to 4 hours
  - Slow controlled cooling inside the furnace
- Nitriding:
  - Before nitriding, stress-relieving heat treatment at 580°C (meusburger standard) is recommended.
- Hardening:
  - 840 to 860°C
  - Quenching in oil/heat bath (180 to 220°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

**TEMPERING CHART:**
**MATERIAL NO.: 1.2316**

**DESIGNATION:**
- DIN: X 38 CrMo 16
- AFNOR: Z 35 CD 17
- UNI: X 38 CrMo 16 KU = 422

**TECHNICAL TIP:**
- Corrosion resistant like 1.2085
- For demanding surfaces

**INDICATORY ANALYSIS:**
- C: 0.36
- Cr: 16.00
- Mo: 1.20

**STRENGTH:**
- 280 - 325 HB
  
  ≈ 950 - 1100 N/mm²

**THERMAL CONDUCTIVITY AT 100°C:**
- 18 W/mK

**CHARACTER:**
- Corrosion resistant, high-alloy, polishable, pre-toughened tool steel

**APPLICATION:**
- Moulds for processing corrosive plastics

**TREATMENT BY:**
- Polishing: good suitability
- Etching, EDM: possible
- Nitriding: reduces the corrosion resistance

**HEAT TREATMENT:**
- Already pre-toughened, usually no heat treatment required
- Soft annealing: 760 to 800°C for about 4 to 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: 1030 to 1050°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/compressed gas/hot bath
  - 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:**

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**MATERIAL NO.: 1.2343 / 1.2343 ESR**

**DESIGNATION:**
- DIN: X 37 CrMoV 5-1
- AFNOR: Z 38 CDV 5
- UNI: X 37 CrMoV 5-1 KU ≈ H 11 / H 11 ESR

**TECHNICAL TIP:**
- 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

**INDICATORY ANALYSIS:**
- C: 0.38
- Si: 1.00
- Mn: 0.40
- Cr: 5.30
- Mo: 1.20
- V: 0.40

**STRENGTH:**
- max. 230 HB
  
  ≈ max. 780 N/mm²

**THERMAL CONDUCTIVITY AT 200°C:**
- 27 W/mK

**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

**HEAT TREATMENT:**
- Soft annealing: 750 to 800°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. 205 HB
- Nitriding: before nitriding, stress-relieving heat treatment at 550°C (Meusburger standard) is recommended.
- Hardening: 1000 to 1040°C
  - 15 to 30 minutes keeping curing temperature
  - quenching in oil/air/compressed gas/hot bath
  - 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:**

---

Overview
### MATERIAL NO.: 1.2344 / 1.2344 ESR*

<table>
<thead>
<tr>
<th>DESIGNATION:</th>
<th>DIN: X 40 CrMoV 5-1</th>
<th>AFNOR: Z 40 CDV 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>UNI: X 40 CrMoV 5-1 KU</td>
<td>AISI: H13 / H13 ESR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TECHNICAL TIP:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Susceptible to corrosion; during machining, continuous corrosion protection has to be ensured (especially during wire EDM)</td>
</tr>
<tr>
<td>➤ 1.2344 ESR is highly suitable for mirror polishing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INDICATORY ANALYSIS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 0.40</td>
</tr>
<tr>
<td>Si 1.00</td>
</tr>
<tr>
<td>Cr 5.30</td>
</tr>
<tr>
<td>Mo 1.40</td>
</tr>
<tr>
<td>V 1.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STRENGTH:</th>
</tr>
</thead>
<tbody>
<tr>
<td>max. 230 HB (≈ max. 780 N/mm²)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THERMAL CONDUCTIVITY AT 100°C:</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 W m⁻¹ K⁻¹</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHARACTER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ High-alloy high-work steel, high heat resistance, high wear resistance, good toughness, thermal conductivity and hot crack resistance, for very high requirements available in grade <em>ESR (Electro-Slag Remelted)</em></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APPLICATION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Standard material for hot-work tools, extrusion moulds, dies, tools for plastic processing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TREATMENT BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Polishing, etching, EDM, nitriding: possible</td>
</tr>
<tr>
<td>➤ Hard chrome plating: in special cases</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEAT TREATMENT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Soft annealing: 750 to 800°C for about 4 to 5 hours</td>
</tr>
<tr>
<td>➤ Slow controlled cooling inside the furnace: 10 to 20°C per hour to about 600°C; further cooling in air, max. 230 HB</td>
</tr>
<tr>
<td>➤ Hardening: 1020 to 1060°C</td>
</tr>
<tr>
<td>➤ Keep curing temperature for 15 to 30 minutes</td>
</tr>
<tr>
<td>➤ Quenching in oil/air/compressed gas/hot bath</td>
</tr>
<tr>
<td>➤ Obtainable hardness: 54 HRC</td>
</tr>
<tr>
<td>➤ Tempering: slow heating to tempering temperature immediately after hardening; minimum time in furnace: 1 hour per 20 mm part thickness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERING CHART:</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image-url" alt="Tempering Chart" /></td>
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</tbody>
</table>

### MATERIAL NO.: 1.2363

<table>
<thead>
<tr>
<th>DESIGNATION:</th>
<th>DIN: X 100 CrMoV 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AFNOR: Z 100 CDV 5</td>
</tr>
<tr>
<td></td>
<td>UNI: X 100 CrMoV 5-1 KU</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>STRENGTH:</th>
</tr>
</thead>
<tbody>
<tr>
<td>max. 240 HB (≈ max. 820 N/mm²)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THERMAL CONDUCTIVITY AT 100°C:</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 W m⁻¹ K⁻¹</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHARACTER:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Steel for through hardening with good machinability, high wear resistance and low warpage; very good dimensional stability, toughness and through hardenability</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>APPLICATION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Cavity plates and inserts as well as cutting punches, wear plates and cutting dies with high requirements on toughness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TREATMENT BY:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Polishing, etching, nitriding, hard chrome plating: possible</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HEAT TREATMENT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>➤ Soft annealing: 800°C to 840°C for about 4 to 5 hours</td>
</tr>
<tr>
<td>➤ Slow controlled cooling inside the furnace: 10 to 20°C per hour to about 600°C; further cooling in air, max. 240 HB</td>
</tr>
<tr>
<td>➤ Hardening: 950°C to 980°C</td>
</tr>
<tr>
<td>➤ Quenching in oil/air/compressed gas/hot bath</td>
</tr>
<tr>
<td>➤ Obtainable hardness: 62 HRC</td>
</tr>
<tr>
<td>➤ Tempering: slow heating to tempering temperature immediately after hardening; double tempering is recommended</td>
</tr>
<tr>
<td>➤ Rapid cooling following the tempering improves the dimensional stability; maximum hardness achievable aftertempering: 58-60 HRC</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TEMPERING CHART:</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image-url" alt="Tempering Chart" /></td>
</tr>
</tbody>
</table>
**MATERIAL NO.:** 1.2379

**DESIGNATION:**
- X 153 CrMoV 12
- Z 160 CDV 12

**TECHNICAL TIP:**
- Secondary hardening, makes very good base material for nitriding or coating

**INDICATORY ANALYSIS:**
- C: 1.53
- Si: 0.30
- Mn: 0.35
- Cr: 12.00
- Mo: 0.80
- V: 0.80

**STRENGTH:**
- max. 255 HB (≈ max. 860 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
- 21 W/mK

**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 with high requirements for wear resistance

**TREATMENT BY:**
- Polishing: ideal 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 chrome plating: 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 inside the furnace: 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:**
- 55 NiCrMoV 7
- 55 NCDV 7

**INDICATORY ANALYSIS:**
- C: 0.56
- Cr: 1.10
- Mo: 0.50
- Ni: 1.70
- V: 0.10

**STRENGTH:**
- max. 250 HB (≈ max. 850 N/mm²)

**THERMAL CONDUCTIVITY AT 100°C:**
- 36 W/mK

**CHARACTER:**
- Steel for through hardening with 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 chrome plating: 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:
  - 830 to 900°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/water/compressed gas
  - 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.: 1.2714 HH

DESIGNATION: DIN: 55 NiCrMoV 7
AFNOR: 55 NCDV 7
UNI: A15
AISI: L6

INDICATORY ANALYSIS:
- C: 0.56
- Cr: 1.10
- Mo: 0.50
- Ni: 1.70
- V: 0.10

STRENGTH:
- 41 - 45 HRC
- (≈ 1300 - 1450 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:
- 36 W/mK

CHARACTER:
- Steel for through hardening, quenched and tempered, with high temperature resistance, through hardenability and toughness

APPLICATION:
- Mould inserts, cores and slides for die casting (Al, Mg, Zn etc) and plastic injection moulds

TREATMENT BY:
- Polishing: technical polishing possible
- Etching, EDM, nitriding, hard chrome plating: possible

HEAT TREATMENT:
- Already pre-toughened; usually no heat treatment required
- 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:
  - 830 to 900°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/water/compressed gas
  - 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: DIN: 40 CrMnNiMo 8-6-4
AFNOR: 40 CMNDF 8
UNI: ≈ P20 + Ni
AISI: 

INDICATORY ANALYSIS:
- C: 0.40
- Mn: 1.50
- Cr: 1.90
- Mo: 0.20
- Ni: 1.10
- Si: 0.30

STRENGTH:
- 280 - 325 HB
- (≈ 950 - 1100 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:
- 33.5 W/mK

CHARACTER:
- Low-sulphur tool steel, supplied in pre-toughened condition; due to its nickel content, it features uniform strength even with maximum plate dimensions

APPLICATION:
- Large cavity plates with deep cavities for items such as bumpers or dashboards, moulding frames

TREATMENT BY:
- Polishing, etching, EDM, nitriding: highly suitable
- Hard chrome plating: suitable

HEAT TREATMENT:
- Already pre-toughened; usually no heat treatment required
- 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 600°C; further cooling in air; max. 235 HB
- Hardening:
  - 840 to 870°C
  - keep curing temperature for 15 to 30 minutes
  - quenching in oil/hot bath (180 to 220°C)/air
  - obtainable hardness: 53 HRC
- Tempering:
  - slow heating to tempering temperature immediately after hardening;
  - minimum time in furnace: 1 hour per 20 mm part thickness;
  - double tempering is recommended

TEMPERING CHART:
MATERIAL NO.: 1.2738 TSHH

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

TECHNICAL TIP:
- Uniform hardness over the entire cross section
- Improved weldability
- Higher toughness than 1.2738

INDICATORY ANALYSIS:
- C: 0.26
- Mn: 1.45
- Cr: 1.25
- Mo: 0.50
- Ni: 1.05
- V: 0.12

STRENGTH:
- 33 - 38 HRC
- (≈ 1050 - 1200 N/mm²)

THERMAL CONDUCTIVITY AT 250°C:
- 41.3 W/m K

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

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

TREATMENT BY:
- Polishing, etching, EDM, nitriding: highly suitable
- Hard chrome plating: is possible

HEAT TREATMENT:
- Already pre-toughened; usually no heat treatment required
- Soft annealing: 720°C 1 hour per 25 mm part thickness
- slow controlled cooling inside the furnace
- max. 245 HB
- Hardening:
- 880 °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

TEMPERING CHART:

---

MATERIAL NO.: 1.2767

DESIGNATION:
- DIN: 45 Ni/Cr/Mo 16
- AFNOR: 45 NCD 16
- UNI: 40 Ni/Cr/Mo/V 16 KU
- AISI: ≈ 467

TECHNICAL TIP:
- To avoid unwanted warping during plastic injection, the tempering temperature after hardening must exceed the operating temperature by 50°C.
- Example: Operation at 200°C
  Tempering at 250°C = 52 HRC

INDICATORY ANALYSIS:
- C: 0.45
- Si: 0.25
- Mn: 0.40
- Cr: 1.35
- Mo: 0.25
- Ni: 4.00

STRENGTH:
- max. 280 HB
- (≈ max. 950 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:
- 30 W/m K

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

APPLICATION:
- High-performance cavity plates and inserts for the processing of plastics with high surface requirements (mirror finish);
- stamping, forming, bending inserts for particularly high pressure and bending stresses

TREATMENT BY:
- Polishing:
  - best metallurgical properties for mirror polishing
- Etching:
  - is possible
- EDM:
  - highly suitable
- Nitriding:
  - not usual
- Hard chrome plating:
  - particularly increases the steel’s wear resistance and corrosion resistance

HEAT TREATMENT:
- Soft annealing:
  - 610 to 650°C for about 2 to 5 hours
  - slow controlled cooling inside the furnace: 10 to 20°C per hour to 600°C; further cooling in air, max. 260 HB
- Hardening:
  - 840 to 870°C
  - quenching in oil/hot 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;
  - double tempering is recommended

TEMPERING CHART:
MATERIAL NO.: 1.2842

DESIGNATION:
- DIN: 90 MnCrV 8
- AFNOR: 90 M5V 8
- UNI: 90 MnVCr 8 KU
- AISI: ≈ O2

TECHNICAL TIP:
- Steel grade 1.2510 is an adequate alternative with regards to its properties, machinability and dimensional stability after heat treatment.

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

STRENGTH:
- max. 230 HB
  (= max. 780 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, etching, nitriding: not usual - use 1.2379 instead
- EDM, hard chrome plating: is possible

HEAT TREATMENT:
- Soft annealing: 680 to 720°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:
  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; double tempering with intermediate cooling down to 20°C increases the steel's toughness max. obtainable hardness after tempering: 58-60 HRC

TEMPERING CHART:

MATERIAL NO.: 1.3343 (HSS)

DESIGNATION:
- DIN: HS 6-5-2 C
- AFNOR: 2.85 WDCV 6
- UNI: X 82 WMoV 6 5
- AISI: M 2 reg. C

TECHNICAL TIP:
- Excellent for PVD and CVD coating; highest dimensional stability because the steel was tempered at more than 520°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:
- max. 269 HB
  (= max. 915 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:
- 27.4 W/mK

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
- Coating: highly suitable

HEAT TREATMENT:
- Soft annealing: 820 to 850°C, about 2 to 5 hours
  slow controlled cooling inside the furnace of 10 to 20°C per hour to about 550°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:
MATERIAL NO.: 1.3344 PM (PM23)

TECHNICAL TIP:
- Excellent for PVD and CVD coating; highest dimensional stability because the steel was tempered at more than 520 °C.

INDICATORY ANALYSIS:

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Mo</th>
<th>V</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>1.25</td>
<td>0.30</td>
<td>0.30</td>
<td>4.0</td>
<td>5.0</td>
<td>3.0</td>
<td>6.2</td>
</tr>
</tbody>
</table>

STRENGTH:
- max. 265 HB
- (= max. 905 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:
- 24 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, Etching, EDM: possible
- Nitriding: highly suited for nitriding
- Hard chroming: recommended, increases wear and corrosion resistance

HEAT TREATMENT:
- Soft annealing: 650 to 700°C for about 2 to 5 hours
- Carburising: 880 to 980°C. The choice of carburising means and carburising temperature depends on the desired surface carbon content, the carburising graph and the required case depth.
- Intermediate heat treatment: 650 to 700°C, about 2 to 4 hours with slow cooling in the furnace
- Hardening: 1 hour per 20 mm part thickness, min. 2 hours

TEMPERING CHART:
**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:**
- TENSILE STRENGTH: max. 217 HB (≈ max. 740 N/mm²)
- THERMAL CONDUCTIVITY AT 20°C: 42.6 W m⁻¹ K⁻¹

**CHARACTER:**
- Alloyed steel, suitable for quenching and tempering, with high resistance and high toughness; universally usable 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
- Coating: suitable

**HEAT TREATMENT:**
- Normalising: 840 to 880°C afterwards cooling in air; some components need tempering afterwards
- Soft annealing: 680 to 720°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. 217 HB
- Toughening: max. 1.600 N/mm²
- Hardening: 820 - 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 tempering temperature (to avoid forming of cracks) immediately after hardening; at least 60 minutes cooling in air

**TEMPERING CHART:**

---

**MATERIAL NO.:** 3.3547

**DESIGNATION:**
- DIN: AlMg4.5Mn
- EN: AW-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:**
- THERMAL CONDUCTIVITY AT 20°C: 110-140 W m⁻¹ K⁻¹

**CHARACTER:**
- Not hardenable, homogenised, annealed aluminium alloy with particularly good machining and welding properties; excellent dimensional stability, ideally suited for anodising, hard chrome plating and chemical nickel plating; very high resistance to corrosion density: 2.66 kg/dm³
coefficient of thermal expansion: 24.2 10⁻⁶m/mK
max. temperature permanent/short term: 90/110°C

**APPLICATION:**
- Plates for mould bases, rotary tables, machined components for machine and jig construction, moulds for prototypes and foamed parts

**TREATMENT BY:**
- Polishing, EDM, etching: suitable
- Milling, welding: ideally suited

**HEAT TREATMENT:**
- Note: Subsequent heat treatment may lead to a deterioration of the mechanical properties!
MATERIAL NO.: 3.4365

DESIGNATION: DIN: AW-7075
EN: A - Z5GU
AFNOR: UNI: 9007 / 2

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

DELIVERY CONDITION: T651 - Solution annealed, stress relieved by controlled stretching and artificially aged.

STRENGTH:

<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>
</tr>
</thead>
<tbody>
<tr>
<td>tensile strength Rm [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 Rp 0,2 [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 W/mK

CHARACTER:
Hardened, high-strength aluminium zinc alloy with good properties for grain etching, as well as good machinability, EDM and polishing properties
Density: 2.8 kg/dm³
Coefficient of thermal expansion: 23.4 10^-6m/mK
max. temperature permanent/short term: 90/120°C

APPLICATION:
Plates for mould bases and dies sets with increased requirements for strength; components for machine and jig construction

TREATMENT BY:
Polishing, machining, EDM: possible
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:
C 2.45
Si 0.90
Mn 0.50
Cr 5.20
Mo 1.30
V 9.75

STRENGTH:
max. 280 HB

THERMAL CONDUCTIVITY AT 100°C: 20 W/mK

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, fineblanking punches, pressing punches for sinter press tools.

TREATMENT BY:
Polishing: best metallurgical properties for mirror polishing
Nitriding: highly suitable
EDM: highly suitable
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:
MATERIAL NO.: CF-H40S+

DESIGNATION: ISO:
US Industry: K40/C11/C12

CHEMICAL COMPOSITION (%):

<table>
<thead>
<tr>
<th></th>
<th>WC</th>
<th>Co (Binder)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>86.6</td>
<td>11.8</td>
</tr>
</tbody>
</table>

TECHNICAL TIP:

- Excellent corrosion resistance in connection with the mechanical and physical characteristics required in die making.

PHYSICAL AND MECHANICAL CHARACTERISTICS:

- Average WV grit size: fine
- Density (ISO 3369): 14.15 g/cm³
- Hardness (ISO 3878): 1400 HV10
- Flexural strength (ISO 3327): 3200 MPa
- Compressive strength: 4900 MPa
- Elastic modulus: 551 GPa
- Fracture toughness: 12.5 MPa m½
- Thermal conductivity at 100°C: 90 W/mK
- Coefficient of thermal expansion (20-400°C): 5.4 10⁻⁶ m/mK
- Corrosion resistance: Yes

CHARACTER:

- The universal carbide grade - the ideal compromise between hardness and fracture toughness with high edge stability.

APPLICATION:

- Blocks for eroding, cutting punches, and dies with maximum wear resistance; active parts for stamping, embossing, bending, and forming

TREATMENT BY:

- Polishing: well-suitable
- EDM: suitable
- Coating: suitable
- Laser cutting: suitable

TYPICAL MICROSTRUCTURE VIEW:

![Typical Microstructure View](image-url)
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