meusburger

Standards for your success.

MATERIAL GRADES

RAW MATERIALS

HIGH-QUALITY RAW MATERIAL

Not all steel is the same.
This is why we select the best-known steel-works 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

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

STRESS-RELIEVING HEAT TREATMENT

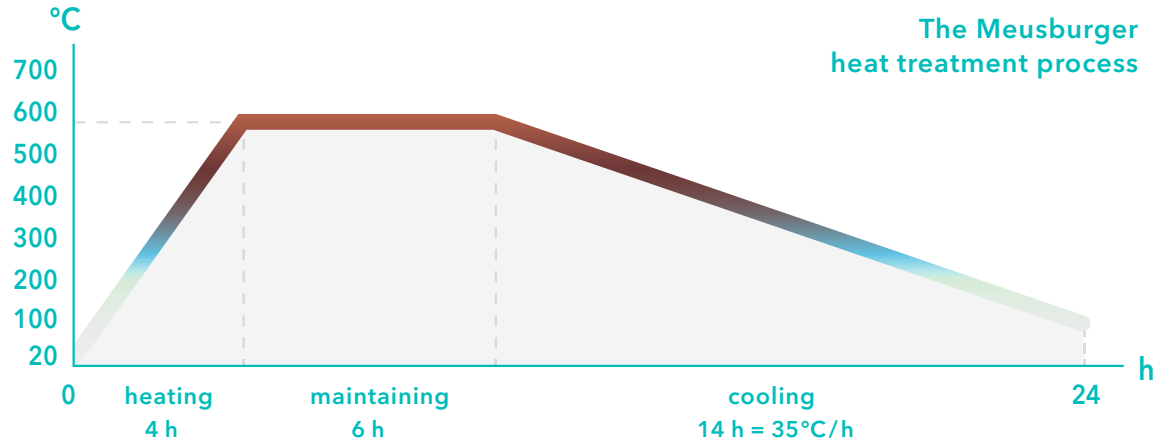
THREE FURNACES FOR 240 TONNES OF STEEL

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.

REDUCING TENSION

Through the stress-relieving heat treatment, the tension that exists in the material is reduced to a minimum, without changing the microstructure or the 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. There are no hard spots in the microstructure so sudden tool breakage is avoided. During the stress-relieving heat treatment, 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

Unalloyed steel
1.0577 1.1730

Steel for case-hardening
1.2162 1.7131

Pre-toughened steel
1.2311 1.2312 1.2714HH 1.2738 1.2085 1.2316 1.2738TSHH

Corrosion resistant steel
1.2083 1.2083ESU 1.2085 1.2316

Steel for through hardening Cold-work steel
1.2083 1.2083 ESU 1.2210 1.2363 1.2379 1.2767 1.2842

Steel for through hardening Hot-work steel
1.2343 1.2343 ESU 1.2344 1.2344 ESU 1.2714

HSS High-speed steel
1.3343

HSS high speed / powder steel
1.3344PM MV10PM MW10PM

Quenched and tempered alloy steel
1.7225

Carbides
CF-H25S+ CF-H40S+

Non-ferrous metals
3.3547 3.4365

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.


0.5t

Alloying elements

Element	Melting point	Importance
ALUMINIUM (AL)	658 °C	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.
CARBON (C)	3450 °C	Carbon is the most important and indispensable alloying element in steel.
COBALT (CO)	1492 °C	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.
CHROMIUM (CR)	1920 °C	Chromium forms hard carbides, which increases the wear resistance and the durability of cutting edges. At the same time it facilitates through hardening.
COPPER (CU)	1084 °C	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.
MANGANESE (MN)	1221 °C	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%.
MOLYBDENUM (MO)	2623 °C	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.
NICKEL (NI)	1453 °C	Nickel gives cold work steels a higher toughness. Engineering steels contain nickel in combination with chromium and molybdenum in order to improve their strength.
PHOSPHOR (P)	44 °C	This strong alloying element usually has a damaging effect on steel.
SULPHUR (S)	118 °C	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.
SILICON (SI)	1414 °C	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%.
VANADIUM (V)	1726 °C	Vanadium is a good carbide former. It binds nitrogen and has a refining eff ect on the crystals. The result is a finer structure. The hard carbides increase the heat resistance, wear resistance and resistance to tempering.
TUNGSTEN (W)	3380 °C	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.

Overview of material grades

Material no.	Designation		Indicatory analysis		Strength	Character	Application
1.0577	**DIN:** **AFNOR:** **AISI:**	S 355 J2 (St 52-3) A 52 FP A738	C Si Mn	≤ 0.22 ≤ 0.55 ≤ 1.60	132 - 185 HB (≈ 450 - 630 N/mm²)	***Structural steel*** *unalloyed, with good weldability*	*For common applications in mould and die making and machine and jig construction*
1.1730	**DIN:** **AFNOR:** **AISI:**	C 45 U XC 48 1045	C Si Mn	0.45 0.30 0.70	max 215 HB (≈ max. 710 N/mm²)	***Tool steel*** *unalloyed, suitable for flame hardening*	*Unhardened parts for mould, die and jig construction or plates and frames for mould bases and die sets*
1.2083	**DIN:** **AFNOR:** **AISI:**	X 40 Cr 14 Z 40 C 14 420	C Si Mn Cr	0.40 0.40 0.30 13.00	max. 240 HB (≈ max. 800 N/mm²)	***Steel for through hardening*** *low corrosion, high-alloy*	*Cavity plates and inserts for the processing of plastics, mainly for the processing of corrosive plastics*
1.2083 ESU (ESR)	**DIN:** **AFNOR:** **AISI:**	X 40 Cr 14 Z 40 C 14 420 ESR	C Si Mn Cr	0.40 0.40 0.30 13.00	max. 240 HB (≈ max. 800 N/mm²)	***Steel for through hardening*** *low corrosion, suitable for mirror polishing, electro-slag remelted, high-alloy*	*Cavity plates and inserts for the processing of plastics, mainly for the processing of corrosive plastics*
1.2085	**DIN:** **AFNOR:** **AISI:**	X 33 CrS 16 Z 35 CD 17.S ≈ 422+S	C Si Mn Cr S Ni	0.33 0.30 0.80 16.00 0.06 0.30	280 - 325 HB (≈ 950 - 1100 N/mm²)	***Tool steel*** *pre-toughened, corrosion resistant, with good machinability, high-alloyed*	*Plates for corrosion resistant mould bases and die sets; moulds for corrosive plastics*
1.2162	**DIN:** **AFNOR:** **AISI:**	21 MnCr 5 20 MC 5 5120	C Si Mn Cr	0.21 0.25 1.25 1.20	max. 210 HB (≈ max. 710 N/mm²)	***Steel for case-hardening*** *alloyed*	*Cavity plates and machine parts*
1.2210	**DIN:** **AFNOR:** **UNI:** **AISI:**	115 CrV 3 100 C3 107 CrV 3 KU L2	C Si Mn Cr V	1.18 0.25 0.30 0.70 0.10	max. 220 HB (≈ max. 750 N/mm²)	***Cold-work steel*** *alloyed, wear-resistant*	*Core pins, punches, small turned parts*
1.2311	**DIN:** **AFNOR:** **UNI:** **AISI:**	40 CrMnMo 7 40 CMD 8 35 CrMo 8 KU P20	C Si Mn Cr Mo	0.40 0.40 1.50 1.90 0.20	280 - 325 HB (≈ 950 - 1100 N/mm²)	***Tool steel*** *alloyed and pre-toughened, ideal for nitriding and polishing*	*Cavity plates, inserts and high-strength machine parts*
1.2312	**DIN:** **AFNOR:** **AISI:**	40 CrMnMoS 8-6 40 CMD 8.S P20+S	C Si Mn Cr Mo S	0.40 0.40 1.50 1.90 0.20 0.06	280 - 325 HB (≈ 950 - 1100 N/mm²)	***Tool steel*** *alloyed and pre-toughened, ideal for nitriding and good machinability*	*Cavity plates for mould bases and die sets with increased requirements on strength*
1.2316	**DIN:** **AFNOR:** **UNI:** **AISI:**	X 38 CrMo 16 Z 35 CD 17 X 38 CrMo 16 KU ≈ 422	C Cr Mo	0.36 16.00 1.20	280 - 325 HB (≈ 950 - 1100 N/mm²)	***Tool steel*** *pre-toughened, corrosion-resistant, polishable, high-alloyed*	*Moulds for processing corrosive plastics*
1.2343	**DIN:** **AFNOR:** **UNI:** **AISI:**	X 37 CrMoV 5-1 Z 38 CDV 5 X 37 CrMoV 5-1 KU H11	C Si Mn Cr Mo V	0.38 1.00 0.40 5.30 1.20 0.40	max. 230 HB (≈ max. 780 N/mm²)	***Hot-work steel*** *high-alloyed*	*Cavity plates and inserts for plastic injection moulds*
1.2343 ESU (ESR)	**DIN:** **AFNOR:** **UNI:** **AISI:**	X 37 CrMoV 5-1 Z 38 CDV 5 X 37 CrMoV 5-1 KU H11 ESR	C Si Mn Cr Mo V	0.38 1.00 0.40 5.30 1.20 0.40	max. 230 HB (≈ max. 780 N/mm²)	***Hot-work steel*** *suitable for mirror polishing, electro-slag remelted, high-alloy*	*Cavity plates and inserts for die casting (Al, Mg, Zn etc.) and injection moulds*
1.2344	**DIN:** **AFNOR:** **UNI:** **AISI:**	X 40 CrMoV 5-1 Z 40 CDV 5 X 40 CrMoV 5-1 KU H13	C Si Cr Mo V	0.40 1.00 5.30 1.40 1.00	max. 230 HB (≈ max. 780 N/mm²)	***Hot-work steel*** *high-temperature resistant, high temperature wear resistant, excellent thermal conductivity, high-alloy*	*Standard material for hot-work tools, extrusion moulds, dies, tools for plastics processing*
1.2344 ESU (ESR)	**DIN:** **AFNOR:** **UNI:** **AISI:**	X 40 CrMoV 5-1 Z 40 CDV 5 X 40 CrMoV 5-1 KU H13 ESR	C Si Cr Mo V	0.40 1.00 5.30 1.40 1.00	max. 230 HB (≈ max. 780 N/mm²)	***Hot-work steel*** *suitable for mirror polishing, electro-slag remelted, high-alloy*	*Standard material for hot-work tools, extrusion moulds, dies, tools for plastics processing*
1.2363	**DIN:** **AFNOR:** **UNI:** **AISI:**	X 100 CrMoV 5 Z 100 CDV 5 X 100 CrMoV 5-1 KU A2	C Si Mn Cr Mo V	1.00 0.30 0.50 5.20 1.10 0.20	max. 240 HB (≈ max. 820 N/mm²)	***Steel for through hardening*** *dimensional stability and high hardenability; wear-resistant, cold-work steel with good machinability*	*Cavity plates and inserts as well as cutting punches, wear plates and cutting dies with high requirements on toughness*
1.2379	**DIN:** **AFNOR:** **AISI:**	X 153 CrMoV 12 Z 160 CDV 12 ≈ D2	C Si Mn Cr Mo V	1.53 0.30 0.35 12.00 0.80 0.80	max. 255 HB (≈ max. 860 N/mm²)	***Steel for through hardening*** *wear-resistant cold-work steel, high-alloyed*	*Cavity plates and inserts as well as wear plates and cutting dies with increased wear resistance*

Material no.	Designation		Indicatory analysis		Strength	Character	Application
1.2714	**DIN:** **AFNOR:** **AISI:**	55 NiCrMoV 7 55 NCDV 7 L6	C Cr Mo Ni V	0.56 1.10 0.50 1.70 0.10	max. 250 HB (≈ max. 850 N/mm²)	***Steel for through hardening*** *good high-temperature resistance and toughness*	*Extrusion dies, hot-forging tools, dies for processing tin, lead and zinc alloys*
1.2714 HH	**DIN:** **AFNOR:** **AISI:**	55 NiCrMoV 7 55 NCDV 7 L6	C Cr Mo Ni V	0.56 1.10 0.50 1.70 0.10	40 - 43 HRC (≈ 1250 - 1400 N/mm²)	***Steel for through hardening*** *hardened and tempered; good high-temperature resistance and toughness*	*Inserts, cores and slides for injection moulds*
1.2738	**DIN:** **AFNOR:** **AISI:**	40 CrMnNiMo 8-6-4 40 CMND 8 ≈ P20 + Ni	C Mn Cr Mo Ni Si	0.40 1.50 1.90 0.20 1.10 0.30	280 - 325 HB (≈ 950 - 1100 N/mm²)	***Tool steel*** *quenched and tempered steel, with uniform strength for larger dimensions; suitable for polishing and nitriding*	*Large moulds with deep cavities for items such as bumpers or dashboards*
1.2738 TSHH	**DIN:** **AFNOR:** **UNI:** **AISI:**	Sonderlegierung - - -	C Mn Cr Mo Ni V	0.26 1.45 1.25 0.50 1.05 0.12	33 - 38 HRC (≈ 1050 - 120 N/mm²)	***Steel for plastic injection moulds*** *modified, hardened and tempered; good polishability and excellent grainability; high thermal conductivity and wear resistance*	*Cavity plates without dimension restrictions, with deep cavities and high core loads*
1.2767	**DIN:** **AFNOR:** **UNI:** **AISI:**	45 NiCrMo 16 45 NCD 16 40 NiCrMoV 16 KU ≈ 6F7	C Si Mn Cr Mo Ni	0.45 0.25 0.40 1.35 0.25 4.00	max. 280 HB (≈ max. 950 N/mm²)	***Steel for through hardening*** *alloy suitable for polishing, with high resistance to pressure and good flexural strength*	*High-performance cavity plates and inserts; cutting and bending inserts for high compressive loads*
1.2842	**DIN:** **AFNOR:** **UNI:** **AISI:**	90 MnCrV 8 90 MV 8 90 MnVCr 8 KU ≈ O2	C Si Mn Cr V	0.90 0.20 2.00 0.40 0.10	max. 230 HB (≈ max. 780 N/mm²)	***Steel for through hardening*** *dimensional stability and high hardenability; wear-resistant, cold-work steel with very good machinability*	*Cavity plates, inserts exposed to abrasive stress cutting punches, wear plates, cutting dies and guiding plates; guiding rails*
1.3343 (HSS)	**DIN:** **AFNOR:** **UNI:** **AISI:**	HS 6-5-2 C Z 85 WDCV 6 X 82 WMoV 6 5 M 2 reg. C	C Si Mn Cr Mo V W	0.90 0.30 0.30 4.00 5.00 1.90 6.20	max. 269 HB (≈ max. 915 N/mm²)	***HSS - High speed steel*** *very high adhesive and abrasive wear resistance in combination with high toughness and compressive strength*	*Blocks for eroding, cutting punches and fine blanking punches; impact extrusion punches and dies; inserts with a very high wear resistance*
1.3344 PM	**DIN:** **AFNOR:** **UNI:** **AISI:**	PM 6-5-3 X 130 WMoCrV 6-5-4-3 W 6 Mo 5 Cr 4 V 3 M 3-2 (PM)	C Si Mn Cr Mo V W	1.25 0.30 0.30 4.0 5.0 3.0 6.2	max. 265 HB (≈ max. 905 N/mm²)	***Powder metallurgy steel*** *maximum adhesive and abrasive wear resistance with optimal toughness and good through hardenability*	*Blocks for eroding, cutting punches and dies with maximum edge stability, inserts with excellent wear resistance*
1.7131	**DIN:** **AFNOR:** **AISI:**	16 MnCr 5 16 MC 5 5115	C Si Mn Cr	0.16 0.25 1.15 0.95	max. 186 HB (≈ max. 635 N/mm²)	***Steel for case-hardening*** *alloyed*	*Guiding elements, cores and machine parts*
1.7225	**DIN:** **AFNOR:** **UNI:** **AISI:**	42 CrMo 4 42 CD 4 42 CrMo 4 4140	C Si Mn S Cr Mo	0.42 0.25 0.75 < 0.035 1.10 0.22	max. 217 HB (≈ max. 740 N/mm²)	***Steel for quenching and tempering*** *high resistance, high toughness, universally useable in engineering*	*Cavity plates, inserts exposed to abrasive stress cutting punches, wear plates, cutting dies and guiding plates; guiding rails*
3.3547 (AW-5083)	**DIN:** **EN:** **AFNOR:** **UNI:**	AlMg 4.5 Mn AW-5083 A-G4.5MC 7790	Si Fe Cu Mn Mg Cr Zn Ti	0.40 0.40 0.10 0.70 4.40 0.15 0.25 0.15	▬ 68 - 75 HB (cast hardened) (≈ 230 - 260 N/mm²) ● min. 78 HB (≈ min. 270 N/mm²)	***Aluminium alloy***	*Plates for mould bases and jigs and fixtures*
3.4365 (AW-7075)	**DIN:** **EN:** **AFNOR:** **UNI:**	AlZnMgCu 1.5 AW-7075 A-Z5GU 9007/2	Si Fe Cu Mn Mg Cr Zn Ti	0.40 0.50 1.60 0.30 2.40 0.23 5.60 0.20	≤ 540 N/mm² (depending on thickness)	***Aluminium zinc alloy*** *high-strength, hardened*	*Plates for mould bases and die sets with increased requirements on strength*
CF-H25S+	**ISO:** **US Industry**	K20/K30 C10/C13	WC Co Rest	90.3 8.5 1.2		***Carbide*** *The universal carbide grade - the ideal compromise between hardness and fracture toughness with high edge stability.*	*Blocks for eroding, cutting punches, and dies with maximum wear resistance; active parts for stamping, embossing, bending, and forming*
CF-H40S+	**ISO:** **US Industry:**	K40 C11/C12	WC Co	86.6 11.8		***Carbide*** *The universal carbide grade - the ideal compromise between hardness and fracture toughness with high edge stability.*	*Blocks for eroding, cutting punches, and dies with maximum wear resistance; active parts for stamping, embossing, bending, and forming*
M V10 PM	**AISI:**	A11 (PM)	C Si Mn Cr Mo V	2.45 0.90 0.50 5.20 1.30 9.75	max. 280 HB (≈ max. 960 N/mm²)	***Powder metallurgy steel*** *Highest abrasive wear resistance and excellent toughness. Good machinability through a homogeneous microstructure.*	*Blocks for eroding, dies and cutting punches with extreme requirements, fine blanking punches, pressing punches for sinter presses*
M W10 PM	**EN:**	HS 10-2-5-8	C Cr Mo V W Co	1.6 4.8 2.0 5.0 10.5 8.0	max. 285 HB (≈ max. 970 N/mm²)	***Powder metallurgical steel*** *High adhesive wear resistance and excellent toughness.* *Very high working hardness and therefore highest compressive strength*	*Blocks for eroding, dies, cutting punches and cutting tools for extremely high requirements, fine blanking punches, embossing tools, cold solid forming*

MATERIAL NO.: 1.0577

DESIGNATION:

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

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 $\frac{W}{m\,K}$

TECHNICAL TIP:

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

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.1	12.1	12.9	13.5	13.9		

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:	XC 48
UNI:	-
AISI:	1045

INDICATORY ANALYSIS:

C	0.45
Si	0.30
Mn	0.70

STRENGTH:

max. 215 HB
(≈ max. 710 N/mm²)

THERMAL CONDUCTIVITY AT 20°C:

50 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.0	11.8	12.8	13.6	13.8		

CHARACTER:

» Unalloyed ***tool steel*** with excellent machinability; chilled cast steel, suitable for flame and inductive hardening

APPLICATION:

» Unhardenend parts for mould, die and jig construction or plates and frames for mould bases and die sets

TREATMENT BY:

» Polishing, etching, EDM, nitriding, hard chrome plating: not usual

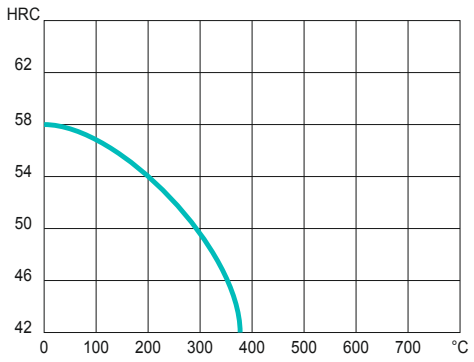
HEAT TREATMENT:

» 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:



Overview

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:

max. 240 HB
(≈ max. 800 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

23.5 $\frac{W}{m\,K}$

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.

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.5	11.0	11.5	11.8			

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

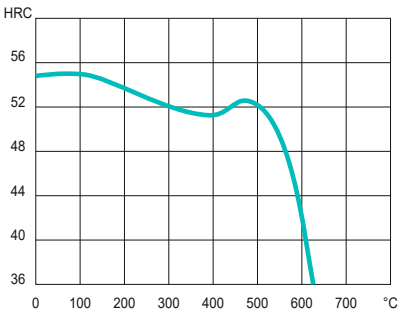
TREATMENT BY:

- 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)
- EDM:
  in the hardened and tempered condition, treat again for stress relief about 20°C below the last temperature
- Nitriding, hard chrome plating:
  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:



ESR)* Electro-Slag Remelted

Overview

MATERIAL NO.: 1.2085

DESIGNATION:

DIN:	X 33 CrS 16
AFNOR:	Z35 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: 280 - 325 HB
(≈ 950 - 1100 N/mm²)

THERMAL CONDUCTIVITY AT 100°C: 18 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.5	11.0	11.1	11.8			

CHARACTER:

» 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:

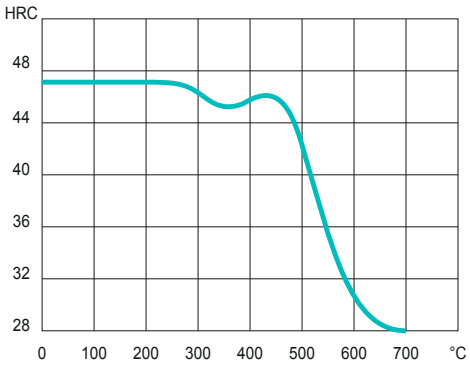
Usually no heat treatment is required.

» 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:



Overview

MATERIAL NO.: 1.2162

DESIGNATION:

DIN:	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 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
12.2	12.8	13.5	13.8	14.1	14.4	14.7

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 thermosets

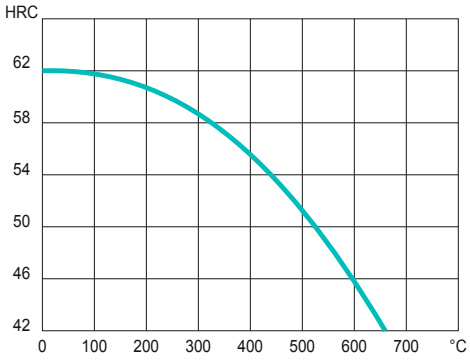
TREATMENT BY:

» 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:



Overview

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:

max. 220 HB
(≈ max. 750 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

33 $\frac{W}{m\,K}$

TECHNICAL TIP:

» Silver steel 1.2210 is dispatched finish-ground to h9 tolerance.

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.8	12.5	12.9	13.5			

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

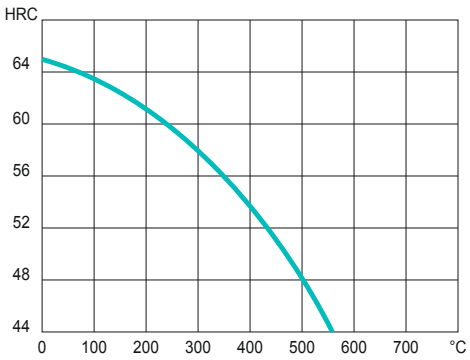
HEAT TREATMENT:

» 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:



Overview

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:

280 - 325 HB
(≈ 950 - 1100 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

35 $\frac{W}{m\,K}$

TECHNICAL TIP:

» The core strength decreases with increasing plate thickness:
for thickness >300 we recommend 1.2738.

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
12.0	12.8	13.3	13.5			

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:

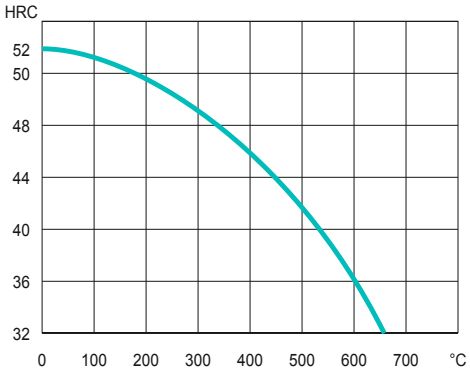
» Polishing:
good suitability for polishing; for higher surface requirements we recommend steel for through hardening
» Etching, EDM:
possible
» Nitriding:
increases the steel's wear resistance
» Hard chrome plating:
particularly increases the steel´s wear resistance and corrosion resistance

HEAT TREATMENT:

*A*lready 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/hot 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:



Overview

MATERIAL NO.: 1.2312

DESIGNATION:

DIN:	40 CrMnMoS 86
AFNOR:	40 CMD 8.S
UNI:	-
AISI:	P20 + S

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 $\frac{W}{m\,K}$

TECHNICAL TIP:

» For increased surface quality requirements use material grade 1.2311.

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
12.1	12.8	13.3	13.6			

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

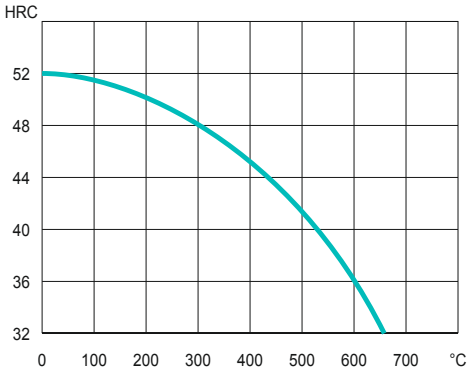
TREATMENT BY:

» Polishing:
technical polishing possible; for higher surface requirements we recommend 1.2311 or 1.2738
» Etching, EDM:
not 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/hot 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:



Overview

MATERIAL NO.: 1.2316

DESIGNATION:

DIN:	X 38 CrMo 16
AFNOR:	Z 35 CD 17
UNI:	X 38 CrMo 16 KU
AISI:	≈ 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 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.5	10.8	11.1	11.6			

CHARACTER:

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

APPLICATION:

» Moulds for processing corrosive plastics

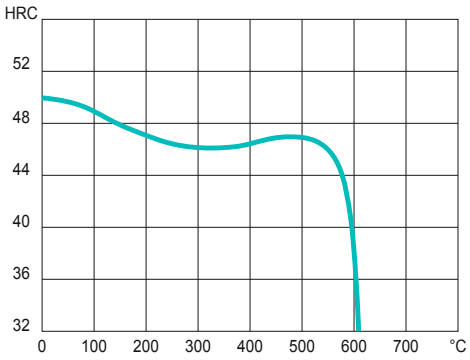
TREATMENT BY:

» 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:



Overview

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
AISI:	H11 / H11 ESR

INDICATORY ANALYSIS:

C	0.38
Si	1.00
Mn	0.40
S	0.03 (ESR 0.002)
Cr	5.30
Mo	1.20
V	0.40

STRENGTH:

max. 230 HB
(≈ max. 780 N/mm²)

THERMAL CONDUCTIVITY AT 200°C:

27 $\frac{W}{m\,K}$

TECHNICAL TIP:

» Susceptible to corrosion:
during maching, continuous corrosion protection has to be ensured (especially during wire EDM)

» ***1.2343 ESR*** is highly suitable for mirror polishing

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.9	11.4	12.0	12.6	12.9	13.1	13.2

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**

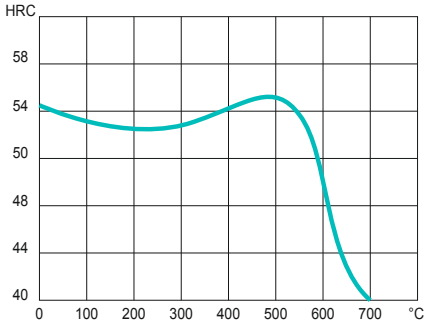
» Nitriding:
before nitriding, stress-relieving heat treatment at 550°C (Meusburger standard) is recommended.

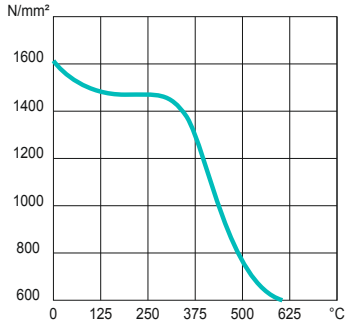
» Hardening:
1000 to 1040°C
15 to 30 minutes keeping curing temperature
cooling in oil/air/compressed gas/hot bath
obtainable hardness: **50-56 HRC**

» 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:





ESR)* Electro-Slag Remelted

Overview

MATERIAL NO.: 1.2344 / 1.2344 ESR*

DESIGNATION:

DIN:	X 40 CrMoV 5-1
AFNOR:	Z 40 CDV 5
UNI:	X 40 CrMoV 5-1 KU
AISI:	H13 / H13 ESR

INDICATORY ANALYSIS:

C	0.38
Si	1.00
Mn	0.40
S	0.03 (ESR 0.002)
Cr	5.30
Mo	1.20
V	0.40

STRENGTH:

max. 230 HB
(≈ max. 780 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

26 $\frac{W}{m\,K}$

TECHNICAL TIP:

» Susceptible to corrosion;
during maching, continuous corrosion protection has to be ensured (especially during wire EDM)
» **1.2344 ESR** is highly suitable for mirror polishing

COEFFICIENT OF THERMAL EXPANSION [10⁻⁶/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.0	11.6	12.2	12.6	13.4	13.6	13.7

CHARACTER:

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

APPLICATION:

» Standard material for hot-work tools, extrusion moulds, dies, tools for plastic processing

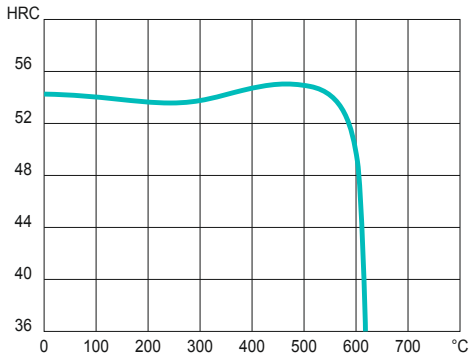
TREATMENT BY:

» Polishing, etching, EDM, nitriding:
possible
» Hard chrome plating:
in special cases

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. 230 HB**
» Hardening:
1020 to 1060°C
keep curing temperature for 15 to 30 minutes
quenching in oil/air/compressed gas/hot bath
obtainable hardness: **54 HRC**
» Tempering:
slow heating to tempering temperature immediately after hardening;
minimum time in furnace: 1 hour per 20 mm part thickness

TEMPERING CHART:



ESR)* Electro-Slag Remelted

Overview

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:

C	1.00
Si	0.30
Mn	0.50
Cr	5.20
Mo	1.10
V	0.20

STRENGTH:

max. 240 HB
(≈ max. 820 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

19 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.5	12.4	12.8	13.4			

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, nitriding, hard chrome plating: possible

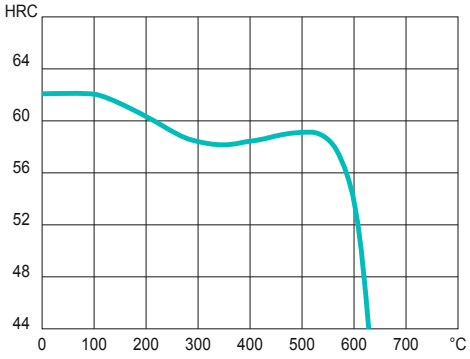
HEAT TREATMENT:

» Soft annealing:
800°C to 840°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. 240 HB**

» Hardening:
950°C to 980°C
quenching in oil/air/compressed gas/hot bath
obtainable hardness: 62 HRC

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

TEMPERING CHART:



Overview

MATERIAL NO.: 1.2379

DESIGNATION:

DIN:	X 153 CrMoV 12
AFNOR:	Z 160 CDV 12
UNI:	-
AISI:	≈ D2

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 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.5	11.3	11.5	12.5			

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

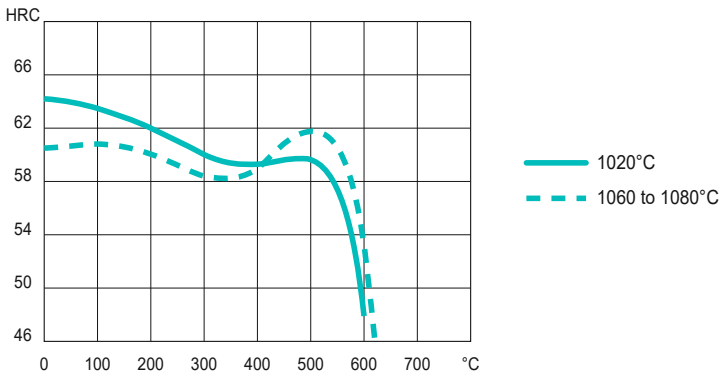
TREATMENT BY:

» 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:



Overview

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:

max. 250 HB
(≈ max. 850 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

36 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
12.2	13.2	13.6	14.0	14.2	14.4	

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

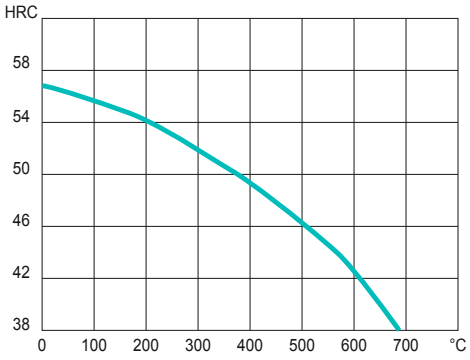
TREATMENT BY:

» 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:



Overview

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:

40 - 43 HRC
(≈ 1250 - 1400 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

36 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
12.2	13.0	13.3	13.7	14.2	14.4	

CHARACTER:

» **Steel for through hardening, quenched and tempered,** with high temperature resistance, through hardenability and toughness

APPLICATION:

» Mould inserts, cores and slides for dplastic injection moulds

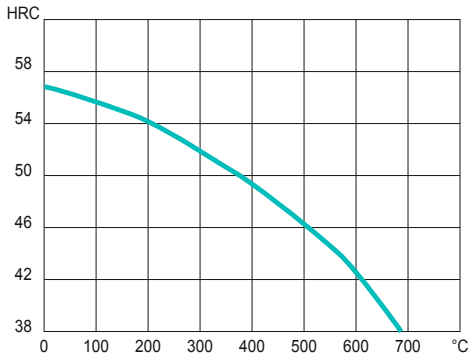
TREATMENT BY:

» 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:



Overview

MATERIAL NO.: 1.2738

DESIGNATION:

DIN:	40 CrMnNiMo 8-6-4
AFNOR:	40 CMND 8
UNI:	-
AISI:	≈ P20 + Ni

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 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.8	12.9	13.4	13.8			

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:

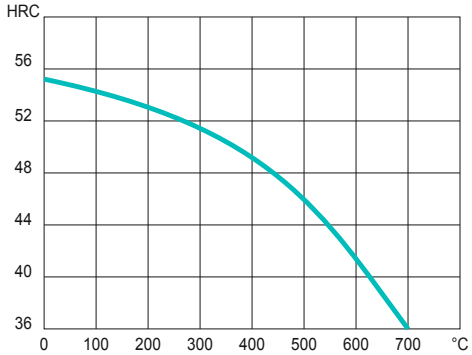
» Polishing, etching, EDM, nitriding:
highly suitable
» Hard chrome plating:
suitable

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:



Overview

MATERIAL NO.: 1.2738 TSHH

DESIGNATION:

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

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 $\frac{W}{m\,K}$

TECHNICAL TIP:

» Uniform hardness over the entire cross section
» Improved weldability
» Higher toughness than 1.2738

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.8	11.5	12.2	13.1			

CHARACTER:

» Modified, pre-toughened steel for plastic 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:

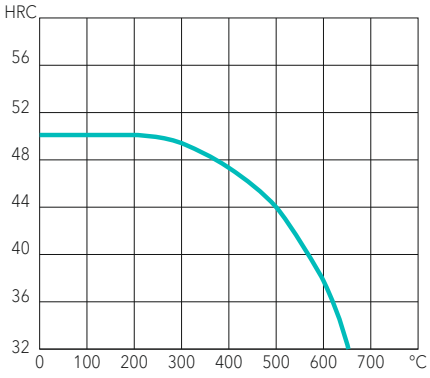
» Polishing, etching, EDM, nitriding:
highly suitable
» Hard chrome plating:
is possible

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:



Overview

MATERIAL NO.: 1.2767

DESIGNATION:

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:
max. 280 HB
(≈ max. 950 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:
30 $\frac{W}{m\,K}$

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

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.6	12.4	12.8	13.1	13.4	13.8	13.6

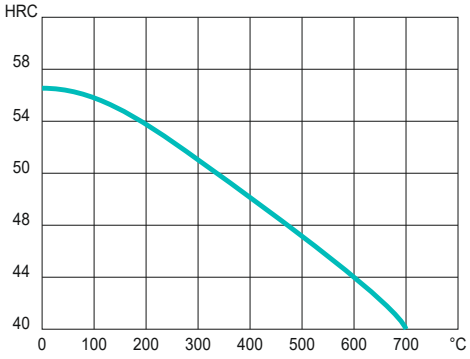
CHARACTER:
» Nickel alloyed **steel for through hardening**, with moderate machinability; very high resistance against bending and high compressive strength; very high toughness and good through hardenability, also for bigger sections.

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:



Overview

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:

max. 230 HB
(≈ max. 780 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

33 $\frac{W}{m\,K}$

TECHNICAL TIP:

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

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
12.2	13.2	13.8	14.3			

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

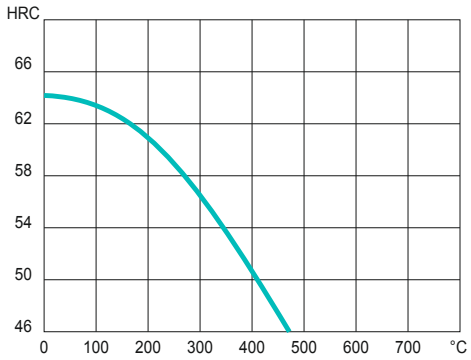
TREATMENT BY:

» 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:	Z 85 WDCV 6
UNI:	X 82 WMoV 6 5
AISI:	M 2 reg. C

TECHNICAL TIP:

» Due to the high tempering resistance, excellent for PVD and PACVD coating.

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:

$27.4 \frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.8	11.8	12.0	12.5			

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

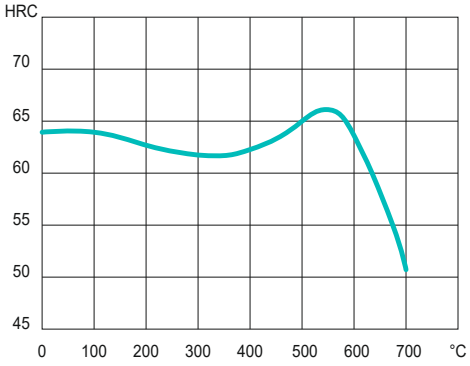
TREATMENT BY:

» 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:



Overview

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:

max. 265 HB
(≈ max. 905 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

24 $\frac{W}{m\,K}$

TECHNICAL TIP:

» Due to the high tempering resistance, excellent for PVD and PACVD coating.

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.4	11.6	11.8	12.1			

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

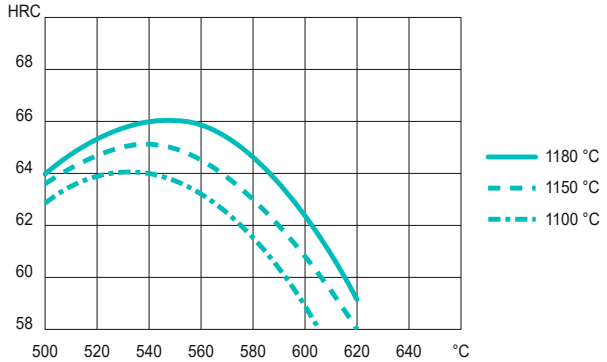
TREATMENT BY:

» Polishing:
best metallurgical properties for mirror polishing
» Nitriding:
highly suited for nitriding
» EDM:
highly suited
» Coating:
highly suited

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;
triple tempering is recommended

TEMPERING CHART:



Overview

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:

max. 186 HB
(≈ max. 635 N/mm²)

THERMAL CONDUCTIVITY AT 20°C:

44 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.5	12.5	13.3	13.9			

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:*
650 to 700°C for about 2 to 5 hours
slow controlled cooling inside the furnace, further cooling in air, ***max. 205 HB***
» *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 inside the furnace
» *Hardening:*
curing temperature 810 to 840°C
quenching in oil/hot bath to 160 - 250°C
» *Tempering:*
1 hour per 20 mm part thickness, min. 2 hours
Tempering: 150°C - 200°C

Overview

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 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
11.6	12.5	13.1	13.5			

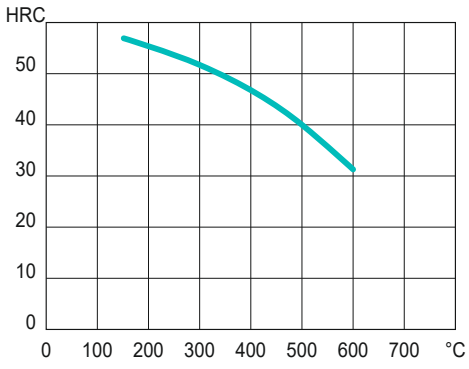
CHARACTER:
» Alloyed steel, suitable for quenching and tempering, with high resistance and high toughness; universally usable in engineering when toughened and pre-hardened

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:



Overview

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:

▬ 68 - 75 HB (cast hardened)
(≈ 230 - 260 N/mm²)
● min. 78 HB
(≈ min. 270 N/mm²)

THERMAL CONDUCTIVITY AT 100°C:

110-140 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
24.2	25.0	26.0				

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^{-6}m/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!

Overview

MATERIAL NO.: 3.4365

DESIGNATION:

DIN:	AlZnMgCu 1.5
EN:	AW-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

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

STRENGTH: depending on the thickness of the plate

plate thickness [mm]	10	20	50	60	80	90	100	120	150	200
tensile strength Rm [N/mm^2]	540	540	530	525	495	490	460	410	360	360
yield point Rp 0,2 [N/mm^2]	470	470	460	440	420	390	360	300	260	240

THERMAL CONDUCTIVITY AT 100°C: 130-160 $\frac{W}{m\,K}$

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
23.4	24.3	25.2				

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/dm^3
Coefficient of thermal expansion: 23.4 10^{-6}m/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.

Overview

MATERIAL NO.: CF-H25S+

DESIGNATION:

ISO:	K40
US Industry:	C11/C12

CHEMICAL COMPOSITION (%):

WC	90.3
Co	8.5
Other	1.2

TECHNICAL TIP:

- Alternative to CF-H40S+ for abrasive wear
- After wire cutting, dry the parts for approx. 2–3 hours in a furnace at max. 100–110 °C to remove the liquid from the binder

PHYSICAL AND MECHANICAL CHARACTERISTICS:

Average WC grit size:	very fine to fine
Density (ISO 3369):	14.55 g / cm^3
Hardness (ISO 3878):	1680 HV10
Flexural strength (ISO 3327):	3600 MPa
Compressive strength:	6500 MPa
Elastic modulus:	592 GPa
Fracture toughness:	10.3 MPa $m^{½}$
Thermal conductivity at 100 °C:	90 W/mK
Coefficient of thermal expansion (20–400 °C):	5.1 10^{-6}/ K
Corrosion resistance:	yes

CHARACTER:

- Very fine/fine grain grade with good edge stability despite high hardness

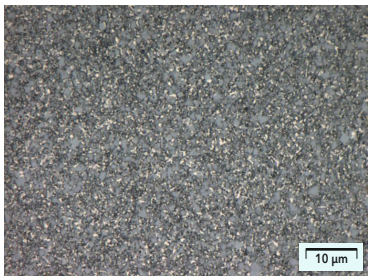
APPLICATION:

- Cutting punches and dies for abrasive materials and materials prone to welding

TREATMENT BY:

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

TYPICAL MICROSTRUCTURE VIEW:



Overview

MATERIAL NO.: CF-H40S+

DESIGNATION:

ISO: K40
US Industry: C11/C12

CHEMICAL COMPOSITION (%):

WC	86.6
Co (Binder)	11.8

TECHNICAL TIP:

» Excellent corrosion resistance in connection with the mechanical and physical characteristics required in die making.
» Place the parts after wirecutting into a furnace with 100-110 °C to dry the binding material

PHYSICAL AND MECHANICAL CHARACTERISTICS:

» Average WV grit size:	fine
» Density (ISO 3369):	14.15 g/cm^3
» Hardness (ISO 3878):	1400 HV10
» Flexural strength (ISO 3327):	3200 MPa
» Compressive strength:	4900 MPa
» Elastic modulus:	551 GPa
» Fracture toughness:	12.5 MPa m^{½}
» 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.

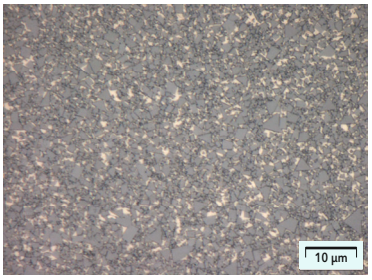
APPLICATION:

» 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:



Overview

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 (≈ max. 960 N/mm²)

THERMAL CONDUCTIVITY AT 100°C: 20 $\frac{W}{m\,K}$

TECHNICAL TIP:

- Due to the high vanadium content the steel is enriched with small, hard carbides. This guarantees optimum edge stability with maximum abrasive wear resistance
- Ideally suitable for highly stressed parts with complicated geometries

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.7	10.9	11.1	11.4			

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.

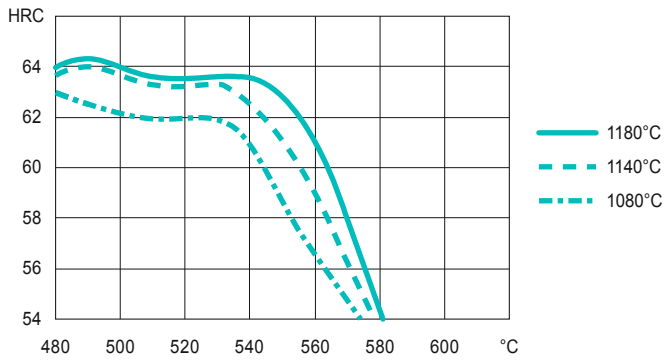
TREATMENT BY:

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



Overview

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

THERMAL CONDUCTIVITY AT 100°C: 26 $\frac{W}{m\,K}$

STRENGTH: max. 285 HB
(≈ max. 970 N/mm²)

TECHNICAL TIP:

- 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

COEFFICIENT OF THERMAL EXPANSION [10^{-6}/K]

100°C	200°C	300°C	400°C	500°C	600°C	700°C
10.0	10.5	10.8	11.2			

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

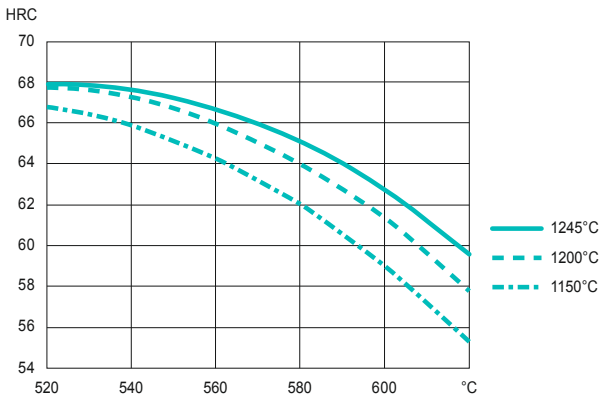
TREATMENT BY:

- 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:



Overview