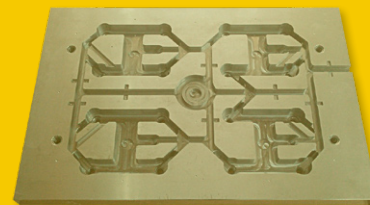


VR TOOL **STEELS**



PLASTIC MOLDS

1.1730



1 Main characteristics and applications

Surface hardenable tool steel with hard surface and tough core, after hardening.

Used for cold heading dies, mould base plates for plastic mould and die casting tools, hand tools, tongs, agricultural tools, blanking tools, leather knives.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
C45U	1.1730	C45U	XC48	~1045	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	P	S
0.45	0.7	0.30	0.025	0.003

4 Critical points

Ac1	730 °C
Ac3	795 °C
Ms	340 °C

5 Production technology

EAF – LF – VD - Forging – Heat treatment +A /+NSR

6 US specification

In according to standard EN10160 Class S3E3 and standard SEP 1921 Class C/c

7 Delivery condition

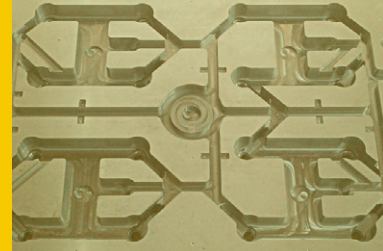
W1.1730 is delivered annealed condition (+A), with hardness max 207 HB or in normalized and stress relieved condition (+NSR).

8 Physical properties (reference values)

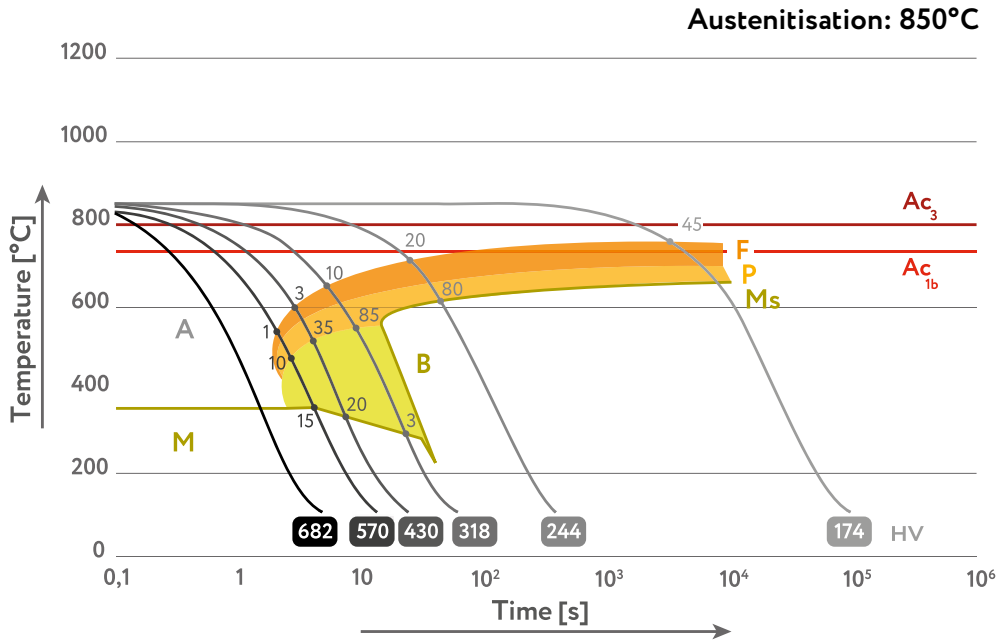
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	12.4	12.7	13.2	14.5
Thermal conductivity (W/mk)	40.9	41.1	41.5	35.6
Young modulus (Kn/mm ²)	212	207	196	175

9 Heat treatment

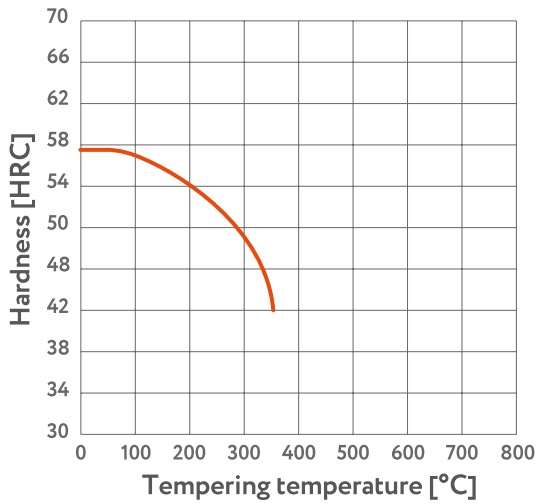
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 680 - 720 °C	Min. H.T. for 2 minute /mm	Furnace	-
Stress relieving (Normalized condition)	Heat to 600 - 650 °C	Min. H.T. for 2 minute /mm	Furnace	-
Normalizing / Hardening	Heat to 830 - 850 °C	Min. H.T. for 1 minute /mm	Air	Hardness after normalizing: 190 HB Hardness after hardening: 57 HRC (on surface)
Tempering	-	-	-	To be carried out after hardening



10 C.C.T. curve

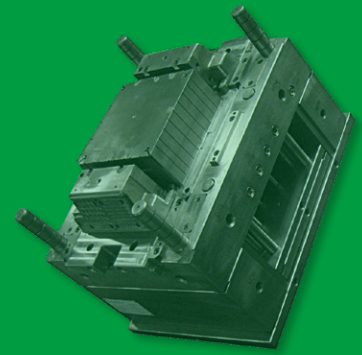


11 Tempering curve



VR HOLDER

Plastic mould steel



1 Main characteristics and applications

It is a Chromium – Molybdenum steel that gives good hardness penetration for smaller sizes; uniform hardness, high strength and good toughness. The Sulphur content improves machinability, steel not to be used for high surface requirements.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
~42CrMo4	1.7225	~42CrMo4	~42CD4	-	~708A42

3 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	Cr	Mo
0.38	0.8	0.30	0.025	0.03	1	0.20

4 Critical points

Ac1	745 °C
Ac3	790 °C
Ms	300 °C

5 Production technology

EAF – LF – VD - Forging – Heat treatment +A/+QT

6 US specification

In according to standard EN10160 Class S3E3 and standard SEP 1921 Class C/c

7 Delivery condition

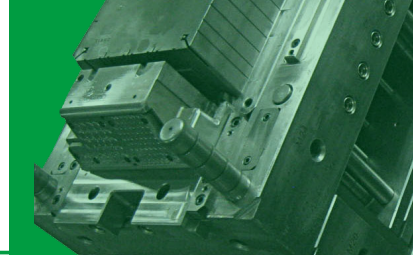
VR HOLDER is delivered in annealed condition, with hardness max 245 HB or quenched and tempered condition, with hardness range 262 - 321 HB (22 - 31 HRC).

8 Physical properties (reference values)

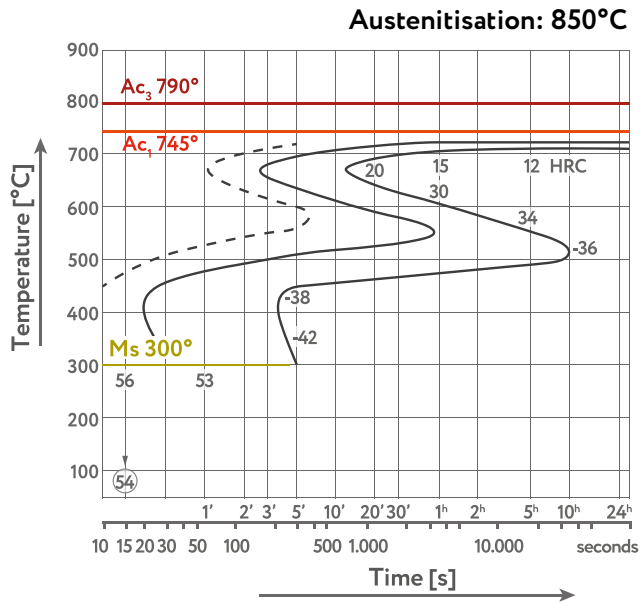
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	12.1	12.7	12.9	13.9
Thermal conductivity (W/mk)	40	39.8	38.9	36.9
Young modulus (Kn/mm ²)	212	207	200	175

9 Heat treatment

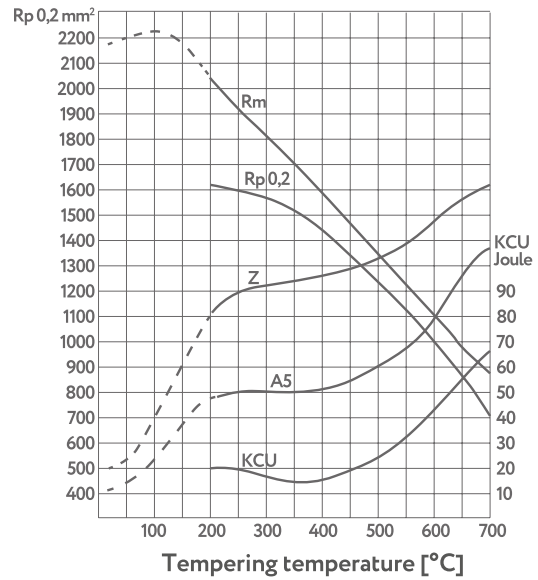
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 700 - 720 °C	Min. H.T. for 2 minute /mm	Furnace	-
Hardening	Heat to 850 - 880 °C	Min. H.T. for 1 minute /mm	Polymer quenching	-
Tempering	-	-	-	To be carried out after hardening



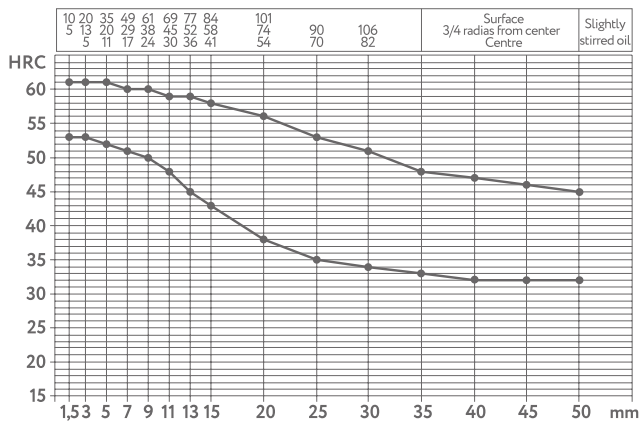
10 C.C.T. curve



11 Tempering curve



12 Jominy hardenability

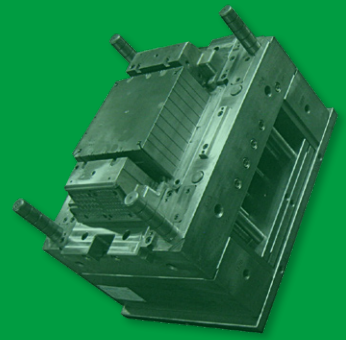


Distance from quenched end	Rockwell hardness	
	HRc min	HRc max
mm. 1,5	53	61
3	53	61
5	52	61
7	51	60
9	50	60
11	48	59
13	45	59
15	43	58
20	38	56
25	35	53
30	34	51
35	33	48
40	32	47
45	32	46
50	32	45



1.2311

Plastic mould steel



1 Main characteristics and applications

Pre-hardened plastic mould steel with hardening penetration up to 400mm, with good polishing and texturing properties. This steel is suitable for nitriding (around 800 HV), chrome and nickel PVD plating.

Used for plastic moulds with excellent surface finishing properties. It is also used for mould frames, plates, dies box, etc.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2311	X40CrMnMo7	40CMD8	~P20	~P20

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	P	S
0.38	1.5	0.30	2	0.2	0.025	0.003

4 Critical points

Ac1	740 °C
Ac3	820 °C
Ms	310 °C

5 Production technology

EAF – LF – VD - Forging – Heat treatment QT

6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

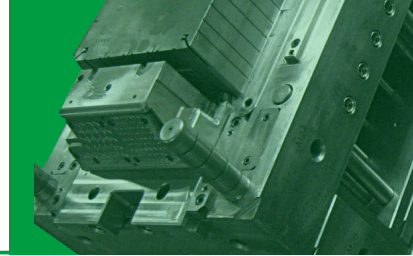
W1.2311 is delivered in quenched and tempered condition, with hardness range 280 - 325 HB (29 - 35 HRC).

8 Physical properties (reference values)

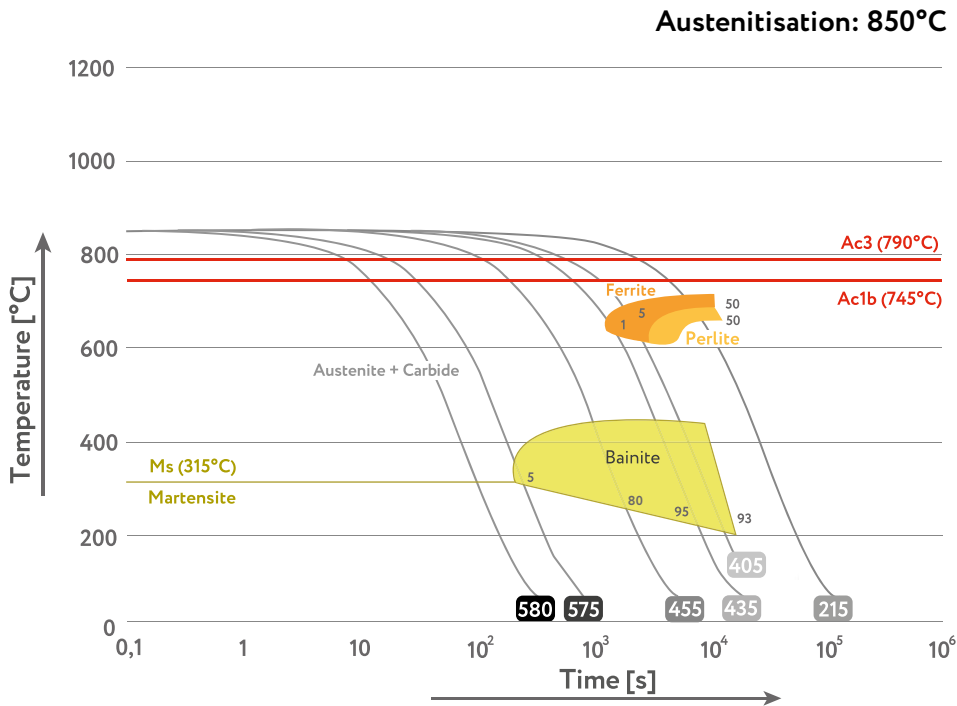
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	12.1	12.4	12.9	14.1
Thermal conductivity (W/mk)	36.1	36.2	36.4	33.5
Young modulus (Kn/mm ²)	212	205	200	175

9 Heat treatment

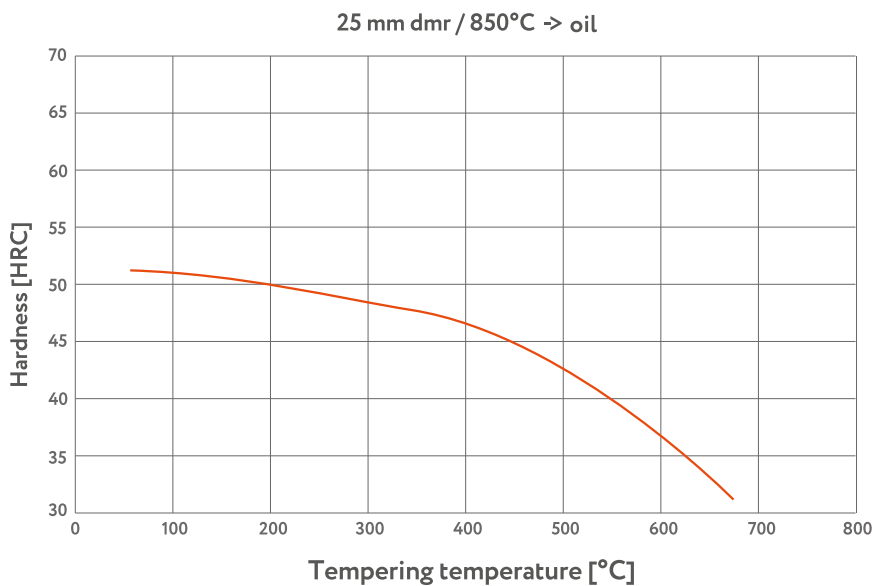
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 700 - 720 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 560 - 600 °C (max 30 °C below tempering temperature)	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 880 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 550 - 620 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature



10 C.C.T. curve

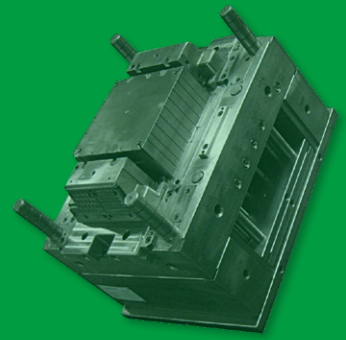


11 Tempering curve



1.2312

Plastic mould steel



1 Main characteristics and applications

Pre-hardened Sulphur alloyed plastic mold steel with excellent machinability, also in hardened and tempered condition, thanks to the Manganese-sulfide.

The main application is for core-parts and underbodies of plastic moulds also in large sizes; steel not to be used for polishing and texturing.

It is also used for plates, mould frames, die boxes. It is suitable for nitriding (around 800 HV).

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2312	X40CrMnMoS8-6	(40CMD8S)	P20	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	P	S
0.38	1.5	0.30	2	0.2	0.025	0.08

4 Critical points

Ac1	740 °C
Ac3	820 °C
Ms	310 °C

5 Production technology

EAF – LF – VD - Forging – Heat treatment QT

6 US specification

In according to standard EN10228-3 Class 3 and standard SEP 1921 Class D/d

7 Delivery condition

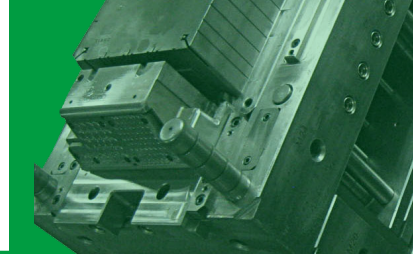
W1.2312 is delivered in quenched and tempered condition, with hardness range 270 - 310 HB (28 - 33 HRC).

8 Physical properties (reference values)

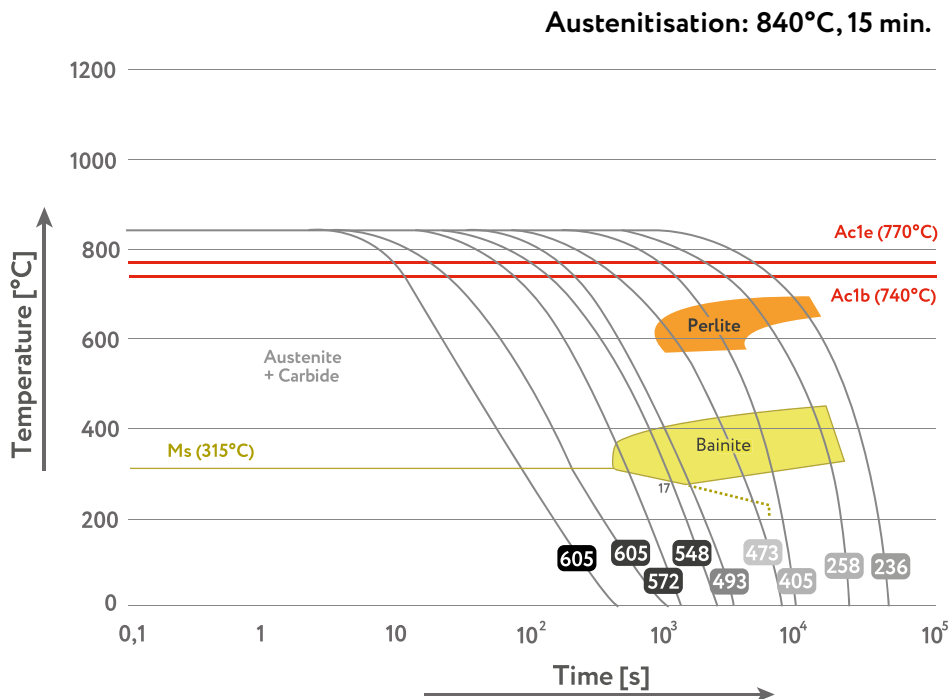
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	12.1	12.4	12.9	13.9
Thermal conductivity (W/mk)	38.9	39	40.1	35.7
Young modulus (Kn/mm ²)	212	205	200	175

9 Heat treatment

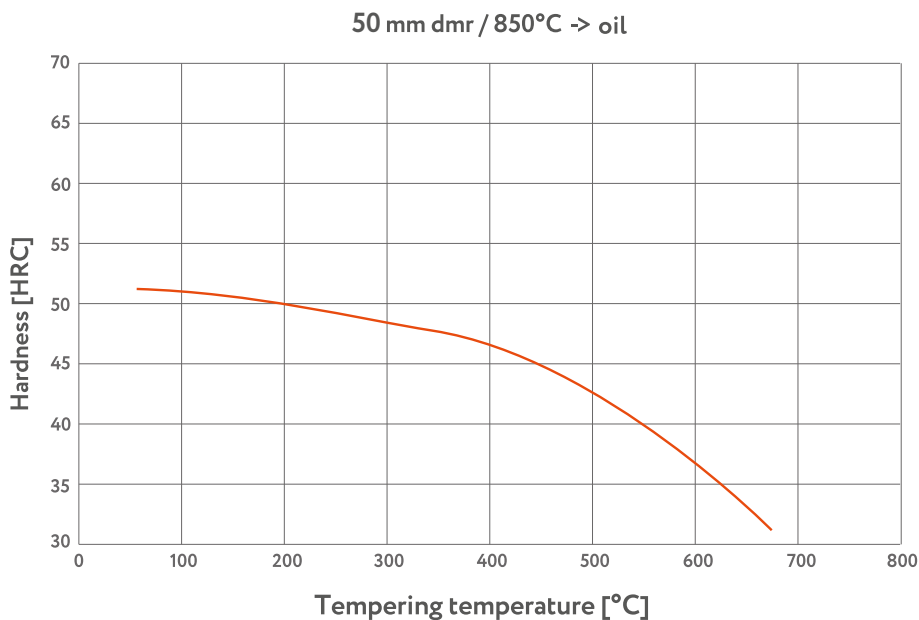
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 700 - 720 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 560 - 600°C (max 30 °C below tempering temperature)	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 880 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 550 - 620 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature



10 C.C.T. curve

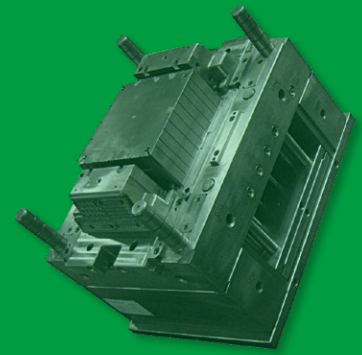


11 Tempering curve



VR16 VR16HH

Plastic mould steel



1 Main characteristics and applications

VR16 is a Pre-hardened stainless martensitic Chrome-Molybdenum steel with excellent toughness, good polishability, improved machinability and excellent resistance to corrosion.

Main benefits of steel with excellent corrosion resistance are:

- Lower mould maintenance cost.
- Higher production performance due to the lower production cost (cooling channels are not affected by corrosion).

Applications:

- plastic moulds.
- particularly for corrosive plastic as PVD.
- Dies for plastic extrusion.
- Mould for household appliances.

2 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	Ni	P	S
0.28	0.9	0.30	14	1	0.7	0.008	0.003

3 Production technology

EAF – LF – VD - Forging – Rolling - Heat treatment QT

4 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

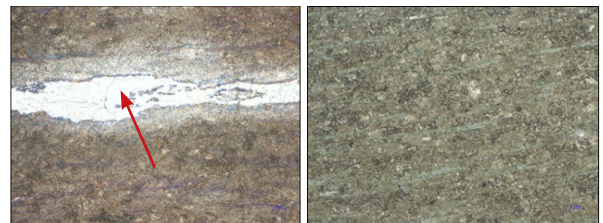
5 Delivery condition

VR16 is delivered in quenched and tempered condition:

VR16, Standard version: hardness range 280 - 325 HB (29 - 35 HRC)

VR16HH, High hardness: hardness range 350 - 390HB (38 - 42 HRC)

6 Microstructure



W1.2316

50X Martensitic structure with carbides

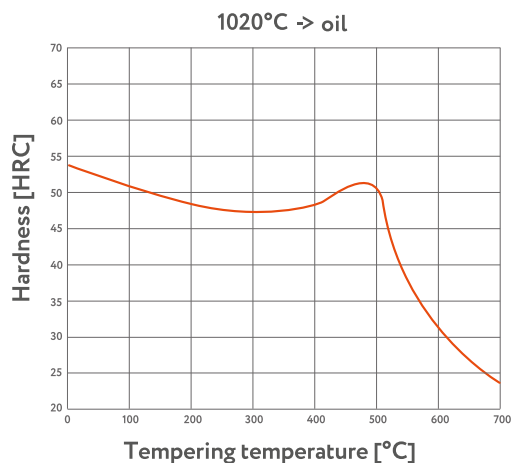
VR16

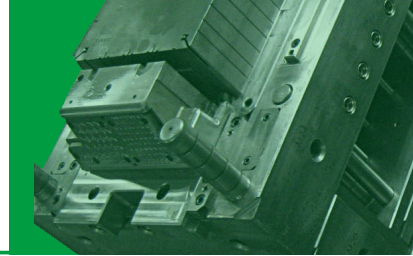
50X Homogenous microstructure, without carbides

7 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	10.5	10.5	10.9	11.7
Thermal conductivity (W/mk)	23.4	23.7	24	-
Young modulus (Kn/mm ²)	218	213	205	180

8 Tempering curve



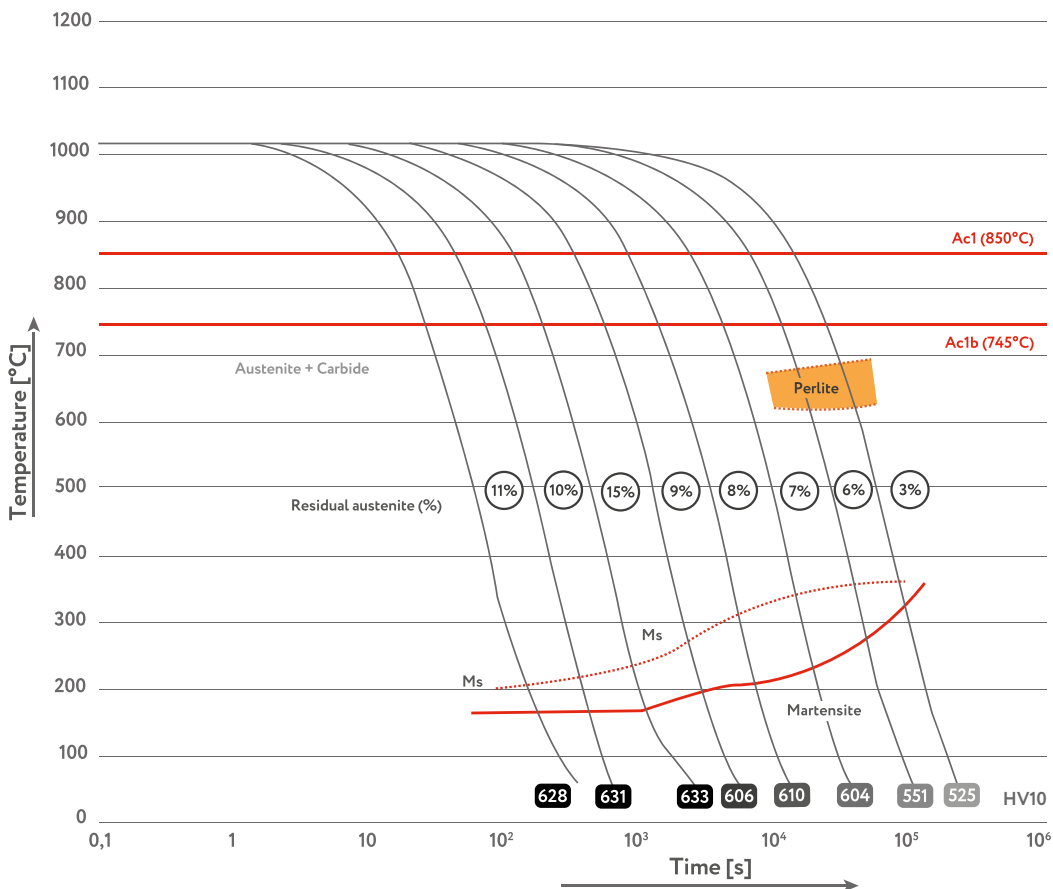


9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 770 - 820 °C	Min. H.T. for 2 minute /mm	Furnace up to 600°C than in air	-
Stress relieving	Heat to 550 - 600 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 600-700°C. Austenitizing to 990 - 1040 °C	Min. H.T. for 1 minute /mm	Polymer or gas air	Quenched hardness 50 HRC
Tempering	-	-	Air	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature

10 C.C.T. curve

Austenitisation: 1020°C, 30 min.



VR 16 VR 16HH ESR



Plastic mould steel

1 Main characteristics and applications

VR16 is a Pre-hardened stainless martensitic Chrome-Molybdenum steel with excellent toughness, good polishability, improved machinability and excellent resistance to corrosion.

Main benefits of steel with excellent corrosion resistance are:

- Lower mould maintenance cost.
- Higher production performance due to the lower production cost (cooling channels are not affected by corrosion).

Applications:

- plastic moulds.
- particularly for corrosive plastic as PVD.
- Dies for plastic extrusion.
- Mould for household appliances.

2 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	Ni	P	S
0.28	0.9	0.30	14	1	0.7	0.008	0.003

3 Production technology

Electro-slag-remelting (ESR) - Forging - Rolling - Heat treatment QT

4 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

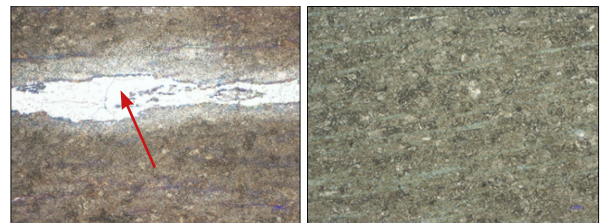
5 Delivery condition

VR16 is delivered in quenched and tempered condition:

VR16, Standard version: hardness range 280 - 325 HB (29 - 35 HRC)

VR16HH, High hardness: hardness range 350 - 390HB (38 - 42 HRC)

6 Microstructure



W1.2316

50X Martensitic structure with carbides

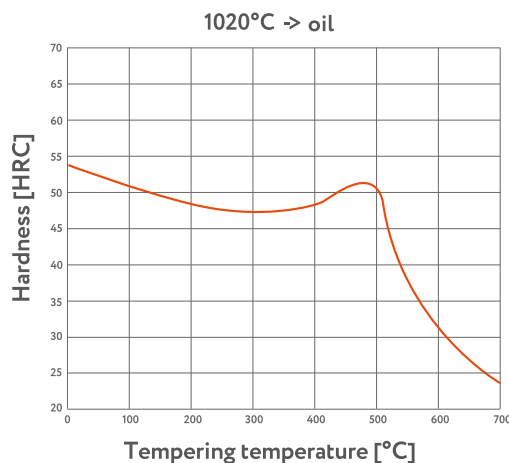
VR16

50X Homogenous microstructure, without carbides

7 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	10.5	10.5	10.9	11.7
Thermal conductivity (W/mk)	23.4	23.7	24	-
Young modulus (Kn/mm ²)	218	213	205	180

8 Tempering curve



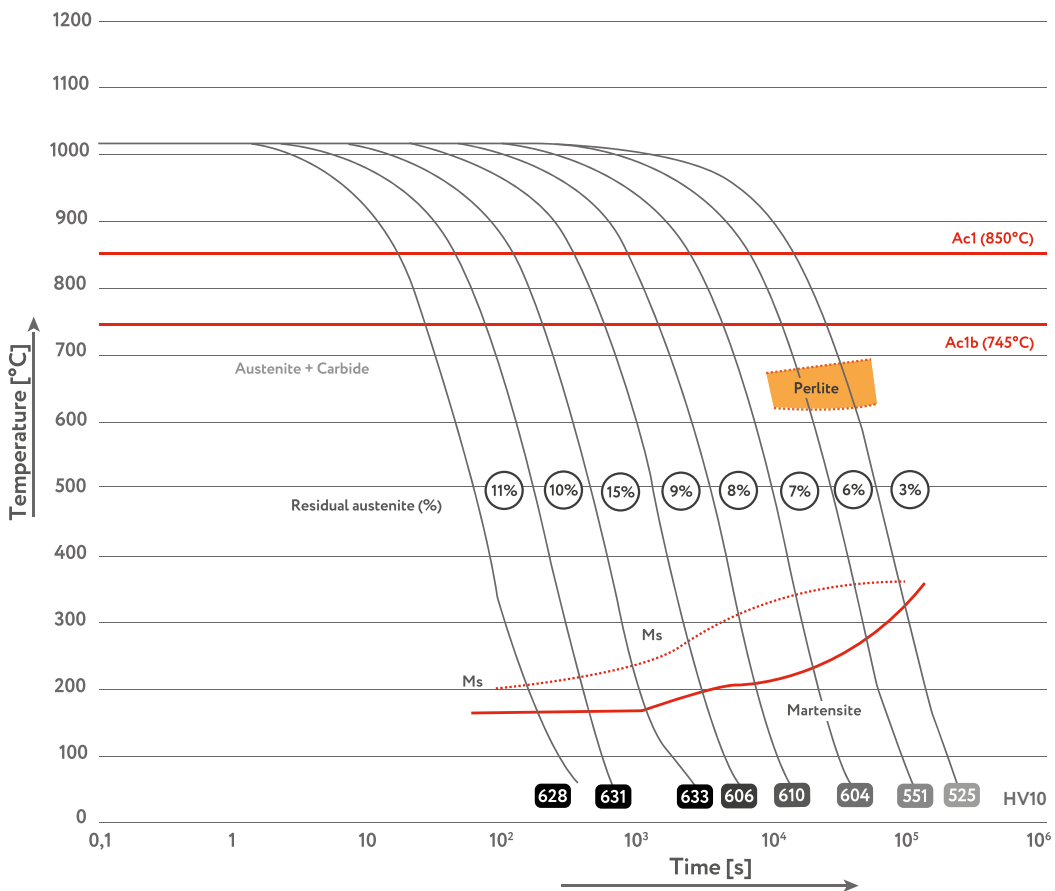


9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 770 - 820 °C	Min. H.T. for 2 minute /mm	Furnace up to 600°C than in air	-
Stress relieving	Heat to 550 - 600 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 600-700°C. Austenitizing to 990 - 1040 °C	Min. H.T. for 1 minute /mm	Polymer or gas air	Quenched hardness 50 HRC
Tempering	-	-	Air	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature

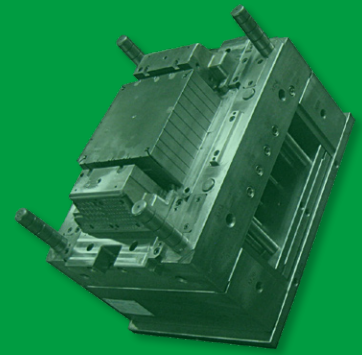
10 C.C.T. curve

Austenitisation: 1020°C, 30 min.



VR200

Plastic mould steel



1 Main characteristics and applications

VR200 is a prehardened plastic mold steel with hardening penetration up to 600mm, for medium size molds and tool with excellent machinability.

To be used for plastic dies with excellent surface finish properties, compression moulding, plastic injection moulds core and cavities, moulds for automotive industry with texturing.

VR200 is designed to provide improved performance and offer the following advantages:

- uniform hardness across the full thickness up to 600 mm.
- good polishability.
- good machinability.
- good suitability for texturing.
- good toughness.

2 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	CR	Mo	Ni	B
0.27	1.30	Max 0.15	0.010	0.003	1.3	0.4	0.34	0.003

3 Production technology

EAF - LF - VD- Forging - Rolling - Heat treatment QT

4 US specification

In according to standard

- ASTM A578-S9 2 mm and EFBH up to 407 mm
- ASTM A578-S9 3,2 mm and EFBH over 407 mm

5 Delivery condition

VR200 is delivered in quenched and tempered condition:

VR200, Standard version: hardness range 290 - 320 HB (30 - 34 HRC)

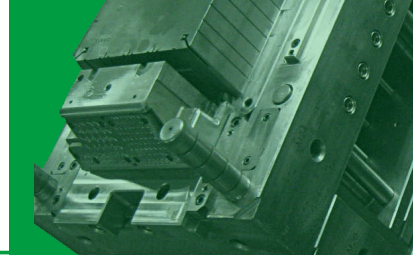
VR200HH High hardness: hardness range 320 - 350HB (34 - 38 HRC)

6 Physical properties (reference values)

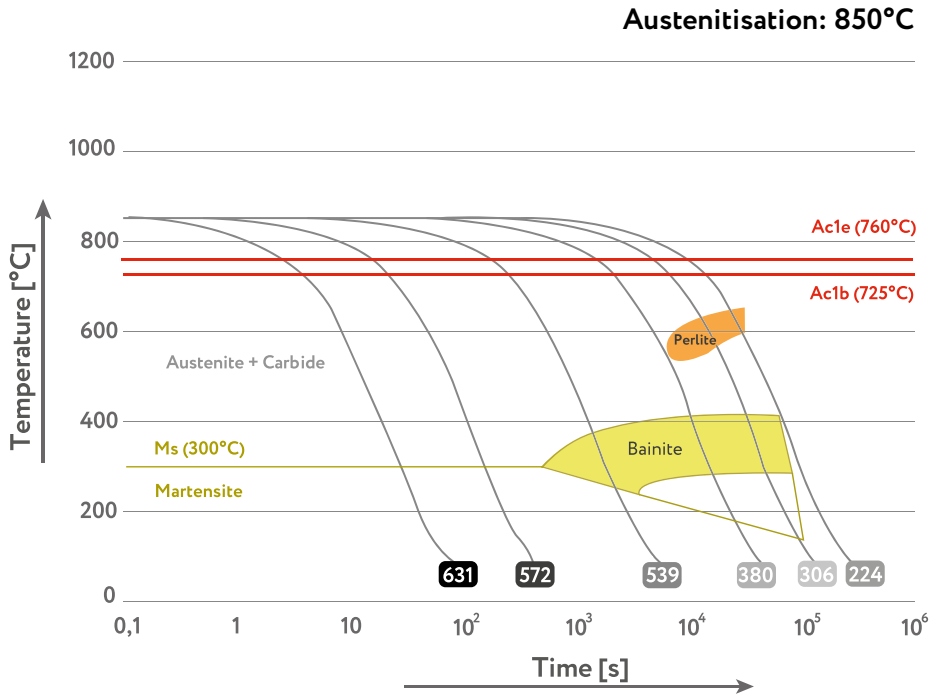
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.3	11.8	12.3	13.6
Thermal conductivity (W/mk)	40.0	39.2	38.3	35.1
Young modulus (Kn/mm ²)	205	201	182	-

7 Heat treatment

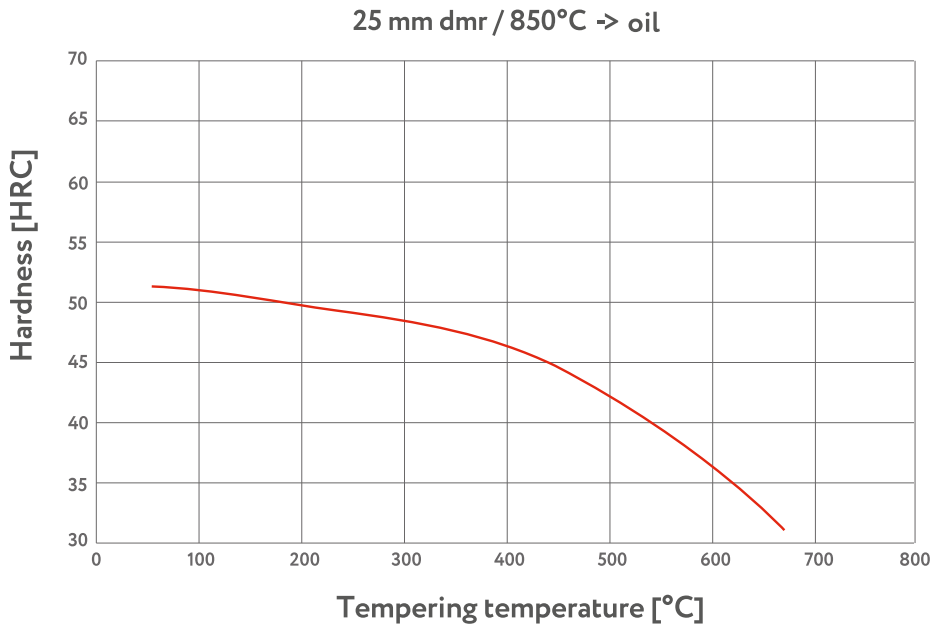
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 650 - 700 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 500 - 550 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 900 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 530 - 610 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature



8 C.C.T. curve



9 Tempering curve



VR300

Plastic mould steel



1 Main characteristics and applications

VR300 is a pre-hardened steel with excellent hardening penetration up to thickness 600mm. To be used for plastic dies with excellent surface finishing properties, compression moulding, plastic injection moulds, moulds for automotive industry with texturing.

VR300 is designed to provide improved performance and offers the following advantages:

- uniform hardness across the full thickness up to 600mm.
- high polishability.
- high machinability.
- excellent suitability for texturing.
- greatly increased thermal conductivity.
- good toughness.

2 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	Cr	Mo	Ni
0.30	1.45	Max 0.30	0.010	0.003	1.6	0.4	0.65

3 Production technology

EAF - LF - VD - Forging - Rolling - Heat treatment QT

4 US specification

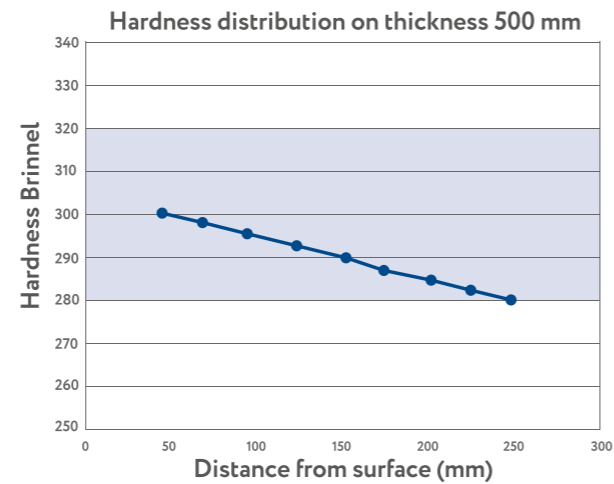
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

5 Delivery condition

VR300 is delivered in quenched and tempered condition, with hardness range 280 - 325 HB (29 - 35 HRC).

6 Through hardenability

The high performance of hardenability for thickness 600 mm, is obtained by an optimized balance of chemical composition and a special manufacturing process.



7 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11	11.6	12.1	13.8
Thermal conductivity (W/mk)	40.0	39.3	38.4	35.2
Young modulus (Kn/mm ²)	205	201	-	-

12 Polishing Range

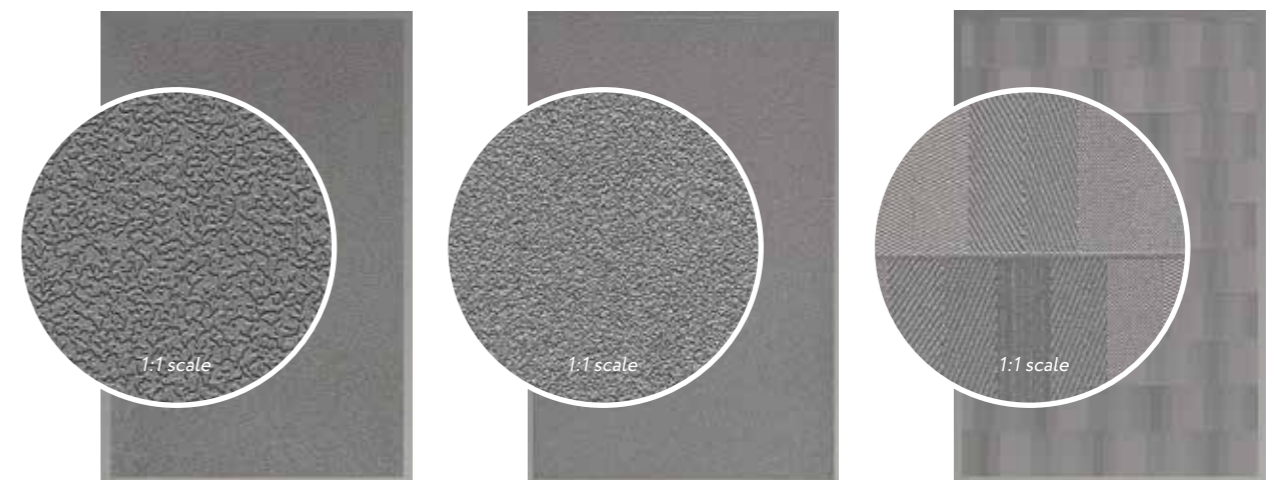
Code	Type of polishing	Application	Roughness μm
VR01	Silicon Carbide Grinding Paper "100"	Technical polishing of internal parts or stamp	RA 0.69-RZ 4.62
VR03	Silicon Carbide Grinding Paper "150"	Technical polishing of extraction parts	RA 0.57-RZ 3.62
VR05	Silicon Carbide Grinding Paper "240"	Technical polishing of stamps and mold	RA 0.39-RZ 3.40
VR07	Silicon Carbide Grinding Paper "400"	Technical polishing of mold product to paint	RA 0.23-RZ 2.28
VR09	Silicon Carbide Grinding Paper "800"	Pre-Lapping	RA 0.21-RZ 1.22
VR11	Polishing Pads 320 Sisal	Polishing from pads 320 and Sisal	RA 0.06-RZ 0.34
VR13	Dry Diamond Polishing Pads 400 (3 μm)	Lapping of paint pieces (frompads 400)	RA 0.03-RZ 0.12

Roughness tolerance: RA +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR13
RZ +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR13



13 Texturing Samples

Texturing performed by Standex Mold-tech with patterns Standex MT 9086, MT 9055 and 9083

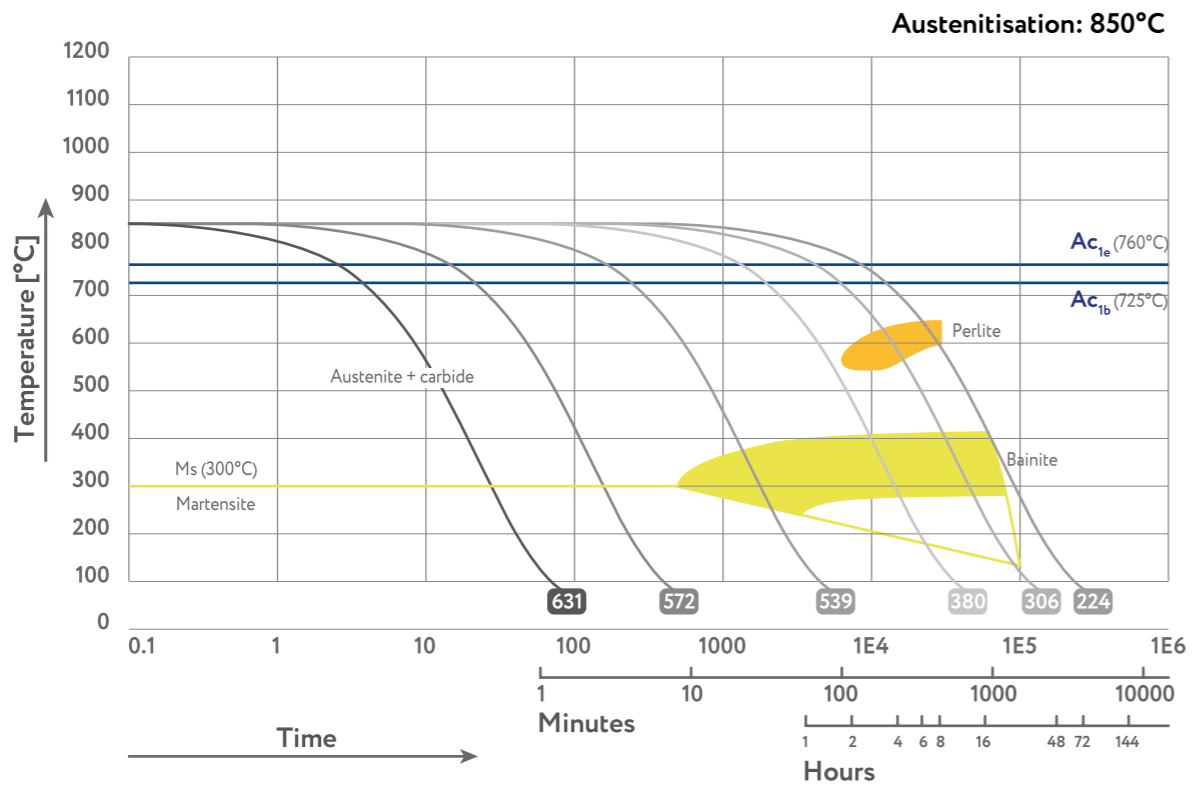




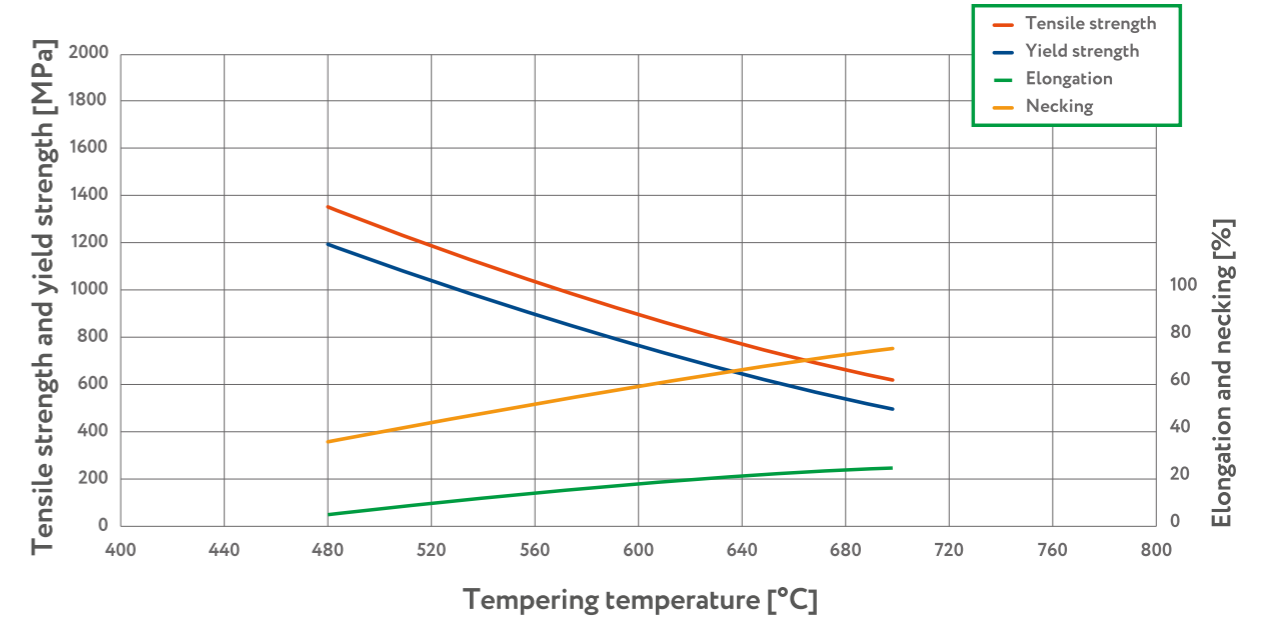
8 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 650 - 700 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 500 - 550 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 900 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 530 - 610 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature

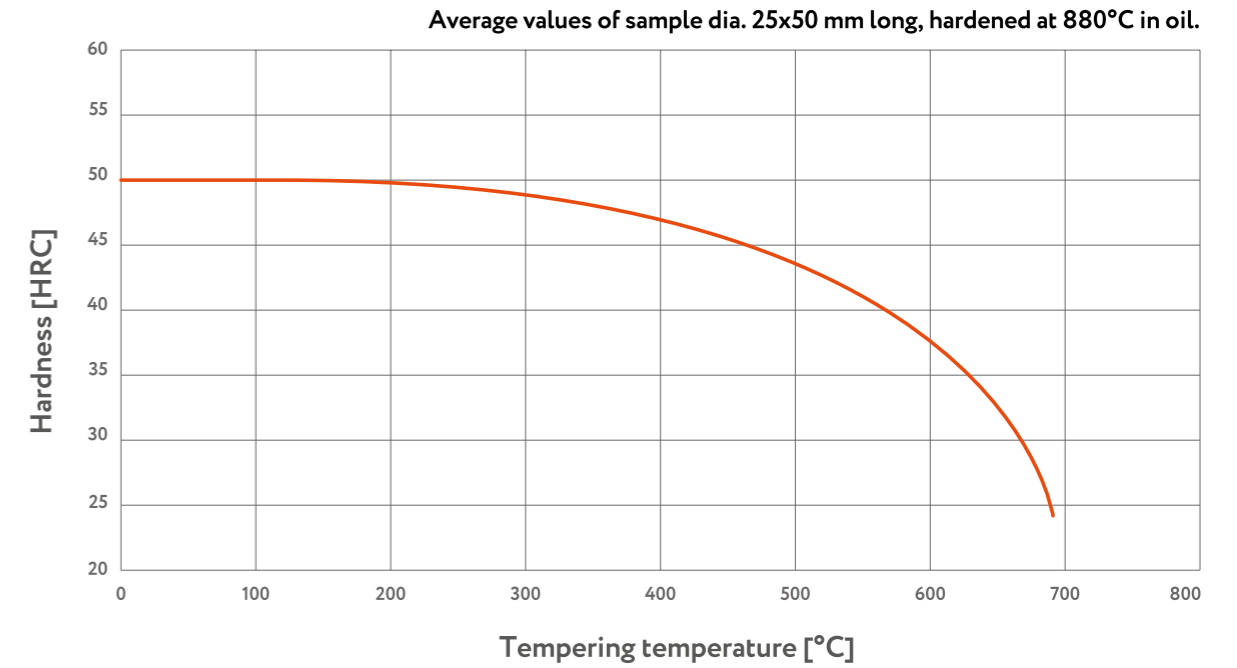
9 C.C.T. curve



10 Mechanical properties

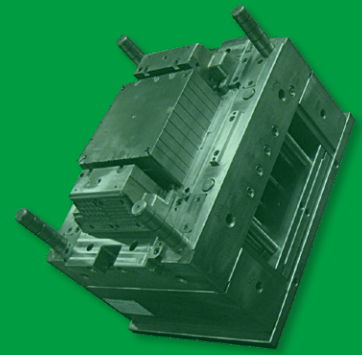


11 Tempering curve



1.2738

Plastic mould steel



1 Main characteristics and applications

Pre-hardened plastic mould steel with excellent hardening penetration, good machinability, polishing and texturing properties.

This steel is used for plastic moulds of medium and big size. It can be subject to a nitriding or PVD treatment to improve its wear resistance.

Main applications: thermoplastic injections and extrusion moulds, rubber moulds, large moulds, frames, containers.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2738	40CrMnNi-Mo8-6-4	40CMND8	~P20+Ni	~P20+Ni

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Ni	Mo	P	S
0.38	1.5	0.30	2	1	0.2	0.025	0.003

4 Critical points

Ac1	720 °C
Ac3	800 °C
Ms	290 °C

5 Production technology

EAF – LF – VD - Forging – Heat treatment QT

6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

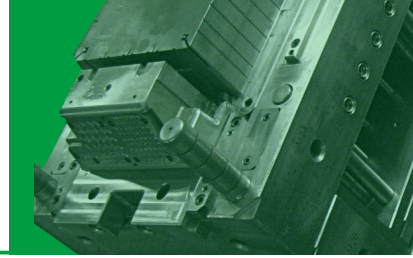
W1.2738 is delivered in quenched and tempered condition, with hardness range 300 - 340 HB (32 - 37 HRC).

8 Physical properties (reference values)

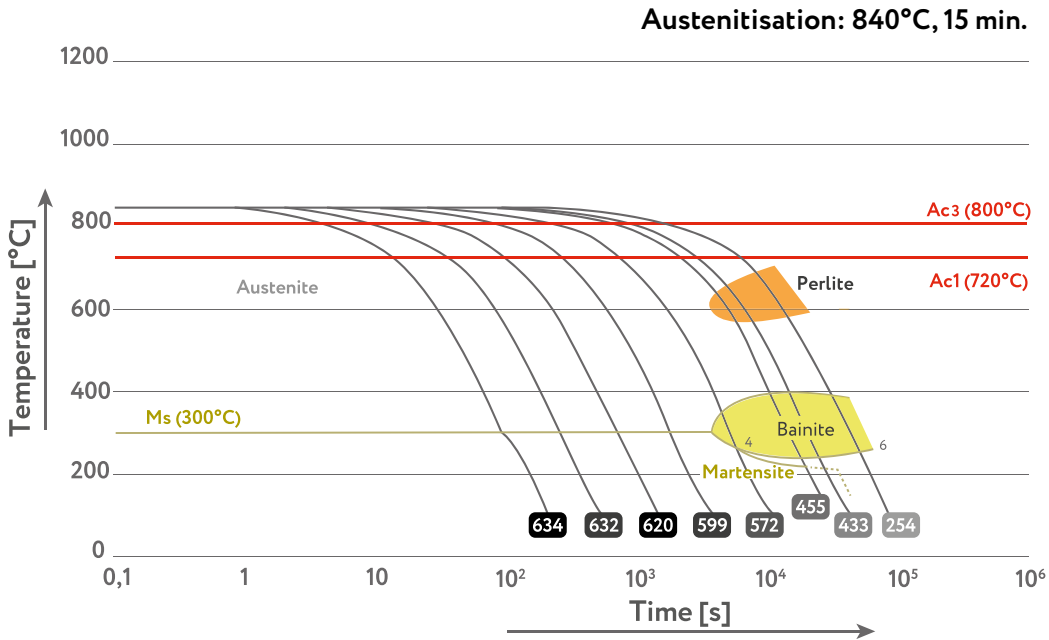
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10-6/K)	12.0	12.4	12.9	14.1
Thermal conductivity (W/mk)	33.1	33.5	34.5	32.6
Young modulus (Kn/mm2)	212	205	200	175

9 Heat treatment

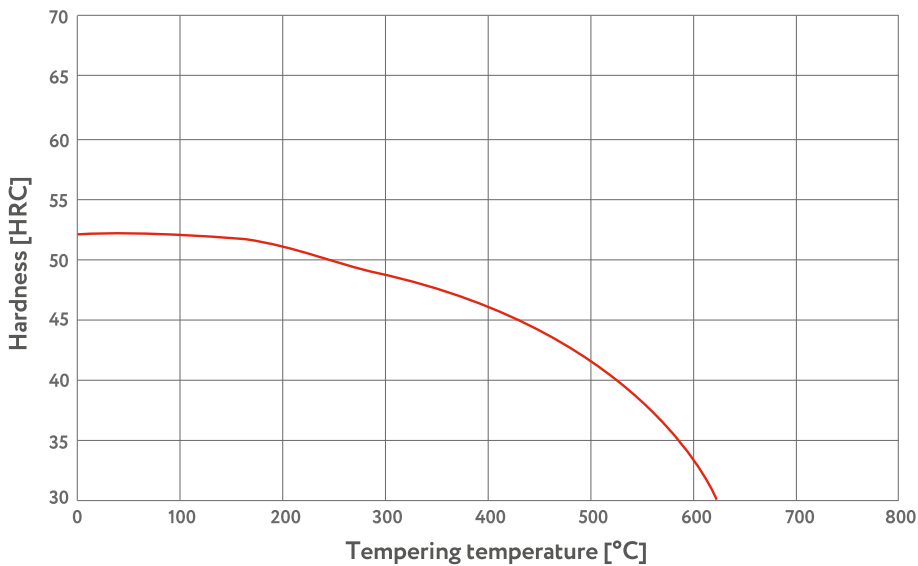
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 680 - 700 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 560 - 600 °C (max 30 °C below tempering temperature)	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 880 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 550 - 620 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature



10 C.C.T. curve



11 Tempering curve



W1.2738HH

Plastic mould steel



1 Main characteristics and applications

W1.2738HH is a Pre-hardened plastic tool steel ideal to produce block with thickness up to 1300mm in large size with an high performance of trough hardening homogeneity. To be used for plastic injection moulds, compression moulds, big sizes moulds for automotive industry with texturing.

W1.2738HH is designed to provide improved performances and offers the following advantages:

- uniform hardness across the full thickness up to 1300mm.
- high polishability.
- high machinability.
- excellent suitability for texturing.
- greatly increased thermal conductivity.
- improved weldability as W 1.2738.
- good toughness.

2 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	Cr	Mo	Ni
0.29	1.50	Max 0.30	0.010	0.001	1.3	0.57	1.05

3 Production technology

EAF – LF – VD - Forging – Heat treatment QT

4 US specification

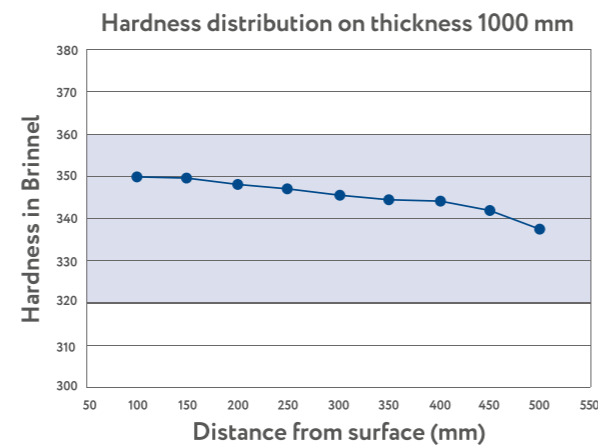
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

5 Delivery condition

W1.2738HH is in delivered quenched and tempered condition, with hardness range 320 - 360 HB (34 - 39 HRC).

6 Through hardenability

The high performance of hardenability for thickness 1300 mm, is obtained by an optimized balance of chemical composition and a special manufactured process.



7 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.4	11.6	12.7	14.2
Thermal conductivity (W/mk)	36	36.7	38	34.3
Young modulus (Kn/mm ²)	211	207	199	166

12 Polishing Range

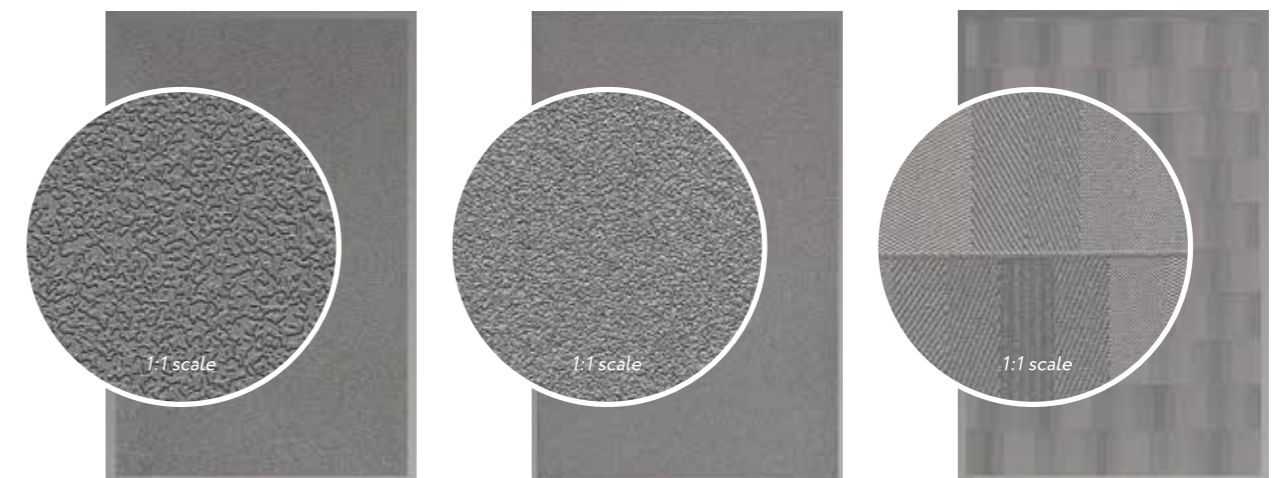
Code	Type of polishing	Application	Roughness μm
VR01	Silicon Carbide Grinding Paper "100"	Technical polishing of internal parts or stamp	RA 0.69-RZ 4.62
VR03	Silicon Carbide Grinding Paper "150"	Technical polishing of extraction parts	RA 0.57-RZ 3.62
VR05	Silicon Carbide Grinding Paper "240"	Technical polishing of stamps and mold	RA 0.39-RZ 3.40
VR07	Silicon Carbide Grinding Paper "400"	Technical polishing of mold product to paint	RA 0.23-RZ 2.28
VR09	Silicon Carbide Grinding Paper "800"	Pre-Lapping	RA 0.21-RZ 1.22
VR11	Polishing Pads 320 Sisal	Polishing from pads 320 and Sisal	RA 0.06-RZ 0.34
VR13	Dry Diamond Polishing Pads 400 (3 μm)	Lapping of paint pieces (frompads 400)	RA 0.03-RZ 0.12
VR15	Dry Diamond Polishing Pads (Lapping 1 μm)	Lapping of transparent pieces	RA 0.02-RZ 0.10
VR17	Optical lapping 1/4 μm	Special lapping of transparent pieces (glasses lens)	

Roughness tolerance: RA +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR17
RZ +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR17



13 Texturing Samples

Texturing performed by Standex Mold-tech with patterns Standex MT 9086, MT 9055 and 9083

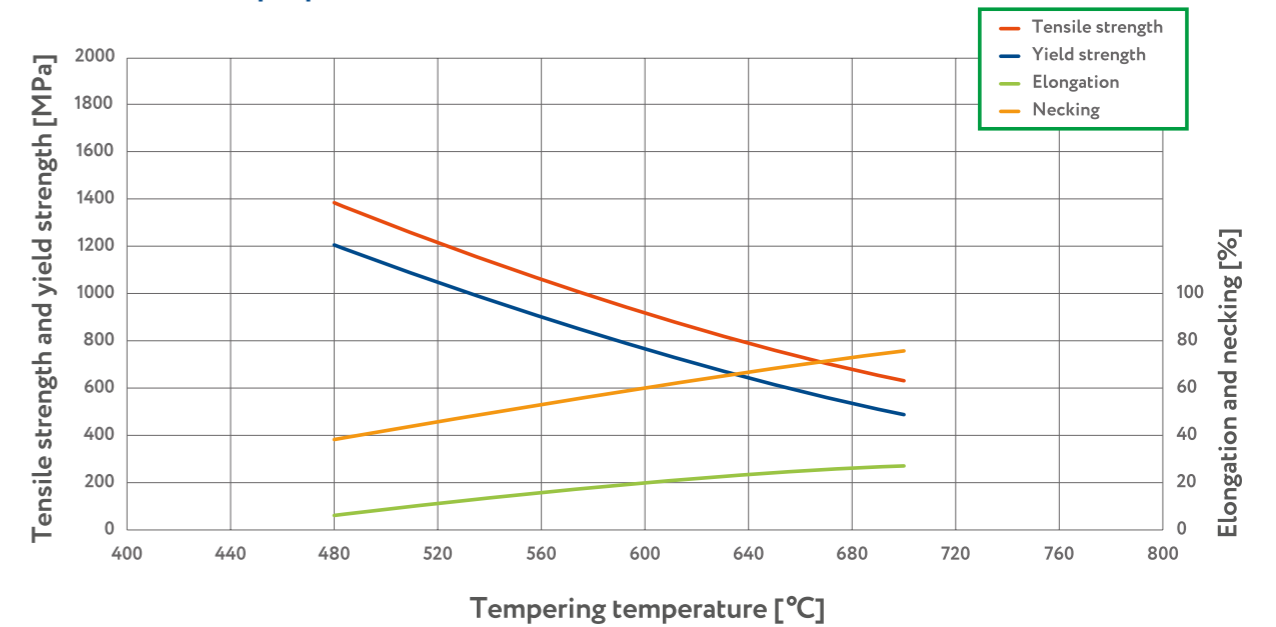




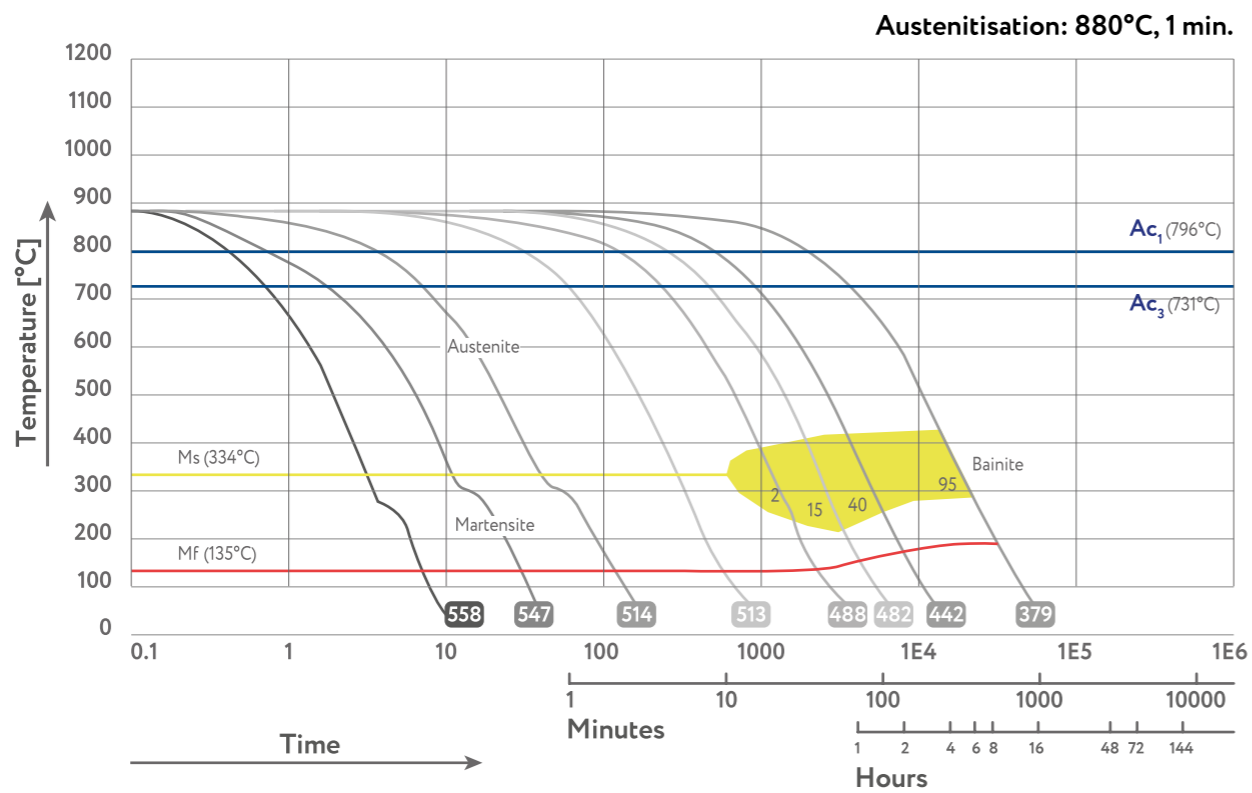
8 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 650 - 700 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 500 - 550 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 900 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 550 - 610 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature

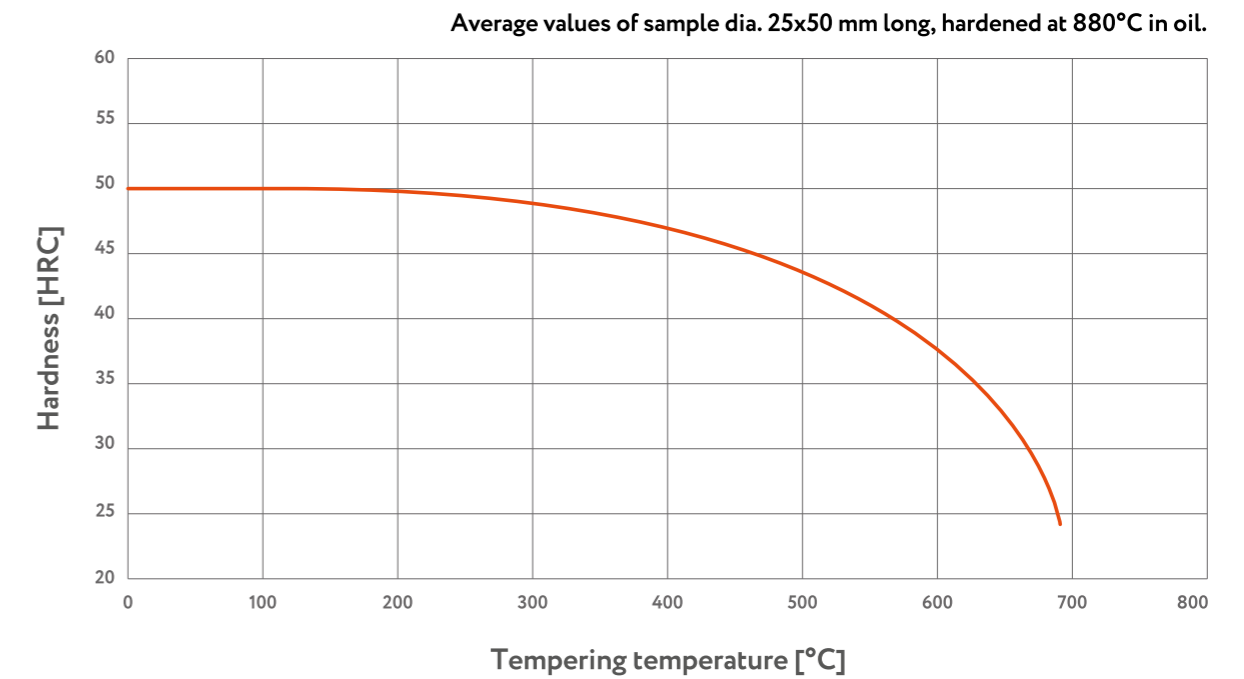
10 Mechanical properties



9 C.C.T. curve



11 Tempering curve



VR 400

Plastic mould steel



1 Main characteristics and applications

VR400 is a high hard tool steel ideal to produce block with thickness up to 1300mm in large size with an high performance of trough hardening homogeneity. To be used for plastic injection moulds, compression moulds, big sizes moulds for automotive industry with texturing.

VR400 is designed to provide improved performances and offers the following advantages:

- uniform hardness across the full thickness up to 1300mm.
- high polishability.
- high machinability.
- excellent suitability for texturing.
- greatly increased thermal conductivity.
- improved weldability as W 1.2738.
- good toughness.

2 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	Cr	Mo	Ni
0.29	1.50	Max 0.30	0.010	0.001	1.3	0.57	1.05

3 Production technology

EAF – LF – VD - Forging – Heat treatment QT

4 US specification

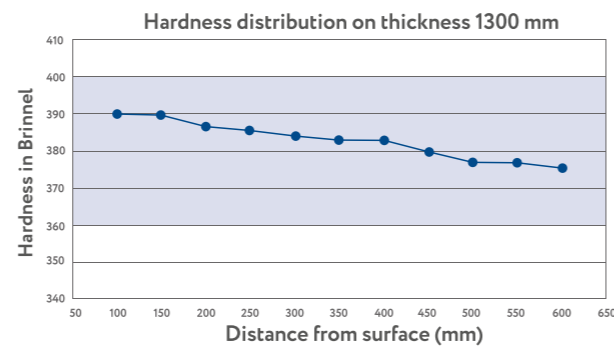
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

5 Delivery condition

VR400 is delivered in quenched and tempered condition, with hardness range 360 - 400 HB (39 - 43 HRC).

6 Through hardenability

The high performance of hardenability for thickness 1300 mm, is obtained by an optimized balance of chemical composition and a special manufactured process.



7 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.4	11.6	12.7	14.2
Thermal conductivity (W/mk)	36	36.7	38	34.3
Young modulus (Kn/mm ²)	211	207	199	166

12 Polishing Range

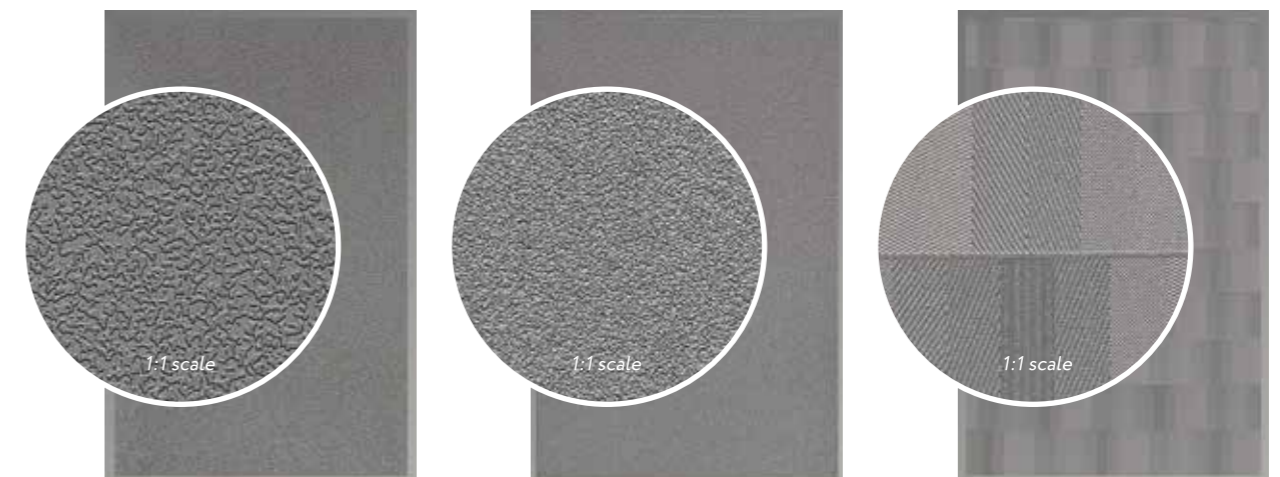
Code	Type of polishing	Application	Roughness µm
VR01	Silicon Carbide Grinding Paper "100"	Technical polishing of internal parts or stamp	RA 0.69-RZ 4.62
VR03	Silicon Carbide Grinding Paper "150"	Technical polishing of extraction parts	RA 0.57-RZ 3.62
VR05	Silicon Carbide Grinding Paper "240"	Technical polishing of stamps and mold	RA 0.39-RZ 3.40
VR07	Silicon Carbide Grinding Paper "400"	Technical polishing of mold product to paint	RA 0.23-RZ 2.28
VR09	Silicon Carbide Grinding Paper "800"	Pre-Lapping	RA 0.21-RZ 1.22
VR11	Polishing Pads 320 Sisal	Polishing from pads 320 and Sisal	RA 0.06-RZ 0.34
VR13	Dry Diamond Polishing Pads 400 (3 µm)	Lapping of paint pieces (frompads 400)	RA 0.03-RZ 0.12
VR15	Dry Diamond Polishing Pads (Lapping 1 µm)	Lapping of transparent pieces	RA 0.02-RZ 0.10
VR17	Optical lapping 1/4 µm	Special lapping of transparent pieces (glasses lens)	

Roughness tolerance: RA +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR17
RZ +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR17



13 Texturing Samples

Texturing performed by Standex Mold-tech with patterns Standex MT 9086, MT 9055 and 9083

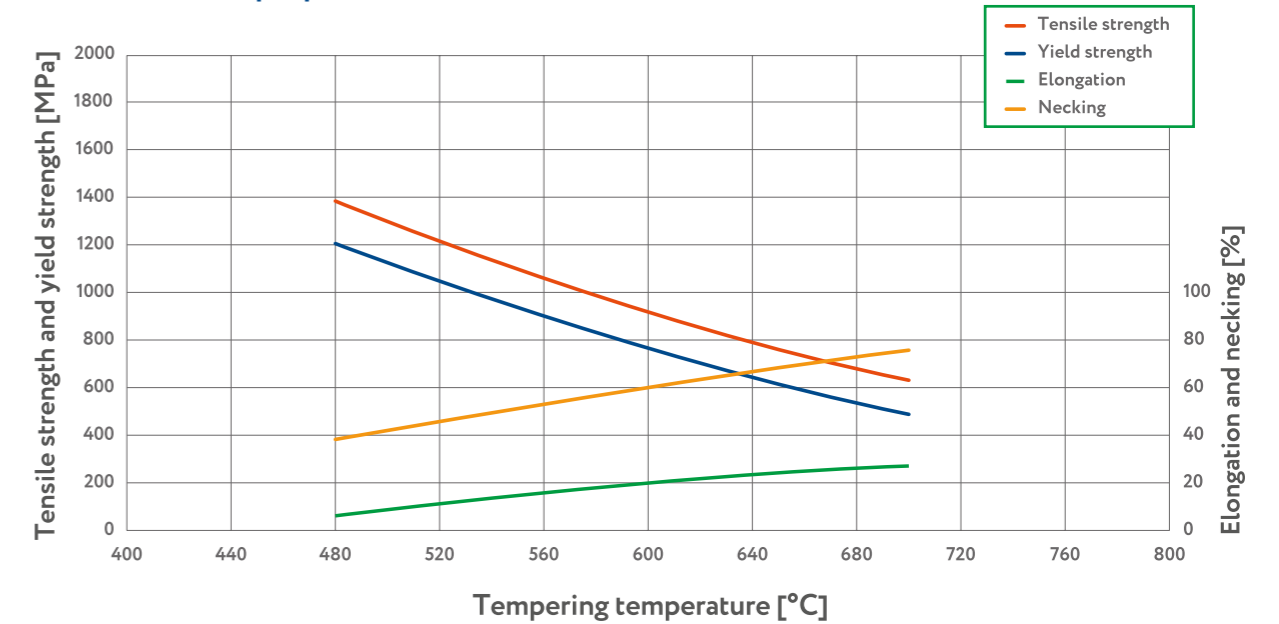




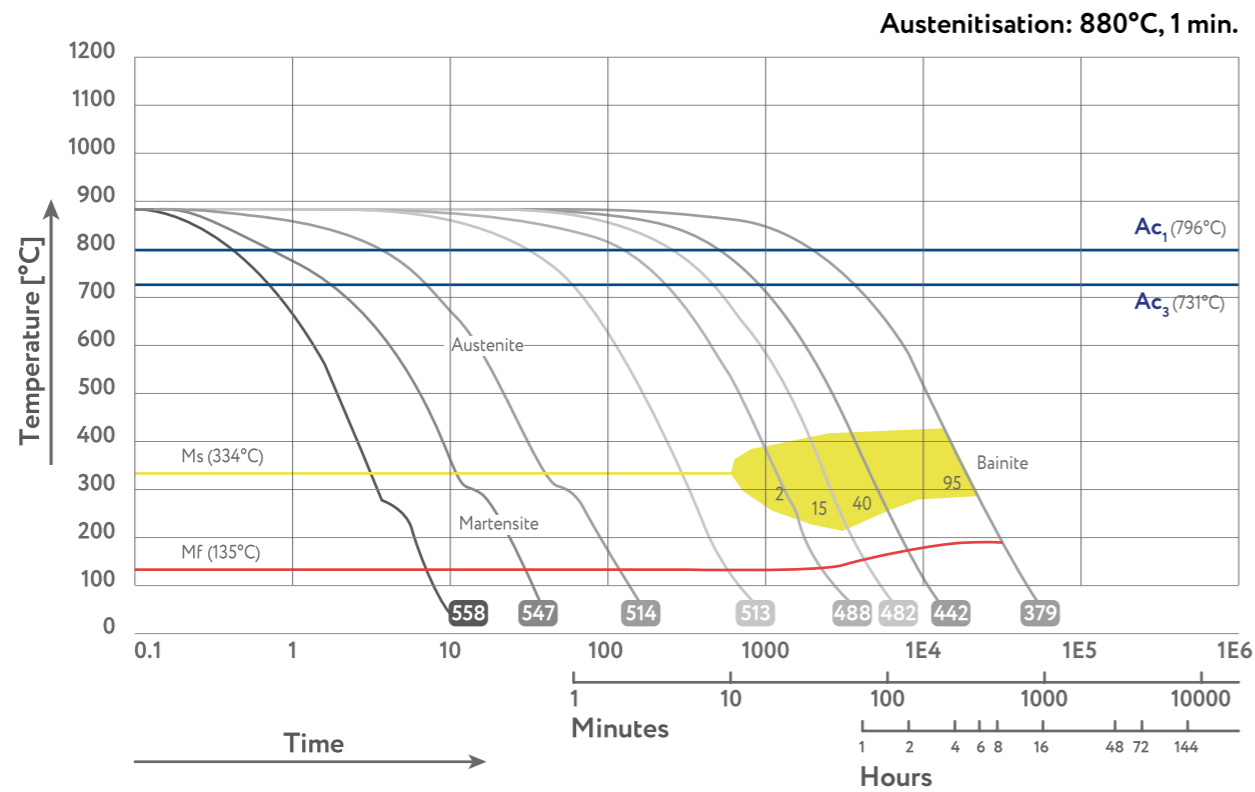
8 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 650 - 700 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 500 - 550 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 900 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 550 - 610 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature

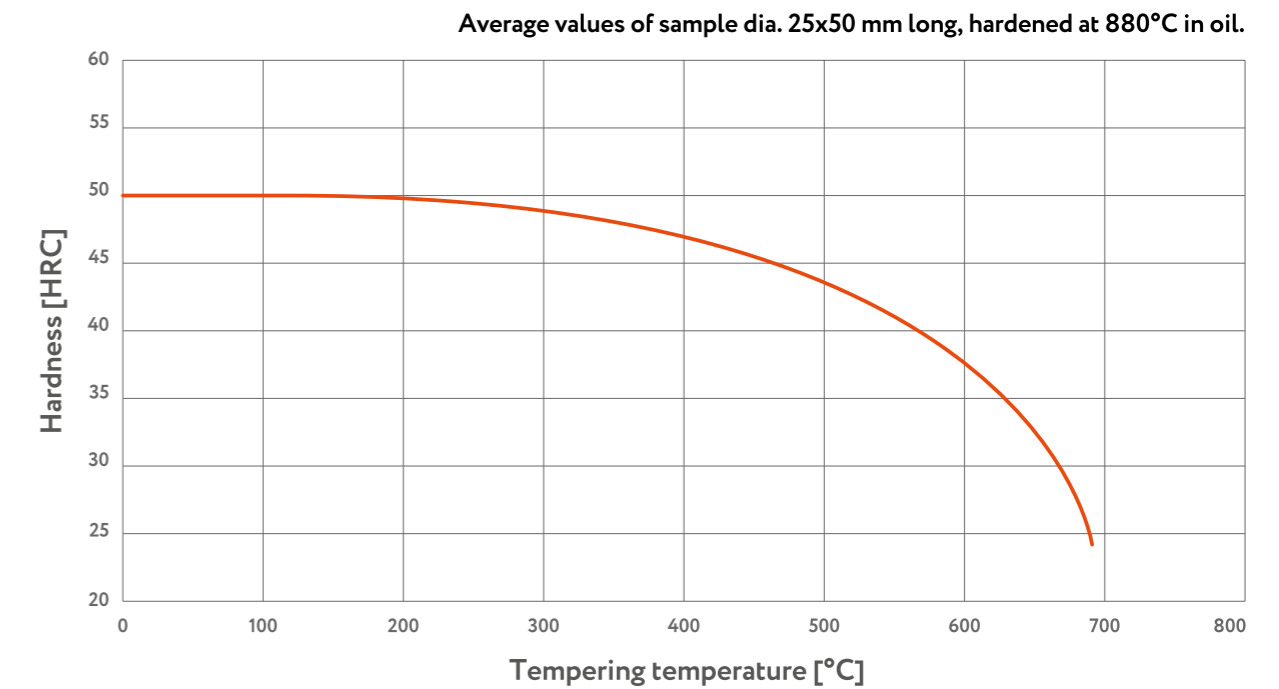
10 Mechanical properties



9 C.C.T. curve



11 Tempering curve



VR 400 ESR



Plastic mould steel

1 Main characteristics and applications

VR400 is a high hard tool steel ideal to produce block with thickness up to 1300mm in large size with an high performance of trough hardening homogeneity. To be used for plastic injection moulds, compression moulds, big sizes moulds for automotive industry with texturing.

VR400 is designed to provide improved performances and offers the following advantages:

- uniform hardness across the full thickness up to 1300mm.
- high polishability.
- high machinability.
- excellent suitability for texturing.
- greatly increased thermal conductivity.
- improved weldability as W 1.2738.
- good toughness.

2 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	Cr	Mo	Ni
0.29	1.50	Max 0.30	0.010	0.001	1.3	0.57	1.05

3 Production technology

Electro-slag-remelting (ESR) - Forging - Heat treatment QT

4 US specification

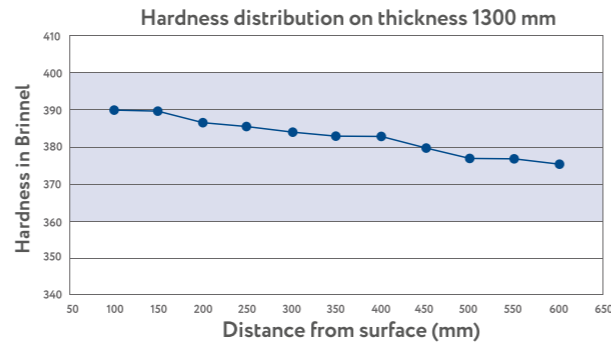
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

5 Delivery condition

VR400 is delivered in quenched and tempered condition, with hardness range 360 - 400 HB (39 - 43 HRC).

6 Through hardenability

The high performance of hardenability for thickness 1300 mm, is obtained by an optimized balance of chemical composition and a special manufactured process.



7 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.4	11.6	12.7	14.2
Thermal conductivity (W/mk)	36	36.7	38	34.3
Young modulus (Kn/mm ²)	211	207	199	166

12 Polishing Range

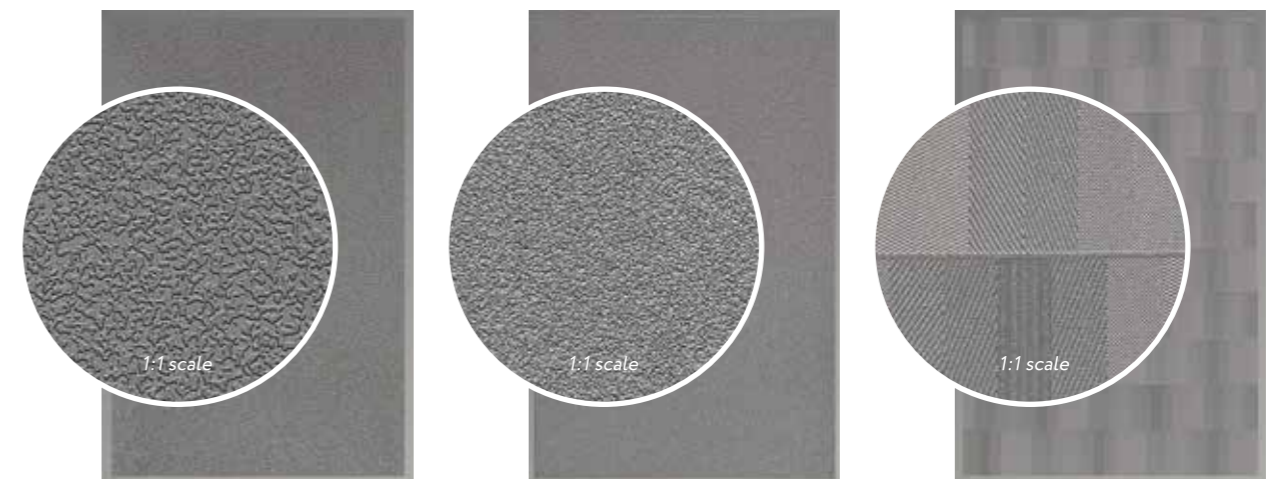
Code	Type of polishing	Application	Roughness μm
VR01	Silicon Carbide Grinding Paper "100"	Technical polishing of internal parts or stamp	RA 0.69-RZ 4.62
VR03	Silicon Carbide Grinding Paper "150"	Technical polishing of extraction parts	RA 0.57-RZ 3.62
VR05	Silicon Carbide Grinding Paper "240"	Technical polishing of stamps and mold	RA 0.39-RZ 3.40
VR07	Silicon Carbide Grinding Paper "400"	Technical polishing of mold product to paint	RA 0.23-RZ 2.28
VR09	Silicon Carbide Grinding Paper "800"	Pre-Lapping	RA 0.21-RZ 1.22
VR11	Polishing Pads 320 Sisal	Polishing from pads 320 and Sisal	RA 0.06-RZ 0.34
VR13	Dry Diamond Polishing Pads 400 (3 μm)	Lapping of paint pieces (frompads 400)	RA 0.03-RZ 0.12
VR15	Dry Diamond Polishing Pads (Lapping 1 μm)	Lapping of transparent pieces	RA 0.02-RZ 0.10
VR17	Optical lapping 1/4 μm	Special lapping of transparent pieces (glasses lens)	

Roughness tolerance: RA +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR17
RZ +/- 10% from VR01 to VR09 and +/- 15% from VR11 to VR17



13 Texturing Samples

Texturing performed by Standex Mold-tech with patterns Standex MT 9086, MT 9055 and 9083

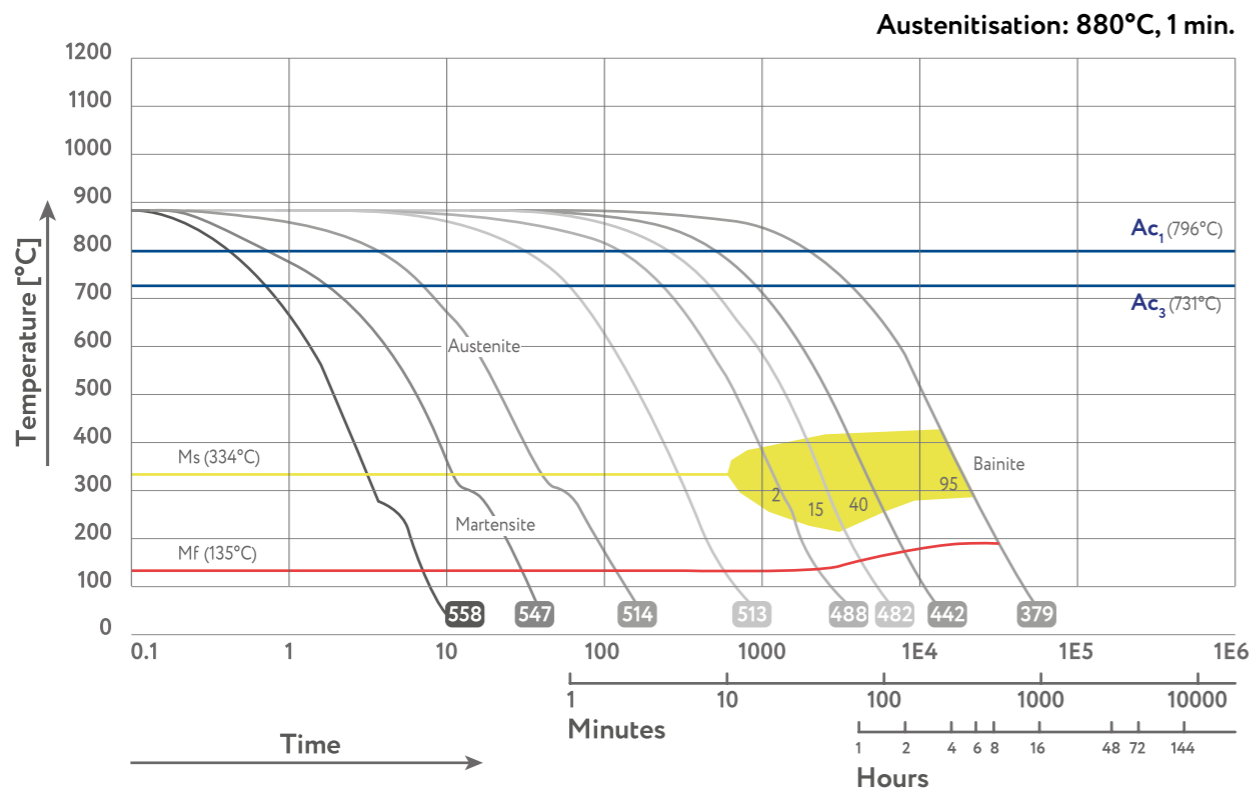




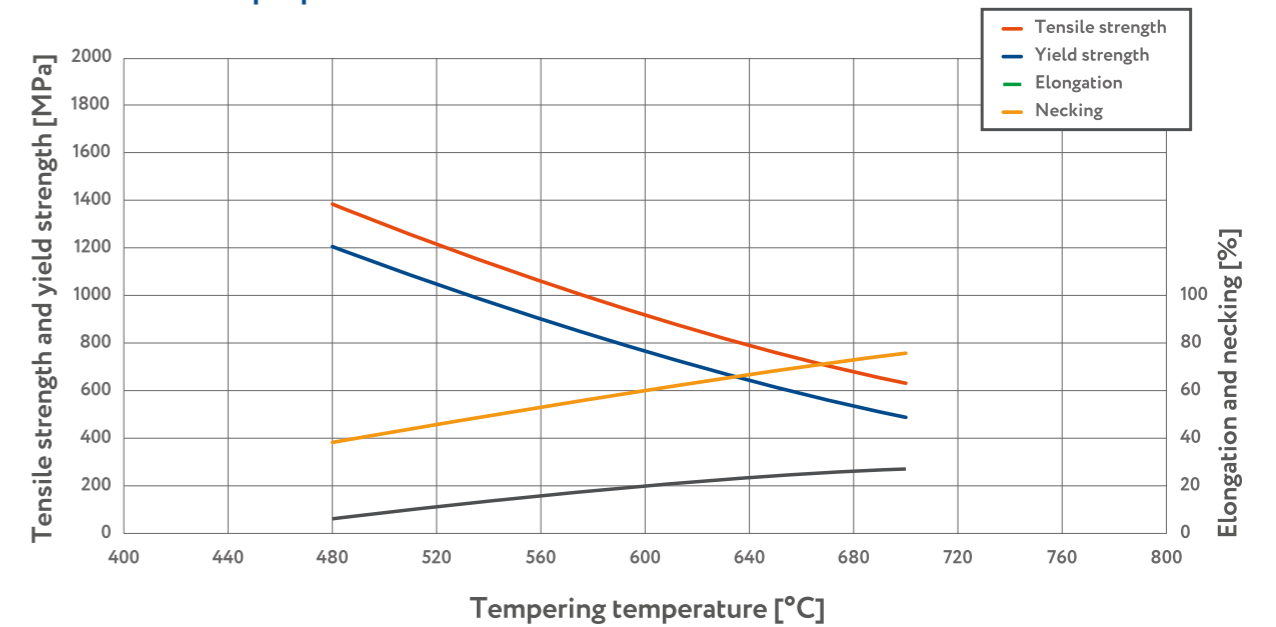
8 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 650 - 700 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 500 - 550 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 860 - 900 °C	Min. H.T. for 1 minute /mm	Polymer	-
Tempering	Heat to 550 - 610 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature

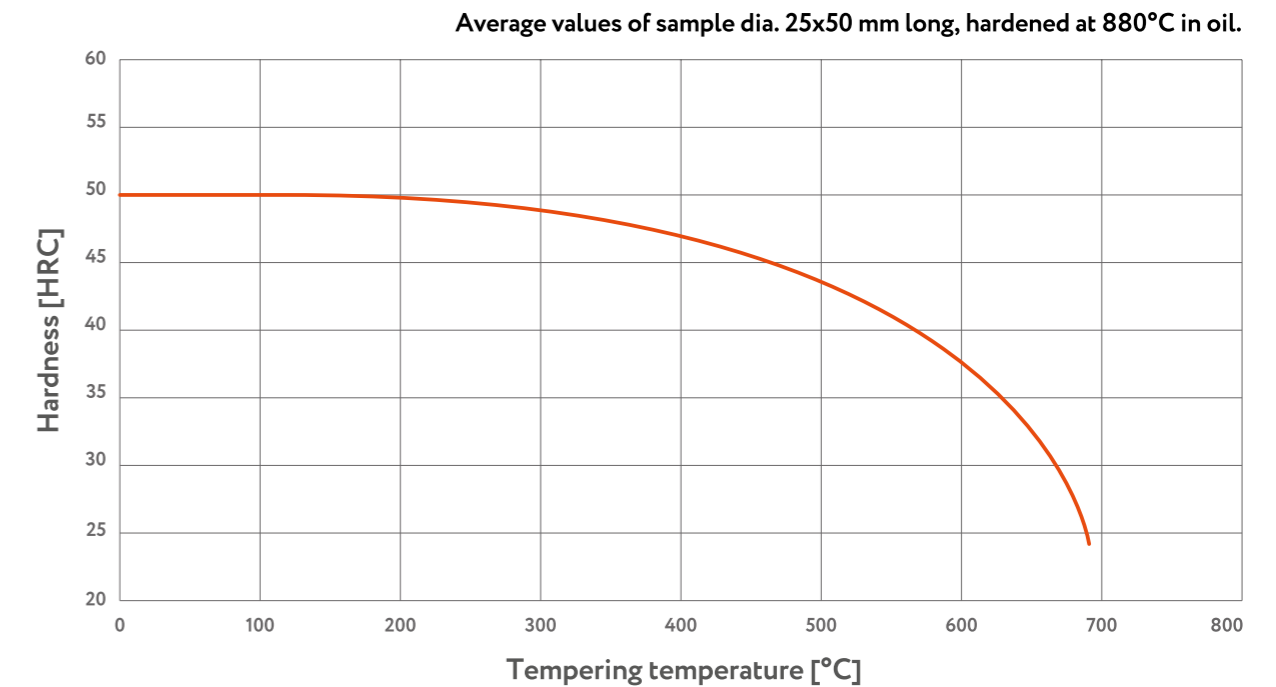
9 C.C.T. curve



10 Mechanical properties

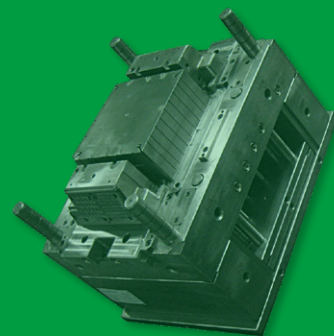


11 Tempering curve



1.2083

Plastic mould steel



1 Main characteristics and applications

Martensitic stainless steel with a high hardenability, good polishing properties, excellent resistance to corrosion and rust.

Its applications are plastic moulds, high wear resistance cavities particularly for processing of acid aggressive plastics (i.e. acetate and PVC), or plastics containing abrasive fillers. Suited for the manufacture of transparent plastics such as moulds for optical and medical products.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
X42Cr13	1.2083	X40Cr14	-	420C	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	P	S
0.40	0.70	0.50	13	0.025	0.003

4 Critical points

Ac1	790 °C
Ac3	850 °C
Ms	165 °C

5 Production technology

EAF - LF - VD - Forging - Heat treatment +A

6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

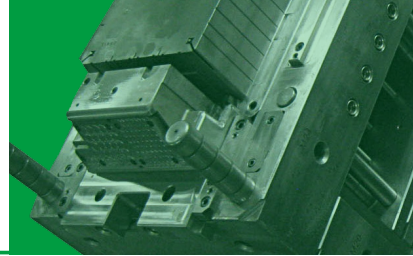
W1.2083 is delivered annealed condition, with hardness max 241 HB (23 HRC).

8 Physical properties (reference values)

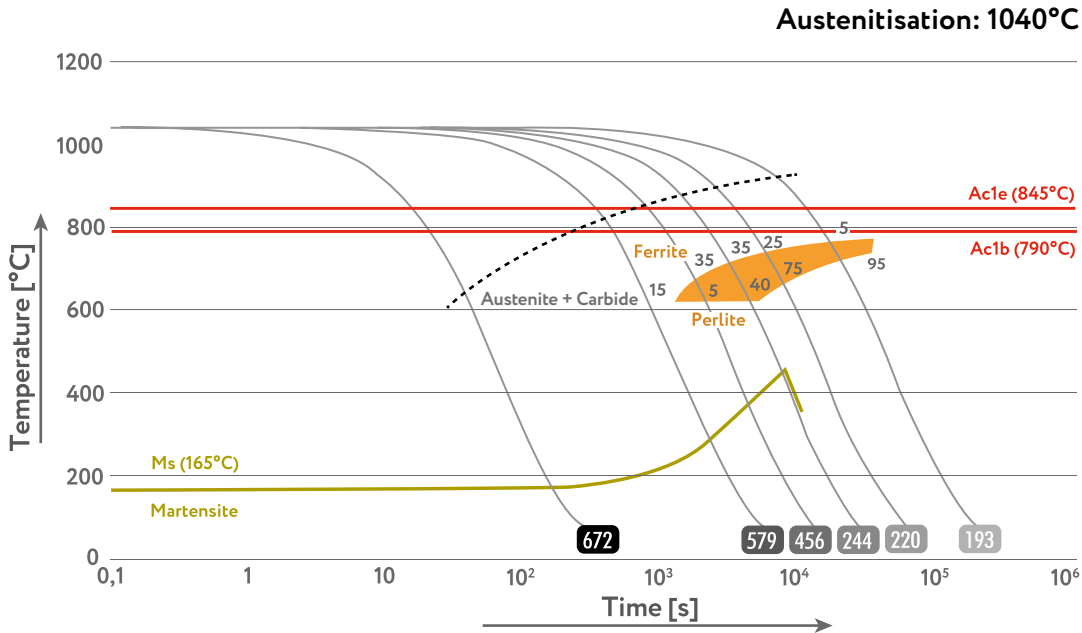
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.1	11.4	11.8	12.6
Thermal conductivity (W/mk)	20.5	22.1	23.6	25.1
Young modulus (Kn/mm ²)	218	210	202	180

9 Heat treatment

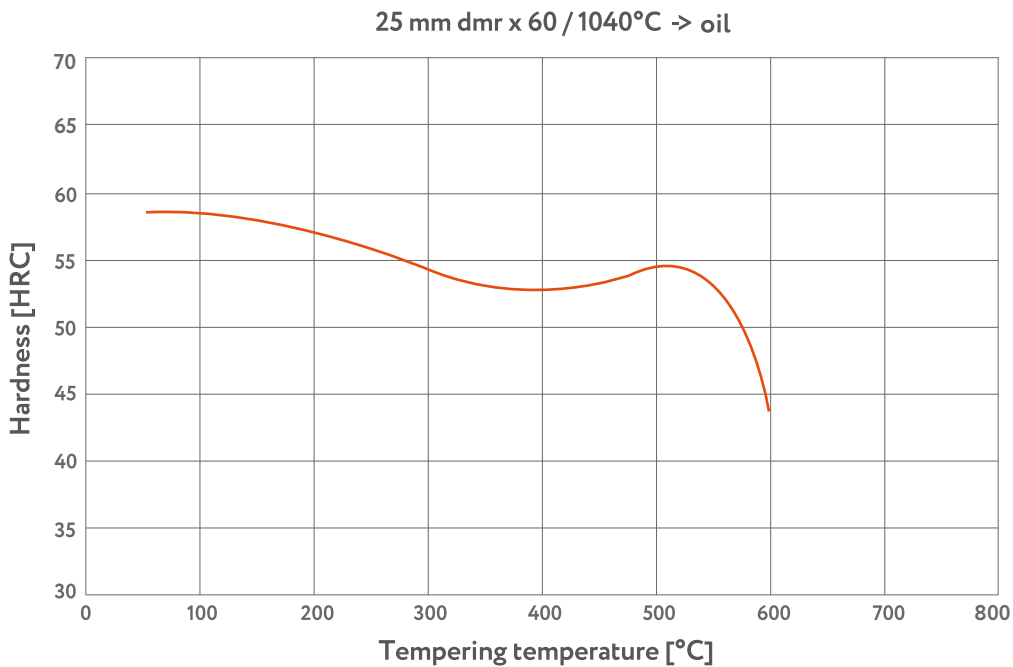
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 780 - 800 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 240 HB (23 HRC) to improve machinability
Stress relieving	Heat to 30 °C below tempering temperature	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 1000-1050 °C	Min. H.T. for 1 minute /mm	Oil - Gas air	-
Tempering	Heat to 170 - 270 °C	Min. H.T. for 3 minute /mm	Air	To be carried out soon after the hardening according to the required hardness; at 170 - 270°C in order to match hardness and resistance to corrosion; permanence for at least 2 hours; tempering must be repeated at least twice at a temperature 30°C lower than the previous



10 C.C.T. curve



11 Tempering curve



1.2083 ESR

Plastic mould steel



1 Main characteristics and applications

Martensitic stainless steel with a high hardenability, good polishing properties, excellent resistance to corrosion and rust.

Its applications are plastic moulds, high wear resistance cavities particularly for processing of acid aggressive plastics (i.e. acetate and PVC), or plastics containing abrasive fillers. Suited for the manufacture of transparent plastics such as moulds for optical and medical products.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
X42Cr13	1.2083	X40Cr14	-	420C	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	P	S
0.40	0.70	0.50	13	0.025	0.003

4 Critical points

Ac1	790 °C
Ac3	850 °C
Ms	165 °C

9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 780 - 800 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 240 HB (23 HRC) to improve machinability
Stress relieving	Heat to 30 °C below tempering temperature	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 1000-1050 °C	Min. H.T. for 1 minute /mm	Oil - Gas air	-
Tempering	Heat to 170 - 270 °C	Min. H.T. for 3 minute /mm	Air	To be carried out soon after the hardening according to the required hardness; at 170 - 270°C in order to match hardness and resistance to corrosion; permanence for at least 2 hours; tempering must be repeated at least twice at a temperature 30°C lower than the previous

5 Production technology

Electro - slag - remelting (ESR) - Forging - Heat treatment +A

6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

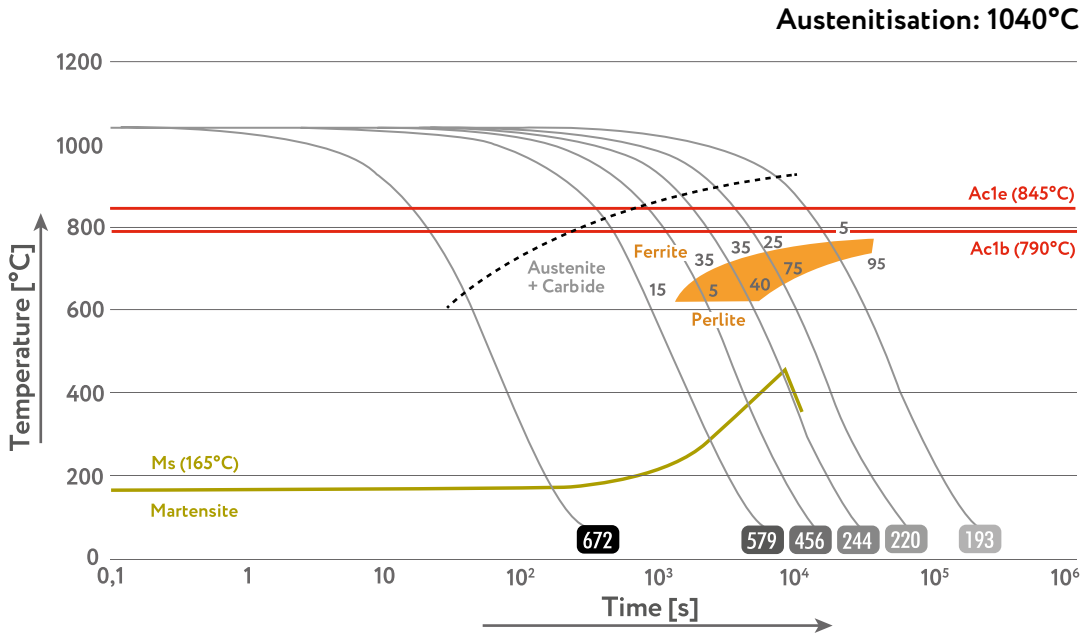
W1.2083 is delivered annealed condition, with hardness max 241 HB (23 HRC).

8 Physical properties (reference values)

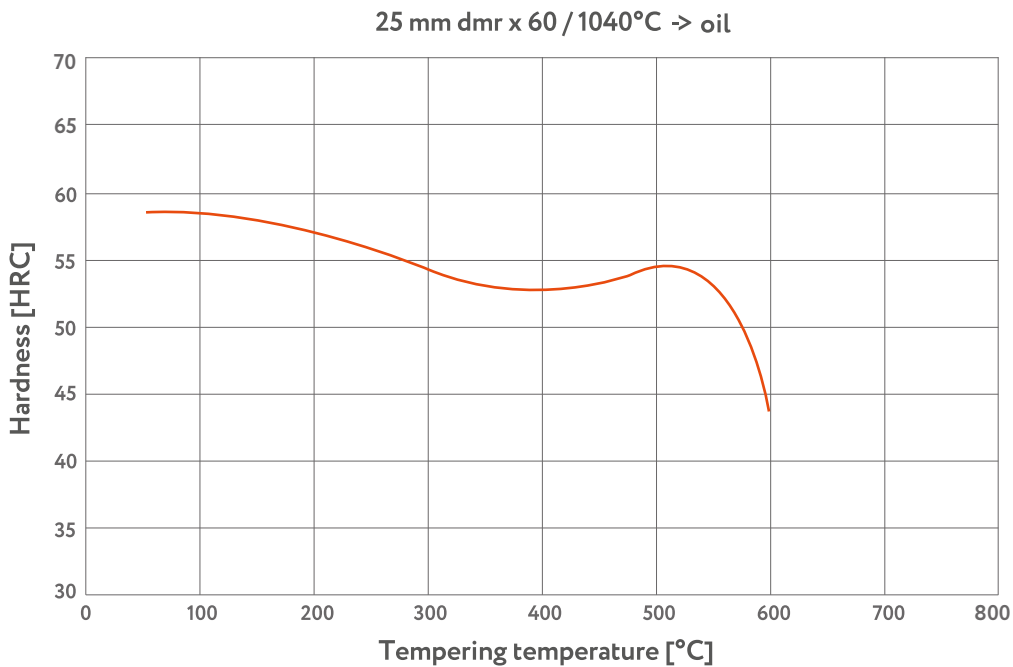
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10-6/K)	11.1	11.4	11.8	12.6
Thermal conductivity (W/mk)	20.5	22.1	23.6	25.1
Young modulus (Kn/mm2)	218	210	202	180



10 C.C.T. curve

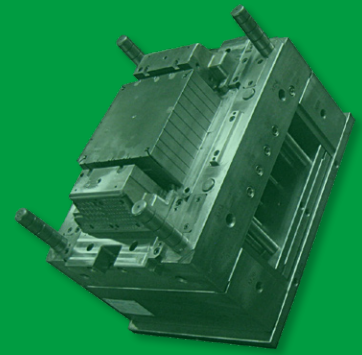


11 Tempering curve



1.2085

Plastic mould steel



1 Main characteristics and applications

Pre-hardened Martensitic stainless chromium steel with excellent corrosion resistance, higher than similar Cr grades (i.e. W1.2083) characterized by special alloying with the addition of Sulphur.

W1.2085 is used for core parts and mould bases of corrosion resistance plastic moulds or where equipment needs to be made with excellent workability and excellent corrosion resistance.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2085	~X33CrS16	~Z33CS16	~442+S	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	Ni	P	S
0.33	1.0	1.0	16	Max 1.0	Max 1.0	0.005	0.08

4 Production technology

EAF - LF - VD - Forging - Heat treatment QT

5 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

6 Delivery condition

W1.2085 is delivered in quenched and tempered condition, with hardness range 280 - 325 HB (29 - 35 HRC).

7 Physical properties (reference values)

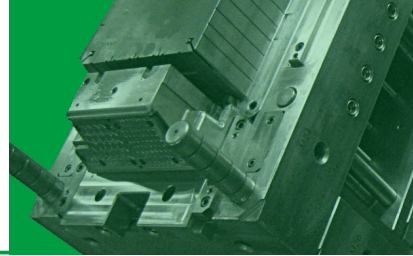
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	10.5	10.7	12	13.2
Thermal conductivity (W/mk)	22.2	22.7	21	24.5
Young modulus (Kn/mm ²)	215	211	203	180

8 Critical points

Ac1	790 °C
Ac3	890 °C
Ms	190 °C

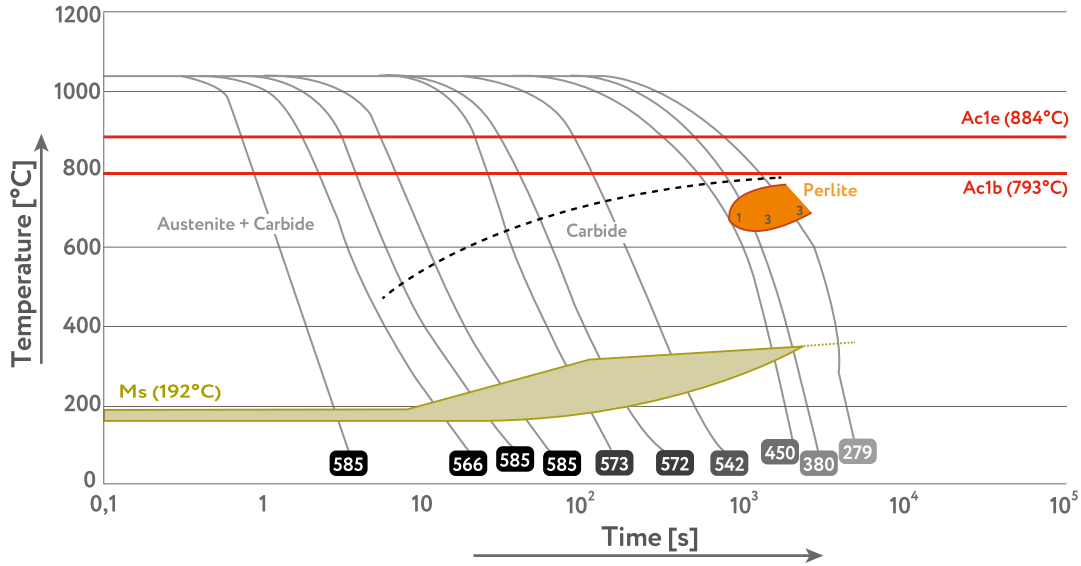
9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 850 - 880 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 250 HB (24 HRC) to improve machinability
Stress relieving	Heat to 590 - 650 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Heat to 1000 - 1050 °C	Min. H.T. for 1 minute /mm	Air or Polymer (depending of size)	-
Tempering	Heat to 550 - 610 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature



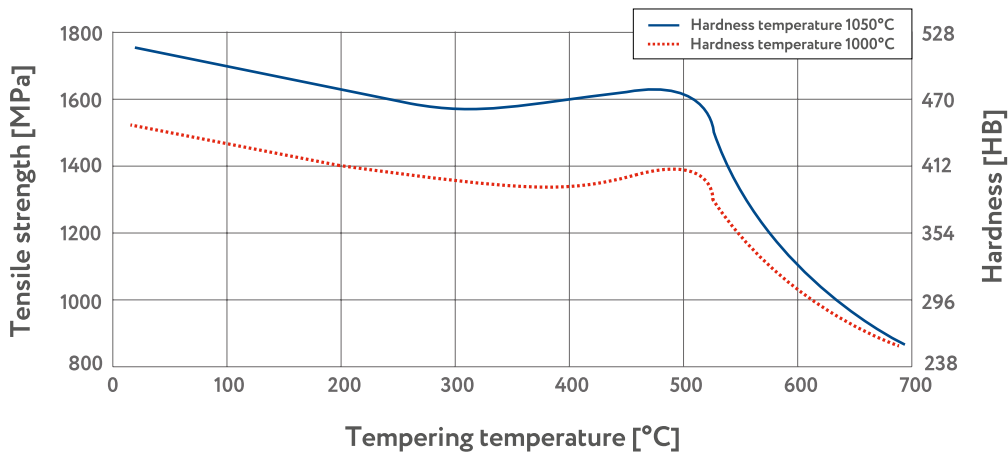
10 C.C.T. curve

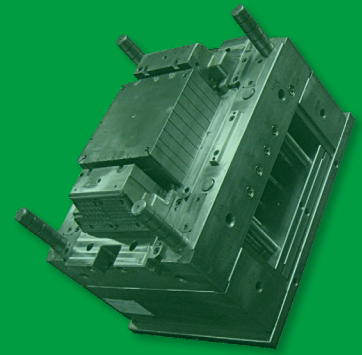
Austenitisation: 1035°C



11 Tempering curve

Holding time: 30 min./oil, Tempering: 2x2h, Specimen size: square 20x20mm





1 Main characteristics and applications

Pre-hardened Martensitic stainless Chromium steel with low Carbon, characterized by special alloying with the addition of Sulphur.

VR Stainless is used for core parts and mould bases of corrosion resistance plastic moulds or where equipment needs to be made with excellent workability and excellent corrosion resistance, dies for plastic extrusion, plastic and rubber molds.

VR Stainless offers the following advantages:

- high machinability.
- good corrosion resistance.
- uniform of hardness.
- improved weldability.
- good ductility.

2 Chemical composition (typical in weight %)

C	Mn	Si	Cr	Mo	P	S
0.07	1.1	0.40	12	Max 0.40	0.005	0.11

3 Production technology

EAF – LF – VD - Forging – Heat treatment QT

4 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/d

5 Delivery condition

VR Stainless is in delivered quenched and tempered condition, with hardness range 280-325HB (29–36 HRC)

6 Mechanical properties

Approximate values

Tensile test UNI EN ISO 6892-1

Impact test UNI EN ISO 148-1

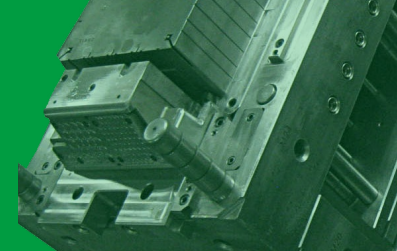
Specimen dimension	S ₀	L ₀	R _{0,2} %	R _m	A ₅	KvX-20°C
a x b (mm)	(mm ²)	(mm ²)	(N/mm ²)	(N/mm ²)	(%)	(J)
25,1 x 11	276,1	95	786	1076	10	26
25 x 11	275	95	800	1078	10	24
25 x 11	275	95	1040	1074	11	24

7 Inclusion content

Microcleanliness: to ASTM E 45 method A: The check must be carried out as per ASTM E 45 met. A. The maximum permissible grade in the worst filed must be but not certificate:

ASTM E 45	At	Ah	Bt	Bh	Ct	Ch	Dt	Dh
max	-	-	1,5	1,0	1,0	0,5	1,0	0,5

Sulphide Type A, not considered for S 0,12%



8 Physical data

Approximate values

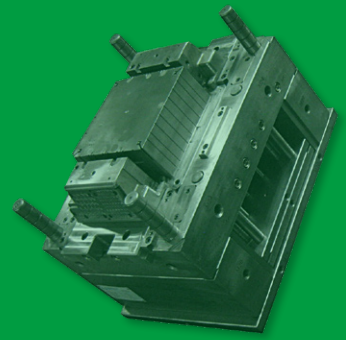
PHYSICAL DATA

Temperature	20°C	100°C	200°C
Density	7800	-	7750
Kg/m ³			
Modulus of elasticity	200000	-	190000
N/mm ²			
Coefficient of thermal expansion	-	10.7 x 10 ⁻⁶	10.8 x 10 ⁻⁶
1/°C from 20°C			
Thermal conductivity	27,5	28,1	27,9
W/m °C			
Btu in/(ft ² h °F)	190	195	193



1.2316

Plastic mould steel



1 Main characteristics and applications

Pre-hardened stainless martensitic chrome- molybdenum steel with excellent resistance to corrosion, higher than similar Cr grades (i.e. W1.2083), good polishing and photoengraving properties.

Its applications are equipments and plastic moulds, particularly for corrosive plastic as PVD.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2316	~X36CrMo17	~Z35CD17	~442	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	Ni	P	S
0.40	0.7	0.30	15.5	1	0.5	0.005	0.003

4 Production technology

EAF - LF - VD - Forging - Heat treatment QT

5 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

6 Delivery condition

W1.2316 is delivered in quenched and tempered condition, with hardness range 280 - 325 HB (29 - 35 HRC) or in annealed condition with hardness max 240 HB (23 HRC)

7 Critical points

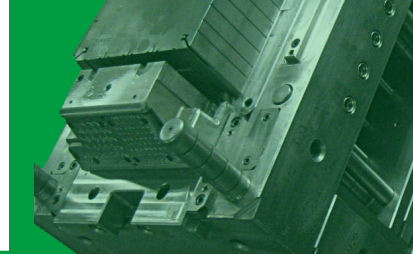
Ac1	800 °C
Ac3	910 °C
Ms	200 °C

8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	10.4	10.7	11	11.9
Thermal conductivity (W/mk)	23.5	23.9	24.2	23.2
Young modulus (Kn/mm ²)	218	209	202	180

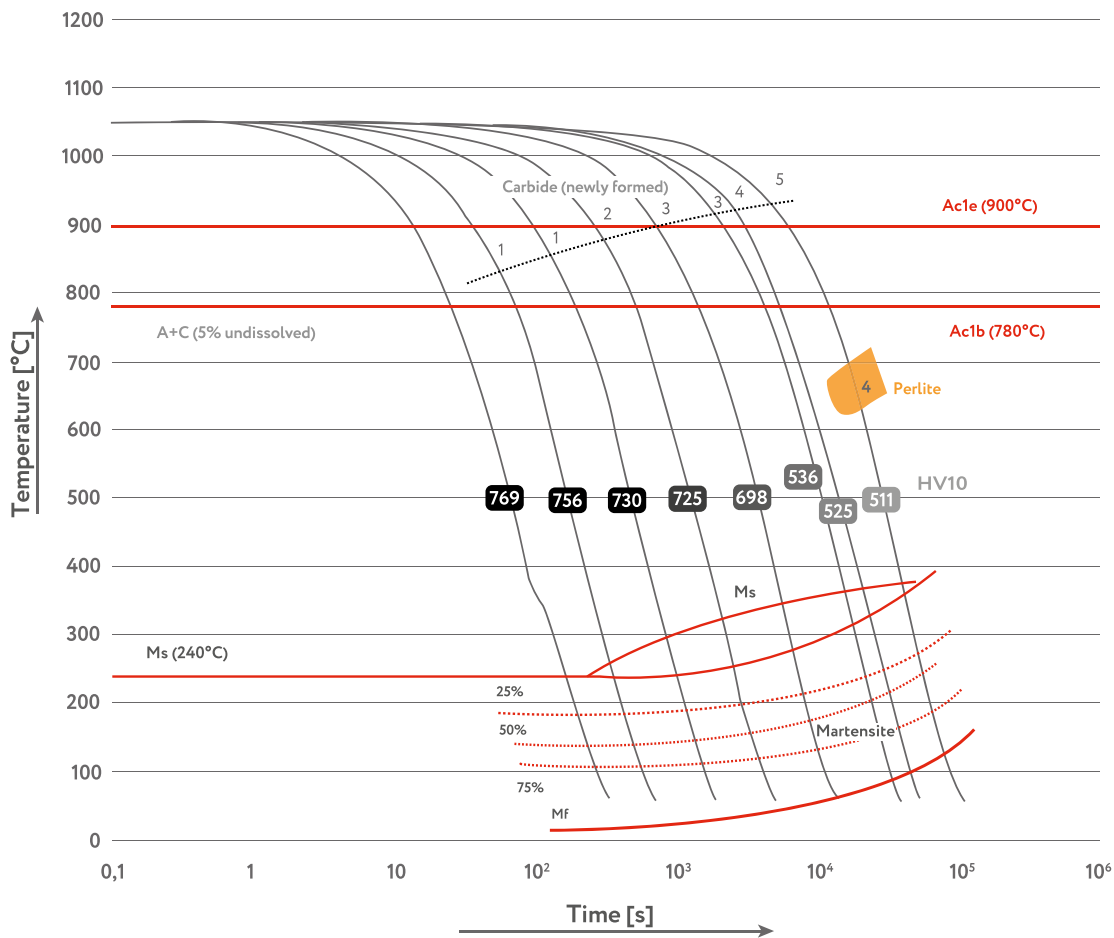
9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 770 - 820 °C	Min. H.T. for 2 minute /mm	Furnace up to 600°C than in air	-
Stress relieving	Heat to 550 - 600 °C	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 600-700°C Austenitizing to 1000 - 1050 °C	Min. H.T. for 1 minute /mm	Polymer or gas air	Quenched hardness 50 HRC
Tempering	-	-	Air	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature



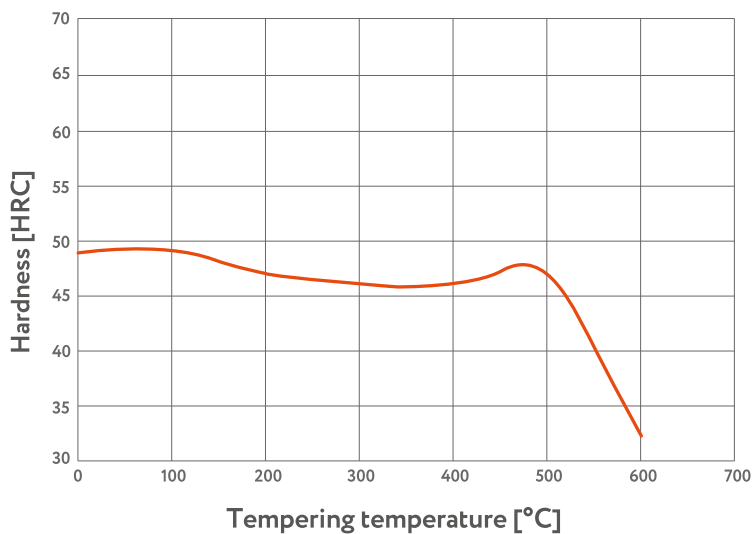
10 C.C.T. curve

Austenitisation: 1050°C, 15 min.



11 Tempering curve

Tempering diagram 2316

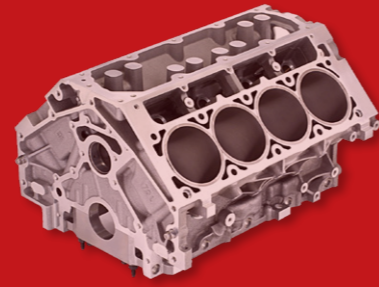




HOT WORK

1.2343

Hot working steel



1 Main characteristics and applications

Hot working special steel with high wear resistance associated with special thermal fatigue properties. Steel can be air hardened or pressure gas (vacuum) which makes it possible to reduce distortion and cracks caused by heat treatment.

At working hardness of 50HRC excellent toughness and is therefore suitable for use in a wide field of operating condition.

This steel is used for tools as:

- dies for the pressure casting of light alloys.
- wear resistance moulds for plastic processing.
- dies for friction and mechanical presses for hot forming of steel, brass, aluminum and its alloys.
- extrusion dies for aluminum processing.
- hot work shear blades.

To raise lifetime of tools this steel can be submitted to surface treatment as thermo-chemical treatments on the tools or nitriding (ion – saline – gaseous).

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
(X37CrMoV51KU)	1.2343	~X38CrMoV5-1	Z38CDV5	~H11	~BH11

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	P	S	V
0.39	0.4	1	5	1.2	0.015	0.003	0.4

4 Critical points

Ac1	840 °C
Ac3	880 °C
Ms	260 °C

5 Production technology

EAF – LF – VD – Forging – Heat treatment +EFS

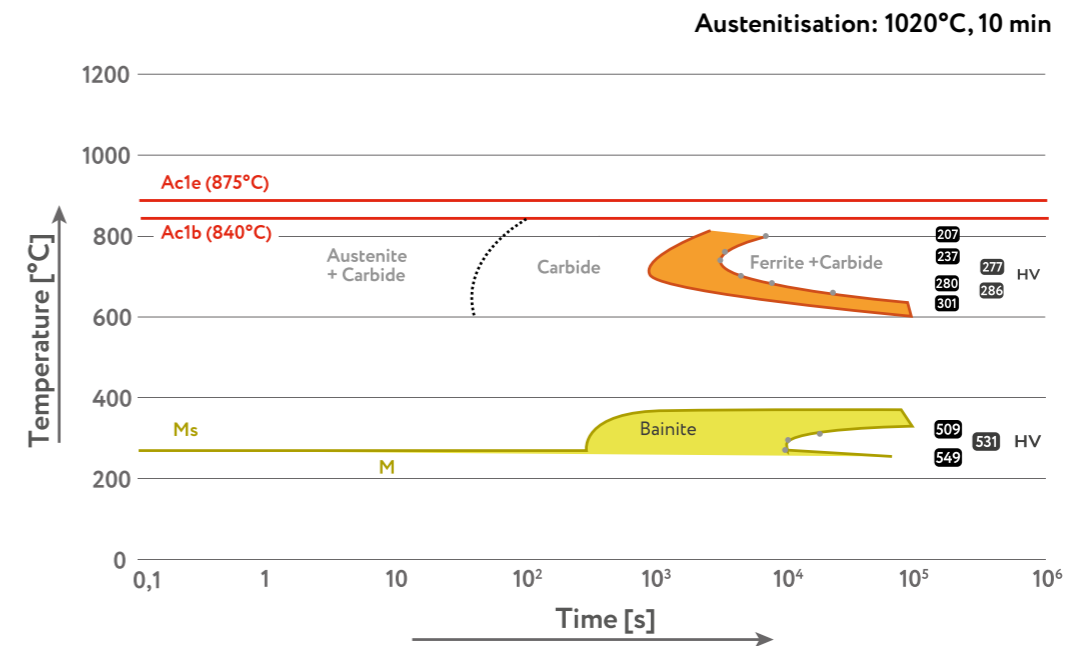
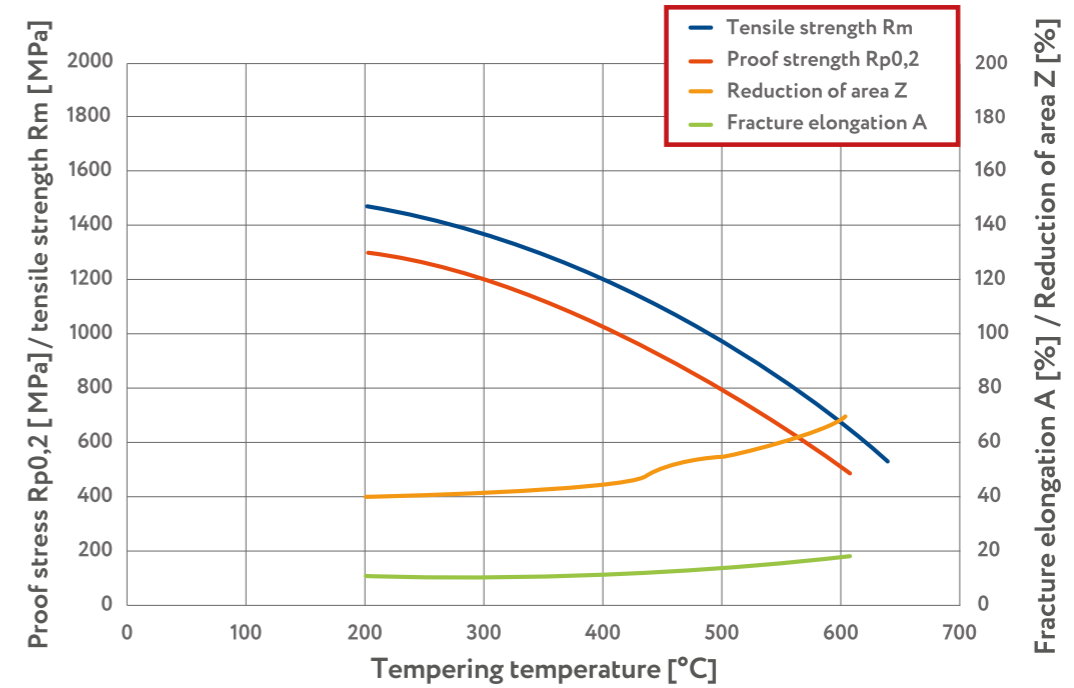
6 US specification

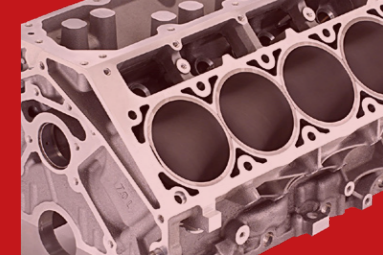
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

W1.2343 is delivered in annealed condition (EFS), with hardness max 230 HB (21 HRC)

12 Tempering curve





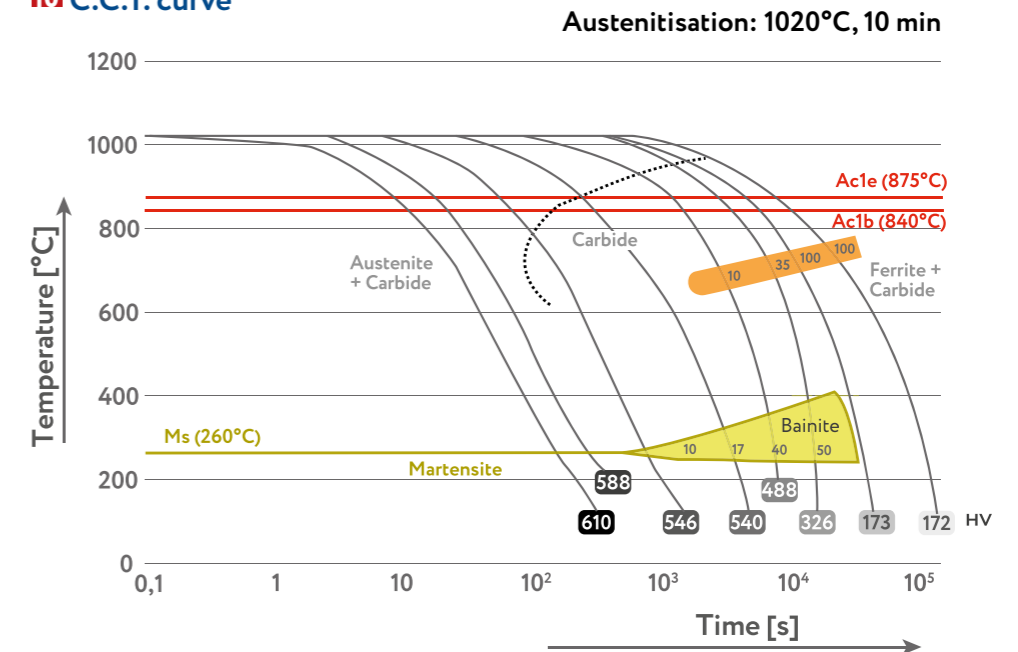
8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.3	11.7	12.1	13.2
Thermal conductivity (W/mk)	18.8	19	22.9	24.9
Young modulus (Kn/mm ²)	212	209	197	175

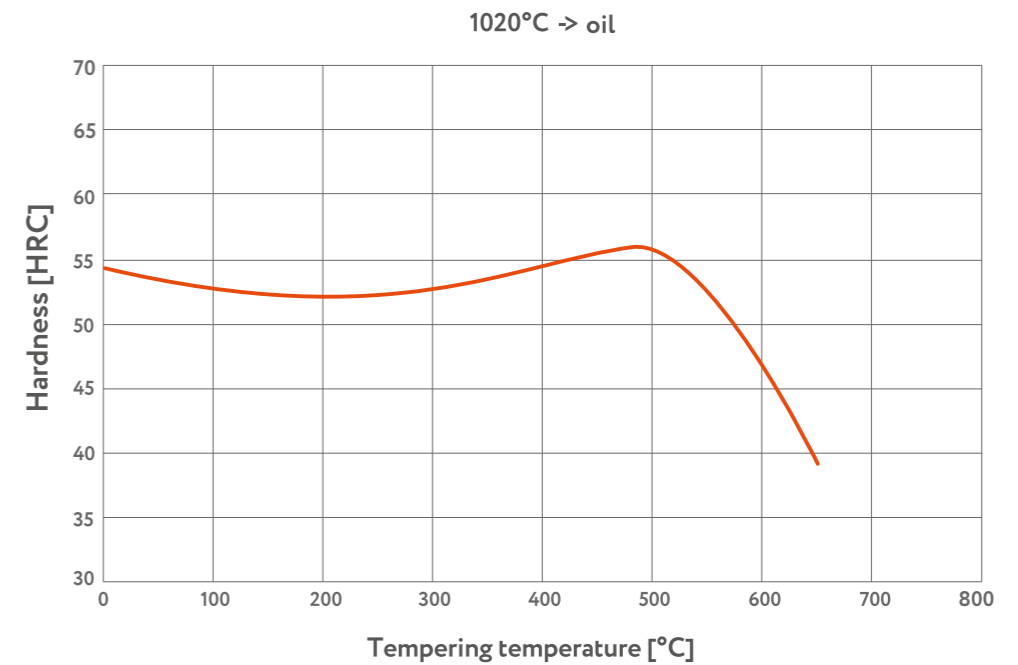
9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 850 °C	Min. H.T. for 2 minute /mm	Furnace up to 550°C than in air	-
Stress relieving	Heat to 650-700°C	Min. H.T. for 2 minute /mm	Furnace up to 300-350°C	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 350-400°C Second preheating to 750-850°C Heat to hardening temperature to 1000-1020°C	Min. H.T. for 1 minute /mm	Air or pressure gas by vacuum	Quenched hardness 52-56HRC
Tempering	In the range 550 – 600°C for at least 3 h according to hardness requirements and conditions of use. Tempering must be repeated a second time at a temperature equal to or 20°C lower than the previous. Before tempering, the parts must be preheated to 200 – 300°C		Air	Usual service hardness: 48-52 HRC

10 C.C.T. curve



11 Tempering curve



1.2343 ESR

Hot working steel



1 Main characteristics and applications

Hot working special steel with high wear resistance associated with special thermal fatigue properties. Steel can be air hardened or pressure gas (vacuum) which makes it possible to reduce distortion and cracks caused by heat treatment.

At working hardness of 50HRC excellent toughness and is therefore suitable for use in a wide field of operating condition.

This steel is used for tools as:

- dies for the pressure casting of light alloys.
- wear resistance moulds for plastic processing.
- dies for friction and mechanical presses for hot forming of steel, brass, aluminum and its alloys.
- extrusion dies for aluminum processing.
- hot work shear blades.

To raise lifetime of tools this steel can be submitted to surface treatment as thermo-chemical treatments on the tools or nitriding (ion – saline – gaseous).

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
(X37CrMoV51KU)	1.2343	~X38CrMoV5-1	Z38CDV5	~H11	~B111

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	P	S	V
0.39	0.4	1	5	1.2	0.015	0.003	0.4

4 Critical points

Ac1	840 °C
Ac3	880 °C
Ms	260 °C

5 Production technology

Electro-slag-remelting (ESR) - Forging - Heat treatment +EFS

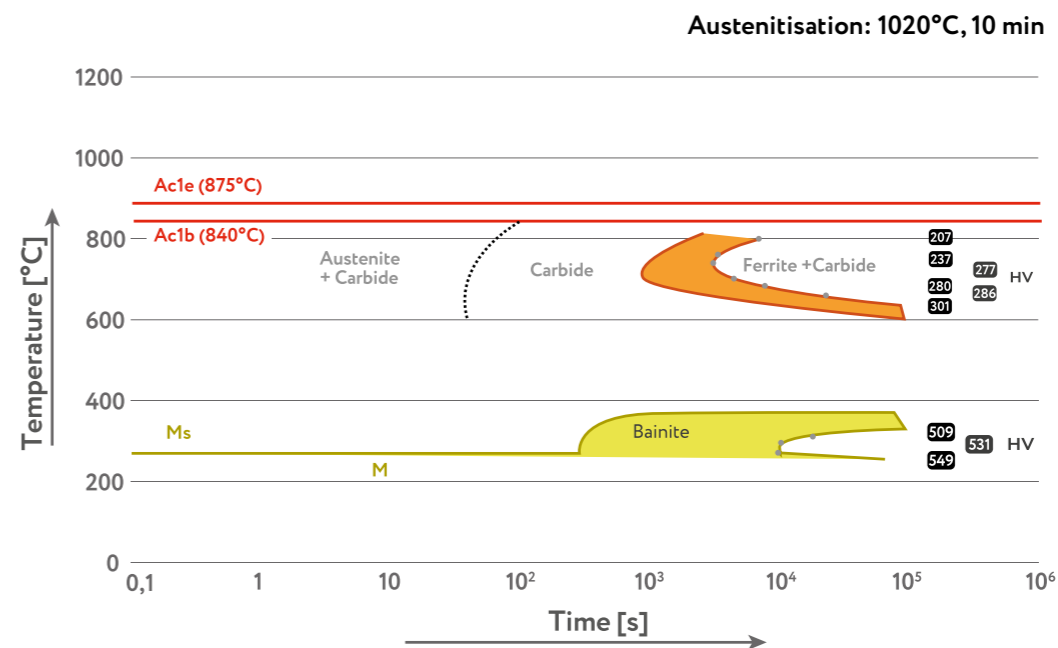
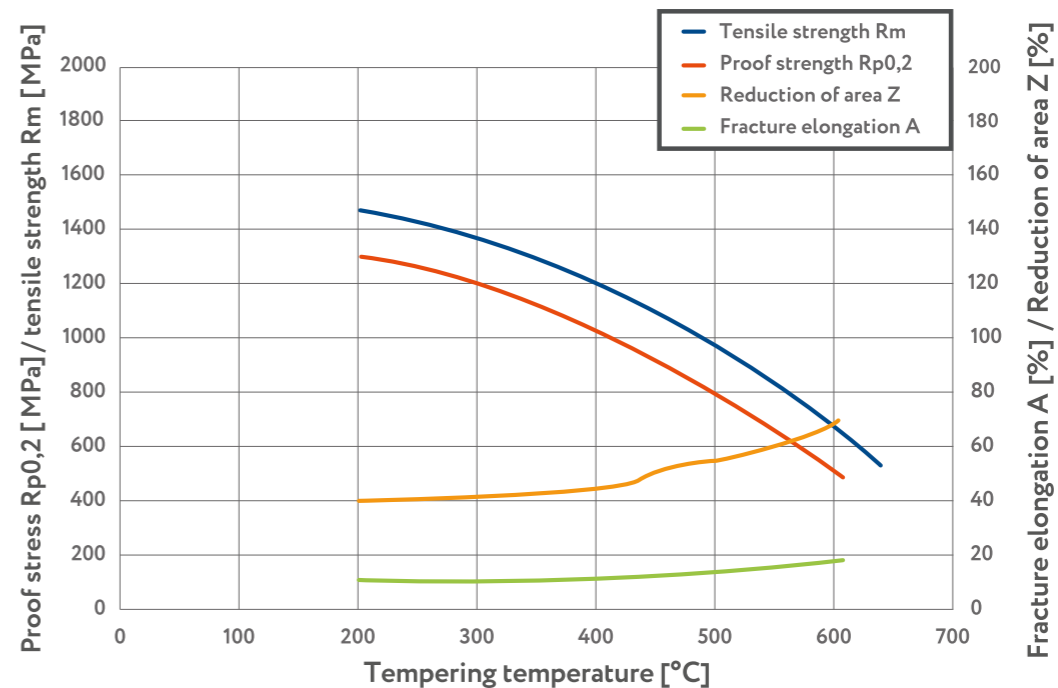
6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

W1.2343 is delivered in annealed condition (EFS), with hardness max 230 HB (21 HRC)

12 Tempering curve



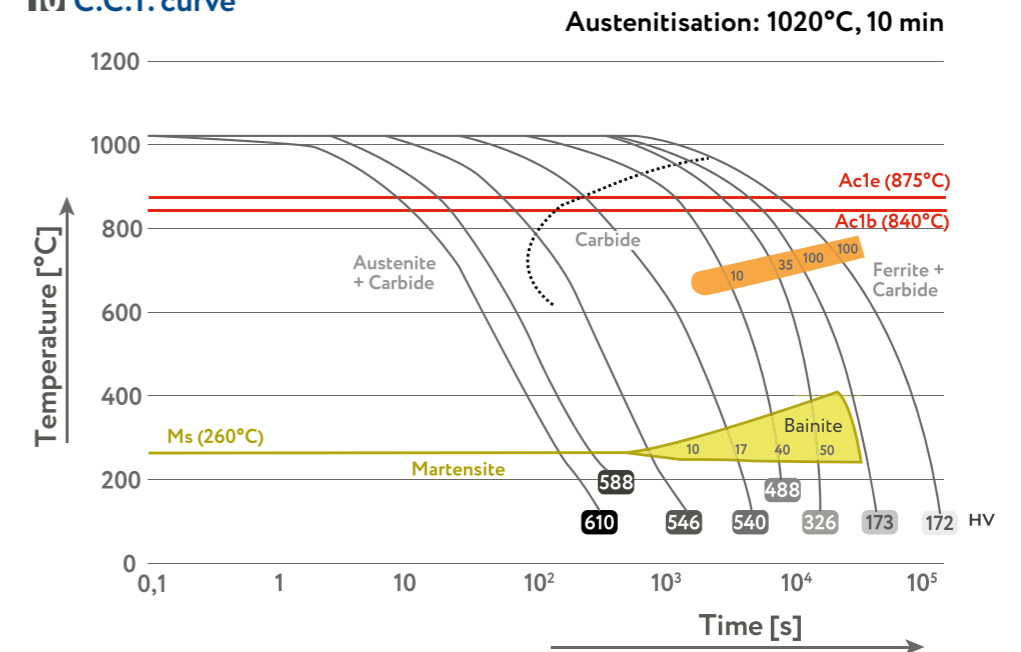
8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.3	11.7	12.1	13.2
Thermal conductivity (W/mk)	18.8	19	22.9	24.9
Young modulus (Kn/mm ²)	212	209	197	175

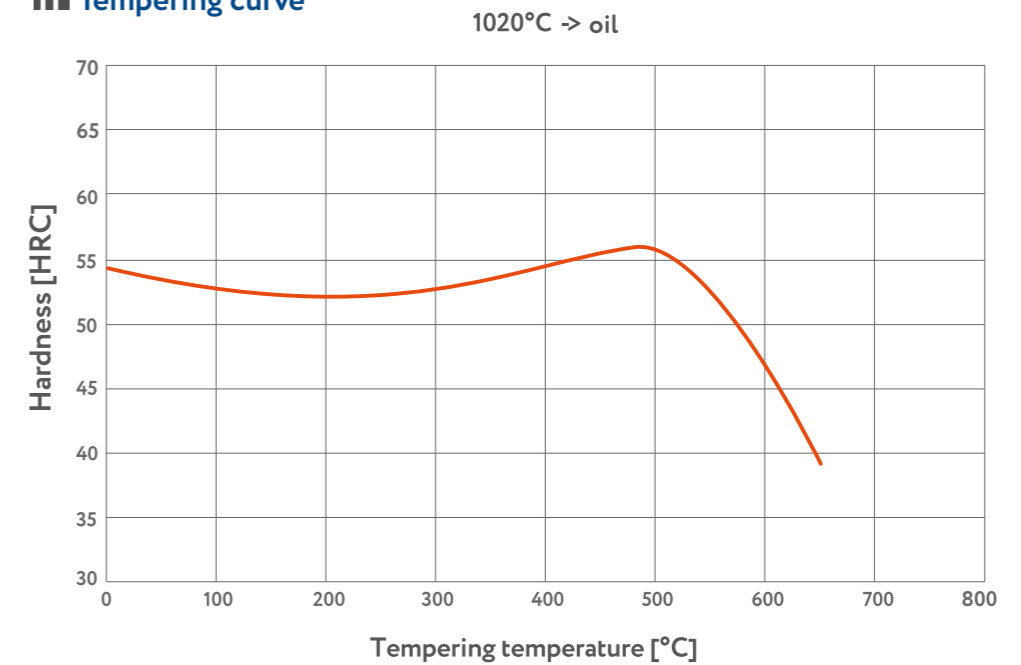
9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 850 °C	Min. H.T. for 2 minute /mm	Furnace up to 550°C than in air	-
Stress relieving	Heat to 650-700°C	Min. H.T. for 2 minute /mm	Furnace up to 300-350°C	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 350-400°C Second preheating to 750-850°C Heat to hardening temperature to 1000-1020°C	Min. H.T. for 1 minute /mm	Air or pressure gas by vacuum	Quenched hardness 52-56HRC
Tempering	In the range 550 – 600°C for at least 3 h according to hardness requirements and conditions of use. Tempering must be repeated a second time at a temperature equal to or 20°C lower than the previous. Before tempering, the parts must be preheated to 200 – 300°C		Air	Usual service hardness: 48-52 HRC

10 C.C.T. curve

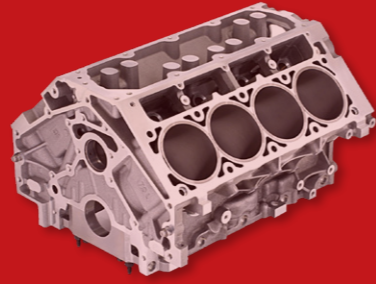


11 Tempering curve



1.2344

Hot working steel



1 Main characteristics and applications

High wear resistance hot-working steel, also be used for wear resistance and polished plastic moulds. Steel is easy to machine in the annealed condition and needs a hardening process before final machining. This steel also shows excellent toughness and high level insensitivity to thermal shock and thermal fatigue. A nitriding surface treatment can be carried out to increase the life of the tooling.

Main applications:

- dies for the pressure casting of light alloys.
- wear resistance plastic moulds.
- tooling for the extrusion of light alloys and steels.
- hot work shear blades.
- rolls for profiling tools (welding area).
- Forging dies.

Hot working tools should be preheated to temperatures in the range 250 – 300°C before use.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
(X40CrMoV51.1KU)	1.2344	X40CrMoV5-1	-	(H13)	(BH13)

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	P	S	V
0.39	0.4	1	5	1.3	0.015	0.003	1

4 Critical points

Ac1	860 °C
Ac3	940 °C
Ms	340 °C

5 Production technology

EAF - LF - VD - Forging - Heat treatment +EFS

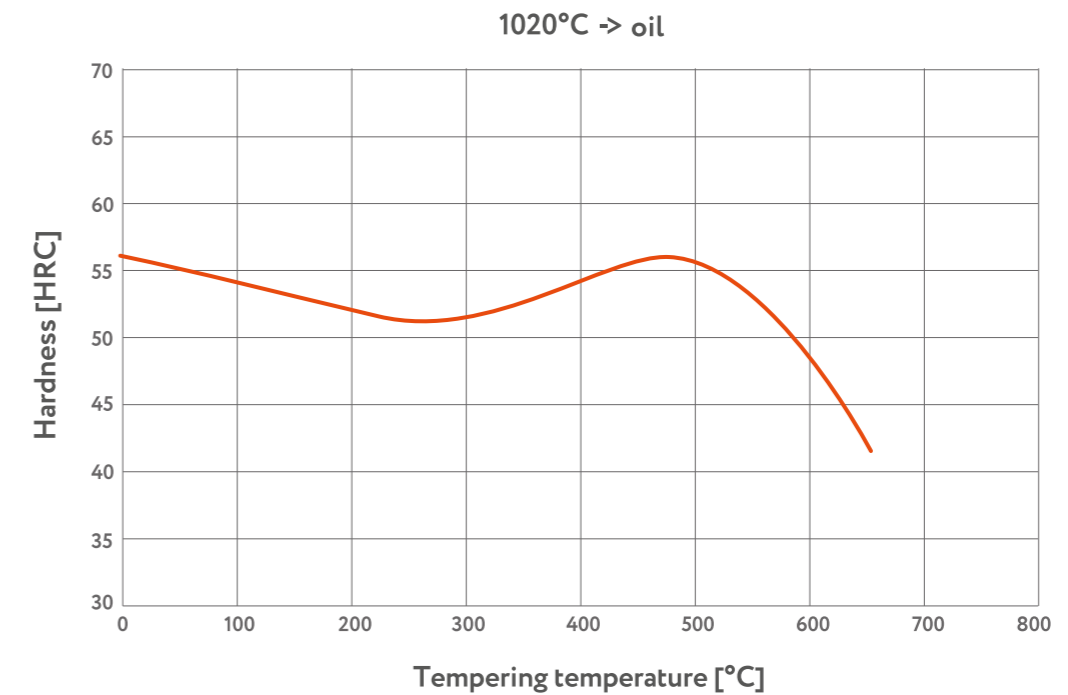
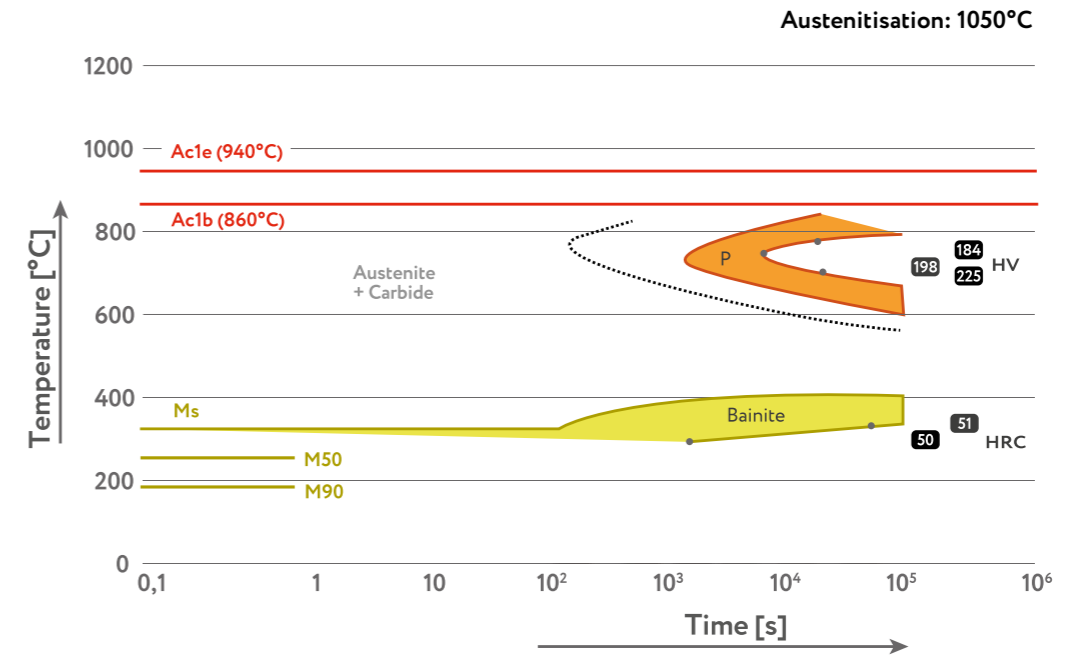
6 US specification

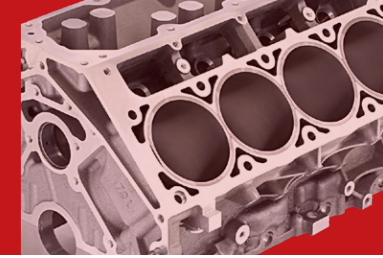
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

W1.2344 is delivered in annealed condition (EFS), with hardness max 230 HB (21 HRC)

11 Tempering curve





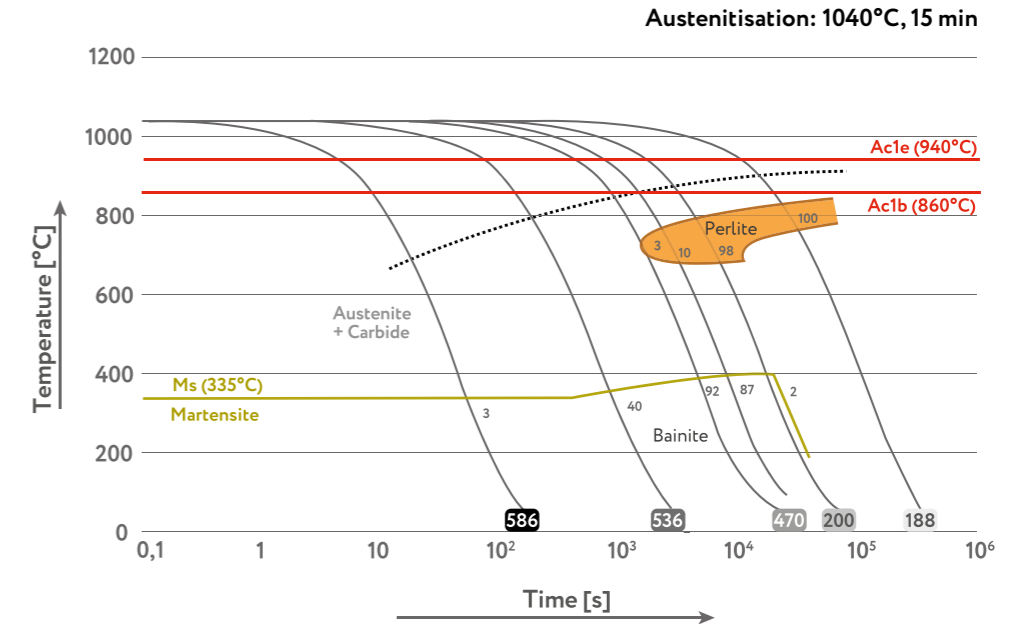
8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.3	11.6	12	13
Thermal conductivity (W/mk)	18.8	19	22.9	25.1
Young modulus (Kn/mm ²)	212	209	197	175

9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 850 °C	Min. H.T. for 2 minute /mm	Furnace up to 550°C than in air	-
Stress relieving	Heat to 650-700°C	Min. H.T. for 2 minute /mm	Furnace up to 300-350°C	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 350-400°C Second preheating to 750-850°C Heat to hardening temperature to 1000-1020°C	Min. H.T. for 1 minute /mm	Air or pressure gas by vacuum	Quenched hardness 52-56HRC
Tempering	In the range 550 – 600°C for at least 3 h according to hardness requirements and conditions of use. Tempering must be repeated a second time at a temperature equal to or 20°C lower than the previous. Before tempering, the parts must be preheated to 200 – 300°C		Air	Usual service hardness: 44-52 HRC

10 C.C.T. curve



1.2344 ESR

Hot working steel



1 Main characteristics and applications

High wear resistance hot-working steel, also be used for wear resistance and polished plastic moulds.

Steel is easy to machine in the annealed condition and needs a hardening process before final machining.

This steel also shows excellent toughness and high level insensitivity to thermal shock and thermal fatigue.

A nitriding surface treatment can be carried out to increase the life of the tooling.

Main applications:

- dies for the pressure casting of light alloys.
- wear resistance plastic moulds.
- tooling for the extrusion of light alloys and steels.
- hot work shear blades.
- rolls for profiling tools (welding area).
- Forging dies.

Hot working tools should be preheated to temperatures in the range 250 – 300°C before use.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
(X40CrMoV5.1KU)	1.2344	X40CrMoV5-1	-	(H13)	(BH13)

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	P	S	V
0.39	0.4	1	5	1.3	0.015	0.003	1

4 Critical points

Ac1	860 °C
Ac3	940 °C
Ms	340 °C

5 Production technology

Electro-slag-remelting (ESR) - Forging – Heat treatment +EFS

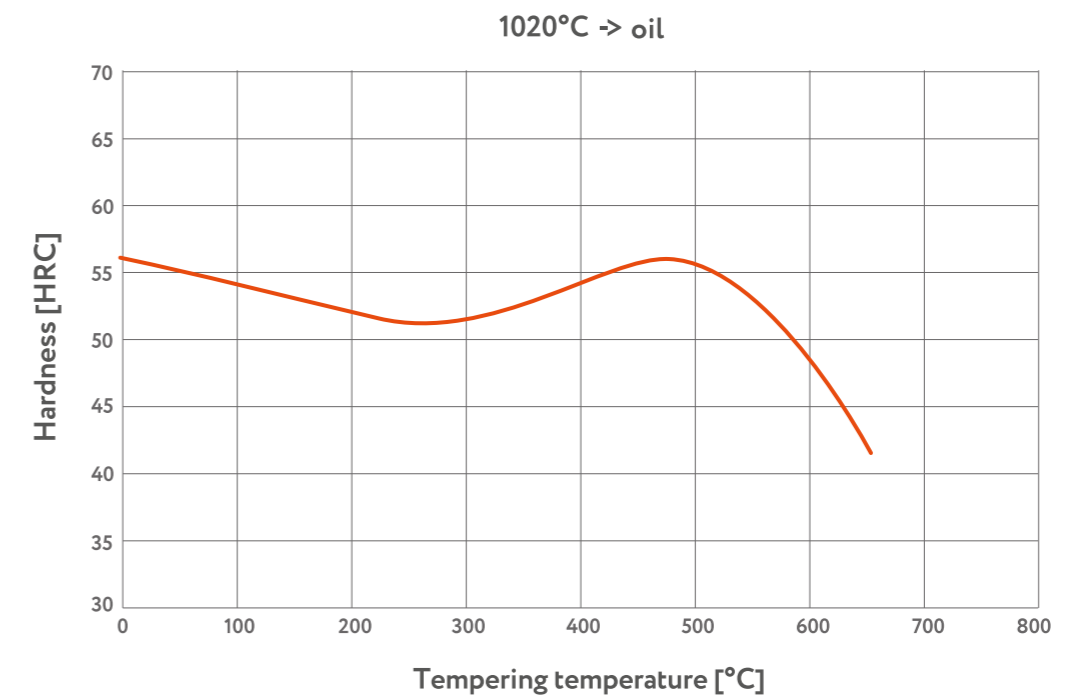
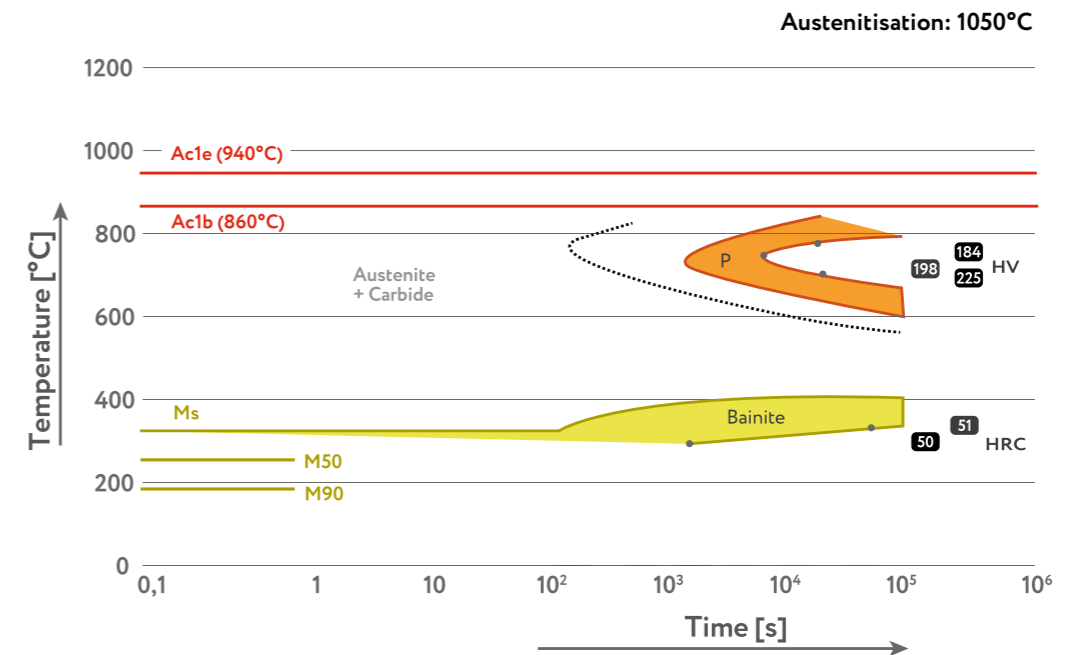
6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

W1.2344 is delivered in annealed condition (EFS), with hardness max 230 HB (21 HRC)

11 Tempering curve





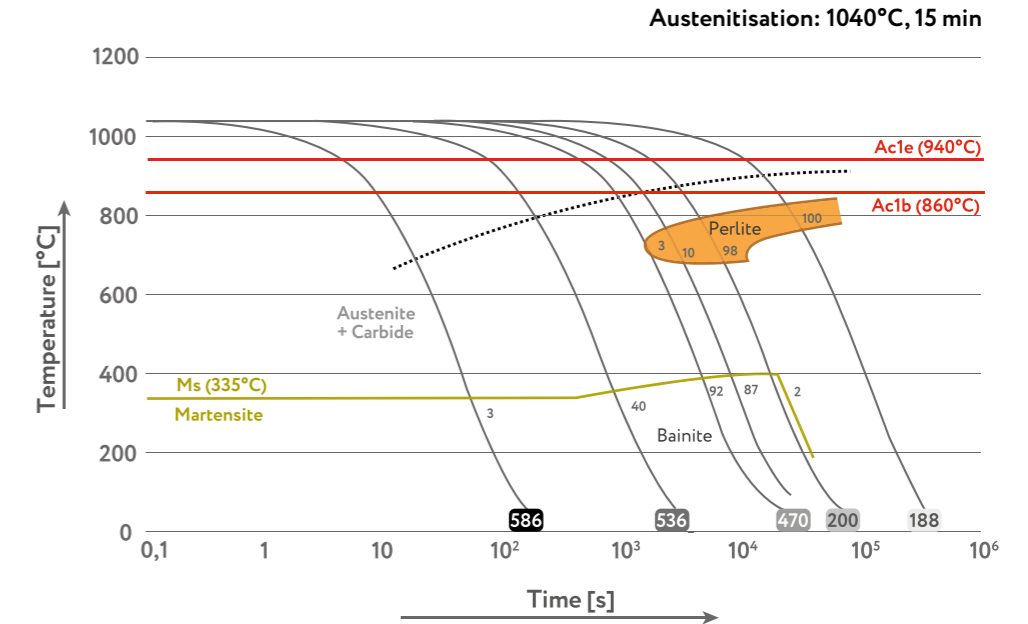
8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.3	11.6	12	13
Thermal conductivity (W/mk)	18.8	19	22.9	25.1
Young modulus (Kn/mm ²)	212	209	197	175

9 Heat treatment

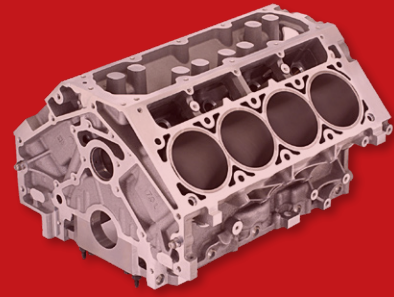
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 850 °C	Min. H.T. for 2 minute /mm	Furnace up to 550°C than in air	-
Stress relieving	Heat to 650-700°C	Min. H.T. for 2 minute /mm	Furnace up to 300-350°C	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 350-400°C Second preheating to 750-850°C Heat to hardening temperature to 1000-1020°C	Min. H.T. for 1 minute /mm	Air or pressure gas by vacuum	Quenched hardness 52-56HRC
Tempering	In the range 550 – 600°C for at least 3 h according to hardness requirements and conditions of use. Tempering must be repeated a second time at a temperature equal to or 20°C lower than the previous. Before tempering, the parts must be preheated to 200 – 300°C		Air	Usual service hardness: 44-52 HRC

10 C.C.T. curve



1.2367

Hot working steel



1 Main characteristics and applications

3% Molybdenum alloyed hot working steel for very high thermal stress and hot strength.

For wear sensitive hot working tools and inserts.

To be used for die casting inserts, forging machine dies, mandrels hot extrusion tools, hot shear blades.

Steel can be nitrided after hardening and final machining.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2367	X38CrMoV5-3	-	-	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	P	S	Cr	Mo	V
0.38	0.42	0.35	0.020	0.003	5	3	0.50

4 Production technology

EAF - LF - VD - Forging - Heat treatment +A

5 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

6 Delivery condition

W1.2367 is delivered in annealed condition, with hardness max 229 HB (21 HRC).

7 Critical points

Ac1	860°C
Ac3	940°C
Ms	265°C

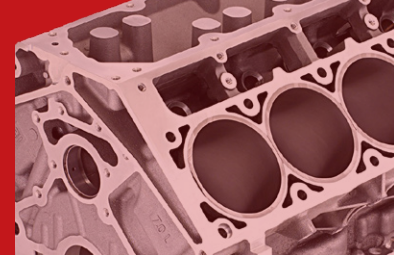
8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.3	11.7	12	13
Thermal conductivity (W/mk)	18.8	19	22.9	24.9
Young modulus (Kn/mm ²)	212	209	201	175

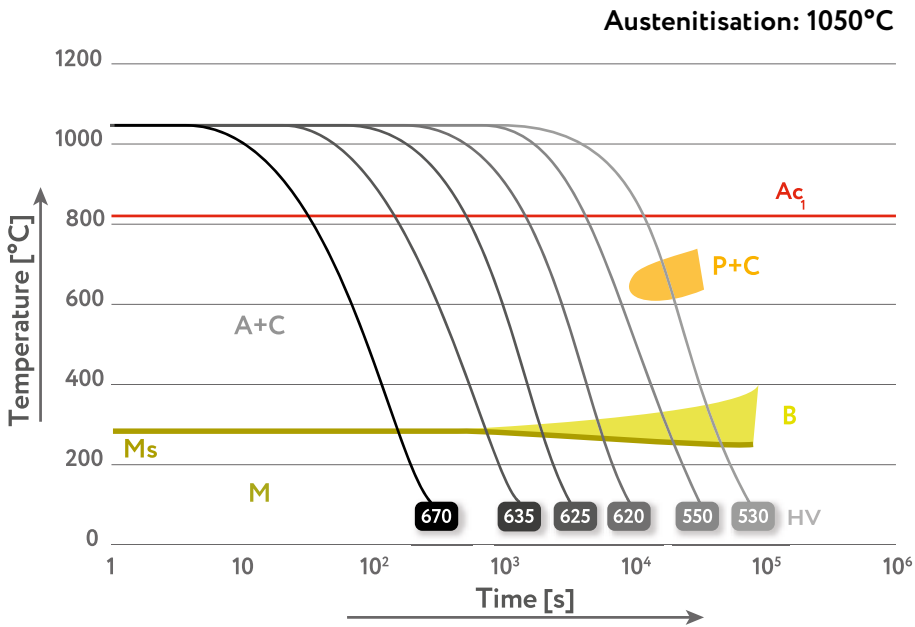
9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 850 °C	Min. H.T. for 2 minute /mm	Furnace up to 600°C	-
Stress relieving	Heat to 600-650°C	Min. H.T. for 2 minute /mm	Furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheating to 350-400°C Second preheating to 750-800°C Austenitizing to 1030-1050°C	Min. H.T. for 1 minute /mm	Air, vacuum, oil	Quenched hardness 53-58HRC

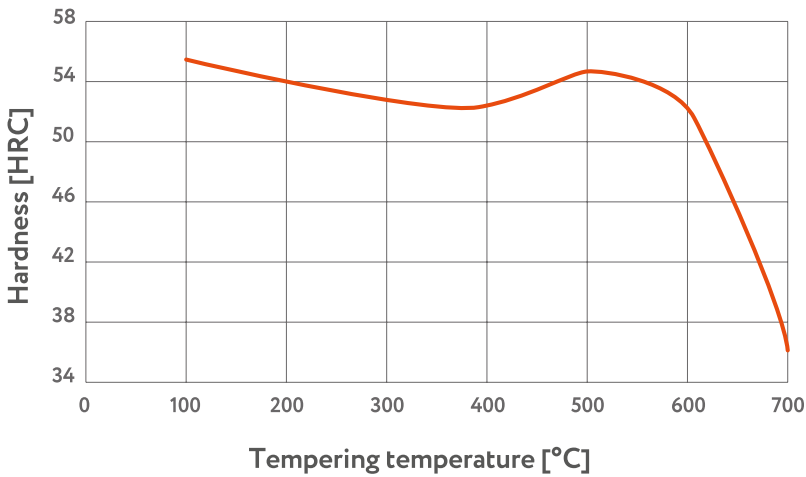
Tempering Tempering must be repeated at least three times after the hardening, with preheating to 350 ÷ 400 °C. Initial tempering at about the same temperature of the secondary hardness. Second tempering useful to obtain the work hardness, normally 35 ÷ 50 HRC. Third tempering at 30 ÷ 40 °C lower than the second tempering



10 C.C.T. curve

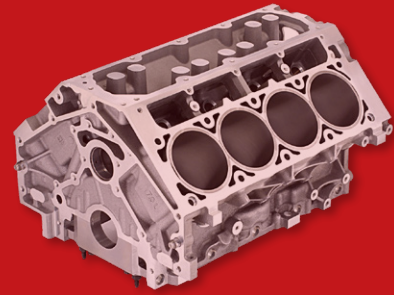


11 Tempering curve



1.2714

Hot working steel



1 Main characteristics and applications

Ni – Cr – Mo die steel characterized by high level hardenability and toughness, good resistance to repeated thermal and good wear resistance.

Main applications:

- hammer and press forging dies.
- rams for power hammers.
- hot mill rolls.
- very hard cold work dies and punches.

It is advisable to use the blocks for dies treated at various hardness limits according to the depth cavity complying with the indications given below.

Cavity depth (mm)	HRC	R(N/mm ²)
20	39÷43	1200/1350
50	36÷42	1100/1320
100	32÷38	980/1170

Before starting machining, preheat the tools to temperatures between 250 – 300°C.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
(56NiCr-MoV7KU)	1.2714	56NiCr-MoV7	~55NCD07-05	~L6	~224

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	Ni	P	S	V
0.52	0.7	0.20	0.75	0.3	1,75	0.025	0.003	0.10

4 Critical points

Ac1	730°C
Ac3	760°C
Ms	230°C

5 Production technology

EAF – LF – VD - Forging – Heat treatment QT

6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

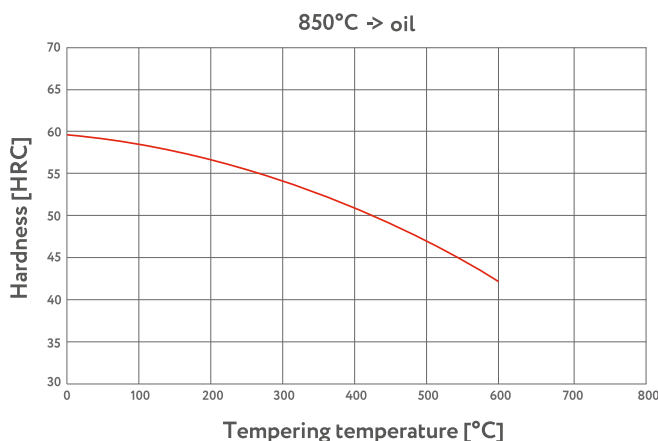
7 Delivery condition

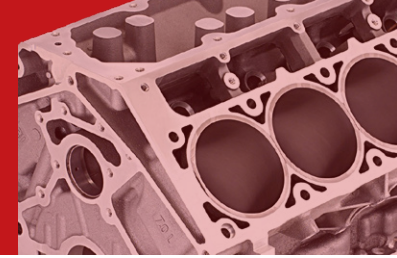
W1.2714 is delivered in quenched and tempered condition, with hardness range 360 - 410 HB (39 - 44 HRC) or in annealed condition, with hardness max 240 HB (23 HRC)

8 Physical properties (reference values)

	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	12.1	12.4	12.9	14.0
Thermal conductivity (W/mk)	36.7	36.9	39.3	35.7
Young modulus (Kn/mm ²)	212	208	197	175

9 Tempering curve

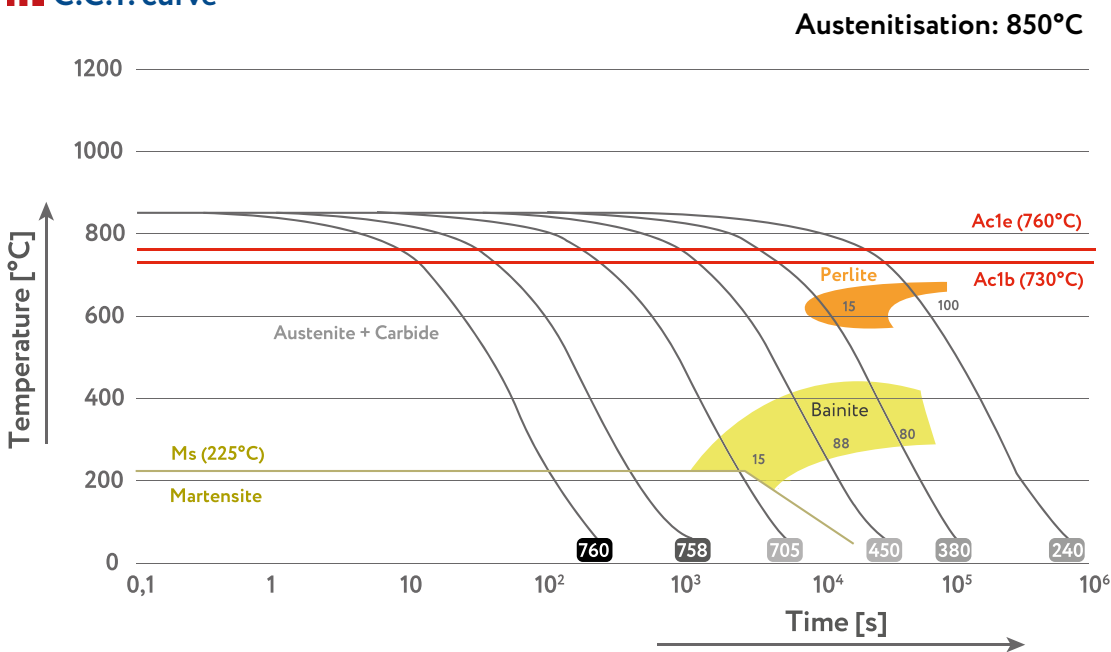




10 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS	
Annealing	Heat to 700 - 720 °C	Min. H.T. for 2 minute /mm	Air or furnace	In order to obtain hardness lower than 240 HB (23 HRC) to improve machinability	
Stress relieving	Heat to 600 - 650 °C (max 30 °C below tempering temperature)	Min. H.T. for 2 minute /mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working	
Hardening	Initial preheating to 350 - 450°C Second preheating to 650 - 750°C Heat to hardening temperature 850 - 870°C and hold at temperature	Min. H.T. for 1 minute /mm	Oil	-	
The average hardness values that can be obtained with hardening in oil in the range 840 - 920°C are given below:					
°C	840	860	880	900	920
HRC	57	58	59	59.5	60
Tempering	Heat to 550 - 630 °C	Min. H.T. for 3 minute /mm	Air or furnace	To be carried out after hardening. 2nd Tempering must be performed to max 30°C below tempering temperature	

11 C.C.T. curve





COLD WORK

1.2363

Cold working steel



1 Main characteristics and applications

Cr-Mo-V cold- working steel with 1% Carbon with high through-hardenability, dimension stability, extra high wear resistance and good toughness.

Typical application are cutting and stamping tools, shear blades, cold rolling mandrels, extrusion tools, cold working application where high wear resistance is needed.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2363	X100CrMoV5-1	Z100CDV5	A2	BA2

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	Mo	Ni	V	P+S
0.95	0.40	0.10	4.75	0.90	-	0.15	-
1.05	1.00	0.50	5.50	1.40	-	0.50	<0.03

4 Critical points

Ac1	770 °C
Ac3	815 °C
Ms	120 °C

5 Production technology

EAF - LF - VD - Forging - Heat treatment +A

6 US specification

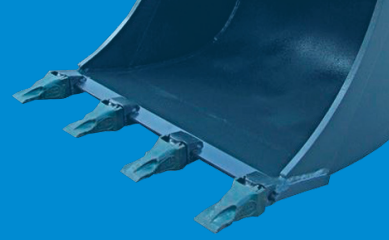
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

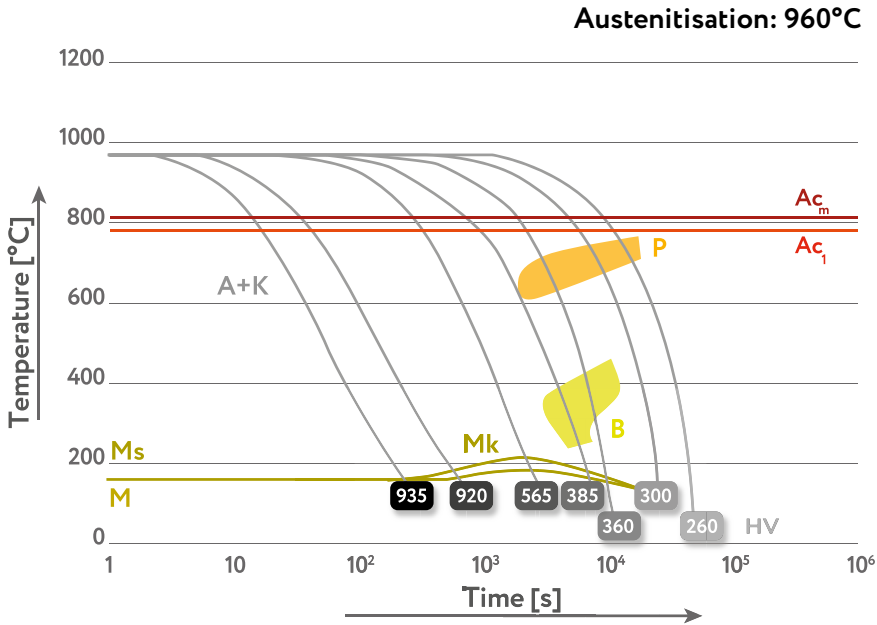
W1.2363 is delivered in annealed condition, with hardness max 240 HB (23 HRC).

8 Heat treatment

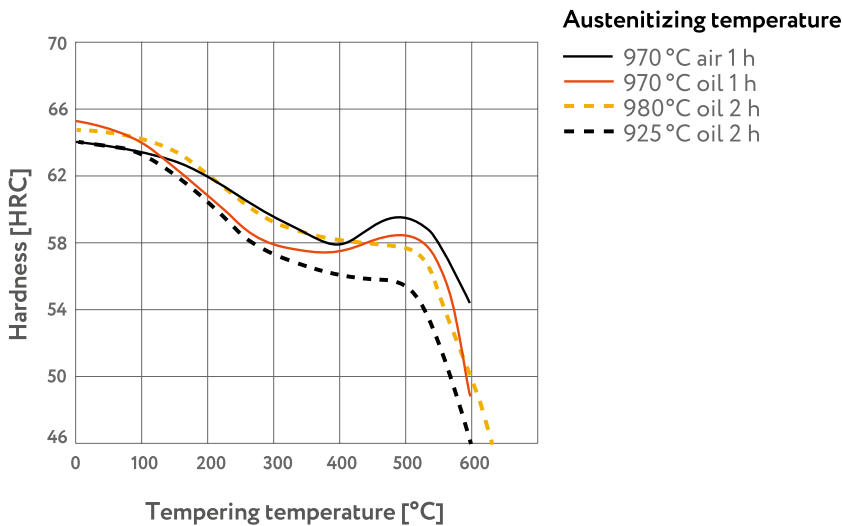
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 820 - 850 °C	Min. H.T. for 3 hours	Cooling in air to 730°C then 760-770°C and hold 1 h each 15 mm. Cooling in furnace to 500°C than cooling in air	-
Stress relieving	Heat to 650-680°C	Min. H.T. for 1 hour/25 mm	Air or furnace	To be carried out after machining, is recommended to eliminate the residual stresses induced by mechanical working
Hardening	Preheat to 600-700°C Heat to 960-980 °C	Min. H.T. for 1 minute /mm	Oil - salt bath or vacuum pressure gas	In order to obtain hardness 63-65 HRC
Tempering	-	-	Air	To be carried out soon after the hardening according to the required hardness



9 C.C.T. curve



10 Tempering curve



1.2510

Cold working steel



1 Main characteristics and applications

Medium alloyed cold work steel with good hardening capacity, high wear resistance, dimensionally stable during heat treatment.

Its applications are small tools for cutting and punching, shear knives, thread rolling tools, measuring tools, wood working tools.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
-	1.2510	100MnWCr4	95MnWCr5	(O1)	-

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	V	W
0.95	1.15	0.30	0.55	0.10	0.50

4 Critical points

Ac1	740 °C
Ac3	770 °C
Ms	215 °C

5 Production technology

EAF - LF - VD - Forging - Heat treatment +A

6 US specification

In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

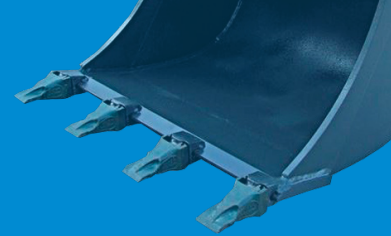
W1.2510 is delivered in annealed condition, with hardness max 230 HB (21 HRC).

8 Physical properties (reference values)

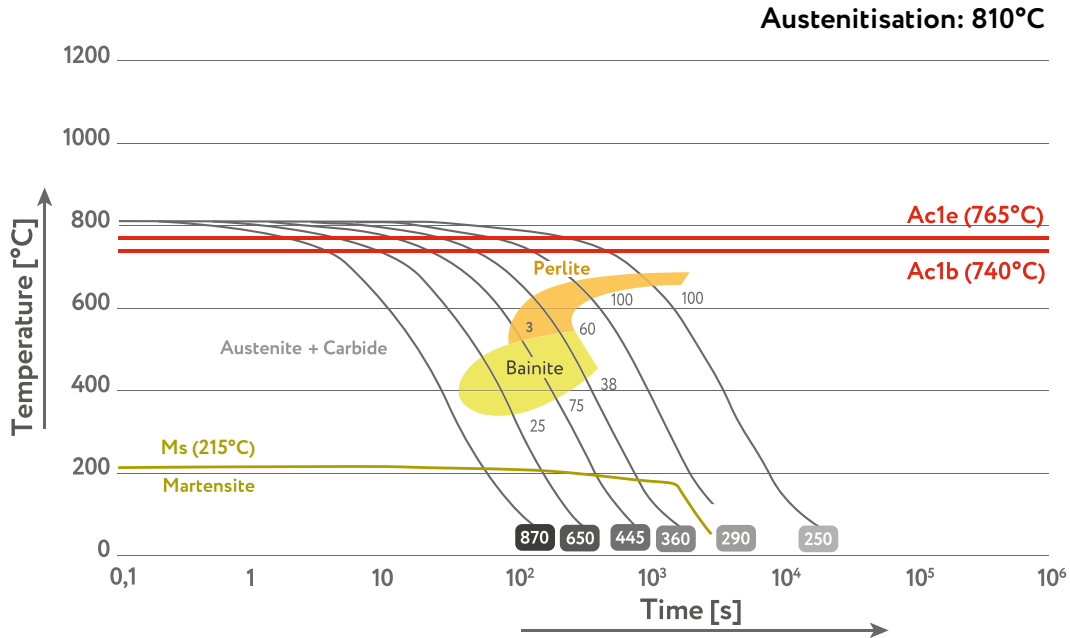
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10 ⁻⁶ /K)	11.4	11.7	12	12.7
Thermal conductivity (W/mk)	29.9	30.1	31.7	31.2
Young modulus (Kn/mm ²)	212	209	200	175

9 Heat treatment

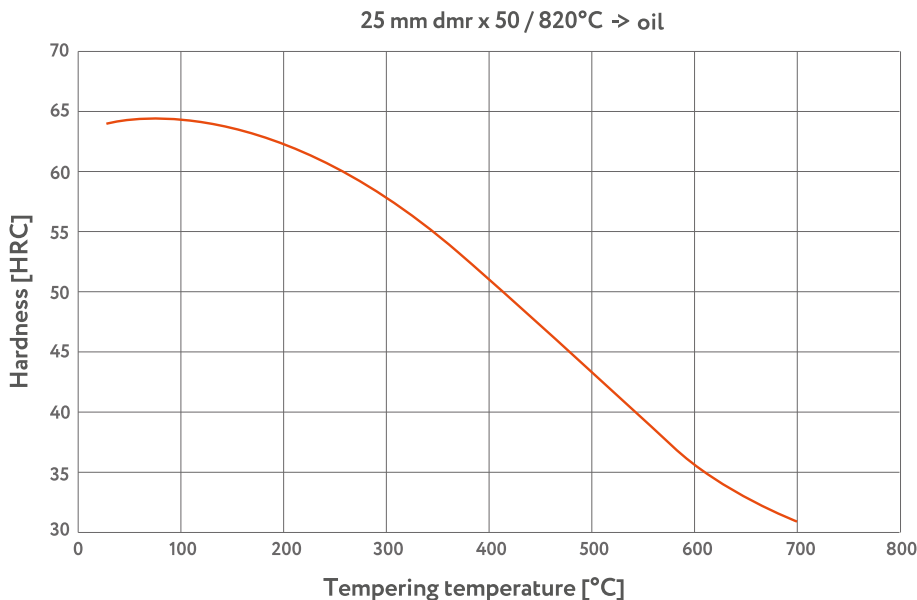
TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 700 - 720 °C	Min. H.T. for 2 minute /mm	Furnace to 600°C than in air	-
Stress relieving	Heat to 600 - 650 °C	Min. H.T. for 2 minute /mm	Air or furnace	-
Hardening	Heat to 790-820 °C	Min. H.T. for 1 minute /mm	Oil or pressure gas (vacuum)	-



10 C.C.T. curve



11 Tempering curve



1.2842

Cold working steel



1 Main characteristics and applications

Low hardening distortion and good wear resistance. The chemical composition of this steel permits fairly simple in service heat treatment (low hardening temperature with therefore limited distortion).

Main applications are taps, shear knives, small moulds for plastic materials, gauges, cutting and stamping tools.

2 Comparable standards

UNI	W.Nr	DIN	AFNOR	AISI/SAE	BS
(90Mn- VCr8KU)	1.2842	90MnCrV8	(90MV8)	(O2)	(BO2)

3 Chemical composition (typical; in weight %)

C	Mn	Si	Cr	V
0.90	2	0.30	0.30	0.10

4 Critical points

Ac1	725 °C
Ac3	770 °C
Ms	160 °C

9 Heat treatment

TREATMENT	TEMPERATURE	HOLDING TIME (HT)	COOLING	COMMENTS
Annealing	Heat to 700 - 720 °C	Min. H.T. for 2 minute /mm	Furnace to 600°C than in air	-
Stress relieving	Heat to 600 - 650 °C	Min. H.T. for 2 minute /mm	Air or furnace	-
Hardening	Heat to 790-820 °C	Min. H.T. for 1 minute /mm	Oil or pressure gas (vacuum)	Quenched hardness surface 63-65 HRC

The average hardness values that can be obtained with hardening in oil from 800 – 820°C are indicated below:

780°C 64 HRC 800°C 65 HRC 820°C 65 HRC

And the average hardness values and hardness penetration in oil from 800 – 820°C:

Ømm	40	50	60	70
Hrc surface	65	65	64	64
HRC ½ radius	64	64	63	58
HRC center	64	63	62	52

5 Production technology

EAF – LF – VD - Forging – Heat treatment +A

6 US specification

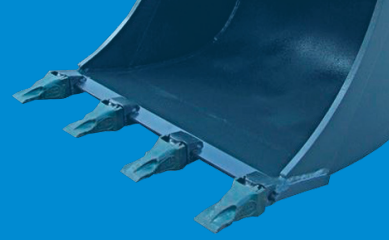
In according to standard EN10228-3 Class 4 and standard SEP 1921 Class E/e

7 Delivery condition

W1.2842 is delivered in annealed condition, with hardness max 230 HB (21 HRC).

8 Physical properties (reference values)

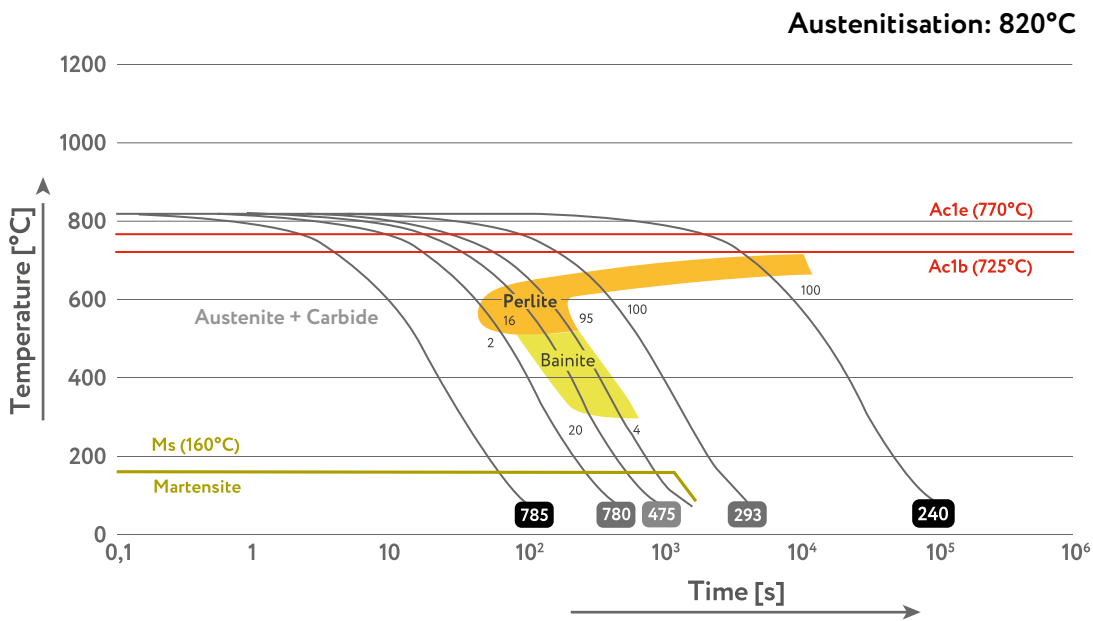
	20°C	100°C	250°C	500°C
Thermal expansion coefficient (10-6/K)	12.1	12.5	12.9	14
Thermal conductivity (W/mk)	45	44.7	44	37.9
Young modulus (Kn/mm2)	212	209	200	175



Tempering

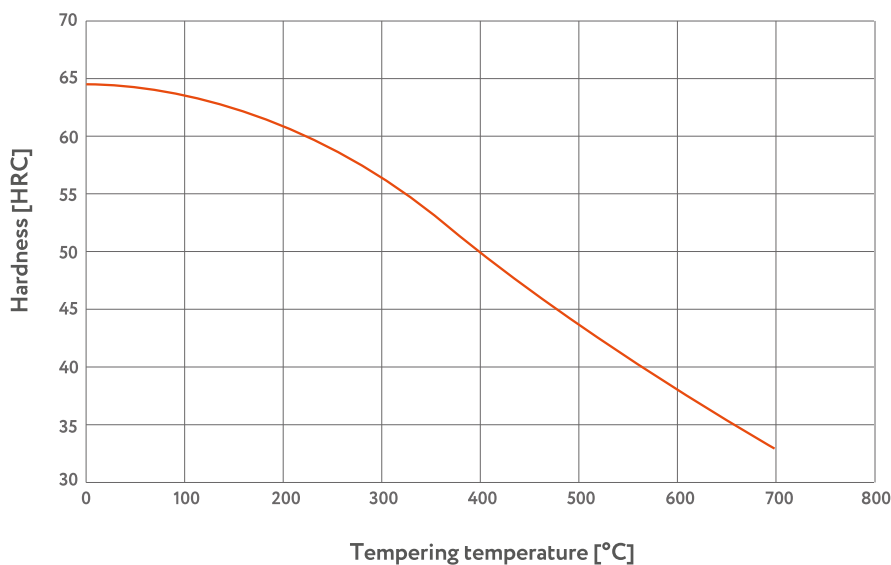
- To be carried out in the range 150 – 250°C for at least 2 hours according to hardness requirements and operating conditions
- Cooling in still air
- To achieve maximum stability with tempering at the lower temperature limit, tempering must be repeated several times (at least twice) and for long periods.

10 C.C.T. curve

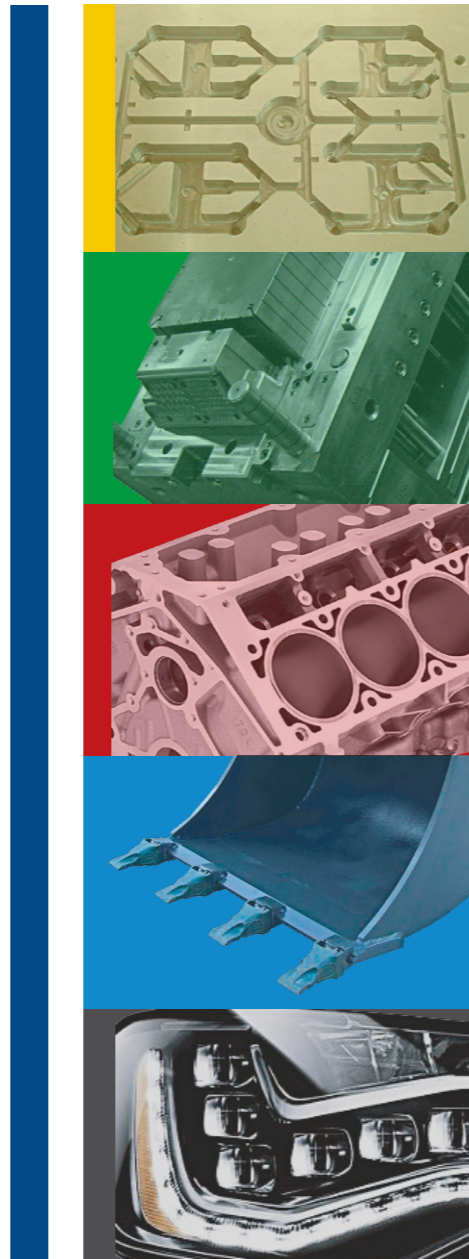



11 Tempering curve

780 °C in oil, specimen: Ø 25x50



Sizes



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GRADES	PLATES & BLOCKS THICKNESS																												HEAT TREATMENTS																															
	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	370	380	390	400	450	500	550	600	650	700	750	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	Annealing	EFS annealing	Normalizing
1.1730	Width 2000>2900mm														Width 1200>2500mm														•		•	•																												
Plastic mould	VR Holder	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	1.2311	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	1.2312	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	VR 200	Width 2000>2500mm						Width 1200>2500mm																		•			•																															
	VR300	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	1.2738	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	VR400	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	1.2083	Width 2000mm						Width 1550>2000mm																		•			•																															
	1.2085	Width 1150>1500mm						Width 1550>2000mm																		•			•																															
	VR Stainless	Width 2000mm						Width 1550>2000mm																		•			•																															
	1.2316 - 1.2316HH							Width 1550>2000mm																		•			•																															
VR16-VR16HH	Width 2000mm						Width 1550>2000mm																		•			•																																
Hot-work	1.2714	Width 2000>2500mm											Width 1200>2500mm											Width 1200>1850mm						•			•																											
	1.2343												Width 1150>2000mm																		•	•		•																										
	1.2344												Width 1150>2000mm																		•	•		•																										
	1.2367												Width 1150>2000mm																		•	•		•																										
Cold-work	1.2363	Width 1150>1500mm																								•	•		•																															
	1.2842	Width 2000>2500mm																								•	•		•																															
	1.2510	Width 2000>2500mm																								•	•		•																															
ESR	1.2343 ESR												Width 1000>1400mm																		•	•		•																										
	1.2344 ESR												Width 1000>1400mm																		•	•		•																										
	VR400 ESR												Width 1000>1400mm																		•			•																										
	VR16 ESR												Width 1000>1400mm																		•			•																										
	1.2083 ESR												Width 1000>1400mm																		•			•																										

Update: April 2019

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