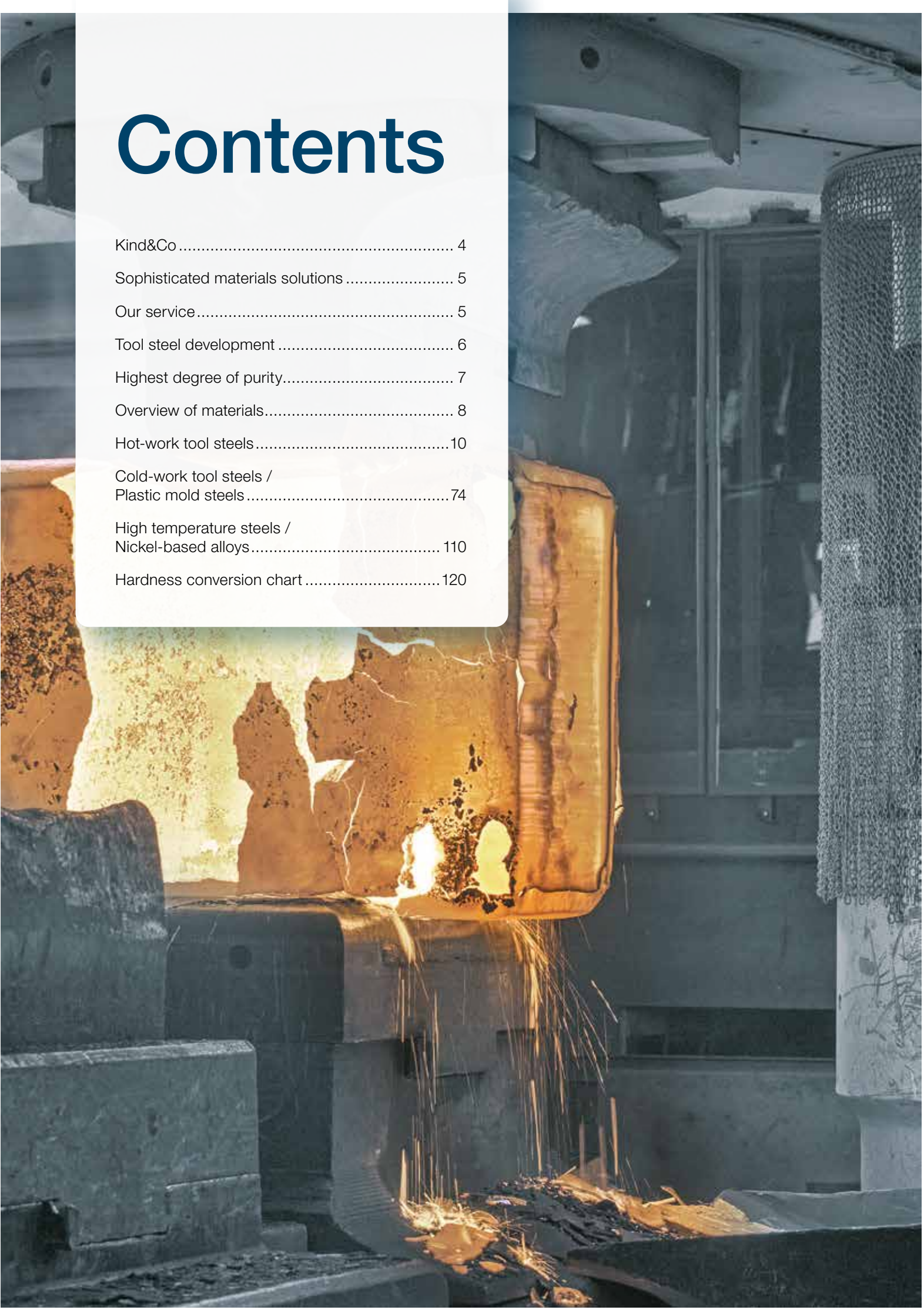
KIND&CO
EDELSTAHLWERK

Materials Catalogue

Sophisticated Materials Solutions

Contents



KIND&CO
EDELSTAHLWERK

Our company has a very special soul: The „soul of steel“!

For more than 130 years, we have been producing high quality tool steel exclusively at our traditional location. Even today, Kind&Co is still a wholly-owned family company.

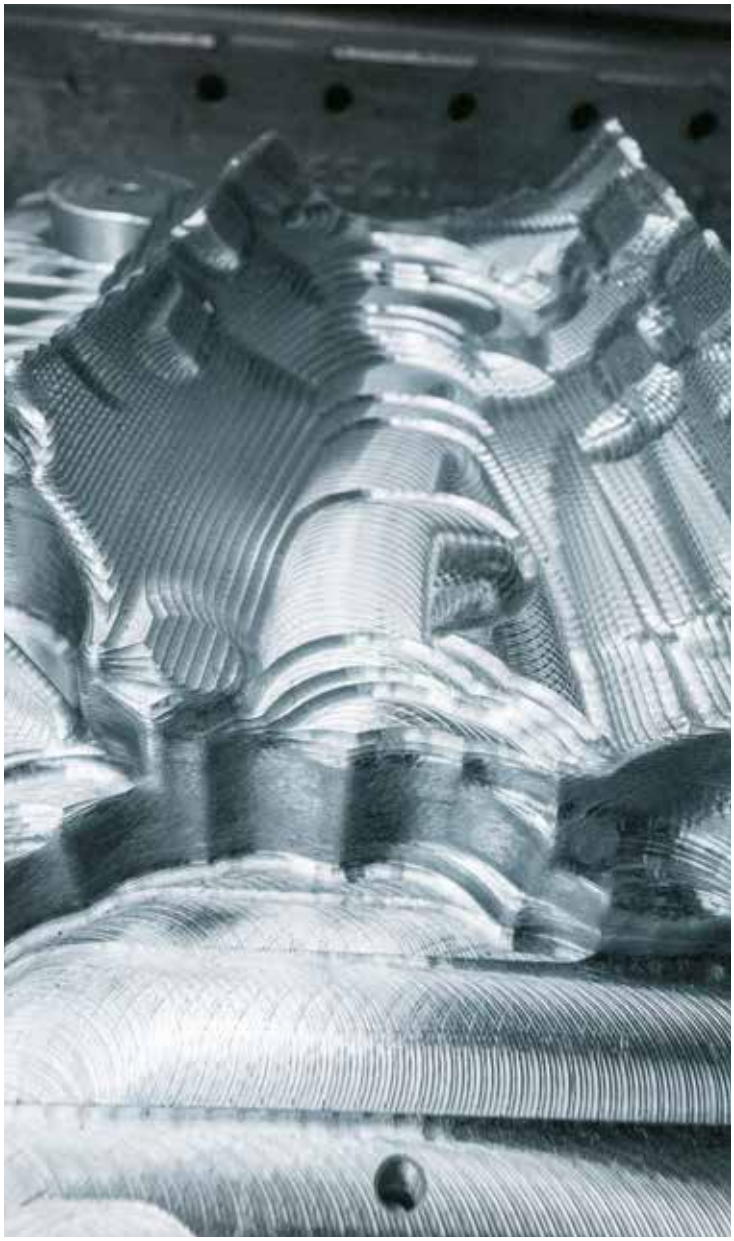
We stand for sophisticated material solutions, maximum quality, reliable service and competent advice – tailored to the individual purpose. We have particularly strong application expertise in the segments of extrusion, pressure die casting and die forging. Our range of services is the guarantee for economic and save production processes of our customers.

As the only hot-work tool steel specialist worldwide, we are expanding our service and our value-added chain in our home market of Europe. Through our international subsidiary companies and trading partners, we are growing successfully in the global market and thus fortify our Bielstein production site.

The experience and capabilities of our employees are our most important resource. We are working with respect for each other and with commitment to each other. New challenges are met with a willingness for change.

Sophisticated materials solutions

This materials catalogue describes the materials produced in our company with regard to their properties and applications. The various materials are produced by melting of selected scrap, depending on the quality requirements with remelting in the electro-slag remelting process (ESR), forming of the cast ingots on hydraulic forging presses and further mechanical processing until the finished product is ready for installation according to customer drawings. All process steps are accompanied heat treatments, which make an important contribution to achieving maximum material properties. Our wide range of services is aimed at meeting the individual needs of our customers. In addition to our high-performance steels we offer a comprehensive range of services in the area of tool steel processing and finishing. Benefit from our relevant know-how and the experience of our specialists, coupled with modern technical equipment.



Our service

With a high level of flexibilty we offer individual and tailord techniques and processes that support your quality tools to achieve top perfomance.
Contact our experts for qualified advice and get help solving your problems.

Tool steel development –
A step in the right direction

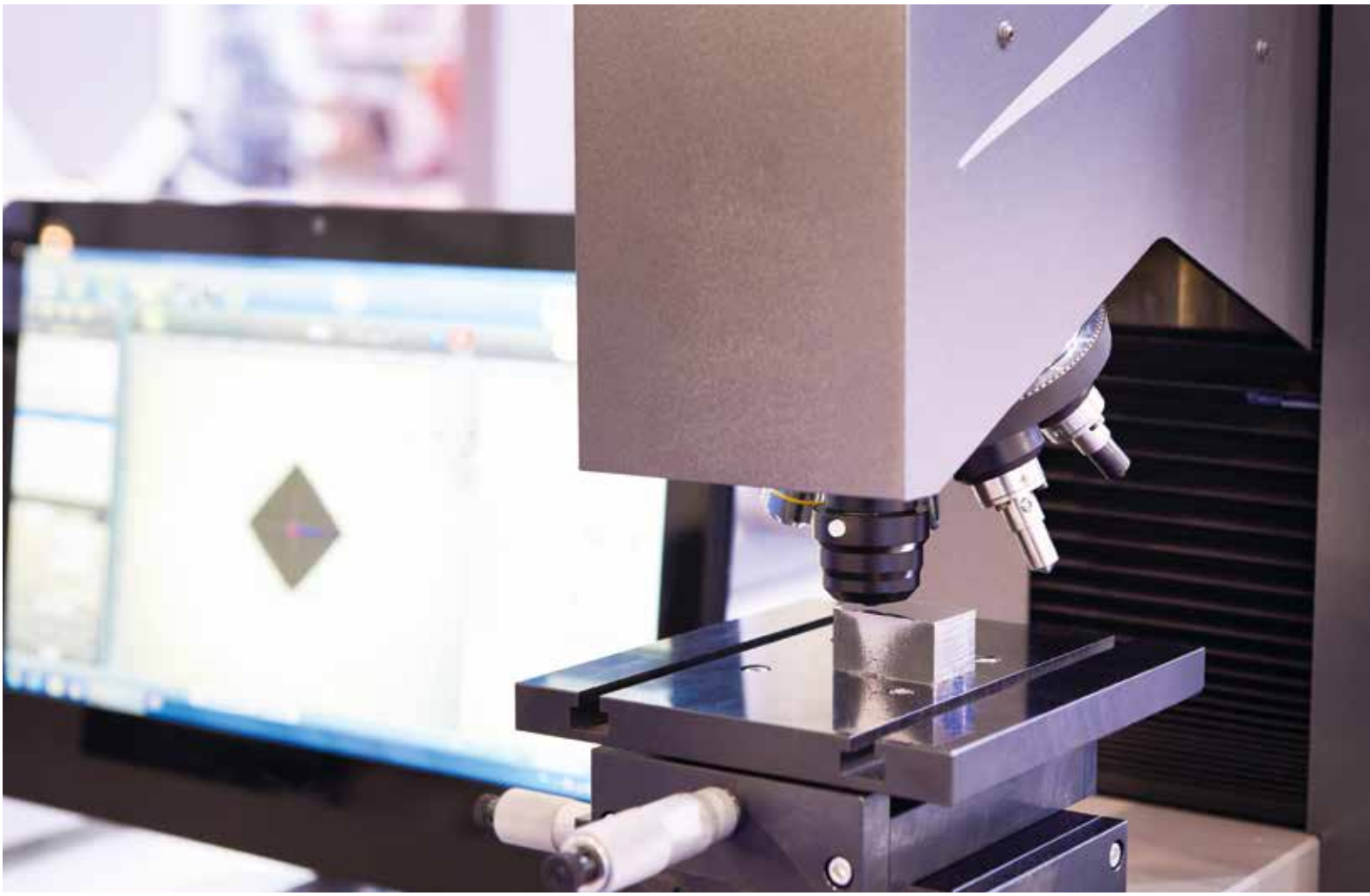
In addition to standardized tool steels according to DIN EN ISO 4957, we develop our own premium materials for applications according to customer requirements. We see ourselves as a customer-oriented problem solver for your applications of tool steels in numerous production processes.

With the premium steels developed in-house, we have expanded our range of products in order to find solutions also at the threshold between various applications.

In principle, we divide the materials in this catalogue on the basis of DIN EN ISO 4957 as follows:

- Cold-work tool steels
  with a surface temperature < 200 °C
- Hot-work tool steels
  with a surface temperature > 200 °C
- High temperature steels
  with a surface temperature > 600 °C

Through competent and solution-oriented customer consultation we would like to offer you a sophisticated material solution.



Highest degree of purity due to ESR process

In the ESR process, an already cast, completely solidified block, the so-called electrode, is remelted in a water-cooled mold. The electrode is immersed in a liquid slag bath, which is heated by a voltage applied to the electrode to such an extent that the tip of the electrode melts continuously. The dripping steel is cleaned of impurities as it passes through the slag, accumulates under the slag bath as a liquid melt and solidifies again. The proportion of liquid steel is always very low, and cooling and solidification are very uniform.

By means of the electro-slag remelting process described above (ESR process), the remelted steel has a very homogeneous macro- and microstructure and a more uniform distribution of the alloying elements. This leads to improved isotropy of the material properties and thus, among other things to an increase in toughness. This results in e.g. slower crack propagation, which can significantly delay a possible tool failure.

Another advantage of the ESR process is the reduction of non-metallic inclusions. This results in a further improvement in toughness. Due to the higher purity of the steel, better polishing results can be achieved, which is a distinct advantage not only for the injection molding and glass industries.

Thanks to the latest process technology, the ESR process at Kind&Co runs almost completely automatically. Our strong focus on the best hot-work tool steels allows us to optimize the process parameters and operating materials (especially slag) specifically for this group of materials. With our two ESR plants it is possible to produce ESR blocks up to a diameter of up to 1,000 mm and a weight of up to max. 24 t. The modern plant concept also allows blocks to be remelted in parallel operation.

Hot-work tool steels

Brand name	Mat.-no.	Short name	AISI	Page
Cr7V-L	Premium	-	-	12
CS1	Premium	-	-	14
FTCo	Premium	-	-	16
GSF	Premium	-	-	18
HP1	Premium	-	-	20
HTR	Premium	-	-	22
PWCo	Premium	-	-	24
Q10	Premium	-	-	26
TQ1	Premium	-	-	28
LMF	Premium	-	-	30
HSF	Premium	-	-	32
UH1	Premium	-	-	34
CM167	1.2323	48CrMoV6-7	-	36
USN	1.2343	X37CrMoV5-1	H 11	38
USD	1.2344	X40CrMoV5-1	H 13	40
USD-H	1.2345	X50CrMoV5-1	-	42
RP	1.2365	32CrMoV12-28	H 10	44
RPU	1.2367	X38CrMoV5-3	-	46
MA	1.2581	X30WCrV9-3	-	48
W44	1.2603	45CrVMoW5-8	-	50
US	1.2606	X37CrMoW5-1	-	52
PD	1.2622	X60WCrMoV9-4	-	54
HWD	1.2678	X45CoCrWV5-5-5	H 19	56
UHF3	1.2709	X3NiCoMoTi18-9-5	-	58
PWM	1.2714	55NiCrMoV7	L 6	60
AWS	1.2731	X50NiCrWV13-13	-	62
PWU	1.2744	57NiCrMoV7-7	-	64
FAM	1.2787	X23CrNi17	~ 431	66
RPCo	1.2885	X32CrMoCoV3-3-3	H 10A	68
RM10Co	1.2888	X20CoCrWMo10-9	-	70
HMoD	1.2889	X45CoCrMoV5-5-3	H 19A	72

Cold-work tool steels / Plastic mold steels

High temperature steels / Nickel-based alloys

Hot-work tool steel

Hot-work tool steels are used in tools that are used in general temperatures above 200 °C. As a result of the alloying elements Cr, Mo, V and W these steels have a high high-temperature strength, high tempering resistance and hot wear resistance.

The main needs are found in the areas of pressure die casting, die forging, extrusion presses and various processes for manufacturing seamless pipes.

Specifically for these application areas we have developed several premium steels in-house over the last few years. Material properties such as high-temperature toughness, thermal conductivity and high-temperature strength could be increased considerably in these new materials.

Cr7V-L

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Premium	Cr7V-L	0.42	0.50	0.50	6.50	1.30	0.80

Material properties

This high Cr-alloyed premium steel with additions of Mo and V is characterized by good high-temperature strength, particularly high wear resistance and thermal shock resistance in both cold and hot work.

Application

For cold work:

- Punches and shear blades for sheet thicknesses of approx. 6-12 mm
- Straightening rolls

For hot work:

- Die inserts for forging presses with high wear requirements
- Extrusion dies for steel forming
- Hot extrusion of copper and copper alloys
- Hot shear blades and trimming tools
- Drawing rollers, drawing dies and piercing dies in steel bottle production
- Tools for hot-stamping

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,4	11,9	12,5	13,1

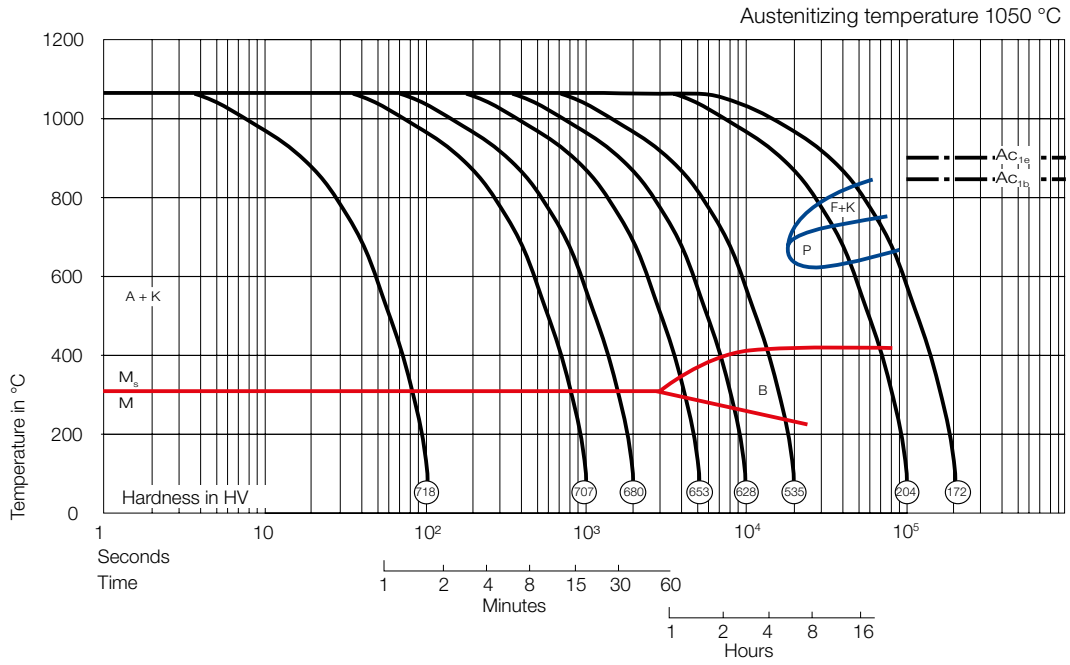
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	26,7	29,8	30,8

Temperature in °C	20
Density in g/cm^3	7,60

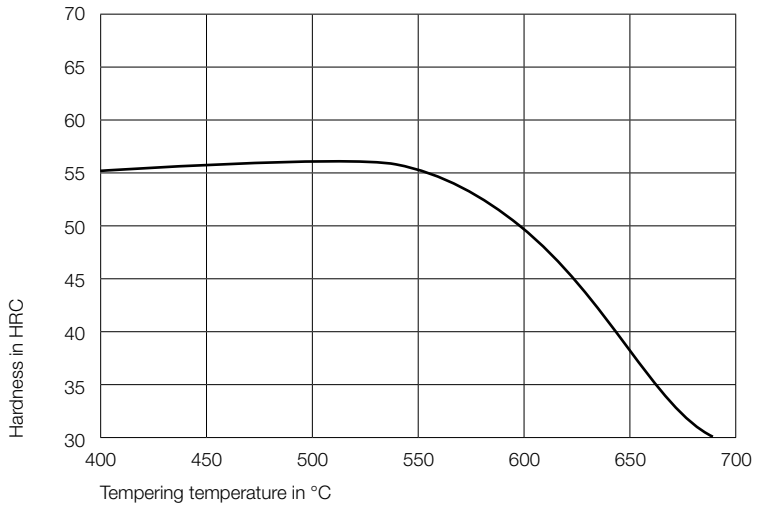
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1030 - 1040 °C
	Cooling	Cooling in warm bath of approx. 540 °C in air or in oil/polymer; Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening.
Tempering	Temperature	500 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

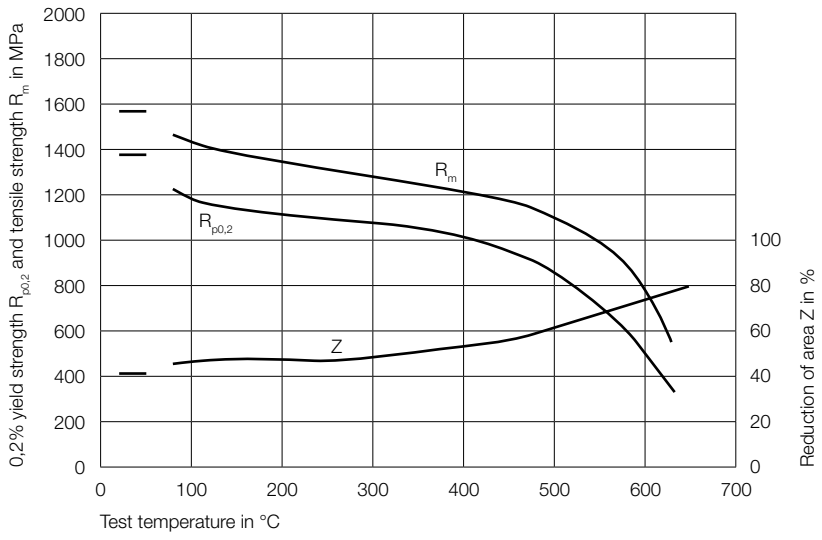
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



CS1

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Premium	CS1	0.50	0.30	0.40	5.00	1.90	0.55	+

Material properties

CS1 is a Cr-Mo-V-alloyed hot-work tool steel specially designed for mechanical highly stressed tools. It is characterized by particularly high wear resistance, excellent high-temperature strength and at the same time very high toughness and thermal shock resistance. CS1 is only produced in remelted version using the ESR process.

Application

CS1 is particularly suitable for highly stressed tools, such as:

- Extrusion: CS1, with a possible yield strength > 1500 MPa, is suitable for highly stressed extrusion stems, press discs, inner liners and dies
- Die forging: dies with high surface hardness and for dies subjected to abrasive stresses
- Die casting: for the highest surface requirements and shape tolerances in die casting, as well as special requirements for thermal shock resistance
- Texturized and polished mold inserts and mold plates for processing plastics with high glass fiber content or molds with highest surface requirements

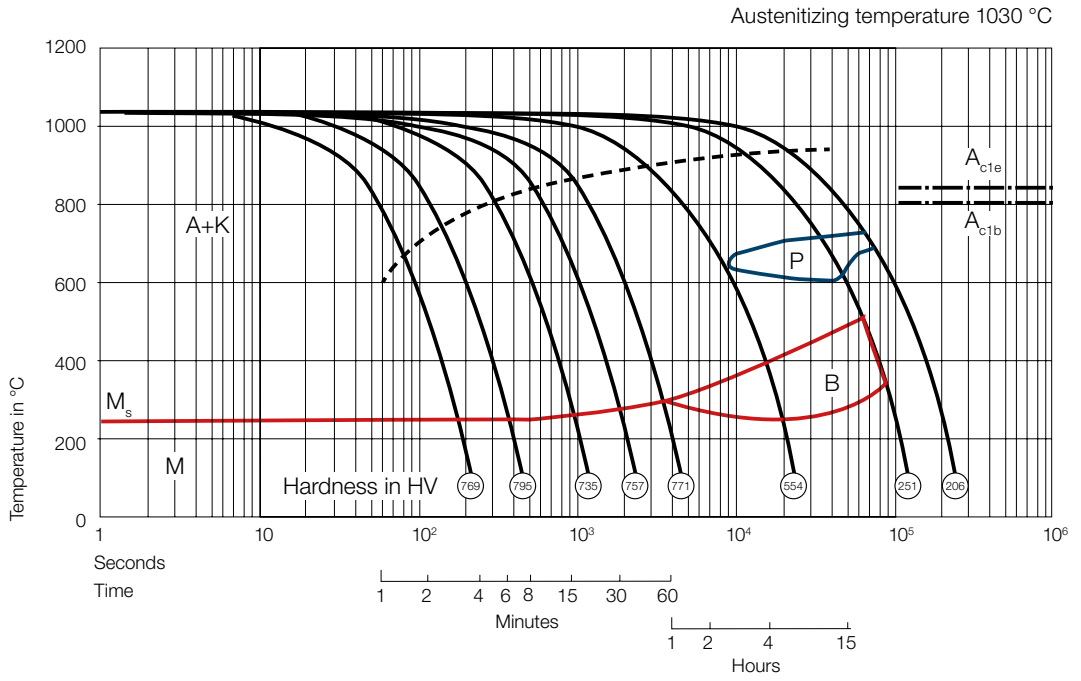
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,5	13,2	13,4
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	28,8	30,0	29,4	
Temperature in °C	20			
Density in g/cm³	7,79			
Temperature in °C	20			
Young's modulus in GPa	213			

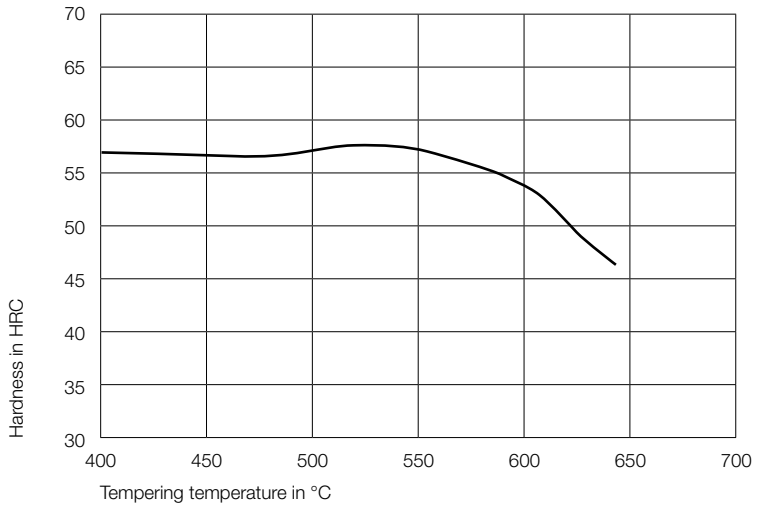
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	1010 - 1040 °C
	Cooling	Air, warm bath of approx. 540 °C, oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C according to application

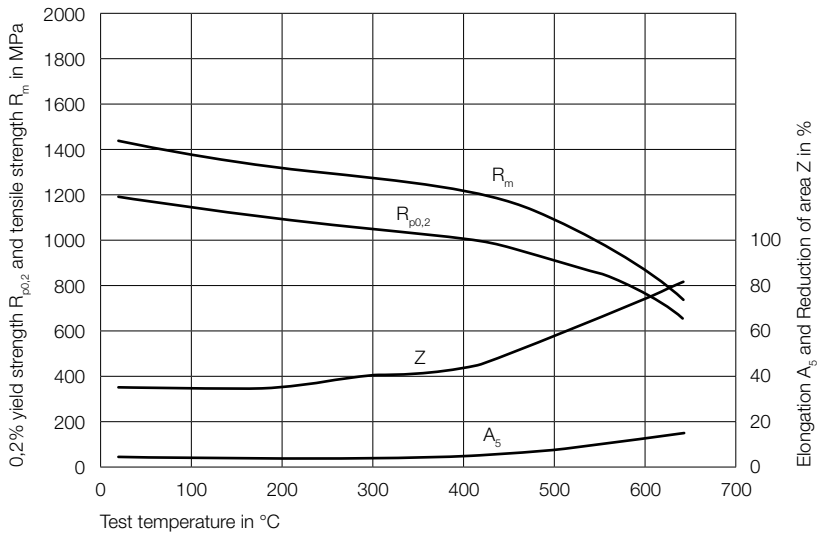
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



FTCo

Mat.-no.	Brand name	Mass.-%								
		C	Si	Mn	Cr	Mo	V	Co	W	Nb
Premium	FTCo	0.53	0.25	0.40	4.00	2.00	1.10	0.90	1.50	+

Material properties

FTCo is a premium steel with high proportions of carbide-forming elements (Cr, Mo, V, W, Nb), which ensure particularly high tempering resistance and high wear resistance.

Application

- Dies and mandrels for forging applications with very high thermal and abrasive loads
- Especially suitable for mandrels in high-speed forging machines
- Tools in warm forming and brass processing

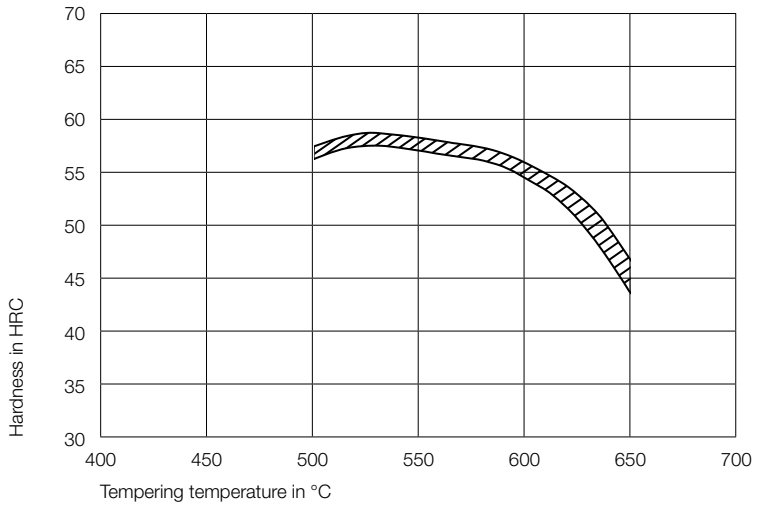
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,1	13,0
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	27,2	28,1	29,3

Heat treatment

Soft annealing	Temperature	820 °C, 10 hours
	Cooling	slow furnace cooling
	Hardness	max. 300 HB
Hardening	Temperature	1120 - 1140 °C
	Cooling	Vacuum hardening or salt bath hardening with oil/polymer quenching
Tempering	Temperature	560 - 600 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

Tempering graph



GSF

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	Ni	V
Premium	GSF	0.28	0.30	0.70	2.80	0.60	1.00	0.40

Material properties

GSF is a Cr-Ni-Mo-V-alloyed premium steel specially designed for hammer or large dies.
GSF features significantly better toughness, weldability and higher high-temperature strength compared to 1.2714.
Due to its good mechanical properties in the quenched and tempered condition, GSF is the suitable steel for various tools and highly stressed machine components.
Especially for large cross-sections or diameters up to 650 mm and strengths above 1000 MPa, GSF is a well-suited alternative to the well-known quenched and tempered steels such as 1.7225.

Application

- Specially developed premium steel with good suitability for buildup and filler welding. The lowered C-content reduces the risk of cracking in the heat-affected zone.
- Can also be used without buildup or filler welding
- Die holder
- Highly loaded tie rods
- Hammers and press saddles, hammer bears, jaws in forging machines
- Mandrel holders, die holders, press columns, piston rods, retraction plungers and nuts in the extrusion industry, tool reinforcements
- Shafts and highly stressed machine parts with yield strengths > 750 MPa

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,0	13,0	14,0

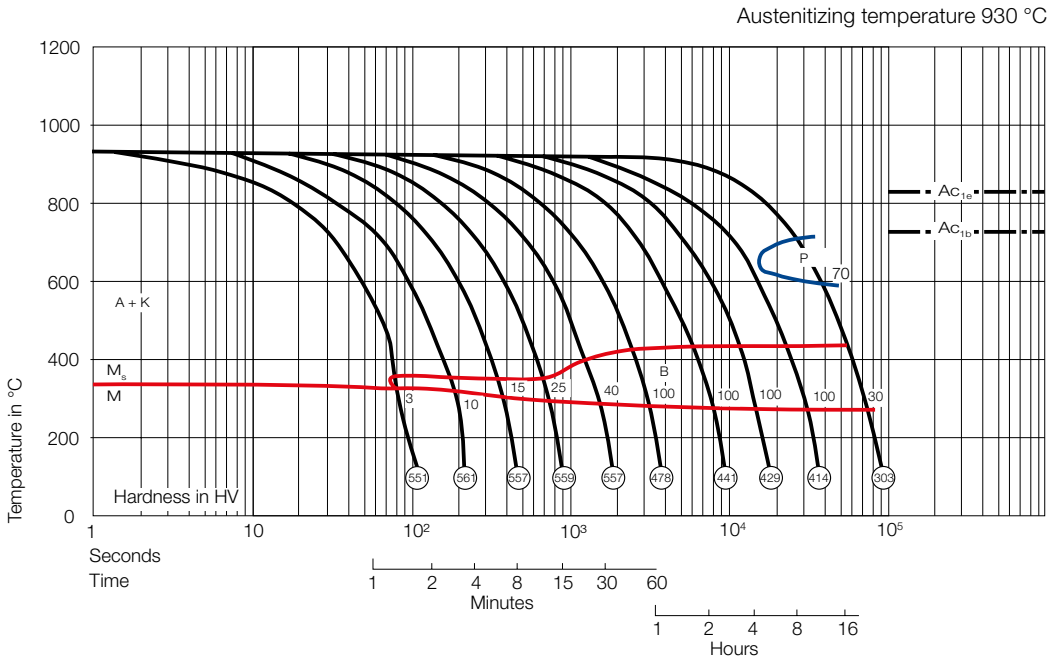
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	31	34	33

Temperature in °C	20
Density in g/cm³	7,76

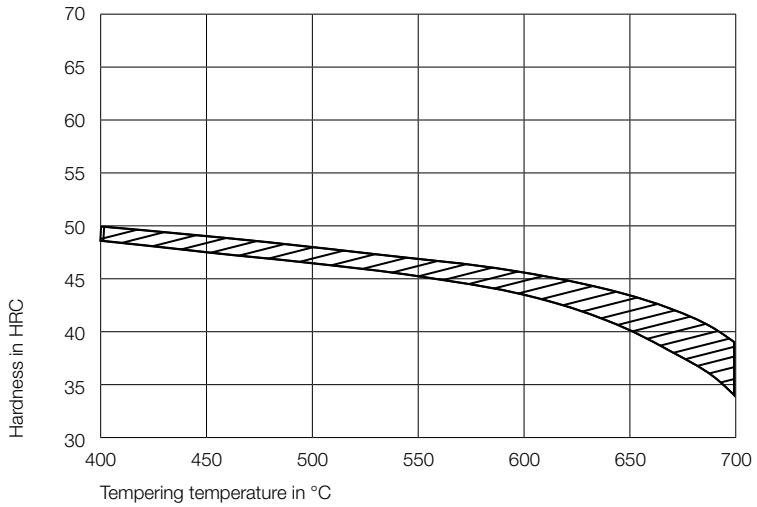
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 6 - 8 hours
	Cooling	slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	920 - 940 °C
	Cooling	Oil/polymer Cooling must be interrupted at approx. 150 - 180 °C or vacuum hardening.
Tempering	Temperature	400 - 650 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C necessary

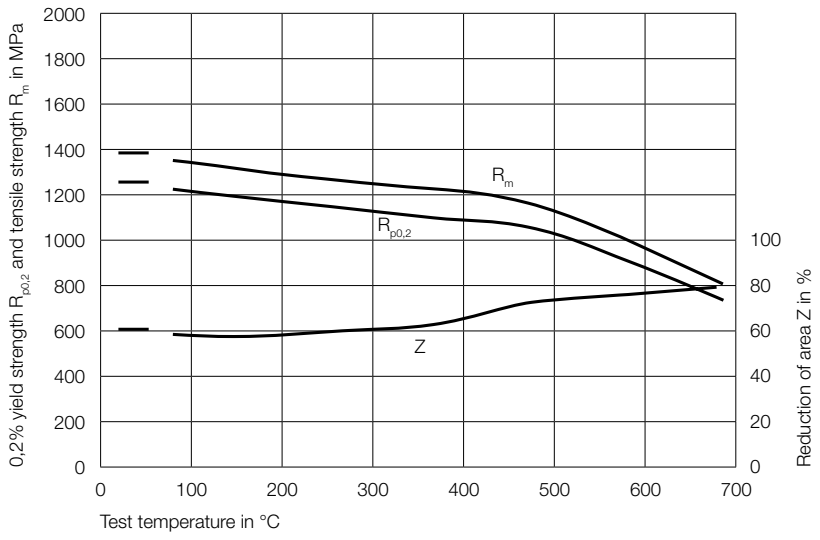
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



HP1

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Premium	HP1	0.35	0.20	0.30	5.20	1.40	0.55	+

Material properties

HP1 is a Cr-Mo-V alloyed premium steel with very good high-temperature strength and highest toughness. In addition, this steel is characterized by good thermal shock resistance. HP1 is only produced in remelted version using the ESR process.

Application

HP1 is particularly suitable for the following applications with the highest mechanical and thermal loads:

- Dies in die casting with high surface requirements
- Extrusion: Dies with high toughness requirements
- Inner liners
- Forging of light metals, especially for deep engravings, such as chassis parts
- Forging of Ti-alloys

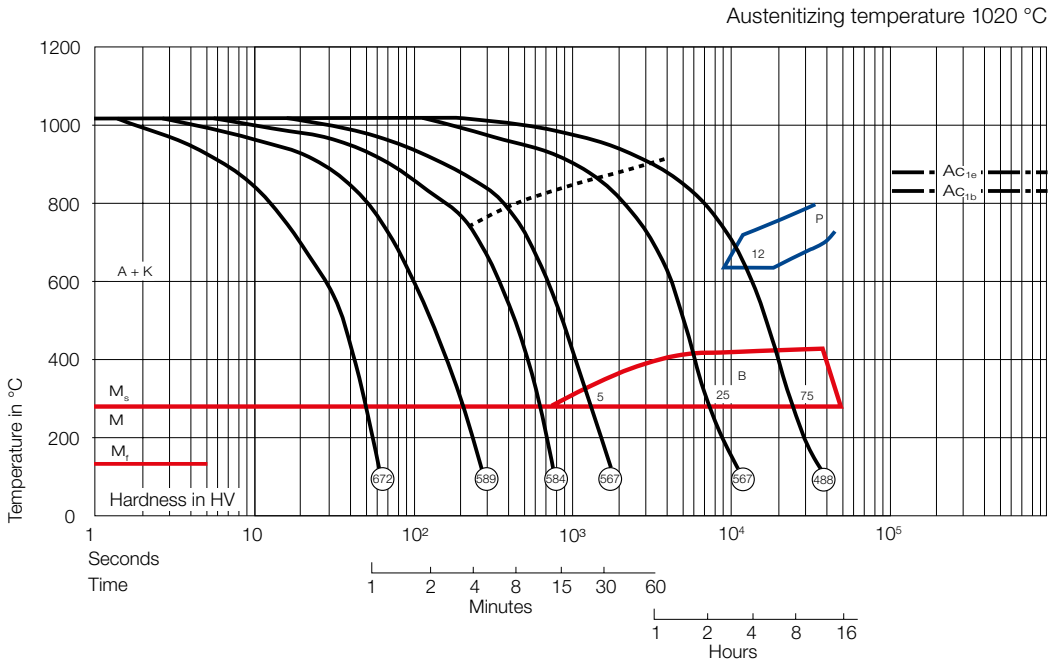
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,5	12,6	13,1
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	29,5	30,5	30,5
Temperature in °C	20		
Density in g/cm³	7,8		
Temperature in °C	20		
Young's modulus in GPa	214		

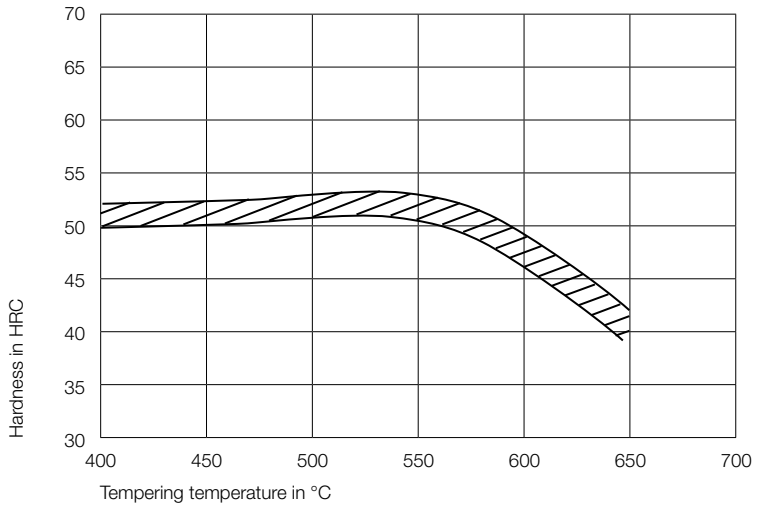
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1015 - 1025°C
	Cooling	Air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

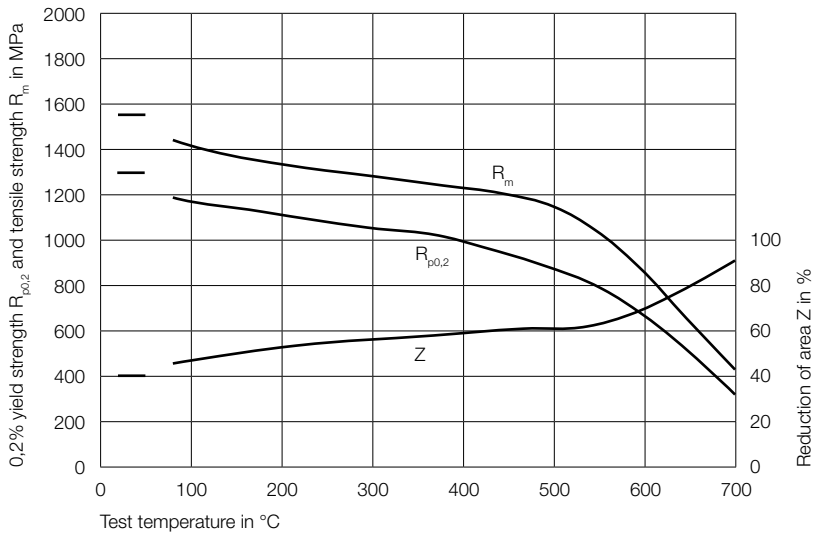
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



HTR

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	W
Premium	HTR	0.32	0.35	0.30	2.20	0.90	0.50	3.80

Material properties

HTR is a premium steel with very good thermal shock resistance, high thermal conductivity and high-temperature strength.

Application

Areas of use with high thermal loads:

- Die casting (max. 42 HRC), small mold inserts with high heat dissipation requirements
- Gravity die casting
- Extrusion, dies and die holders
- Hot and warm forming
- Intermediate bushings in heavy metal and light metal extrusion
- Dies for brass processing

Delivery condition: Annealed max. 230 HB

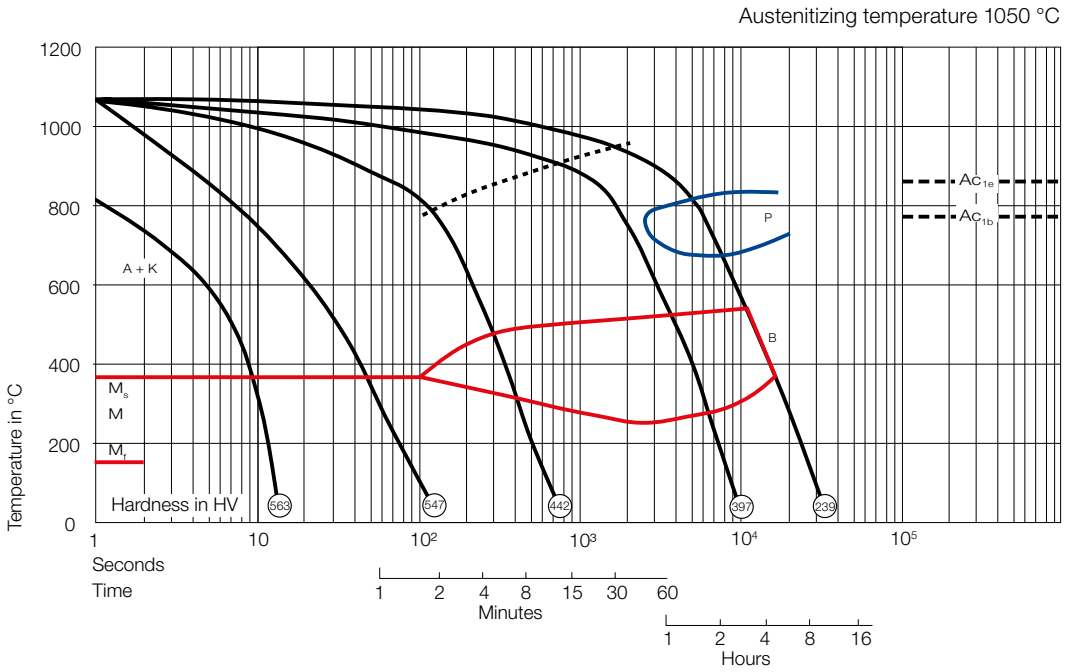
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	12,3	13,6	13,8
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	35,2	34,6	33,0
Temperature in °C	20		
Density in g/cm³	8,0		

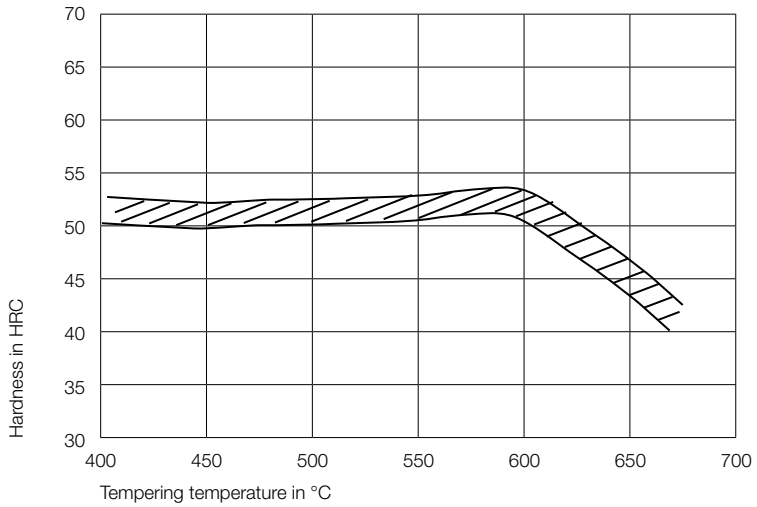
Heat treatment

Soft annealing	Temperature	820 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	1050 - 1070 °C
	Cooling	Oil, polymer, vacuum hardening with nitrogen quenching
Tempering	Temperature	650 - 700 °C
	Hardness	see tempering graph
Preheating before use	Temperature	100 - 300 °C

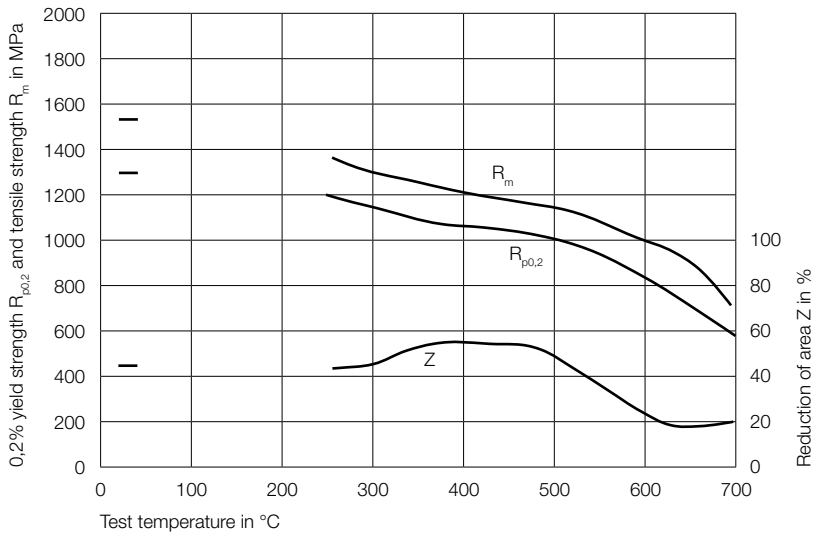
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



PWCo

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Co
Premium	PWCo	0.35	0.35	0.40	4.80	2.90	0.60	2.75

Material properties

Cobalt alloyed hot-work tool steel with good high-temperature strength and high hot wear resistance.

Application

- Forging dies with high requirements for hot wear resistance and shallow engravings

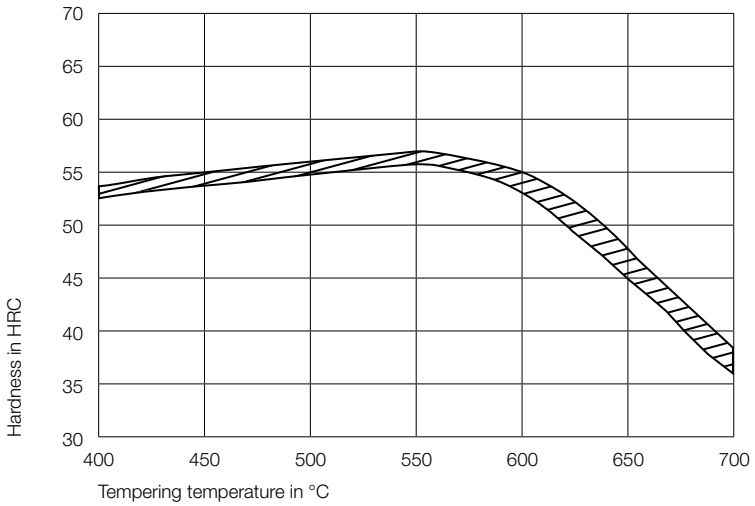
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,5	11,9	12,0
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	30,0	32,0	33,6

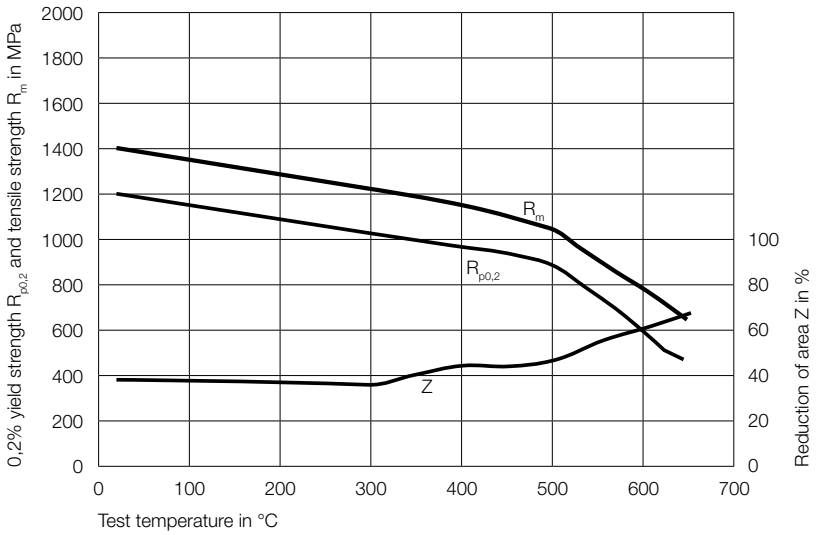
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 235 HB
Hardening	Temperature	1030 - 1040 °C
	Cooling	Vacuum hardening, warm bath of 540 °C
Tempering	Temperature	520 - 600 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	250 - 350 °C

Tempering graph



High-temperature strength graph



Q10

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Premium	Q10	0.36	0.25	0.40	5.20	1.90	0.55

Material properties

Q10 is a Cr-Mo-V-alloyed premium steel. In addition to high toughness, it offers very good high-temperature strength properties and a good thermal shock resistance.

Application

- Extrusion presses with very long lifetime with heavy duty inner linings and press stems, dies and dieholder
- Die forging: dies subject to high impact stress, dies with complex geometry, which are exposed to both high abrasive wear and simultaneous risk of cracking.
- Drawing mandrels
- Tools for the production of seamless gas cylinders

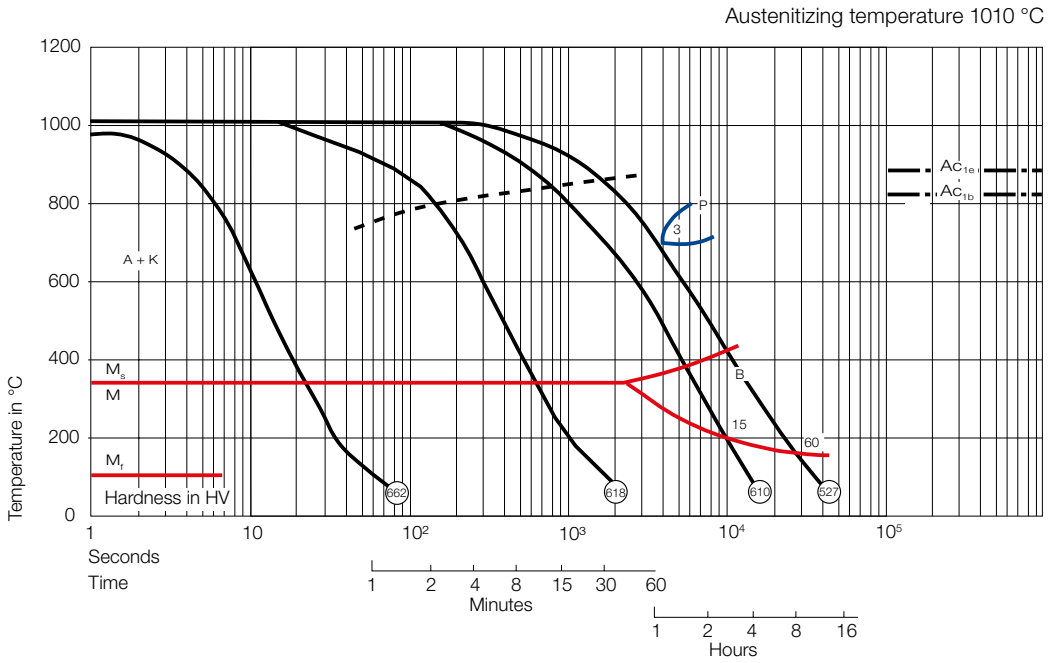
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,3	11,3	12,6	13,0
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	29,8	31,0	31,4	
Temperature in °C	20			
Density in g/cm³	7,8			
Temperature in °C	20			
Young's modulus in GPa	214			

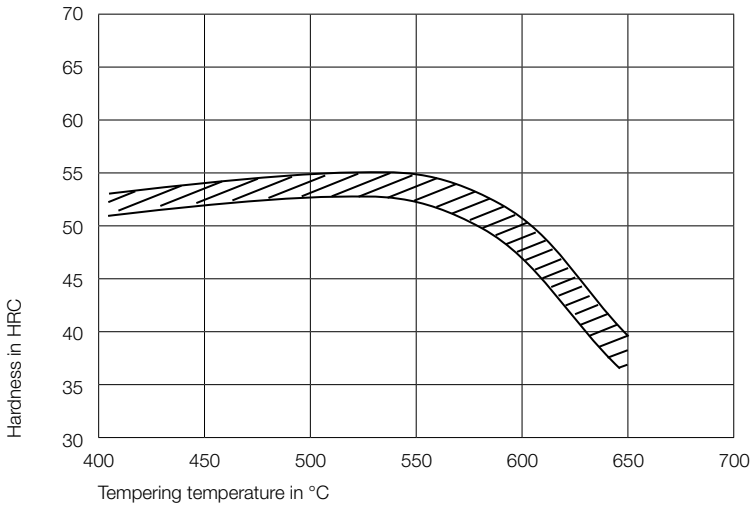
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1010 - 1020 °C
	Cooling	Air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C according to application

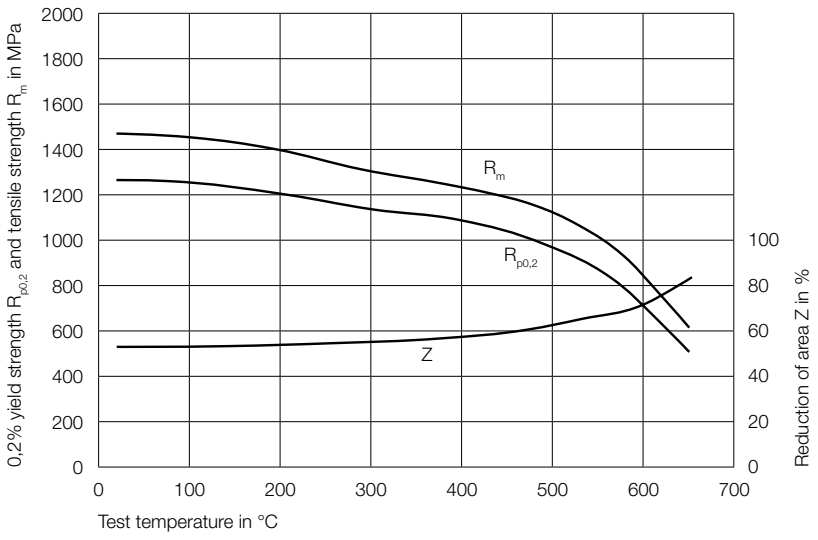
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



TQ1

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Premium	TQ1	0.36	0.25	0.40	5.20	1.90	0.55

Material properties

TQ1 is a Cr-Mo-V-alloyed premium steel with very good high-temperature strength. In addition to good thermal shock resistance TQ1 is characterized by very high toughness. Additionally the premium steel offers high hot wear resistance. TQ1 is only produced in remelted version using the ESR process.

Application

- Die casting dies for castings with high surface requirements, dies for structural components
- Lower cores in low-pressure die casting of alloy wheels
- Extrusion with highly loaded extrusion stems, dies and die holders
- Die forging
- Conformwheels
- Copper wire rolls
- Tools for powder forging

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,3	11,3	12,6	13,0

Temperature in °C	20	200	400
Thermal conductivity in W/m x K	29,8	31,0	31,4

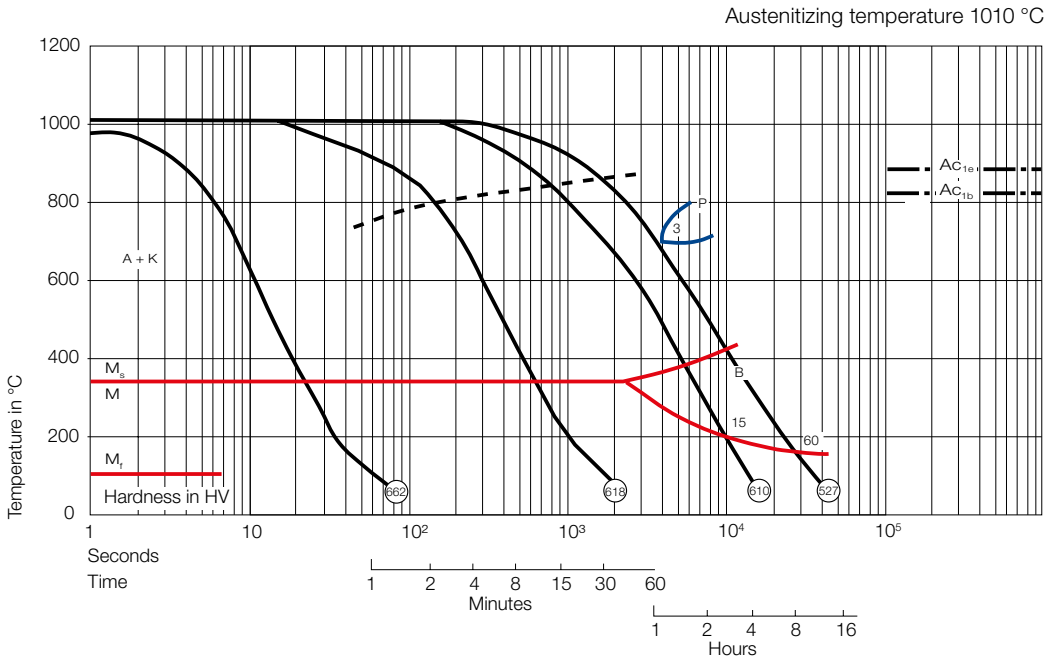
Temperature in °C	20
Density in g/cm^3	7,8

Temperature in °C	20
Young‘s modulus in GPa	214

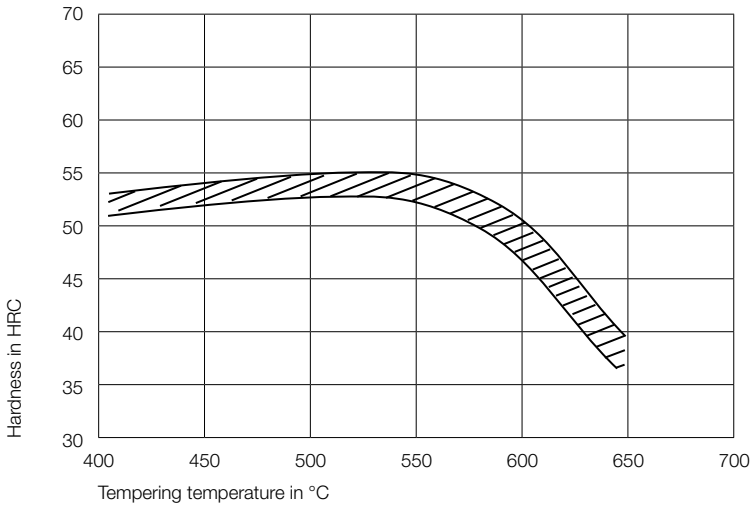
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1010 - 1020 °C
	Cooling	Air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C according to application

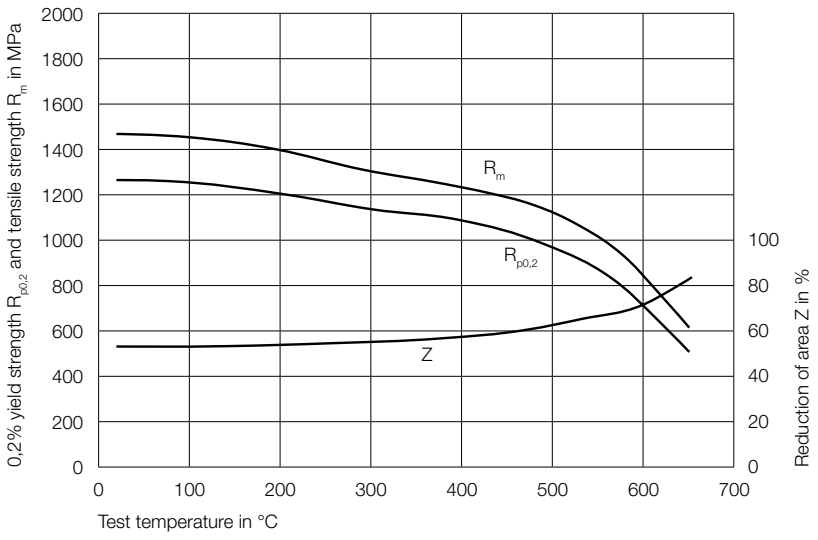
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



LMF

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Premium	LMF	0.35	0.20	0.30	5.20	1.40	0.55	+

Material properties

LMF is a Cr-Mo-V-alloyed hot-work tool steel which combines very good toughness with high-temperature strength at the same time. In addition, the material has a better thermal conductivity compared to 1.2343.

Application

LMF is specially developed for the use in die forging

- Aluminum forging
- Forging dies with a risk for cracks
- Finish dies in steel forging
- Low-pressure die casting

Physical properties

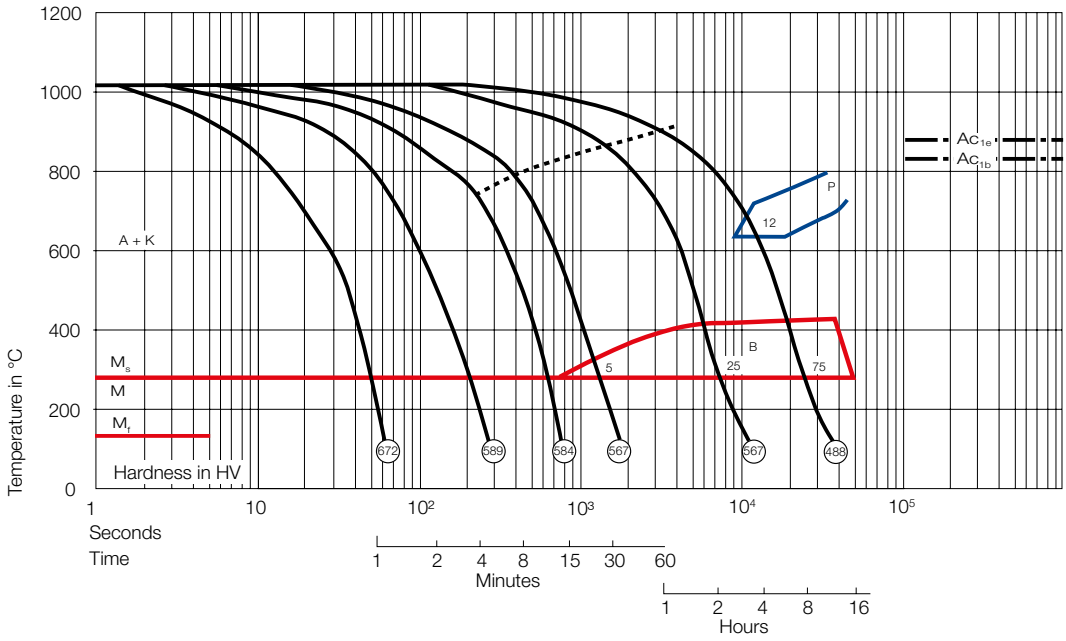
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,5	12,6	13,1
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	29,3	30,2	30,2
Temperature in °C	20		
Density in g/cm3	7,8		
Temperature in °C	20		
Young's modulus in GPa	214		

Heat treatment

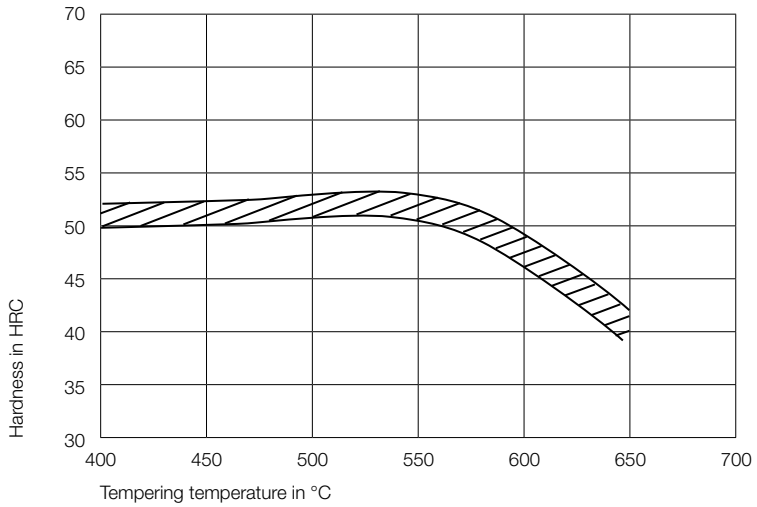
Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	Slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1015 - 1025 °C
	Cooling	Air, warm bath of approx. 540 °C, Oil/polymer; 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

Continuous time-temperature-transformation graph

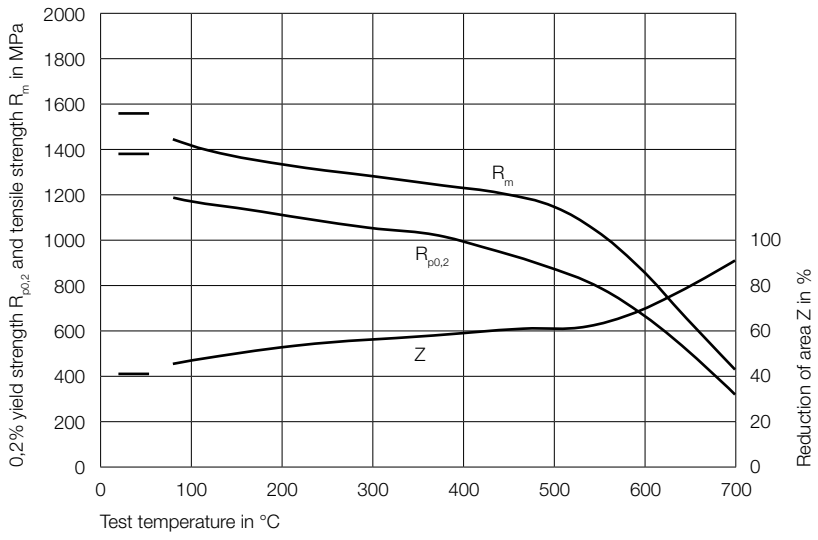
Austenitizing temperature 1020 °C



Tempering graph



High-temperature strength graph



HSF

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Premium	HSF	0.50	0.30	0.40	5.00	1.90	0.55	+

Material properties

HSF is a Cr-Mo-V-alloyed hot-work tool steel with increased C-content and special additives with special treatment to ensure good toughness properties.

Application

- Tools in fully automatic horizontal high speed forging machines
- Stamps, dies and matrices in warm forging of steel alloys
- Warm extrusion dies in steel forming
- Round dies with flat engravings with high demands on hot wear resistance
- Hot punches and shearing tools

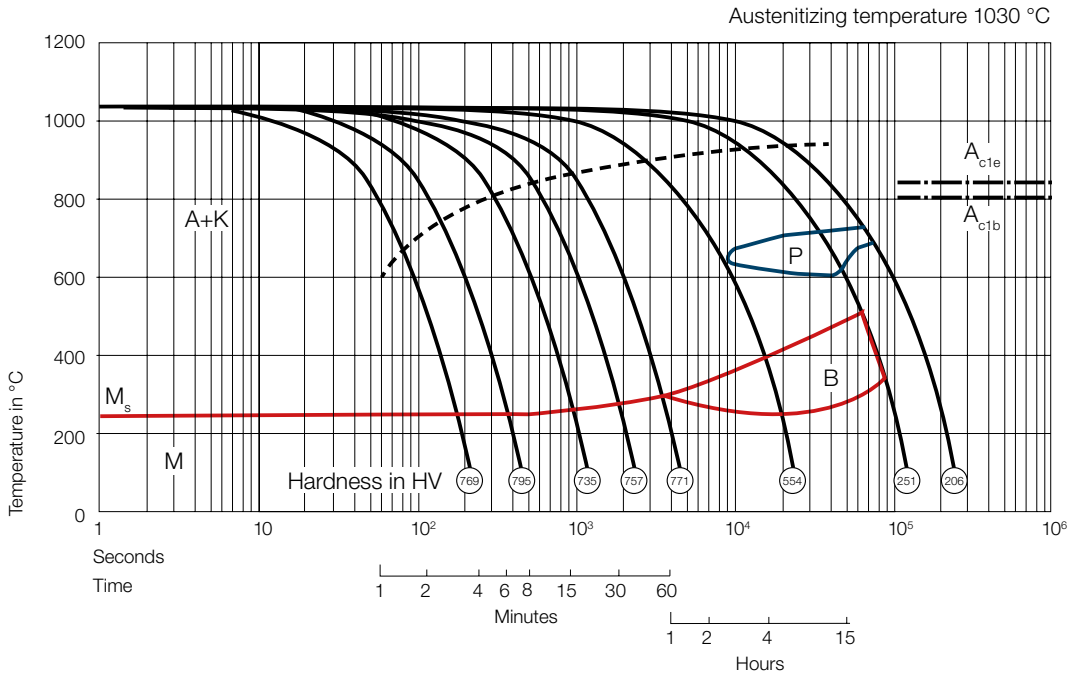
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,5	13,2	13,4
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	28,8	30,0	29,4	
Temperature in °C	20			
Density in g/cm^3	7,79			
Temperature in °C	20			
Young's modulus in GPa	213			

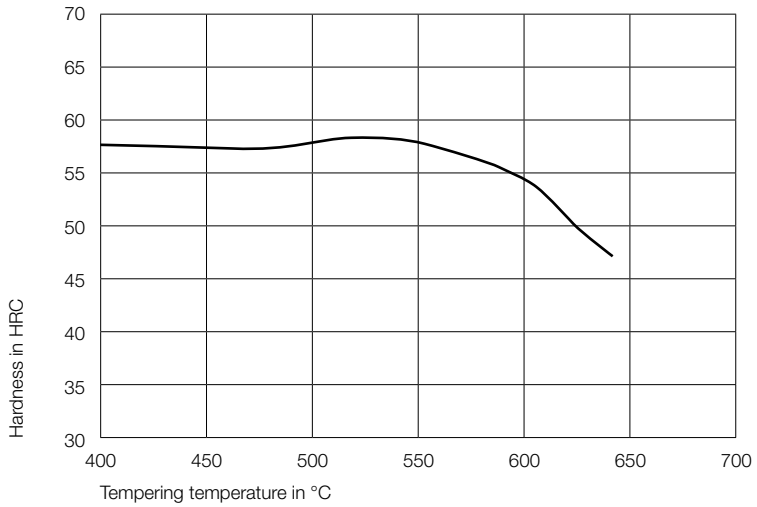
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	1010 - 1040 °C
	Cooling	Air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C according to application

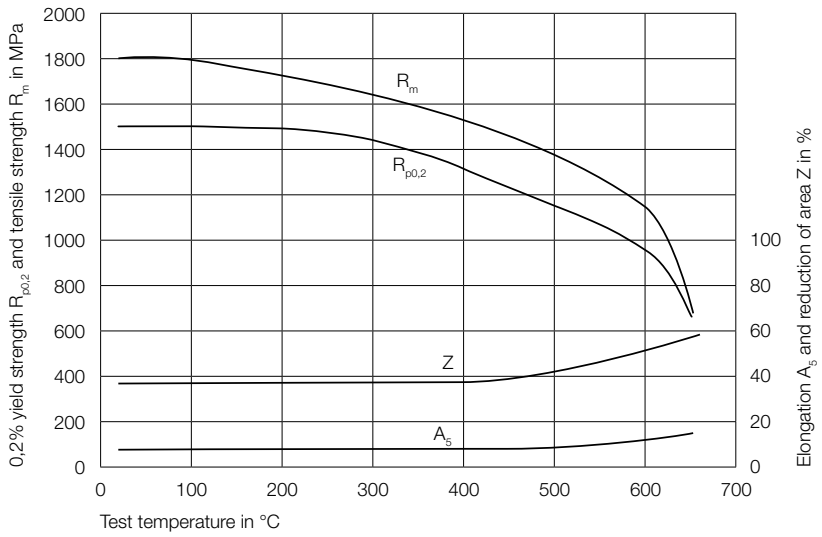
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



UH1

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Premium	UH1	0.46	0.45	0.50	6.70	1.50	0.80

Material properties

UH1 is a Cr-Mo-V-alloyed hot-work tool steel which is characterized by an outstanding wear resistance. In addition, the steel offers good high-temperature strength. The exclusive production using the ESR process confers the steel UH1 a good toughness even at high hardness level.

Application

The newly developed steel UH1 with his excellent wear resistance fulfills the current demand of the hot stamping market.

Further possible applications:

- Highly stressed extruder cylinders in plastics processing
- Cutting and punching tools

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,0	11,6	12,2	12,7

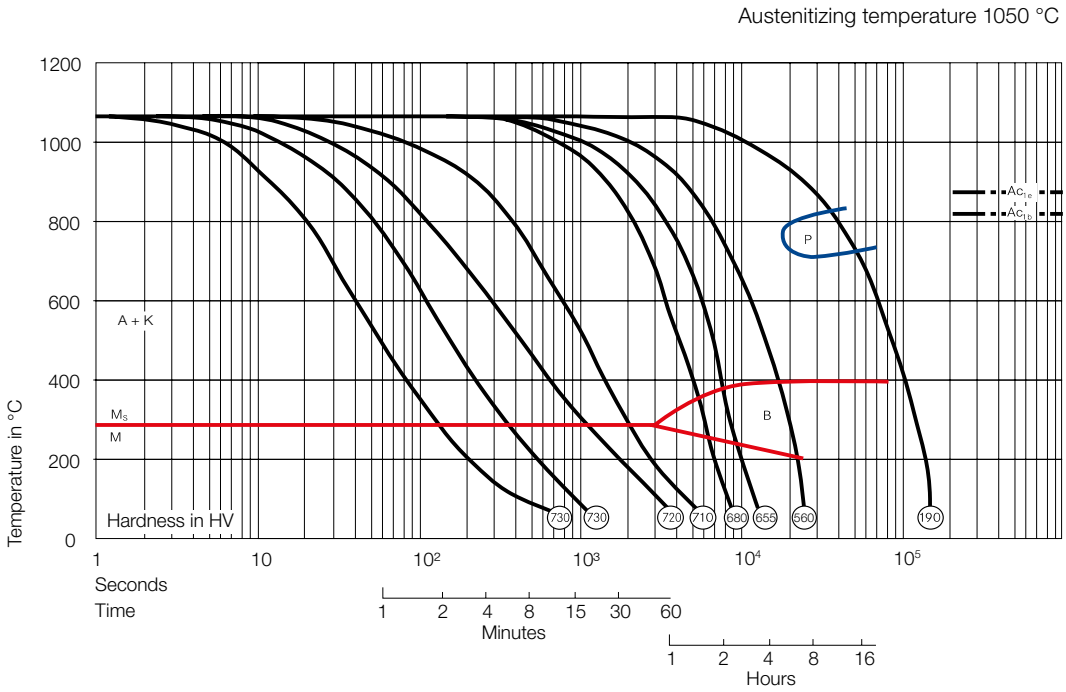
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	25,0	28,2	29,0

Temperature in °C	20
Density in g/cm3	7,79

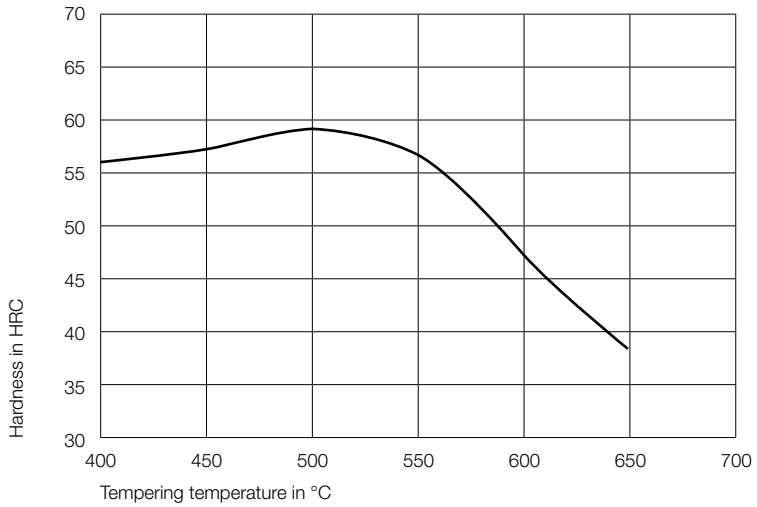
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	Slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1040 - 1070 °C
	Cooling	Air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening
Tempering	Temperature	500 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

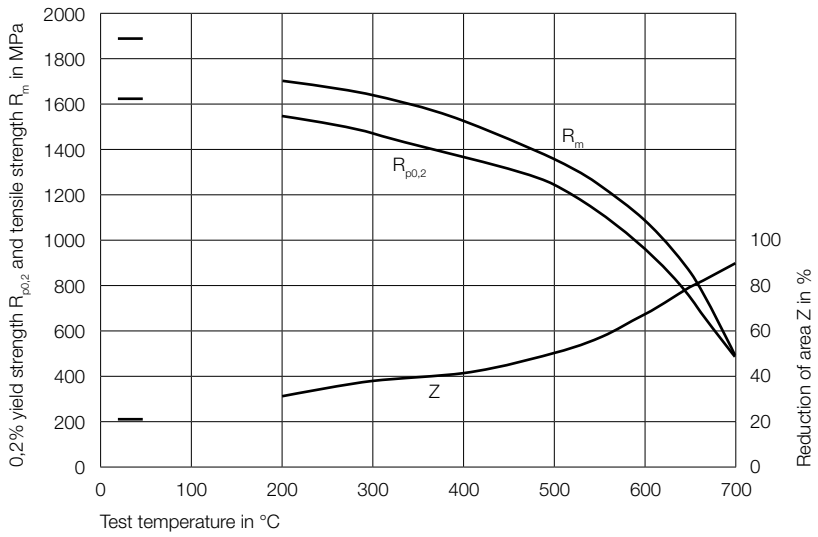
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



CM167 (1.2323)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2323	48CrMoV6-7	CM167	0.45	0.30	0.70	1.50	0.75	0.30

Material properties

CM167 is a low-alloy hot-work tool steel based on Cr-Mo-V with high hot toughness and good tempering resistance. Water cooling possible.

Application

- Tools for pipe and extrusion presses in light metal processing and die holders
- Supports
- Pressure plates
- Impression dies for light and heavy metal

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,6	12,0	12,5	13,0

Temperature in °C	20
Thermal conductivity in W/m x K	36,0

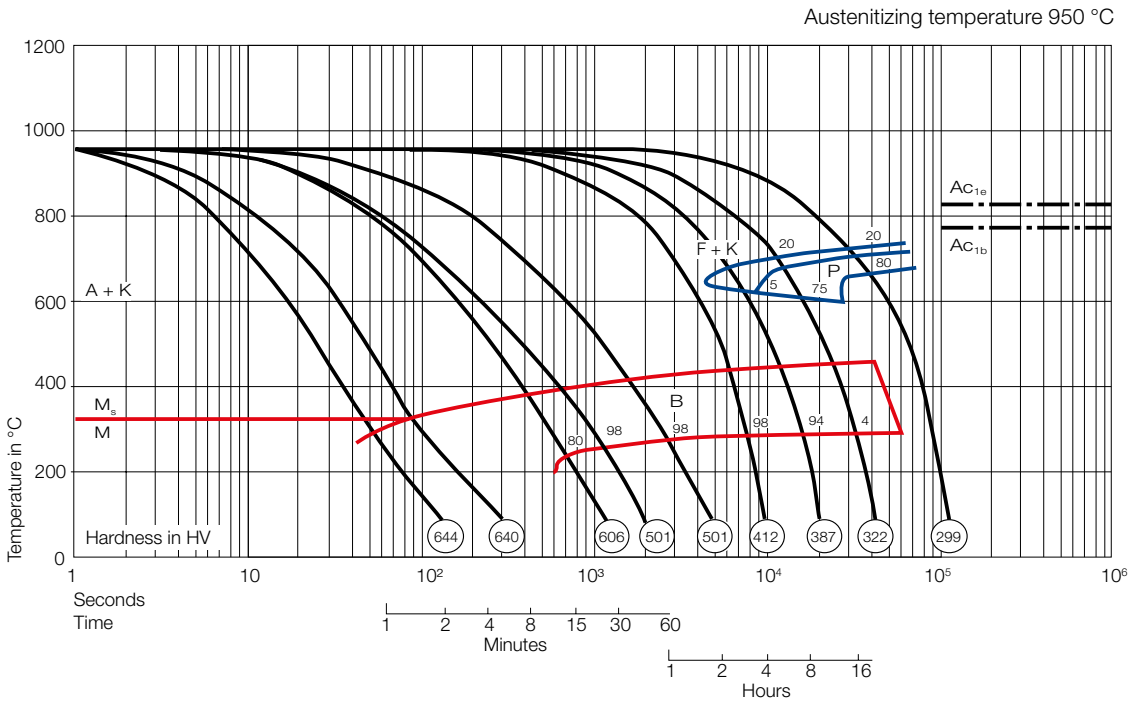
Temperature in °C	20
Density in g/cm3	7,85

Temperature in °C	20
Young‘s modulus in GPa	200

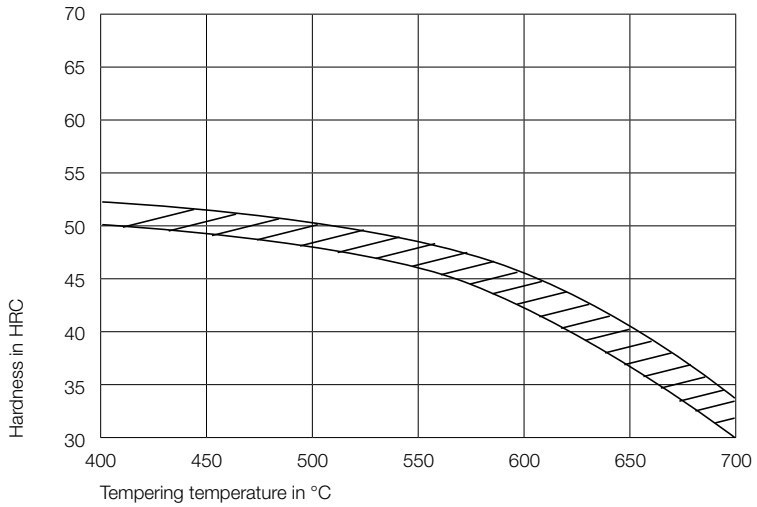
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 215 HB
Hardening	Temperature	950 - 980 °C
	Cooling	in Oil/polymer or warm bath of 300 °C, Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening
Tempering	Temperature	500 - 700 °C
	Hardness	see tempering graph
Nitriding	possible under some conditions	
Preheating before use	Temperature	150 - 350 °C required

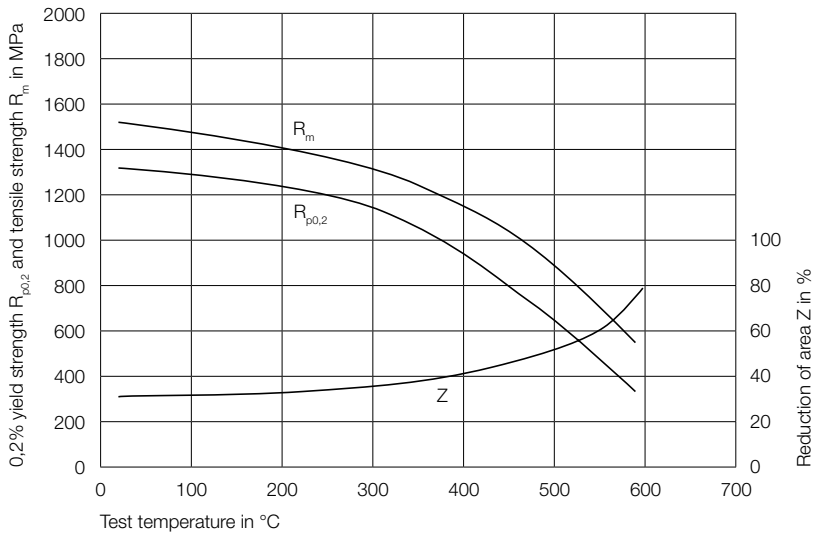
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



USN (1.2343)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2343	X37CrMoV5-1	USN	0.37	1.00	0.40	5.20	1.20	0.40

Material properties

USN is a Cr-Mo-V-alloyed hot-work tool steel with good high-temperature strength characteristics and high hot toughness. USN is thermal shock resistant, water coolable, and is characterized by high hardenability.

Application

- Extrusion press tools for light metal processing, such as dies, chamber tools, die holders, press mandrels, press stems, container mantles, and inner liners
- Press mandrels and stems for steel and heavy metal processing in extrusion presses
- Die casting tools such as mold plates, slides, cores, ejectors, sprue bushes and filling sets in the processing of light metal and zinc alloys
- Tools in forging machines such as pressure dies, die inserts, stamps and mandrels for steel, heavy and light metals
- Molds in the plastics industry
- Hot shear blades and cold shear blades for large cutting thicknesses

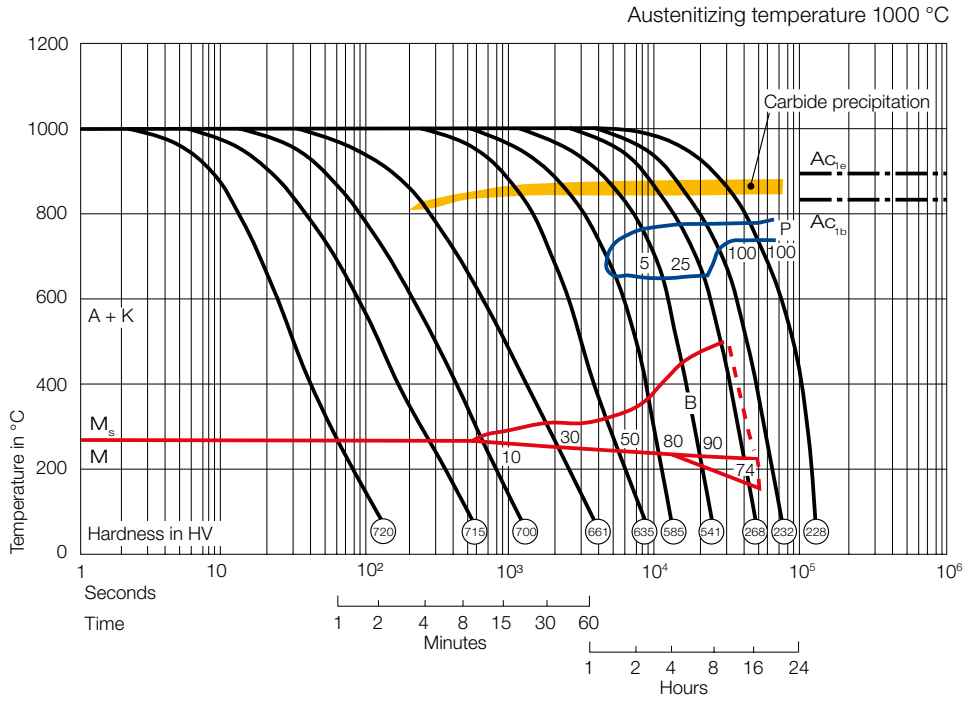
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,7	12,9
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	26,8	27,8	27,3
Temperature in °C	20		
Density in g/cm3	7,74		
Temperature in °C	20		
Young‘s modulus in GPa	215		

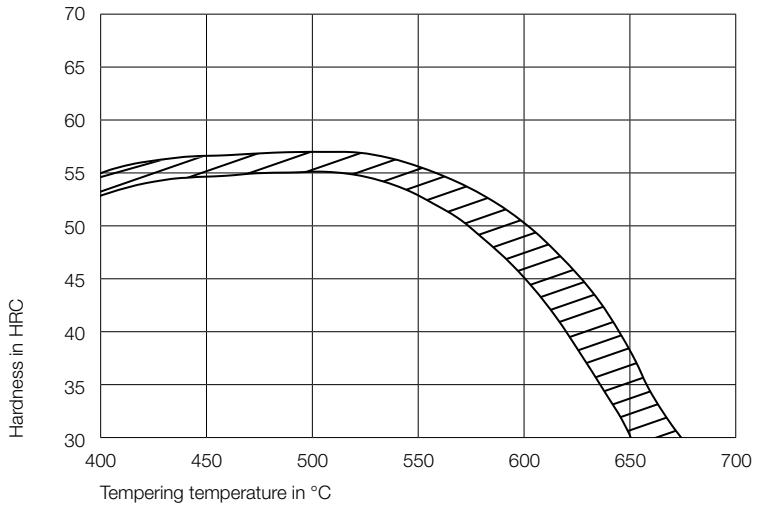
Heat treatment

Soft annealing	Temperature	820 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1000 - 1020 °C
	Cooling	Cooling in air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

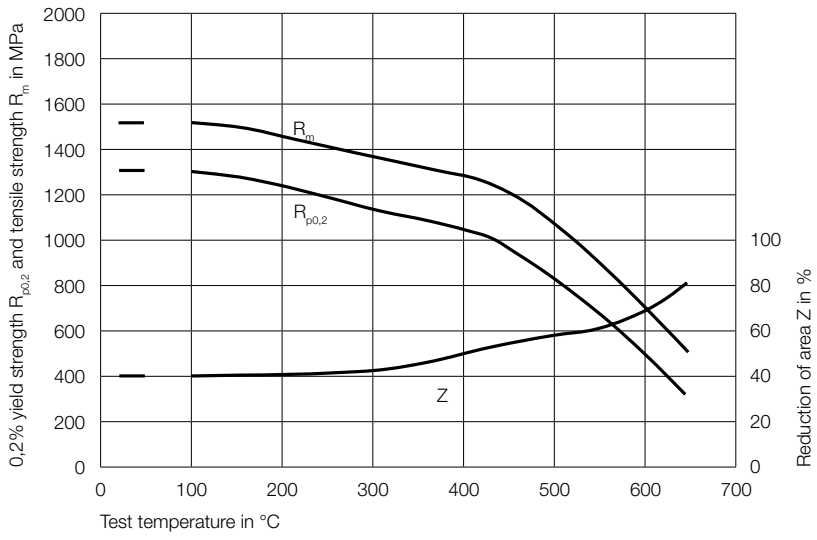
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



USD (1.2344)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2344	X40CrMoV5-1	USD	0.40	1.00	0.40	5.20	1.30	1.00

Material properties

USD is a Cr-Mo-V-alloyed hot-work tool steel with a higher high-temperature strength and higher hot wear resistance than USN. USD is thermal shock resistant, water coolable, and is characterized by high hardenability.

Application

- Extrusion tools for light metal processing, such as dies, chamber tools, die holders, press mandrels, valves and stems, shear blades
- Press mandrels and stems for steel and heavy metal processing in extrusion
- Die casting tools such as molding plates, valves, cores, ejectors, sprue bushings and filling fittings in the processing of light metals and zinc alloys
- Tools in forging machines, compression molding dies, die inserts, punches and mandrels for steel, heavy and light metals
- Hot shear blades and cold shear blades for large cutting thicknesses

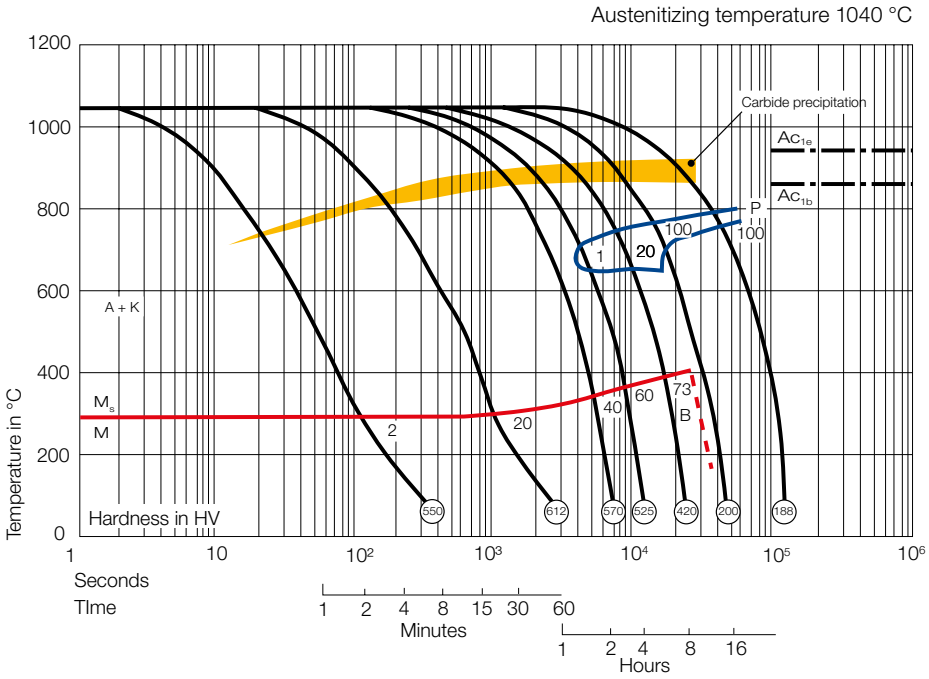
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,3	11,3	12,2	12,8
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	25,5	27,1	27,7	
Temperature in °C	20			
Density in g/cm³	7,8			
Temperature in °C	20			
Young's modulus in GPa	215			

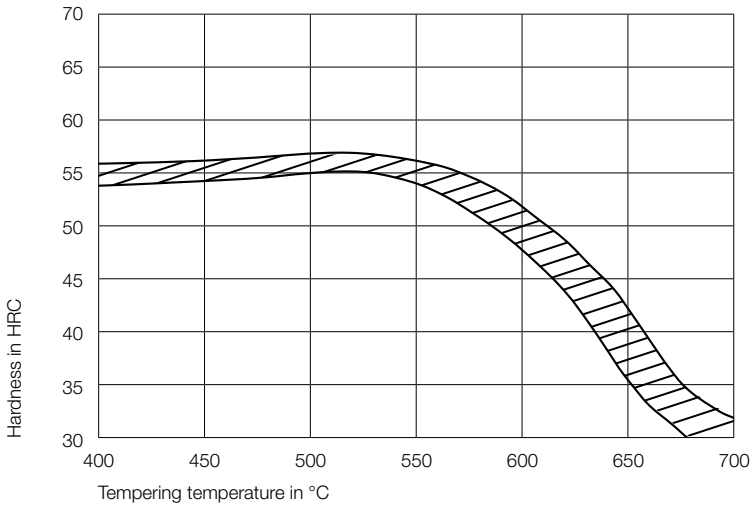
Heat treatment

Soft annealing	Temperature	820 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1020 - 1040 °C
	Cooling	Cooling in air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

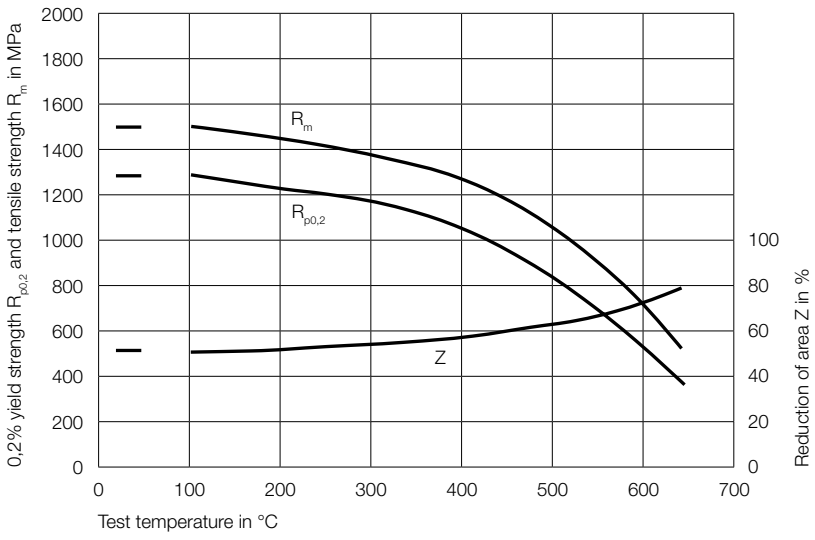
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



USD-H (1.2345)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2345	X50CrMoV5-1	USD-H	0.51	0.85	0.30	4.90	1.35	0.90

Material properties

Hot-work tool steel with increased carbon content for increased wear resistance, higher tempering resistance and hardenability.

Application

- Cold and hot shear blades
- Rolls for pipe production, push bench rolls with high wear requirements

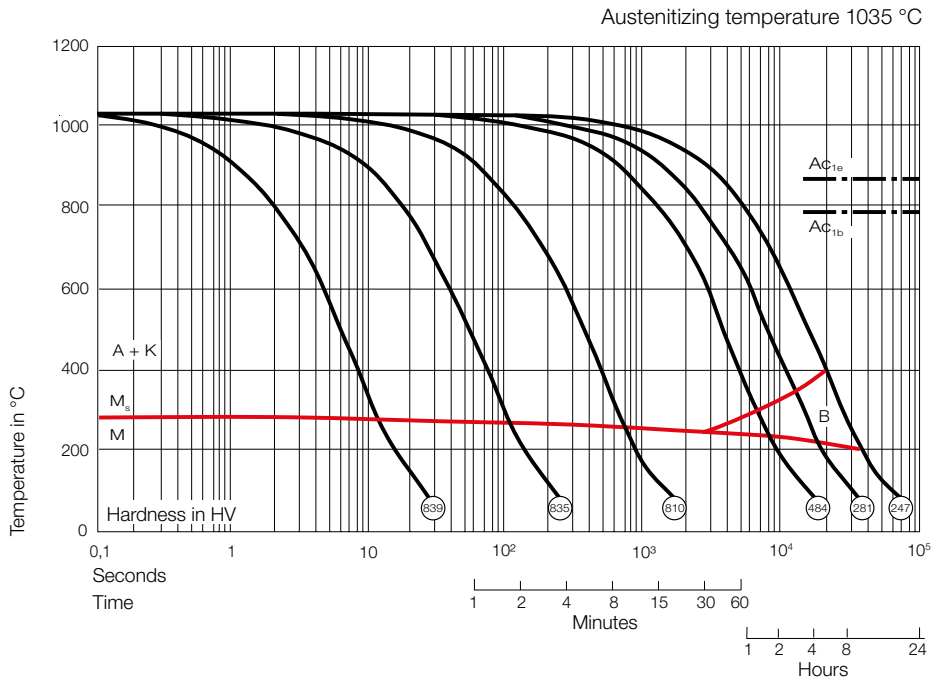
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,5	12,5	13,1
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	25,0	26,7	27,3
Temperature in °C	20		
Density in g/cm³	7,73		
Temperature in °C	20		
Young's modulus in GPa	215		

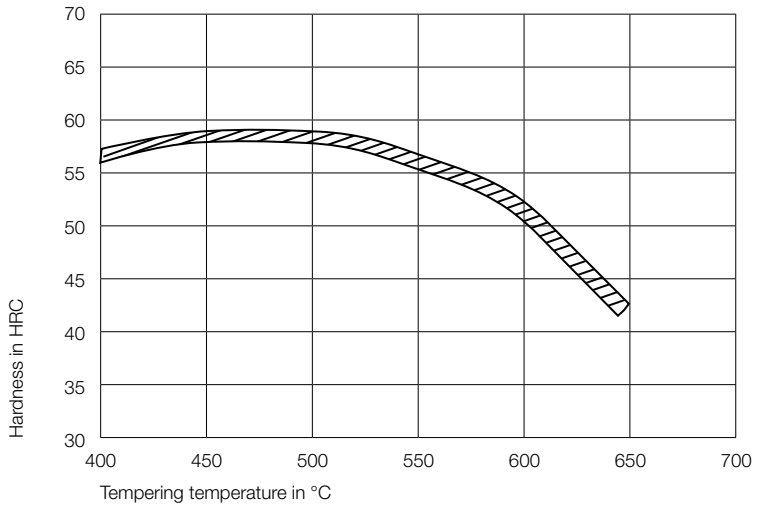
Heat treatment

Soft annealing	Temperature	760 - 810 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1010 - 1040 °C
	Cooling	Oil or polymer cooling or vacuum hardening
Tempering	Temperature	520 - 620 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

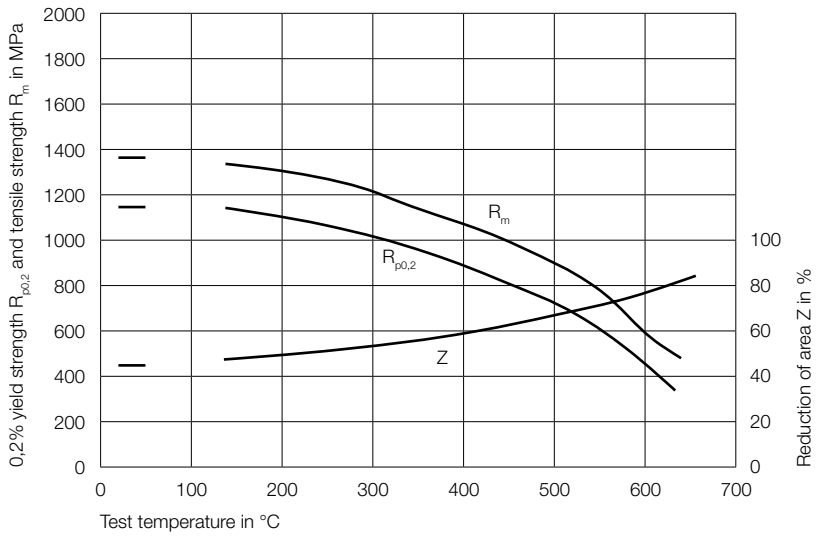
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



RP (1.2365)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2365	32CrMoV12-28	RP	0.32	0.40	0.40	3.00	2.80	0.50

Material properties

RP is a Cr-Mo-V-alloyed hot-work tool steel with very high high-temperature strength and tempering resistance. Due to its good thermal conductivity, it can be water cooled and is therefore insensitive to temperature changes. RP has very good cold drawability.

Application

- Extrusion tools for steel and heavy metal processing, such as pipe extrusion rams, die/die-holders and inner liners
- Molding press die in heavy metal processing
- Tools in forging presses such as die inserts, mandrels, forging dies and steel processing punches
- Tools for high-speed forging presses
- Piercer heads
- Piercer
- Push bench rollers in steel pipe production

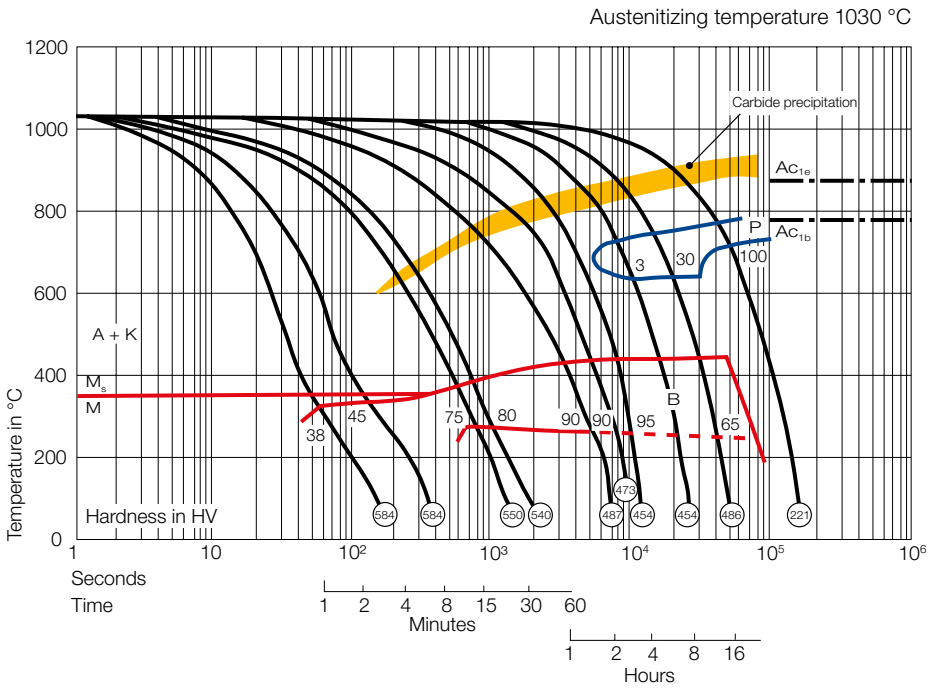
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,3	11,9	13,0	13,7
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	30,0	30,2	29,3	
Temperature in °C	20			
Density in g/cm^3	7,85			
Temperature in °C	20			
Young's modulus in GPa	215			

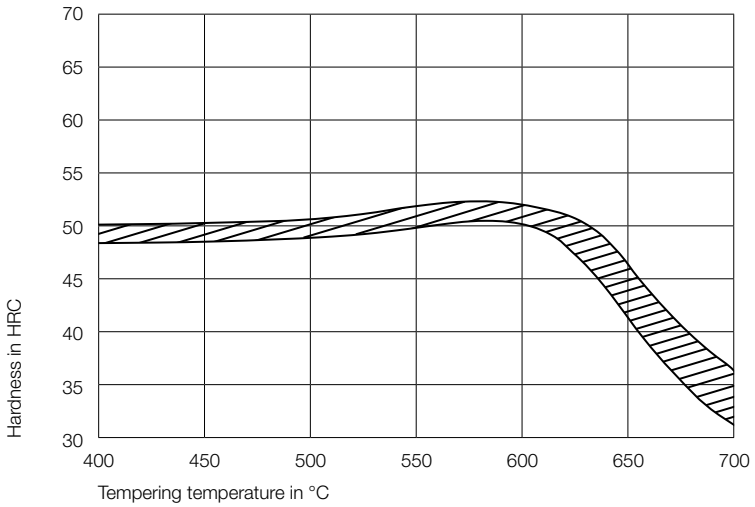
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 220 HB, for cold hobbing max. 175 HB
Hardening	Temperature	1020 - 1050 °C
	Cooling	Polymer, warm bath approx. 540 °C, Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	580 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

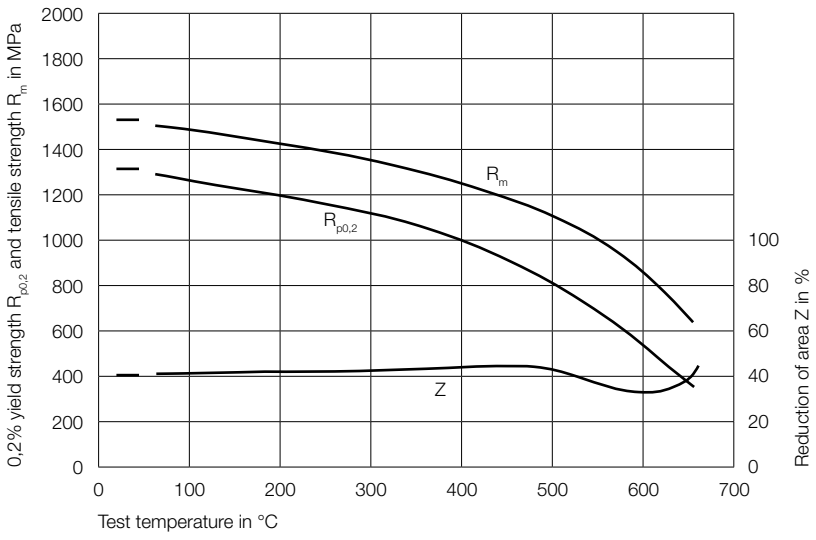
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



RPU (1.2367)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2367	X38CrMoV5-3	RPU	0.38	0.40	0.40	5.00	3.00	0.60

Material properties

Cr-Mo-V-alloyed hot-work tool steel RPU combines good hot toughness with excellent high-temperature strength.

Application

- Extrusion press tools such as pipe extrusion mandrels, press stems, die/die holders and inner liners for heavy metal alloys
- Die casting tools for high shot numbers in light metal processing
- Molding press die for heavy and light metal processing
- Dies or die inserts in forging presses for steel forging

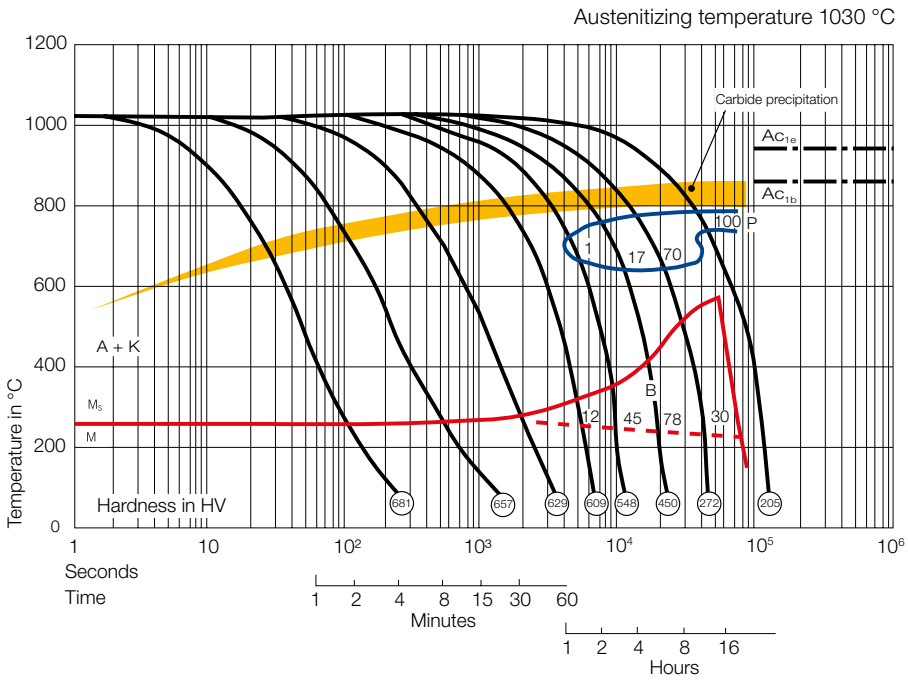
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,9	12,5	12,8	13,3
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	29,9	32,1	32,4	
Temperature in °C	20			
Density in g/cm³	7,85			
Temperature in °C	20			
Young's modulus in GPa	215			

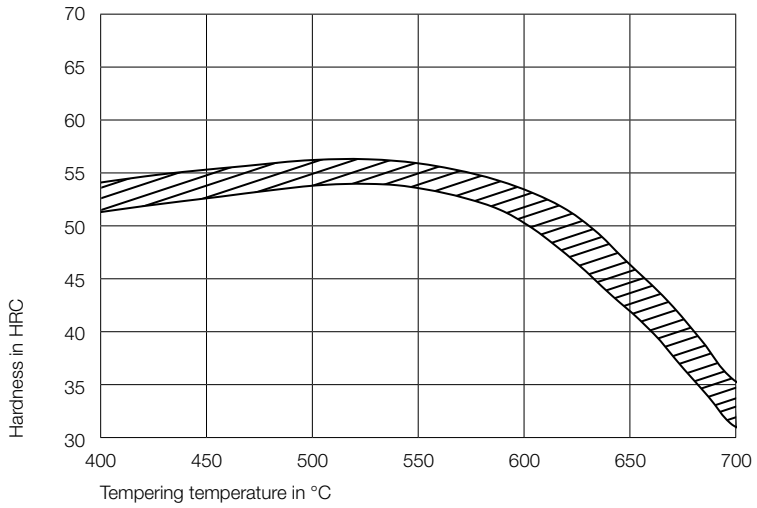
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1030 - 1050 °C
	Cooling	Air, warm bath approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

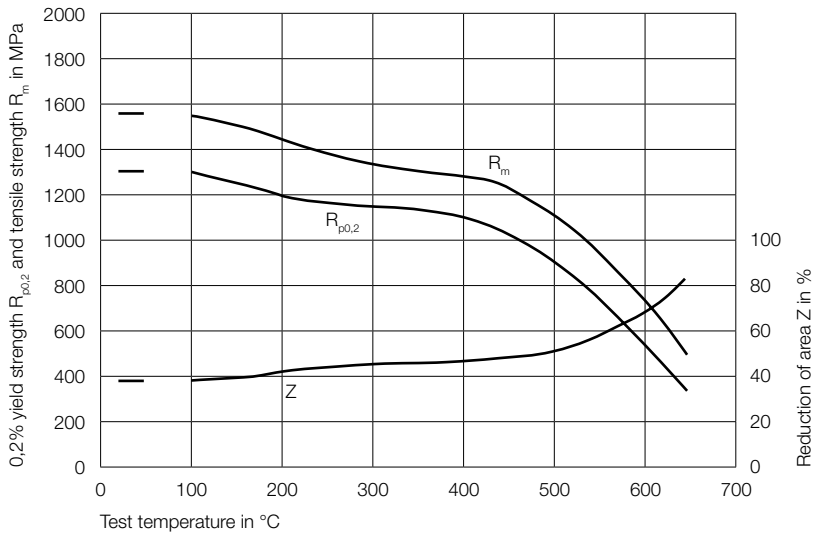
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



MA (1.2581)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	V	W
1.2581	X30WCrV9-3	MA	0.30	0.30	0.30	2.70	0.35	9.00

Material properties

MA is a high W-alloyed hot-work tool steel with best high-temperature strength and tempering resistance with hot wear resistance.

Application

- Highly thermally stressed dies for extrusion of heavy metals such as dies/die holders and mandrels
- Partial pressure dies for heavy metal processing

Water cooling is not possible.

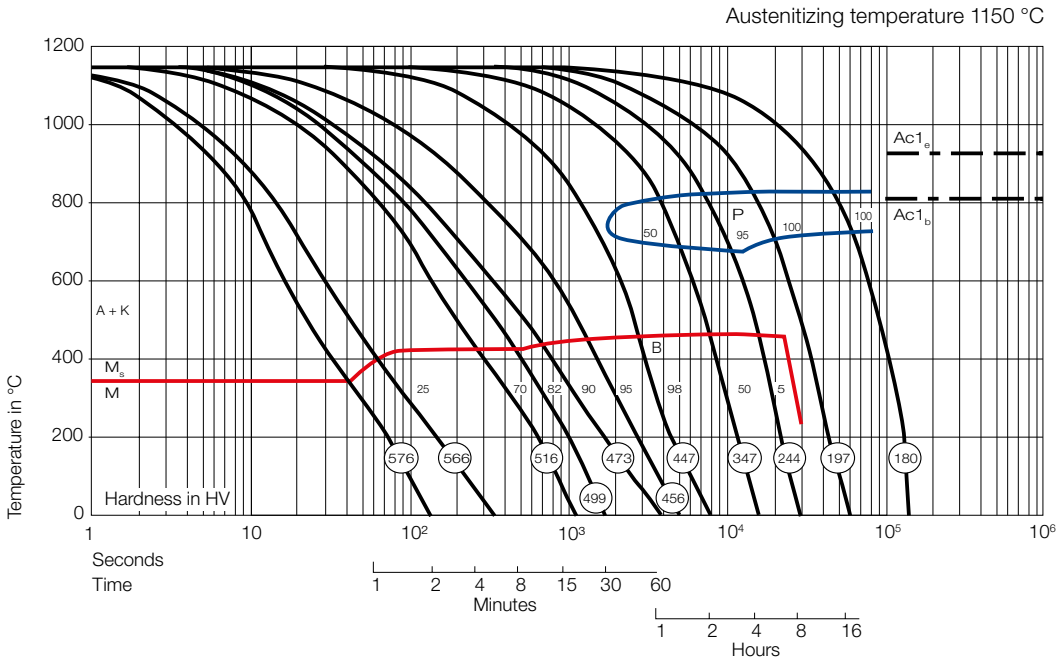
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,2	11,9	12,5	13,0
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	30,6	30,7	30,8	
Temperature in °C	20			
Density in g/cm³	8,4			
Temperature in °C	20			
Young's modulus in GPa	215			

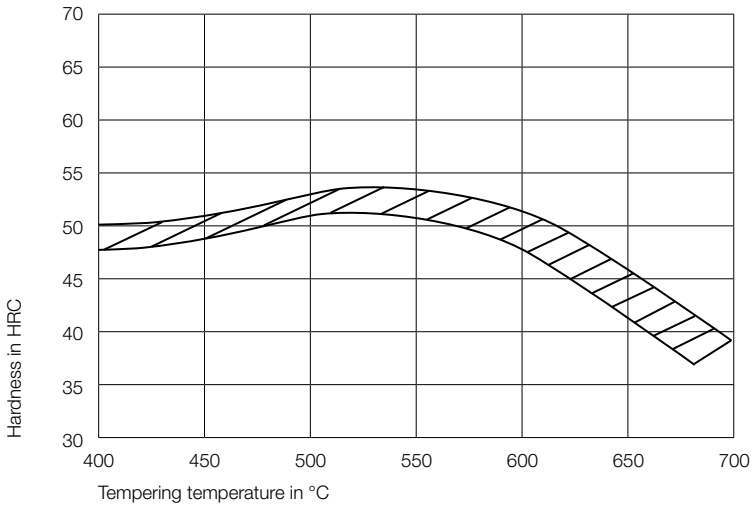
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1100 - 1150 °C
	Cooling	Oil/polymer or warm bath of approx. 540 °C, air; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	580 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	300 - 400 °C essential

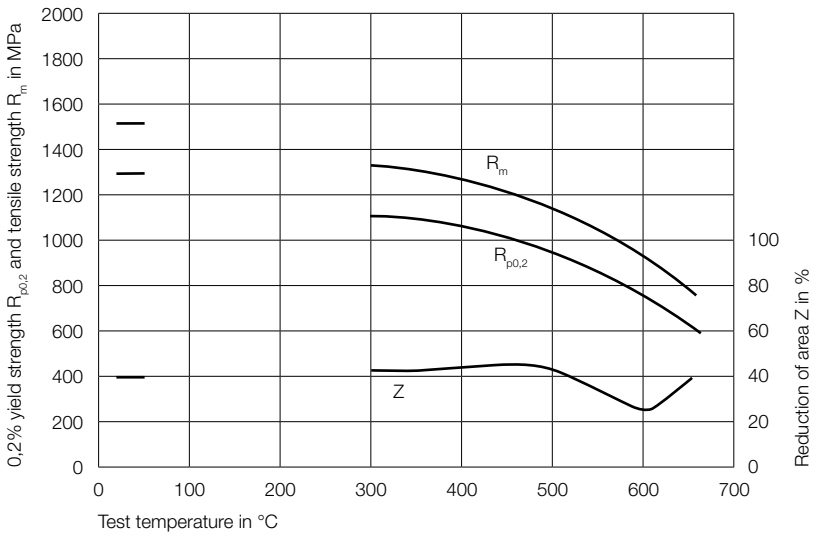
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



W44 (1.2603)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	V	W
1.2603	45CrVMoW5-8	W44	0.45	0.60	0.40	1.60	0.60	0.80	0.50

Material properties

W44 is a medium-alloyed hot-work tool steel with high tempering resistance and good hot wear behavior.

Application

- Extrusion tools such as pressure discs and cleaning discs
- Molding press die for light and heavy metal processing
- Jaws, dies and punches in steel forming for the production of bolts, nuts and rivets under screw presses

Water cooling is possible.

Physical properties

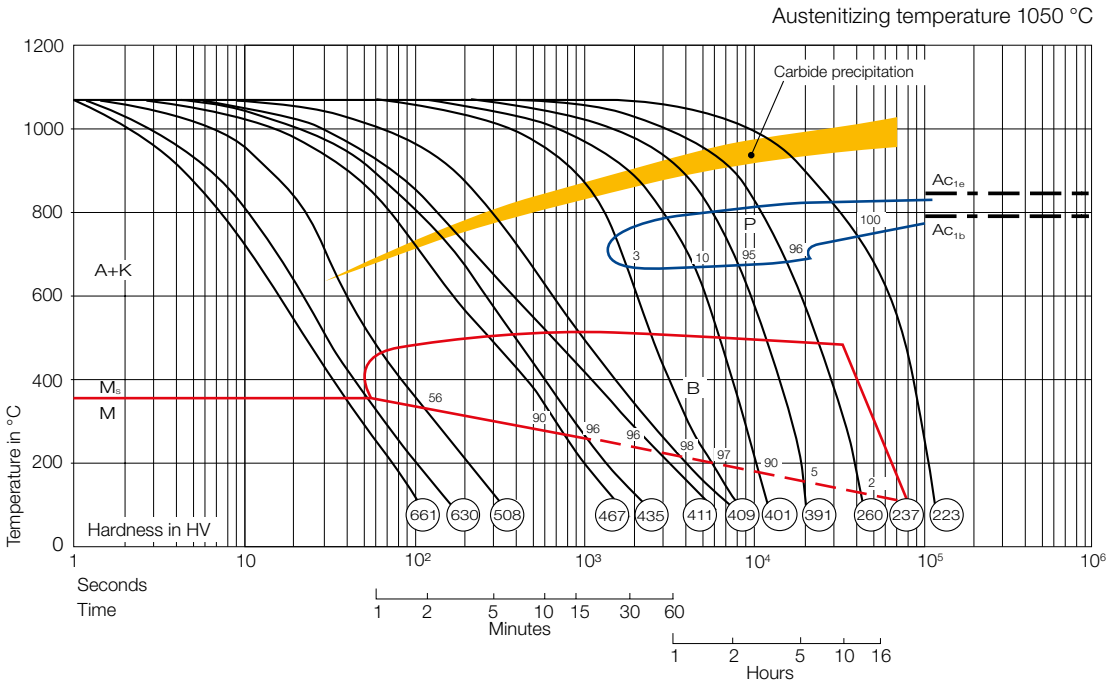
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,7	12,0	12,5	13,0

Temperature in °C	400
Thermal conductivity in W/m x K	34,0

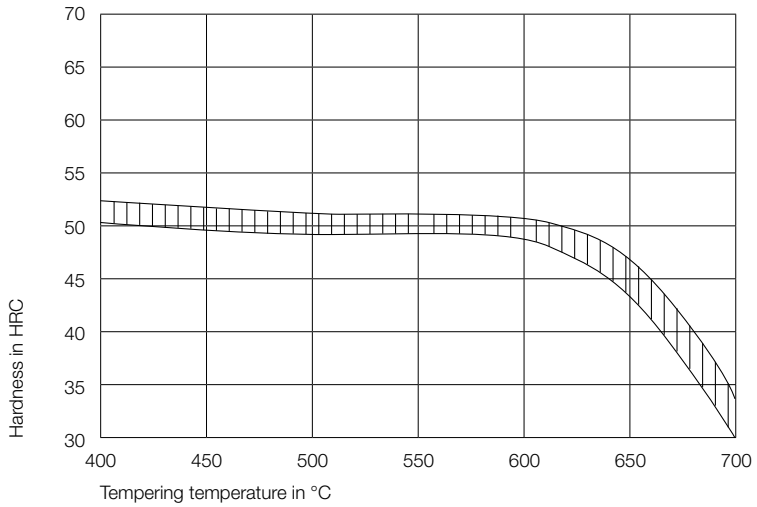
Heat treatment

Soft annealing	Temperature	820 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1000 - 1050 °C
	Cooling	Oil/polymer, for low constant thicknesses also warm bath of approx. 540 °C. Interrupt oil or polymer cooling at 200 - 250 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

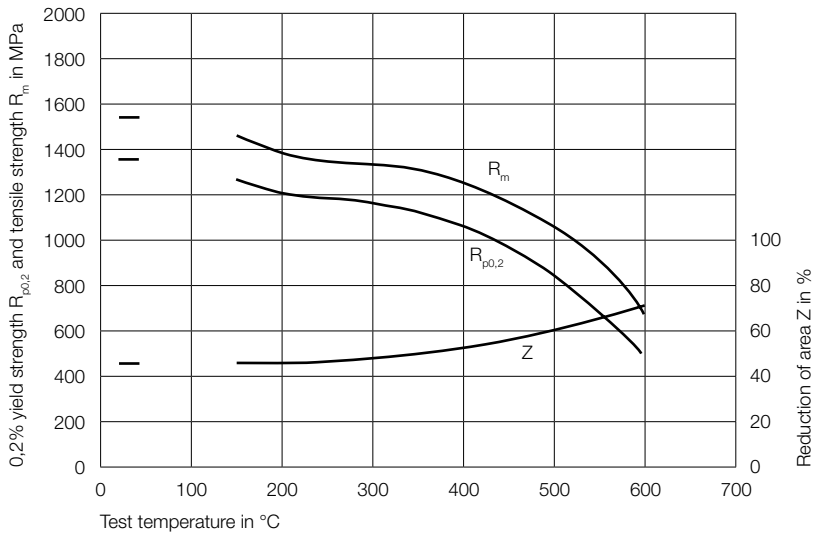
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



US (1.2606)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	V	W
1.2606	X37CrMoW5-1	US	0.36	1.00	0.40	5.20	1.40	0.30	1.40

Material properties

US corresponds to the steel USN with additional W-content. This increases the high-temperature strength and hot wear resistance. Hot toughness and thermal shock resistance are good. Water-coolability is limited.

Application

- Molding press die of heavy and light metal processing
- Forging tools such as small and medium full dies in forging presses
- Die inserts, mandrels, forging dies and punches in steel processing

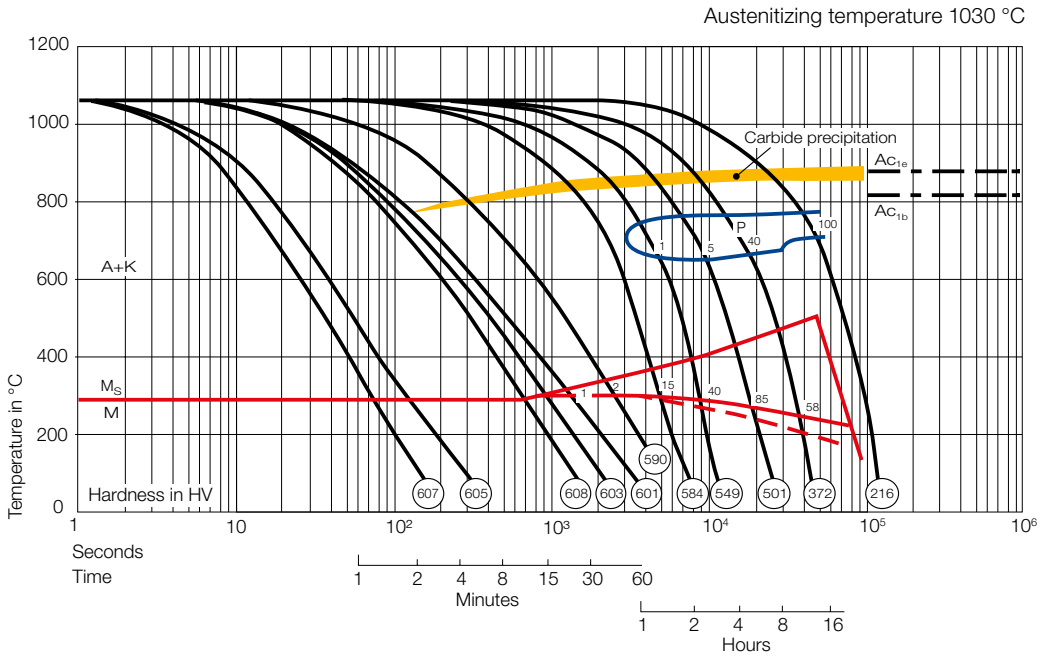
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	9,6	11,0	12,1	13,0
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	24,2	25,6	26,8	
Temperature in °C	20			
Density in g/cm³	7,74			
Temperature in °C	20			
Young's modulus in GPa	210			

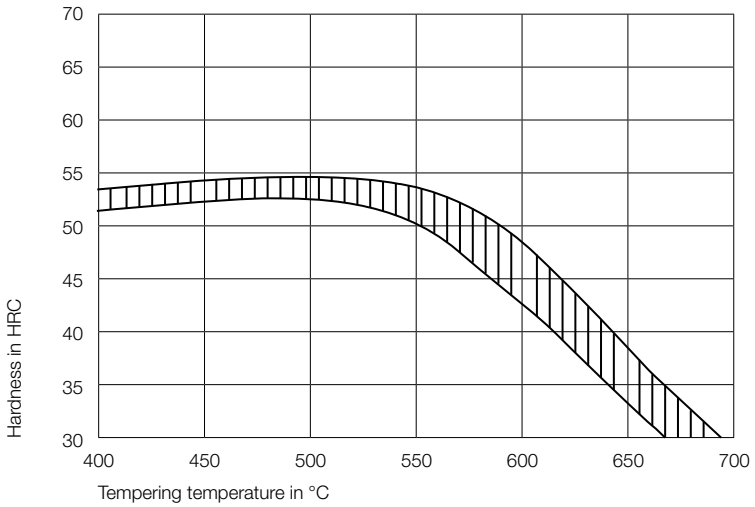
Heat treatment

Soft annealing	Temperature	820 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1000 - 1050 °C
	Cooling	In Air, warm bath of approx. 540 °C, Oil/polymer; Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

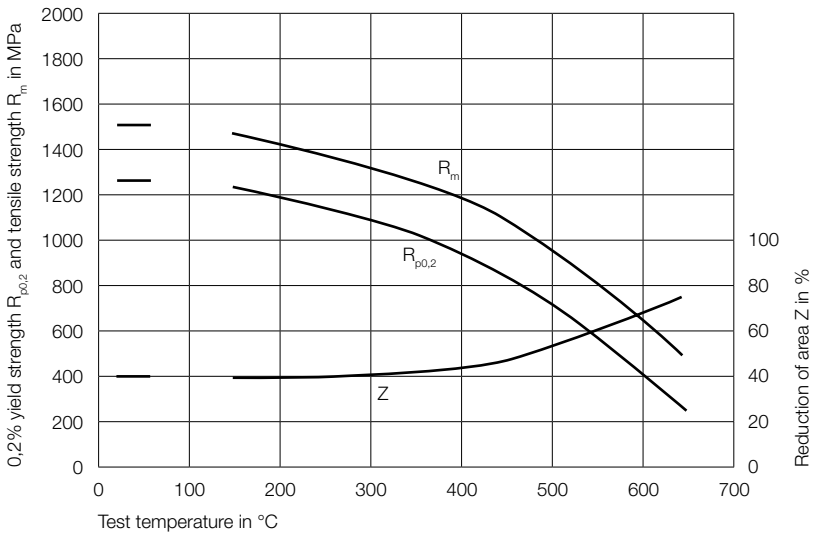
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



PD (1.2622)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	V	W
1.2622	X60WCrMoV9-4	PD	0.58	0.25	0.25	4.00	0.90	0.80	9.00

Material properties

PD is a high W-alloyed hot-work tool steel and combines very good wear resistance with high tempering resistance.

Application

- Hot punching and cutting tools for steel processing
- Hot extrusion mandrels
- Shrunk screw dies, punching tools and shear blades
- Tools for hot pressing of sinter powders

Water cooling is not possible.

Physical properties

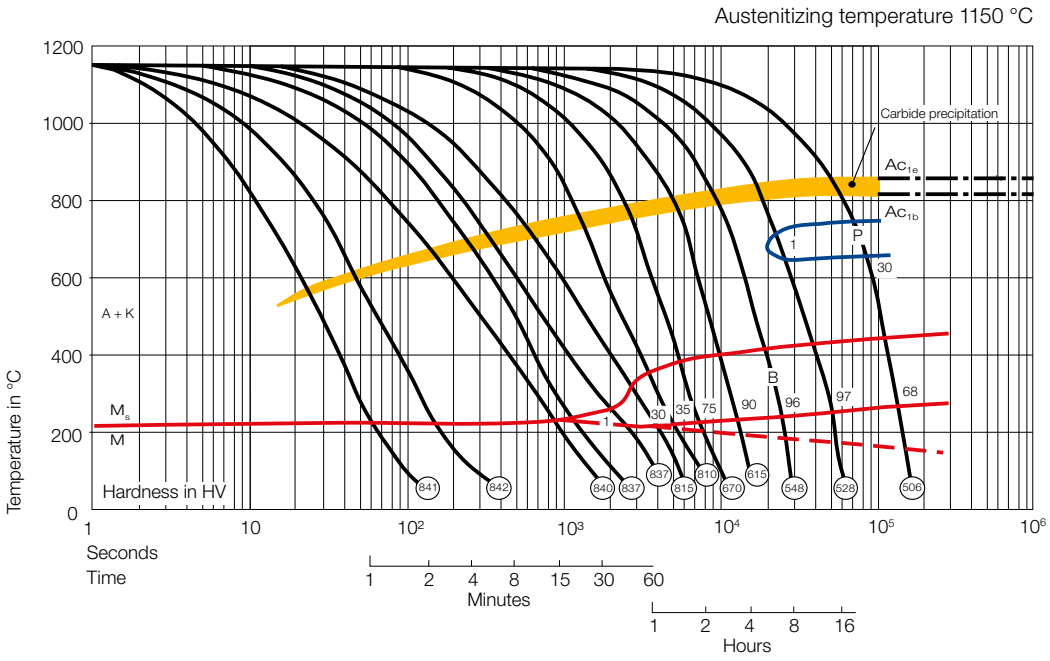
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,0	12,0	13,1	13,4

Temperature in °C	20	200	400
Thermal conductivity in W/m x K	24,2	26,8	27,5

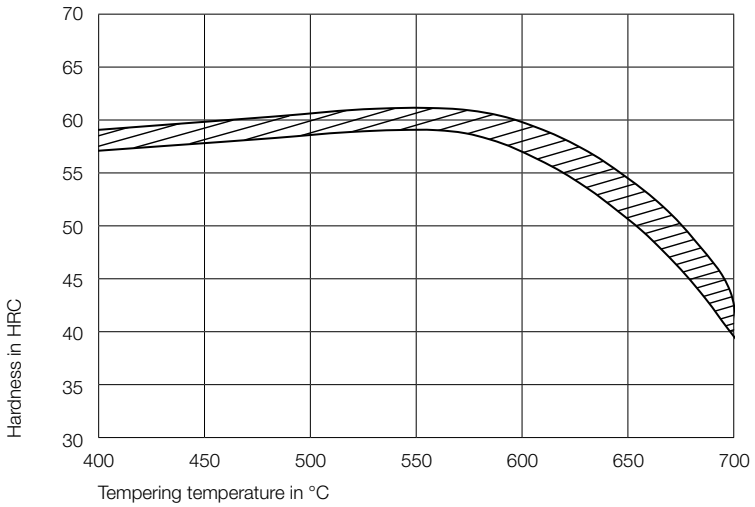
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 260 HB
Hardening	Temperature	1130 - 1180 °C
	Cooling	Air, warm bath of approx. 540 °C oder Oil/polymer; Interrupt oil or polymer quenching at 250 - 300 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	200 - 400 °C

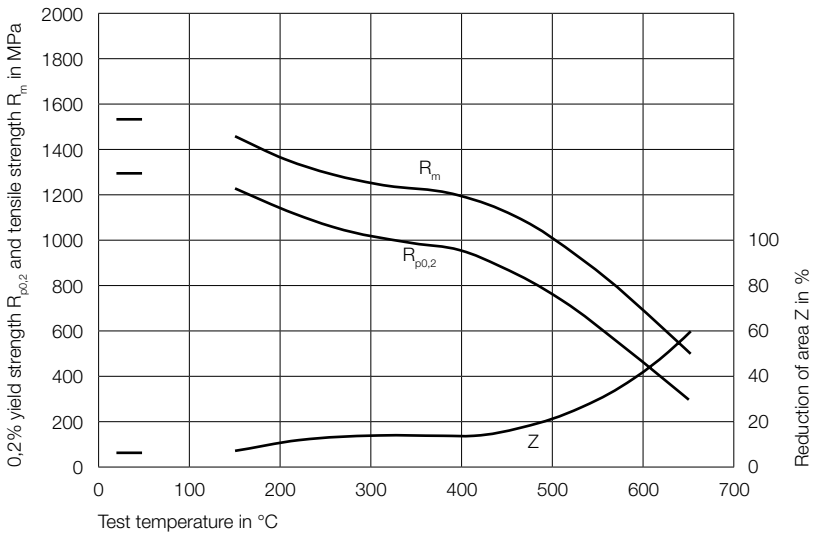
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



HWD (1.2678)

Mat.-no.	Short name	Brand name	Mass.-%							
			C	Si	Mn	Cr	Mo	V	Co	W
1.2678	X45CoCrWV5-5-5	HWD	0.40	0.30	0.40	4.50	0.50	2.10	4.50	4.50

Material properties

Due to its well-balanced composition, HWD is a hot-work tool steel with very high high-temperature strength and tempering resistance and a particularly high hot wear resistance. Compared to MA, HWD does not tend to hot embrittlement.

Application

- Extrusion dies for brass
- Die holders for heavy metal processing
- Die casting dies for brass and relatively thin-walled castings, highly stressed cores, which are in the casting stream
- Light metal casting
- Molding press dies, especially mandrel inserts for hot pressing of heavy metals
- Small die inserts and hot extrusion dies in steel forming

Water cooling is not possible.

Physical properties

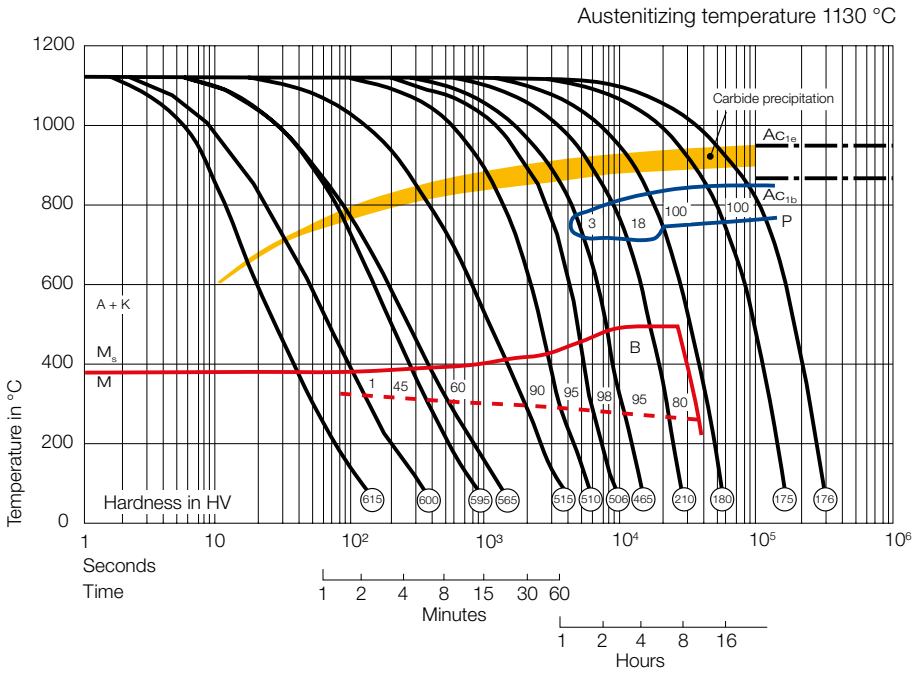
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,6	12,0	12,5	13,0

Temperature in °C	20	200	400
Thermal conductivity in W/m x K	24,0	28,5	31,7

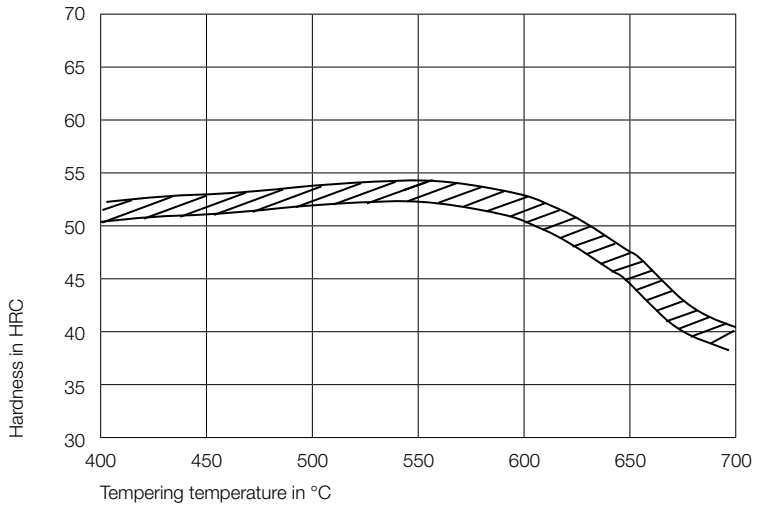
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1130 - 1180 °C
	Cooling	Air, warm bath of approx. 540 °C oder Oil/polymer; Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening
Tempering	Temperature	580 - 750 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	200 - 400 °C

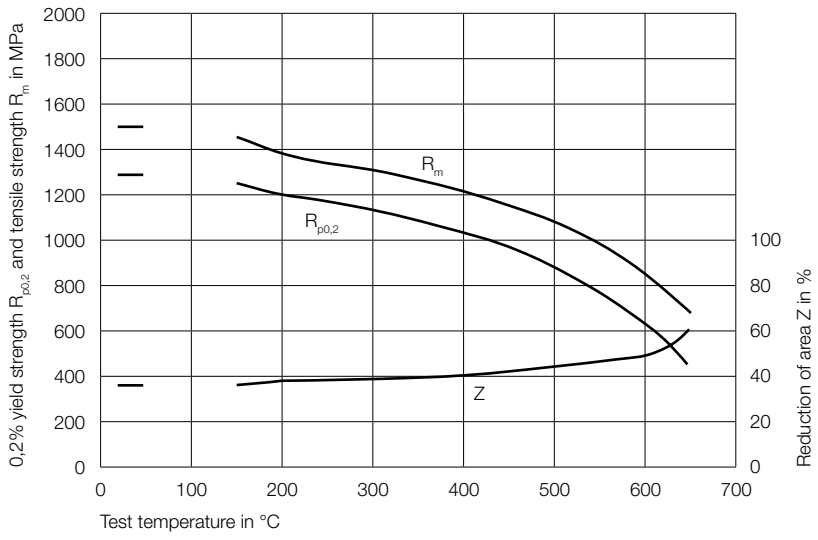
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



UHF3 (1.2709)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Mo	Ni	Co	Ti
1.2709	X3NiCoMoTi18-9-5	UHF3	≤ 0.03	≤ 0.10	≤ 0.15	5.20	18.00	9.50	0.95

Material properties

UHF3 is a high-strength and high-toughness maraging nickel steel with simple heat treatment and is suitable for tools exposed to moderate thermal loads and for cold work tools.

Application

- Die casting dies for light metal and zinc alloys such as inserts and cores
- Molding press die for light metal processing
- Plastic molds
- Cold impact pressing tools
- Cold punches
- Cylinders and shrink rings for cold extrusion tools or hard metal inserts
- Highly stressed cold pilger mandrels for steel and heavy metal processing in the production of thin-walled tubes

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 500
Thermal expansion in 10^{-6}m/m x K	10,4	11,0	11,7	12,0

Temperature in °C	20
Thermal conductivity in W/m x K	16,0

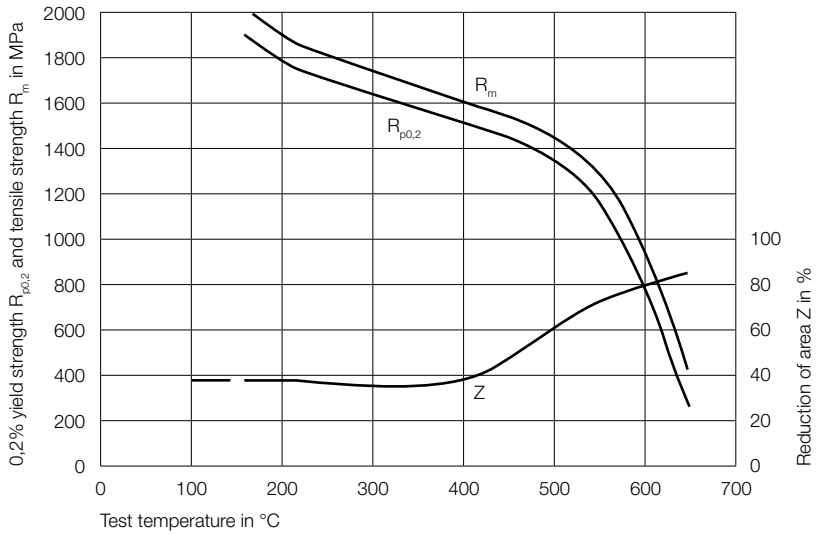
Temperature in °C	20
Density in g/cm³	8,08

Temperature in °C	20
Young's modulus in GPa	190

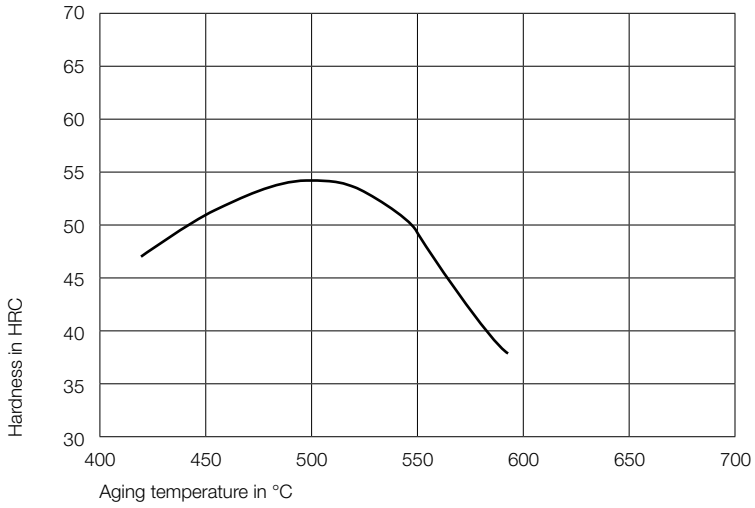
Heat treatment

Solution annealing	Temperature	900 °C
	Cooling	Air
	Hardness	950 - 1100 MPa
Aging	Temperature	500 °C
	Cooling	6 hours with cooling in calm air This results in a considerable increase in strength.
Nitriding	possible under some conditions	
Preheating before use	UHF3 can be welded easily without preheating with equivalent filler metal.	

High-temperature strength graph



Age hardening graph



PWM (1.2714)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	Ni	V
1.2714	55NiCrMoV7	PWM	0.55	0.30	0.80	1.10	0.45	1.70	0.10

Material properties

PWM is the classic die steel with good toughness, high through hardenability and compressive strength.

Application

- Forging dies for all kinds of steel forming
- Hammer and press saddles
- Jaws in forging machines
- Tools for extrusion
- Press die holder
- Linings and support tools
- Tool holder
- Molding press dies of all types for all light metals and their alloys
- Piercer shafts and hole pots for steel pipe bloom manufacturing

Physical properties

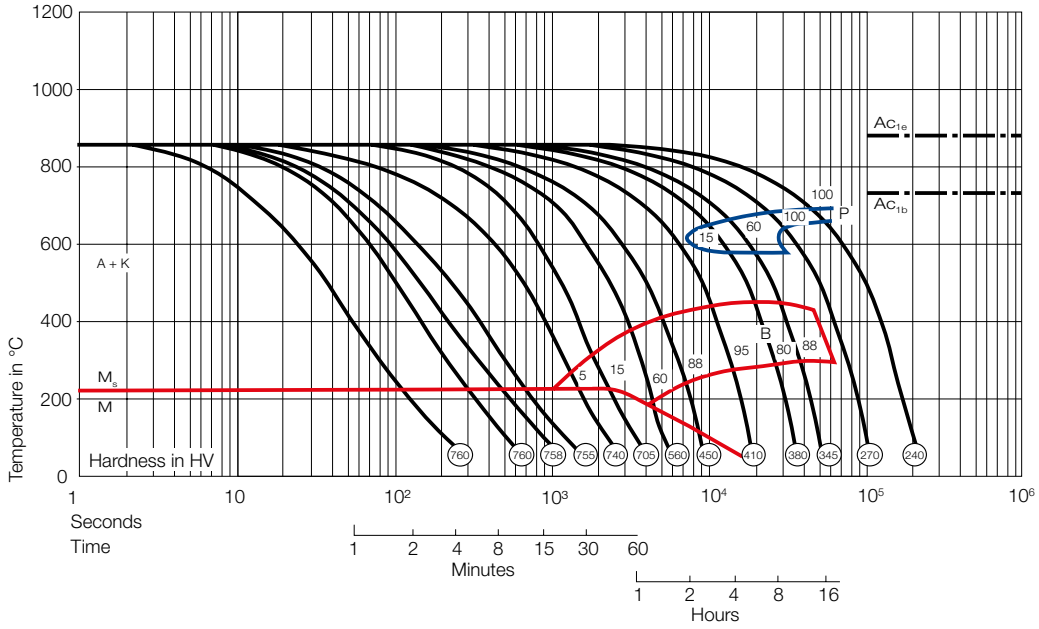
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,0	12,5	13,3	14,0
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	36,0	36,5	36,0	
Temperature in °C	20			
Density in g/cm³	7,8			
Temperature in °C	20			
Young's modulus in GPa	215			

Heat treatment

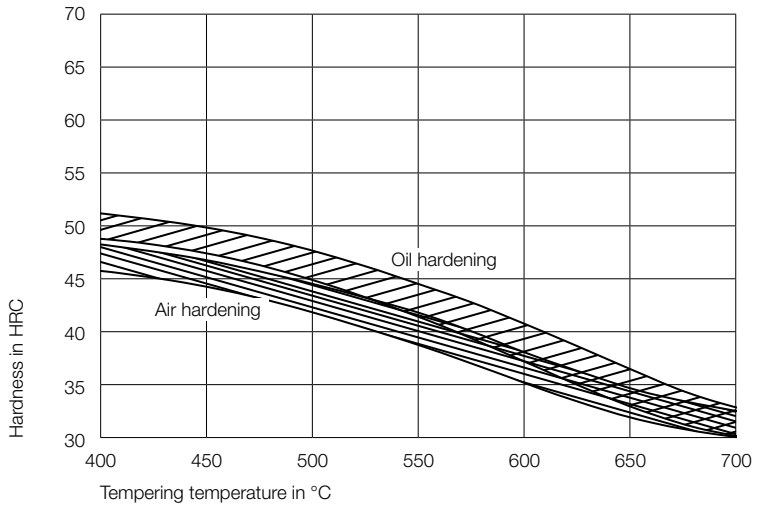
Soft annealing	Temperature	740 - 760 °C, 6 - 8 hours
	Cooling	slow furnace cooling
	Hardness	max. 250 HB
Hardening	Temperature	850 - 880 °C in Oil/polymer 880 - 900 °C in blast air
	Cooling	Cooling must be interrupted at approx. 150 °C or vacuum hardening.
Tempering	Temperature	400 - 700 °C
	Hardness	see tempering graph
Nitriding	possible under some conditions	
Preheating before use	Temperature	150 - 350 °C

Continuous time-temperature-transformation graph

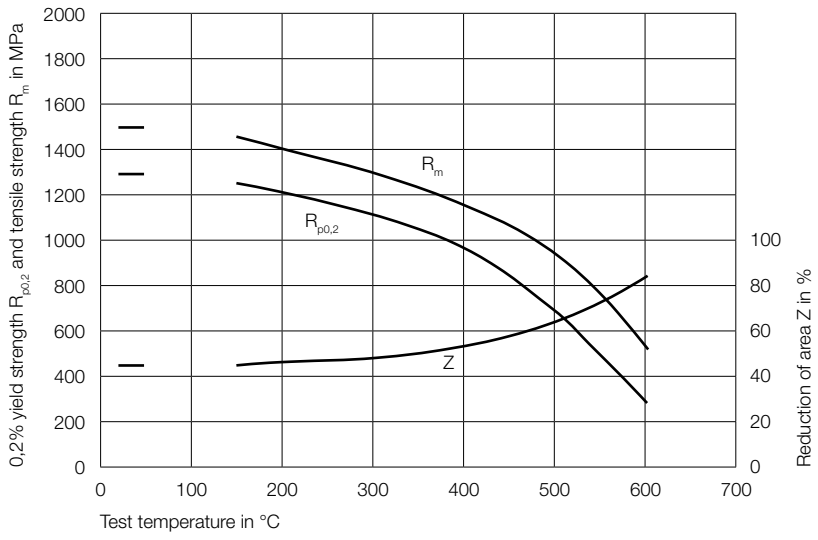
Austenitizing temperature 850 °C



Tempering graph



High-temperature strength graph



AWS (1.2731)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Ni	V	W
1.2731	X50NiCrWV13-13	AWS	0.50	1.40	0.70	13.00	13.00	0.60	2.40

Material properties

AWS is a high alloyed hot-work tool steel with an austenitic structure.
By forging below the recrystallization temperature or by a special heat treatment, the operational strength of approx. 1000 MPa is achieved.

Application

- Dies in extrusion for processing copper and its alloys in the production of rods, tubes and simple profiles
- Tools for processing sinter powders

Delivery form: Individually forged discs and bar material

Physical properties

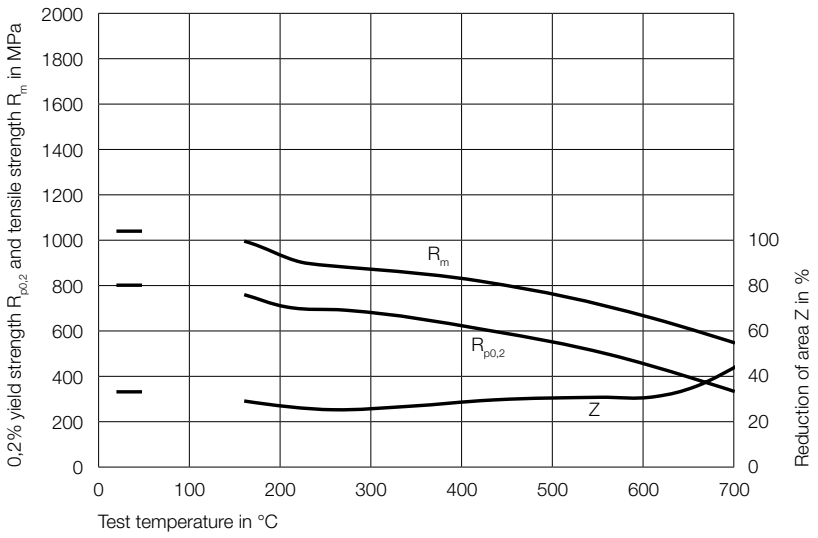
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	16,3	17,4	17,9	17,7

Temperature in °C	20
Thermal conductivity in W/m x K	13,0

Heat treatment

Preheating before use	Temperature	400 - 500 °C

High-temperature strength graph



PWU (1.2744)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	Ni	V
1.2744	57NiCrMoV7-7	PWU	0.55	0.30	0.70	1.10	0.80	1.70	0.10

Material properties

PWU is a die steel with higher tempering resistance than PWM. In addition, it has a high hot wear resistance and good through hardenability and allows use at higher strength.

Application

- Dies for all kinds of steel forming
- Jaws in forging machines
- Tools in extrusion such as stamps, linings and shear blades
- Molding press die for all light metals and their alloys
- Tough shear blades for cold and hot work

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,6	11,9	12,7	13,3

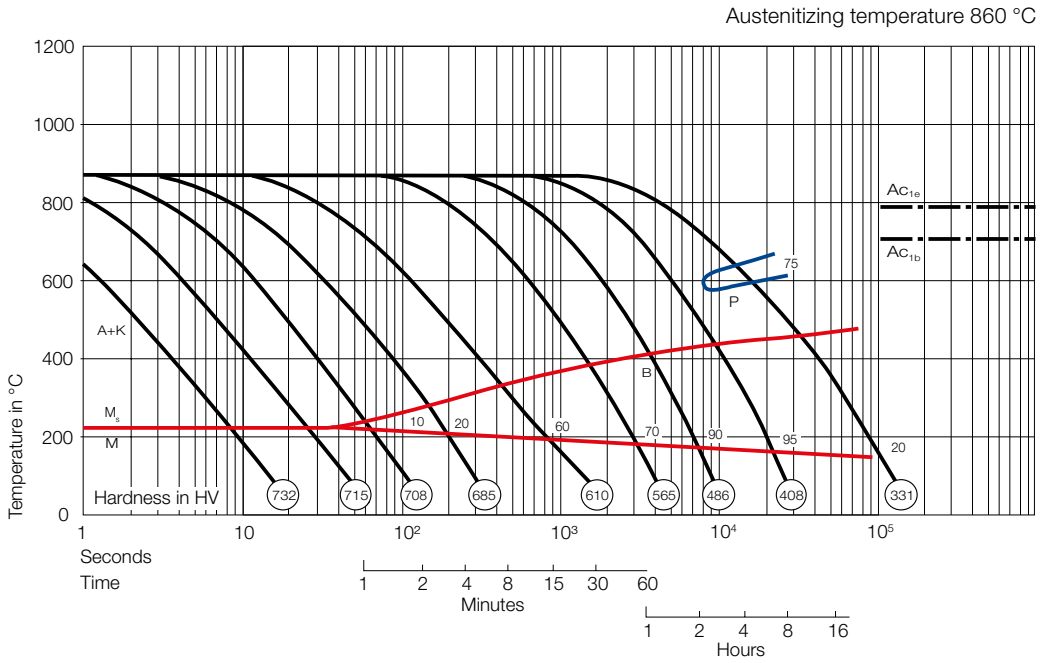
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	36,0	37,0	35,0

Temperature in °C	20
Young‘s modulus in GPa	215

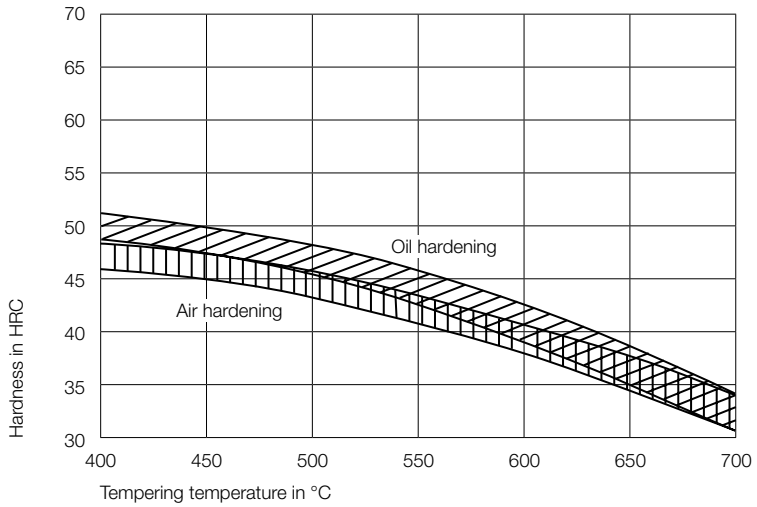
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 6 - 8 hours
	Cooling	slow furnace cooling
	Hardness	max. 250 HB
Hardening	Temperature	850 - 880 °C in Oil/polymer 870 - 900 °C in blast air
	Cooling	Cooling must be interrupted at approx. 150 °C or vacuum hardening.
Tempering	Temperature	400 - 700 °C
	Hardness	see tempering graph
Nitriding	possible under some conditions	
Preheating before use	Temperature	150 - 350 °C

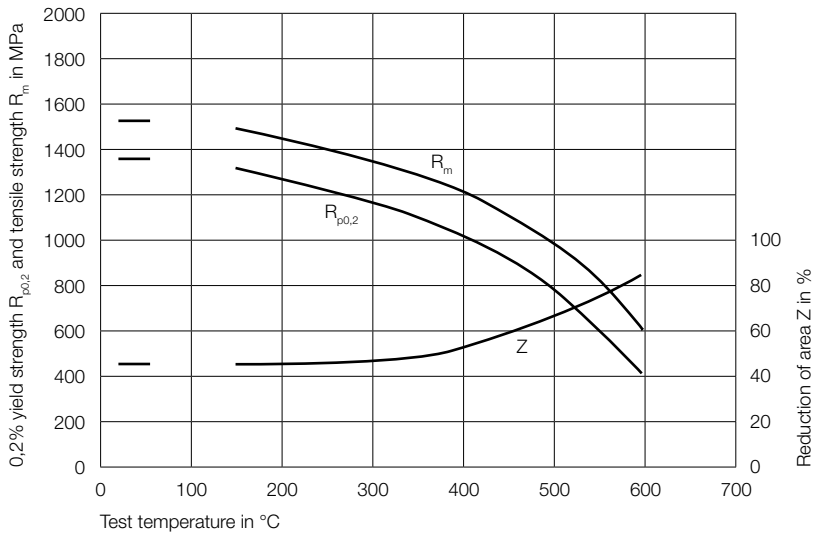
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



FAM (1.2787)

Mat.-no.	Short name	Brand name	Mass.-%				
			C	Si	Mn	Cr	Ni
1.2787	X23CrNi17	FAM	0.20	≤ 1.00	≤ 1.00	17.00	1.70

Material properties

This high Cr-alloyed steel has good resistance to scale and corrosion.

Application

- Glass molds for household glass with high requirements in terms of glass quality, also for high-melting-point, technical, hard glass

Delivery condition: Hardened and tempered, or specially heat treated, i.e. ready to use
Tensile strength R_m = 950 - 1100 MPa

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,5	11,0	12,0	12,5

Temperature in °C	20
Thermal conductivity in W/m x K	25,1

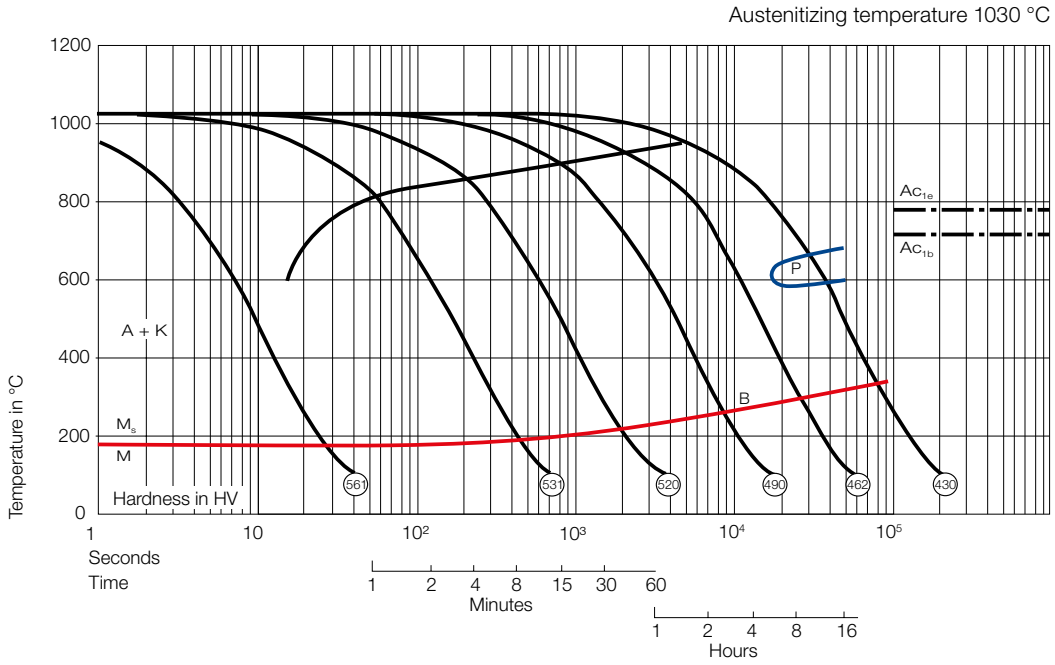
Temperature in °C	20
Density in g/cm³	7,7

Temperature in °C	20
Young's modulus in GPa	213

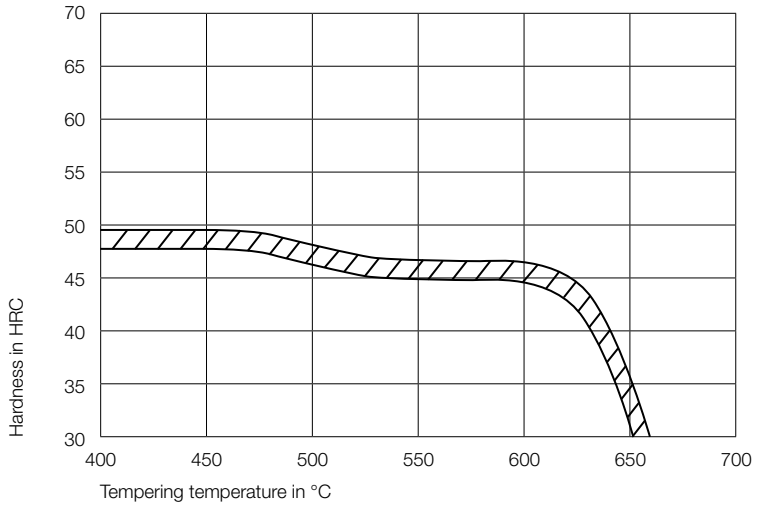
Heat treatment

Soft annealing	Temperature	680 - 720 °C, 8 - 10 hours
	Cooling	slow furnace cooling
Hardening	Temperature	980 - 1030 °C
	Cooling	Oil/polymer, interrupt oil or polymer cooling at 120 - 150 °C
Tempering	Hardness	see tempering graph
Mold preheating in the glass industry	Temperature	approx. 350 - 400 °C

Continuous time-temperature-transformation graph



Tempering graph



RPCo (1.2885)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	V	Co
1.2885	X32CrMoCoV3-3-3	RPCo	0.32	0.40	0.40	3.00	2.80	0.60	3.00

Material properties

RPCo corresponds to the steel RP with additional Co content. The high-temperature strength, tempering resistance and also hot wear resistance are increased.

Application

- Extrusion tools such as pressure dies and discs, die holders
- Extrusion punch heads for copper and copper alloys
- Molding press dies, especially mandrel inserts for copper and copper alloys
- Piercer heads in steel pipe production

Water cooling is possible.

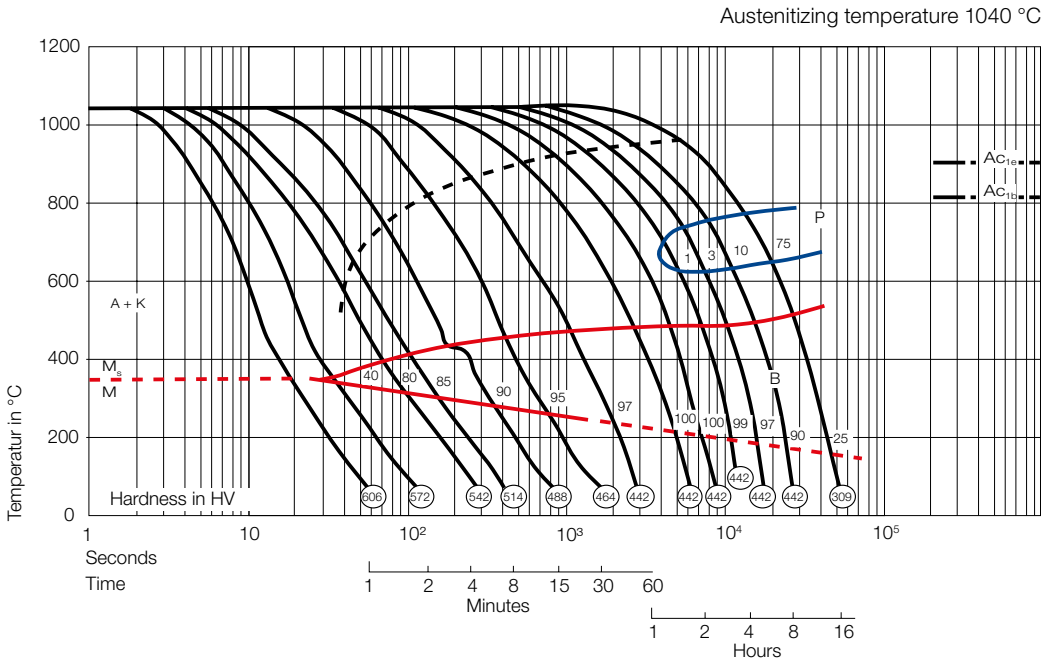
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,5	12,0	12,2
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	30,0	32,1	34,1
Temperature in °C	20		
Density in g/cm³	7,9		
Temperature in °C	20		
Young's modulus in GPa	215		

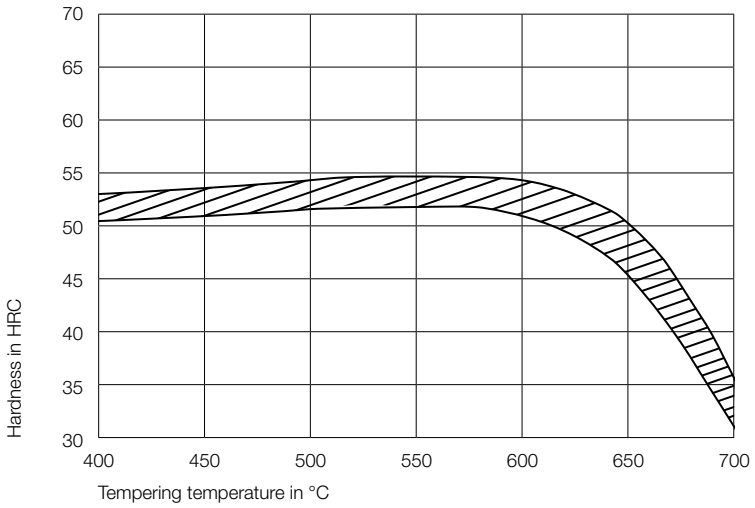
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1040 - 1060 °C
	Cooling	Oil or warm bath of approx. 540 °C, Interrupt oil quenching at approx. 300 °C or vacuum hardening
Tempering	Temperature	560 - 700 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

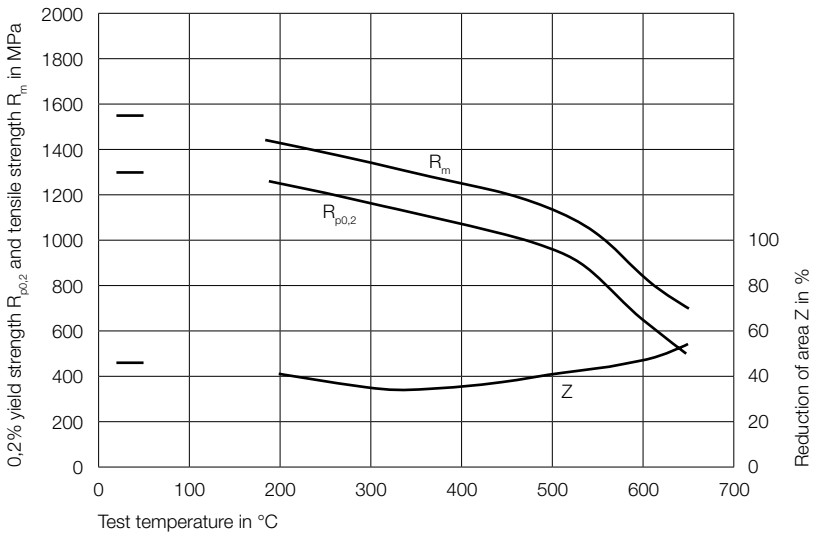
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



RM10Co (1.2888)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	Co	W
1.2888	X20CoCrWMo10-9	RM10Co	0.20	0.20	0.50	9.50	2.00	10.00	5.50

Material properties

RM10Co is a high alloyed hot-work tool steel with extremely high tempering resistance.
RM10Co is suitable for particular requirements in respect of hot wear resistance and resistance against molten metals.

Application

- Tools for extrusion such as press dies for steel and heavy metal processing, as well as spider tools and frame tools for processing copper and its alloys
- Mold plates for brass pressure die casting
- Valves
- Cores and filling sets
- Dies for hot-extrusion
- Filling sets in magnesium die casting in hot chamber machines
- Filling sets for Thixomolding
- Punches for steel forming
- Screws and barrels for Thixomolding
- Inserts in filling sleeves under high thermal load

Water cooling is not possible.

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,3	12,2	12,6	12,6

Temperature in °C	20	200	400
Thermal conductivity in W/m x K	20,5	24,2	27,5

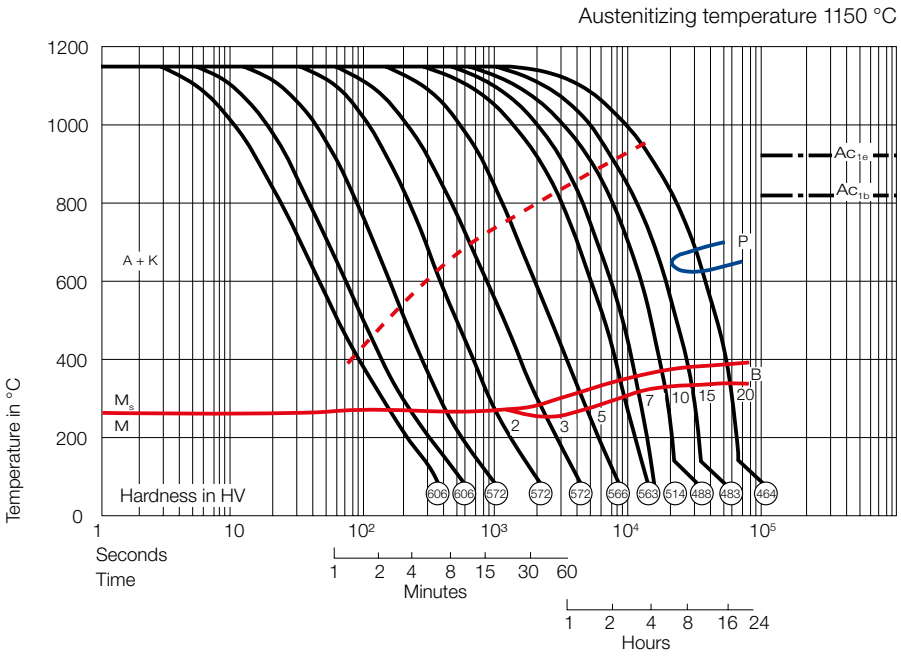
Temperature in °C	20
Density in g/cm³	8,08

Temperature in °C	20
Young's modulus in GPa	215

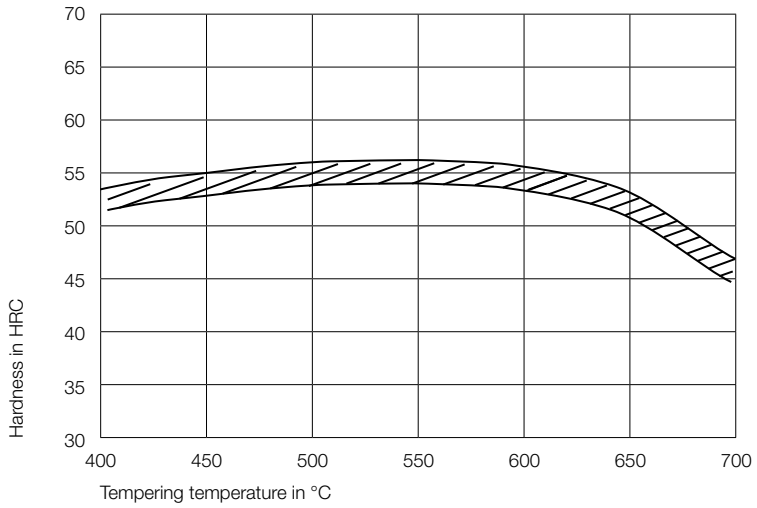
Heat treatment

Soft annealing	Temperature	840 + 760 °C, 4 - 6 hours each
	Cooling	slow furnace cooling
	Hardness	max. 320 HB
Hardening	Temperature	1100 - 1150 °C
	Cooling	Hot strip of approx. 540 °C, Air or oil/polymer; Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening
Tempering	Temperature	600 - 750 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C

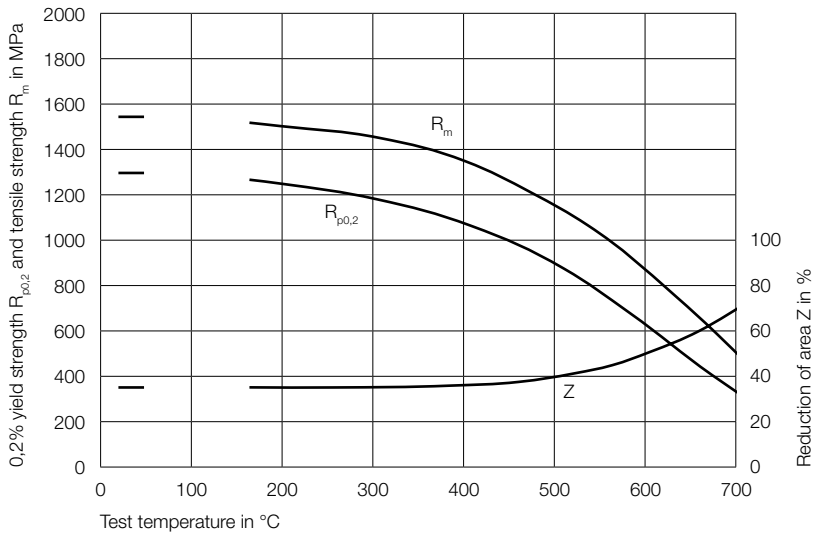
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



HMoD (1.2889)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	V	Co
1.2889	X45CoCrMoV5-5-3	HMoD	0.45	0.30	0.40	4.50	3.00	2.00	4.50

Material properties

Due to its composition, HMoD is a hot-work tool steel with very high high-temperature strength and tempering resistance with high hot wear resistance.

Application

- Extrusion dies for brass
- Die settings in heavy metal processing
- Die casting dies for casting heavy metals and relatively thin-walled cast pieces
- Highly stressed cores located in the casting stream when casting light metals
- Molding press dies, especially mandrel inserts in the hot pressing of heavy metals.
- Small die inserts and hot extrusion dies in steel forming
- Heated die inserts for hot-stamping

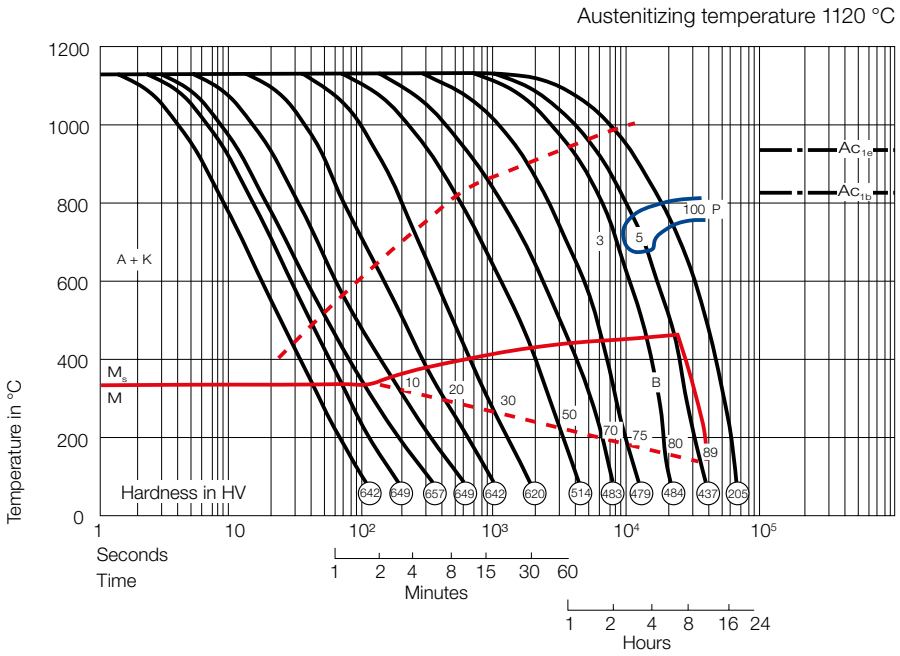
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,2	11,8	12,3
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	24,1	28,8	32,3

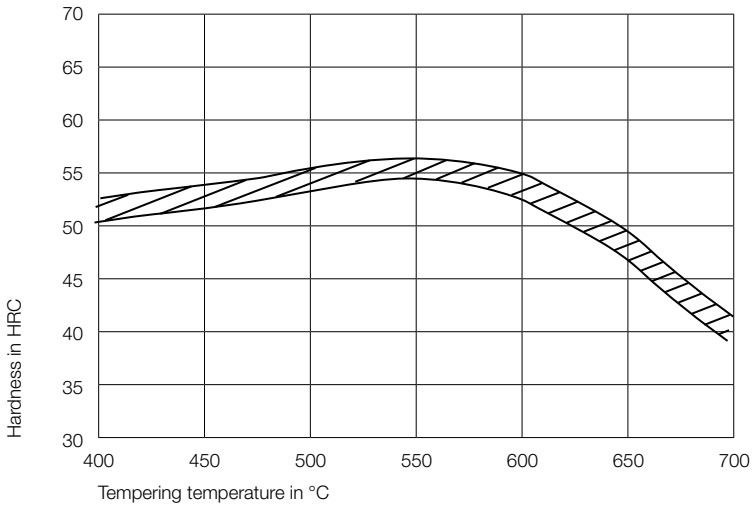
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1120 - 1150 °C
	Cooling	Air, warm bath of approx. 540 °C oder Oil/polymer; Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening
Tempering	Temperature	580 - 750 °C
	Hardness	see tempering graph
Nitriding	possible	
Preheating before use	Temperature	200 - 400 °C

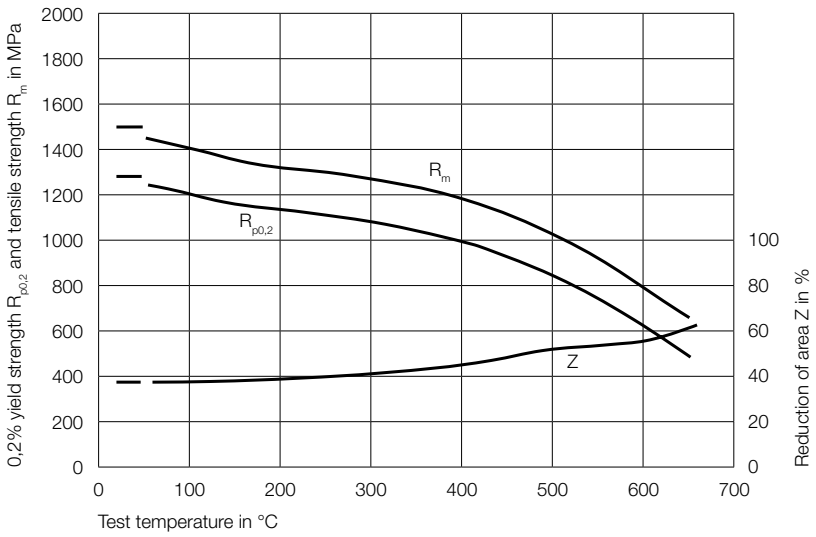
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



Cold-work tool steels / Plastic mold steels

Cold-work tool steels are used in tools whose surface temperature generally remains under 200 °C when they are being used. If cold-work tool steels are used at higher temperatures, there is a tempering effect and weakening of the steels can be expected.

While the low-alloyed cold-work tool steels have a higher toughness with sufficient compression strength but lower wear resistance, high-alloyed cold-work tool steels have a high resistance against wear with good compression strength. Cold-work tool steels are therefore mainly used as cutting materials or for forming tools that have a high resistance against abrasive wear.

The plastic mold steels meet the requirements of plastics processing for good polishability and corrosion resistance. Therefore they are used in a wide range of plastics processing technologies such as extrusion, injection molding, compression molding and blow molding. The focus here is on corrosion-resistant plastic mold steels, which are largely chemically resistant to the products of plastics processing, which are largely chemically resistant to the fission products used in plastics processing.

FSR

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	W
Premium	FSR	1.20	0.30	0.30	11.50	1.40	1.70	2.40

Material properties

FSR is a cold-work tool steel based on 11.5% Cr. The remaining alloying elements give FSR the necessary tempering resistance and wear resistance. Compared to a similarly used high-speed steel HS6-5-2C, FSR is characterized by better toughness at comparable performance.

Application

- Cutting tools with special wear resistance for processing silicided or austenitic sheets or hardened strip steel, fine blanking tools
- Cold extrusion tools
- Thread rolling tools
- Broaches
- Extruder screws

Physical properties

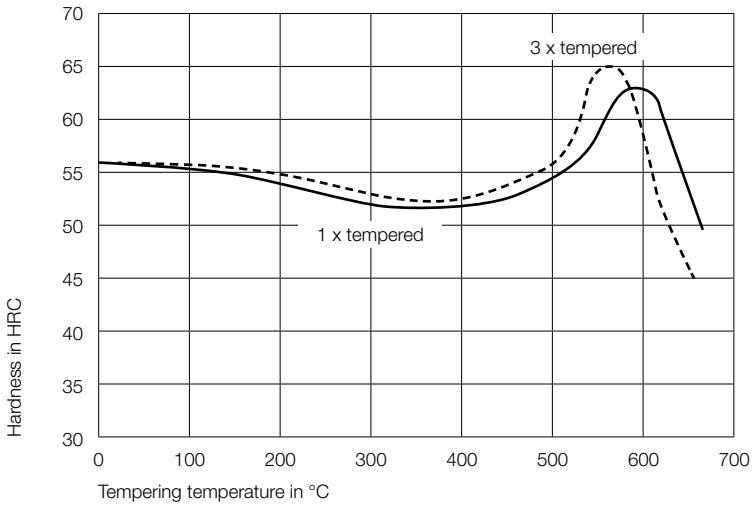
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	10,6	12,0	13,0

Temperature in °C	20
Thermal conductivity in W/m x K	22,8

Heat treatment

Soft annealing	Temperature	800 - 850 °C
	Cooling	slow furnace cooling
	Hardness	max. 300 HB
Hardening	Temperature	1150 - 1180 °C
	Cooling	Hot strip from 450 - 550 °C or oil, interrupt oil cooling at approx. 400 °C
Tempering	Temperature	540 - 550 °C
	Hardness	see tempering graph
Nitriding	possible, temper correspondingly	

Tempering graph



PM823

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Premium	PM823	0.84	0.85	0.35	7.70	1.50	2.45

Material properties

Premium cold-work tool steel with a wide range of applications, combining very high abrasive wear resistance with good toughness and excellent compressive strength.

Application

- Shear blades
- Punching, bending and forming tools
- Thread rolling dies, thread rolling rolls
- Straightening and profiling rolls for high toughness and wear resistance requirements
- Tools for spring production
- Calibration tools
- Tools for pressing sheet metal with high yield strengths

Physical properties

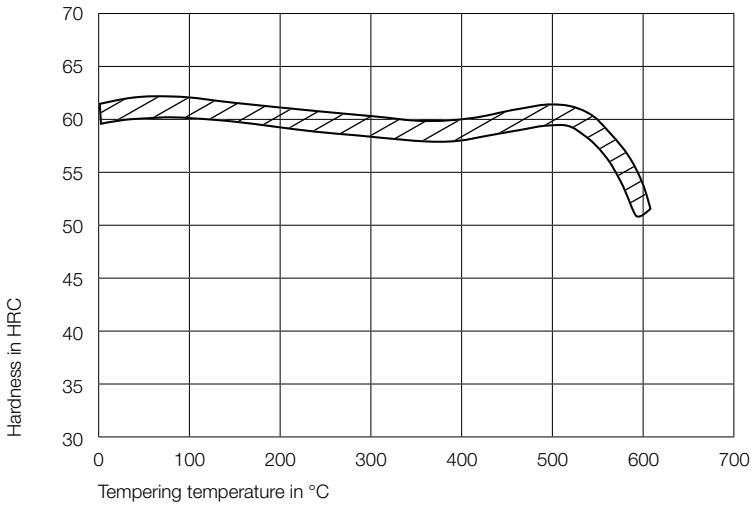
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	11,3	12,2	12,7

Temperature in °C	20
Thermal conductivity in W/m x K	24,8

Heat treatment

Soft annealing	Temperature	800 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 280 HB
Hardening	Temperature	1070 - 1090 °C
	Cooling	Oil or polymer quenching, warm bath of 540 °C
Tempering	Temperature	530 - 600 °C
	Hardness	see tempering graph

Tempering graph



PW812

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	W
Premium	PW812	1.13	0.85	0.35	7.70	1.50	2.45	1.10

Material properties

Premium steel with high vanadium and tungsten content. The steel offers good secondary hardenability as well as high toughness.

Application

- Shear blades
- Cutting tools
- Straightening and profiling rolls for high toughness and wear resistance requirements
- Bending tools
- Punches

Physical properties

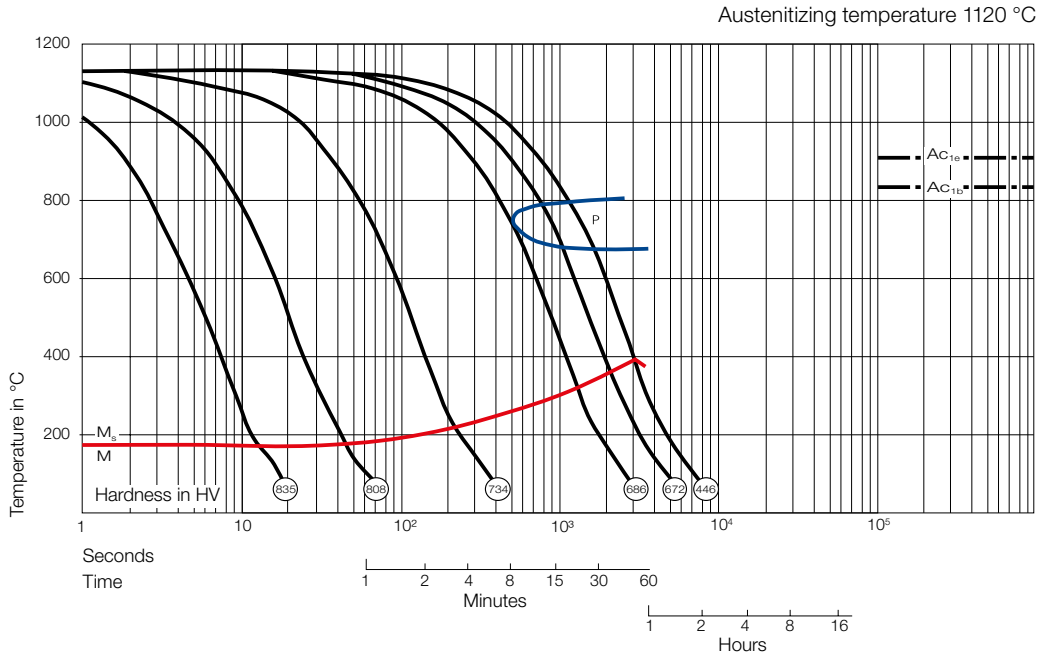
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	11,0	12,2	12,7

Temperature in °C	20
Thermal conductivity in W/m x K	24,9

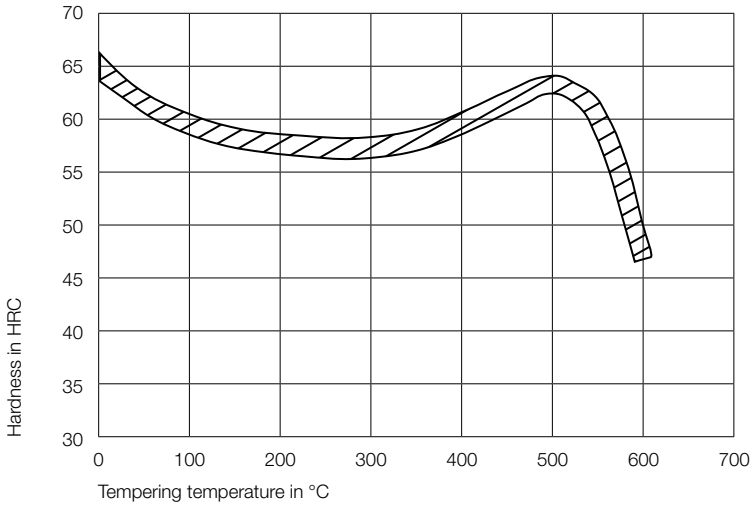
Heat treatment

Soft annealing	Temperature	800 - 840 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 285 HB
Hardening	Temperature	1100 - 1120 °C
	Cooling	Air, salt bath 500 - 550 °C oil, polymer, vacuum
Tempering	Temperature	510 - 600 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph



Tempering graph



HS1

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Premium	HS1	0.50	0.90	0.80	8.00	1.50	1.70

Material properties

This high Cr steel is characterized by increased wear resistance and high compressive strength with balanced toughness in both cold and hot work. Suitable for secondary hardening and use at elevated temperature. Nitriding and coating is possible.

Application

- Shear blades
- Cutting and punching tools
- Bending tools
- Pressure and profile rollers
- Segments for pressing tools

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,2	11,7	12,2	12,7

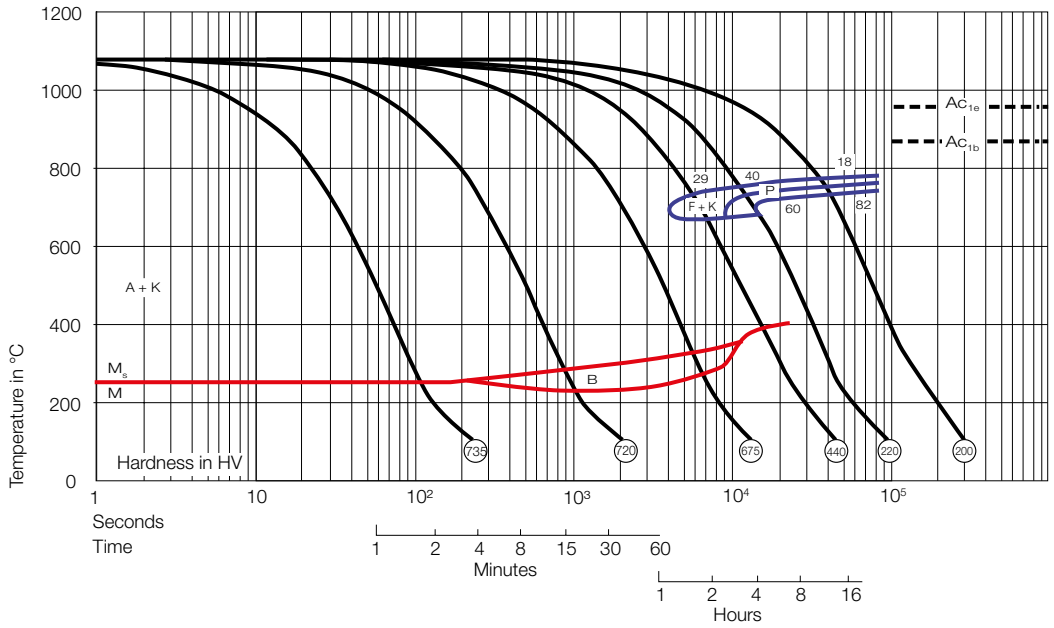
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	25,2	27,3	29,3

Heat treatment

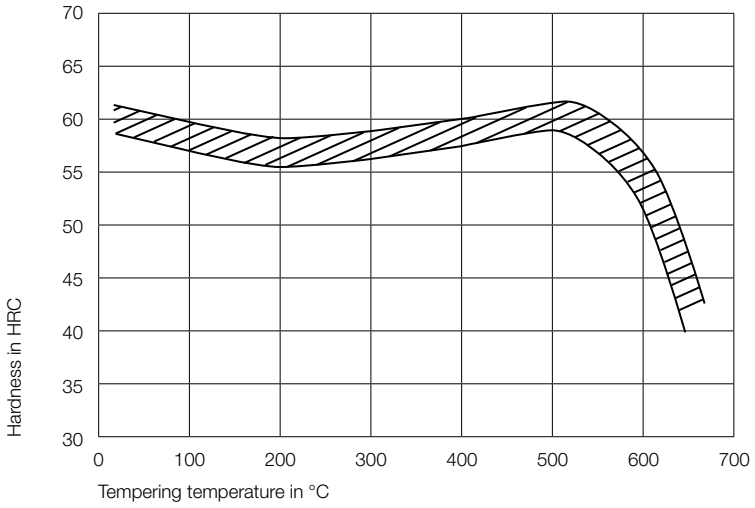
Soft annealing	Temperature	800 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 295 HB
Hardening	Temperature	1050 - 1080 °C
	Cooling	Oil, polymer, gas
Tempering	Temperature	540 - 560 °C
	Hardness	see tempering graph
Nitriding	possible	

Continuous time-temperature-transformation graph

Austenitizing temperature 1080 °C



Tempering graph



RF (1.2083)

Mat.-no.	Short name	Brand name	Mass.-%			
			C	Si	Mn	Cr
1.2083	X40Cr14	RF	0.42	0.40	0.30	13.00

Material properties

RF is a highly hardenable stainless and acid resistant steel. It is used for the production of smaller molds or inserts for the plastics industry in the processing of duroplasts and thermoplasts, where corrosive by-products may be produced. RF is through hardenable and low in distortion, has high wear resistance and high compressive strength. In the quenched and tempered state RF is very easy to polish.

Application

- Inserts and smaller injection molds under corrosive stress
- Press molds in the processing of plastics

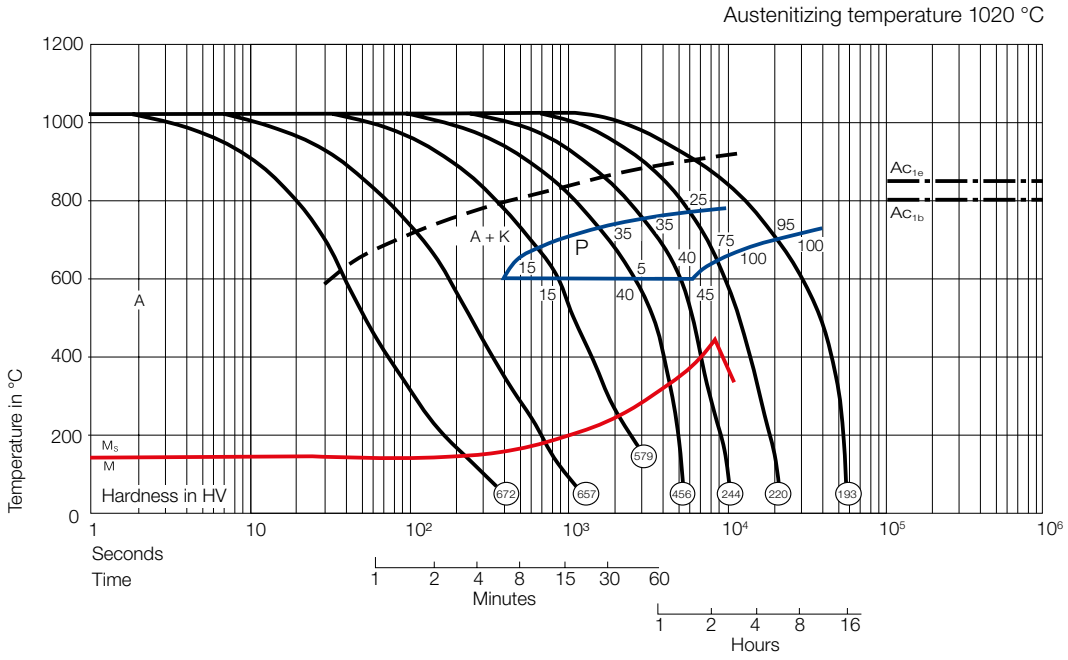
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,6	11,7	12,2
Temperature in °C	20		
Thermal conductivity in W/m x K	25,3		
Temperature in °C	20		
Density in g/cm³	7,7		
Temperature in °C	20		
Young's modulus in GPa	217		

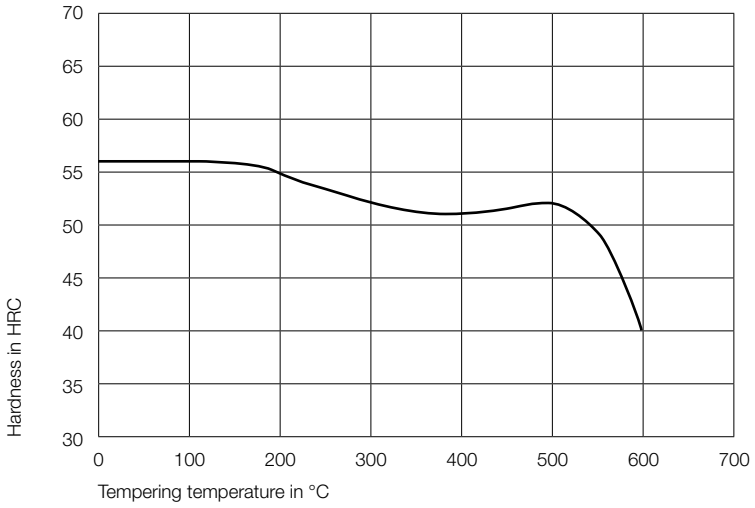
Heat treatment

Soft annealing	Temperature	760 - 800 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1000 - 1030 °C
	Cooling	Interrupt oil cooling at approx. 300 °C; in blast air for thin cross-sections; in warm bath of approx. 200 °C
Tempering	Temperature	100 - 400 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph



Tempering graph



KS80 (1.2108)

Mat.-no.	Short name	Brand name	Mass.-%			
			C	Si	Mn	Cr
1.2108	90CrSi5	KS80	0.90	1.20	0.70	1.20

Material properties

This Cr-Si-based moderate-alloy steel is characterized by good toughness and sharpness.
The hardening behavior is moderate for large cross-sections.

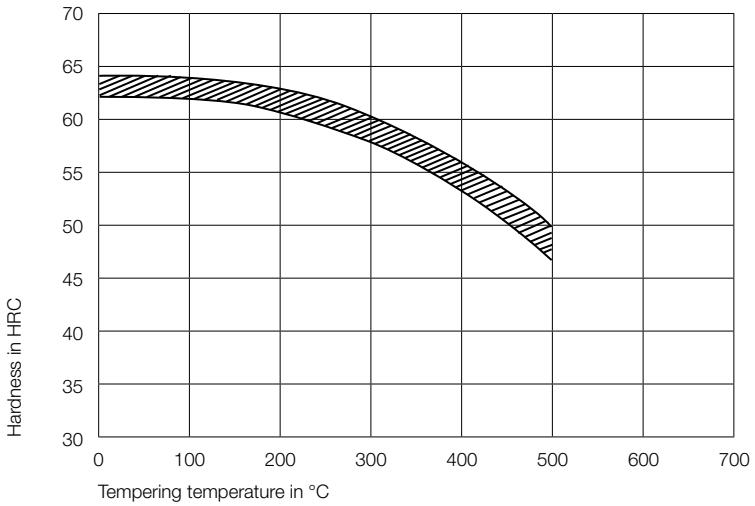
Application

- Cutting and punching tools for sheet thicknesses of approx. 6-12 mm
- Trimming tools
- Profile shear blades
- Cold punches
- Small stamping tools
- Ejectors and similar tools

Heat treatment

Soft annealing	Temperature	720 - 750 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	830 - 860 °C
	Cooling	Interrupt oil cooling at approx. 150 °C
Tempering	Temperature	100 - 400 °C
	Hardness	see tempering graph

Tempering graph



CMR (1.2316)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	Ni
1.2316	X38CrMo16	CMR	0.40	≤ 1.00	≤ 1.00	16.00	1.20	≤ 1.00

Material properties

CMR belongs to the group of heat-treatable corrosion-resistant steels. This resistance against corrosion is achieved by the high Cr and low C content. CMR is suitable for processing plastics that are particularly chemically aggressive, such as PVC. Chrome-plating is unnecessary. CMR has a good polishability.

Application

- Injection molds as well as shaping extrusion dies in the processing of plastics that can release corrosive substances

Delivery condition: Quenched and tempered, strength as required between 800 and 1100 MPa

Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	10,5	11,4	11,9

Temperature in °C	20
Thermal conductivity in W/m x K	20,7

Temperature in °C	20
Density in g/cm³	7,7

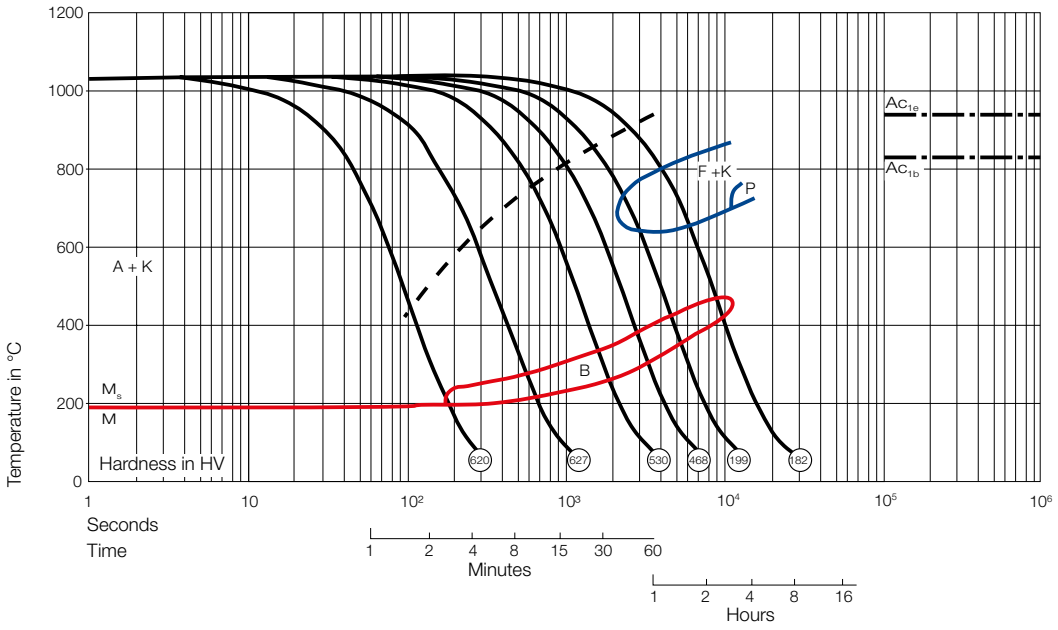
Temperature in °C	20
Young's modulus in GPa	215

Heat treatment

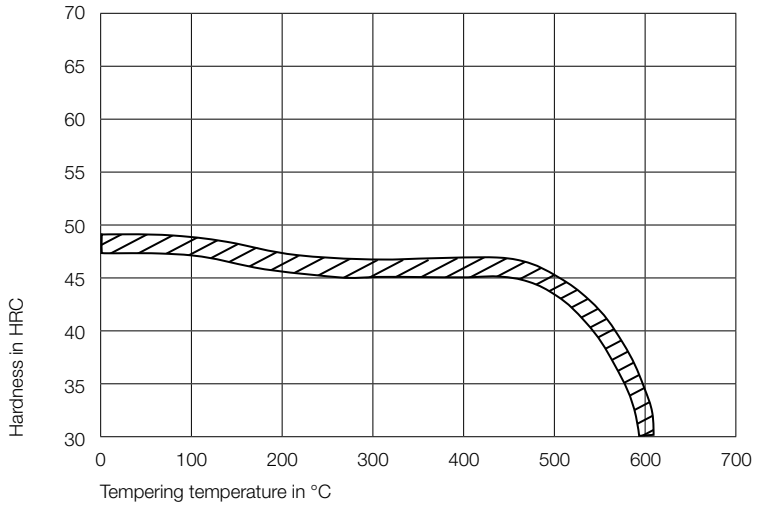
Hardening	Temperature	1020 - 1050 °C
	Cooling	Interrupt oil cooling at 250 °C
Tempering	Temperature	580 - 620 °C Avoid temperature range of the secondary hardeness maximum
	Hardness	see tempering graph
Nitriding	possible, temper correspondingly. The corrosion resistance is reduced by such a treatment.	

Continuous time-temperature-transformation graph

Austenitizing temperature 1020 °C



Tempering graph



RM189 (1.2361)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2361	X91CrMoV18	RM189	0.90	≤ 1.00	≤ 1.00	18.00	1.10	0.10

Material properties

RM189 belongs to the group of heat-treatable rust and acid-resistant steels. Because of the chemical composition and the associated high hardness, there is good resistance against abrasive wear.

Application

- Plastic molds
- Rust-resistant hand and machine blades of all kinds
- Perforated disks in meat grinders
- Valve parts
- Bearings and similar parts, which are exposed to increased wear in a corrosive environment

Physical properties

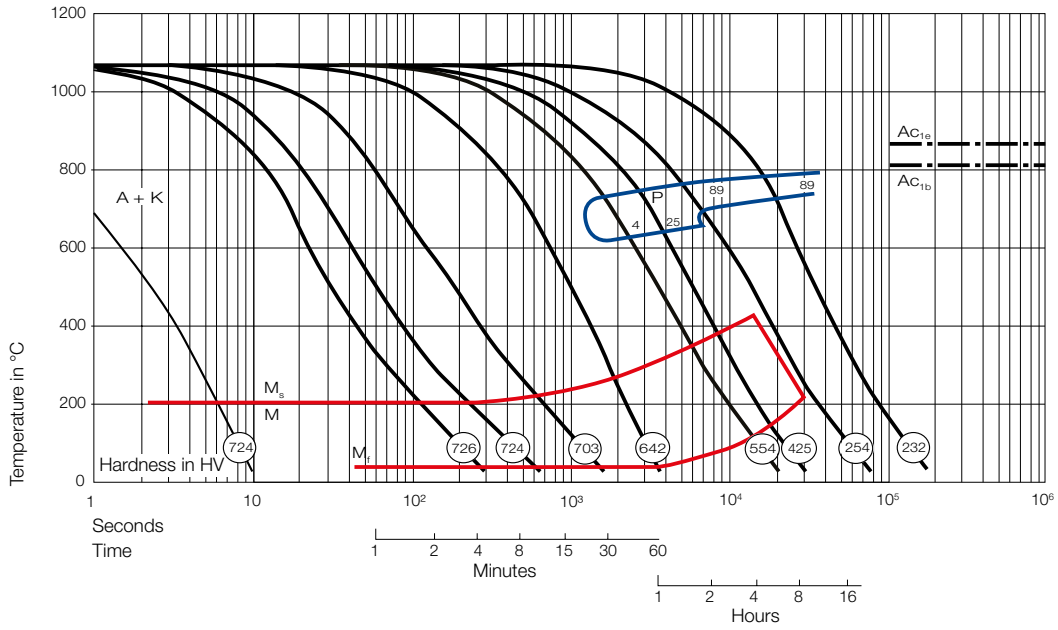
Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6}m/m x K	10,4	10,8	11,6
Temperature in °C	20		
Thermal conductivity in W/m x K	15,9		
Temperature in °C	20		
Density in g/cm³	7,7		
Temperature in °C	20		
Young's modulus in GPa	215		

Heat treatment

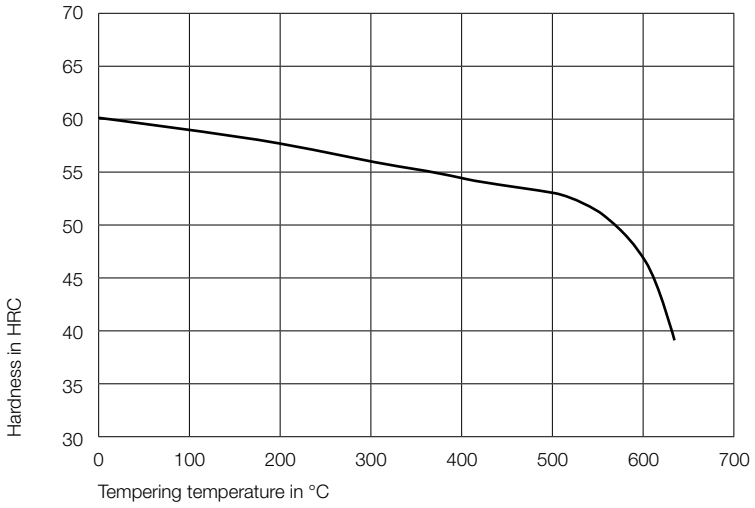
Soft annealing	Temperature	780 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 265 HB
Hardening	Temperature	1000 - 1050 °C
	Cooling	Oil
Tempering	Temperature	100 - 200 °C
	Hardness	see tempering graph
Nitriding	possible	

Continuous time-temperature-transformation graph

Austenitizing temperature 1050 °C



Tempering graph



CH5M (1.2363)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2363	X100CrMoV5	CH5M	1.00	0.30	0.60	5.25	1.10	0.20

Material properties

CH5M is an air-hardening cold-work tool steel with very high dimensional stability and a high cutting stability and wear resistance.
The hardenability and toughness are good.

Application

- Cutting and punching tools
- Roller and table knives
- Threaded rolling tools
- Embossing stamps

Physical properties

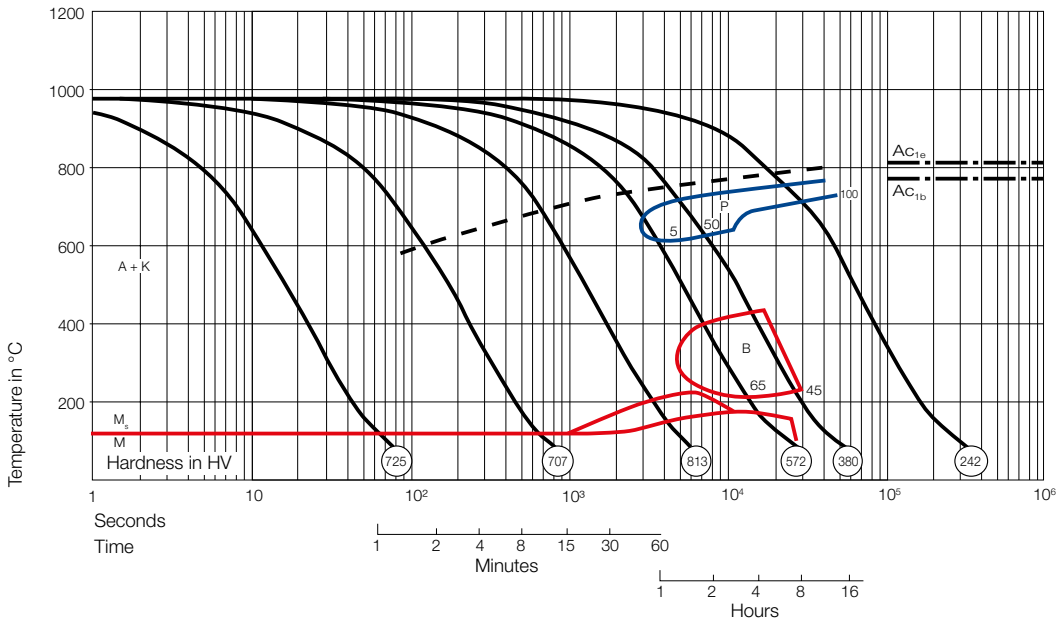
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,6	13,2	14,1
Temperature in °C	20		
Thermal conductivity in W/m x K	23,0		
Temperature in °C	20		
Density in g/cm³	7,7		
Temperature in °C	20		
Young's modulus in GPa	210		

Heat treatment

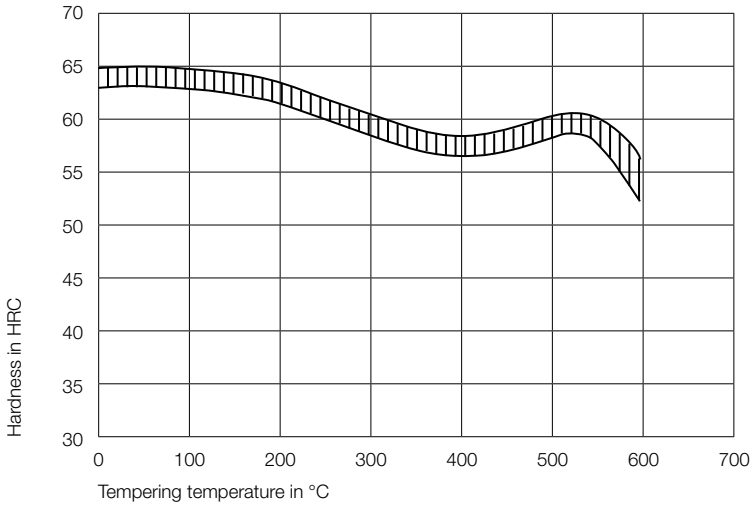
Soft annealing	Temperature	820 - 850 °C
	Cooling	slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	950 - 1000 °C
	Cooling	Blast air, thick cross-sections also in oil or warm bath of 350 - 450 °C
Tempering	Hardness	see tempering graph

Continuous time-temperature-transformation graph

Austenitizing temperature 980 °C



Tempering graph



CH16V (1.2379)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	V
1.2379	X153CrMoV12	CH16V	1.50	0.25	0.25	11.25	0.80	0.85

Material properties

CH16V is a high Cr-alloyed ledeburitic steel with Mo and V additives. These additives increase cutting stability, hardenability and the through-hardenability. Dimensional stability is good. The ledeburitic structure ensures high wear resistance. CH16V can be nitrided after special heat treatment.

Application

- High performance cutting and punching tools
- Cold extrusion tools
- Master hobs
- Thread rolling tools
- Flanging and straightening rolls
- Form rollers for continuous profile and pipe manufacturing from steel strips
- Woodworking tools
- Cutting tools for the paper and plastics industry
- Small plastic molds or inserts for processing plastics with abrasive fillers

Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,0	12,2	12,8

Temperature in °C	20
Thermal conductivity in W/m x K	20,5

Temperature in °C	20
Density in g/cm³	7,67

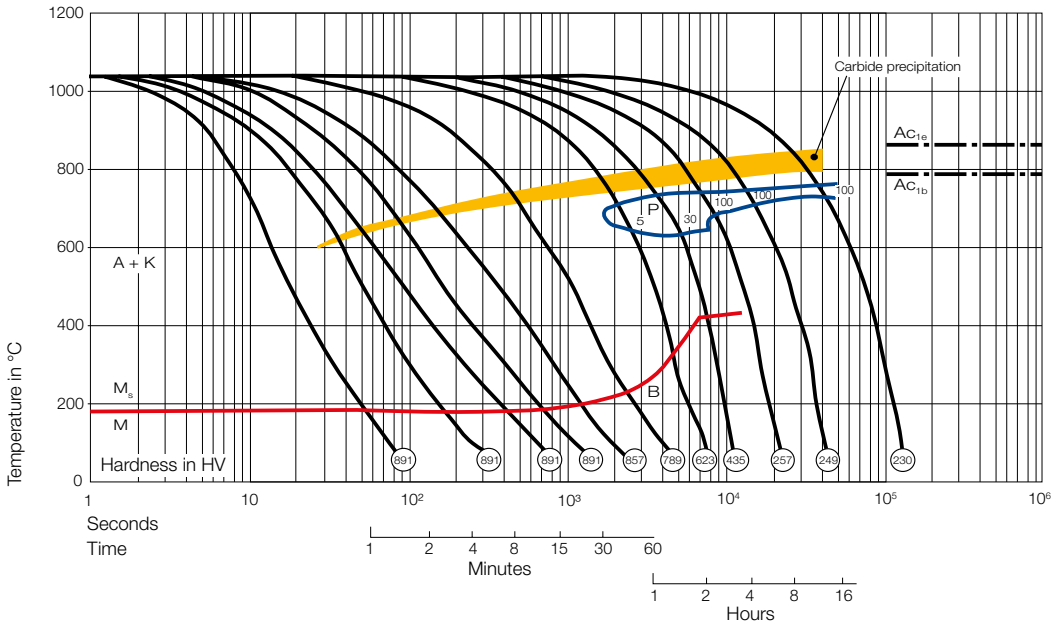
Temperature in °C	20
Young's modulus in GPa	215

Heat treatment

Soft annealing	Temperature	820 - 850 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 250 HB
Hardening	Temperature	1010 - 1050 °C
	Cooling	Vacuum hardening, oil, polymer, air or warm bath of 350 - 450 °C
Tempering	Hardness	see tempering graph, the higher tempering temperature is preferred for the desired hardness
Special heat treatment for nitriding:		
Hardening	Temperature	1060 - 1080 °C
	Cooling	Vacuum hardening, oil, polymer, warm bath of 350 - 450 °C
	Tempering	520 - 580 °C Triple tempering is essential
Nitriding	approx. 540 °C after special heat treatment	

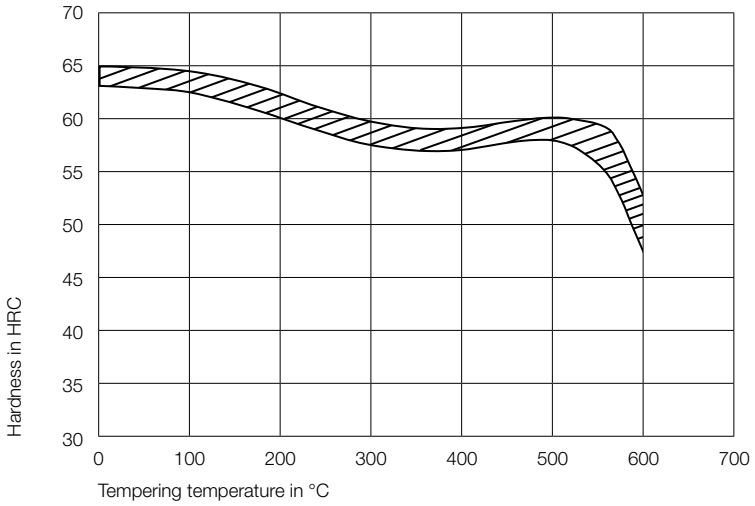
Continuous time-temperature-transformation graph

Austenitizing temperature 1030 °C

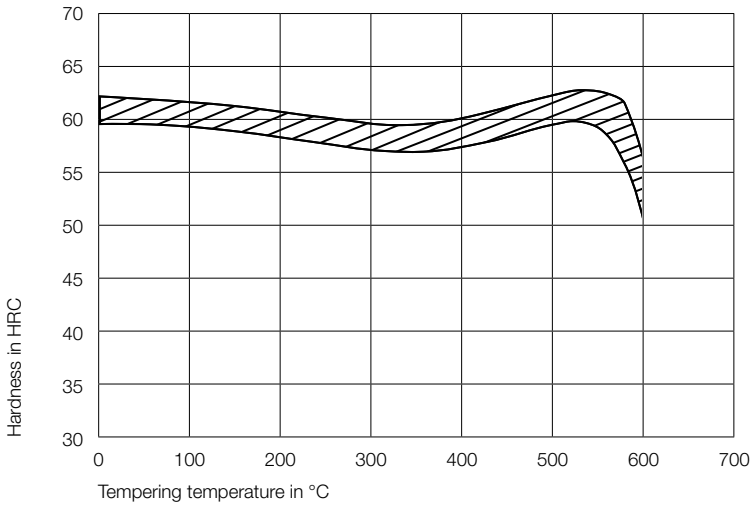


Tempering graph

Austenitizing temperature 1030 °C



Austenitizing temperature 1080 °C



PK (1.2542)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	V	W
1.2542	45WCrV7	PK	0.45	1.00	0.30	1.10	0.20	2.00

Material properties

PK is a tough cold-work tool steel for use under permanent hitting and impact stress.

Application

- Compressed air tools of all kinds, such as chisels, riveting heads, rivet dies, rivet blasters, etc.
- Hand chisels
- Strainers
- Deburring tools
- Cold punches
- Scrap chisels
- Profile shear blades
- Hot shear blades for medium temperature cutting material (gently preheat tools) and similar tools

Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,0	13,5	14,5

Temperature in °C	20
Thermal conductivity in W/m x K	25,0

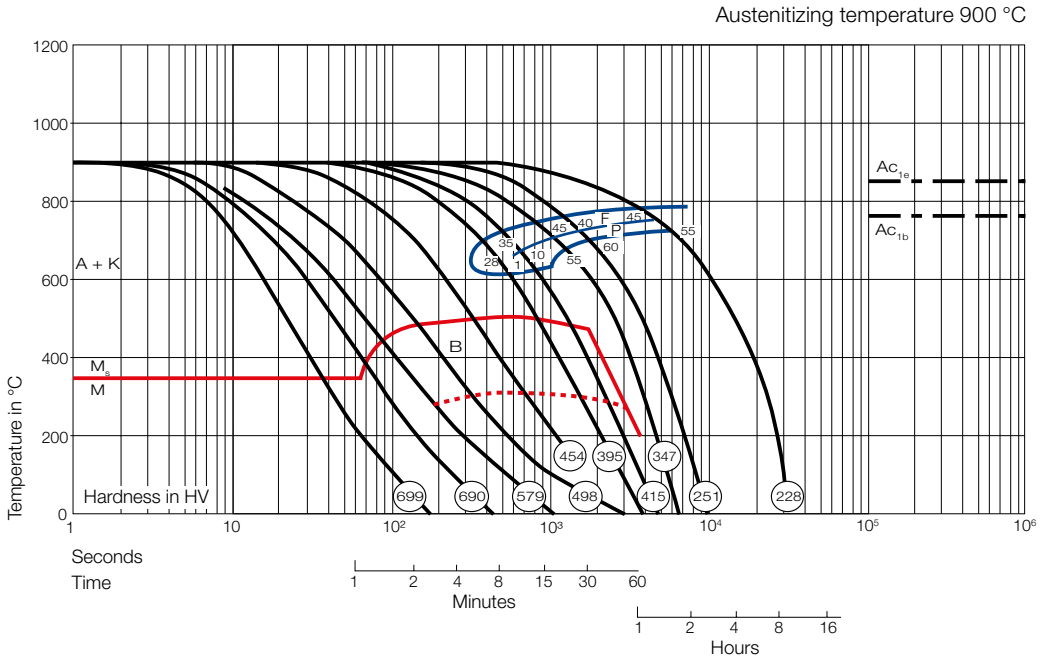
Temperature in °C	20
Density in g/cm^3	8,0

Temperature in °C	20
Young‘s modulus in GPa	210

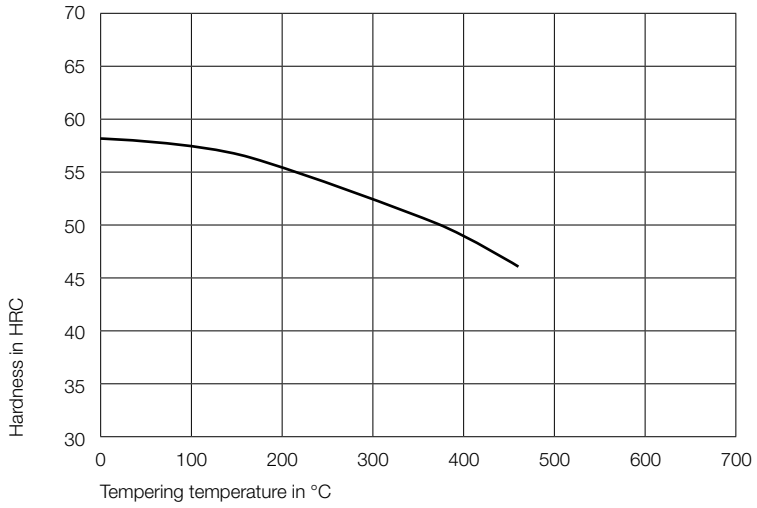
Heat treatment

Soft annealing	Temperature	730 - 760 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 225 HB
Hardening	Temperature	880 - 920 °C
	Cooling	Interrupt oil cooling at approx. 150 °C
Tempering	Temperature	100 - 350 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph



Tempering graph



KL (1.2550)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	V	W
1.2550	60WCrV8	KL	0.60	0.75	0.30	1.10	0.15	2.00

Material properties

KL is an oil-hardenable steel with very good toughness and relatively good cutting performance. The hardenability capacity is moderate for large cross-sections.

Application

- Cutting and punching tools for sheet metal thicknesses of approx. 6-12 mm
- Cold punches
- Deburring tools
- Profile shear blades
- Woodworking tools
- Small stamping tools
- Ejectors and similar tools
- Cutting tools for soft, medium-temperature cutting material (gently preheat tools)

Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	11,8	13,5	14,3

Temperature in °C	20
Thermal conductivity in W/m x K	31,9

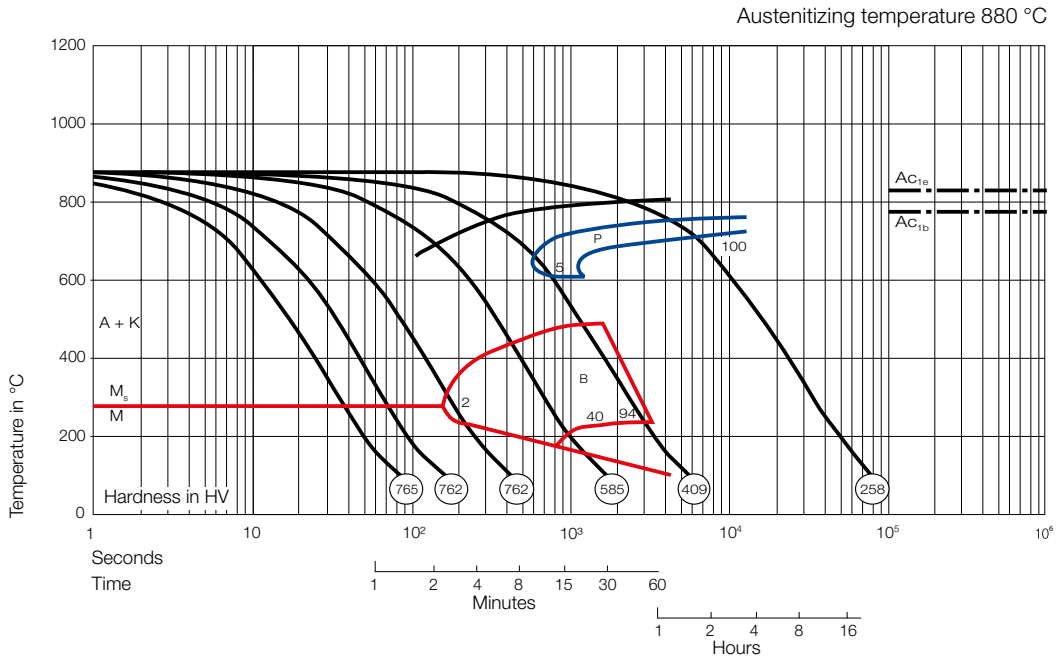
Temperature in °C	20
Density in g/cm³	8,0

Temperature in °C	20
Young's modulus in GPa	210

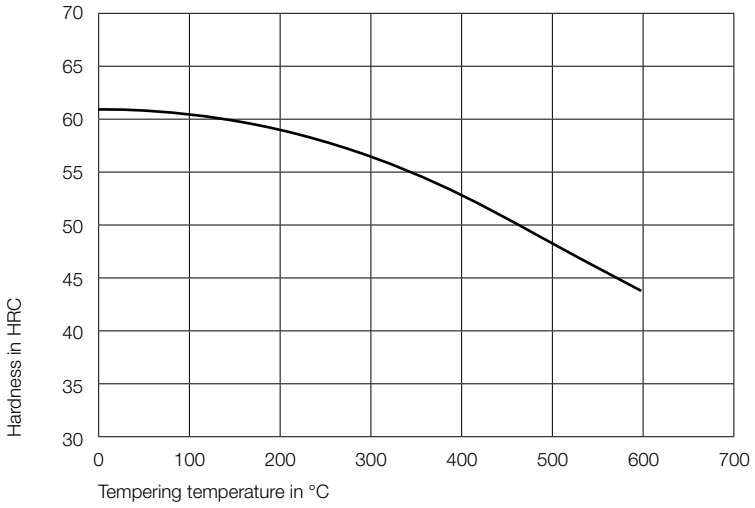
Heat treatment

Soft annealing	Temperature	750 - 780 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 225 HB
Hardening	Temperature	870 - 900 °C
	Cooling	Interrupt oil cooling at approx. 150 °C
Tempering	Temperature	for hot work 550 - 600 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph



Tempering graph



SN (1.2721)

Mat.-no.	Short name	Brand name	Mass.-%				
			C	Si	Mn	Cr	Ni
1.2721	50NiCr13	SN	0.50	0.30	0.50	1.00	3.30

Material properties

SN is an air and oil hardenable steel with the best toughness and sufficient hardness, which is achieved by the high Ni content and low C content.

Application

- Cold stamping tools of all kinds
- Cutlery punching
- Die cutting for high pressures
- Punches
- Drawing jaws and similar tools

Physical properties

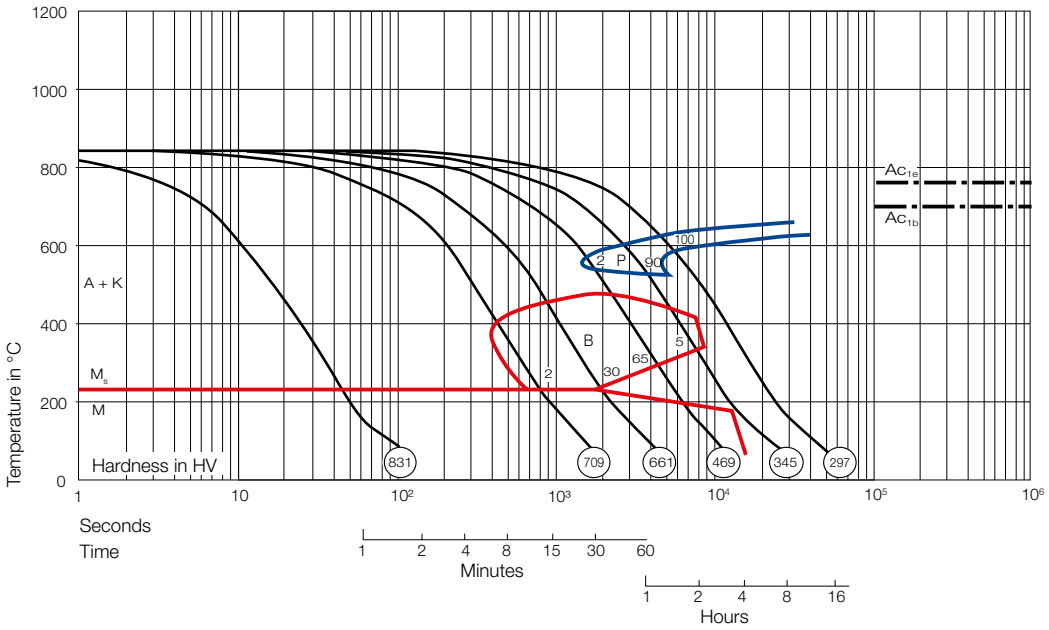
Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6} m/m x K	11,5	12,0	12,8
Temperature in °C	20		
Thermal conductivity in W/m x K	31,0		
Temperature in °C	20		
Density in g/cm³	7,8		
Temperature in °C	20		
Young's modulus in GPa	210		

Heat treatment

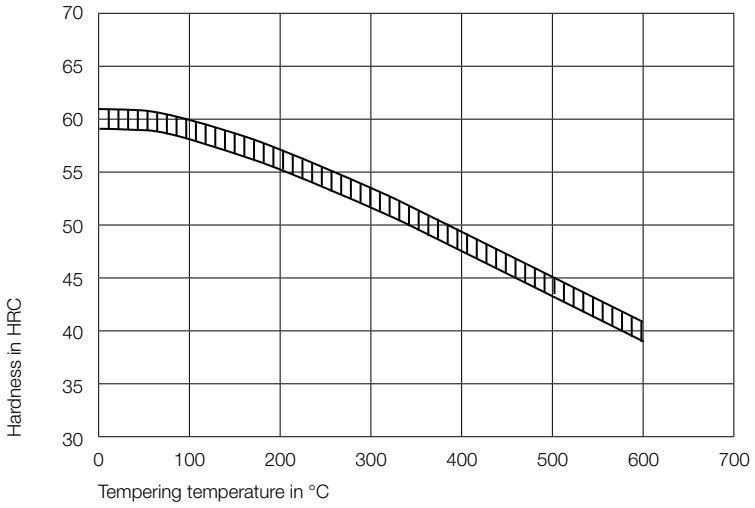
Soft annealing	Temperature	720 °C, 5 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 250 HB
Hardening	Temperature	840 - 870 °C
	Cooling	Air, warm bath from 180 - 220 °C or oil, interrupt oil cooling at approx. 150 °C
Tempering	Temperature	100 - 300 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph

Austenitizing temperature 840 °C



Tempering graph



N400 (1.2767)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	Ni
1.2767	45NiCrMo16	N400	0.45	0.25	0.40	1.35	0.25	4.00

Material properties

N400 is characterized by its high Ni content as a tough cold-work tool steel with high hardenability. N400 shows good polishability and texturing properties as well as good through hardenability.

Application

- Cutlery punching, shear blades for thick goods above 12 mm
- Scrap and billet shear blades
- Embossing and bending tools for heavy cold forming
- Drawing jaws, large lathe punches and similar tools, which demand maximum toughness
- Shrink rings, tempered as required to a strength of 1300-1600 MPa
- Plastic molds

Physical properties

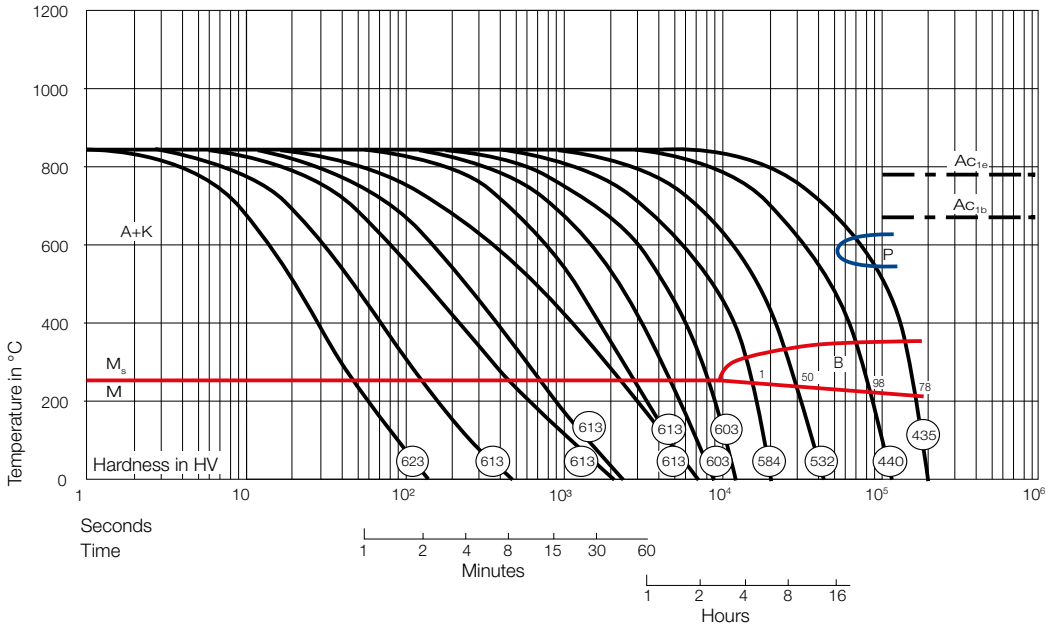
Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6} m/m x K	12,3	13,1	13,7
Temperature in °C	20		
Thermal conductivity in W/m x K	31,0		
Temperature in °C	20		
Density in g/cm³	7,82		
Temperature in °C	20		
Young's modulus in GPa	210		

Heat treatment

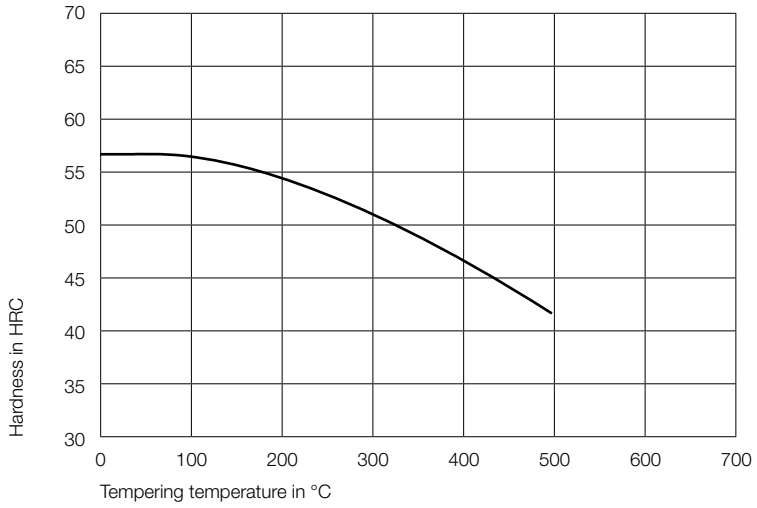
Soft annealing	Temperature	610 - 650 °C
	Cooling	slow furnace cooling, 720 °C 6 - 8 hours and slow furnace cooling, annealing 620 - 640 °C 10 - 12 hours and slow furnace cooling
	Hardness	max. 260 HB
Hardening	Temperature	840 - 870 °C
	Cooling	Air, warm bath from 180 - 220 °C or oil, interrupt oil cooling at approx. 150 °C
Tempering	Temperature	100 - 400 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph

Austenitizing temperature 840 °C



Tempering graph



KSV (1.2838)

Mat.-no.	Short name	Brand name	Mass.-%			
			C	Si	Mn	V
1.2838	145V33	KSV	1.45	0.30	0.40	3.25

Material properties

KSV is a water-hardenable steel (surface-hardening). The V content ensures lack of sensitivity to overheating and also a high wear resistance with a tough core. The hardness penetration depth of KSV can be increased considerably with increasing hardening temperature.

Application

- Cold impact tools of all kinds, such as head stamps, first and second punches, dies in screw and rivet manufacturing
- Impact seams of flat etchers and similar tools
- Cold extrusion tools
- Drawing dies for rod drawing (hardening of the hole)

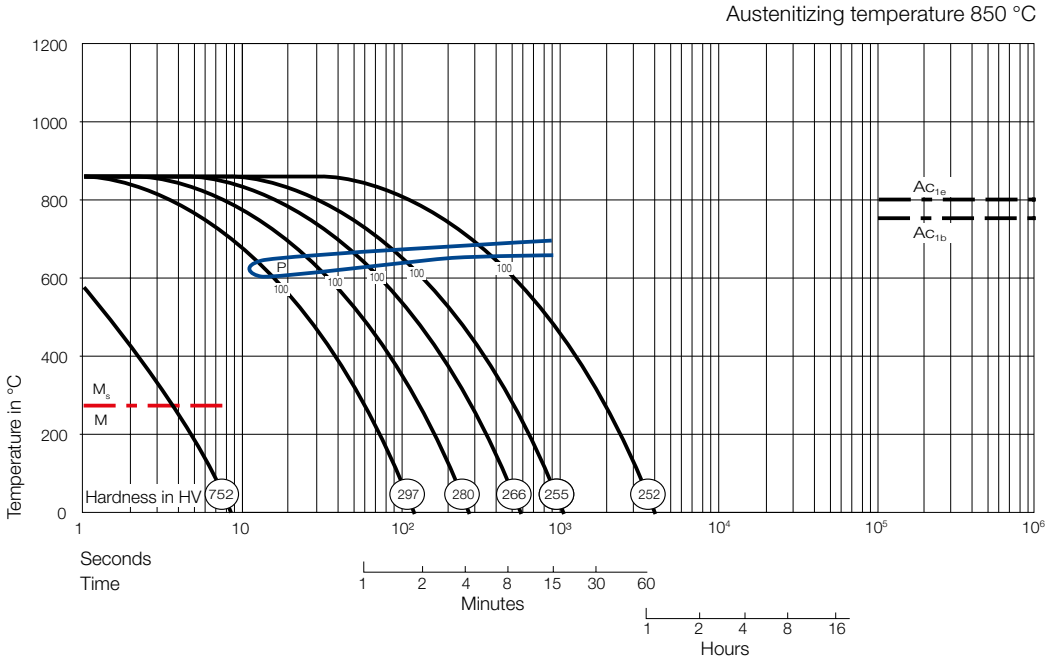
Physical properties

Temperature in °C	20	200	400
Thermal conductivity in W/m x K	25,5	26,4	27,4

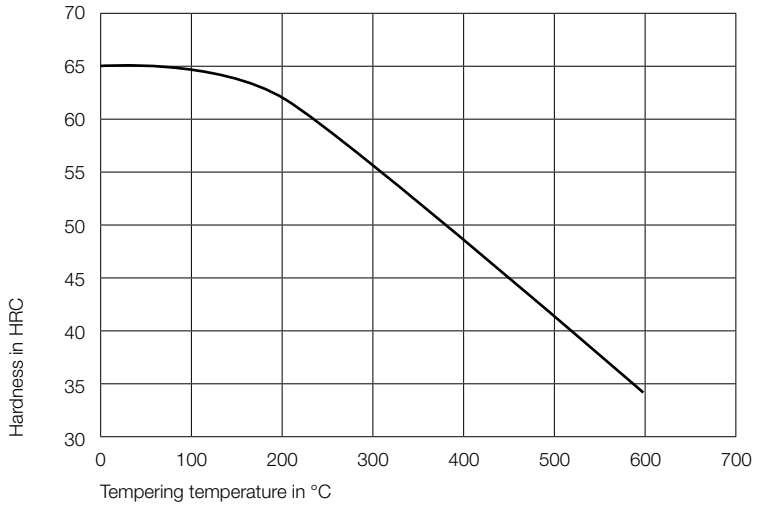
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 4 - 6 hours
	Cooling	slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	800 - 950 °C
	Cooling	Water, interrupt water hardening at approx. 120 °C, further cooling in oil
Tempering	Temperature	100 - 300 °C
	Hardness	see tempering graph

Continuous time-temperature-transformation graph



Tempering graph



RM161a (1.4104)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	S
1.4104	X14CrMoS17	RM161a	0.15	≤ 1.00	≤ 1.50	16.50	0.40	0.25

Material properties

Martensitic, moderately corrosion resistant steel. Improved machinability through the addition of sulphur.

Application

- Hydraulic valve blocks for mining equipment
- For corrosion resistant screws and bolts

Delivery condition: Quenched and tempered

Physical properties

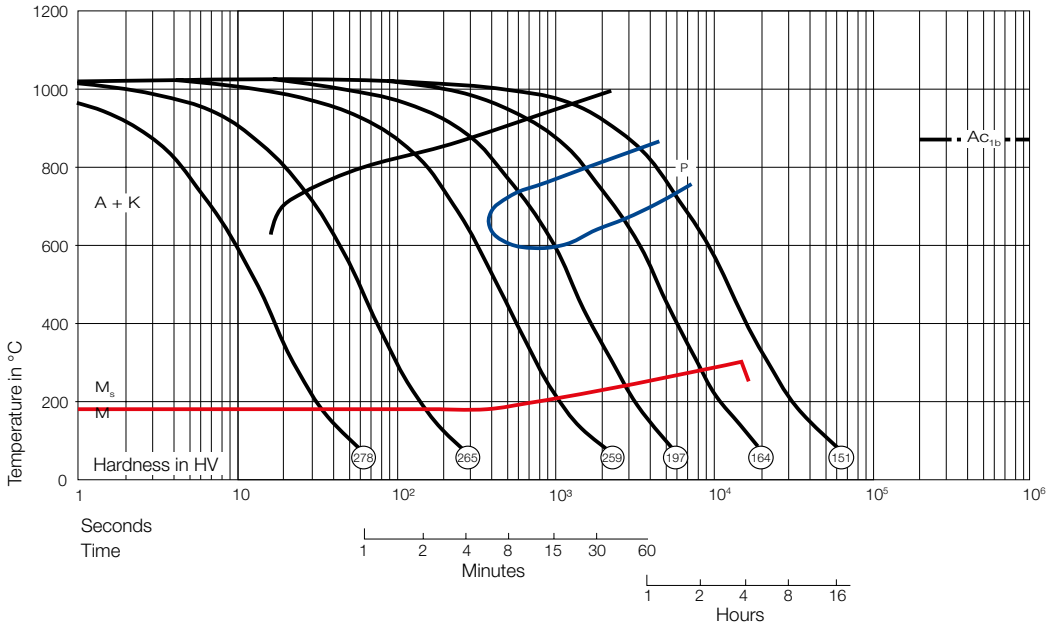
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	10,0	12,0	12,5

Temperature in °C	20
Thermal conductivity in W/m x K	25,0

Temperature in °C	20
Density in g/cm³	7,7

Temperature in °C	20
Young‘s modulus in GPa	215

Austenitizing temperature 1010 °C



RM200 (1.4125)

Mat.-no.	Short name	Brand name	Mass.-%				
			C	Si	Mn	Cr	Mo
1.4125	X105CrMoV17	RM200	1.05	0.40	0.40	16.70	0.50

Material properties

RM200 is a corrosion-resistant, martensitic steel with high hardenability and wear resistance. The steel is polishable.

Application

- Knives and cutting tools
- Perforated discs, screw elements, spray nozzles

Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	10,4	11,6	12,3

Temperature in °C	20
Thermal conductivity in W/m x K	15,5

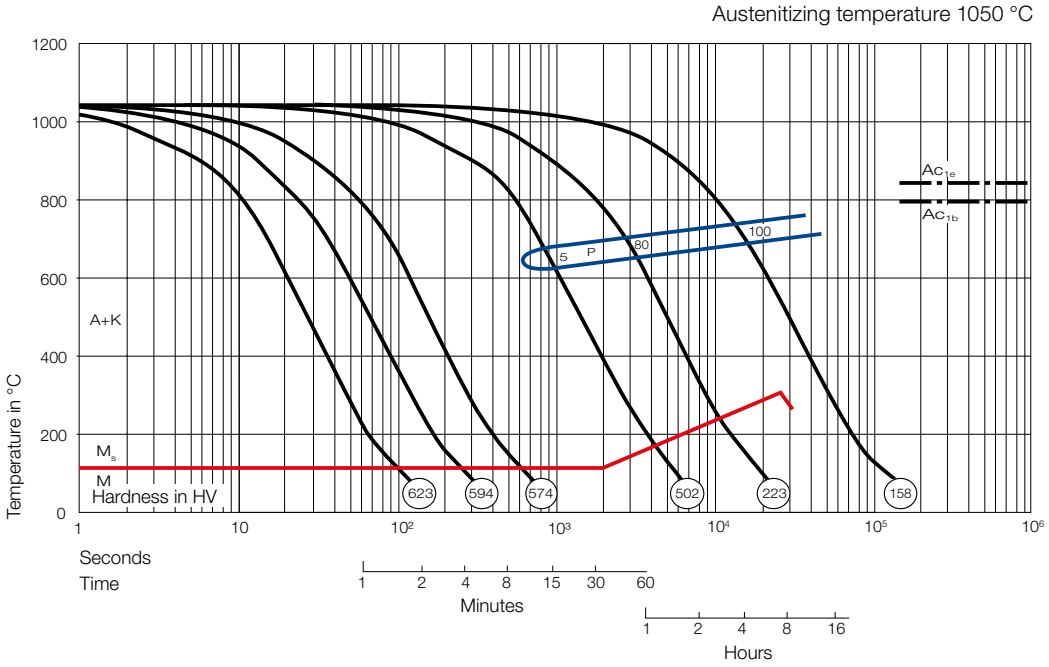
Temperature in °C	20
Density in g/cm³	7,7

Temperature in °C	20
Young's modulus in GPa	215

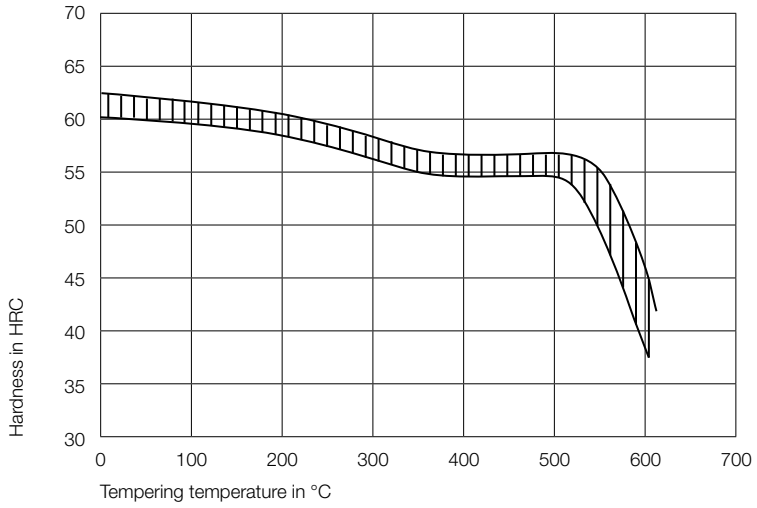
Heat treatment

Soft annealing	Temperature	785 - 840 °C
	Cooling	slow furnace cooling
	Hardness	max. 285 HB
Hardening	Temperature	1000 - 1050 °C
	Cooling	Oil, vacuum hardening, air or warm bath of 500 - 550 °C
Tempering	Temperature	100 - 600 °C
	Hardness	see tempering graph
Nitriding	possible	

Continuous time-temperature-transformation graph



Tempering graph



High temperature steels / Nickel-based alloys

With the traditional martensitic hot-work tool steels, adding elements such as Cr, Co, Mo and W can increase the high-temperature strength up to a certain limit. However, if the thermal stress of the tools exceeds this limit, the use of austenitic hot-work tool steels is recommended. These steels also retrain their strength even under high thermal stress.

For even higher thermal stress, e.g. when forming brass and copper materials, nickel-based alloys are suitable as tool materials.

MA-Rekord (1.2758)

Mat.-no.	Short name	Brand name	Mass.-%								
			C	Si	Mn	Cr	Mo	Ni	V	Co	W
1.2758	X50WNiCrVCo12-12	MA-Rekord	0.51	1.40	0.70	4.00	0.60	11.50	1.10	1.50	12.00

Material properties

MA-Rekord is a high-alloy hot-work tool steel with an austenitic structure. By forging and subsequent precipitation hardening at approx. 800 °C or by a special heat treatment, the operational strength of 1350 - 1550 MPa is achieved.

Application

- Extrusion dies for processing hard-to-press non-ferrous metals and steel in the manufacture of wire, rods, pipes, strips and simple profiles

Delivery condition:
As discs forged on all sides with the smallest possible thickness, so that a roughly consistent temperature increase is guaranteed in extrusion operation, in order to prevent stress cracks due to the limited thermal conductivity.
Tensile strength R_m = 1350 - 1550 MPa

Water cooling is not possible.

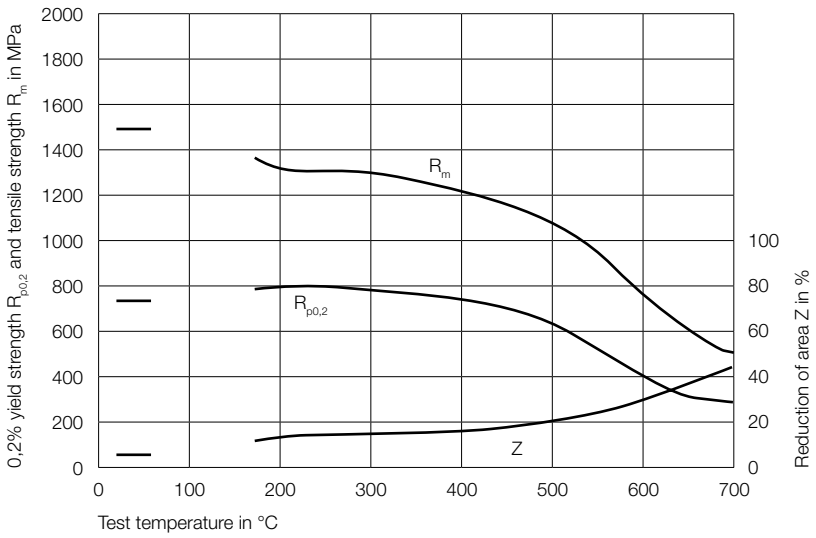
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6} m/m x K	11,3	11,8	12,2

Heat treatment

Preheating before use	Temperature	400 - 600 °C, essential, avoid cooling during press operation
Cooling after use		immediately after the last pressing, slowly from 500 - 600 °C in the furnace

High-temperature strength graph



HWF (1.2779)

Mat.-no.	Short name	Brand name	Mass.-%						
			C	Si	Mn	Cr	Mo	Ni	Ti
1.2779	X6NiCrTi26-15	HWF	≤ 0.08	≤ 1.00	1.10	15.00	1.50	26.00	2.10

Material properties

HWF is an austenitic, age-hardenable steel with excellent high-temperature strength properties. Preferred areas of application are forming operations with high heat input, when the tempering resistance of martensitic steels is not sufficient.

Application

- Extrusion press tools for copper and copper alloys such as inner liners, dies, spider tools
- Hot shear blades in rolling lines

Delivery condition:
Solution annealed or solution annealed and aged with following values:
0,2% yield strength $R_{p0,2} \geq 650$ MPa
Tensile strength $R_m = 950 - 1150$ MPa

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	16,5	16,8	17,2	17,6

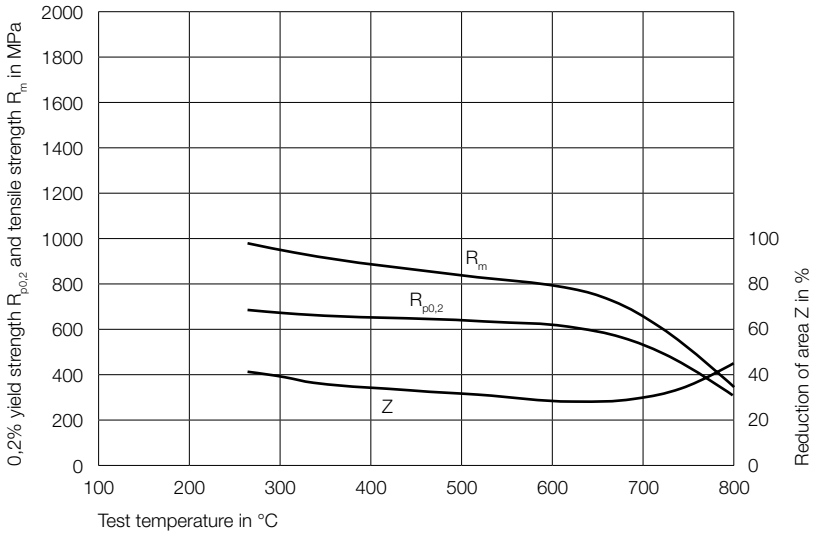
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	13,0	16,4	20,3

Temperature in °C	20
Density in g/cm³	7,95

Temperature in °C	20
Young's modulus in GPa	208

Heat treatment

Solution annealing	Temperature	970 - 990 °C, 1 hour
	Cooling	Air
	Hardness	approx. 850 MPa
Aging	Temperature	710 - 730 °C, 16 hours
	Cooling	Air
Nitriding	possible	


0,2% yield strength $R_{p0,2}$ and tensile strength R_m in MPa
2000
1800
1600
1400
1200
1000
800
600
400
200
0
100
200
300
400
500
600
700
800
Test temperature in °C
R_m
$R_{p0,2}$
Z
100
80
60
40
20
0
Reduction of area Z in %

ZF2 (1.2782)

Mat.-no.	Short name	Brand name	Mass.-%				
			C	Si	Mn	Cr	Ni
1.2782	X16CrNiSi25-20	ZF2	≤ 0.08	≤ 1.00	1.10	24.00	19.00

Material properties

This high-alloyed steel with austenitic structure has excellent scale and corrosion resistance as well as high high-temperature strength over a wide temperature range. In addition, ZF2 offers excellent polishability.

Application

- Upper and lower sections of glass molds, high output with best surface quality of the glass (crystal luster), gathering irons, mouthpieces and blowing pipes in the glass industry
- Fittings for furnace construction, such as rollers, rails, axles
- Equipment for heat treating companies

Delivery condition:
Quenched, i.e. ready for use with the following properties:
0,2% yield strength $R_{p0,2}$ ≥ 230 MPa
Tensile strength R_m = 550 - 800 MPa
Scaling resistance up to approx. 1150 °C

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	16,0	16,5	17,0	17,5

Temperature in °C	20
Thermal conductivity in W/m x K	14,7

Temperature in °C	20
Density in g/cm³	7,9

Temperature in °C	20
Young's modulus in GPa	198

Heat treatment

Solution annealing	Temperature	1050 - 1100 °C
	Cooling	Water
Preheating before use	Temperature	350 - 400 °C

SA50Ni (2.4973)

Mat.-no.	Short name	Brand name	Mass.-%								
			C	Si	Mn	Cr	Mo	Ni	Co	Al	Ti
2.4973	NiCr19CoMo	SA50Ni	≤ 0.12	≤ 0.50	≤ 0.10	19.00	9.50	Bal.	11.00	1.60	3.00

Material properties

Age-hardenable nickel-based alloy with very high high-temperature strength. Particularly suitable as hot-work material for forming work with high thermal loads, if the tempering resistance of the martensitic steels is no longer sufficient.

Application

- Tools for extrusion
- Die forging
- Hot shear blade

Delivery condition:
Solution annealed and aged with following properties:
0,2% yield strength $R_{p0,2}$ = approx. 900 MPa
Tensile strength R_m = approx. 1250 MPa

Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	12,2	12,4	13,0	13,7
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	11,3	13,4	15,9	
Temperature in °C	20			
Density in g/cm³	8,2			

Heat treatment

Solution annealing	Temperature	1080 °C, 4 hours
	Cooling	Air
Tempering	Temperature	760 °C, 16 hours
	Cooling	Air

SA718 (2.4668)

Mat.-no.	Short name	Brand name	Mass.-%									
			C	Si	Mn	Cr	Mo	Ni	Al	Ti	Fe	Nb
2.4668	NiCr19NbMo	SA718	0.05	≤ 0.35	≤ 0.35	19.00	3.00	53.00	0.50	0.90	Bal.	5.00

Material properties

Age-hardenable nickel-based alloy with very high high-temperature strength. Particularly suitable as hot-work material for forming work with high thermal loads, if the tempering resistance of the martensitic steels is no longer sufficient.

Application

- Dies, mandrel tips, press discs for extrusion of copper alloys
- Sinter pressing tools
- Hot shear blade
- Forging dies for titanium alloys
- Dies for isothermal forging
- Inner liners
- Heavy metal extrusion with 1350 - 1450 MPa

Delivery condition:
Solution annealed and aged with following properties:
0,2% yield strength $R_{p0,2}$ = approx. 1100 MPa
Tensile strength R_m = approx. 1300 MPa

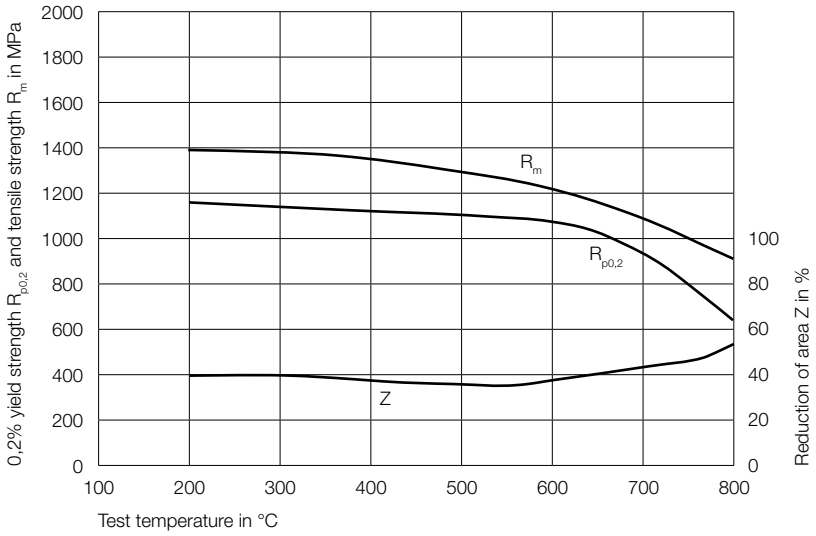
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	13,0	14,0	14,5	15,2
Temperature in °C	20	200	400	600
Thermal conductivity in W/m x K	11,3	14,2	17,2	20,5
Temperature in °C	20			
Density in g/cm³	8,2			
Temperature in °C	20			
Young's modulus in GPa	205			

Heat treatment

Solution annealing	Temperature	980 °C, 1 hour
	Cooling	Air
Tempering	Temperature	720 °C, 8 hours; Cooling to 620 °C, 8 hours; Cooling air

High-temperature strength graph



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DIN EN ISO 18265: Metallic Materials – Conversion of Hardness Values			
Tensile Strength [MPa]	Vickers [HV10]	Brinell [HB]	Rockwell [HRC]
995	310	295	31,0
1030	320	304	32,2
1060	330	314	33,3
1095	340	323	34,4
1125	350	333	35,5
1155	360	342	36,6
1190	370	352	37,7
1220	380	361	38,8
1255	390	371	39,8
1290	400	380	40,8
1320	410	390	41,8
1350	420	399	42,7
1385	430	409	43,6
1420	440	418	44,5
1455	450	428	45,3
1485	460	437	46,1
1520	470	447	46,9
1555	480	456	47,7
1595	490	466	48,4
1630	500	475	49,1
1665	510	485	49,8
1700	520	494	50,5
1740	530	504	51,1
1775	540	513	51,7
1810	550	523	52,3
1845	560	532	53,0
1880	570	542	53,6
1920	580	551	54,1
1955	590	561	54,7
1995	600	570	55,2
2030	610	580	55,7
2070	620	589	56,3
2105	630	599	56,8
2145	640	608	57,3
2180	650	618	57,8

Production processes

Melting

Forging

Heat treatment

Mechanical processing

Vacuum hardening

Surface treatment

Products

Hot-work tool steels

Cold-work tool steels

Die forging steels

Plastic mold steels

Industries

Die casting

Extrusion

Die forging

Pipe technology

Plastics technology

Hot-stamping

Special applications

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