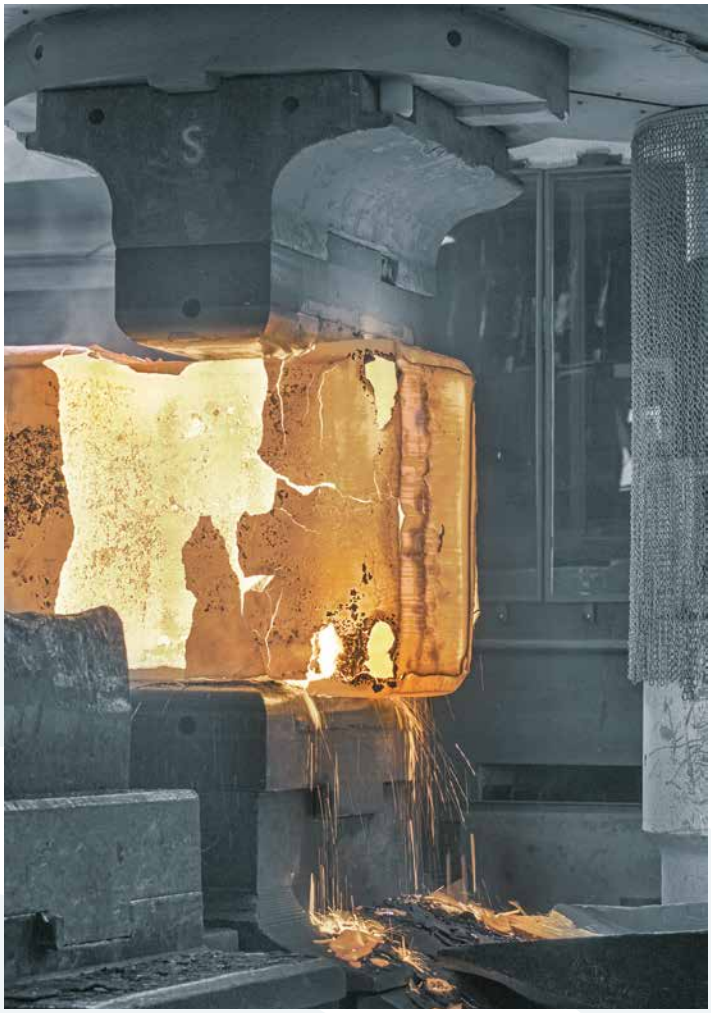
KIND&CO
EDELSTAHLWERK

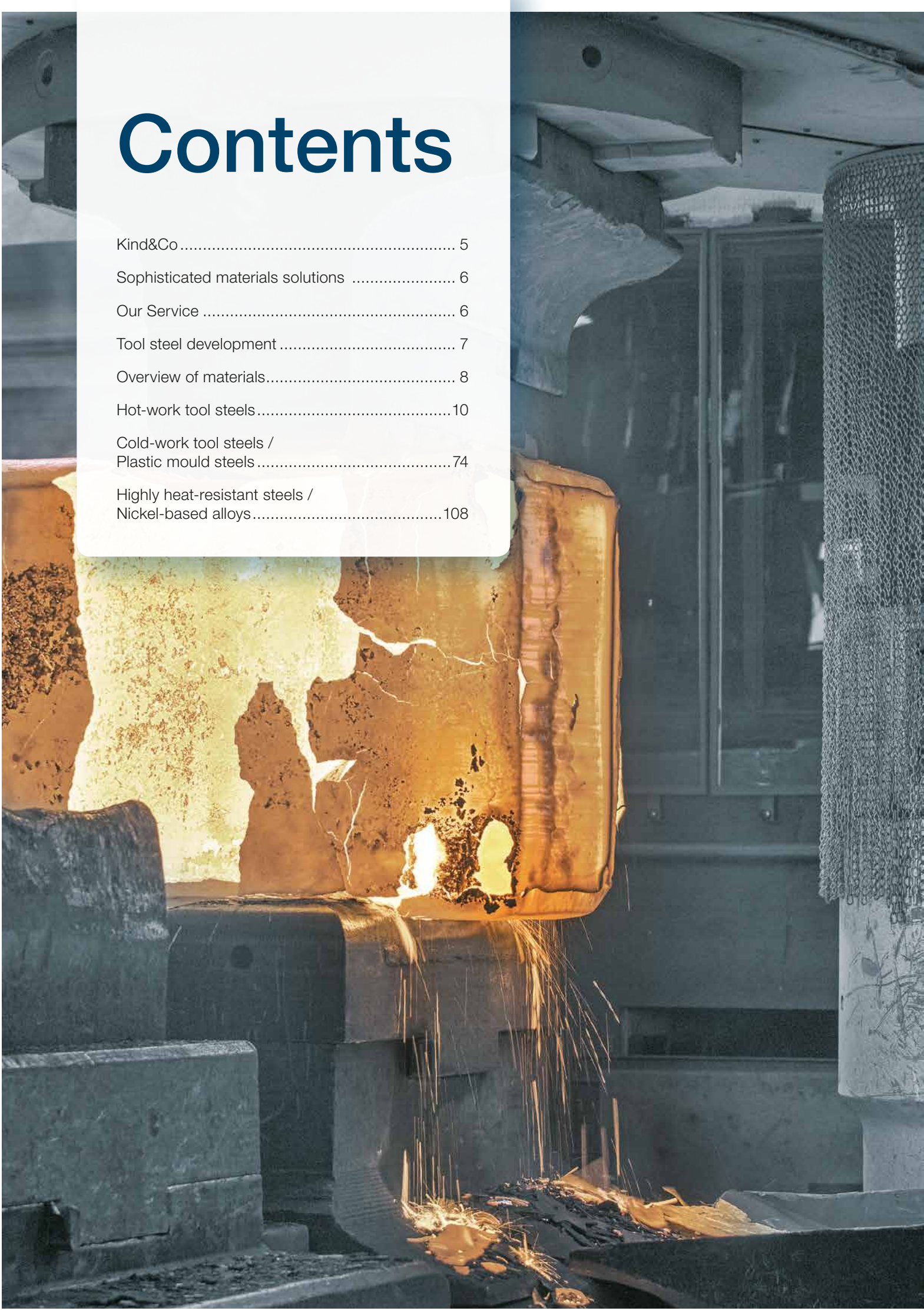


Materials catalogue

Sophisticated Materials solutions

KIND&CO
EDELSTAHLWERK

Contents



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 safe production processes of our customers.

As the only hot work specialist worldwide, we are expanding our service and our added value 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 and classifies the properties and applications of the materials produced by us. The various materials are manufactured by smelting, using selected scrap, by electro-slag-remelting process (ESR) in case of higher quality requirements, by forming the cast blocks on hydraulic forging presses and other mechanical processing until the product is pre-finished according to customer drawing. All process steps are accompanied by treatments, which make an important contribution to achieving the maximum material properties.

Our Service

Our broad range of services targets the individual needs of our customers.

Apart from our high performance steels, we offer you an extensive range of services as part of the tool processing and finishing. Use our relevant know-how and the experience of our specialists, paired with modern technical equipment.

With a high level of flexibility, we realise individual and tailored technologies and processes according to your requirements profile, which help your quality tools achieve maximum performance.

Talk with our experts and get qualified advice – problem-solving is our speciality.

Tool steel development -
A step in the right direction

Apart from the standardised tool steels according to DIN EN ISO 4957, we develop our own special materials for applications according to customer requirements, We see ourselves as a customer-oriented problem-solver for your applications of tool steels in numerous forming processes.

With the special steels developed in-house, we have expanded our delivery spectrum, also at the threshold between various applications, in order to be able to offer solutions.

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
- Highly heat-resistant steels
  with a surface temperature > 600 °C

Through competent and solution-oriented customer advice, we also want to live up to our claim going forward of being able to offer you a sophisticated material solution.

Hot-work tool steels

Brand name	Mat.-no.	Short name	AISI	Mass.-%										Page
				C	Si	Mn	Cr	Mo	Ni	V	Co	W		
CM167	1.2323	48CrMoV6-7	-	0.45	0.30	0.70	1.50	0.75	-	0.30	-	-	-	**12**
USN	1.2343	X37CrMoV5-1	H 11	0.37	1.00	0.40	5.20	1.20	-	0.40	-	-	-	**14**
USD	1.2344	X40CrMoV5-1	H 13	0.40	1.00	0.40	5.20	1.30	-	1.00	-	-	-	**16**
USD-H	1.2345	X50CrMoV5-1	-	0.51	0.85	0.30	4.90	1.35	-	0.90	-	-	-	**18**
RP	1.2365	32CrMoV12-28	H 10	0.32	0.40	0.40	3.00	2.80	-	0.50	-	-	-	**20**
RPU	1.2367	X38CrMoV5-3	-	0.38	0.40	0.40	5.00	3.00	-	0.60	-	-	-	**22**
MA	1.2581	X30WCrV9-3	-	0.30	0.30	0.30	2.70	-	-	0.35	-	9.00	-	**24**
W44	1.2603	45CrVMoW5-8	-	0.45	0.60	0.40	1.60	0.60	-	0.80	-	0.50	-	**26**
US	1.2606	X37CrMoW5-1	-	0.36	1.00	0.40	5.20	1.40	-	0.30	-	1.40	-	**28**
PD	1.2622	X60WCrMoV9-4	-	0.58	0.25	0.25	4.00	0.90	-	0.80	-	9.00	-	**30**
HWD	1.2678	X45CoCrWV5-5-5	H 19	0.40	0.30	0.40	4.50	0.50	-	2.10	4.50	4.50	-	**32**
UHF3	1.2709	X3NiCoMoTi18-9-5	-	≤ 0.03	≤ 0.10	≤ 0.15	-	5.20	18.00	-	9.50	-	Ti 0.95	**34**
PWM	1.2714	55NiCrMoV7	L 6	0.55	0.30	0.80	1.10	0.45	1.70	0.10	-	-	-	**36**
AWS	1.2731	X50NiCrWV13-13	-	0.50	1.40	0.70	13.00	-	13.00	0.60	-	2.40	-	**38**
PWU	1.2744	57NiCrMoV7-7	-	0.55	0.30	0.70	1.10	0.80	1.70	0.10	-	-	-	**40**
FAM	1.2787	X23CrNi17	~ 431	0.20	≤ 1.00	≤ 1.00	17.00	-	1.70	-	-	-	-	**42**
RPCo	1.2885	X32CrMoCoV3-3-3	H 10A	0.32	0.40	0.40	3.00	2.80	-	0.60	3.00	-	-	**44**
RM10Co	1.2888	X20CoCrWMo10-9	-	0.20	0.20	0.50	9.50	2.00	-	-	10.00	5.50	-	**46**
HMoD	1.2889	X45CoCrMoV5-5-3	H 19A	0.45	0.30	0.40	4.50	3.00	-	2.00	4.50	-	-	**48**
-	1.4418	X4CrNiMo16-5-1	-	0.06	≤ 0.70	≤ 1.50	15.00	0.90	5.00	-	-	-	N ≥ 0.02	**50**
CR7V-L	Special	-	-	0.42	0.50	0.40	6.50	1.30	-	0.80	-	-	-	**52**
CS1	Special	-	-	0.50	0.30	0.40	5.00	1.90	-	0.55	-	-	+ Nb	**54**
FTCo	Special	-	-	0.53	0.35	0.40	4.00	2.00	-	1.10	0.90	1.50	+ Nb	**56**
GSF	Special	-	-	0.28	0.30	0.70	2.80	0.60	1.00	0.40	-	-	-	**58**
HP1	Special	-	-	0.35	0.20	0.30	5.20	1.40	-	0.55	-	-	+ Nb	**60**
HS1	Special	-	-	0.50	0.90	0.80	8.00	1.50	-	1.70	-	-	-	**62**
HTR	Special	-	-	0.32	0.20	0.30	2.20	1.20	-	0.50	-	3.80	-	**64**
PWCo	Special	-	-	0.35	0.35	0.40	4.80	2.90	-	0.60	2.75	-	-	**66**
Q10	Special	-	-	0.36	0.25	0.40	5.20	1.90	-	0.55	-	-	-	**68**
S10	Special	-	-	0.50	0.30	0.40	5.00	1.90	-	0.55	-	-	+ Nb	**70**
TQ1	Special	-	-	0.36	0.25	0.40	5.20	1.90	-	0.55	-	-	-	**72**

Cold-work tool steels / Plastic mould steels

Brand name	Mat.-no.	Short name	AISI	Mass.-%										Page
				C	Si	Mn	Cr	Mo	Ni	V	Co	W		
RF	1.2083	X40Cr14	~ 420	0.42	0.40	0.30	13.00	-	-	-	-	-	-	**76**
KS80	1.2108	90CrSi5	-	0.90	1.20	0.70	1.20	-	-	-	-	-	-	**78**
CMR	1.2316	X38CrMo16	-	0.40	≤ 1.00	≤ 1.00	16.00	1.20	≤ 1.00	-	-	-	-	**80**
RM189	1.2361	X91CrMoV18	-	0.90	≤ 1.00	≤ 1.00	18.00	1.10	-	0.10	-	-	-	**82**
CH5M	1.2363	X100CrMoV5	A 2	1.00	0.30	0.60	5.25	1.10	-	0.20	-	-	-	**84**
CH16V	1.2379	X153CrMoV12	D 2	1.50	0.25	0.25	11.25	0.80	-	0.85	-	-	-	**86**
PK	1.2542	45WCrV7	-	0.45	1.00	0.30	1.10	-	-	0.20	-	2.00	-	**88**
KL	1.2550	60WCrV8	S 1	0.60	0.60	0.30	1.10	-	-	0.15	-	2.00	-	**90**
SN	1.2721	50NiCr13	-	0.50	0.30	0.50	1.00	-	3.30	-	-	-	-	**92**
N400	1.2767	45NiCrMo16	-	0.45	0.25	0.40	1.35	0.25	4.00	-	-	-	-	**94**
KSV	1.2838	145V33	-	1.45	0.30	0.40	-	-	-	3.25	-	-	-	**96**
RM161A	1.4104	X14CrMoS17	-	0.15	≤ 1.00	≤ 1.50	16.50	0.40	-	-	-	-	S 0.25	**98**
RM200	1.4125	X105CrMo17	-	1.05	0.40	0.40	16.70	0.50	-	-	-	-	-	**100**
FSR	Special	-	-	1.20	0.30	0.30	11.50	1.40	-	1.70	-	2.40	-	**102**
PM823	Special	-	-	0.84	0.85	0.35	7.70	1.50	-	2.45	-	-	-	**104**
PW812	Special	-	-	1.13	0.85	0.35	7.70	1.50	-	2.45	-	1.10	-	**106**

Highly heat-resistant steels / Nickel-based alloys

Brand name	Mat.-no.	Short name	AISI	Mass.-%										Page
				C	Si	Mn	Cr	Mo	Ni	V	Co	W		
MA-Rekord	1.2758	X50WNiCrVCo12-12	-	0.55	1.40	0.70	4.00	0.60	11.5	1.10	1.50	12.00	-	**110**
HWF	1.2779	X6NiCrTi26-15	A286	≤ 0.08	≤ 1.00	1.10	15.00	1.50	26.00	-	-	-	Ti 2.10	**112**
ZF2	1.2782	X16CrNiSi25-20	310/314	0.12	2.00	0.90	25.00	-	20.00	-	-	-	-	**114**
SA50Ni	2.4973	NiCr19CoMo	R41	≤ 0.12	≤ 0.50	≤ 0.10	19.00	9.50	Rest	-	11.00	-	Al 1.60 Ti 3.00	**115**
SA718	2.4668	NiCr19Fe19Nb5Mo3	UNS 7718	0.05	≤ 0.35	≤ 0.35	19.00	3.00	53.00	-	-	-	Al 0.50 Ti 0.90 Nb 5.00 Fe Rest	**116**

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 alloy elements Cr, Mo, V and W these steels have a high high-temperature strength, high tempering resistance and high-temperature toughness.

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 special 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.

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 high-temperature 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 10-6m/m x K	11,6	12,0	12,5	13,0

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

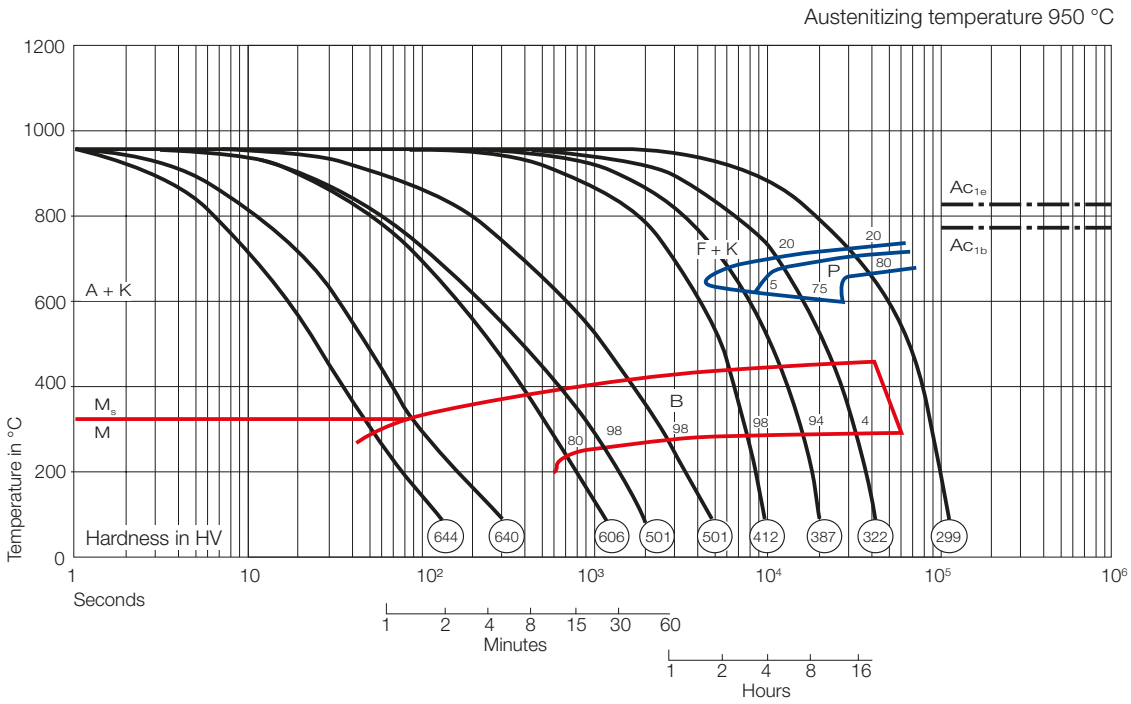
Temperature in °C	20
Density in g/cm3	7,85

Temperature in °C	20
E module in GPa	200

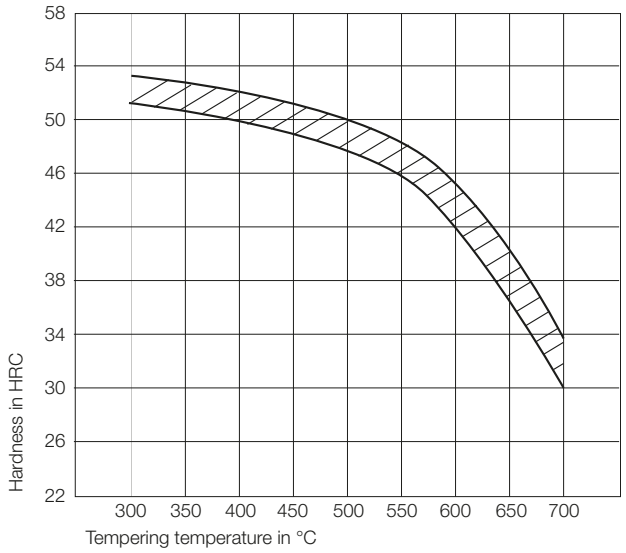
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 4 - 6 hrs.
	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

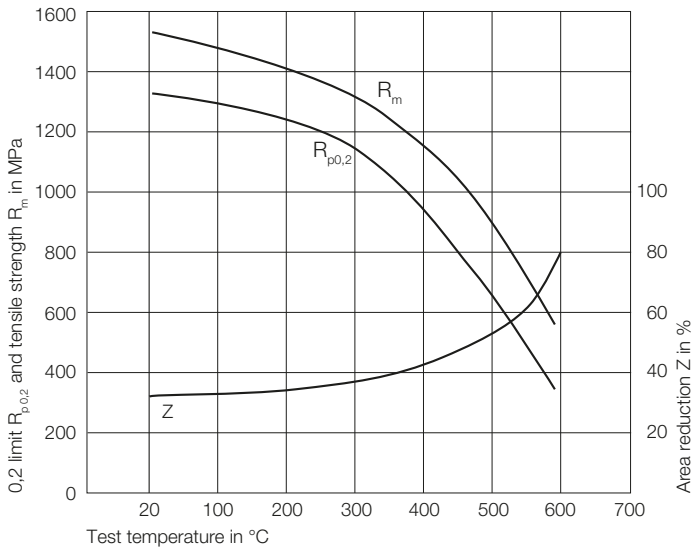
Continuous time-temperature-transformation graph



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 high-temperature toughness. USN is thermal shock resistant, water coolable, and is characterised by high hardenability.

Application

- Extrusion press tools for light metal processing, such as dies, chamber tools, die holders, press mandrels, press stems, container mantles, inner liners
- Press mandrels and stems for steel and heavy metal processing in extrusion presses
- Die casting tools such as moulding plates, valves, cores, ejectors, sprue bushings and filling fittings in the processing of light metals and zinc alloys
- Tools in forging machines such as pressure dies, die inserts, stamps and mandrels for steel, heavy and light metals

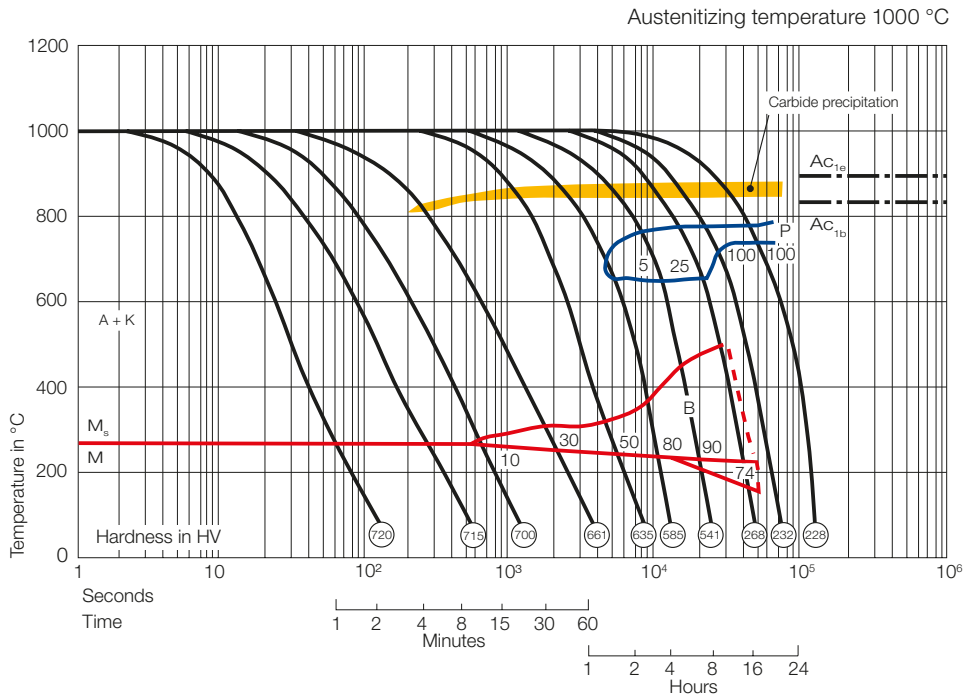
Physical properties

Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10-6m/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		
E module in GPa	215		

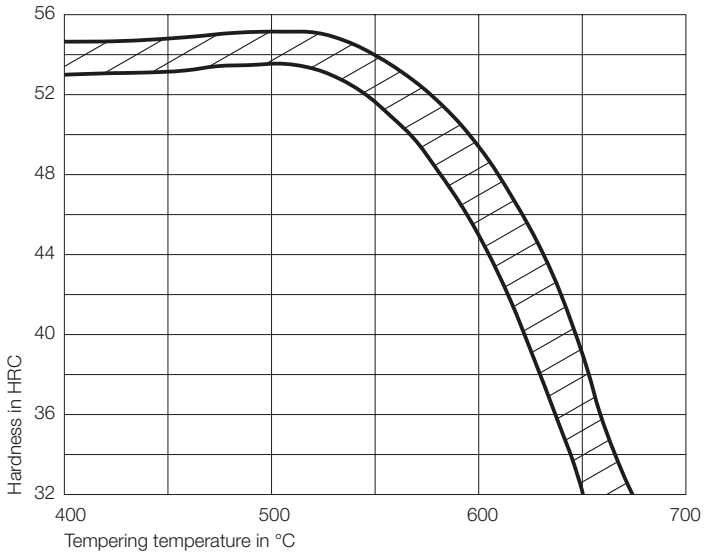
Heat treatment

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 quenching at 230 - 280 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering diagram
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

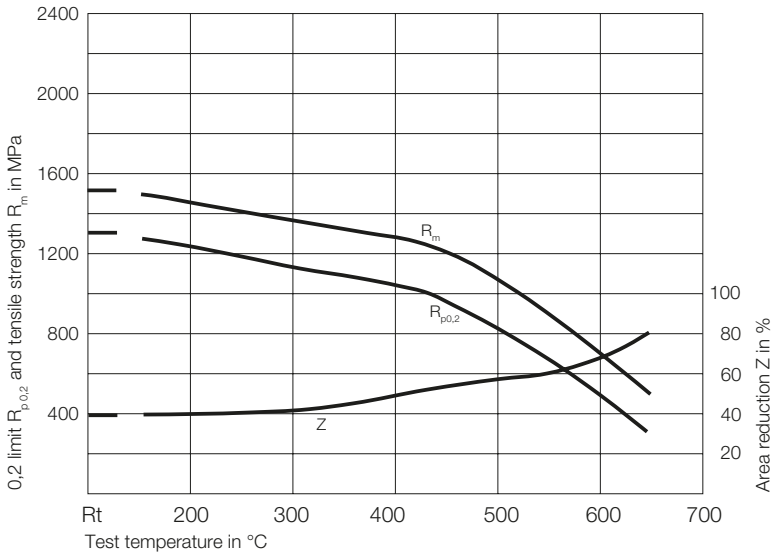
Continuous time-temperature-transformation graph



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 high-temperature strength and higher thermal shock resistance than USN. USD is thermal shock resistant, water coolable, and is characterised by high hardenability.

Application

- Extrusion press 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 presses
- Die casting tools such as moulding plates, valves, cores, ejectors, sprue bushings and filling fittings in the processing of light metals and zinc alloys
- Tools in forging machines, compression moulding dies, die inserts, punches and mandrels for steel, heavy and light metals

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

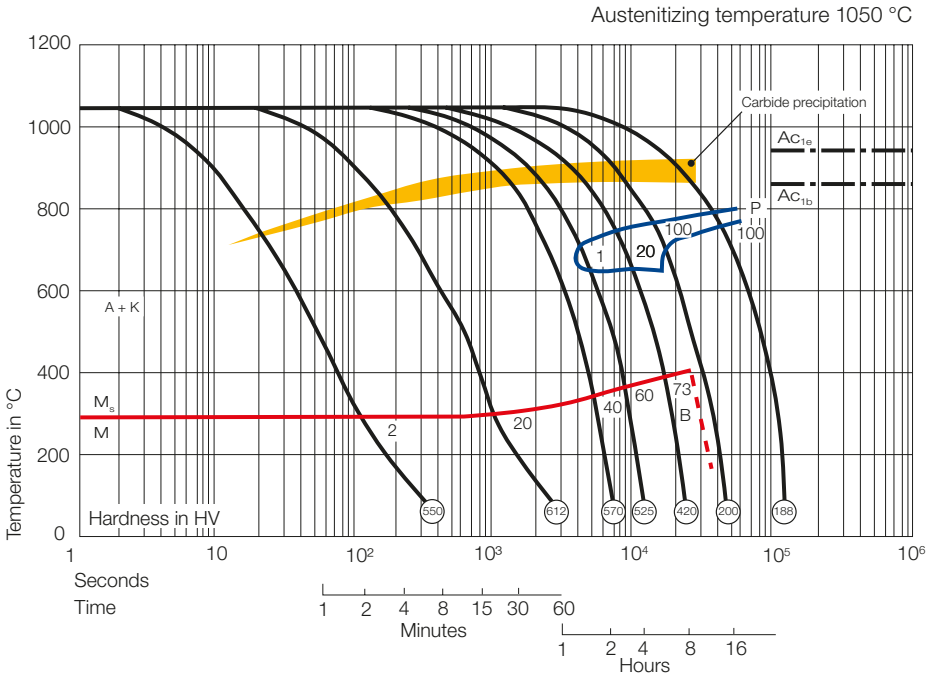
Temperature in °C	20
Density in g/cm^3	7,8

Temperature in °C	20
E module in GPa	215

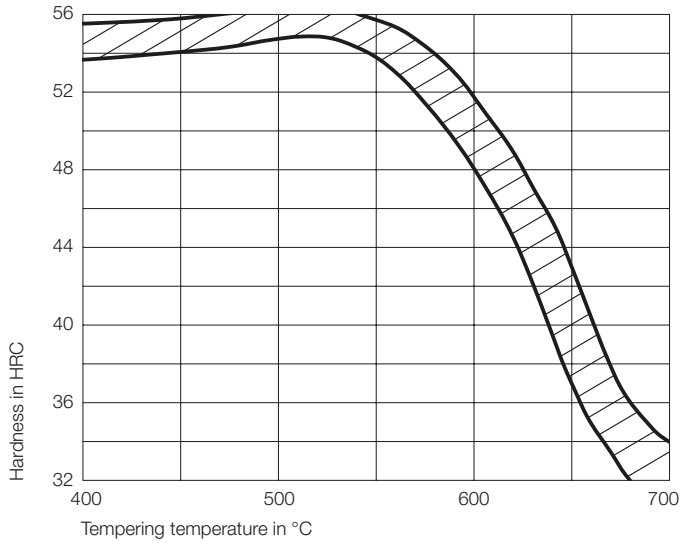
Heat treatment

Soft annealing	Temperature	820 - 840 °C
	Cooling	Slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1020 - 1040 °C
	Cooling	Air cooling, 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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

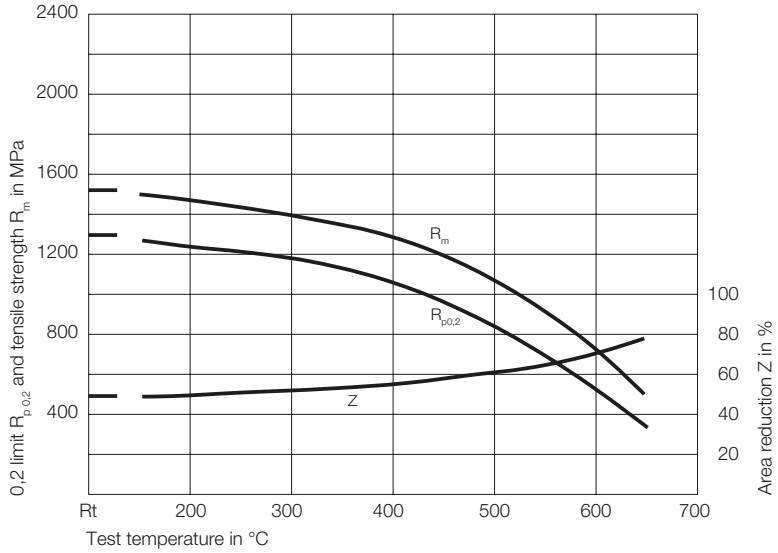
Continuous time-temperature-transformation graph



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 resistance to wear, higher temper resistance and hardenability.

Application

- Cold and hot shear blades
- Forging dies
- Rollers for pipe manufacturing

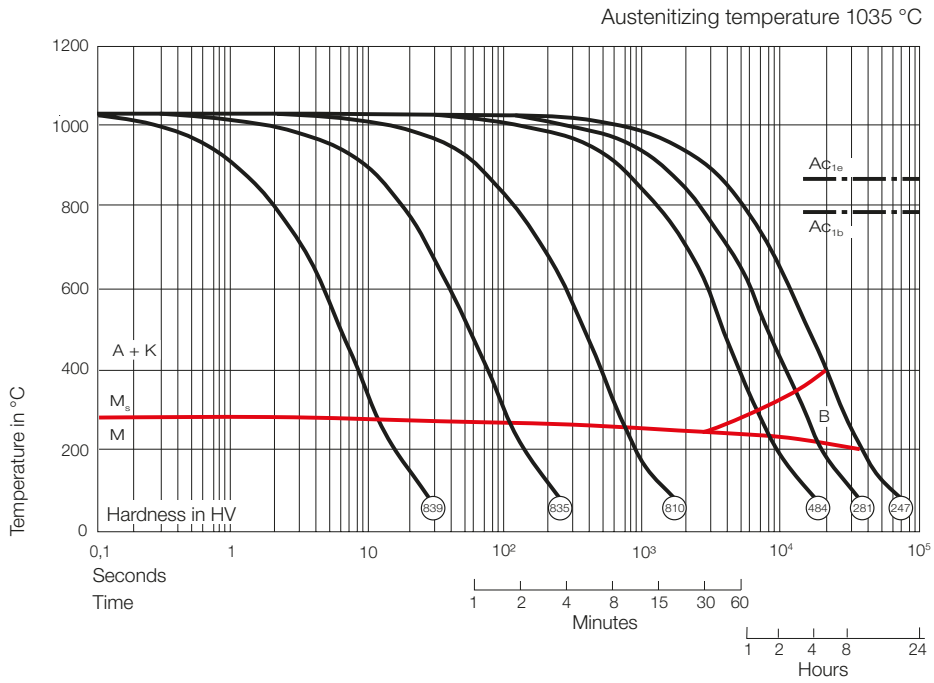
Physical properties

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/cm^3	7,73		
Temperature in °C	20		
E module in GPa	215		

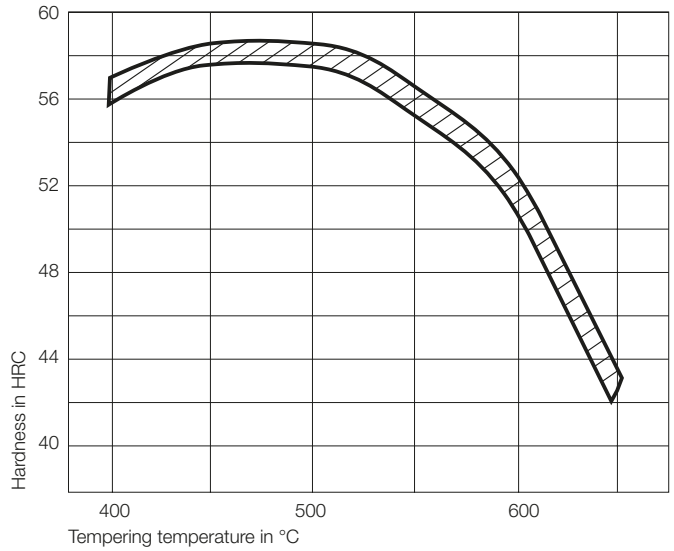
Heat treatment

Soft annealing	Temperature	760 - 810 °C, 4 - 6 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

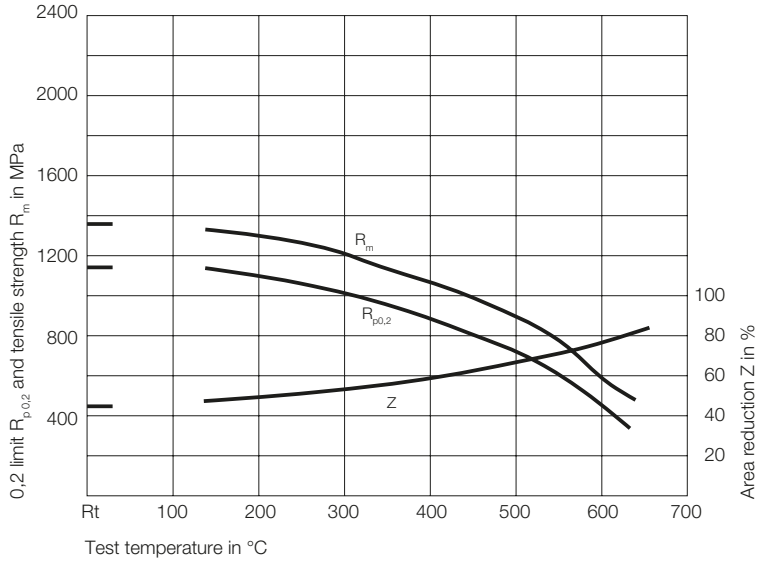
Continuous time-temperature-transformation graph



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 thermal resistance and tempering resistance, water coolable due to good thermal conductivity, so not sensitive to thermal shock. RP is very good for hobbing.

Application

- Extrusion press tools for steel and heavy metal processing, such as pipe extrusion rams, die holders and inner liners
- Compression moulding dies for heavy metal processing
- Tools in forging presses such as die inserts, mandrels, forge jaws and stems for steel processing
- Piercer heads
- Piercers
- 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

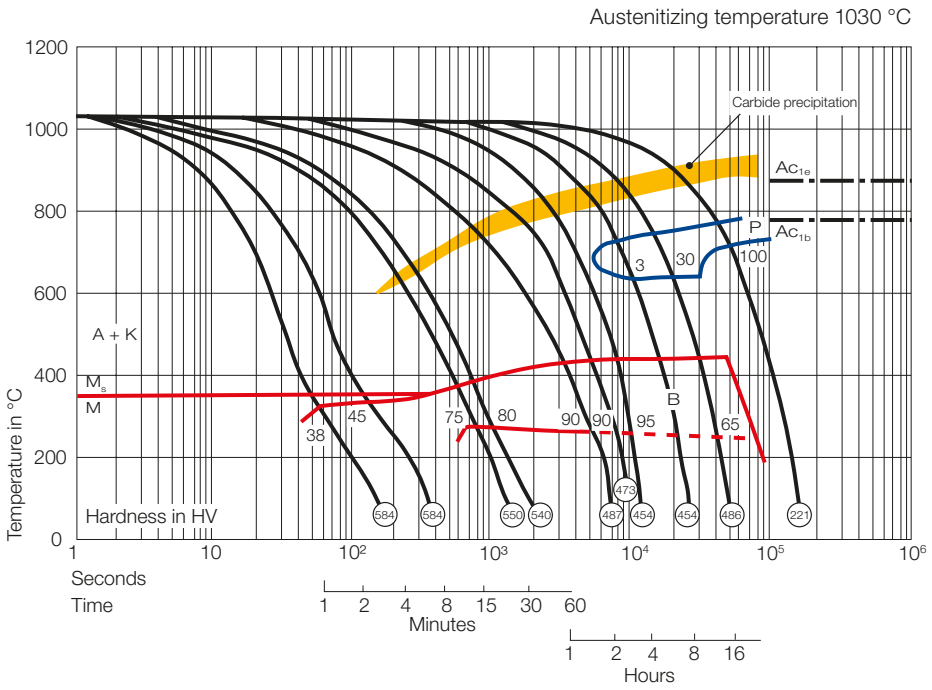
Temperature in °C	20
Density in g/cm^3	7,85

Temperature in °C	20
E module in GPa	215

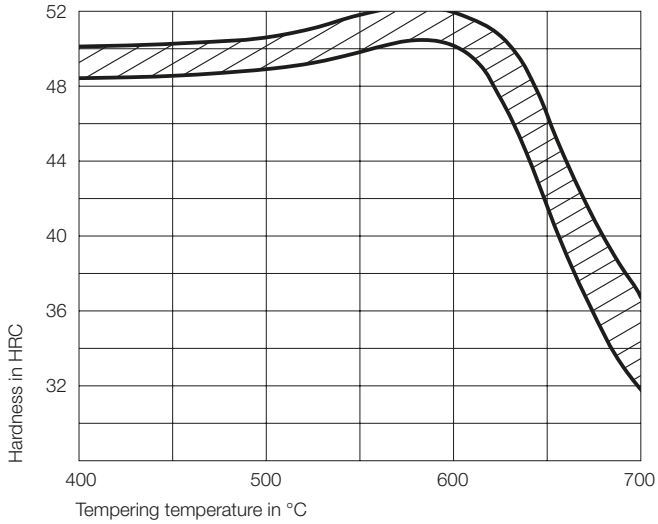
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 220 HB, for 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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

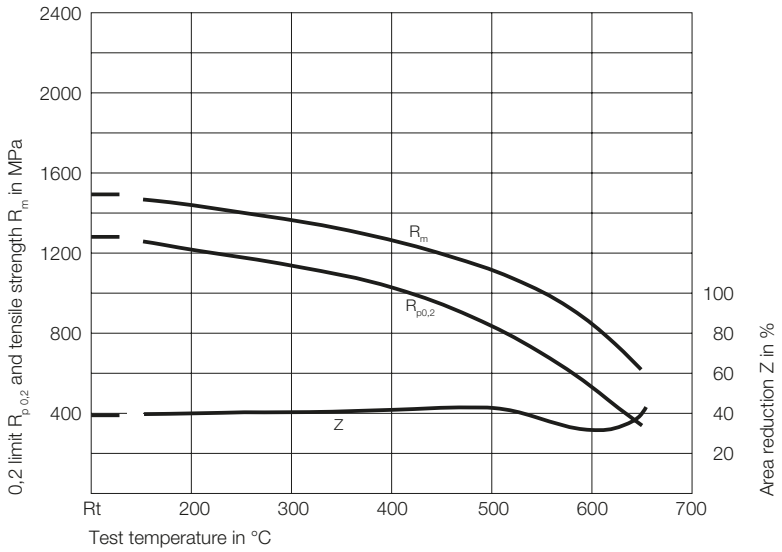
Continuous time-temperature-transformation graph



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

RPU as a Cr-Mo-V alloyed hot-work tool steel is a combination of the steels USN and RP. Good high temperature toughness combined with good high temperature strength.

Application

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

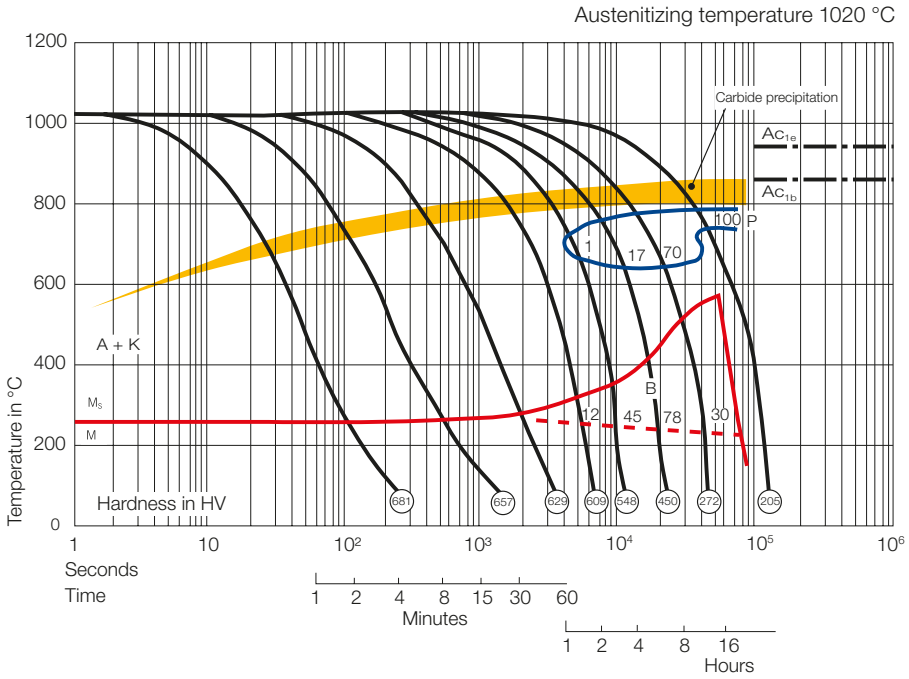
Physical properties

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/cm^3	7,85			
Temperature in °C	20			
E module in GPa	215			

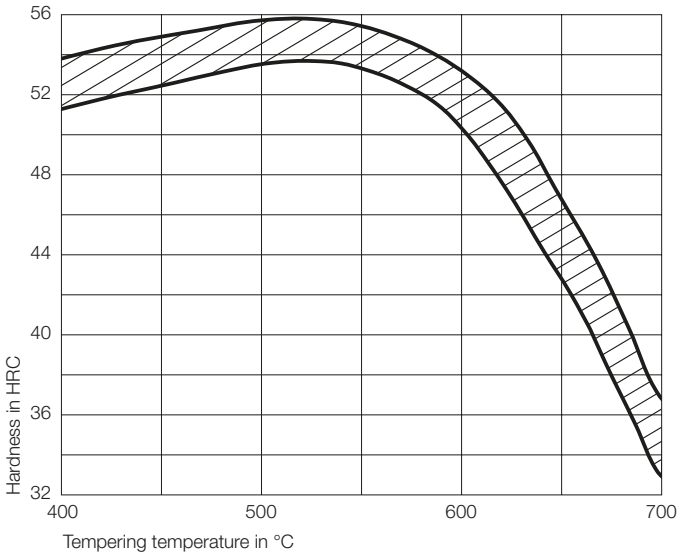
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

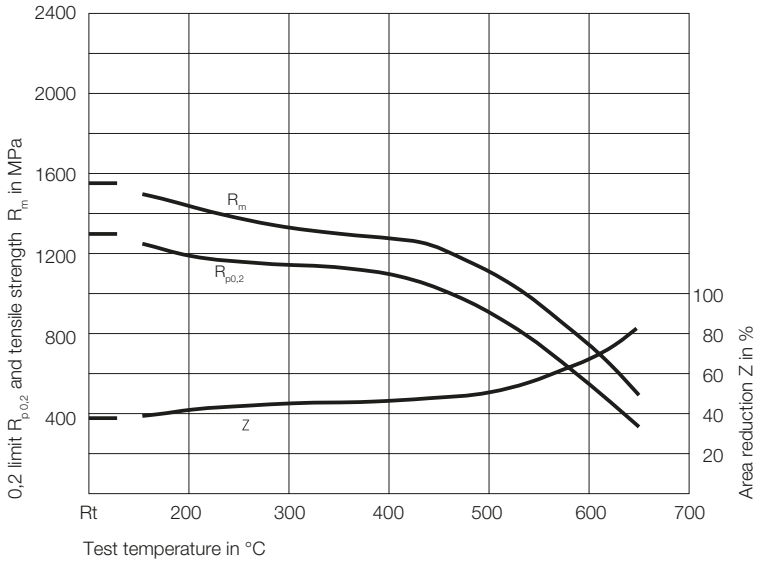
Continuous time-temperature-transformation graph



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 high-temperature wear resistance.

Application

- Thermally heavy duty tools for extrusion pressing of heavy metals such as dies, die holders and mandrels
- Partial pressure dies for heavy metal processing

Water cooling is not possible.

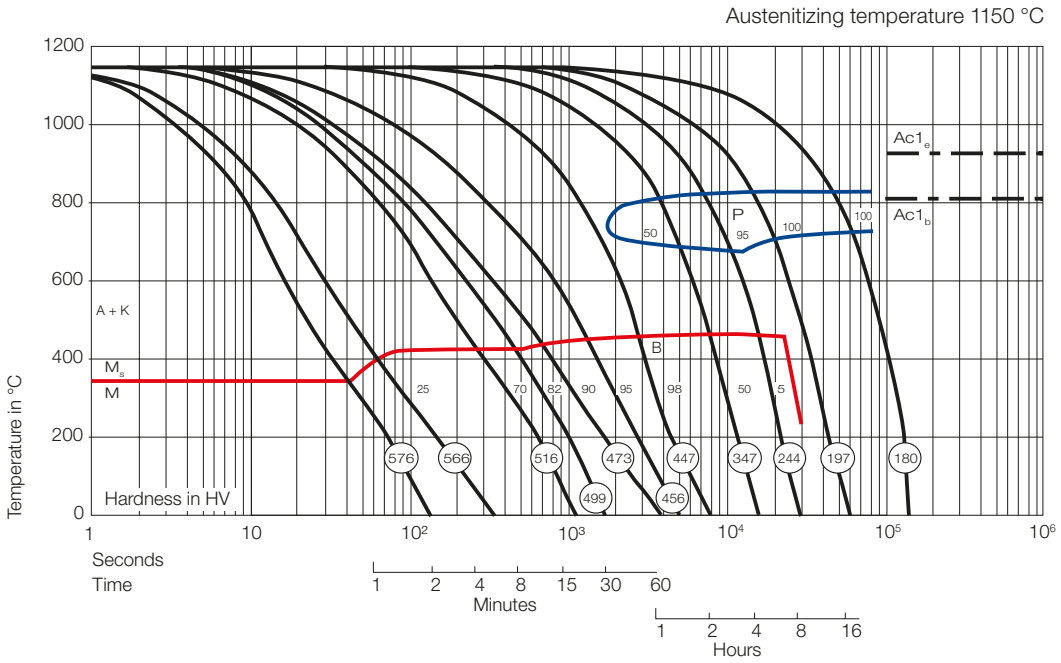
Physical properties

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			
E module in GPa	215			

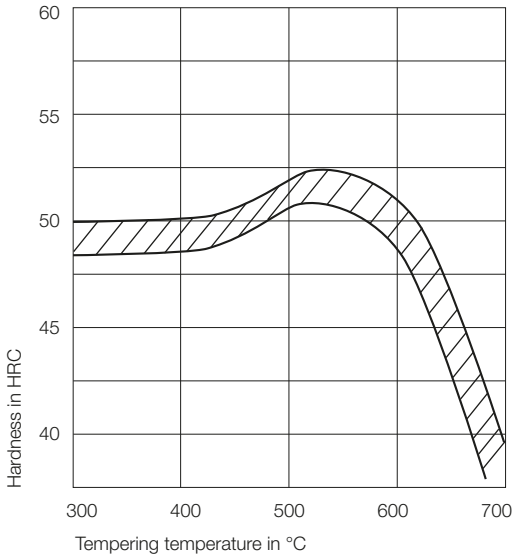
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	300 - 400 °C essential

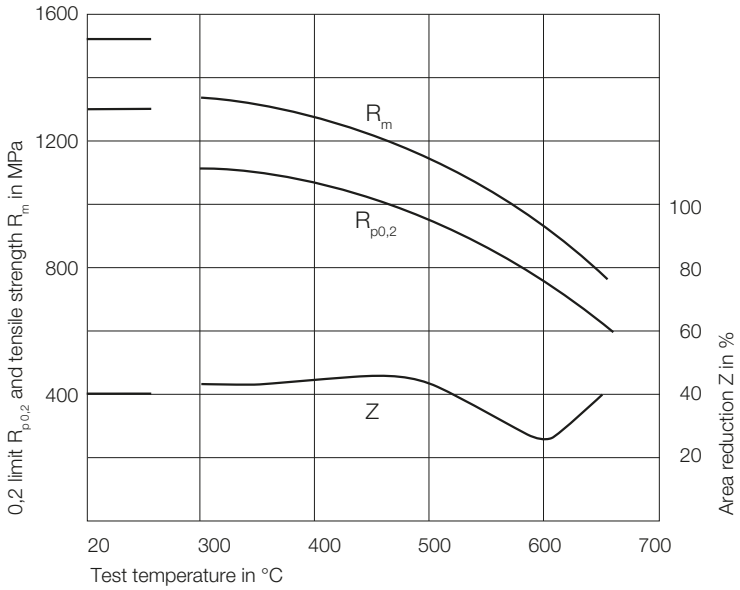
Continuous time-temperature-transformation graph



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, with good high temperature wear behaviour and which is not sensitive to sudden temperature change.

Application

- Extrusion press tools such as pressure disks, cleaning disks, dies, die holders for light metal processing
- Impression dies for light and heavy metal processing
- Dies and stems for steel forming in the manufacture of screws, nuts and rivets under spindle presses

Water cooling is possible.

Physical properties

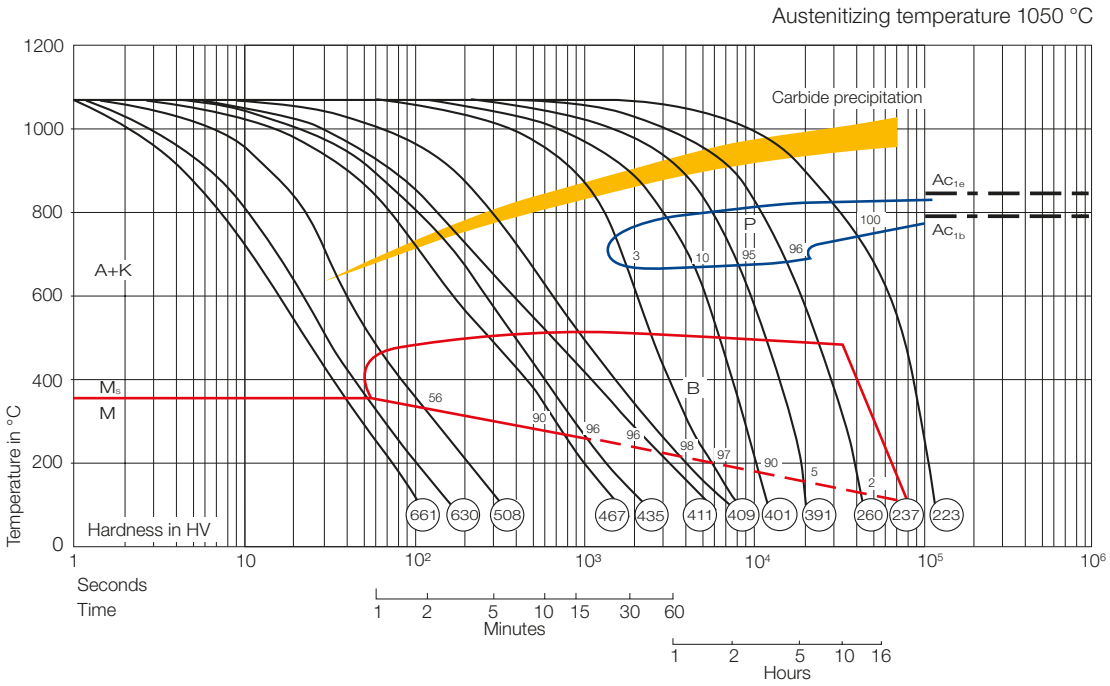
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,7	12,0	12,5	13,0

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

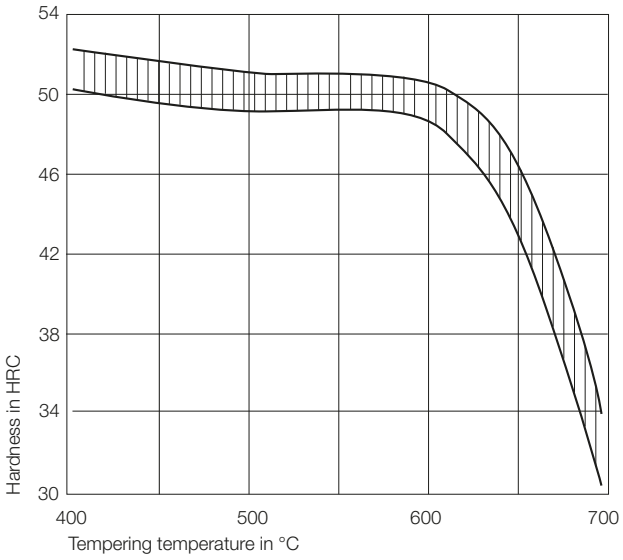
Heat treatment

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. oil or polymer cooling at 200 - 250 °C or vacuum hardening
Tempering	Temperature	520 - 700 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

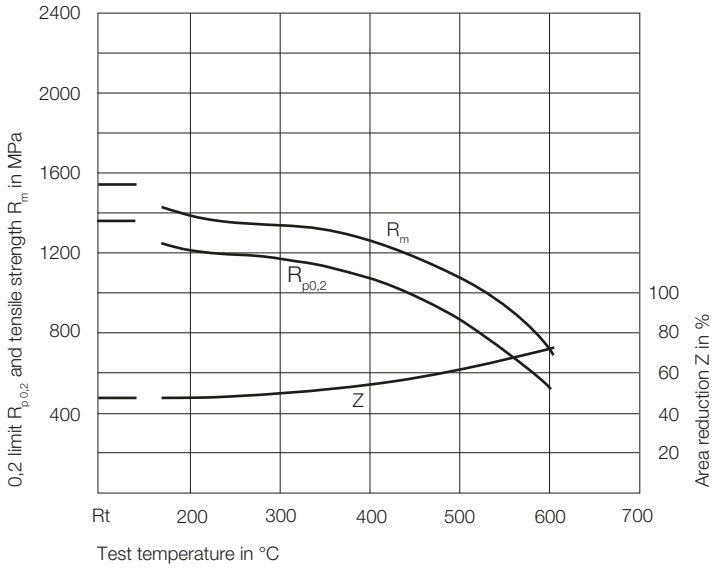
Continuous time-temperature-transformation graph



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 high temperature strength and high temperature wear resistance. High temperature toughness and thermal shock resistance are good. Water coolability is somewhat limited.

Application

- Extrusion press tools for light metal processing
- Die casting tools for light metal and zinc alloys
- Impression dies for heavy and light metal processing
- Forging tools such as small and medium full dies in forging presses
- Die inserts, mandrels, forge jaws and stamps and 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

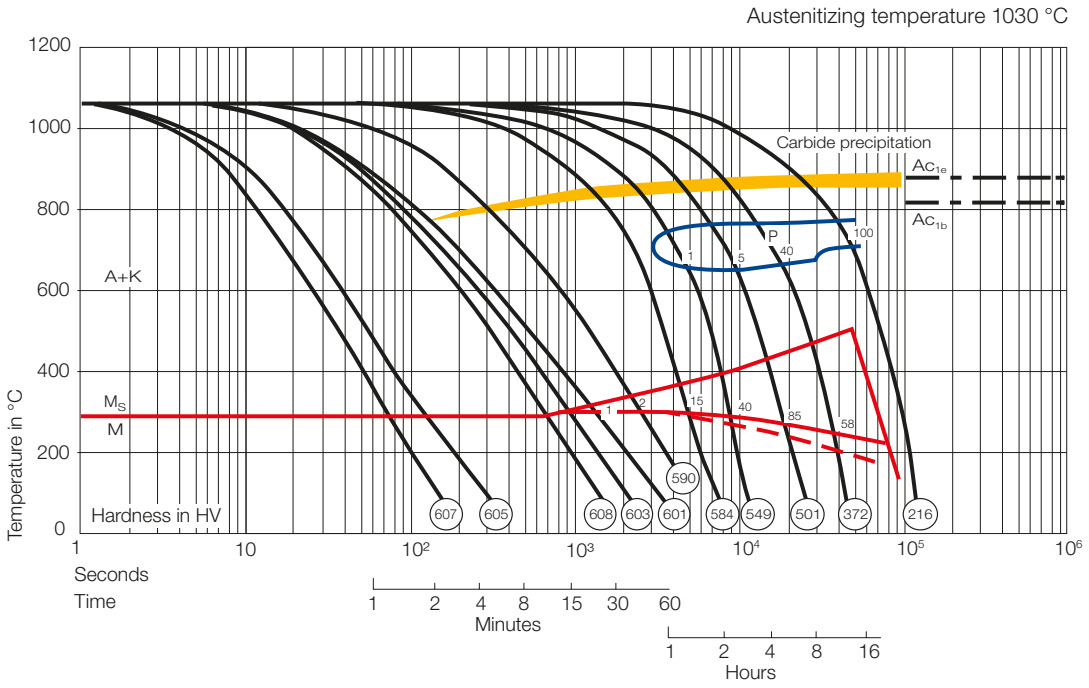
Temperature in °C	20
Density in g/cm^3	7,74

Temperature in °C	20
E module in GPa	210

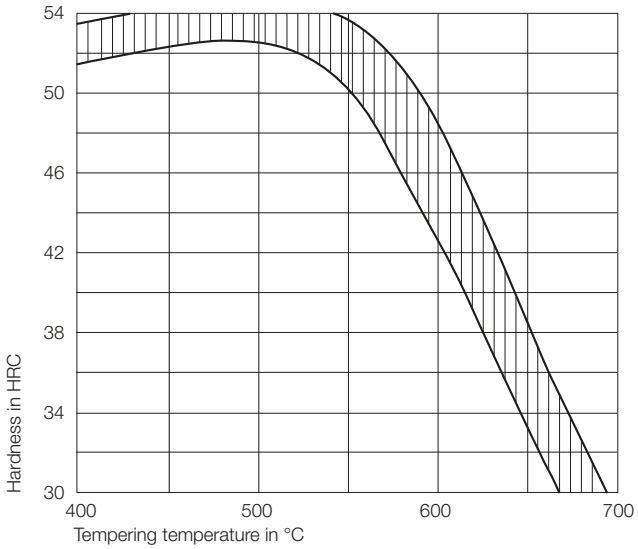
Heat treatment

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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

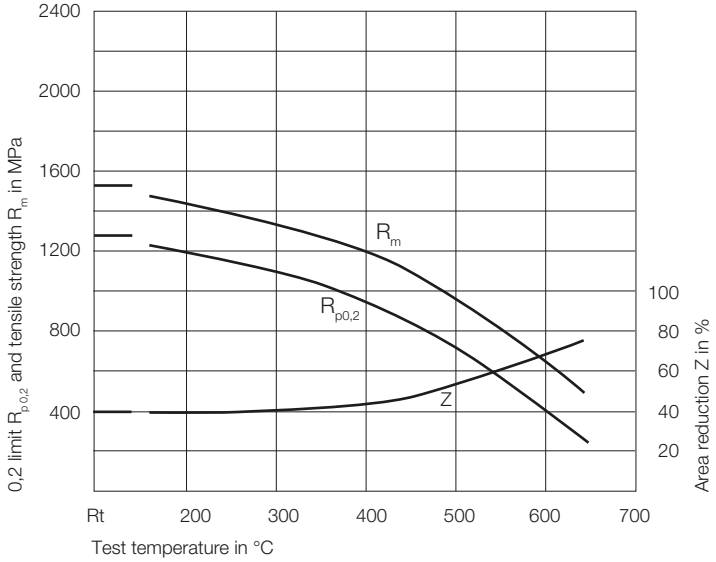
Continuous time-temperature-transformation graph



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 the highest wear resistance with high tempering resistance.

Application

Hot punching and cutting tools for steel processing
Hot extrusion mandrels and shrunk dies (steel processing)
Shrunk screw dies, punching tools and shear blades
Tools for hot pressing of sintered powders

Water cooling is not possible.

Physical properties

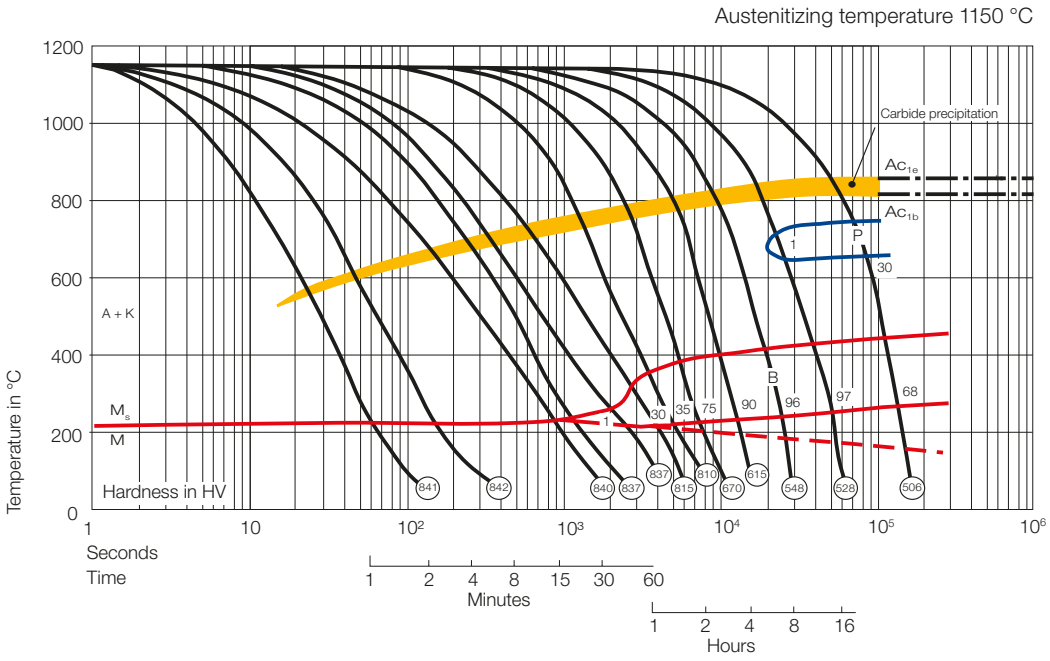
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,0	12,0	13,1	13,4

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

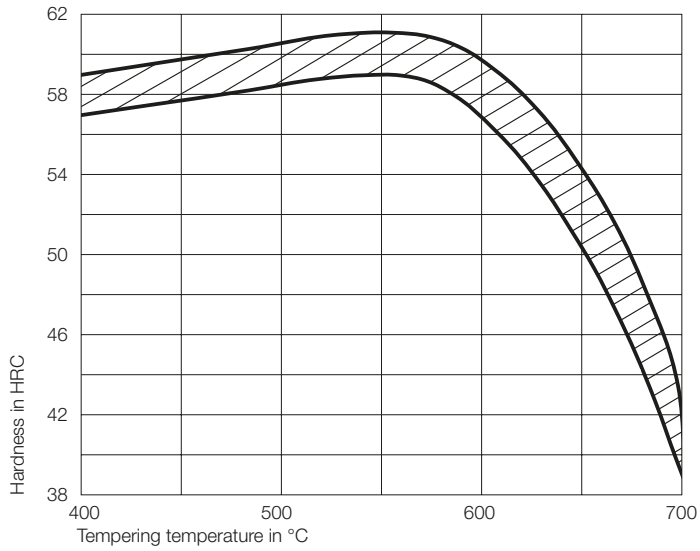
Heat treatment

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

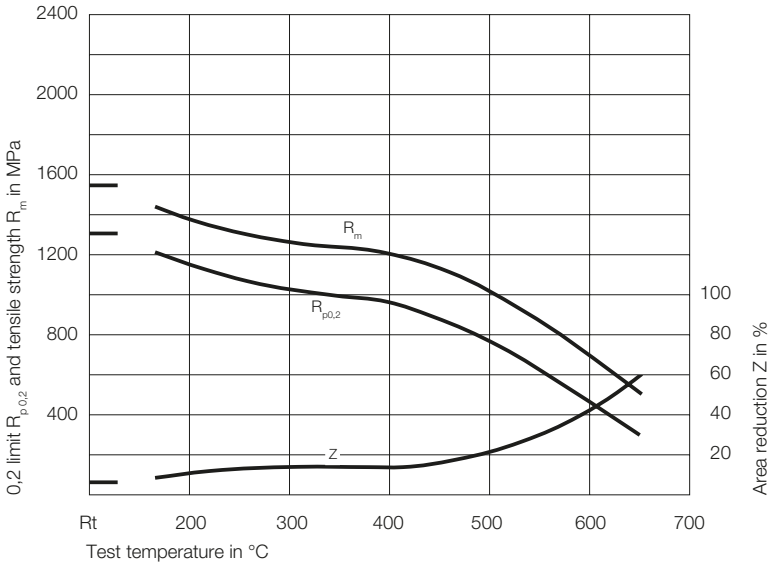
Continuous time-temperature-transformation graph



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

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

Application

- Extrusion press dies for brass
- Die holders for heavy metal processing
- Die-casting dies for heavy metals and relatively thin-walled cast pieces, heavy duty cores, which lie in the casting stream, light metal casting
- Impression dies, especially mandrel inserts for hot pressing of heavy metals
- Small die inserts and warm extrusion dies in steel forming

Water cooling is not possible.

Physical properties

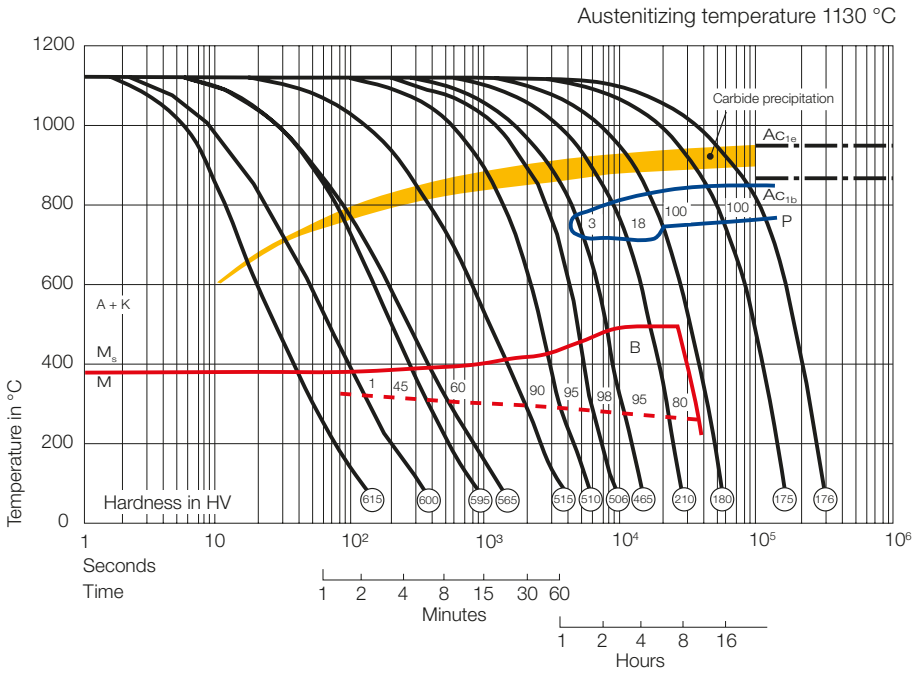
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,6	12,0	12,5	13,0

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

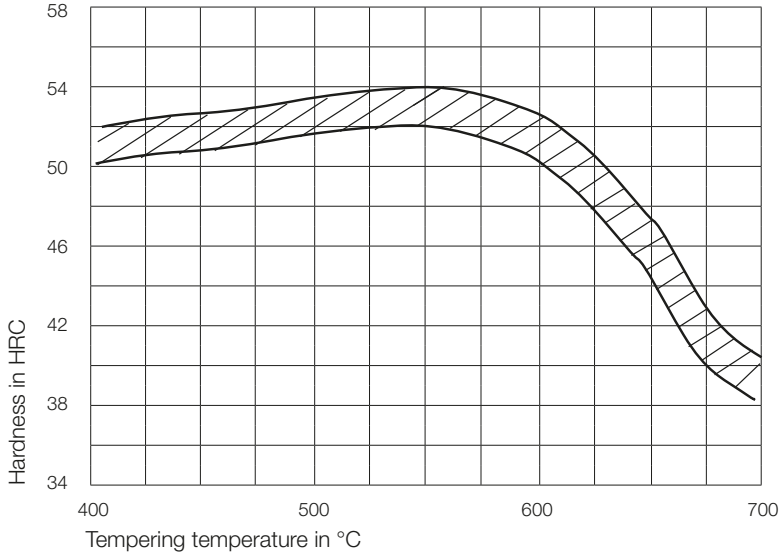
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1130 - 1180 °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	580 - 750 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	200 - 400 °C essential

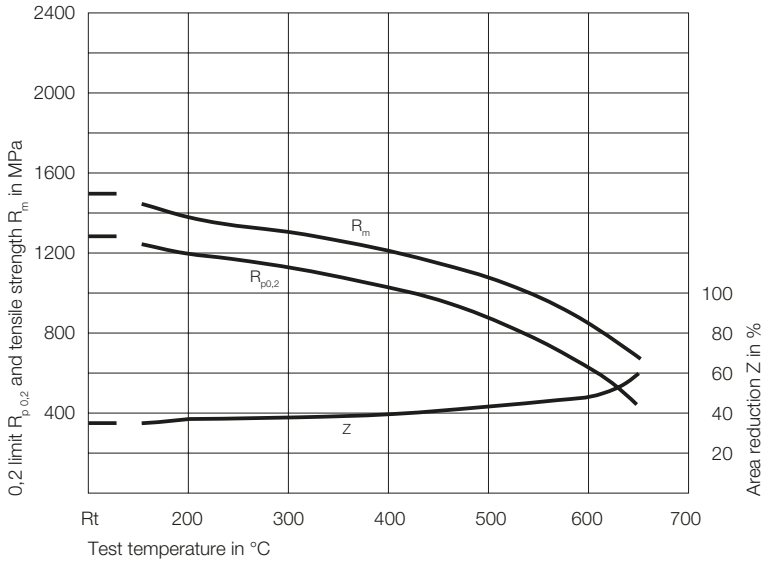
Continuous time-temperature-transformation graph



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 moulds for light metal and zinc alloys such as inserts and cores
- Impression dies for light metal processing
- Plastic moulds
- Cold impact pressing tools
- Cold punches
- Cylinders and shrink rings for cold extrusion tools or hard metal inserts
- Heavy duty cold pilger mandrels for steel and heavy metal processing in the production of thin-walled pipes

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

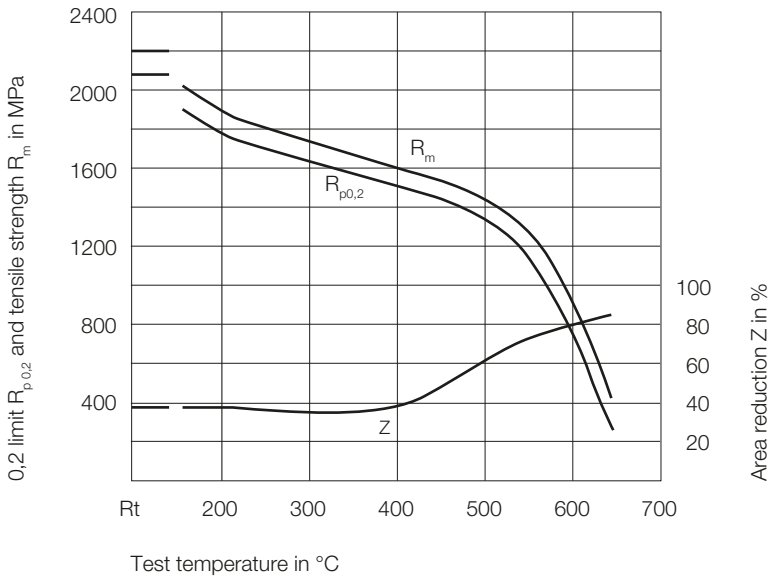
Temperature in °C	20
Density in g/cm^3	8,08

Temperature in °C	20
E module in GPa	190

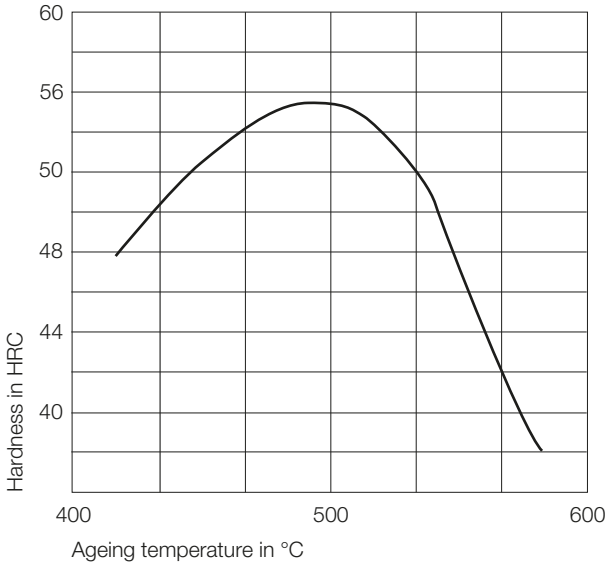
Heat treatment

Solution annealing	Temperature	900 °C
	Cooling	Air
	Festigkeit	950 - 1100 MPa
Auslagern	Temperature	500 °C
	Cooling	6 hrs. 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



Ageing 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 traditional high performance die steel with good toughness and high tempering and compression strength.

Application

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

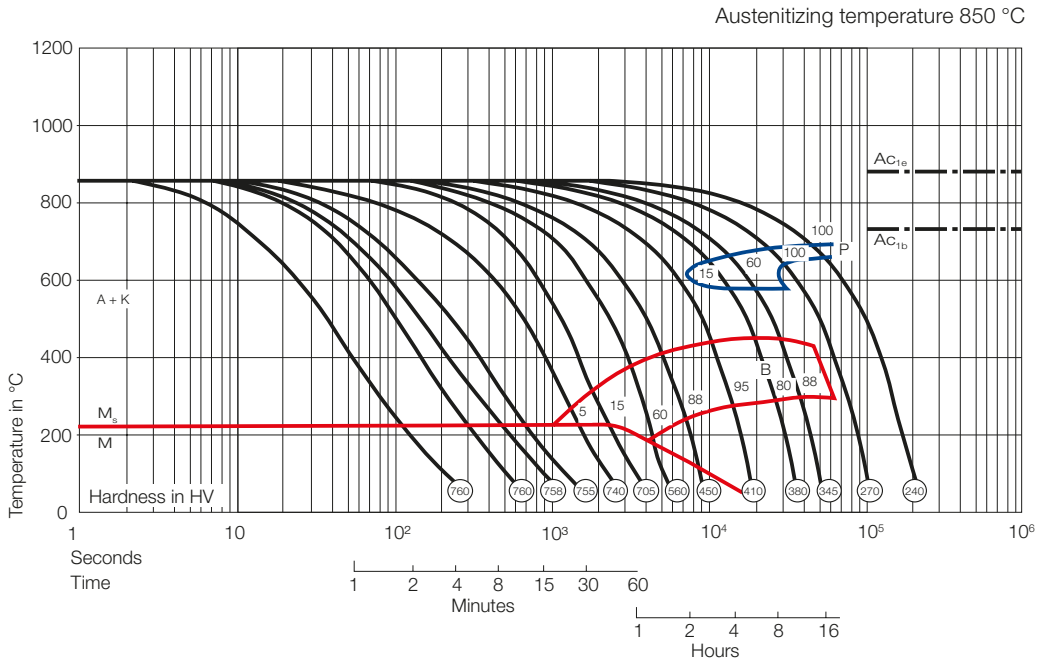
Physical properties

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			
E module in GPa	215			

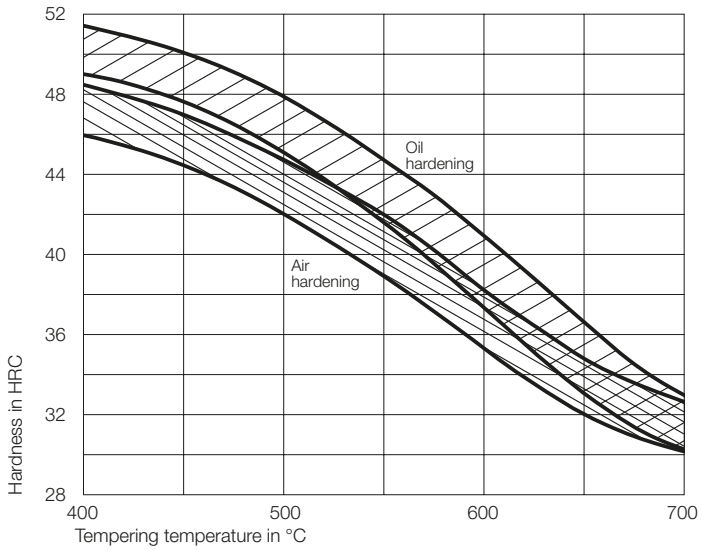
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 6 - 8 hrs.
	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 curve
Nitriding	possible under some conditions	
Preheating before use	Temperature	150 - 350 °C essential

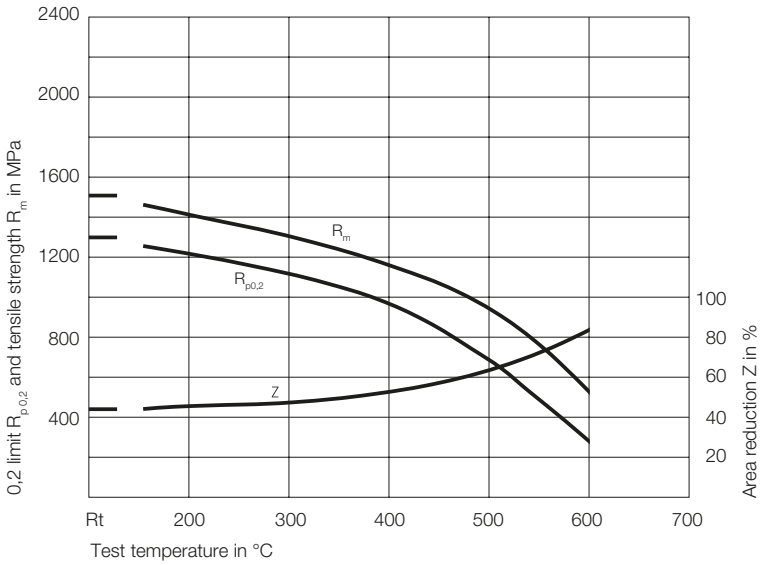
Continuous time-temperature-transformation graph



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-alloy hot-work tool steel with austenitic structure.
The operational strength of approx. 1000 MPa is achieved through hammer-hard forging below the recrystallisation temperature or through a special heat treatment.

Application

- Press dies in metal extrusion presses for processing copper and its alloys in the manufacturing of rods, pipes and simple profiles

Delivery form:
Only individually forged disks, which should have the appropriate dimensions.

Physical properties

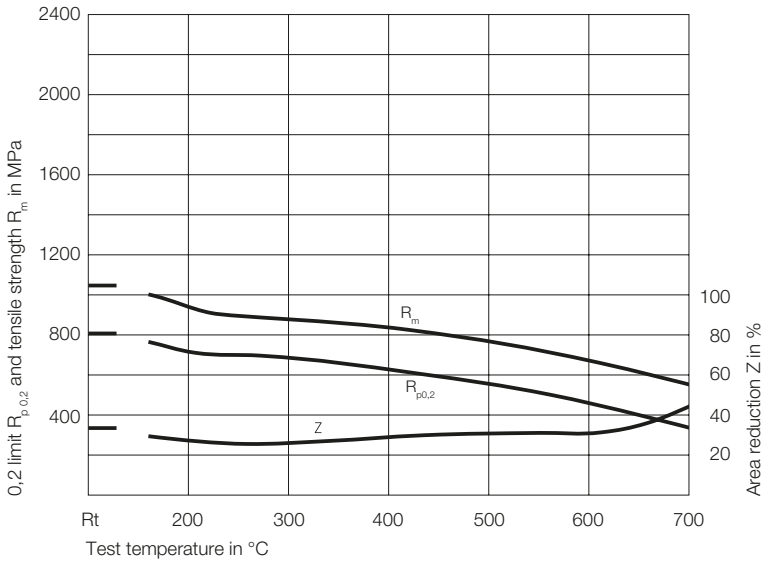
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	16,3	17,4	17,9	17,7

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

Heat treatment

Preheating before use	Temperature	400 - 500 °C essential

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 high performance die steel. As a result of the raised Mo content compared to PWM, there is better high-temperature wear resistance and best tempering.

Application

- Dies for all kinds of steel forming
- Jaws in cutting machines
- Tools in extrusion presses such as stamps, linings and shear blades
- Compression dies 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

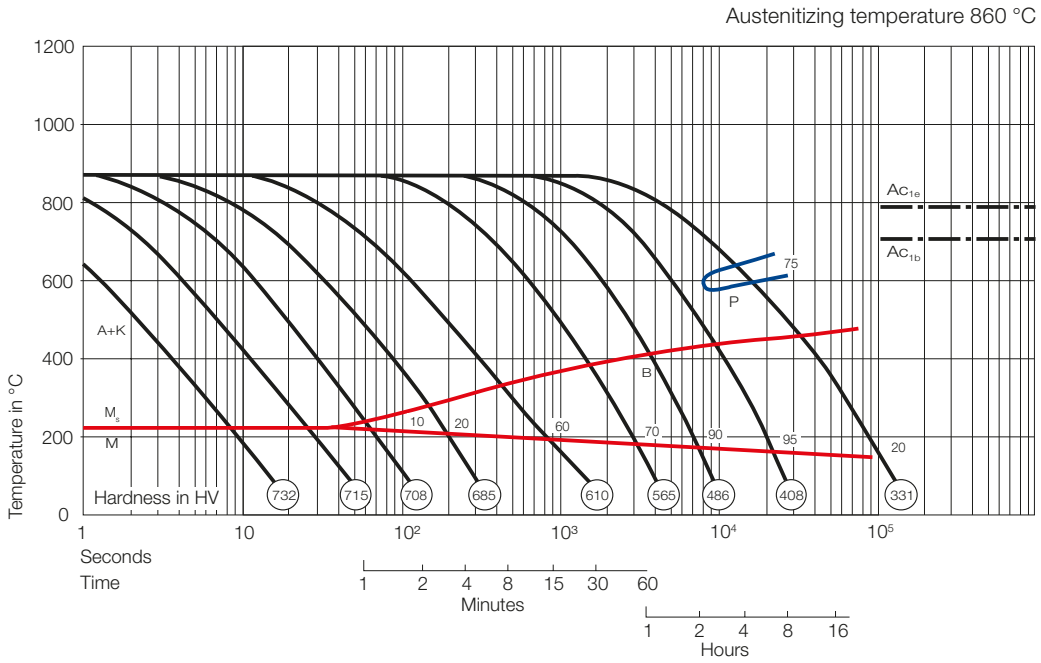
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	36,0	37,0	35,0

Temperature in °C	20
E module in GPa	215

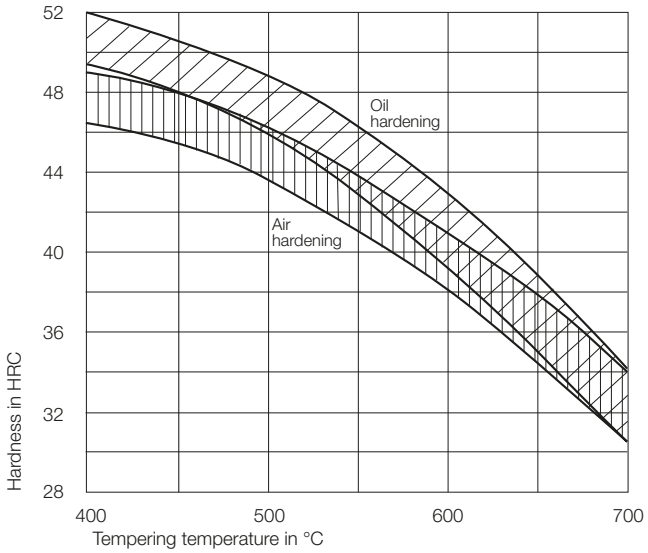
Heat treatment

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

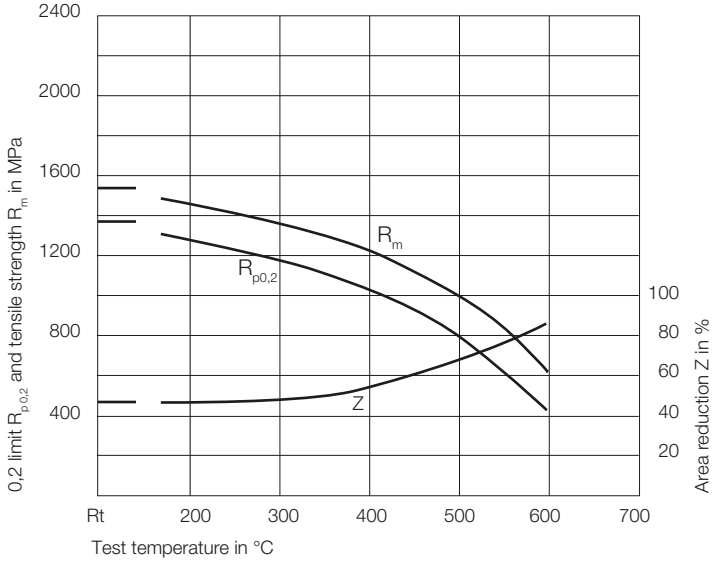
Continuous time-temperature-transformation graph



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 moulds 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

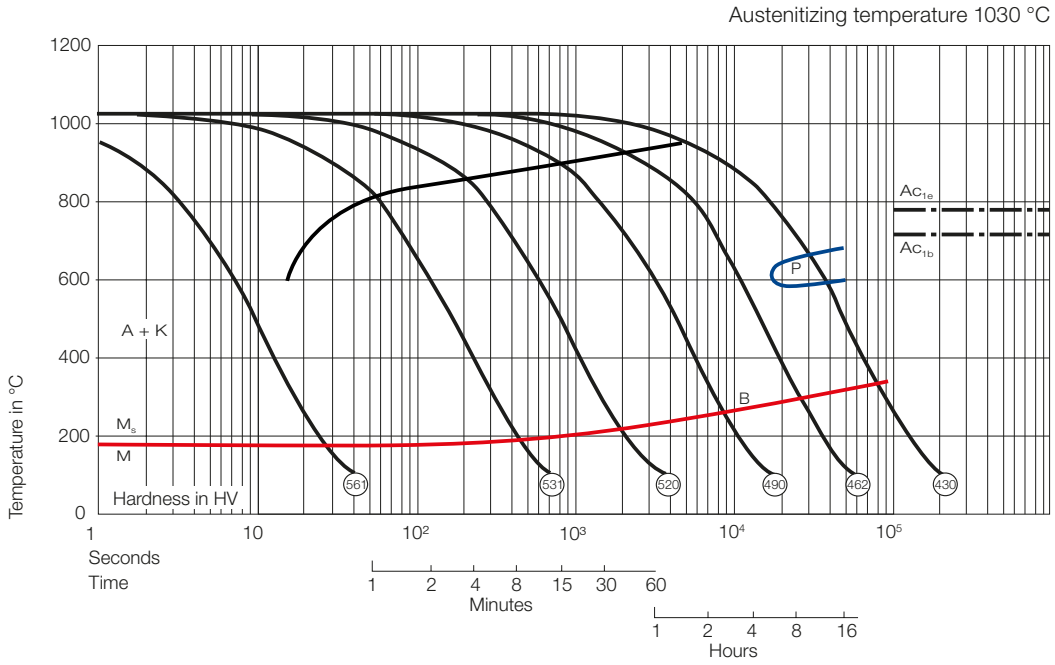
Temperature in °C	20
Density in g/cm³	7,7

Temperature in °C	20
E module in GPa	213

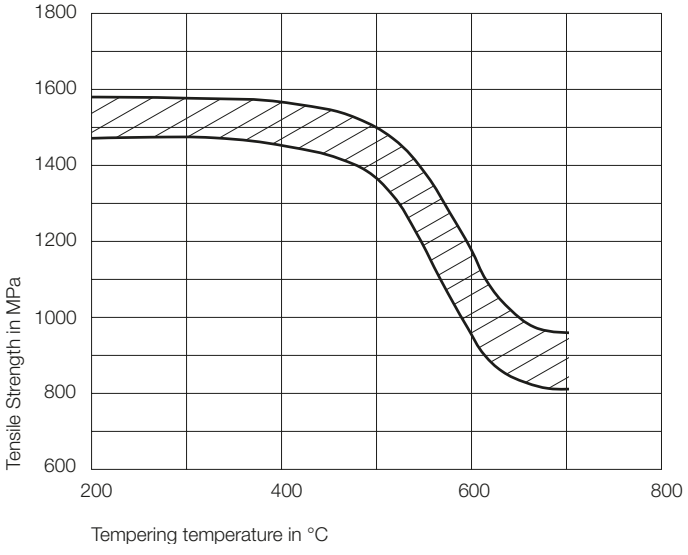
Heat treatment

Soft annealing	Temperature	680 - 720 °C, 8 - 10 hrs.
	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 curve
Mould 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 high temperature wear resistance are increased.

Application

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

Water cooling is possible.

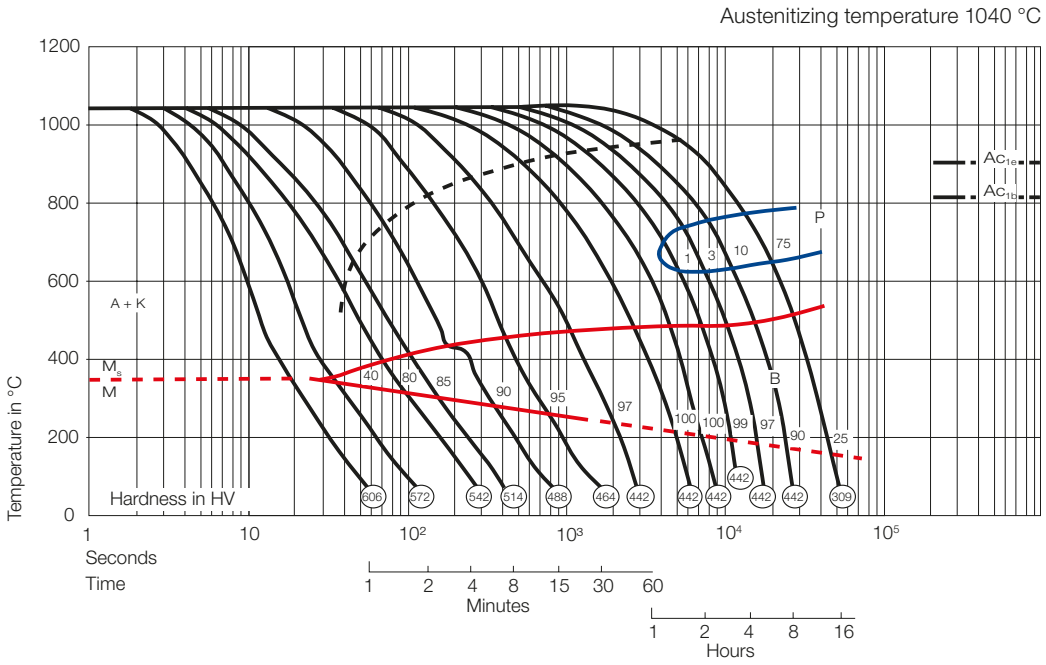
Physical properties

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		
E module in GPa	215		

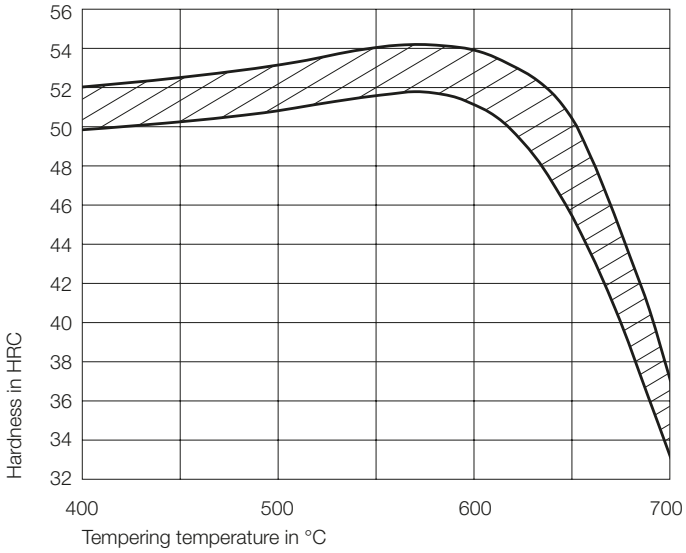
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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. 200 - 300 °C or vacuum hardening
Tempering	Temperature	560 - 700 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

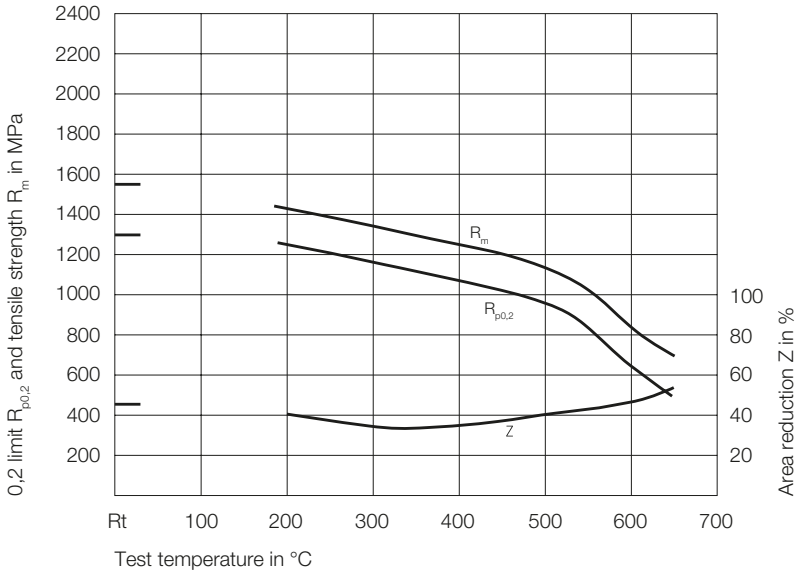
Continuous time-temperature-transformation graph



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-alloy special steel with extremely high tempering resistance. RM10Co is suitable for particular requirements in respect of high-temperature wear resistance and resistance against molten metals.

Application

- Tools for extrusion presses such as press dies for steel and heavy metal processing, as well as spider tools and frame tools for processing copper and its alloys
- Mould plates for brass pressure die-casting
- Valves
- Cores and filling sets
- Filling sets in magnesium die casting in hot chamber machines
- Hot extrusion presses for dies
- Punch for steel forming

Water cooling is not possible.

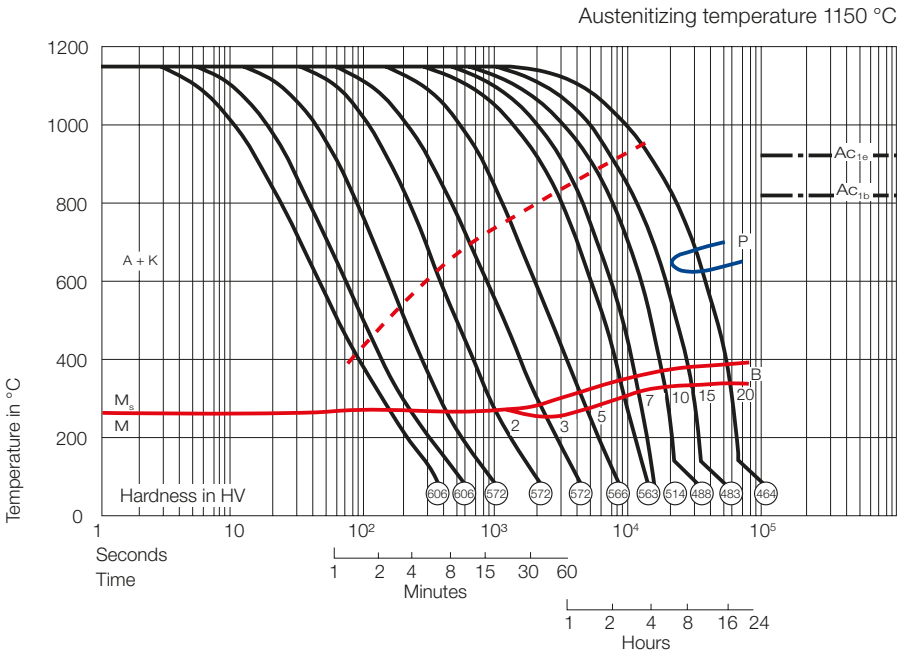
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,3	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			
E module in GPa	215			

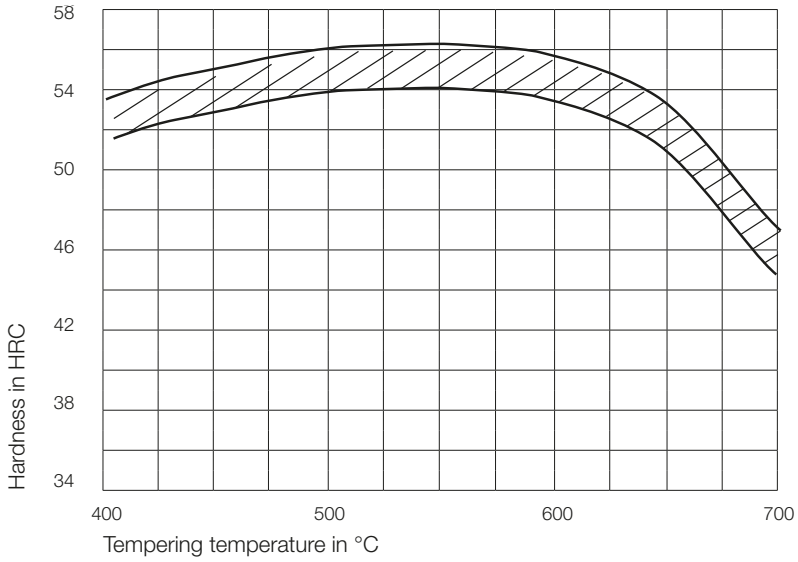
Heat treatment

Soft annealing	Temperature	840 + 760 °C, jeweils 4 - 6 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

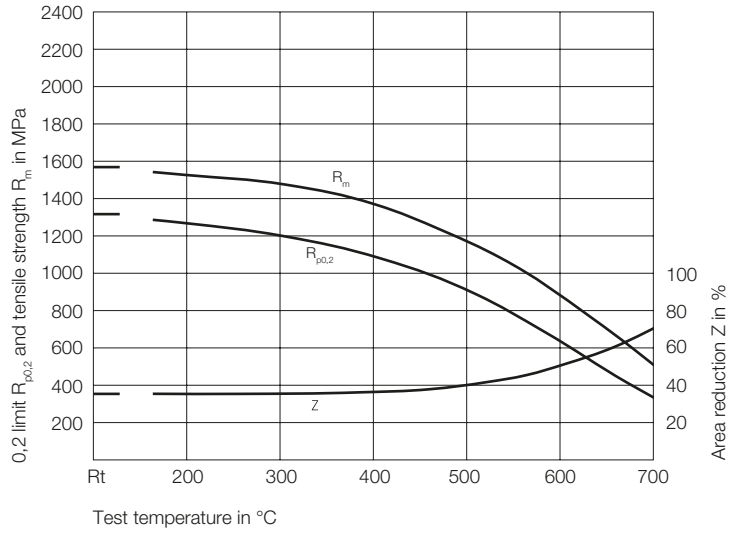
Continuous time-temperature-transformation graph



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

Because of its composition, HMoD is a hot-work tool steel with maximum high-temperature strength and tempering resistance with particular high-temperature wear resistance. HMoD has the same areas of application as the steel HWD and is related in respect of the analysis. HMoD is a molybdenum alloy rather than a tungsten alloy with otherwise comparable analysis. Better toughness behaviour can be achieved as a result.

Application

- Extrusion press dies for brass
- Die versions for heavy metal processing
- Die-casting dies for casting heavy metals and relatively thin-walled cast pieces
- Heavy duty cores in the pouring stream, when casting light metals
- Impression dies, especially mandrel inserts for hot pressing of heavy metals
- Small die inserts and warm extrusion dies in steel forming

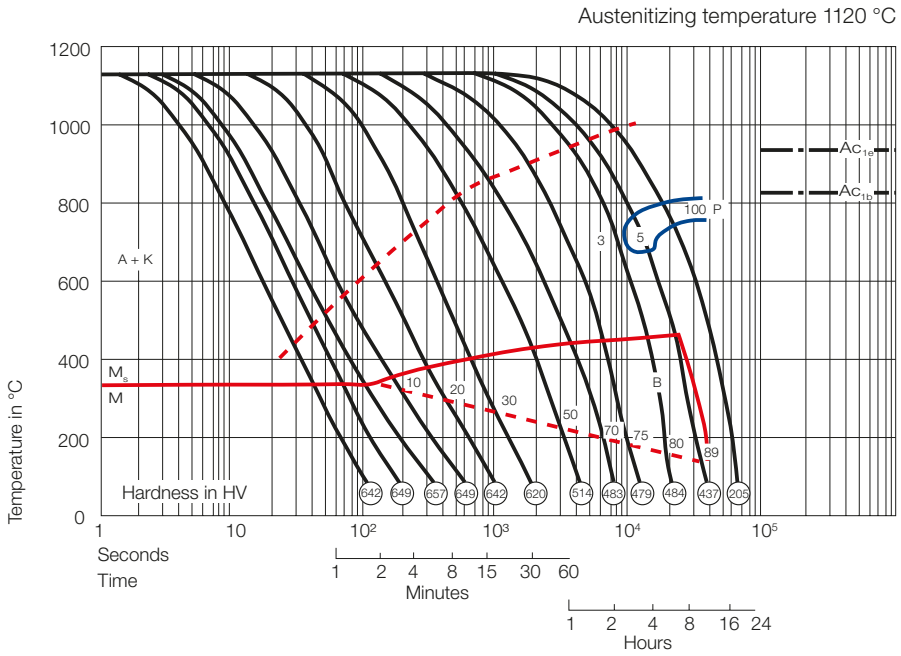
Physical properties

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

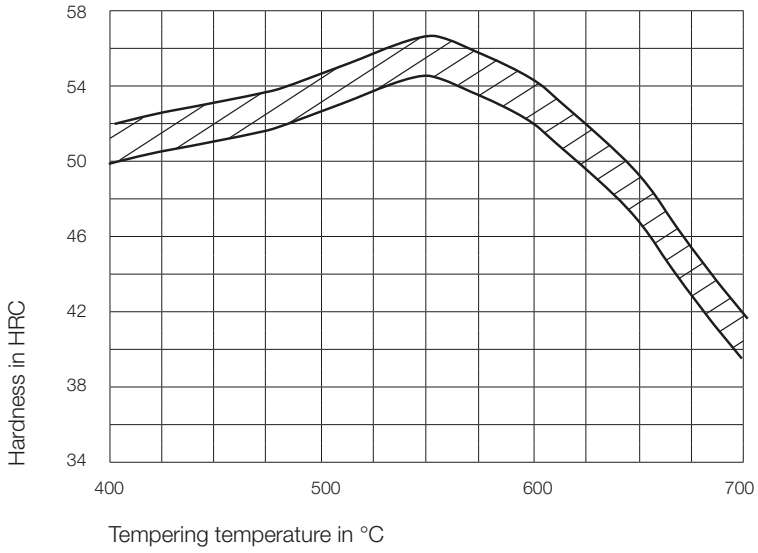
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 240 HB
Hardening	Temperature	1120 - 1150 °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	580 - 750 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	200 - 400 °C essential

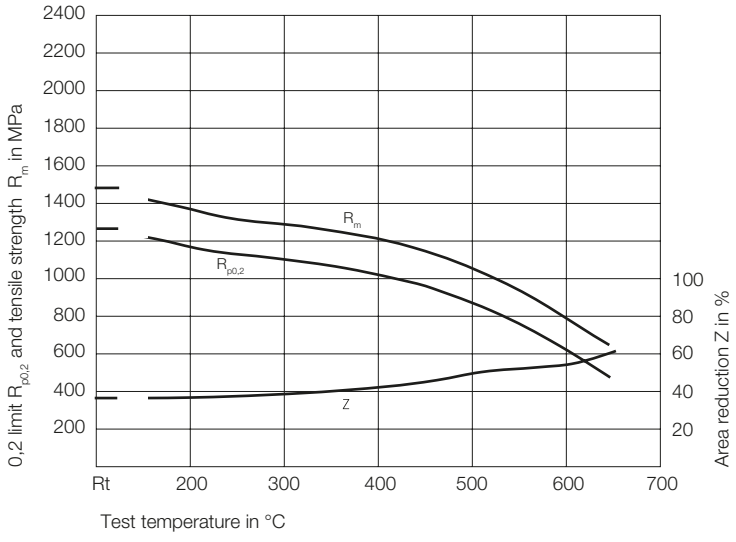
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



1.4418

Mat.-no.	Short name	Mass.-%						
		C	Si	Mn	Cr	Mo	Ni	N
1.4418	X4CrNiMo16-5-1	0.06	≤ 0.70	≤ 1.50	15.00	0.90	5.00	≥ 0.02

Material properties

1.4418 is a low-carbon, corrosion-resistant steel. It combines high strength and good toughness.

Application

- Glass dies

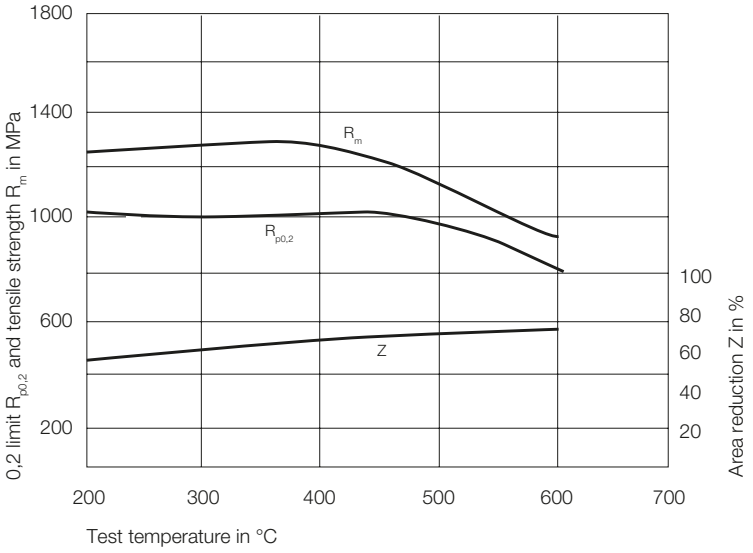
Physical properties

Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6}m/m x K	10,3	10,8	11,6
Temperature in °C	20		
Thermal conductivity in W/m x K	15,0		
Temperature in °C	20		
Density in g/cm^3	7,7		
Temperature in °C	20		
E module in GPa	210		

Heat treatment

Soft annealing	Temperature	600 - 650 °C
	Cooling	Slow furnace cooling
	Hardness	max. 320 HB
Hardening	Temperature	950 - 1050 °C
	Cooling	Oil, polymer, air, water
Tempering	Temperature	550 - 620 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	350 - 400 °C essential

High-temperature strength graph



CR7V-L

Mat.-no.	Brand name	Mass.-%					
		C	Si	Mn	Cr	Mo	V
Special	CR7V-L	0.42	0.50	0.40	6.50	1.30	0.80

Material properties

This high Cr alloyed special steel with Mo and V additives is characterised, with good high-temperature strength, by particularly high wear resistance, both for cold and hot work. Thermal shock resistance is good.

Application

For cold work:

- Punches and shear blade for sheet metal thickness of approx. 6-12 mm

For hot work:

- Die inserts and mandrels
- Extrusion dies for steel forming
- Hot extrusion of copper and copper alloys
- Hot shear blades and deburring tools
- Drawing rollers for steel bottle manufacturing

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

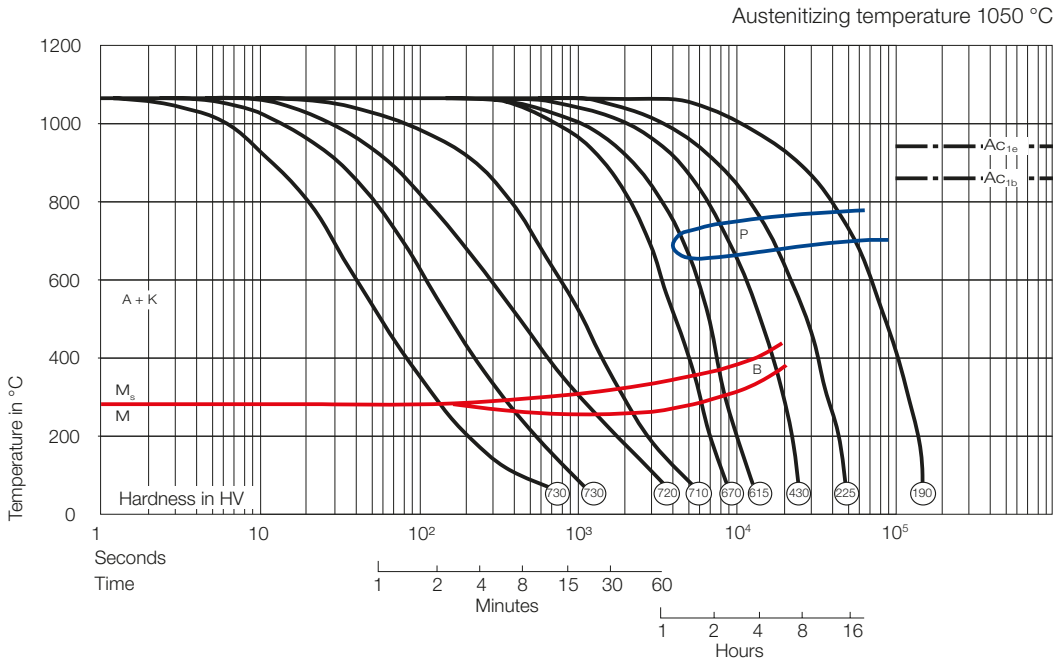
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	26,7	29,8	30,8

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

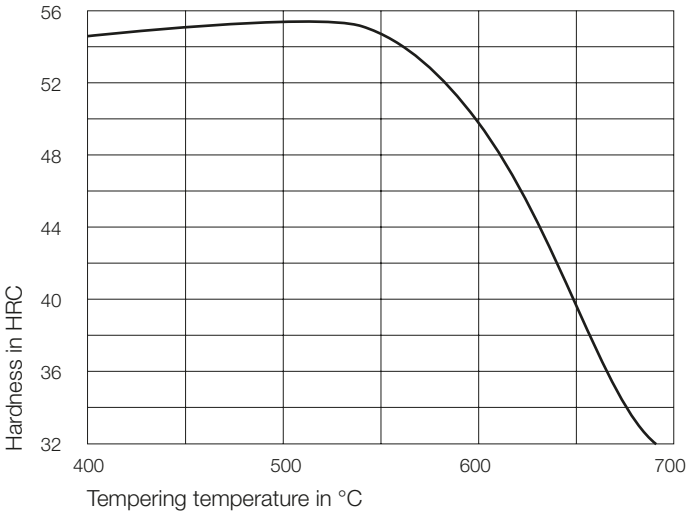
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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 oil/polymer; Interrupt oil or polymer cooling at 250 - 300 °C or vacuum hardening.
Tempering	Temperature	500 - 700 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

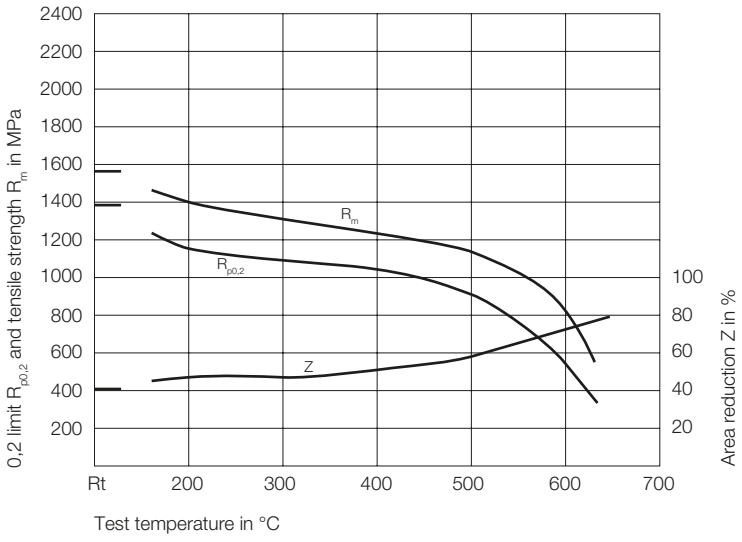
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



CS1

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Special	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 with higher C content compared to TQ1. It is characterised by particularly high strength, high-temperature strength with simultaneously very high toughness and thermal shock resistance and is only manufactured in remelted version according to the ESU process.

Application

CS1 is particularly suitable for loads above the limit of TQ1:

- Extrusion presses: For specific pressures > 1000 MPa, heavy duty press stems, press disks and inner liners
- Drop forging
- Hot forming

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

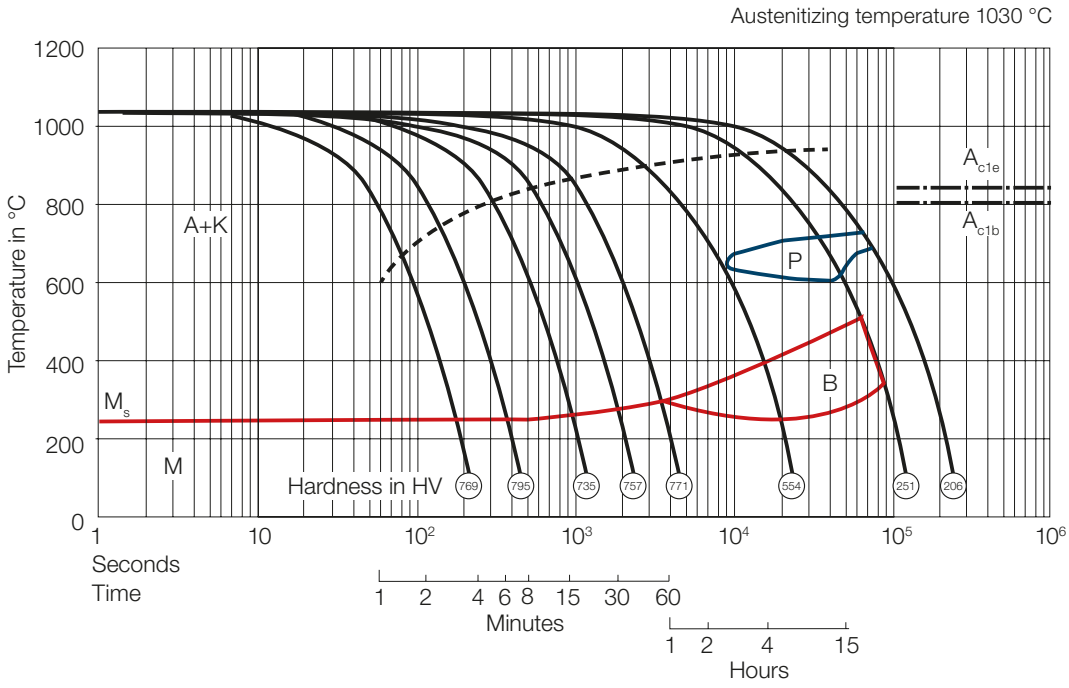
Temperature in °C	20
Density in g/cm^3	7,79

Temperature in °C	20
E module in GPa	213

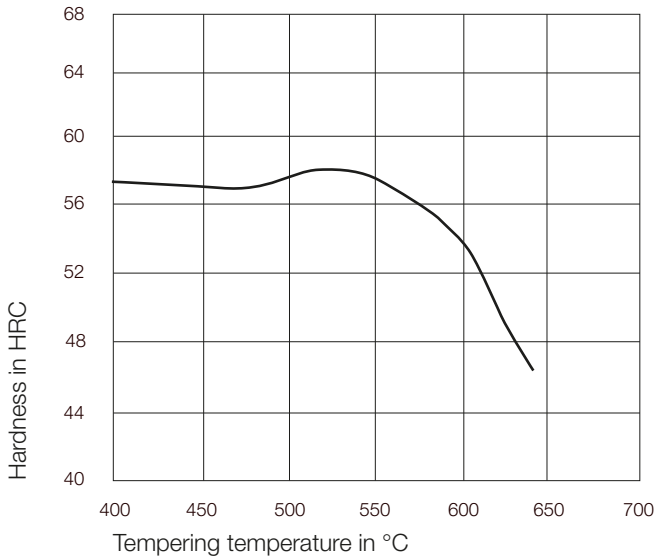
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C according to application

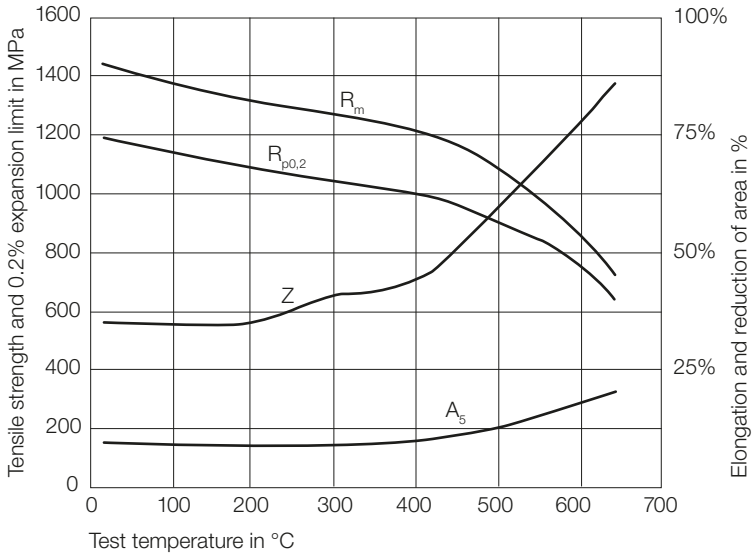
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



FTCo

Mat.-no.	Brand name	Mass.-%								
		C	Si	Mn	Cr	Mo	V	Co	W	Nb
Special	FTCo	0.53	0.35	0.40	4.00	2.00	1.10	0.90	1.50	+

Material properties

FTCo is a special tool steel with high contents of carbide-forming elements (Cr, Mo, V, W, Nb), which guarantee particularly high temper resistance and wear resistance.

Application

- Dies and mandrels for forging applications with very high thermal and abrasive loads
- Particularly suitable for mandrels in fast cutting machines

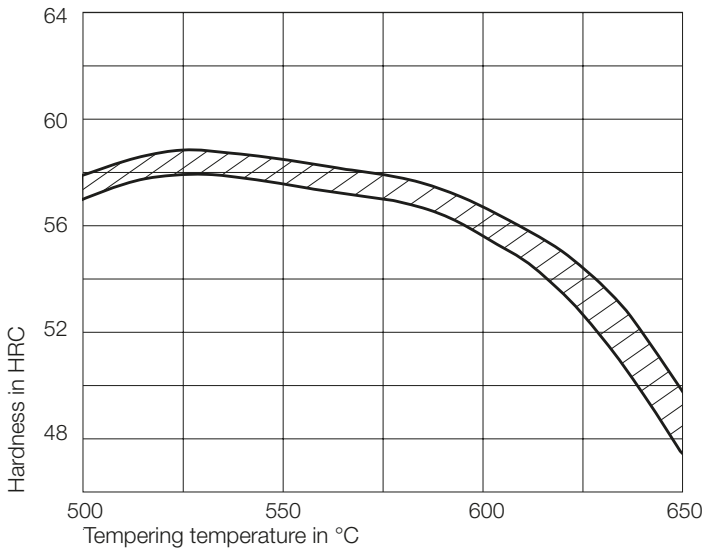
Physical properties

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 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C essential

Tempering graph



GSF

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

Material properties

GSF is a CrNiMoV alloyed high performance steel, which has been specifically developed for dies that are used under the hammer, or for large dies. GSF is the further development of the standard steel 55NiCrMoV7 (1.2714) and is characterised by a better toughness, high-temperature strength and weldability. Because of its good mechanical properties in tempered condition, GSF is the appropriate steel for various tools and heavy duty machine components. GSF is a well-suited alternative to the known tempered steels, especially for large cross-sections or diameters up to 650 mm and strengths above 1000 MPa.

Application

- Specially developed forging die steel with good suitability for deposition and filling welding. Because of the lower C content, the risk of crack formation in the weld transition zone is reduced.
- Can also be used without deposition and filling welding
- Tool brackets
- Heavy duty tie rods

Physical properties

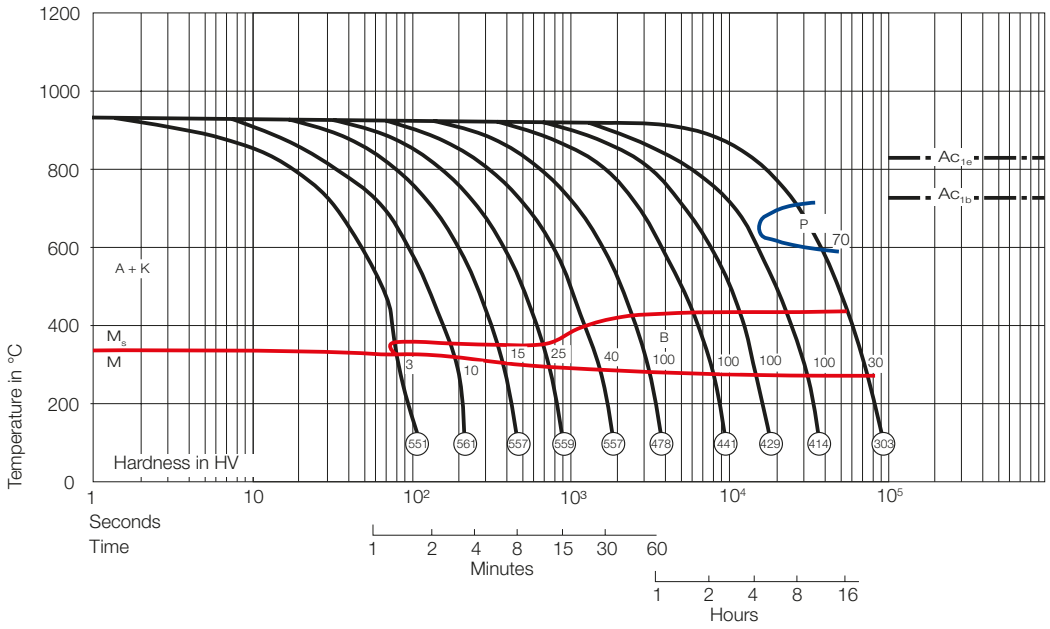
Temperature in °C	20 - 100	20 - 200	20 - 400	20 - 600
Thermal expansion in 10^{-6}m/m x K	11,8	12,0	13,0	14,0
Temperature in °C	20	200	400	
Thermal conductivity in W/m x K	31	34	33	
Temperature in °C	20			
Density in g/cm^3	7,76			

Heat treatment

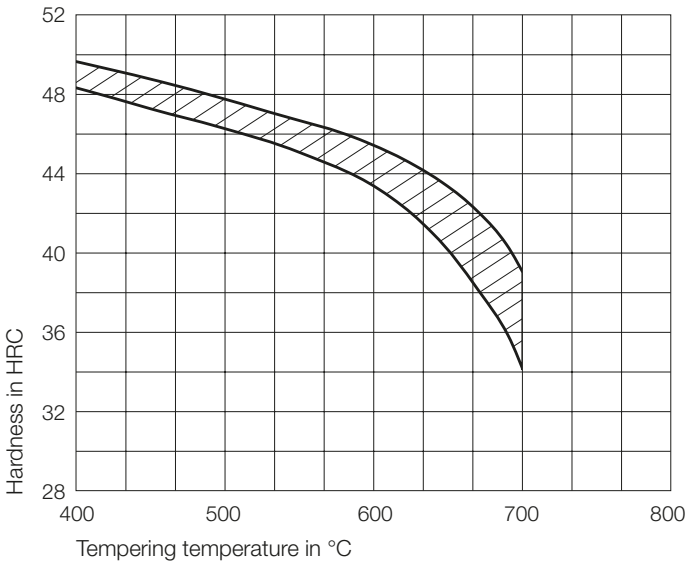
Soft annealing	Temperature	740 - 760 °C, 6 - 8 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	920 - 940 °C
	Cooling	Oil/polymer Cooling must be interrupted at approx. 150 - 180 °C or vacuum hardening.
Tempering	Temperature	400 - 650 °C
	Hardness	see tempering curve
Nitriding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

Continuous time-temperature-transformation graph

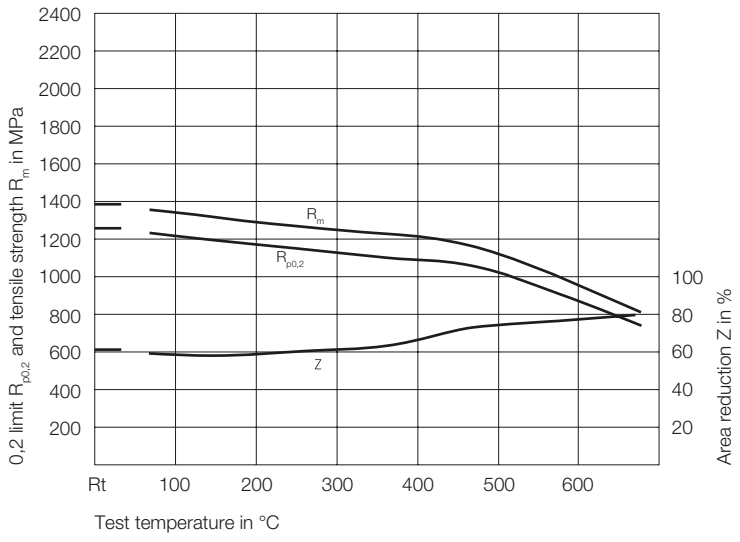
Austenitizing temperature 930 °C



Tempering graph



High-temperature strength graph



HP1

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

Material properties

HP1 is a Cr-Mo-V alloyed hot-work tool steel with very good high-temperature strength characteristics and maximum toughness. This steel is also characterised by good thermal shock resistance. HP1 is only manufactured in remelted version according to the ESU process.

Application

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

- Pressure die casting
- Extrusion presses: Dies with high toughness requirements
- Inner liners
- Hot forming

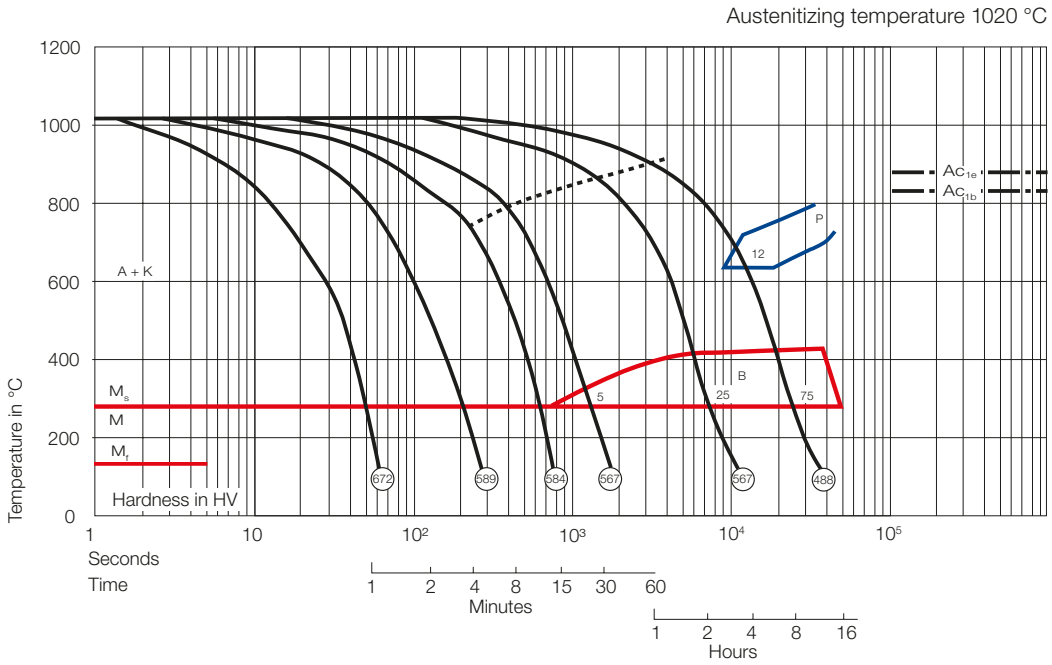
Physical properties

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		
E module in GPa	214		

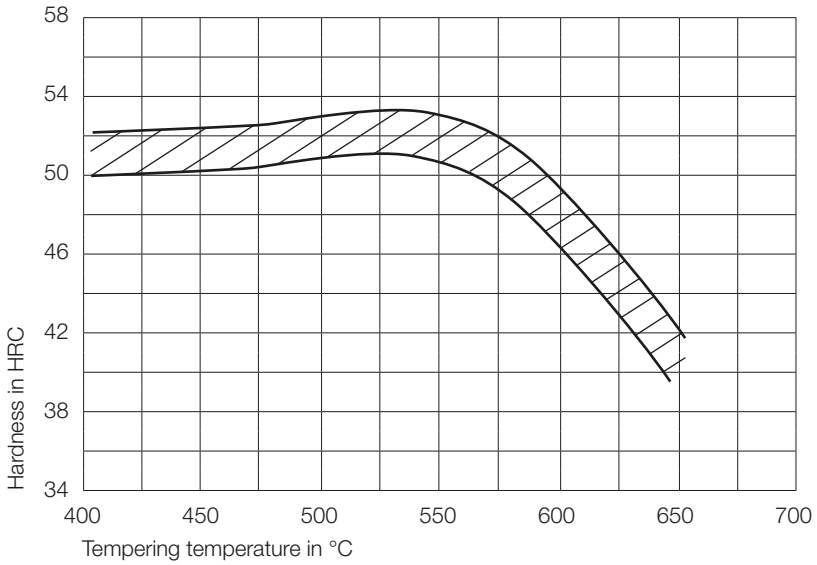
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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 curve
Nitriding	If die-casting dies are to be nitrided, nitriding program 99 should be selected. This nitriding layer does not have a compound layer and therefore does not have a negative influence on the formation of thermal shock cracks.	
Preheating before use	Temperature	150 - 350 °C essential

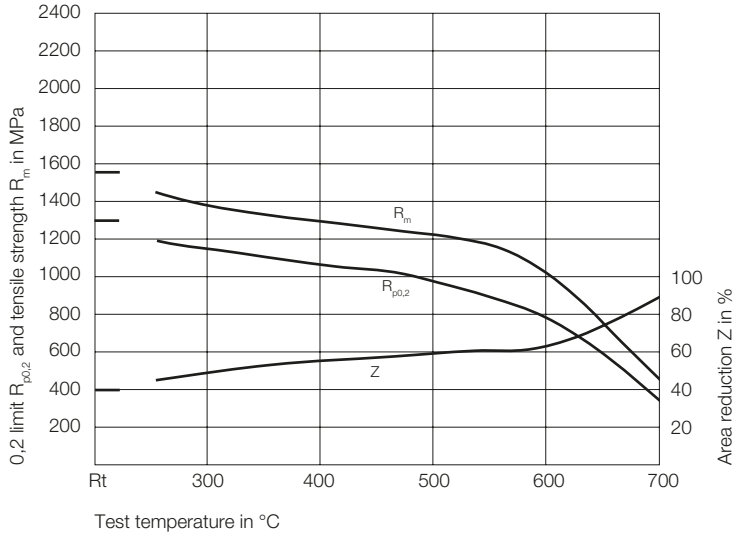
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



HS1

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

Material properties

Hot-work tool steel with high resistance to wear and high compression strength with balanced toughness. Suitable for secondary hardening and for use at high temperatures. Nitriding and coating possible.

Application

- Shear blades
- Cutting and punching tools
- Bending tools
- Pressing and profile rollers
- Segments for press 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

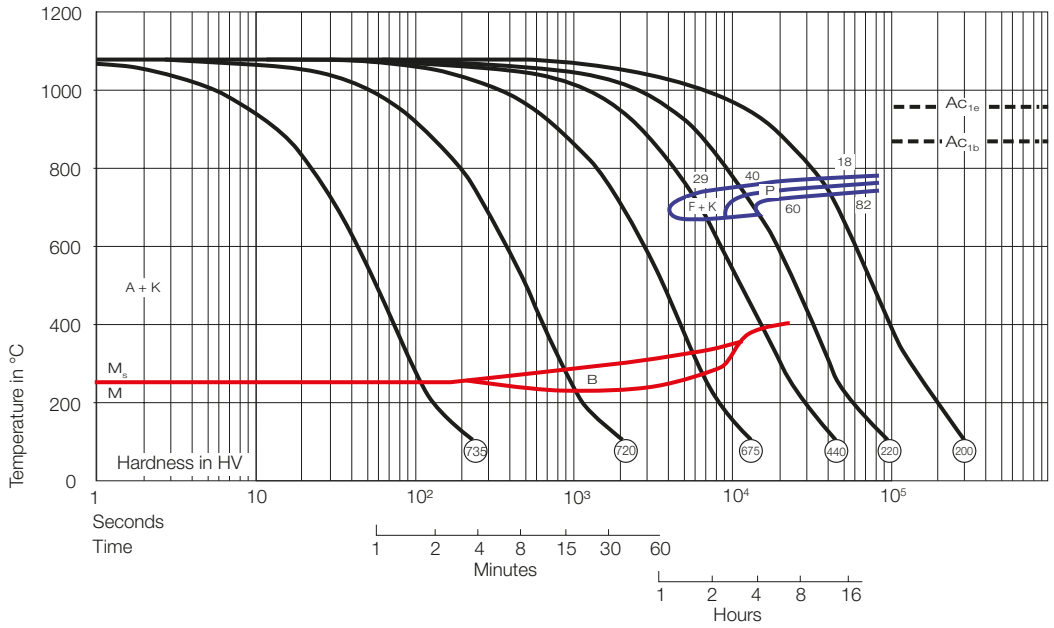
Temperature in °C	20	200	400
Thermal conductivity in W/m x K	25,2	27,3	29,3

Heat treatment

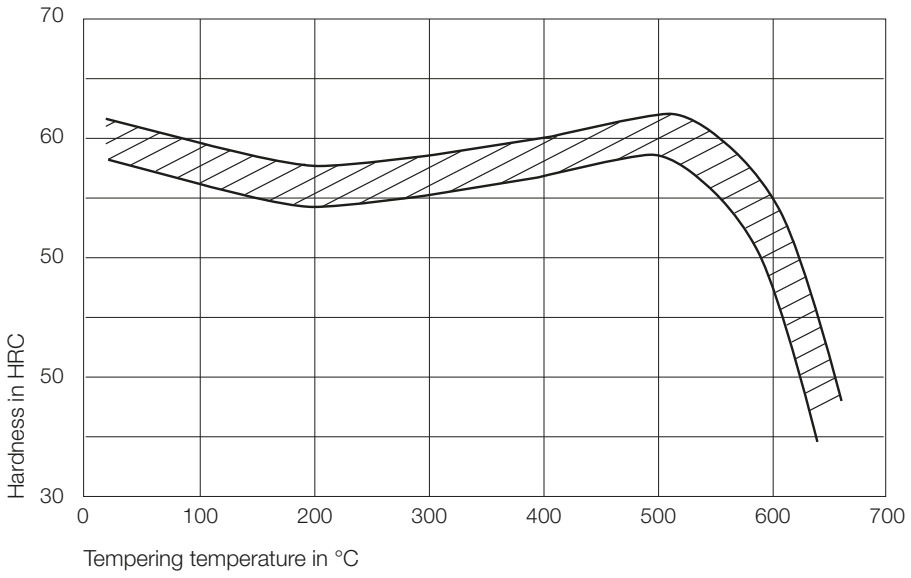
Soft annealing	Temperature	800 - 840 °C
	Cooling	Slow furnace cooling
	Hardness	max. 295 HB
Hardening	Temperature	1050 - 1080 °C
	Cooling	Oil, polymer, gas
Tempering	Temperature	540 - 560 °C
	Hardness	see tempering curve
Nitriding	possible	

Continuous time-temperature-transformation graph

Austenitizing temperature 1080 °C



Tempering graph



HTR

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	W
Special	HTR	0.32	0.20	0.30	2.20	1.20	0.50	3.80

Material properties

HTR is a hot-work tool steel with very good thermal shock resistance, high thermal conductivity and high-temperature strength. HTR is manufactured exclusively according to the ESU process.

Application

Areas of use with high thermal loads:

- Pressure die-casting (max. 42 HRC)
- Gravity die-casting
- Extrusion presses
- Hot/ warm forming
- Inner liners in heavy-metal extrusion presses

Delivery condition:
Annealed max. 230 HB

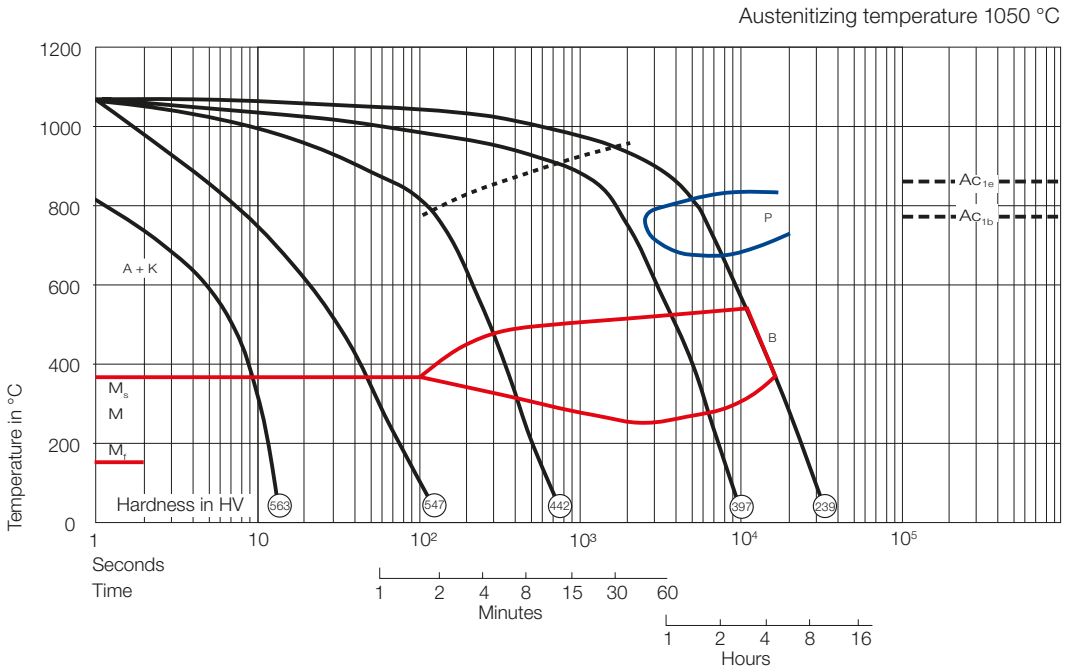
Physical properties

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		

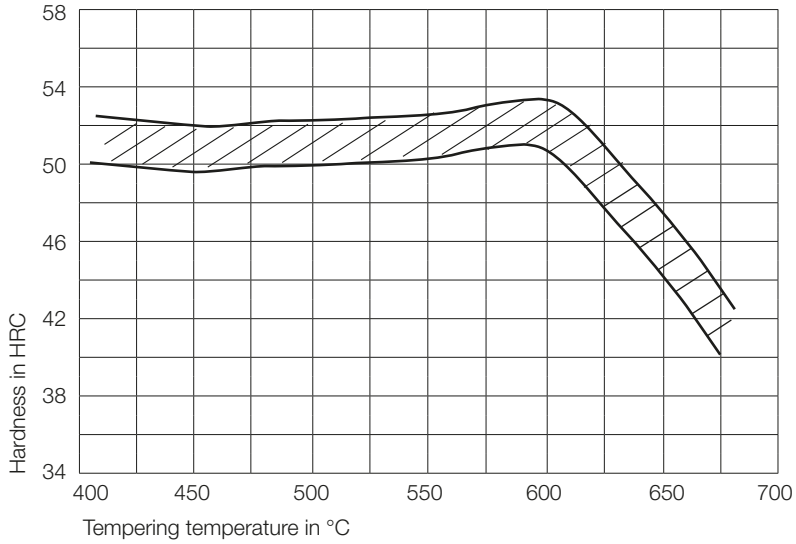
Heat treatment

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 curve
Preheating before use	Temperature	100 - 300 °C essential

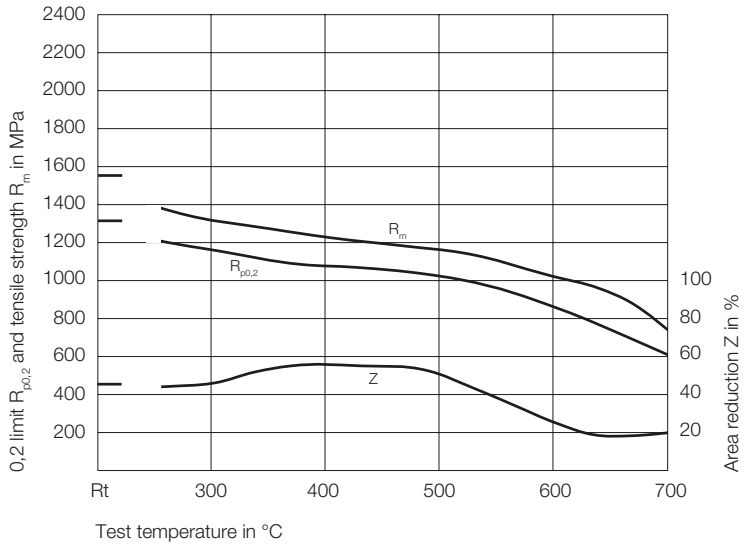
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



PWCo

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Co
Special	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 heat resistance and high hot-wear resistance.

Application

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

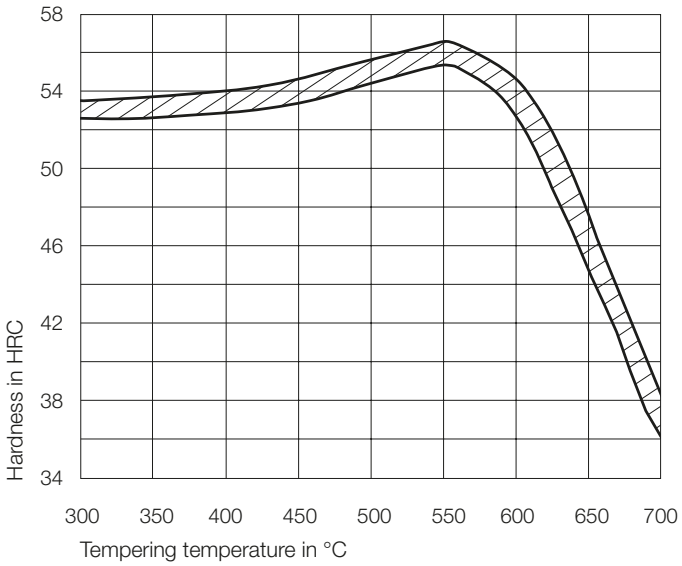
Physical properties

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

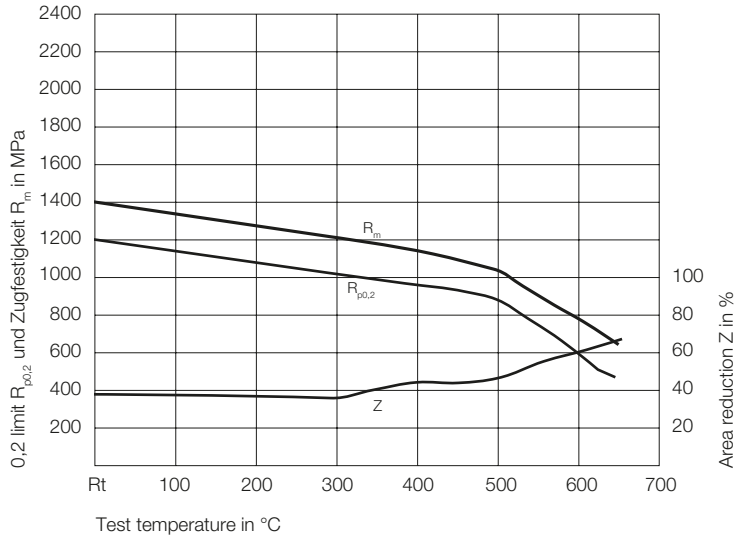
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	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 curve
Nitriding	possible	
Preheating before use	Temperature	250 - 350 °C essential

Tempering graph



High-temperature strength graph



Q10

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

Material properties

Q10 is a Cr-Mo-V alloyed hot-work tool steel with very good high temperature strength characteristics and maximum toughness.
This grade is also characterised by good thermal shock resistance.

Application

- Extrusion presses with very long lifetime with heavy duty inner linings and press stems
- Drop forging
- Hot forming

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

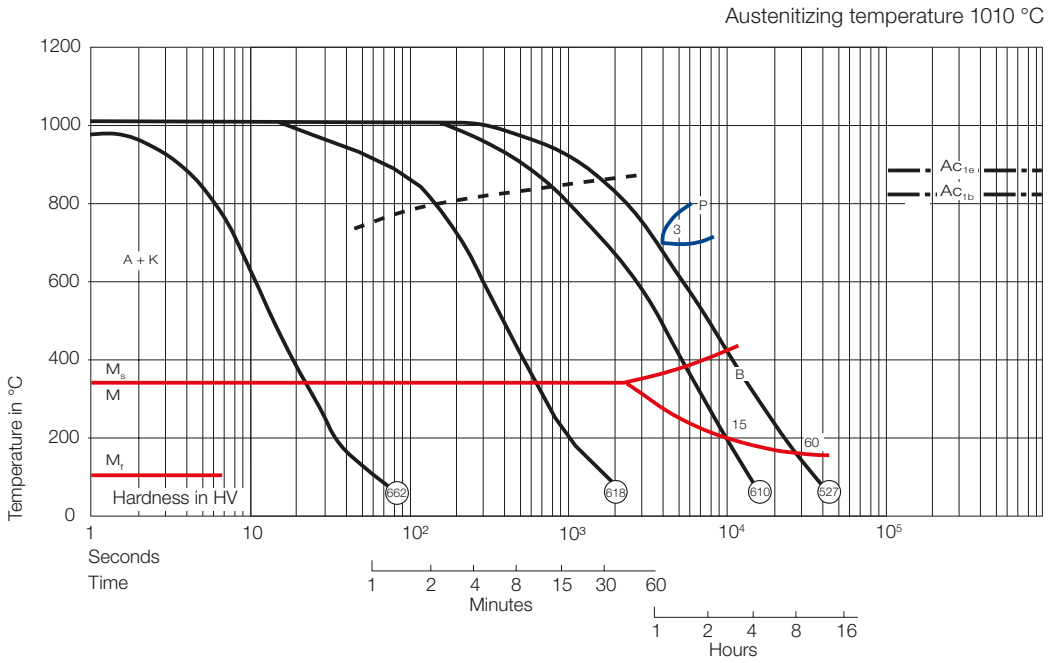
Temperature in °C	20
Density in g/cm^3	7,8

Temperature in °C	20
E module in GPa	214

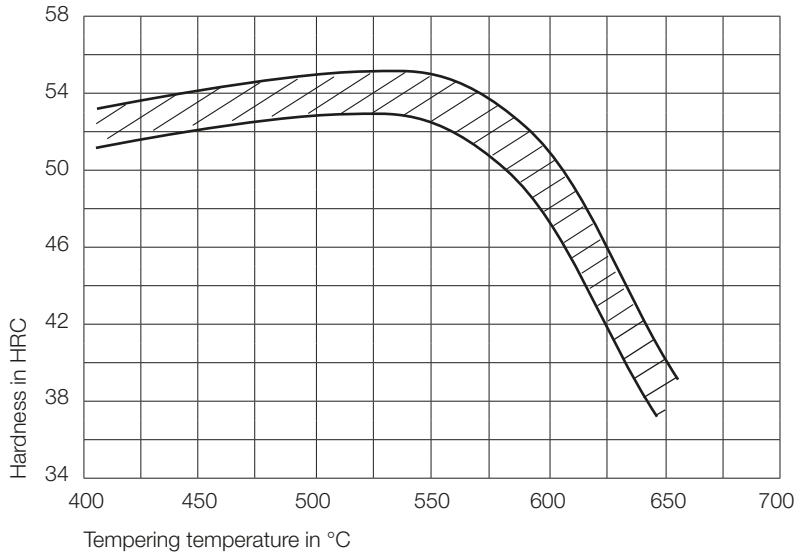
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1010 - 1020 °C
	Cooling	Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C depending on area of application

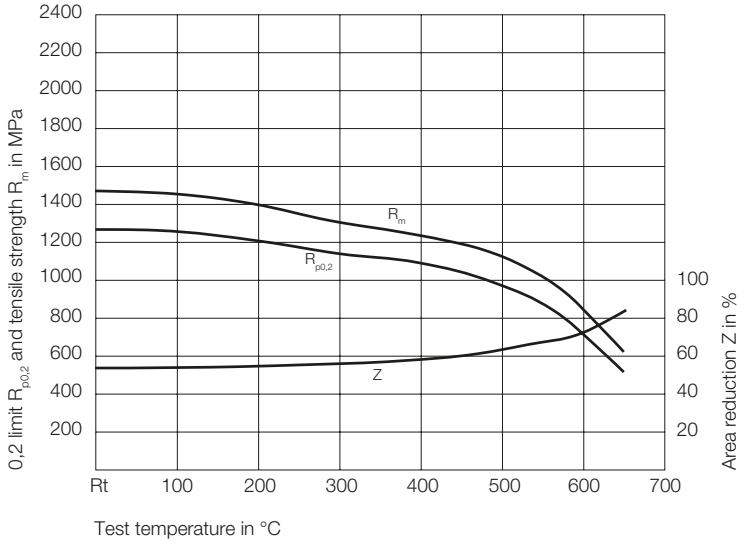
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



S10

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	Nb
Special	S10	0.50	0.30	0.40	5.00	1.90	0.55	+

Material properties

S10 is a Cr-Mo-V alloyed hot-work tool steel with higher C content compared to Q10. It is characterised by particularly high strength and high-temperature strength in combination with high toughness and thermal shock resistance.

Application

- Swages
- Tools in hot forming of sheet metal

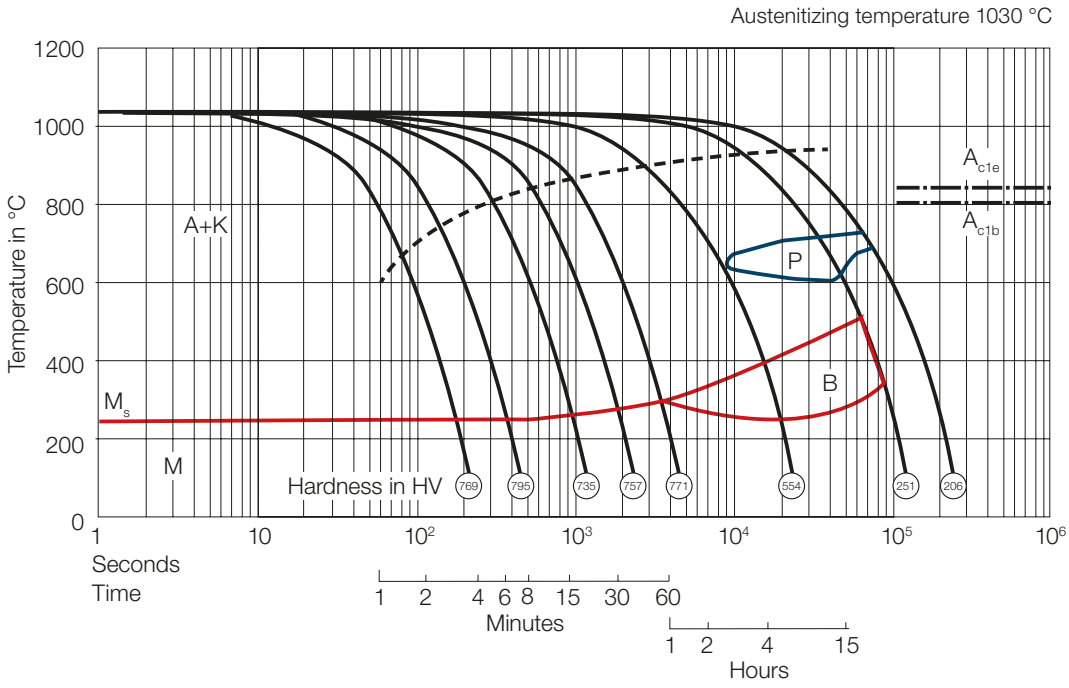
Physical properties

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			
E module in GPa	213			

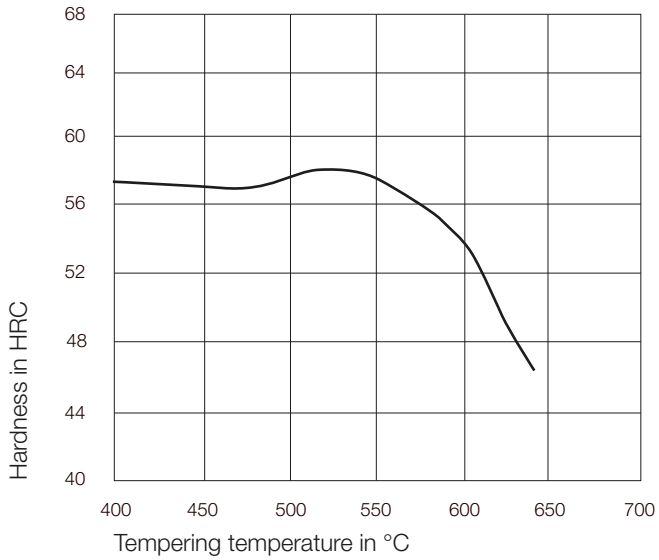
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 230 HB
Hardening	Temperature	1000 - 1040 °C
	Cooling	Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering curve
Nitriding	possible	
Preheating before use	Temperature	150 - 350 °C depending on area of application

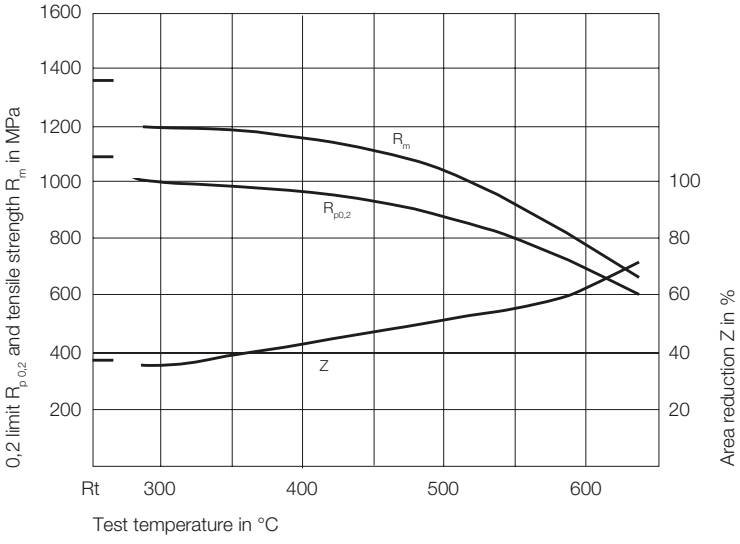
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



TQ1

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

Material properties

TQ1 is a Cr-Mo-V alloyed hot-work tool steel with very good high-temperature strength characteristics and maximum toughness. This quality is also characterised by good thermal shock resistance and is only manufactured in remelted form according to the ESU process.

Application

- Pressure die casting
- Extrusion presses for heavy duty press stamps > 1100 MPa, dies
- Drop forging
- Hot forming

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

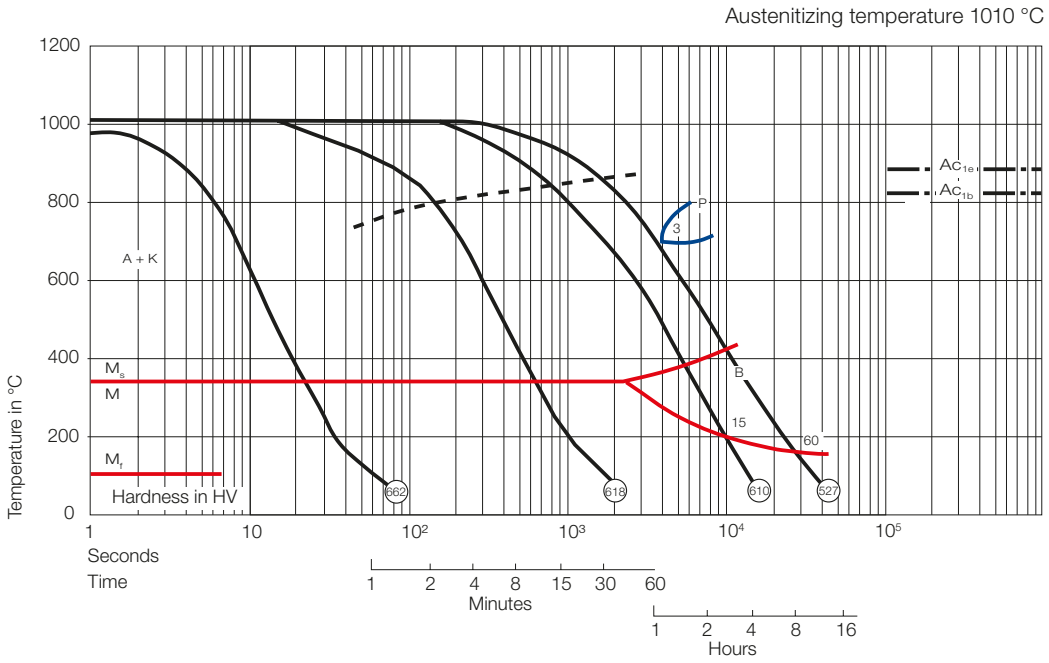
Temperature in °C	20
Density in g/cm³	7,8

Temperature in °C	20
E module in GPa	214

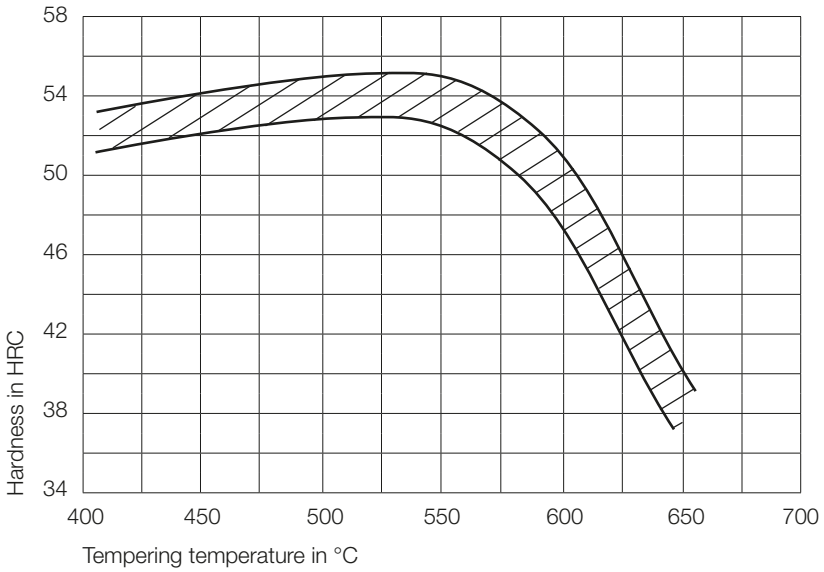
Heat treatment

Soft annealing	Temperature	820 - 840 °C, 4 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 220 HB
Hardening	Temperature	1010 - 1020 °C
	Cooling	Interrupt oil or polymer cooling at 230 - 280 °C or vacuum hardening
Tempering	Temperature	540 - 680 °C
	Hardness	see tempering curve
Nitriding	If die-casting dies are to be nitrided, nitriding program 99 should be selected. This nitriding layer does not have a compound layer and therefore does not have a negative impact on the formation of thermal shock cracks	
Preheating before use	Temperature	150 - 350 °C depending on area of application

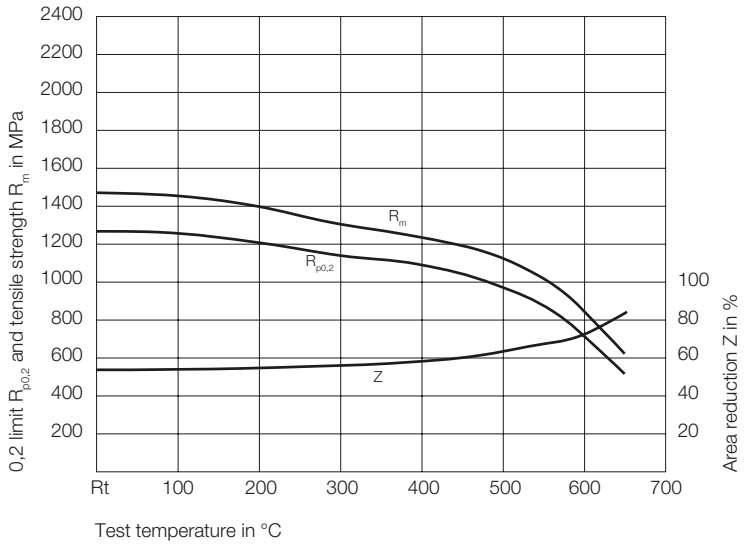
Continuous time-temperature-transformation graph



Tempering graph



High-temperature strength graph



Cold-work tool steels / Plastic mould 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-alloy cold-work tool steels have a higher toughness with sufficient compression strength but lower wear resistance, high-alloy 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 mould steels serve plastic processing according to good polishability and corrosion resistance. They are therefore used in a variety of technologies in injection moulding such as extrusion, die-casting, press and blow moulding. The focus here is on corrosion-resistant plastic mould steels that are largely resistant to decomposition products of plastic processing.

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 high hardenable rust and acid-resistant steel. It is used in the manufacturing of smaller moulds or inserts for the plastics industry in the processing of duroplasts and thermoplasts, in which corrosive side-products can arise. RF is through-hardenable, is low in distortion, has a high wear resistance and compression strength. In tempered condition, RF is very highly polishable.

Application

- Inserts and smaller injection moulds
- Plastic pressure moulds for processing plastics

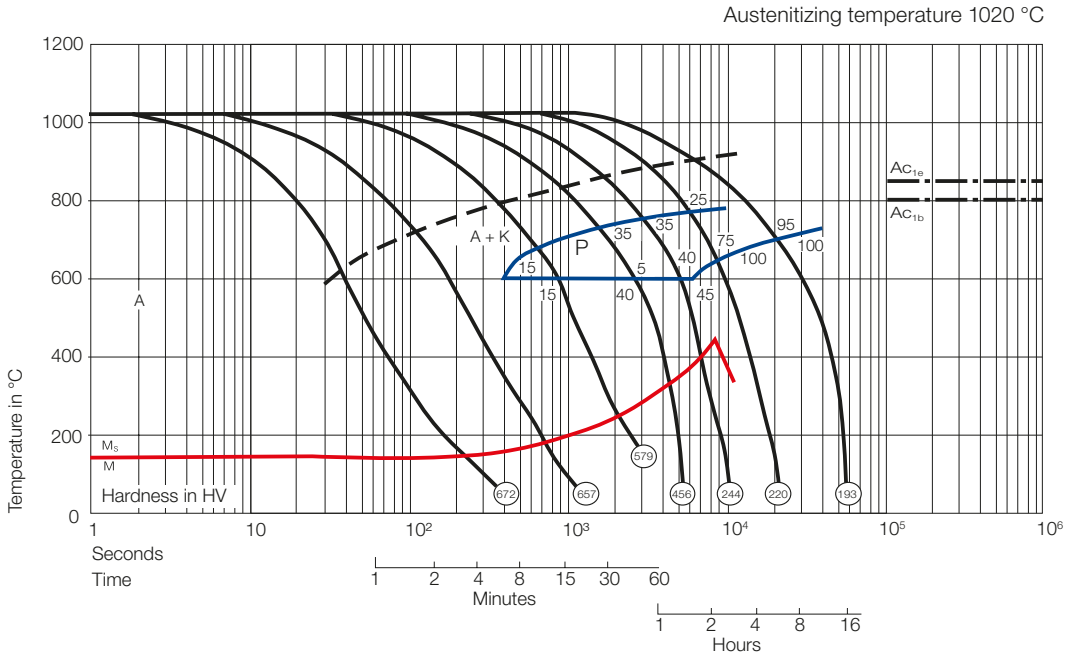
Physical properties

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/cm^3	7,7		
Temperature in °C	20		
E module in GPa	217		

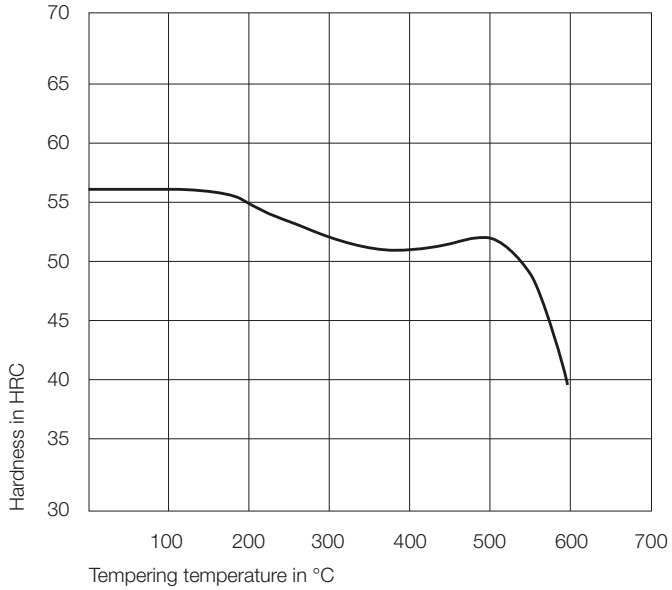
Heat treatment

Soft annealing	Temperature	760 - 800 °C, 4 - 6 hrs.
	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 curve

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 characterised by good toughness and sharpness.
The hardening behaviour is moderate for large cross-sections.

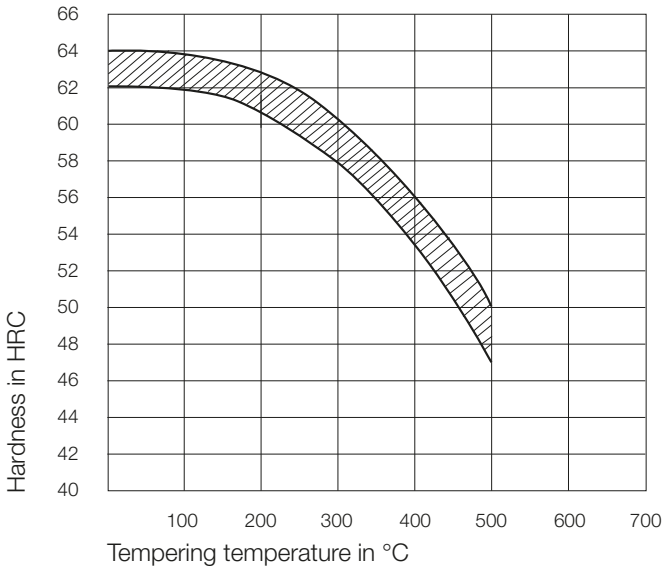
Application

- Cutting and punching tools for sheet metal thickness 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 hrs.
	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 curve

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 through the high Cr and low C content. CMR is suitable for the processing of chemically particularly aggressive plastics such as PVC. Chrome-plating is unneccessary. CMR has a good polishability. Delivery condition: Tempered, strength as required between 800 and 1100 MPa.

Application

- Injection moulds and extrusion tools in the processing of plastics which can release corrosive materials

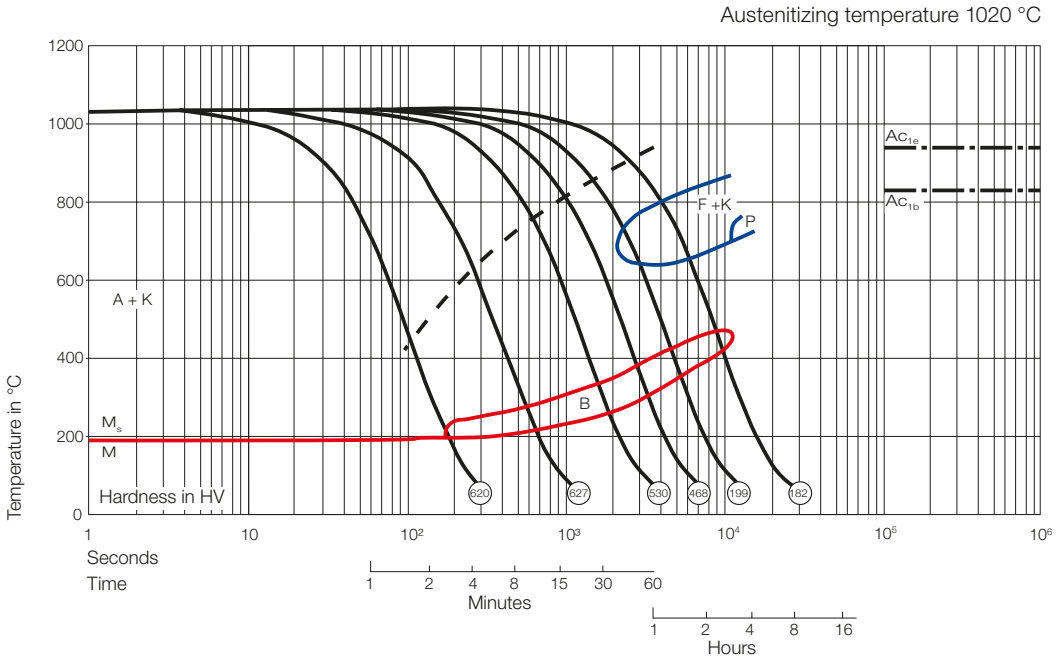
Physical properties

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/cm^3	7,7		
Temperature in °C	20		
E module in GPa	215		

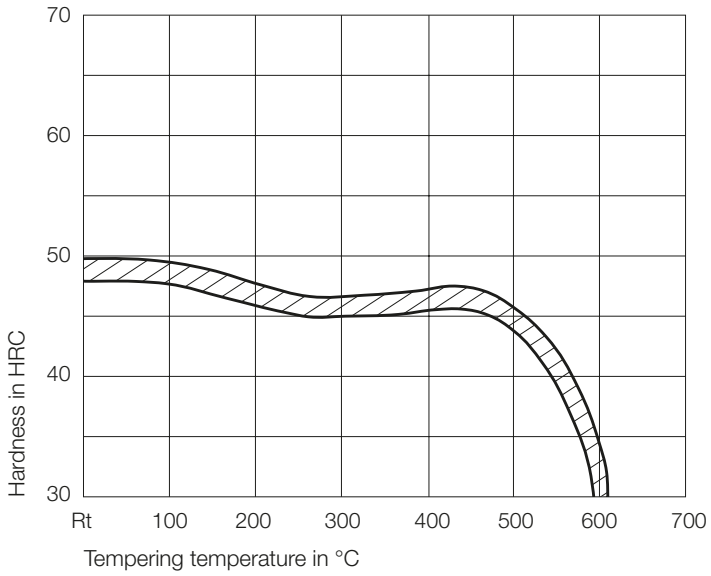
Heat treatment

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 curve
Nitriding	possible, temper correspondingly. The corrosion resistance is reduced by such a treatment.	

Continuous time-temperature-transformation graph



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

- Rust-resistant hand and machine blades of all kinds
- Perforated disks in meat grinders
- Needle valves and valve parts
- Ball bearings and similar parts, which are exposed to increased wear in a corrosive environment, plastic moulds

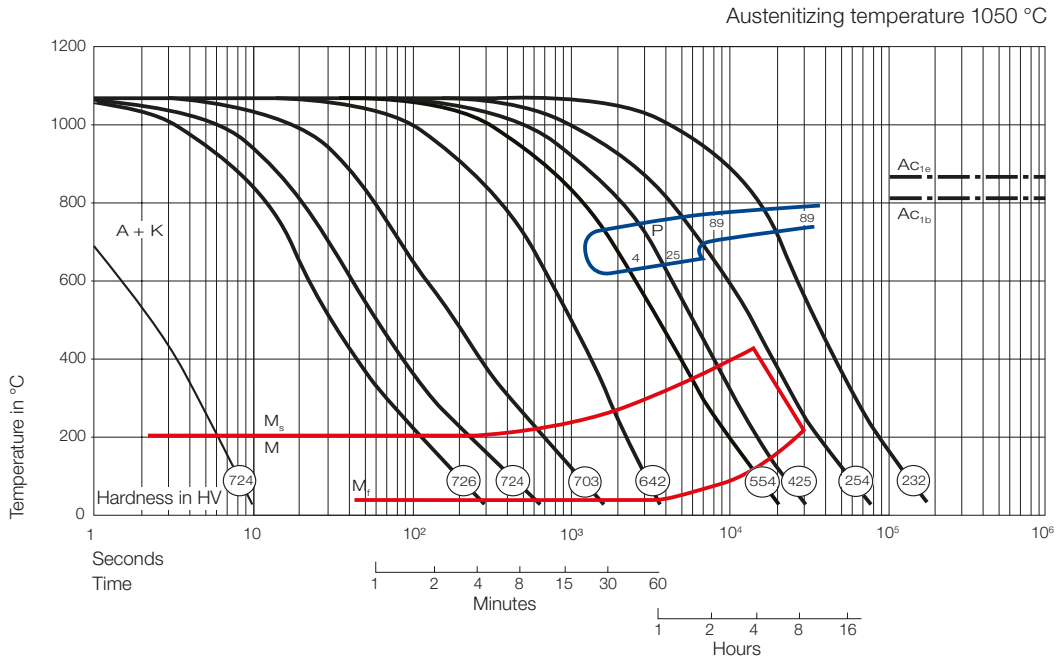
Physical properties

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		
E module in GPa	215		

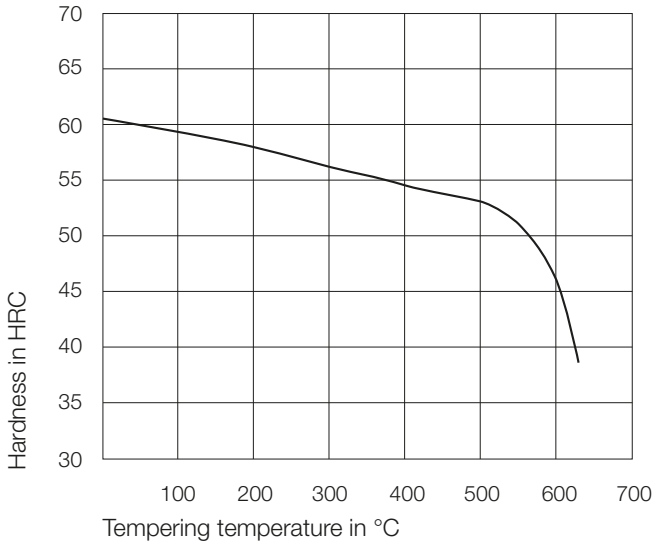
Heat treatment

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 curve
Nitriding	possible	

Continuous time-temperature-transformation graph



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-hardenable 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 and similar

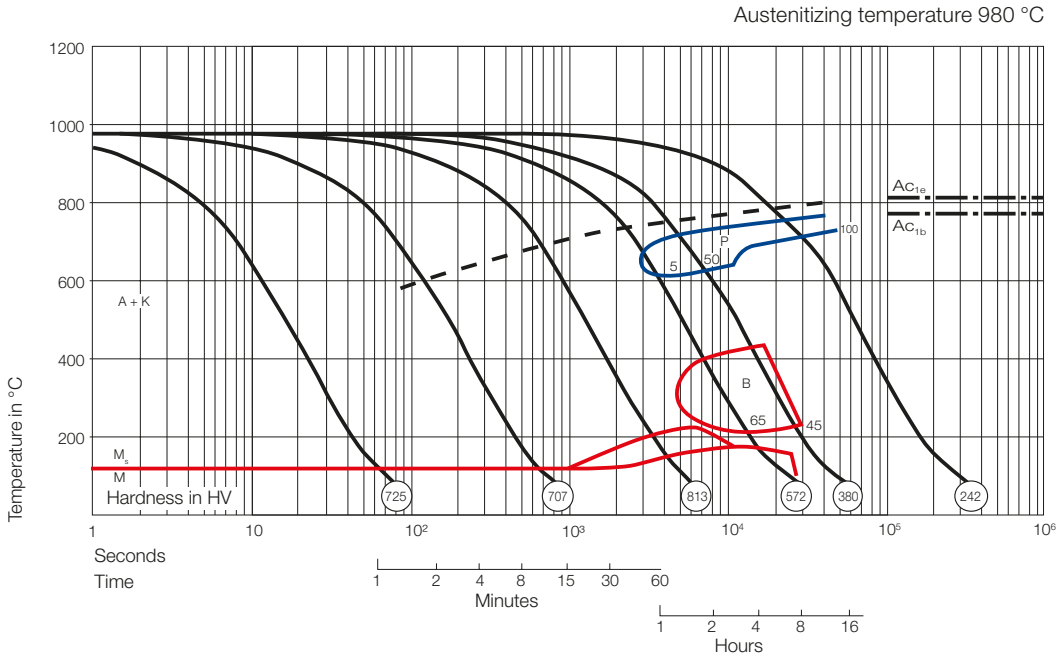
Physical properties

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		
E module in GPa	210		

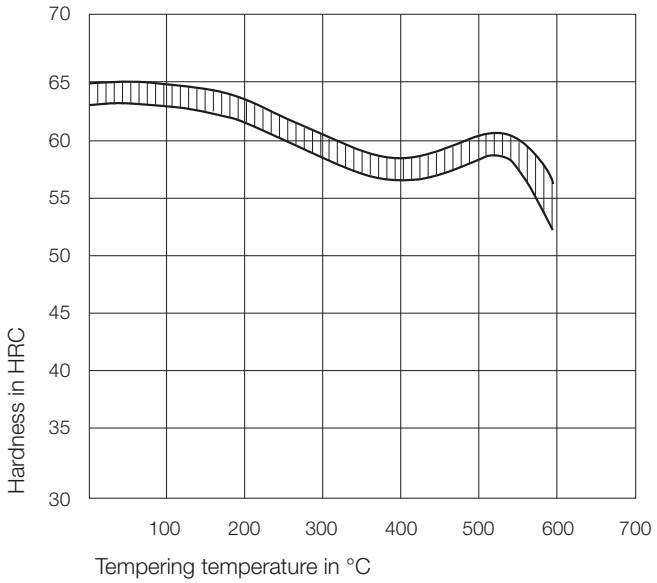
Heat treatment

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 curve

Continuous time-temperature-transformation graph



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 chrome alloy 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 moulds 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

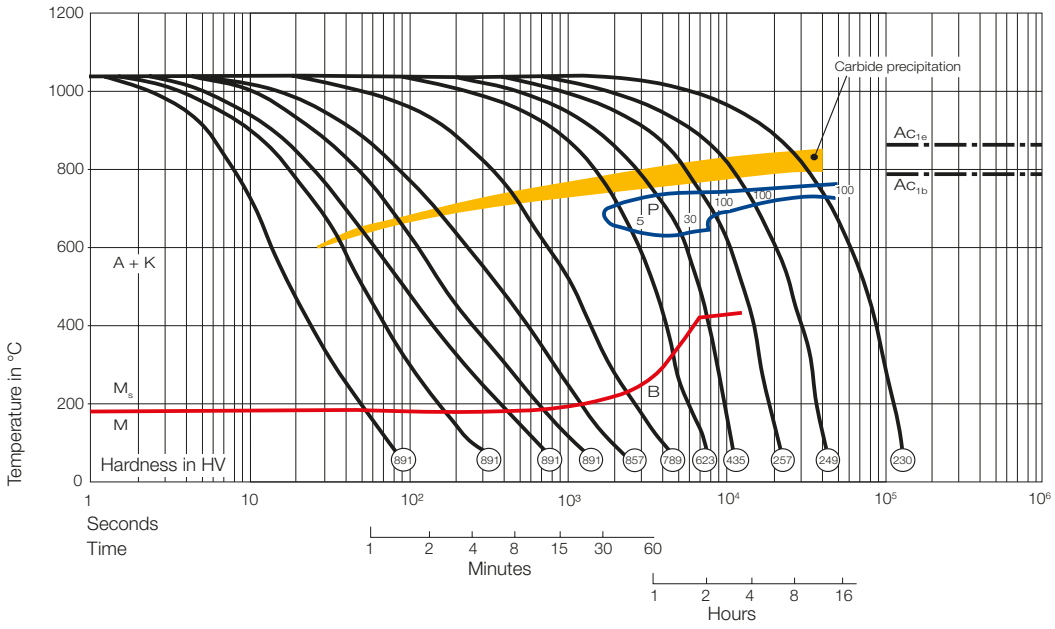
Temperature in °C	20
E module in GPa	215

Heat treatment

Soft annealing	Temperature	820 - 850 °C, 4 - 6 hrs.
	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 curve, 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	

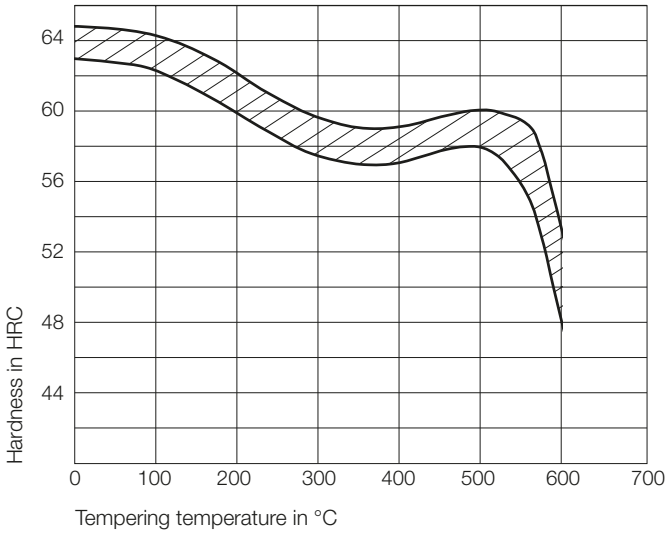
Continuous time-temperature-transformation graph

Austenitizing temperature 1030 °C

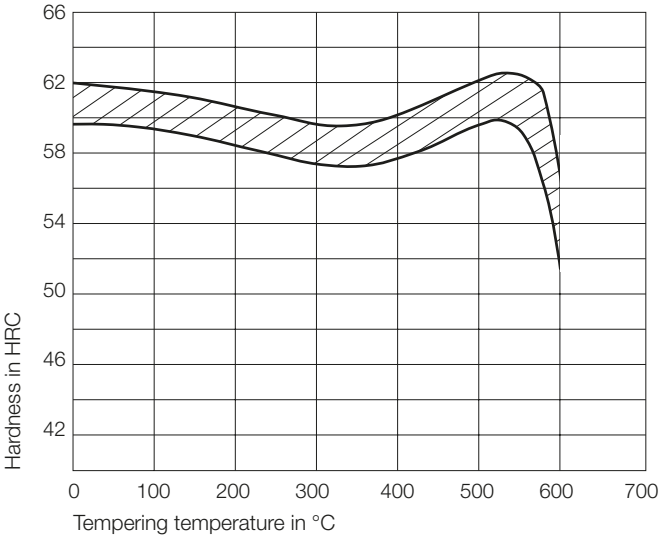


Tempering graph

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

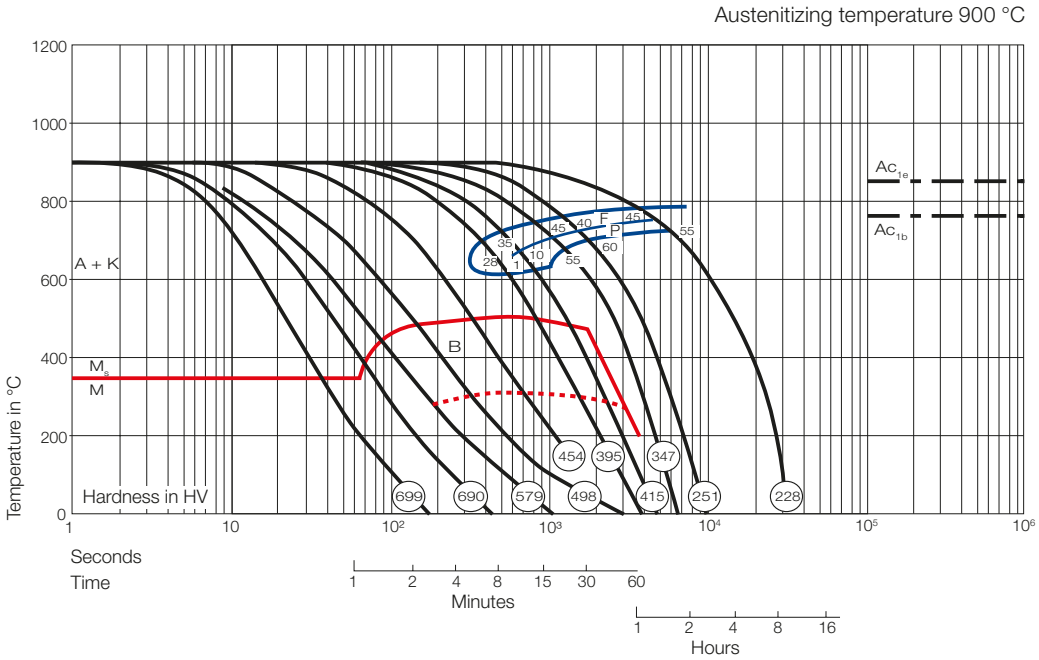
Temperature in °C	20
Density in g/cm³	8,0

Temperature in °C	20
E module in GPa	210

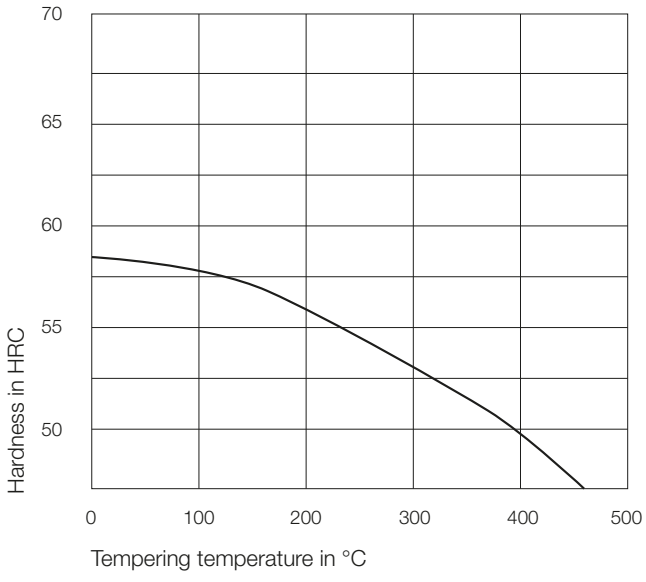
Heat treatment

Soft annealing	Temperature	730 - 760 °C, 4 - 6 hrs.
	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 curve

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

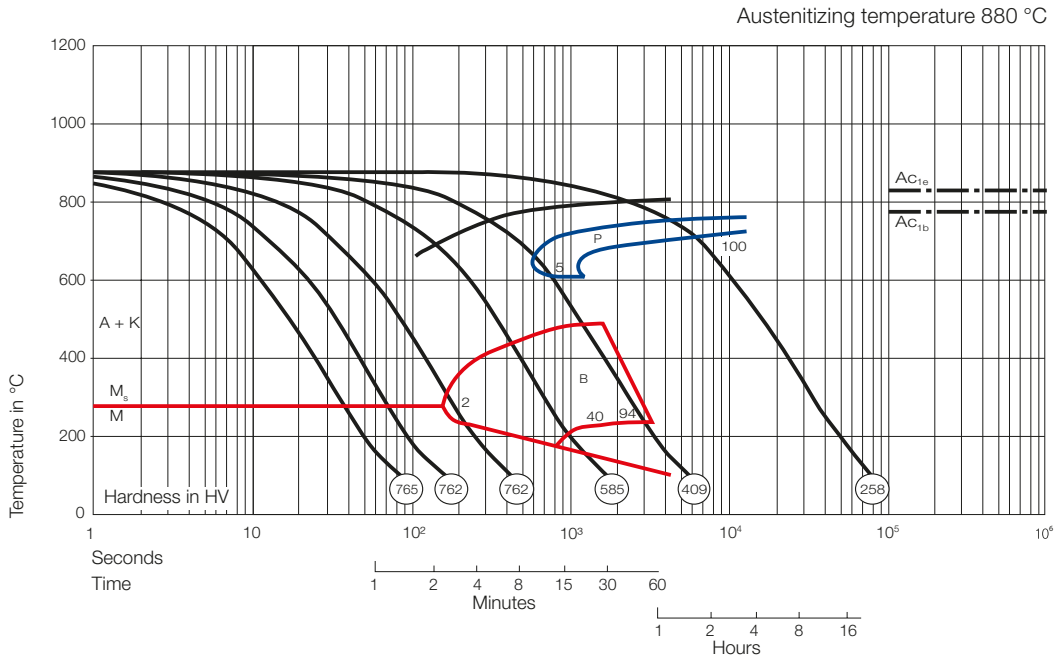
Physical properties

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/cm^3	8,0		
Temperature in °C	20		
E module in GPa	210		

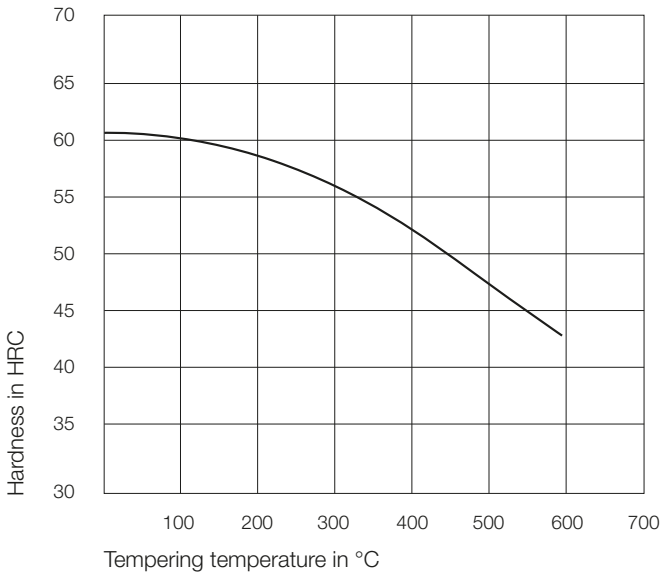
Heat treatment

Soft annealing	Temperature	750 - 780 °C, 4 - 6 hrs.
	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 curve

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 forming tools of all kinds
- Cutlery stamping dies
- Form dies for high pressures
- Punches
- Puller jaws and similar tools

Physical properties

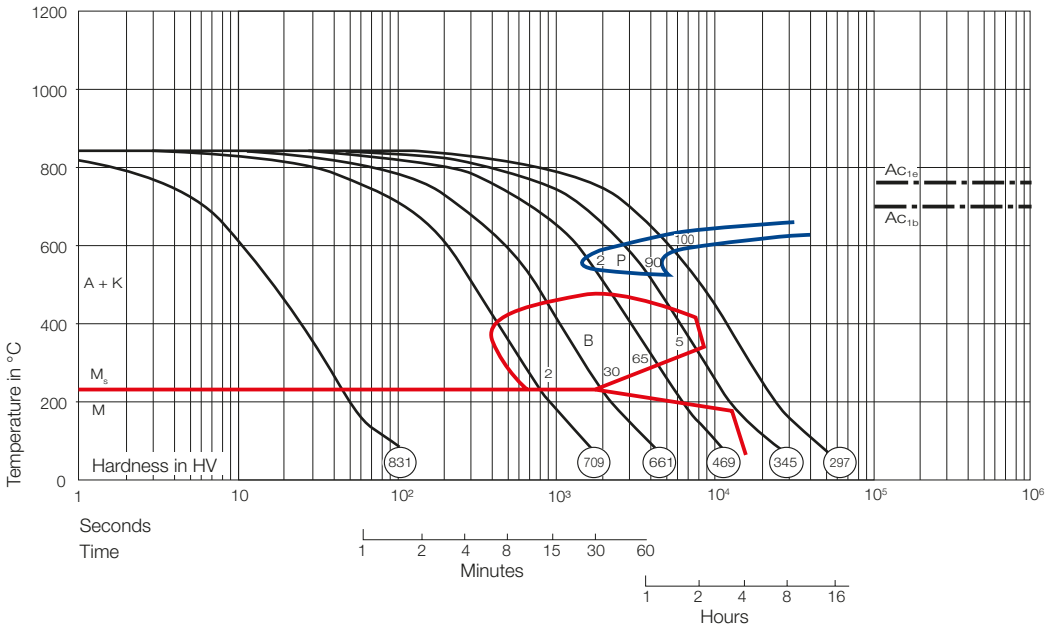
Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6} m/m x K	11,5	12,0	12,8
Temperature in °C	20		
Thermal conductivity in W/m x K	31,0		
Temperature in °C	20		
Density in g/cm³	7,8		
Temperature in °C	20		
E module in GPa	210		

Heat treatment

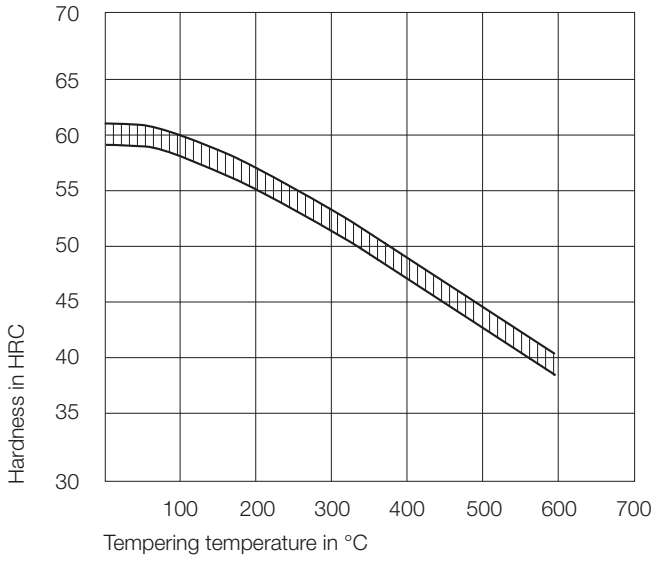
Soft annealing	Temperature	720 °C, 5 - 6 hrs.
	Cooling	Slow furnace cooling
	Hardness	max. 250 HB
Hardening	Temperature	840 - 870 °C
	Cooling	Air, warm bath from 180 - 220 °C or oil, interrupt oil cooling at approx. 150 °C
Tempering	Temperature	100 - 300 °C
	Hardness	see tempering curve

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 characterised by its high Ni content as a tough cold-work tool steel with high hardenability. As well as good polishability and texturing properties, N400 tends towards good through-hardenability.

Application

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

Physical properties

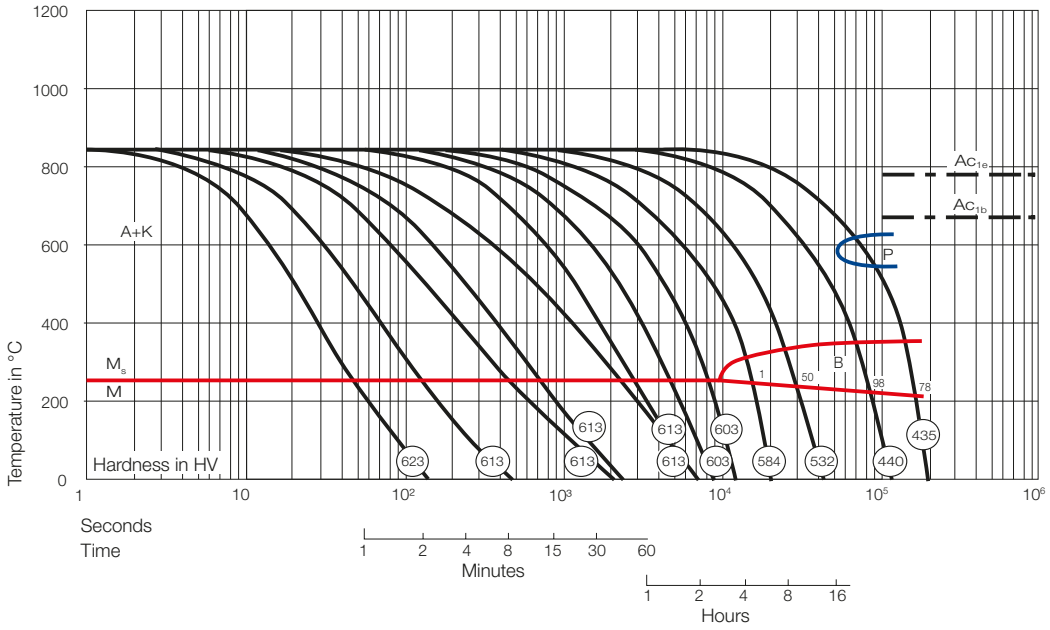
Temperature in °C	20 - 100	20 - 200	20 - 400
Thermal expansion in 10^{-6} m/m x K	12,3	13,1	13,7
Temperature in °C	20		
Thermal conductivity in W/m x K	31,0		
Temperature in °C	20		
Density in g/cm³	7,82		
Temperature in °C	20		
E module in GPa	210		

Heat treatment

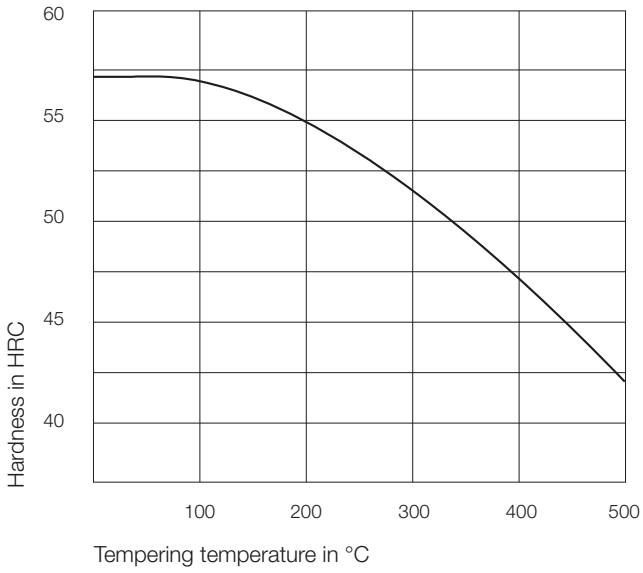
Soft annealing	Temperature	610 - 650 °C
	Cooling	Slow furnace cooling, 720 °C 6 - 8 hrs,. and slow furnace cooling, annealing 620 - 640 °C 10 - 12 hrs, and slow furnace cooling
	Hardness	max. 260 HB
Hardening	Temperature	840 - 870 °C
	Cooling	Air, warm bath from 180 - 220 °C or oil, interrupt oil cooling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

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
- Draw dies for drawing over a mandrel (perforation tempering)

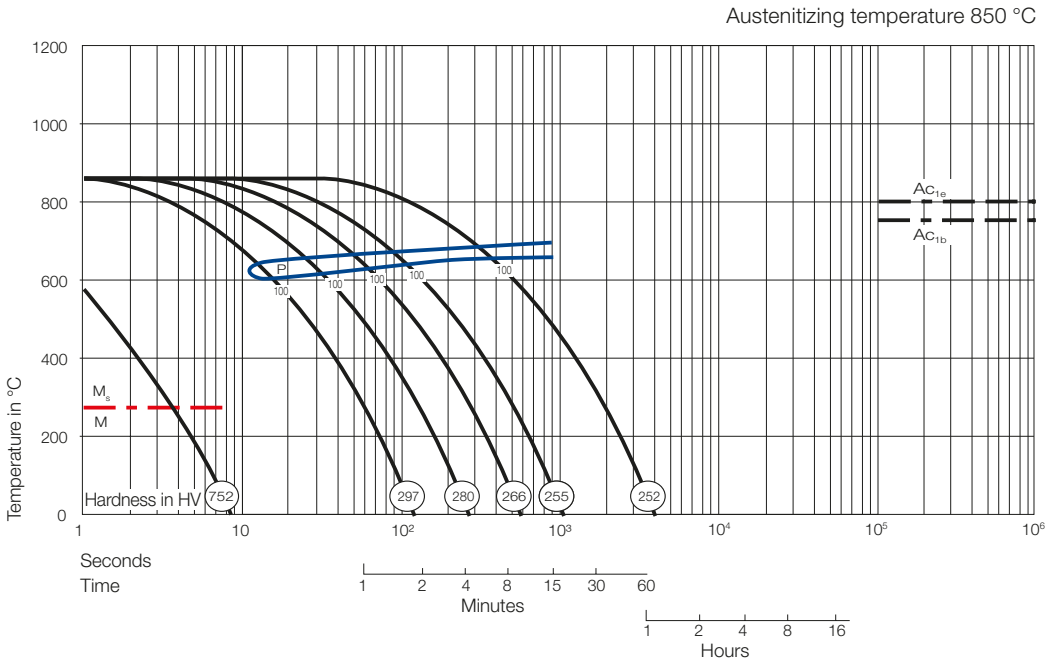
Physical properties

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

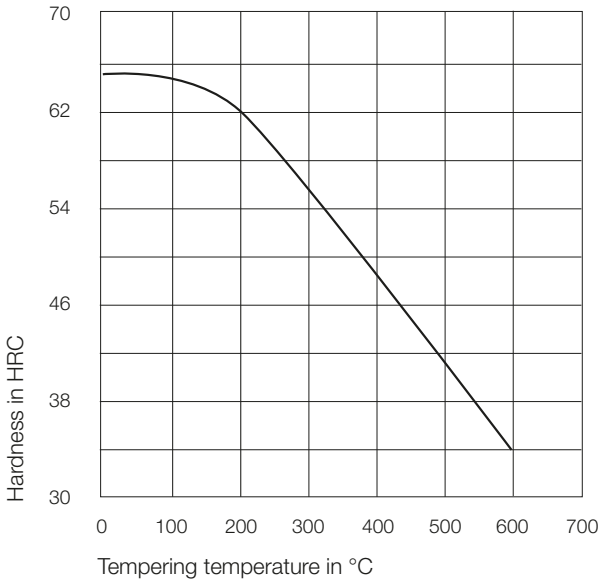
Heat treatment

Soft annealing	Temperature	740 - 760 °C, 4 - 6 hrs.
	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 curve

Continuous time-temperature-transformation graph



Tempering graph



RM161a (1.4104)

Mat.-no.	Short name	Brand name	Mass.-%					
			C	Si	Mn	Cr	Mo	S
1.2838	145V33	KSV	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
- Easily machinable, corrosion resistant steel for screws and bolts

Delivery condition: 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

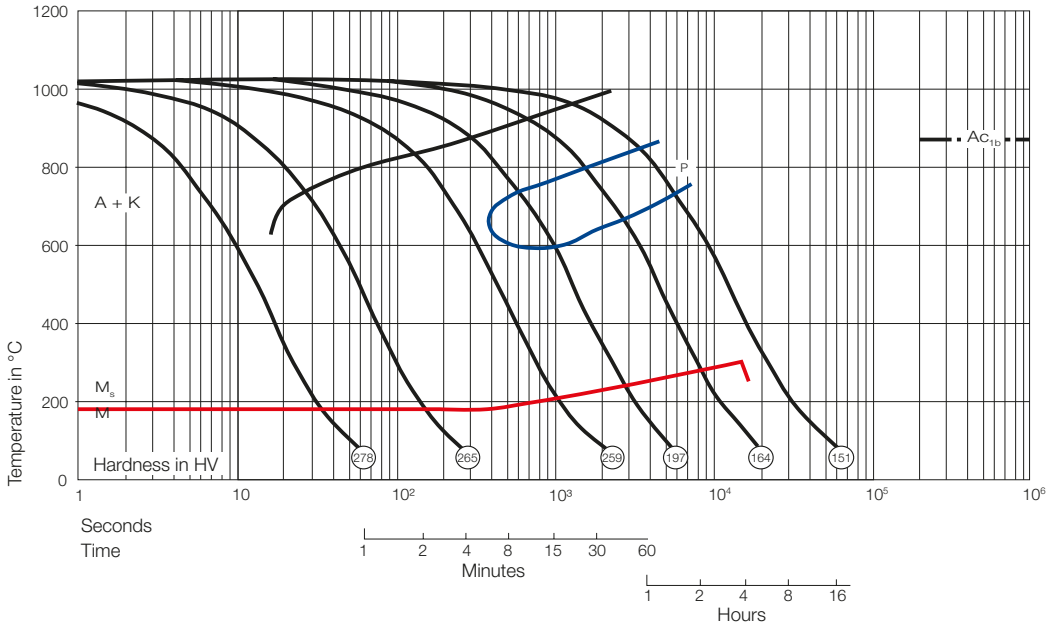
Temperature in °C	20
Thermal conductivity in W/m x K	25,0

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

Temperature in °C	20
E module in GPa	215

Continuous time-temperature-transformation graph

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

Stainless, martensitic steel with high hardenability, high wear resistance, polishable.

Application

- Blade and cutting goods,
- Perforated disks, 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

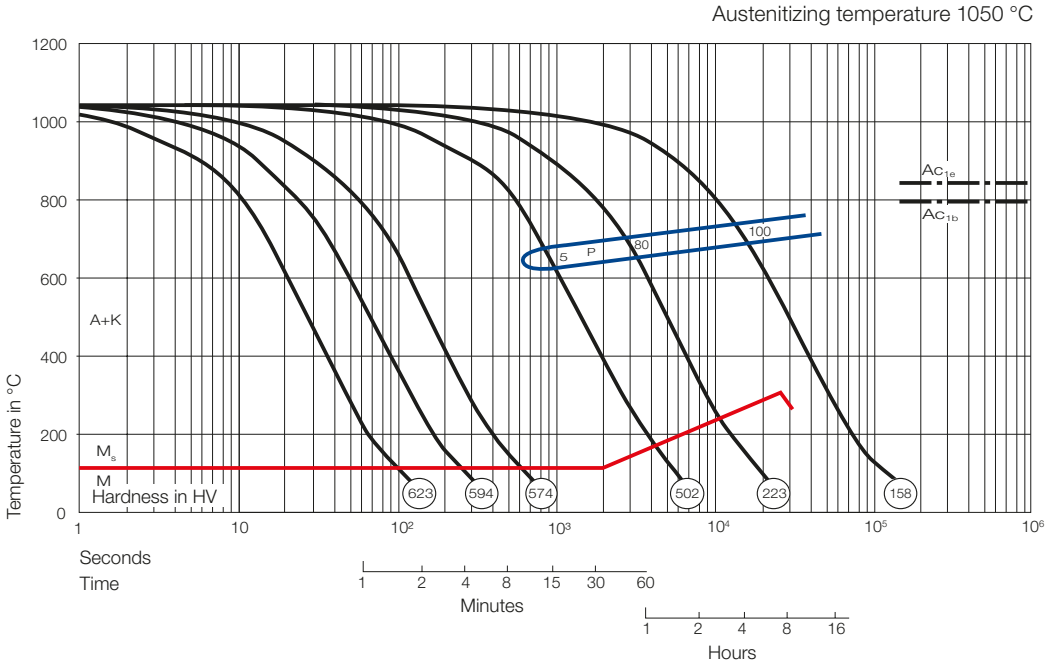
Temperature in °C	20
Density in g/cm³	7,7

Temperature in °C	20
E module in GPa	215

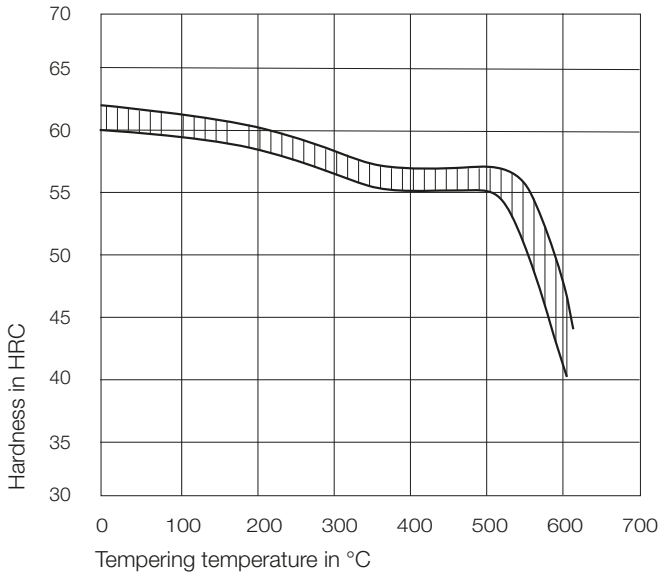
Heat treatment

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 curve
Nitriding	possible	

Continuous time-temperature-transformation graph



Tempering graph



FSR

Mat.-no.	Brand name	Mass.-%						
		C	Si	Mn	Cr	Mo	V	W
Special	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 12% Cr. The other alloy elements give FSR the necessary temper resistance and wear resistance. Compared to a similarly used high-speed steel such as type HS6-5-2C, FSR is characterised by better toughness with equivalent performance.

Application

- Cutting tools with particular wear resistance in the processing of siliconised or austenitic sheet metal or hardened strip steel, precision punching tools
- Cold extrusion tools
- Threaded rolling tools
- Broaches
- Extruder screws

Physical properties

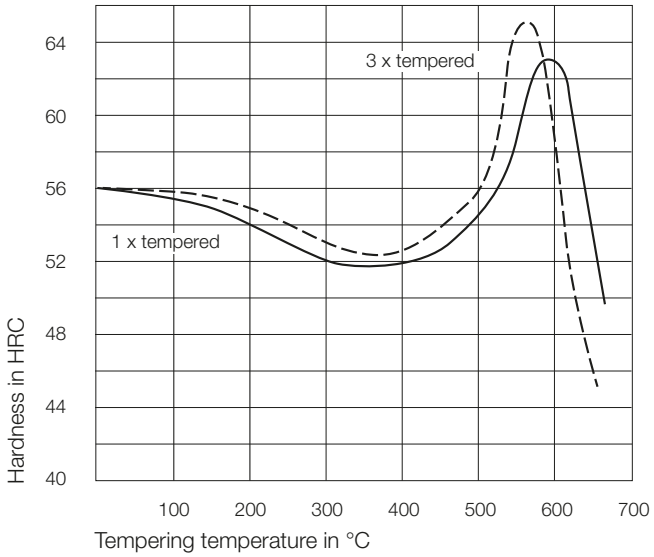
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	10,6	12,0	13,0

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 curve
Nitriding	possible, temper correspondingly	

Tempering graph



PM823

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

Material properties

Cold-work tool steel with high vanadium content. Good tempering ability, high strength.

Application

- Shear blades
- Cutting tools
- Guide and profiled rollers with high requirements in terms of toughness and wear resistance

Physical properties

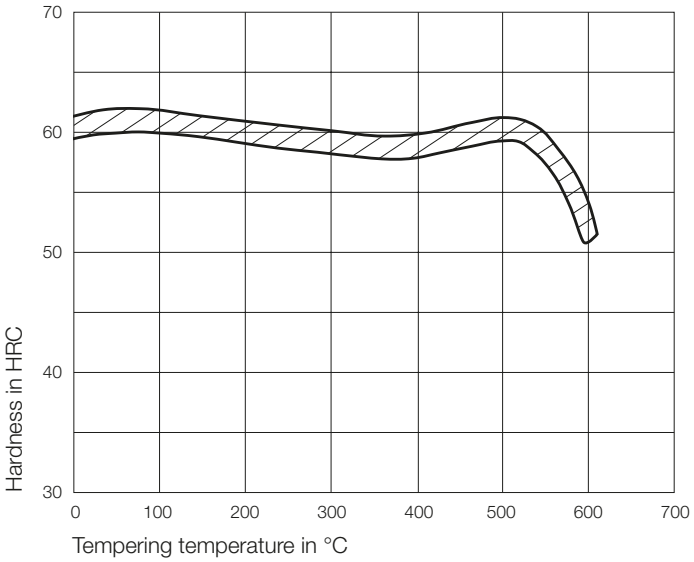
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	11,3	12,2	12,7

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

Heat treatment

Soft annealing	Temperature	800 - 840 °C, 4 - 6 hrs.
	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 curve

Tempering graph



PW812

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

Material properties

Cold-work tool steel with high vanadium and tungsten content. Good secondary tempering ability, high toughness.

Application

- Shear blades
- Cutting tools
- Guide and profiled rollers with high requirements in terms of toughness and wear resistance
- Bending tools
- Punches

Physical properties

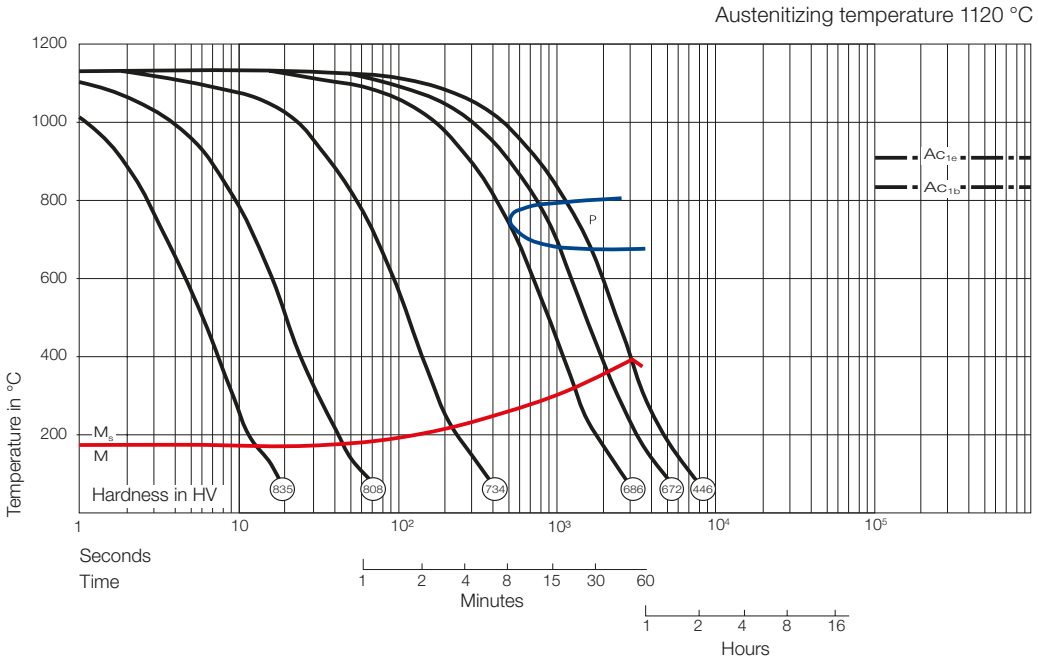
Temperature in °C	20 - 100	20 - 400	20 - 600
Thermal expansion in 10^{-6} m/m x K	11,0	12,2	12,7

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

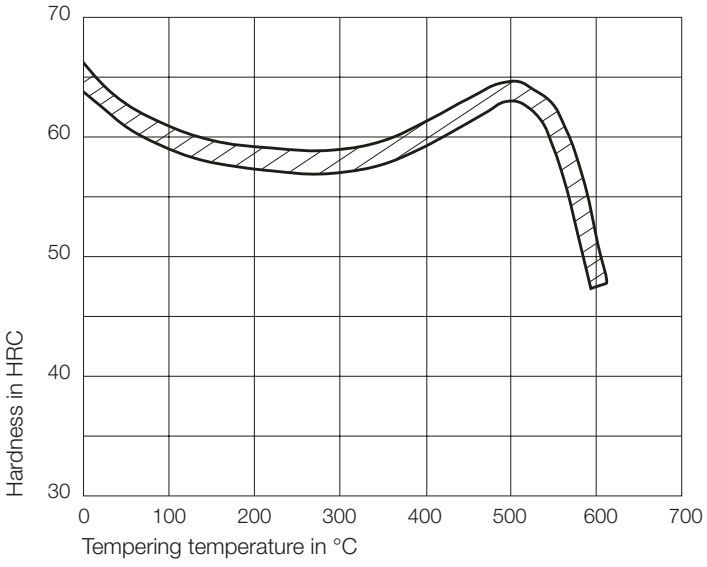
Heat treatment

Soft annealing	Temperature	800 - 840 °C, 4 - 6 hrs.
	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 curve

Continuous time-temperature-transformation graph



Tempering graph



Highly heat-resistant 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	0.55	1.40	0.70	4.00	0.60	11.50	1.10	1.50	12.00

Material properties

MA record is a high-alloy special hot-work tool steel with austenitic structure. The operational strength of approx. 1350-1550 MPa is achieved through forging and then precipitation hardening at approx. 800 °C or through a special heat treatment.

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 disks forged on all sides with the smallest possible thickness, so that a roughly consistent temperature increase is guaranteed in extrusion press 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.

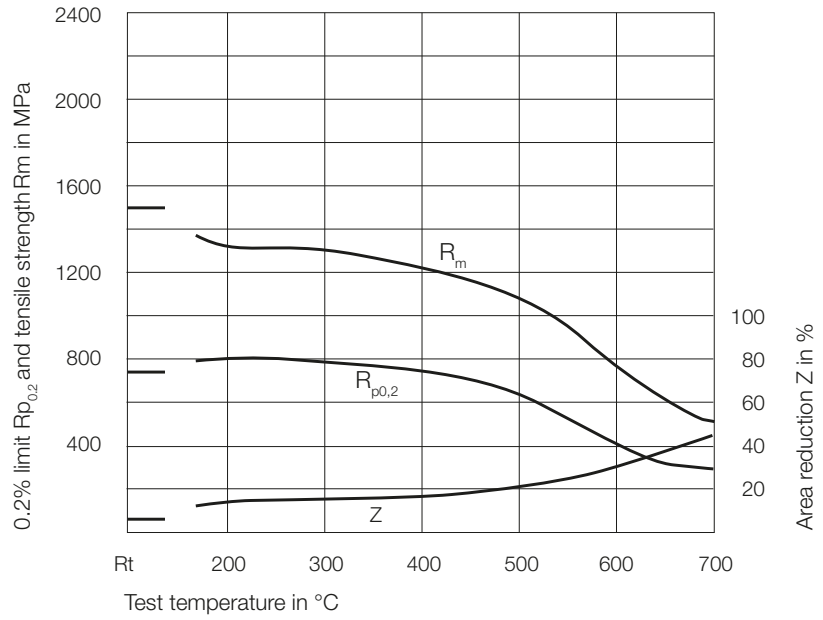
Physical properties

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 best high-temperature strength properties. Preferred areas of use are forming work with thermal load if the temper resistance of the martensitic steels is not enough.

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 $R_{p0,2}$ mind.: 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

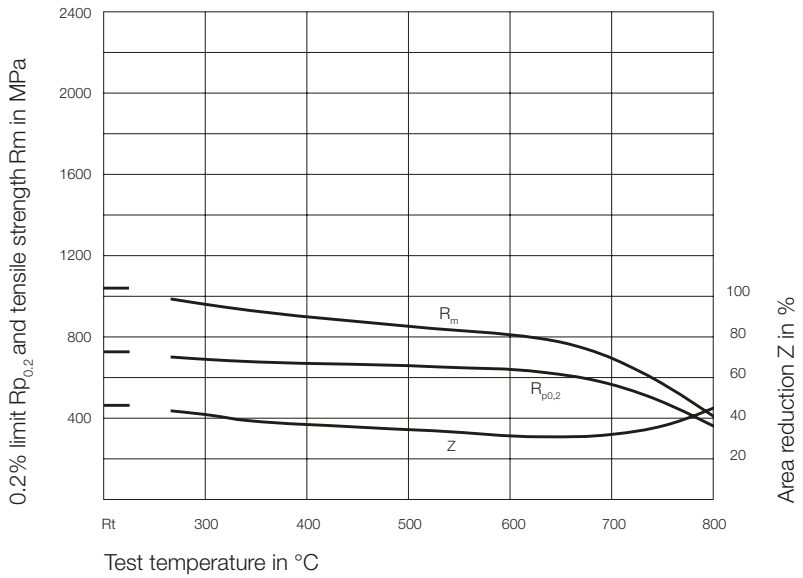
Temperature in °C	20
Density in g/cm³	7,95

Temperature in °C	20
E module in GPa	208

Heat treatment

Solution annealing	Temperature	970 - 990 °C, 1 hr.
	Cooling	Air
	Festigkeit	approx. 850 MPa
Tempering	Temperature	710 - 730 °C, 16 hrs.
	Cooling	Air
Nitriding	possible	

High-temperature strength graph



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	15.00	1.50

Material properties

This high alloyed steel with austenitic microstructure has an excellent scale and corrosion resistance and high-temperature strength.

Application

- Upper and lower sections of glass moulds, high output with best surface quality of the glass (crystal lustre), 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
Tinder 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
E module in GPa	198

Heat treatment

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

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	Rest	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 temper resistance of the martensitic steels is no longer sufficient.

Application

- Extrusion tools
- Forging dies
- Hot shear blades

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 hrs.
	Cooling	Air
Tempering	Temperature	760 °C, 16 hrs.
	Cooling	Air

SA718 (2.4668)

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

Material properties

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

Application

- Dies, mandrel tips, pressure dies for extrusion presses for copper alloys
- Sinter press tools
- Hot shear blades
- Forging dies
- Inner liners
- Heavy metal extrusion presses with 1350-1450 MPa

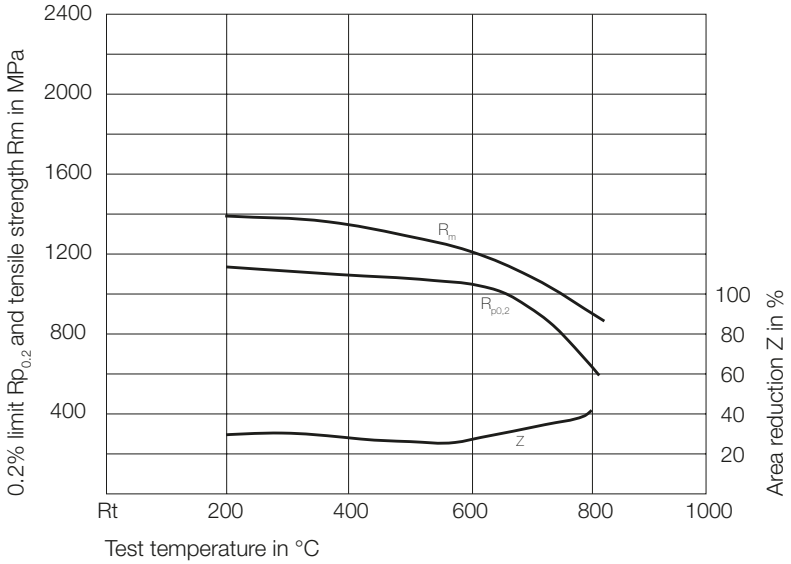
Delivery condition:
Solution annealed and tempered with following properties:
0,2% yield strength $R_{p0,2}$ = approx. 1100 MPa
Tensile strength R_m = approx. 1300 MPa

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			
E module in GPa	205			

Heat treatment

Solution annealing	Temperature	980 °C, 1 hr.
	Cooling	Air
Tempering	Temperature	720 °C, 8 hrs.; Cooling to 620 °C, 8 hrs.; Cooling air


2400
2000
1600
1200
800
400
0.2% limit Rp0.2 and tensile strength Rm in MPa
Rm
Rp0.2
Z
100
80
60
40
20
Area reduction Z in %
Rt
200
400
600
800
1000
Test temperature in °C

Kind&Co., Edelstahlwerk, GmbH & Co. KG
Bielsteiner Str. 124-130 · D-51674 Wiehl
Fon +49 (0) 22 62 / 84-0 · Fax +49 (0) 22 62 / 84-175
info@kind-co.de · www.kind-co.de