

Identification

Material number	Reference number	AISI
1.1520	(C70W)	

Chemical composition Typical analysis in %

C	Si	Mn
0.70	0.25	0.25

Steel properties

Shell-hardenable steel with wear-resistant surface and high core toughness.

Applications

Trimming dies, pliers, tool bits for pneumatic and hand tools.

Heat treatment

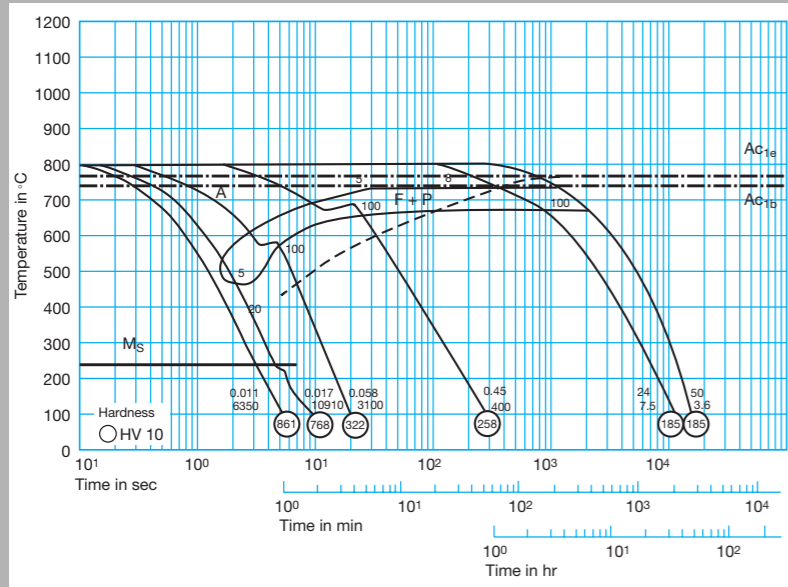
Soft annealing °C	Cooling	Hardness HB
680 – 710	Furnace, from 500 °C air	max. 180

Stress-relief annealing °C	Cooling
approx. 600 – 650	Furnace

Hardening °C	Quenching	Hardness after quenching HRC
780 – 810	Water	64

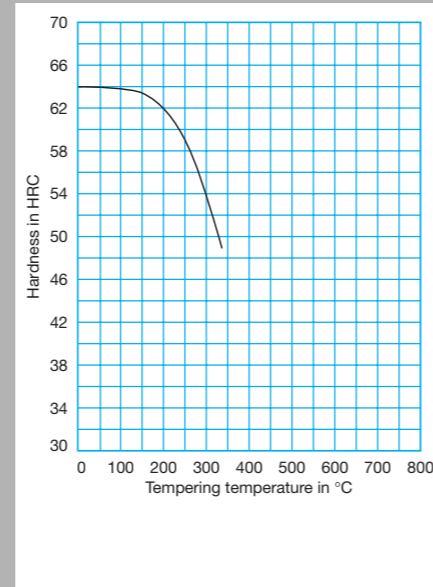
Tempering °C	100	200	300	350
	HRC	64	61	56

Time-temperature-transformation diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Tempering diagram



Identification

Material number	Reference number	AISI
1.1730	C45U	1045

Chemical composition Typical analysis in %

C	Si	Mn
0.45	0.20	0.70

Steel properties

Shell-hardenable steel featuring hard surface and tough core.

Applications

Components for tools (e.g. base plates for plastic moulds and pressure casting moulds). Also suitable for hand tools, pliers and agricultural tools of all kinds.

Heat treatment

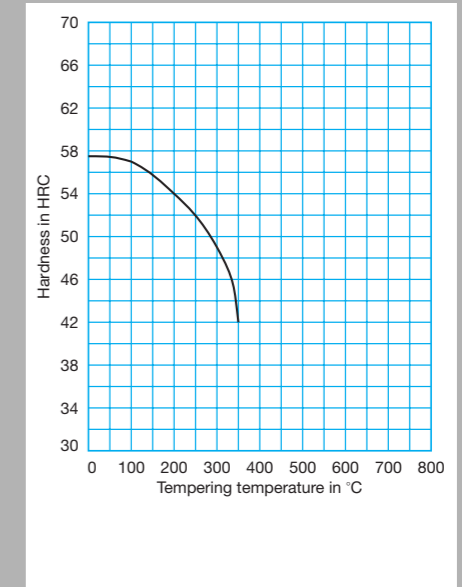
Soft annealing °C	Cooling	Hardness HB
680 – 710	Furnace	max. 207

Stress-relief annealing °C	Cooling
approx. 600 – 650	Furnace

Hardening °C	Quenching	Hardness after quenching HRC
800 – 830	Water	57

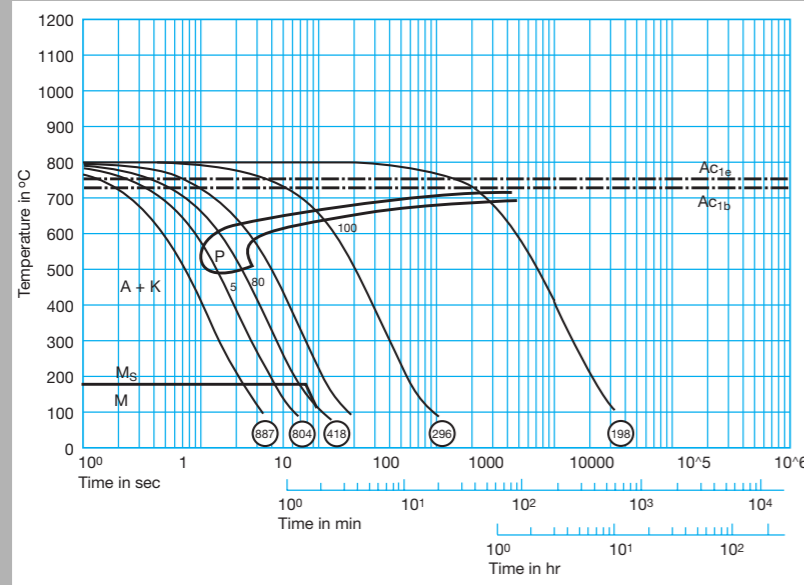
Tempering °C	100	200	300	350
	HRC	57	54	49

Tempering diagram



Identification				
Material number	Reference number	AISI		
1.2002	(125Cr1)			
Chemical composition Typical analysis in %				
C	Cr	Si	Mn	
1.30	0.25	0.25	0.30	
Steel properties				
Tool steel with high surface hardness.				
Applications				
Cutting tools, drawing dies, files and mandrels.				
Heat treatment				
Soft annealing °C	Cooling	Hardness HB		
700 – 720	Furnace	max. 200		
Stress-relief annealing °C	Cooling			
approx. 650 – 680	Furnace			
Hardening °C	Quenching	Hardness after quenching HRC		
770 – 800	< 10 mm Ø: Oil	65		
Tempering °C	100	200	300	400
HRC	64	62	56	49

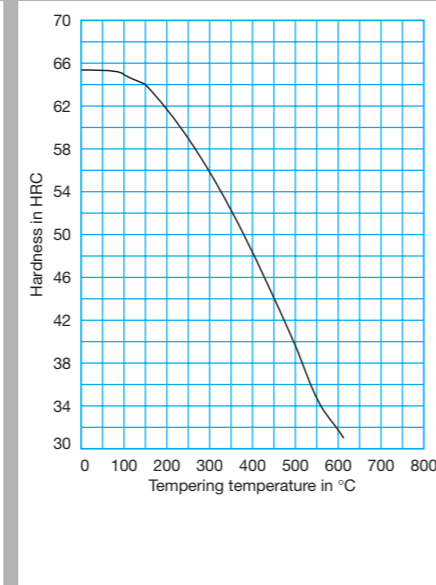
Time-temperature-transformation diagram



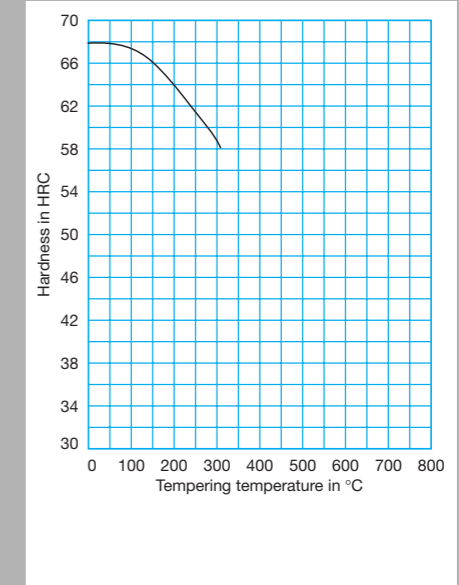
Reference numbers in brackets are not standardized in EN ISO 4957.

Identification				
Material number	Reference number	AISI		
1.2008	(140Cr3)			
Chemical composition Typical analysis in %				
C	Si	Mn	Cr	V
1.50	0.25	0.25	0.85	0.20
Steel properties				
Water-hardening special steel.				
Applications				
Files.				
Heat treatment				
Soft annealing °C	Cooling	Hardness HB		
730 – 760	Furnace	max. 220		
Stress-relief annealing °C	Cooling			
approx. 650 – 680	Furnace			
Hardening °C	Quenching	Hardness after quenching HRC		
780 – 820	Water	68		
Tempering °C	100	200	300	
HRC	63	62	59	

Tempering diagram



Tempering diagram



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Identification		
Material number	Reference number	AISI
1.2067	102Cr6	L1/L3

Chemical composition Typical analysis in %			
C	Si	Mn	Cr
1.00	0.20	0.35	1.50

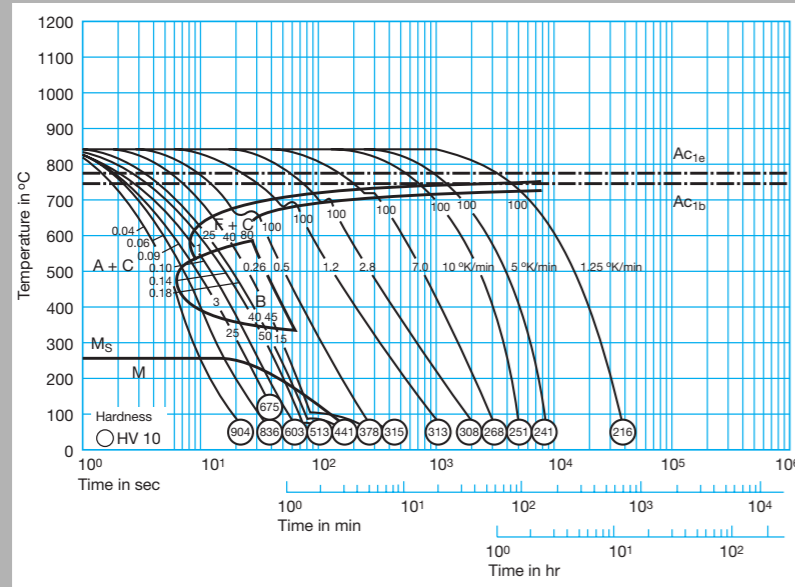
Steel properties
Oil-hardenable grade with low hardening depth, wear-resistant.

Physical properties			
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	33.0	32.2	31.4

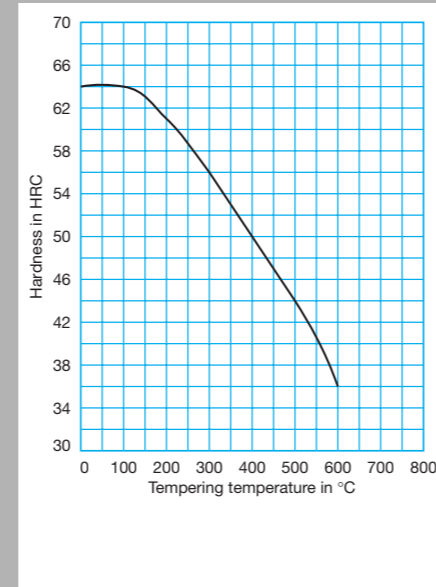
Applications
Cold pilger rolls and jaws, thread cutting tools, gauges, mandrels, wood and paper processing tools, cold extrusion and spinning tools, flanging rolls, shear and rotary shear blades.

Heat treatment						
Soft annealing °C	Cooling			Hardness HB		
710 – 750	Furnace			max. 225		
Stress-relief annealing °C	Cooling					
approx. 650	Furnace					
Hardening °C	Quenching			Hardness after quenching HRC		
830 – 860	Oil or saltbath (180 – 220 °C)			64		
Tempering °C	100	200	300	400	500	600
HRC	64	61	56	50	44	36

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2080	X210Cr12	D3

Chemical composition Typical analysis in %			
C	Si	Mn	Cr
2.00	0.30	0.30	12.00

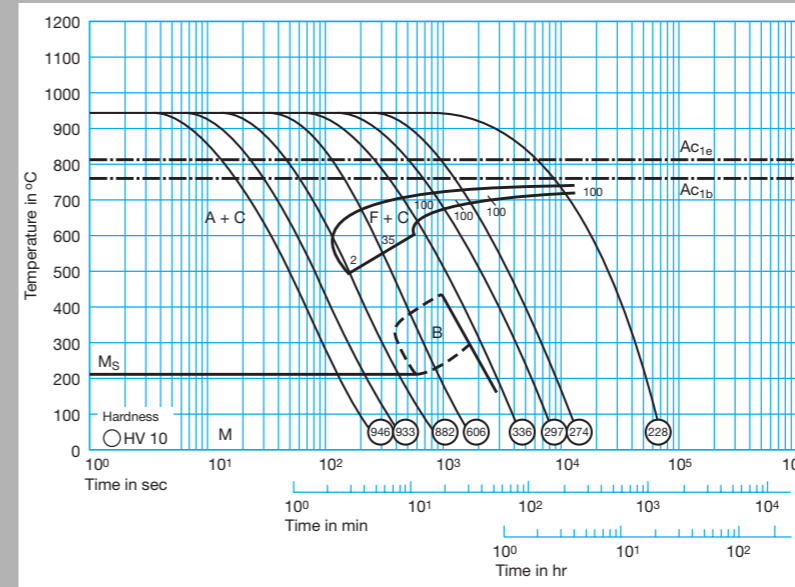
Steel properties
12 % ledeburitic chromium tool steel with extreme wear resistance.

Physical properties							
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
		10.8	11.7	12.2	12.6	12.8	13.1
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C				
	16.7	20.5	24.2				

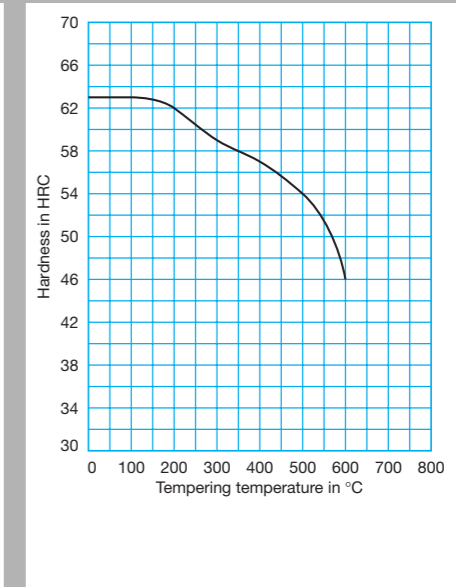
Applications
Cutting tools for sheets up to 4 mm thickness, trimming dies, blanking dies for paper and plastics, shear blades and rotary shear blades for sheet thicknesses up to 2 mm, drawing and deep-drawing tools. Woodworking tools, stone pressing tools, pressure pads and highly wear-resistant plastic moulds, profile rolls.

Heat treatment						
Soft annealing °C	Cooling			Hardness HB		
800 – 840	Furnace			max. 250		
Stress-relief annealing °C	Cooling					
approx. 650 – 700	Furnace					
Hardening °C	Quenching			Hardness after quenching HRC		
930 – 960	Oil			64		
950 – 980	Air (up to 30 mm thickness)					
Tempering °C	100	200	300	400	500	600
HRC	63	62	59	57	54	46

Time-temperature-transformation diagram



Tempering diagram



Identification

Material number	Reference number	AISI
1.2101	(62SiMnCr4)	

Chemical composition Typical analysis in %

C	Si	Mn	Cr
0.65	1.1	1.1	0.7

Steel properties

Good toughness and wear resistance.

Physical properties

Coefficient of thermal expansion $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	20 – 100 °C		20 – 200 °C
		11.8	

Thermal conductivity $\text{W}/(\text{m} \cdot \text{K})$	20 °C	350 °C	700 °C
		31.0	31.5

Applications

Spring collets, shear blades, guide rails and punching tools.

Heat treatment

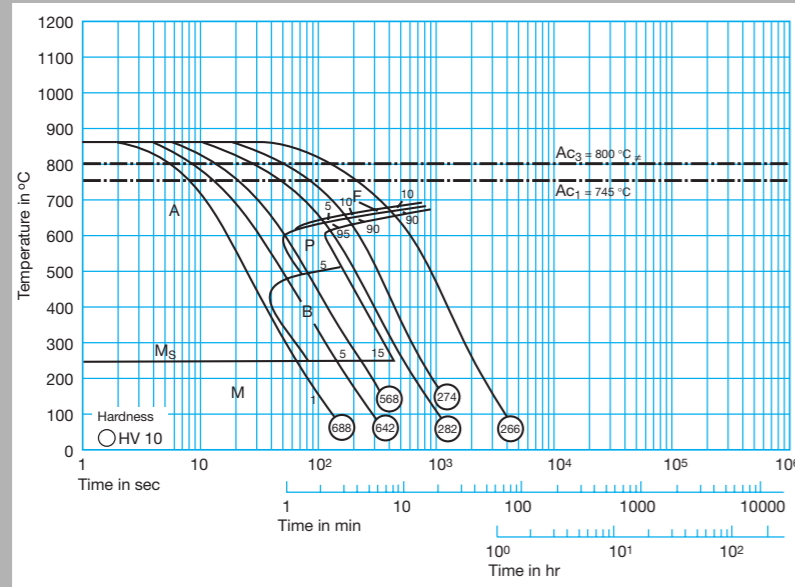
Soft annealing °C	Cooling	Hardness HB
700 – 750	Furnace	max. 225

Stress-relief annealing °C	Cooling
approx. 650 – 680	Furnace

Hardening °C	Quenching	Hardness after quenching HRC
830 – 860	Oil or saltbath (180 – 220 °C)	61

Tempering °C	100	200	300	400	500	600
	HRC	61	59	56	50	45

Time-temperature-transformation diagram



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Identification

Material number	Reference number	AISI
1.2201	(X165CrV12)	

Chemical composition Typical analysis in %

C	Cr	V
1.60	12.0	0.10

Steel properties

Dimensionally stable, oil-hardenable grade featuring extreme wear resistance combined with sufficient toughness.

Applications

High-performance steel for cutting, hobbors, thread rolls, metal saws, wood milling machines and similar items.

Heat treatment

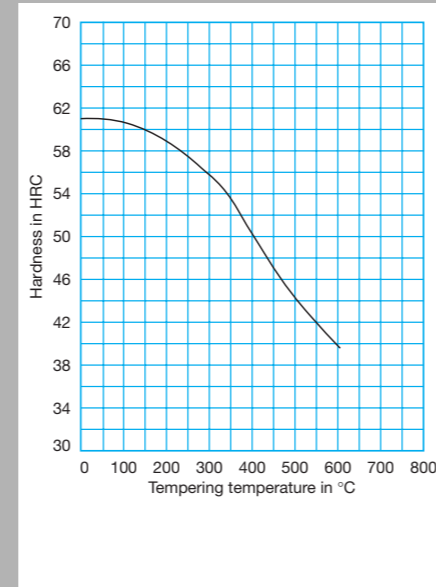
Soft annealing °C	Cooling	Hardness HB
800 – 830	Furnace	231

Stress-relief annealing °C	Cooling
approx. 650 – 680	Furnace

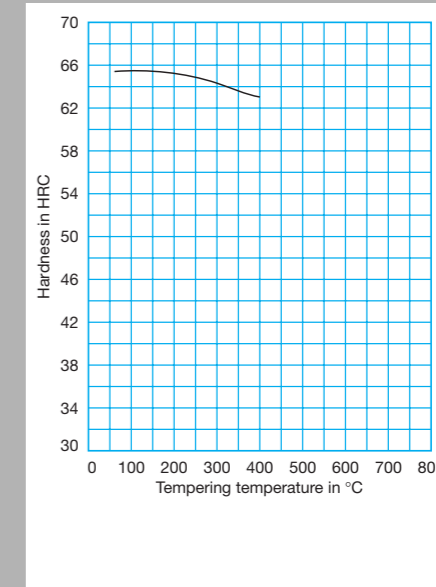
Hardening °C	Quenching	Hardness after quenching HRC
960 – 1000	Oil or saltbath (350 – 400 °C)	64

Tempering °C	100	200	300	400
	HRC	64	63	61

Tempering diagram



Tempering diagram



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Identification		
Material number	Reference number	AISI
1.2210	(115CrV3)	L2

Chemical composition Typical analysis in %		
C	Cr	V
1.20	0.7	0.1

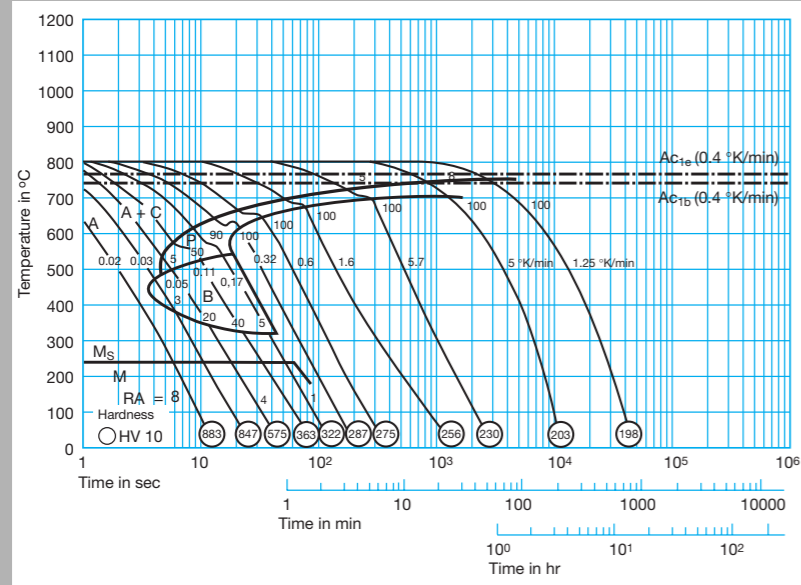
Steel properties
Wear resistant chromium-vanadium alloyed cold-work steel.

Physical properties							
Coefficient of thermal expansion $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
		10.0	12.7	13.7	14.2	14.9	15.8
Thermal conductivity $\text{W}/(\text{m} \cdot \text{K})$	20 °C		350 °C		700 °C		
	34.2		32.6		31.0		

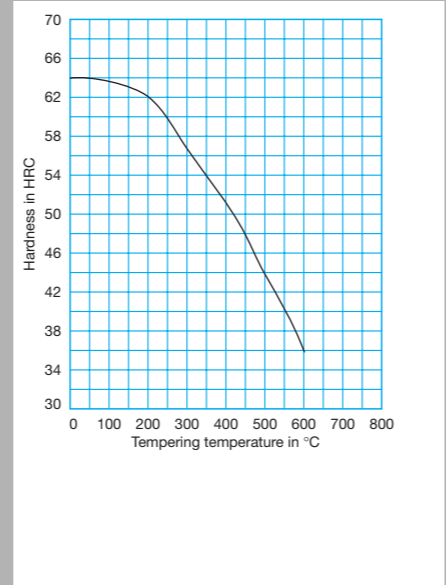
Applications
Piercing dies, guide rods, twist drills, ejector pins and wood chisels.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
710 – 750	Furnace	max. 220				
Stress-relief annealing °C	Cooling	Hardness after quenching HRC				
approx. 650 – 680	Furnace	64				
Hardening °C	Quenching		Hardness after quenching HRC			
	810 – 840	Oil (< 15 mm Ø)	64			
780 – 810	Water (> 15 mm Ø)	64				
Tempering °C	100	200	300	400	500	600
	HRC	64	62	57	51	44

Time-temperature-transformation diagram



Tempering diagram



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Identification		
Material number	Reference number	AISI
1.2235	(80CrV2)	

Chemical composition Typical analysis in %		
C	Cr	V
0.80	0.60	0.20

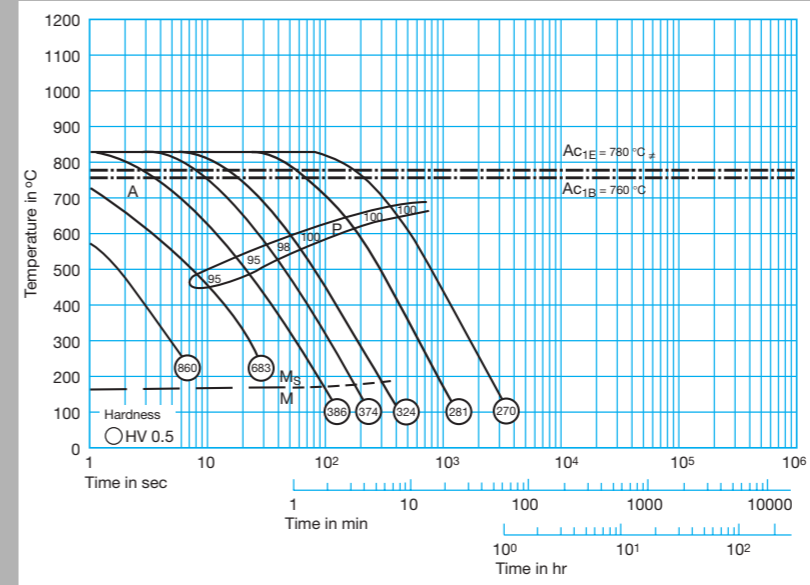
Steel properties
Special steel for woodworking, featuring a keen cutting edge.

Physical properties			
Thermal conductivity $\text{W}/(\text{m} \cdot \text{K})$	20 °C	350 °C	700 °C
		33.5	32.0

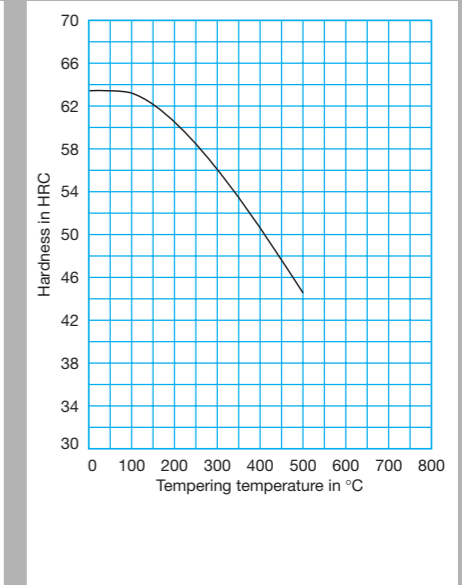
Applications
Circular and gang saws, machine knives, cutting tools for wood and non-ferrous metals, pliers and wood chisels.

Heat treatment					
Soft annealing °C	Cooling	Hardness HB			
680	Furnace	225			
Stress-relief annealing °C	Cooling	Hardness after quenching HRC			
approx. 650 – 680	Furnace	63			
Hardening °C	Quenching		Hardness after quenching HRC		
	800 – 830	Oil	63		
Tempering °C	100	200	300	400	500
	HRC	63	61	57	52

Time-temperature-transformation diagram



Tempering diagram



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Identification		
Material number	Reference number	AISI
1.2242	(59CrV4)	

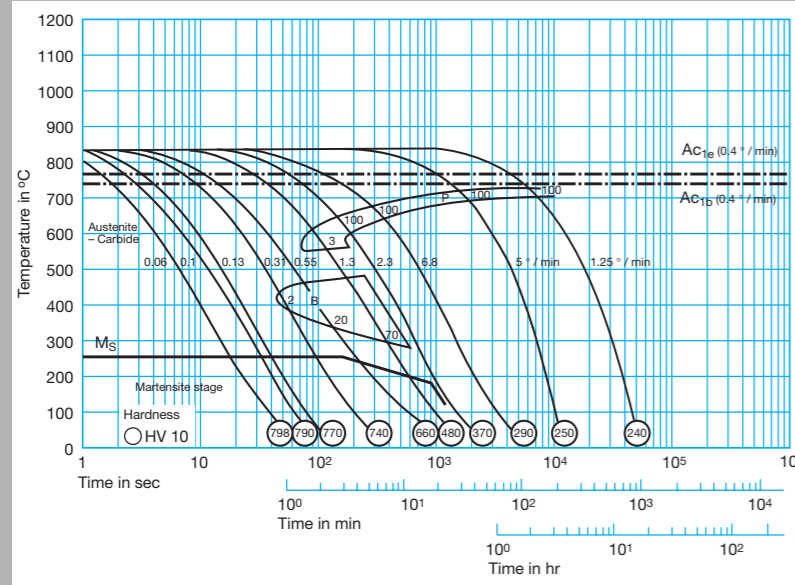
Chemical composition Typical analysis in %				
C	Mn	Cr	V	
0.59	0.9	1.0	0.1	

Steel properties
Wear resistant, high toughness.

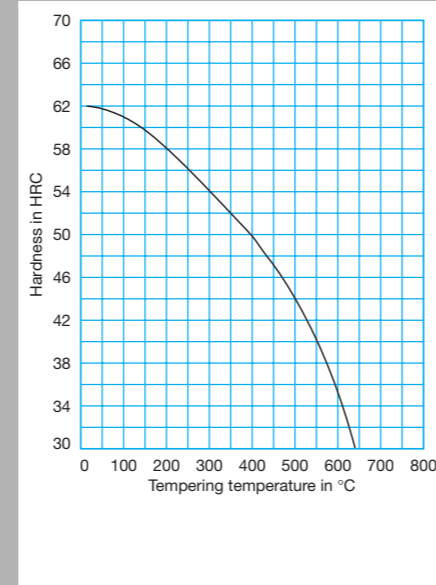
Applications
Special steel for hand chisels of all types, including flat, cross-cut and pointed chisels for the treatment of hard materials. Also for screwdrivers and other hand tools.

Heat treatment				
Soft annealing °C	Cooling	Hardness HB		
710 – 740	Furnace	max. 230		
Stress-relief annealing °C	Cooling			
approx. 650 – 680	Furnace			
Hardening °C	Quenching	Hardness after quenching HRC		
810 – 850	Oil	62		
Tempering °C	100	200	300	400
HRC	61	58	55	50

Time-temperature-transformation diagram



Tempering diagram



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Identification		
Material number	Reference number	AISI
1.2243	(61CrSiV5)	

Chemical composition Typical analysis in %				
C	Si	Mn	Cr	V
0.60	0.9	0.8	1.1	0.1

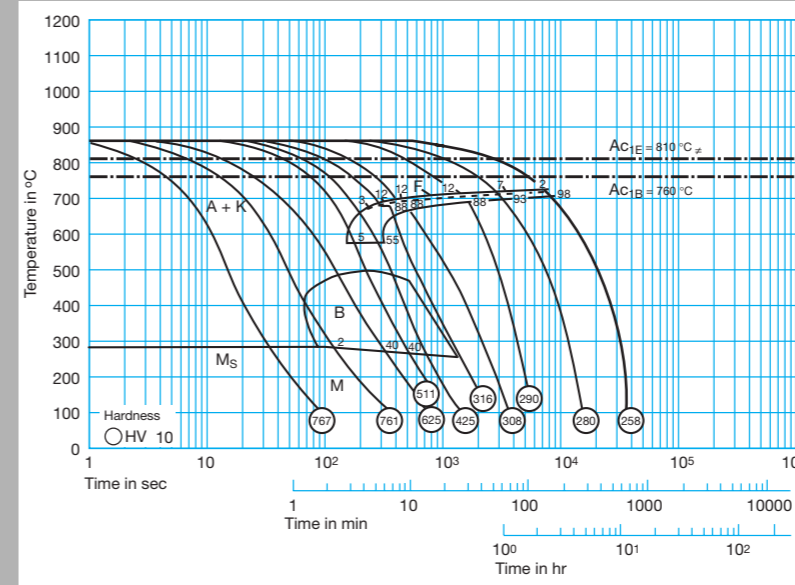
Steel properties
Wear resistant, high toughness.

Physical properties			
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	33.5	32.0	31.0

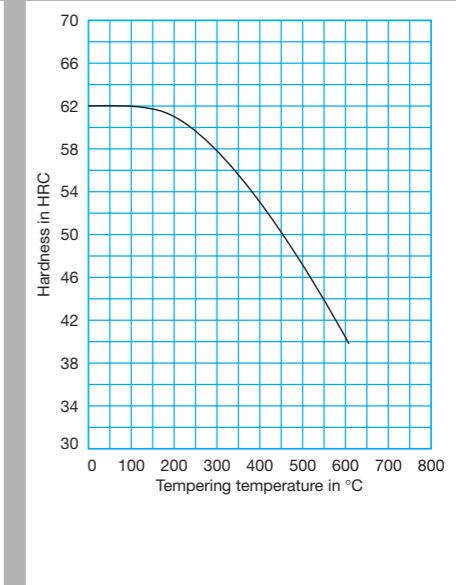
Applications
Cold heading dies, shear blades, section-cutting shear blades and trimming dies, punching tools and bolting tools.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
700 – 740	Furnace	max. 220				
Stress-relief annealing °C	Cooling					
approx. 650 – 680	Furnace					
Hardening °C	Quenching	Hardness after quenching HRC				
850 – 880	Oil or saltbath (180 – 220 °C)	62				
Tempering °C	100	200	300	400	500	600
HRC	62	61	57	52	47	40

Time-temperature-transformation diagram



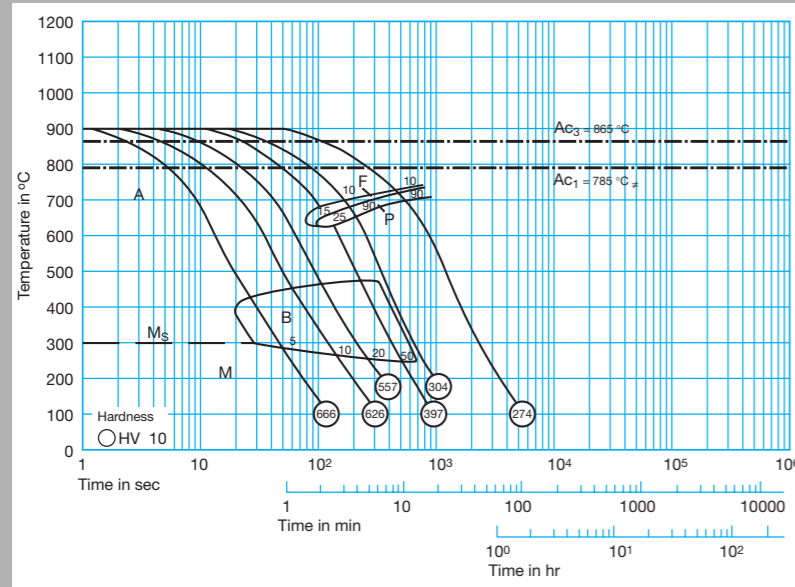
Tempering diagram



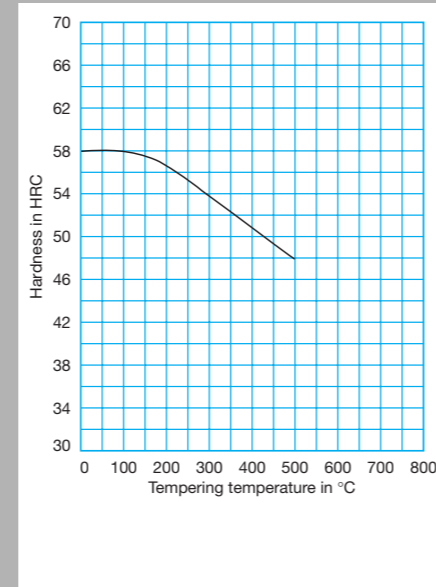
Reference numbers in brackets are not standardized in EN ISO 4957.

Identification						
Material number	Reference number		AISI			
1.2249	(45SiCrV6)					
Chemical composition Typical analysis in %						
C	Si	V	Cr			
0.45	1.35	0.10	1.35			
Steel properties						
Tough, impact-resistant tool steel.						
Applications						
Pneumatic chipping hammers, punching tools, riveting hammers, punches and woodworking tools.						
Heat treatment						
Soft annealing °C	Cooling		Hardness HB			
710 – 750	Furnace		219			
Stress-relief annealing °C	Cooling		Hardness after quenching HRC			
approx. 650 – 680	Furnace					
Hardening °C	Quenching		Hardness after quenching HRC			
860 – 890	Oil		58			
Tempering °C	100	200	300	400	500	
HRC	58	57	53	51	50	

Time-temperature-transformation diagram



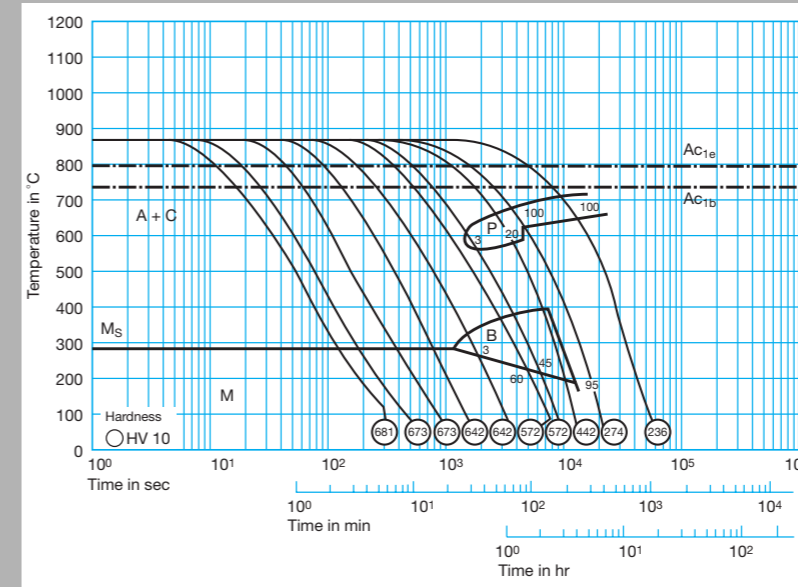
Tempering diagram



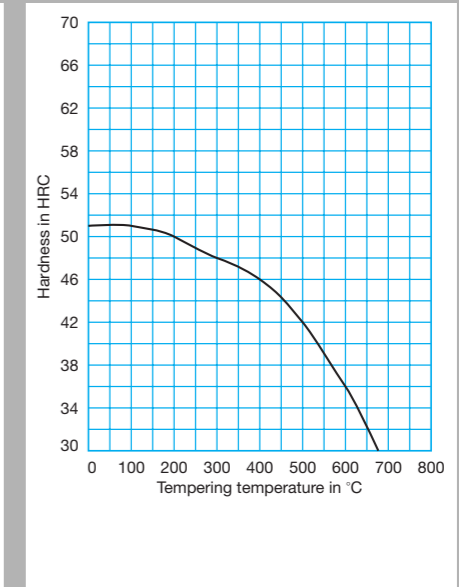
Reference numbers in brackets are not standardized in EN ISO 4957.

Identification							
Material number	Reference number		AISI				
1.2312	40CrMnNiMo8-6-4 ¹		P20+S				
Chemical composition Typical analysis in %							
C	Si	Mn	Cr	Mo	S		
0.40	0.35	1.50	1.90	0.20	0.05		
Steel properties							
Quenched and tempered plastic mould steel with a hardness in as-delivered condition of 280 to 325 HB. Improved machinability in comparison with THYROPLAST® 2311. Polishable.							
Physical properties							
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C		20 – 200 °C		20 – 300 °C		
Annealed	12.5		13.4		13.9		
Quenched and tempered	12.3		13.0		13.7		
Thermal conductivity W/(m · K)	100 °C	150 °C	200 °C	250 °C	300 °C		
Annealed	40.2	40.9	40.3	40.0	39.0		
Quenched and tempered	39.8	40.4	40.4	39.9	39.0		
Applications							
Plastic moulds, mould frames for plastic and pressure casting moulds, recipient sleeves, brake dies.							
Heat treatment							
Soft annealing °C	Cooling		Hardness HB				
710 – 740	Furnace		max. 235				
Stress-relief annealing (annealed) °C	Stress-relief annealing (quenched and tempered) °C		Cooling				
approx. 600	approx. 30 – 50 under tempering temperature		furnace				
Hardening °C	Quenching		Hardness after quenching HRC				
840 – 870	Oil or saltbath (180 – 220 °C)		51				
Tempering °C	100	200	300	400	500	600	700
HRC	51	50	48	46	42	36	28

Time-temperature-transformation diagram



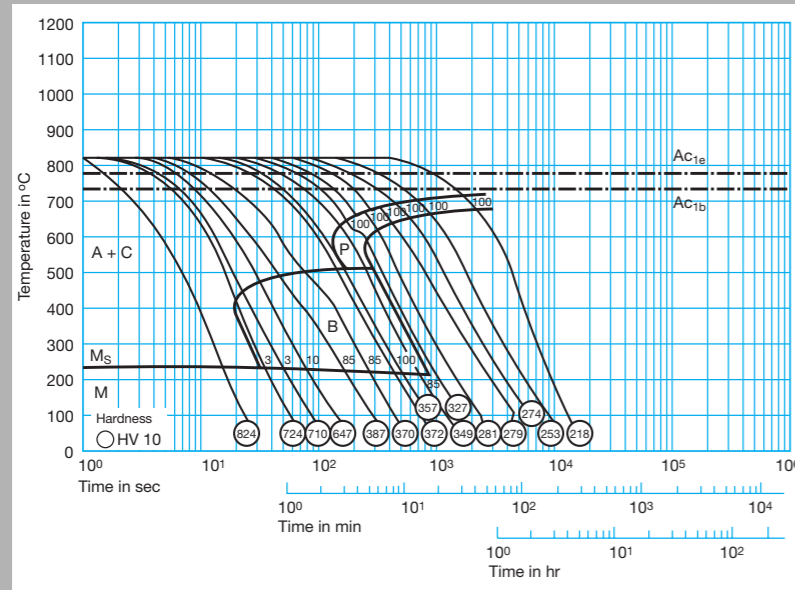
Tempering diagram



¹S can be raised between 0.05 and 0.1% whereas Ni can be left out completely.

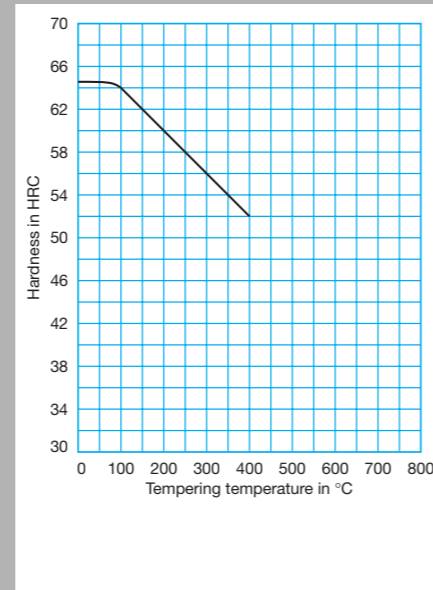
Identification				
Material number	Reference number	AISI		
1.2327	(~86CrMoV7)			
Chemical composition Typical analysis in %				
C	Si	Mn	Cr	Mo
0.83	0.45	0.40	1.90	0.30
Steel properties				
Cr-Mo alloyed shell-hardenable grade with high wear resistance.				
Applications				
Standard cold-roll steel for rolls of all sizes, backup rolls and work rolls.				
Heat treatment				
Soft annealing °C	Cooling	Hardness HB		
710 – 750	Furnace	max. 250		
Hardening °C	Quenching	Hardness after quenching HRC		
830 – 850	Water	64 – 65		
Tempering °C	100	200	300	400
HRC	64	60	56	52

Time-temperature-transformation diagram



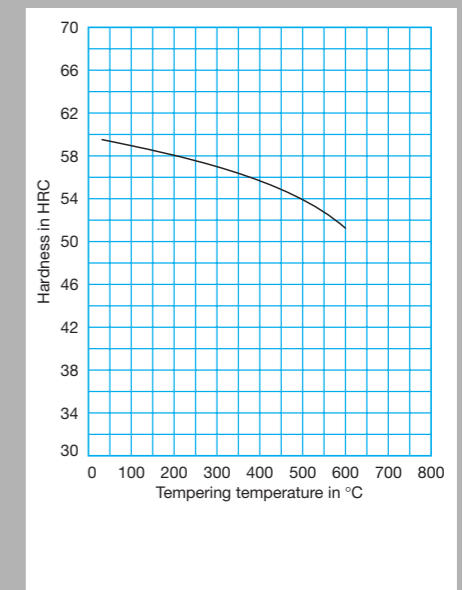
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Tempering diagram



Identification					
Material number	Reference number	AISI			
1.2328	(45CrMoV7)				
Chemical composition Typical analysis in %					
C	Mn	Cr	Mo	V	
0.45	0.90	1.8	0.30	0.05	
Steel properties					
Air-hardening steel of great hardness and toughness.					
Applications					
Special steel for chisels.					
Heat treatment					
Soft annealing °C	Cooling	Hardness HB			
690 – 730	Furnace	max. 248			
Stress-relief annealing °C	Cooling	Hardness after quenching HRC			
approx. 650	Furnace	55			
Hardening °C	Quenching	Hardness after quenching HRC			
840 – 860	Air	55			
Tempering °C	100	200	300	400	500
HRC	57	55	52	49	45

Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2343	X37CrMoV5-1	H11

Chemical composition Typical analysis in %					
C	Si	Cr	Mo	V	
0.38	1.0	5.3	1.3	0.4	

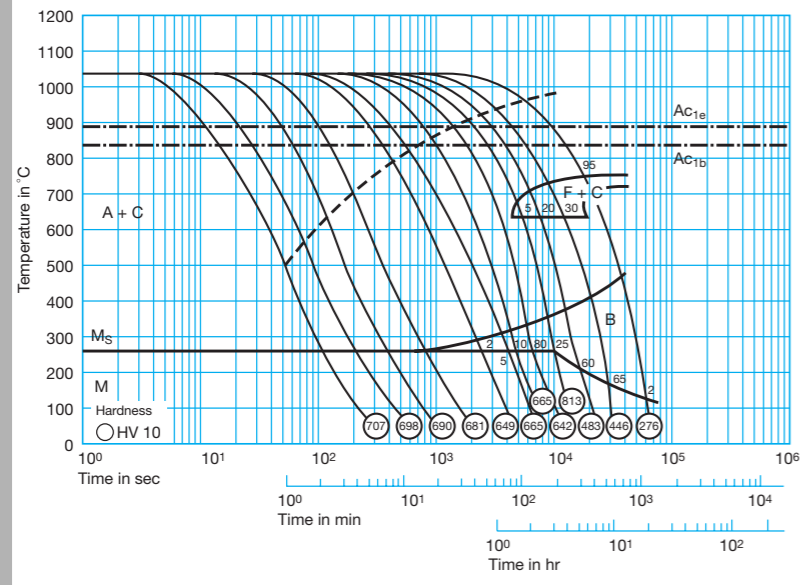
Steel properties
 High hot tensile strength and toughness. Good thermal conductivity and insusceptibility to hot cracking. Can be water-cooled to a limited extent.

Physical properties							
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
		11.8	12.4	12.6	12.7	12.8	12.9
Thermal conductivity W/(m · K)	20 °C		350 °C			700 °C	
	Annealed		30.0			33.4	
	Quenched and tempered		27.3			30.3	

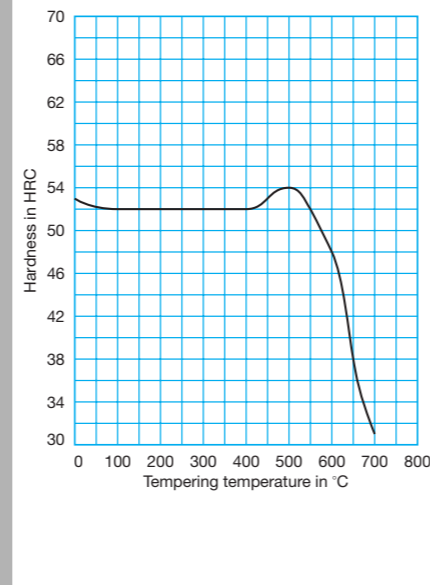
Applications
 Besides applications typical for the area of hot-work steels, this grade is mainly used for ejector pins, tool holders and shrink fit chucks.

Heat treatment									
Soft annealing °C	Cooling			Hardness HB					
750 – 800	Furnace			max. 230					
Stress-relief annealing °C	Cooling								
approx. 600 – 650	Furnace								
Hardening °C	Quenching			Hardness after quenching HRC					
1000 – 1030	Air, oil or saltbath (500 – 550 °C)			54					
Tempering °C	100	200	300	400	500	550	600	650	700
	HRC	52	52	52	52	54	52	48	38

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2344	X40CrMoV5-1	H13

Chemical composition Typical analysis in %					
C	Si	Cr	Mo	V	
0.40	1.0	5.3	1.4	1.0	

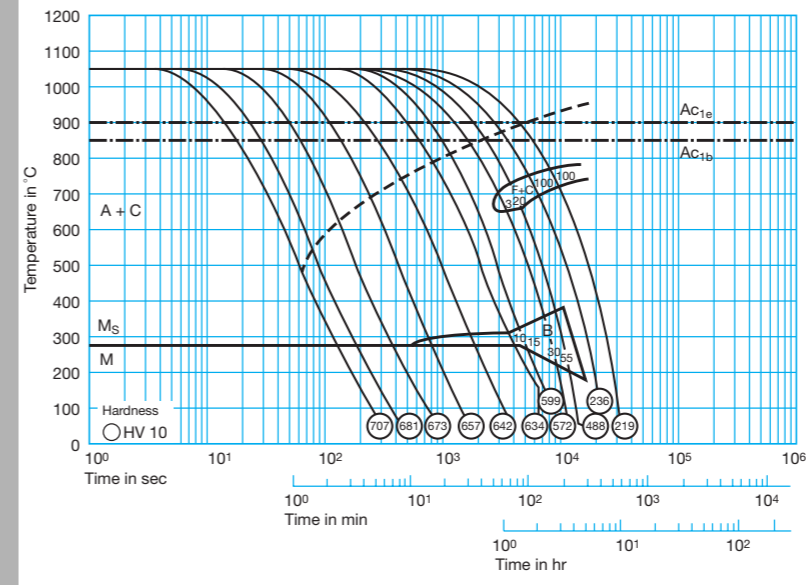
Steel properties
 High hot-wear resistance and hot tensile strength as well as good toughness, thermal conductivity and insusceptibility to hot-cracking. Can be water-cooled to a limited extent.

Physical properties							
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
		10.9	11.9	12.3	12.7	13.0	13.3
Thermal conductivity W/(m · K)	20 °C		350 °C			700 °C	
	Annealed		30.5			33.4	
	Quenched and tempered		27.6			30.3	

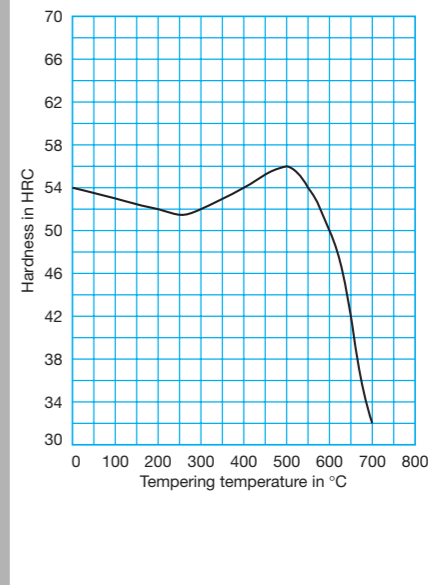
Applications
 Besides applications typical for the area of hot-work steels, this grade is mainly used for ejector pins, tool holders and shrink fit chucks.

Heat treatment									
Soft annealing °C	Cooling			Hardness HB					
750 – 800	Furnace			max. 230					
Stress-relief annealing °C	Cooling								
approx. 600 – 650	Furnace								
Hardening °C	Quenching			Hardness after quenching HRC					
1020 – 1050	Air, oil or saltbath (500 – 550 °C)			54					
Tempering °C	100	200	300	400	500	550	600	650	700
	HRC	53	52	52	54	56	54	50	42

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2357	(50CrMoV13-15)	S7

Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	V	
0.50	0.30	0.70	3.35	1.60	0.25	

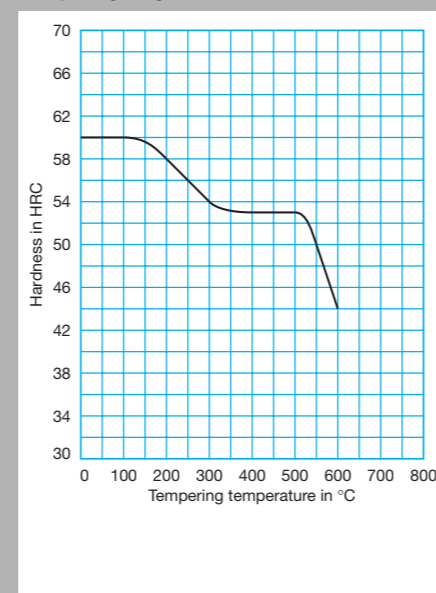
Steel properties
High toughness and wear resistance, high compression strength combined with dimensional stability and good polishability.

Physical properties			
Coefficient of thermal expansion $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	20 – 200 °C		20 – 400 °C
		12.2	
Thermal conductivity $\text{W}/(\text{m} \cdot \text{K})$	20 °C	200 °C	400 °C
	28.9	30.0	31.0

Applications
Cold-work tool steel for punching tools, moulds, scrap shears, piercing dies, hobbers, coining dies, deburring tools, plastic moulds and pelleters.

Heat treatment							
Soft annealing °C	Cooling			Hardness HB			
610 – 650	Furnace			approx. 220			
Hardening °C	Quenching			Hardness after quenching HRC			
920 – 970	Air or oil			60 – 62			
Stress-relief annealing °C	Cooling						
approx. 600	Furnace						
Tempering °C	100	200	300	400	500	550	600
	HRC	60	58	54	53	53	50

Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
~1.2360	(~X48CrMoV8-1-1)	

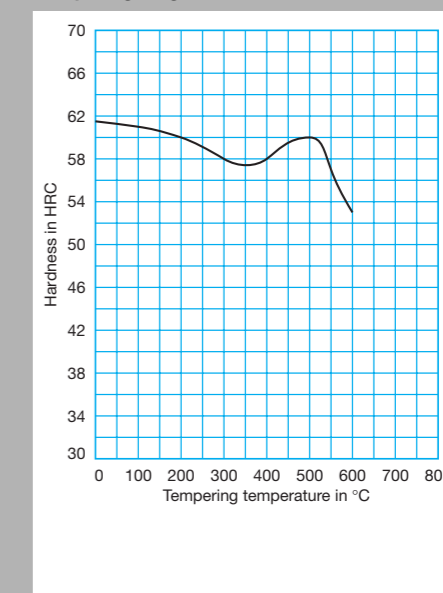
Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	V	
0.50	1.20	0.35	7.30	1.50	0.50	

Steel properties
THYRODUR® 2360 is a 7 % chromium steel that derives its high wear resistance from a balanced combination of the alloying elements. The medium V concentration of 0.5 % generates a sufficiently high hardenability combined with high toughness, even at comparatively low operating temperatures below RT.

Applications
This grade is especially suitable for use with chipper knives, blade holders, veneer slicing blades, blade inserts, billet-shear blades and reinforcements. All require a combination of high hardness and toughness as do large cold extrusion tools of complex geometry.

Heat treatment							
Soft annealing °C	Cooling			Hardness HB			
830 – 860	Furnace			max. 240			
Stress-relief annealing °C	Cooling						
approx. 650	Furnace						
Hardening °C	Quenching			Hardness after quenching HRC			
1030 – 1070	Air, oil or saltbath (550 °C)			60 – 61			
Tempering °C	100	200	300	400	500	550	600
	HRC	61	60	58	58	60	57

Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification

Material number	Reference number	AISI
-1.2362	(~X63CrMoV5-1)	

Chemical composition Typical analysis in %

C	Si	Mn	Cr	Mo	V
0.65	1.10	0.40	5.20	1.40	0.50

Steel properties

Cr-Mo alloyed through-hardening grade with high tempering resistance.

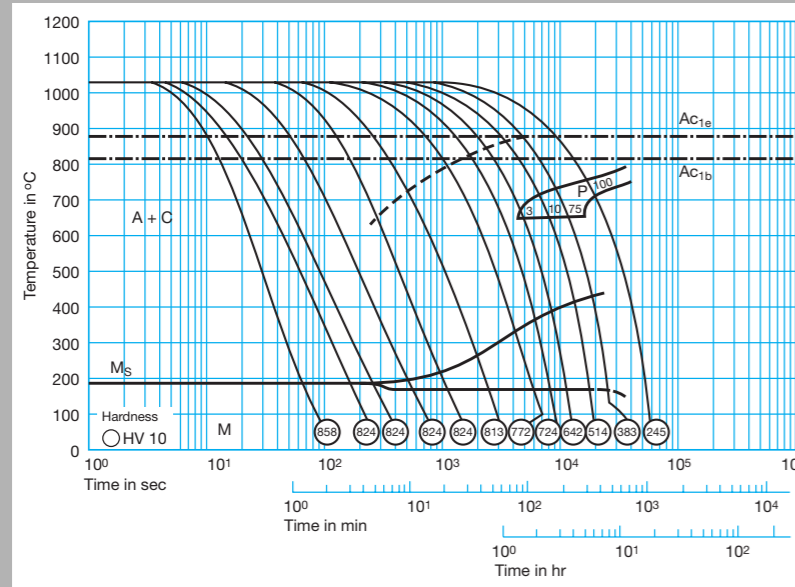
Applications

Intermediate rolls for cluster mills.

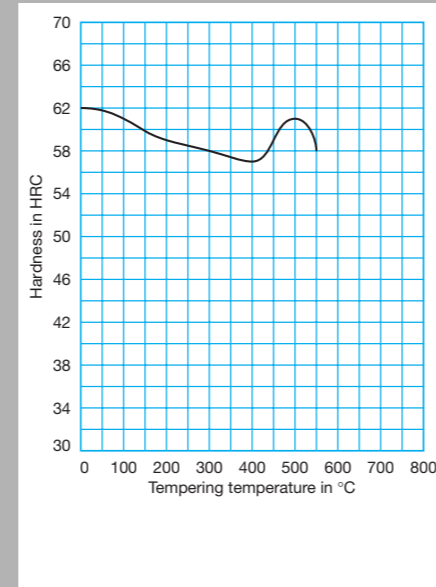
Heat treatment

Soft annealing °C	Cooling	Hardness HB
800 – 840	Furnace	max. 250
Hardening °C	Quenching	Hardness after quenching HRC
980 – 1020	Oil or saltbath	61 – 63
Tempering °C		
HRC	100 200 300 400 500 550	61 59 58 57 61 58

Time-temperature-transformation diagram



Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957

Identification

Material number	Reference number	AISI
1.2363	X100CrMoV5	A2

Chemical composition Typical analysis in %

C	Si	Mn	Cr	Mo	V
1.00	0.30	0.50	5.00	0.95	0.20

Steel properties

High dimensional stability during heat treatment. High wear resistance and toughness.

Physical properties

Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	15.8	26.7	29.1

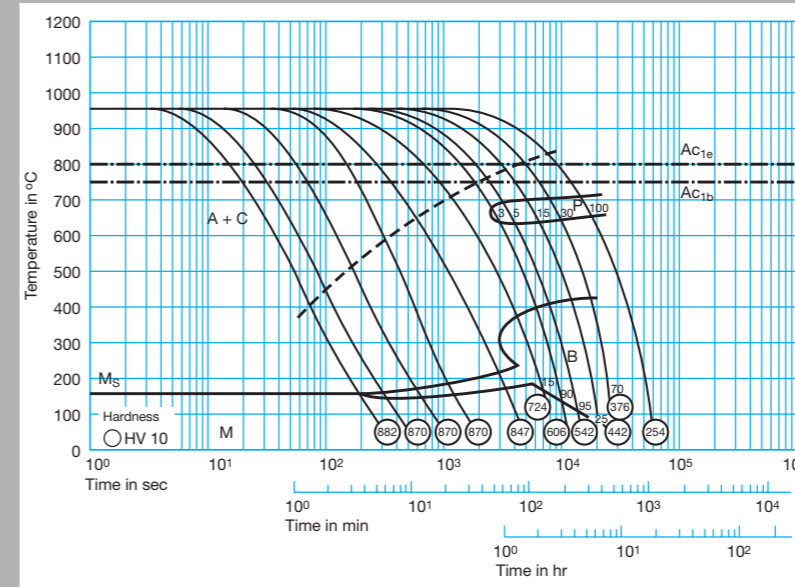
Applications

Cutting tools, rolls, shear blades, cold pilger mandrels, cold stamping tools, moulds for plastics processing.

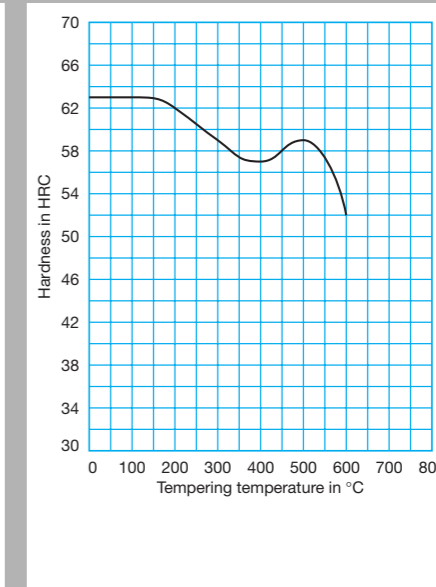
Heat treatment

Soft annealing °C	Cooling	Hardness HB
800 – 840	Furnace	max. 231
Hardening °C	Quenching	Hardness after quenching HRC
930 – 970	Air, oil or saltbath (500 – 550 °C)	63
Stress-relief annealing °C	Cooling	
approx. 650	Furnace	
Tempering °C		
HRC	100 200 300 400 500 600	63 62 59 57 59 52

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2379	X153CrMoV12	D2

Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	V	
1.55	0.30	0.35	12.00	0.75	0.90	

Steel properties
 12 % ledeburitic chromium steel. Combines maximum wear resistance, good toughness, outstanding cutting edge retention and tempering resistance. It can be nitrided after special heat treatment.

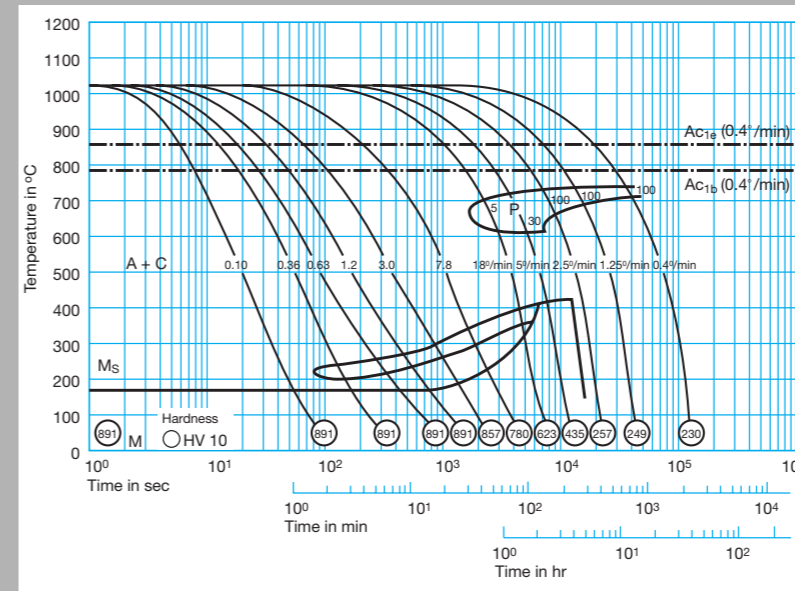
Physical properties				
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C
		10.5	11.5	11.9
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C	
		16.7	20.5	24.2

Applications
 Threading rolls and dies, cold extrusion tools, trimming, cutting and stamping tools for sheet thicknesses up to 6 mm, precision cutting tools for sheet thicknesses up to 12 mm, cold pilger mandrels, circular-shear blades, deep-drawing tools, pressure pads and highly wear-resistant plastic moulds.

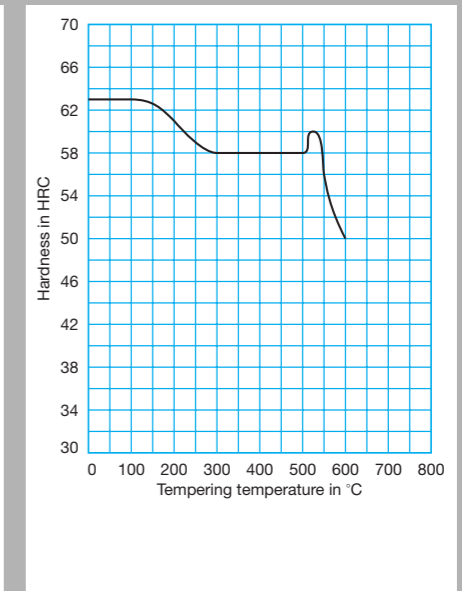
Heat treatment								
Soft annealing °C	Cooling				Hardness HB			
830 – 860	Furnace				max. 250			
Stress-relief annealing °C	Cooling							
650 – 700	Furnace							
Hardening °C	Quenching				Hardness after quenching HRC			
1000 – 1050	Air, oil or saltbath (500 – 550 °C)				63			
Tempering °C	100	200	300	400	500	525	550	600
HRC	63	61	58	58	58	60	56	50

Special heat treatment								
Hardening °C	Quenching				Hardness after quenching HRC			
1050 – 1080	Air, oil or saltbath (500 – 550 °C)				61			
Tempering °C	100	200	300	400	500	525	550	600
(three times) HRC	61	60	58	59	62	62	57	50

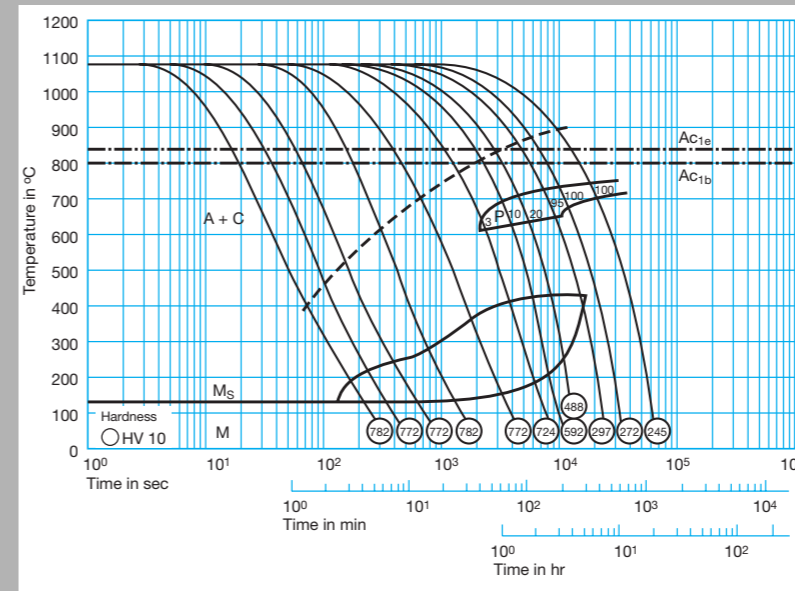
Time-temperature-transformation diagram
 Hardening temperature: 1030 °C



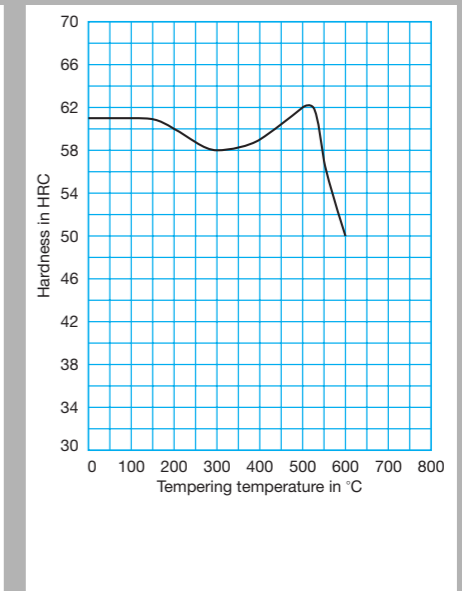
Tempering diagram



Time-temperature-transformation diagram
 Hardening temperature: 1080 °C



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2381	(73MoV5-2)	S2

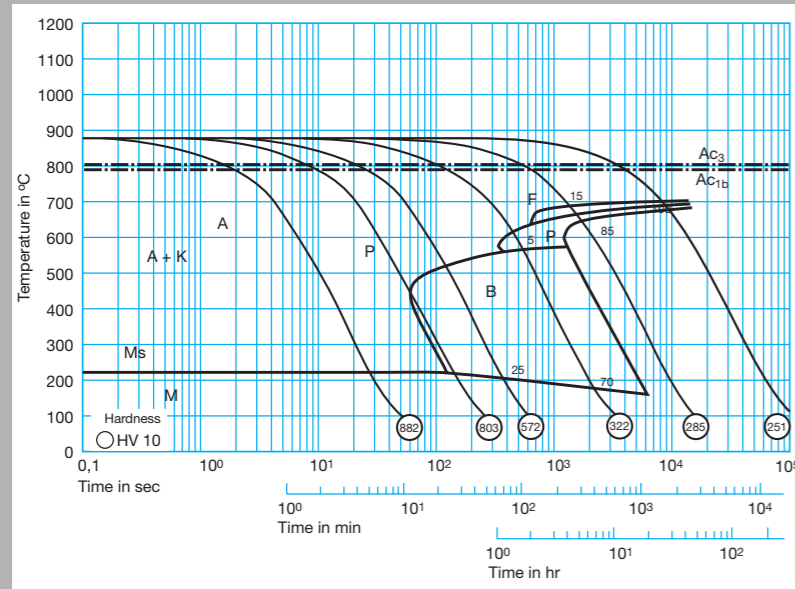
Chemical composition Typical analysis in %					
C	Si	Mn	Mo	V	
0.73	1.20	0.50	0.55	0.20	

Steel properties
High tensile special steel with good resistance to twisting.

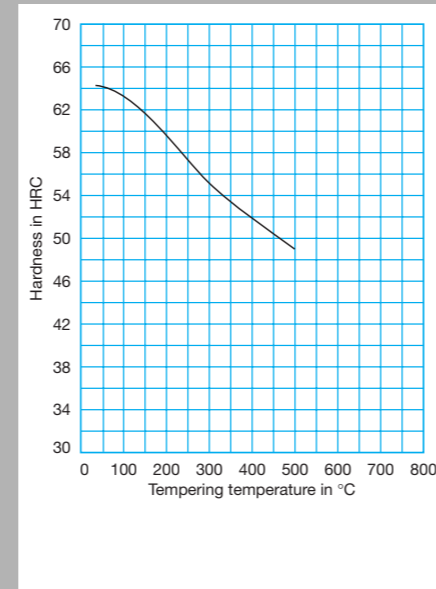
Applications
Screwdrivers, bits, low-stressed tools for the cutting, punching and folding of sheet.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
700 – 750	Furnace	max. 330				
Stress-relief annealing °C	Cooling					
650 – 680	Furnace					
Hardening °C	Quenching	Hardness after quenching HRC				
840 – 860	Oil	64				
Tempering °C	100	200	300	400	500	600
HRC	64	60	56	52	48	45

Time-temperature-transformation diagram



Tempering diagram



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Identification		
Material number	Reference number	AISI
1.2436	X210CrW12	-D6

Chemical composition Typical analysis in %				
C	Si	Mn	Cr	W
2.10	0.35	0.35	12.00	0.70

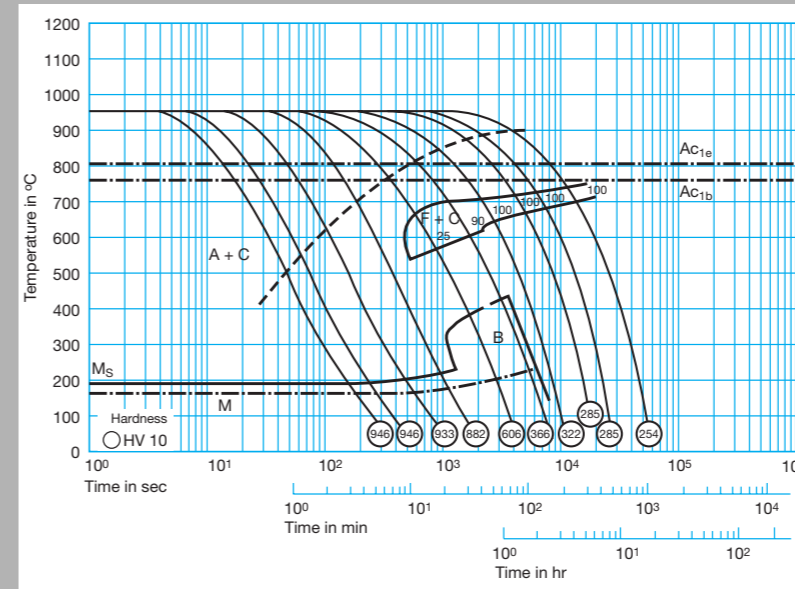
Steel properties
12 % ledeburitic chromium steel with very high wear resistance and cutting edge retention as well as improved hardenability in comparison to THYRODUR® 2080.

Physical properties							
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
		10.9	11.9	12.3	12.6	12.9	13.0
Thermal conductivity W/(m · K)	20 °C	350 °C			700 °C		
	16.7	20.5			24.2		

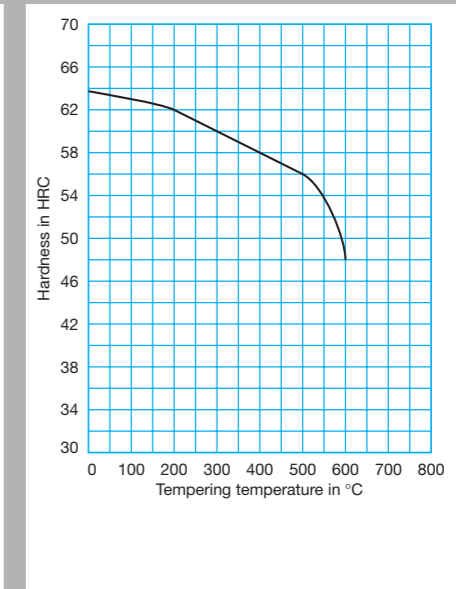
Applications
Heavy-duty blanking dies for cutting transformer and dynamo sheets up to 2 mm thickness as well as for paper and plastics, deep-drawing tools, drawing dies and mandrels, shear blades, stone pressing tools.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
800 – 840	Furnace	max. 250				
Stress-relief annealing °C	Cooling					
650 – 700	Furnace					
Hardening °C	Quenching	Hardness after quenching HRC				
950 – 980	Air, oil or saltbath (500 – 550 °C)	64				
Tempering °C	100	200	300	400	500	600
HRC	63	62	60	58	56	48

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2510	(100MnCrW4)	O2

Chemical composition Typical analysis in %						
C	Si	Mn	Cr	V	W	
0.95	0.20	1.10	0.60	0.10	0.60	

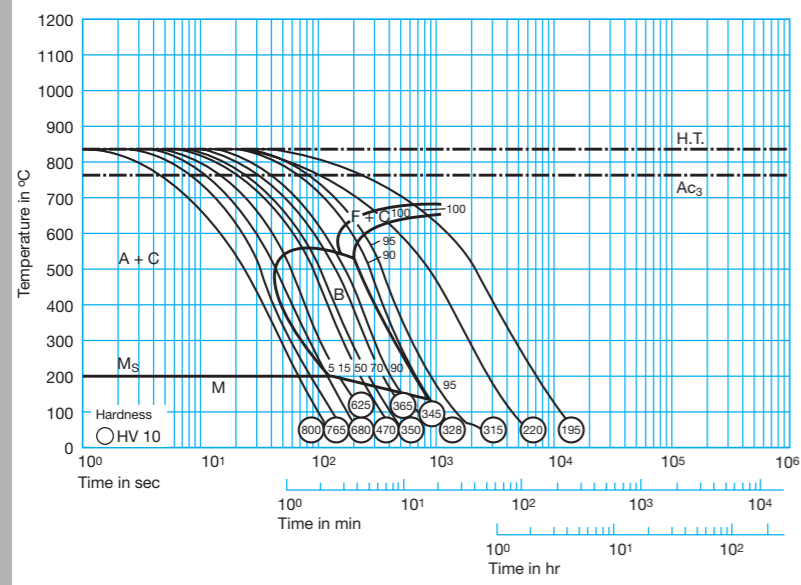
Steel properties
Good cutting edge retention, high hardenability and dimensional stability during heat treatment.

Physical properties			
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	33.5	32.0	30.9

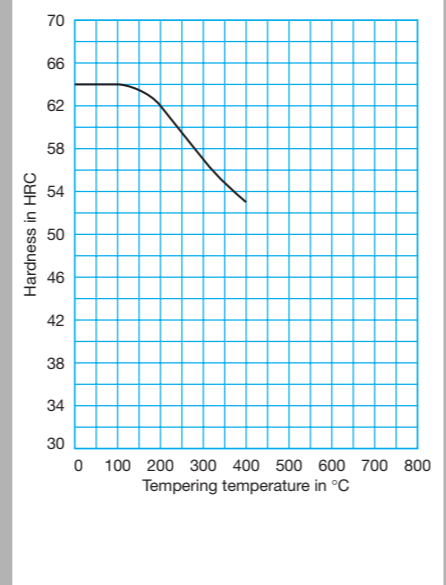
Applications
Blanking and stamping dies for cutting sheets up to 6 mm thickness, threading tools, drills, broaches, gauges, measuring tools, plastic moulds, shear blades, guide rails.

Heat treatment			
Soft annealing °C	Cooling	Hardness HB	
740 – 770	Furnace	max. 230	
Stress-relief annealing °C	Cooling		
approx. 650	Furnace		
Hardening °C	Quenching	Hardness after quenching HRC	
780 – 820	Oil or saltbath (180 – 220 °C)	64	
Tempering °C		100	200
HRC		64	62
		300	400
		57	53

Time-temperature-transformation diagram



Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2516	(120WV4)	

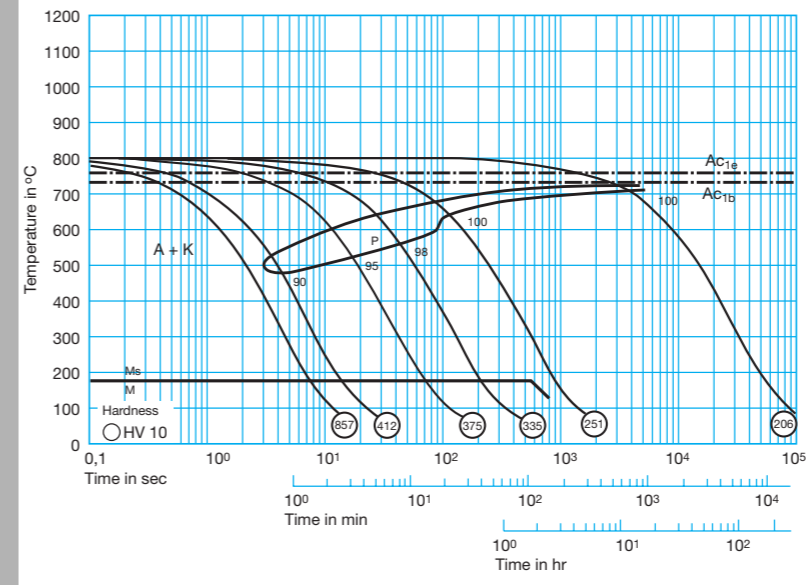
Chemical composition Typical analysis in %			
C	Cr	V	W
1.20	0.2	0.1	1.0

Steel properties
Water-hardening steel featuring good cutting edge retention and high hardenability.

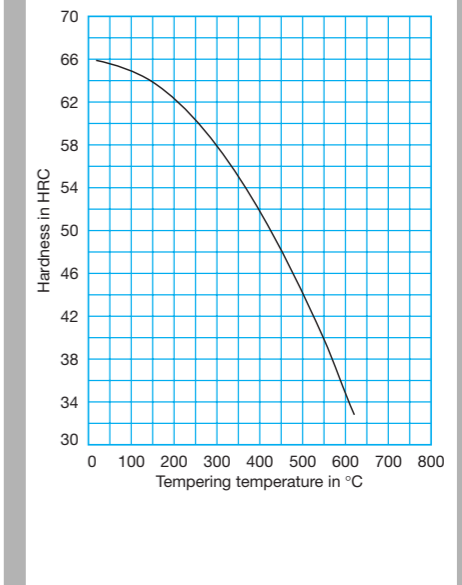
Applications
Thread cutting tools, twist drills, dentist's drills and metal saws.

Heat treatment				
Soft annealing °C	Cooling	Hardness HB		
700 – 720	Furnace	max. 230		
Stress-relief annealing °C	Cooling			
650 – 680	Furnace			
Hardening °C	Quenching	Hardness after quenching HRC		
780 – 820	Oil or water	66		
Tempering °C		100	200	300
HRC		65	62	57
		400	51	

Time-temperature-transformation diagram



Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2550	60WCrV8	

Chemical composition Typical analysis in %						
C	Si	Mn	Cr	V	W	
0.60	0.60	0.35	1.10	0.20	2.00	

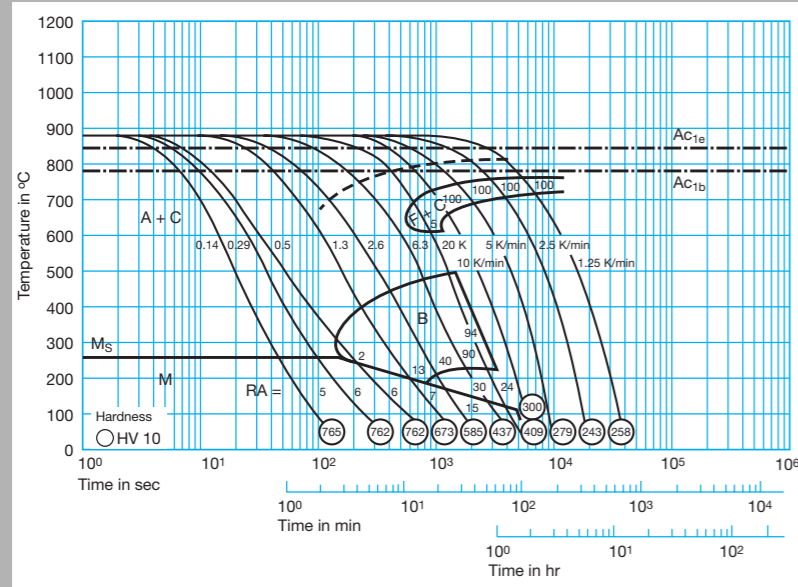
Steel properties
Impact-resistant oil-hardenable steel, characterized by very good toughness in combination with high hardenability.

Physical properties							
Coefficient of thermal expansion $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
		11.8	12.7	13.1	13.5	14.0	14.3
Thermal conductivity $W/(\text{m} \cdot \text{K})$	20 °C		350 °C		700 °C		
	34.2		32.6		30.9		

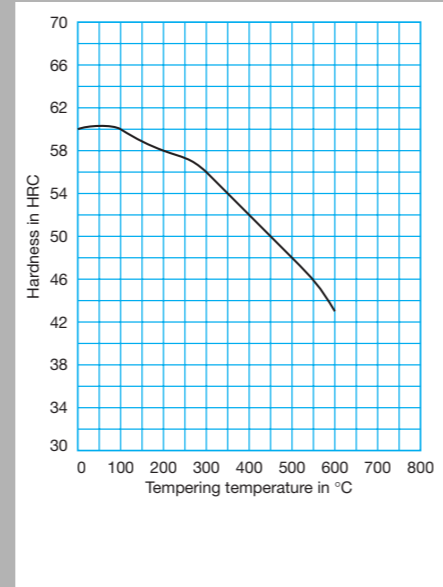
Applications
Blanking dies for cutting sheets up to 12 mm thickness, trimming and splitting dies, cold piercing punches, preforming punches, shear blades, chipping knives, pneumatic chisels, coining tools, cold shear blades, ejectors.

Heat treatment							
Soft annealing °C	Cooling	Hardness HB					
710 – 750	Furnace	max. 225					
Stress-relief annealing °C	Cooling						
approx. 650	Furnace						
Hardening °C	Quenching	Hardness after quenching HRC					
870 – 900	Oil or saltbath (180 – 220 °C)	60					
Tempering °C		100	200	300	400	500	600
		HRC	60	58	56	52	48

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.2709	(X3NiCoMoTi18-9-5)	18MAR300

Chemical composition Typical analysis in %				
C	Mo	Ni	Co	Ti
< 0.02	5.00	18.00	10.00	1.00

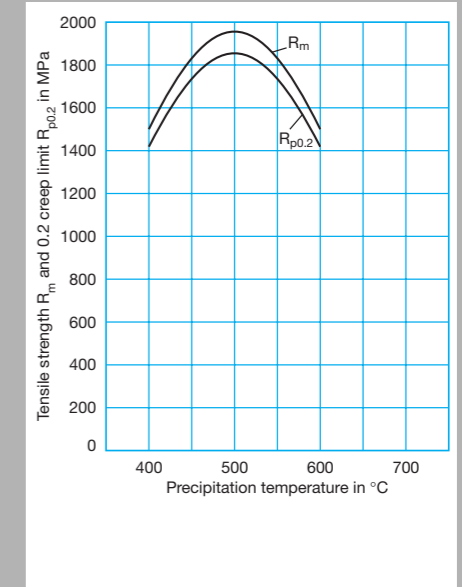
Steel properties
Precipitation-hardenable grade with high yield point and tensile strength combined with good toughness.

Physical properties						
Coefficient of thermal expansion $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C
		10.3	11.0	11.2	11.5	11.8
Thermal conductivity $W/(\text{m} \cdot \text{K})$	20 °C		350 °C		700 °C	
	14.2		18.5		22.5	

Applications
Casings for cold extrusion tools, cutting and punching tools.

Heat treatment		
Solution annealing °C	Cooling	Hardness HB
820 – 850	Water	max. 340
Precipitation temperature °C	Attainable hardness HRC	
490 / 6 h / Air	approx. 55	

Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification

Material number	Reference number	AISI
1.2714	55NiCrMoV7	~6F3

Chemical composition Typical analysis in %

C	Cr	Mo	Ni	V
0.56	1.1	0.5	1.7	0.1

Steel properties

Tough die steel with high tempering resistance and good through-hardening properties. This grade is usually supplied in annealed condition or quenched and tempered to a working hardness of 370 to 410 HB (round) or 355 to 400 HB (square, flat).

Physical properties

Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C
	12.2	13.0	13.3	13.7	14.2	14.4

Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	36.0	38.0	35.0

Applications

Standard steel for forging dies of all types, press dies, extrusion dies, retainer plates, armoured trim dies, hot-shear blades and tool holders.

Heat treatment

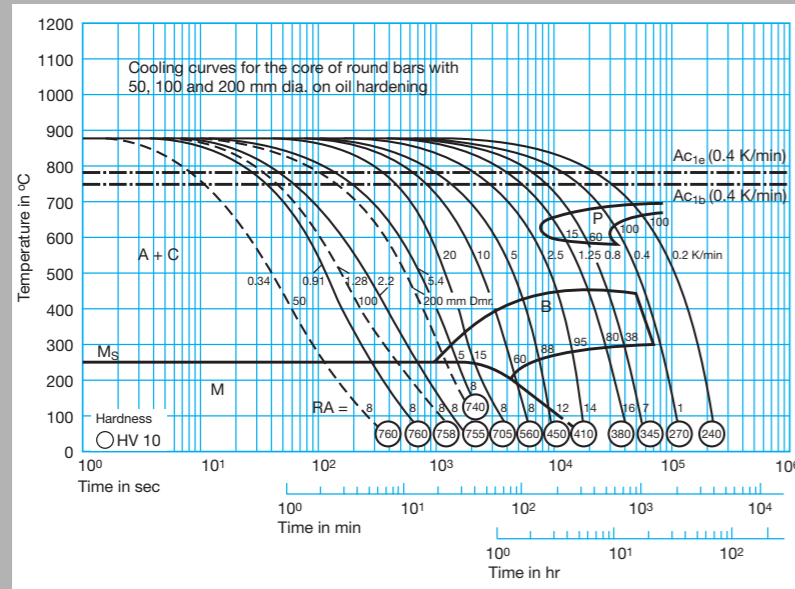
Soft annealing °C	Cooling	Hardness HB
650 – 700	Furnace	max. 250

Hardening °C	Quenching	Hardness after quenching HRC
830 – 870	Oil	58
860 – 900	Air	56

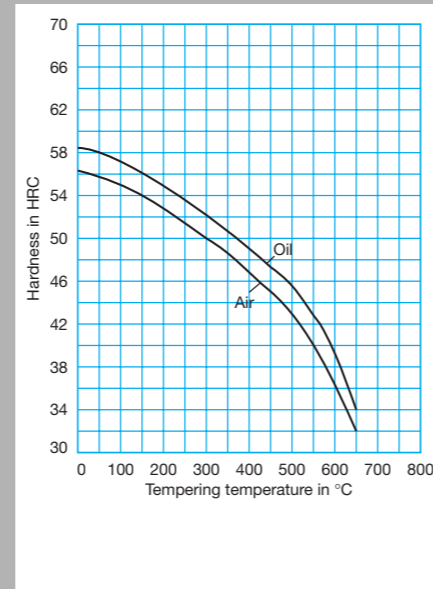
Tempering °C	100	200	300	400	450	500	550	600	650
after quenching in oil – HRC	57	54	52	49	47	46	43	38	34

Tempering °C	100	200	300	400	450	500	550	600	650
after quenching in air – HRC	55	52	50	47	45	43	40	36	32

Time-temperature-transformation diagram



Tempering diagram



Identification

Material number	Reference number	AISI
1.2721	(50NiCr13)	

Chemical composition Typical analysis in %

C	Si	Mn	Cr	Ni
0.55	0.25	0.45	1.00	3.10

Steel properties

Air or oil-hardenable steel with good machinability and high toughness.

Physical properties

Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	31.0	31.2	31.8

Applications

Cold heading dies, hobbers, cutlery dies, reinforcements and pelleters.

Heat treatment

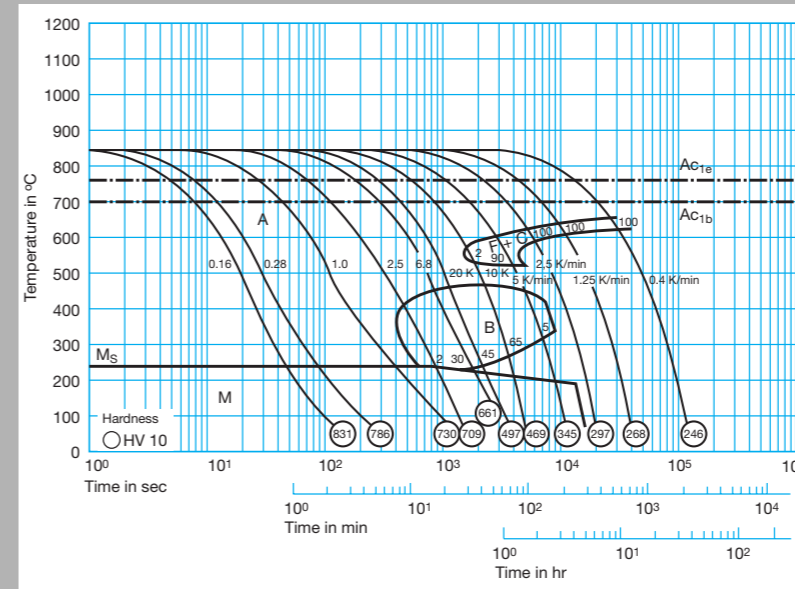
Soft annealing °C	Cooling	Hardness HB
610 – 650	Furnace	max. 250

Stress-relief annealing °C	Cooling	Hardness HB
approx. 600	Furnace	

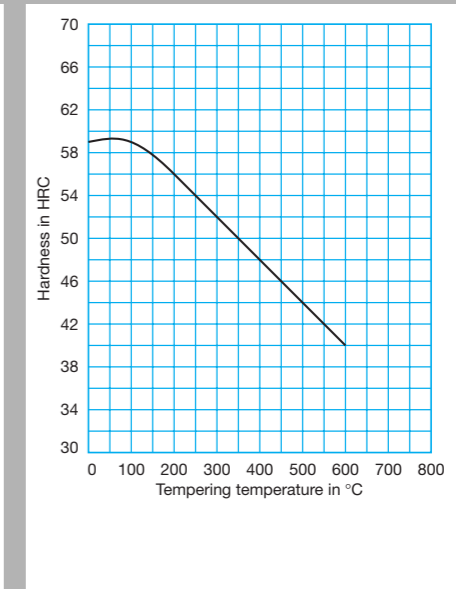
Hardening °C	Quenching	Hardness after quenching HRC
840 – 870	Oil or saltbath (180 – 220 °C)	59

Tempering °C	100	200	300	400	500	600
HRC	59	56	52	48	44	40

Time-temperature-transformation diagram



Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2743	(60NiCrMoV12-4)	

Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	Ni	V
0.58	0.40	0.65	1.15	0.35	2.85	0.10

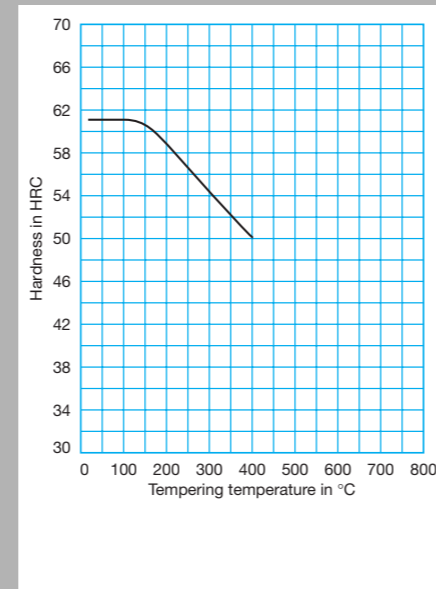
Steel properties
Nickel-alloyed cold-work steel with a good combination of wear resistance and toughness.

Physical properties			
Coefficient of thermal expansion $10^{-6} \text{ m}/(\text{m} \cdot \text{K})$	20 – 200 °C		20 – 400 °C
		12.2	
Thermal conductivity $W/(\text{m} \cdot \text{K})$	20 °C		400 °C
	28.9	30.0	31.0

Applications
Scrap-shear blades, dies and coining tools, piercing punches.

Heat treatment				
Soft annealing °C	Cooling	Hardness HB		
690 – 700	Furnace	approx. 235		
Hardening °C	Quenching	Hardness after quenching HRC		
840– 870	Oil	61		
Stress-relief annealing °C	Cooling			
600 – 650	Furnace			
Tempering °C	100	200	300	400
	HRC	61	59	54

Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2746	(45NiCrMoV16-6)	

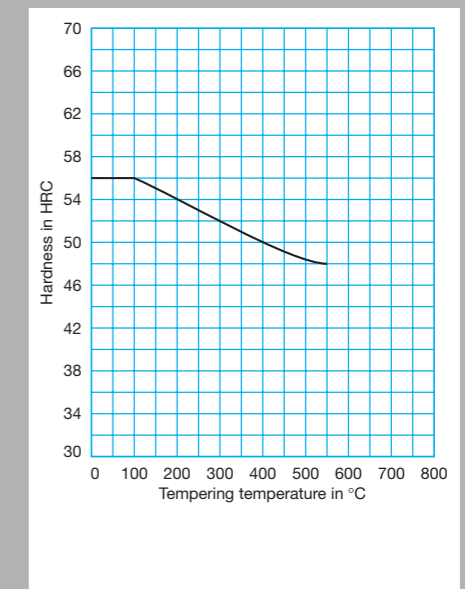
Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	Ni	V
0.45	0.25	0.70	1.50	0.80	4.00	0.50

Steel properties
Air or oil-hardenable steel featuring high toughness.

Applications
Special steel for cold-shear blades, particularly for cutting scrap. Drawing jaws, coining and bending tools.

Heat treatment						
Soft annealing °C	Cooling			Hardness HB		
610 – 650	Furnace			max. 295		
Stress-relief annealing °C	Cooling					
approx. 600	Furnace					
Hardening °C	Quenching			Hardness after quenching HRC		
880 – 910	Air, oil or saltbath (180 – 220 °C)			56		
Tempering °C	100	200	300	400	500	550
	HRC	56	54	52	50	49

Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2764	(X19NiCrMo4)	-P21

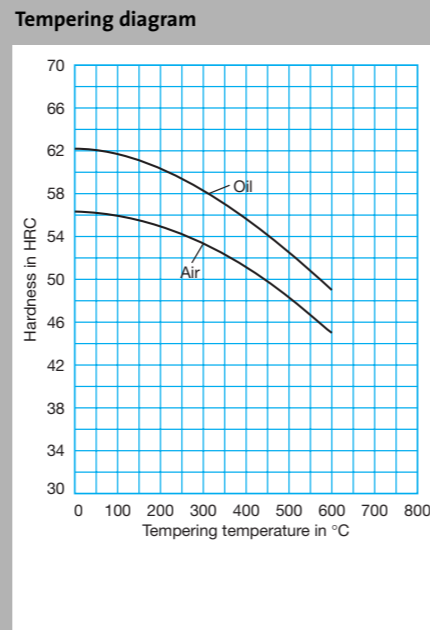
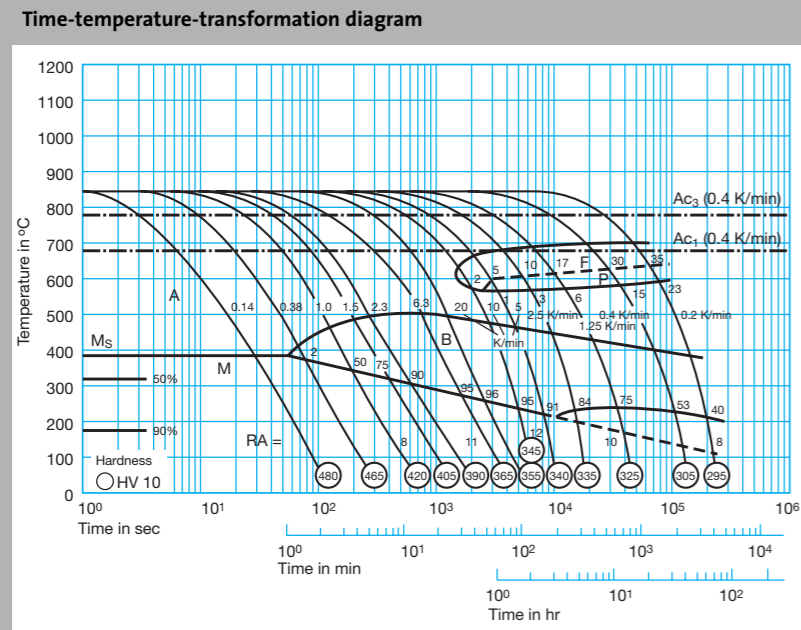
Chemical composition Typical analysis in %				
C	Cr	Mo	Ni	
0.19	1.3	0.2	4.1	

Steel properties
Case-hardening steel, high core strength, good polishability.

Physical properties				
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C
	12.1	13.0	0.2	13.5
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C	
	33.5	32.5	32.0	

Applications
Highly stressed plastic moulds, tool holders for cutter picks.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
620 – 660	Furnace	max. 250				
Stress-relief annealing °C	Cooling					
600	Furnace					
Carburizing °C	Intermediate annealing °C	Hardening °C	Quenching		Hardness after quenching HRC	
860 – 890	80 – 220	780 – 810	Oil or saltbath (180 – 220 °C)		62	
860 – 890	80 – 220	800 – 830	Air		56	
Tempering °C	100	200	300	400	500	600
after oil hardening HRC	62	60	58	56	52	49
after air hardening HRC	56	55	53	51	48	45



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2766	(35NiCrMo16)	

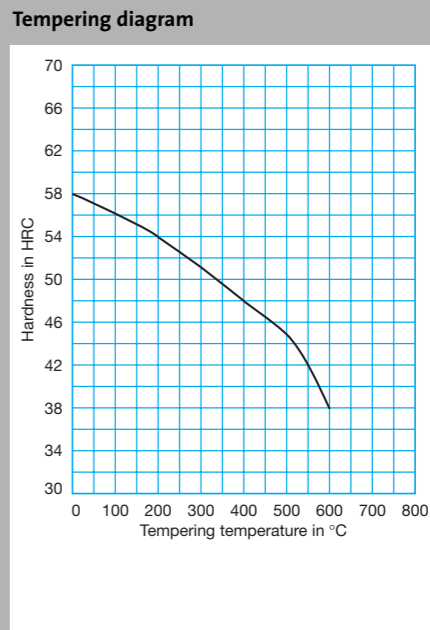
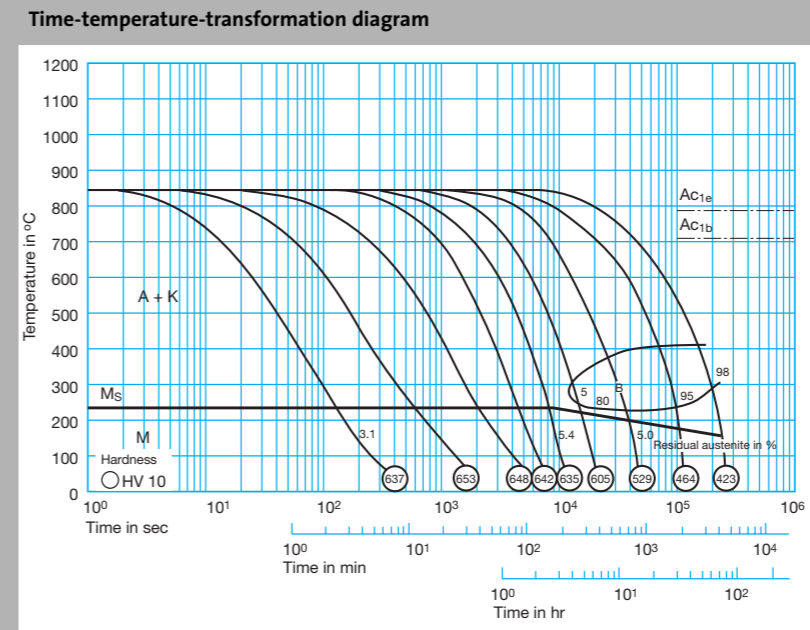
Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Ni	Mo	
0.35	0.25	0.50	1.35	4.10	0.30	

also supplied with lower carbon and higher chromium content

Steel properties
Dimensionally stable air-hardening steel featuring maximum toughness, polishable.

Applications
Moulds, dies with deep engravings, plastic moulds und hydraulic chisels.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
590 – 610	Furnace	max. 260				
Stress-relief annealing °C	Cooling					
600 – 650	Furnace					
Hardening °C	Quenching	Hardness after quenching HRC				
820 – 840	Oil or saltbath (180 – 220 °C)	approx. 58				
Tempering °C	100	200	300	400	500	600
HRC	56	54	51	48	45	38



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.2767	45NiCrMo16	6F3

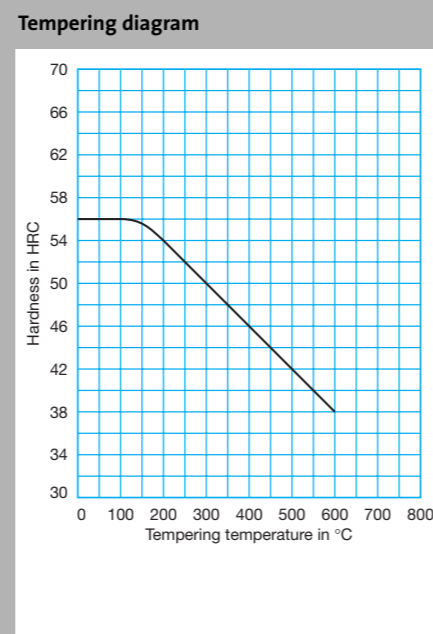
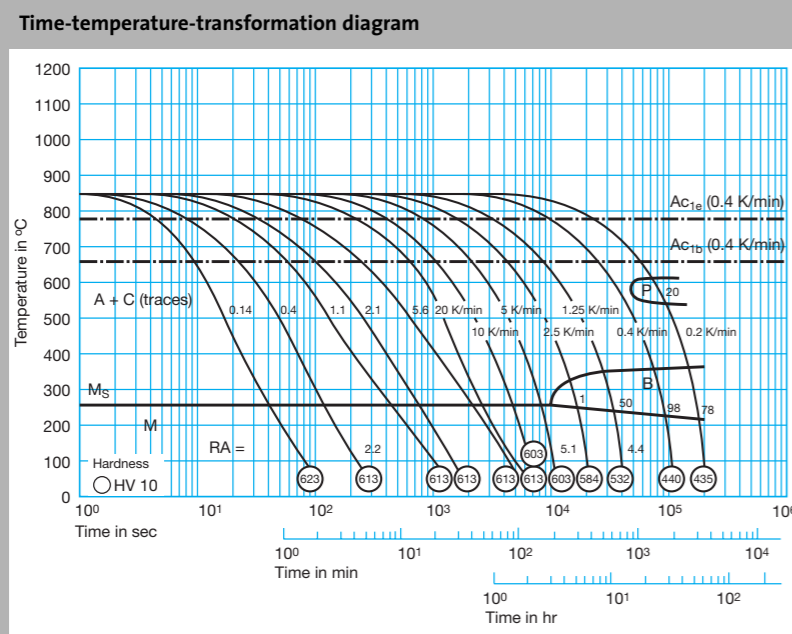
Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	Ni	
0.45	0.25	0.35	1.40	0.20	4.00	

Steel properties
 High hardenability and toughness, highly suitable for polishing, texturing and EDM machining.
 We recommend the use of THYRODUR® 2767 (ESR) for extreme demands.

Physical properties					
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C		20 – 200 °C		20 – 300 °C
	Annealed	11.7		12.6	
Quenched and tempered	12.0		12.5		13.0
Thermal conductivity W/(m · K)	100 °C		150 °C		200 °C
	38.2		38.6		38.9
	27.7		28.9		29.7
250 °C		300 °C			
39.1		39.6			
30.5		31.0			

Applications
 Cutlery dies, cutting tools for thick material, billet-shear blades, drawing jaws, massive embossing and bending tools, plastic moulds, reinforcements.

Heat treatment					
Soft annealing °C	Cooling	Hardness HB			
610 – 650	Furnace	max. 260			
Stress-relief annealing °C	Cooling				
approx. 600 – 650	Furnace				
Hardening °C	Quenching	Hardness after quenching HRC			
840 – 870	Air, oil or saltbath (180 – 220 °C)	56			
Tempering °C	100		200		300
	HRC	56	54	50	46
400		500		600	
		46	42	38	



Identification		
Material number	Reference number	AISI
1.2826	(60MnSiCr4)	S4

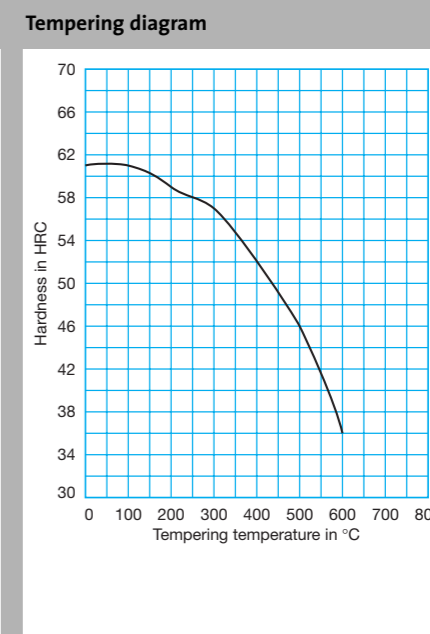
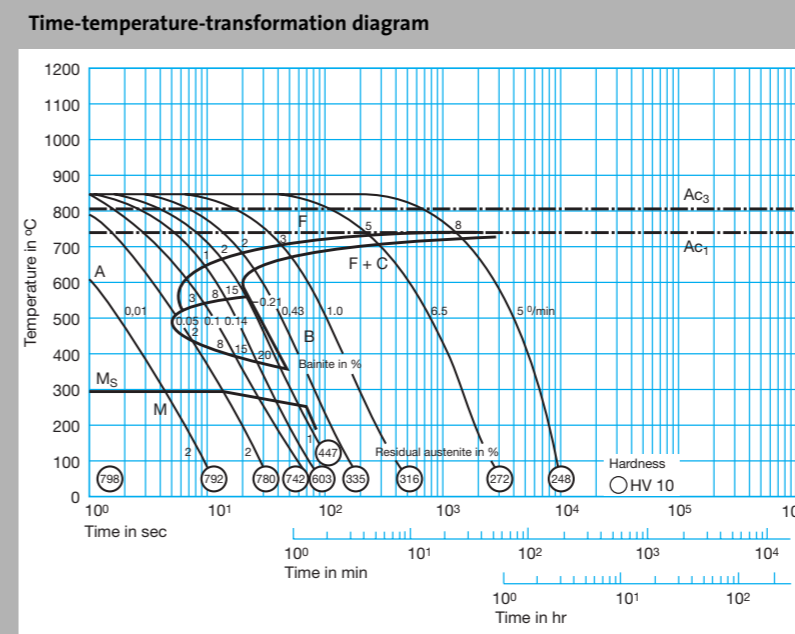
Chemical composition Typical analysis in %			
C	Si	Mn	Cr
0.63	0.80	1.10	0.30

Steel properties
 High toughness and good resilience in tempered condition.

Physical properties			
Thermal conductivity W/(m · K)	20 °C		350 °C
		34.2	
			700 °C
			31.0

Applications
 Spring collets, shear blades and trimming dies.

Heat treatment						
Soft annealing °C	Cooling	Hardness HB				
680 – 710	Furnace	max. 220				
Stress-relief annealing °C	Cooling					
approx. 650	Furnace					
Hardening °C	Quenching	Hardness after quenching HRC				
820 – 860	Oil or saltbath (180 – 220 °C)	61				
Tempering °C	100		200		300	
	HRC	61	59	57	52	
400		500		600		
		52	46	36		



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification

Material number	Reference number	AISI
1.2833	(100V1)	

Chemical composition Typical analysis in %

C	Si	Mn	V
1.0	0.2	0.2	0.1

Steel properties

Wear-resistant water-hardening steel with high insusceptibility to overheating.

Physical properties

Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	37.6	35.2	32.6

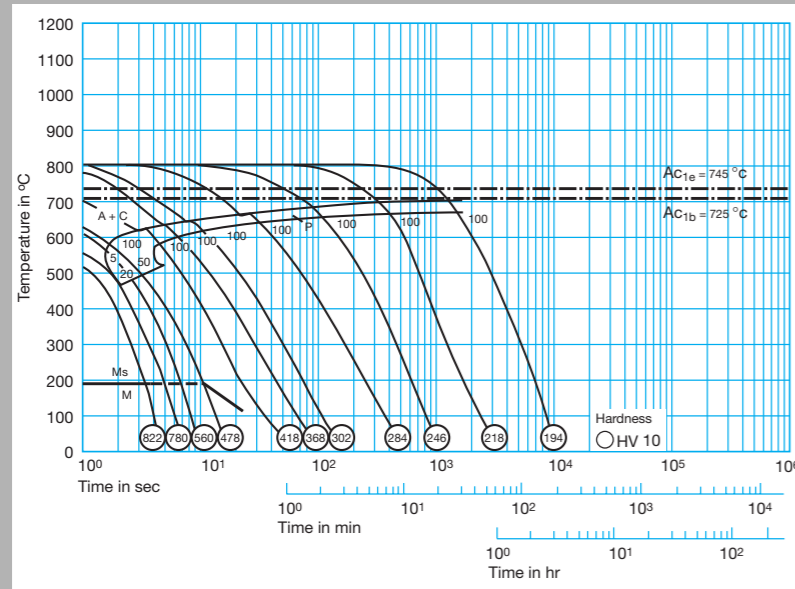
Applications

Cold heading dies, first and finish upsetting punches, cold stamps and dies for the manufacturing of screws, rivets and bolts, compression pistons.

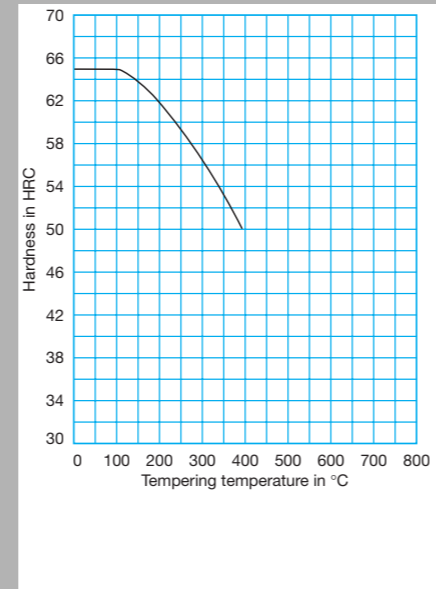
Heat treatment

Soft annealing °C	Cooling	Hardness HB		
730 – 760	Furnace	max. 200		
Stress-relief annealing °C	Cooling			
650 – 680	Furnace			
Hardening °C	Quenching	Hardness after quenching HRC		
780 – 820	Water	65		
Tempering °C				
	100	200	300	400
HRC	65	62	57	50

Time-temperature-transformation diagram



Tempering diagram



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification

Material number	Reference number	AISI
1.2842	90MnCrV8	O2

Chemical composition Typical analysis in %

C	Si	Mn	Cr	V
0.90	0.20	2.00	0.40	0.10

Steel properties

Good cutting edge retention, dimensionally stable during heat treatment.

Physical properties

Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20 – 100 °C	20 – 200 °C	20 – 300 °C	20 – 400 °C	20 – 500 °C	20 – 600 °C	20 – 700 °C
	12.2	13.2	13.8	14.3	14.7	15.0	15.3

Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	33.0	32.0	31.3

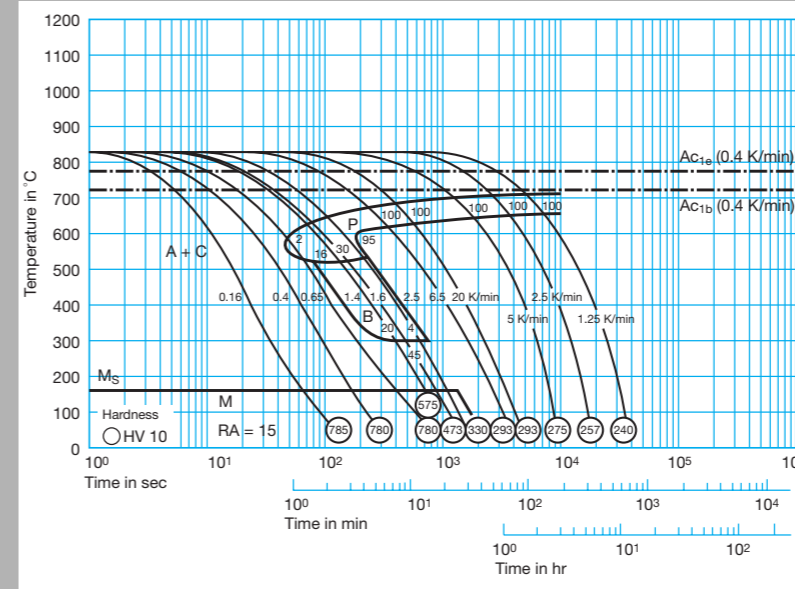
Applications

Tool steel for universal use, cutting and stamping tools for sheet up to 6 mm thickness, thread-cutting tools, reamers, gauges, measuring tools, plastic moulds, shear blades, guide strips and ejector pins.

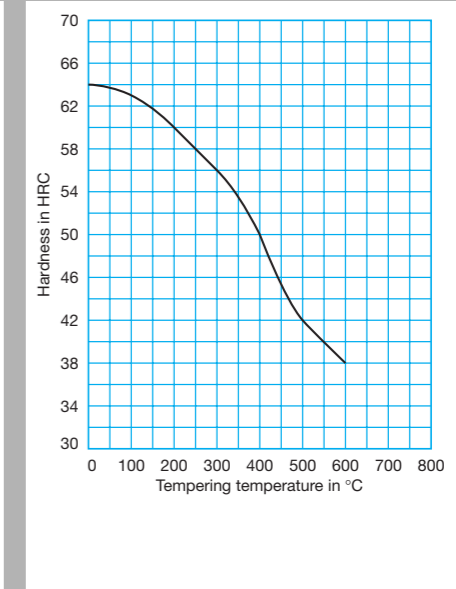
Heat treatment

Soft annealing °C	Cooling	Hardness HB				
680 – 720	Furnace	max. 220				
Stress-relief annealing °C	Cooling					
approx. 650	Furnace					
Hardening °C	Quenching	Hardness after quenching HRC				
790 – 820	Oil or saltbath (180 – 220 °C)	64				
Tempering °C						
	100	200	300	400	500	600
HRC	63	60	56	50	42	38

Time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
	(~X100CrMoV8-1-1)	

Chemical composition Typical analysis in %					
C	Si	Cr	Mo	V	
1.0	0.9	8.0	1.6	1.6	

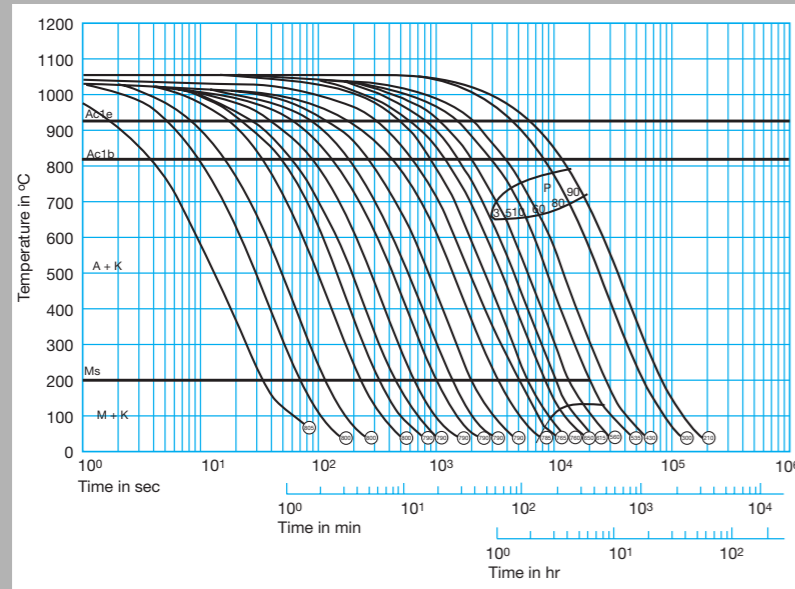
Steel properties
Newly developed ledeburitic cold-work steel with high hardness, good toughness and high tempering resistance combined with high wear resistance.

Physical properties										
Coefficient of thermal expansion 10 ⁻⁶ m/(m · K)	20–100 °C		20–150 °C		20–200 °C		20–250 °C		20–300 °C	
		11.4	11.6	11.7	11.9	12.0	12.1	12.3	12.4	12.6
Thermal conductivity W/(m · K)	RT		100 °C		150 °C		200 °C		300 °C	
	34.2	25.9	26.8	27.1	27.4	27.2	26.8			

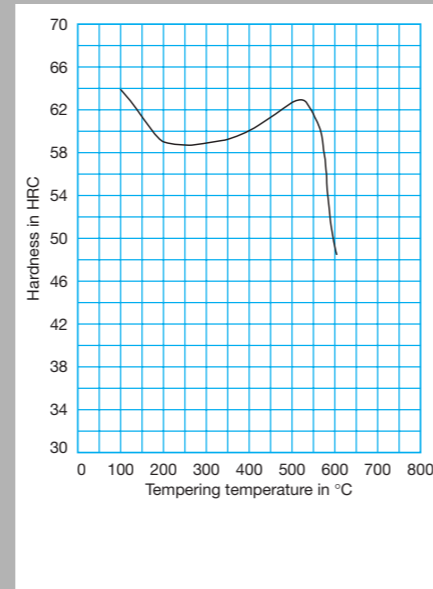
Applications
Cutting and punching tools including precision cutting tools, threading dies and rolls, rotary shear blades, cold pilger mandrels, pressure pads and plastic moulds, cold-forming and deep-drawing dies, woodworking tools and cold rolls.

Heat treatment										
Soft annealing °C	Cooling	Hardness HB								
830 – 860	Furnace	max. 250								
Stress-relief annealing °C	Cooling									
approx. 650	Furnace									
Hardening °C	Quenching	Hardness after quenching HRC								
1030 ¹ – 1080 ²	Air, oil or saltbath (500 – 550 °C)	62 – 64								
Tempering °C	100	200	300	400	500	525	550	575	600	
	¹ HRC	62	59	57	58	60	60	59	55	46
	² HRC	64	59	59	60	63	63	61	57	48

Time-temperature-transformation diagram



Tempering diagram/Hardening from 1080 °C



Reference numbers in brackets are not standardized in EN ISO 4957.

Identification		
Material number	Reference number	AISI
1.3202	(S12-1-4-5)	~T15

Chemical composition Typical analysis in %						
C	Cr	Mo	V	W	Co	
1.35	4.1	0.8	3.8	12.0	4.8	

Steel properties
High-performance high-speed steel featuring an extremely good cutting edge retention and wear resistance due to its high vanadium content. A high cobalt content contributes to a high red hardness and tempering resistance.

Applications
Machining of hard materials which wear cutting edges such as highly quenched and tempered chromium-nickel grades and non-ferrous metals, mother-of-pearl, paper, hard rubber, synthetic resins, marble, slate and the like. Ideally suited for turning and finishing tools, forming tools of all kinds, heavy-duty milling cutters and automatic lathes.

Heat treatment					
Soft annealing °C	Cooling		Hardness HB		
820 – 860	Furnace		max. 280		
Stress-relief annealing °C	Cooling				
630 – 650	Furnace				
1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC
up to approx. 400 in an air-circulating furnace	a) 850 b) 850 and 1050	1190 – 1240	a) Saltbath (550 °C) b) Oil c) Air	at least three times 540 – 580	64 – 67

¹For cold-forming tools with a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.

Reference numbers in brackets are not standardized in EN ISO 4957.

Identification

Material number	Reference number	AISI
1.3207	HS10-4-3-10	~T42

Chemical composition Typical analysis in %

C	Cr	Mo	V	W	Co
1.23	4.1	3.5	3.3	9.5	10.0

Steel properties

High-speed steel of superlative performance combining optimal cutting-edge retention, high-temperature strength and toughness on account of its composition.

Applications

Universally applicable for roughing and finishing where maximum tool life is required and for automatic lathes where wear is caused by large batch production. Also for all kinds of cutting tools and milling cutters exposed to exceedingly high stresses.

Heat treatment

Soft annealing °C	Cooling	Hardness HB
820 – 860	Furnace	max. 302

Stress-relief annealing °C	Cooling
630 – 650	Furnace

1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC
up to approx. 400 in an air-circulating furnace	a) 850 b) 850 and 1050	1190 – 1230	a) Saltbath (550 °C) b) Oil c) Air	at least three times 540 – 570	65 – 67

¹ For cold-forming tools of a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.

Identification

Material number	Reference number	AISI
1.3243	HS6-5-2-5	M35

Chemical composition Typical analysis in %

C	Cr	Mo	V	W	Co
0.92	4.1	5.0	1.9	6.4	4.8

Under the name THYRAPID® 3245, AISI M 35 + S and material number 1.3245, this steel grade is supplied with a higher sulphur content (S = 0.10 %).

Steel properties

The cobalt content in this high-performance high-speed steel results in high red hardness and tempering resistance. As a consequence, this grade is particularly suitable for conditions involving thermal stresses and discontinuous cutting.

Applications

Heavy-duty milling cutters of all kinds, highly stressed twist drills and taps, profile knives, machining of high-strength materials, broaches.

Heat treatment

Soft annealing °C	Cooling	Hardness HB
820 – 860	Furnace	max. 269

Stress-relief annealing °C	Cooling
630 – 650	Furnace

1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC
up to approx. 400 in an air-circulating furnace	a) 850 b) 850 and 1050	1190 – 1230	a) Saltbath (550 °C) b) Oil c) Air	at least three times 540 – 570	64 – 67

¹ For cold-forming tools of a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.

Identification		
Material number	Reference number	AISI
1.3247	HS2-9-1-8	M42

Chemical composition Typical analysis in %						
C	Cr	Mo	V	W	Co	
1.08	4.1	9.5	1.2	1.5	8.0	

Steel properties
High-carbon, high-speed steel based on molybdenum. Characterized by high wear resistance, red hardness and toughness. As a result of its low vanadium content, this grade exhibits good grindability.

Applications
For tools subject to severe mechanical wear (e.g. in case of small cross-section cuts at high cutting speeds). Particularly suitable for die-sinking cutters, milling cutters and engraving machines including gravers as well as for tool bits in automatic lathes. Also suitable for non-cutting shaping (e.g. cold extrusion rams and tools employed in machining materials for the aviation industry such as titanium alloys).

Heat treatment					
Soft annealing °C		Cooling		Hardness HB	
820 – 860		Furnace		max. 277	
Stress-relief annealing °C		Cooling			
630 – 650		Furnace			
1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC
up to approx. 400 in an air-circulating furnace	a) 850 b) 850 and 1050	1160 – 1190	a) Saltbath (550 °C) b) Oil c) Air	at least three times 530 – 560	66 – 69

¹ For cold-forming tools of a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.

Identification		
Material number	Reference number	AISI
1.3333	HS3-3-2	

Chemical composition Typical analysis in %				
C	Cr	Mo	V	W
1.00	4.00	2.60	2.30	3.00

Steel properties
High-speed steel with economic use of alloys, universally applicable at medium performance. Suitable for series tooling.

Applications
Twist drills, circular saws, hacksaws, reamers and milling cutters.

Heat treatment										
Soft annealing °C		Cooling		Hardness HB						
770 – 840		Furnace		max. 255						
Stress-relief annealing °C		Cooling								
630 – 650		Furnace								
1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC					
up to 450	a) 850 b) 850 and 1050	1180 – 1220	a) Saltbath (550 °C) b) Oil c) Air	at least twice 540 – 560	62 – 64					
Tempering °C		100	200	300	400	500	525	550	575	600
HRC ¹		63	61	60	58	62	63	64	63	62

¹ For cold-forming tools of a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.

Identification		
Material number	Reference number	AISI
1.3343	HS6-5-2C	M2

Chemical composition Typical analysis in %						
C	Si	Mn	Cr	Mo	V	W
0.90	0.30	0.30	4.10	5.00	1.90	6.40

This steel is also available with an elevated S content (S = 0.12 %) under the name Thyrapid® 3341, code S 6-5-2 S and material number 1.3341.

Steel properties
Standard high-speed steel grade¹. Its well-balanced alloy composition forms the basis of its high toughness and good cutting edge retention, rendering it suitable for a large variety of applications.

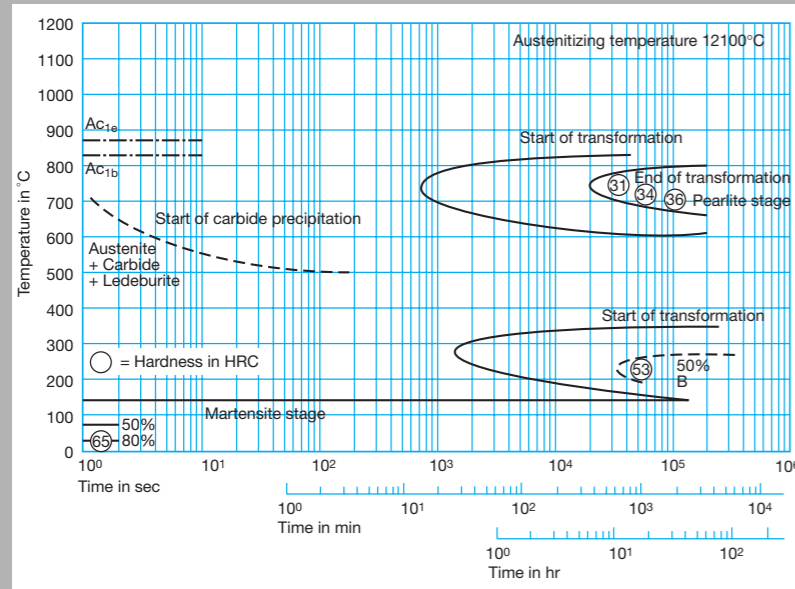
Physical properties			
Thermal conductivity W/(m · K)	20 °C	350 °C	700 °C
	32.8	23.5	25.5

Applications
For all metal-cutting tools for roughing or finishing such as twist drills, diverse milling cutters, thread dies, broaches, reamers, countersinks, thread chasers, circular saw segments, shaping tools and woodworking tools. Also highly suitable for cold-forming tools such as cold extrusion rams and dies, as well as cutting and precision cutting tools, plastic moulds with elevated wear resistance and screws.

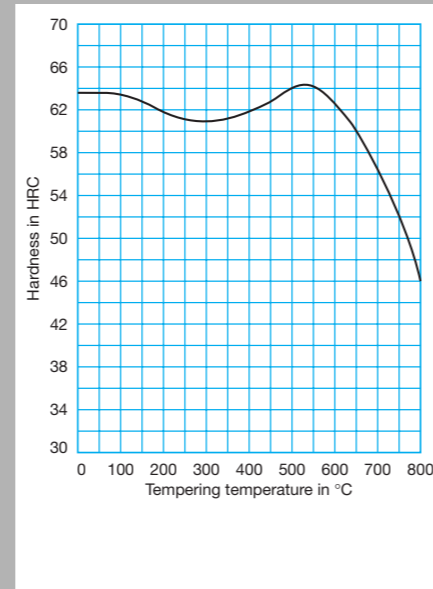
Heat treatment					
Soft annealing °C	Cooling	Hardness HB			
770 – 860	Furnace	max. 269			
Stress-relief annealing °C	Cooling				
630 – 650	Furnace				
1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC
up to approx. 400 in an air-circulating furnace	a) 850 b) 850 and 1050	1190 – 1230	a) Saltbath (550 °C) b) Oil c) Air	at least twice 530 – 560	64 – 66

¹ For cold-forming tools of a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.

Isothermal time-temperature-transformation diagram



Tempering diagram



Identification		
Material number	Reference number	AISI
1.3344	HS6-5-3	M3 Typ 2

Chemical composition Typical analysis in %				
C	Cr	Mo	V	W
1.22	4.1	5.0	2.9	6.4

Steel properties
Very similar composition to THYRAPID® 3343, but with substantially higher V and C content, resulting in combined maximum wear resistance and cutting edge retention with good toughness.

Applications
Taps, reamers, heavy-duty milling cutters, dies, rotary gear shaping and shaving cutters for the processing of hard materials, hexagon socket punches and piercing dies for the nut production.

Heat treatment					
Soft annealing °C	Cooling	Hardness HB			
820 – 860	Furnace	max. 269			
Stress-relief annealing °C	Cooling				
630 – 650	Furnace				
1st pre-heating °C	2nd and 3rd pre-heating °C	Hardening ¹ °C	Quenching	Tempering °C	Hardness after tempering HRC
up to approx. 400 in an air-circulating furnace	a) 850 b) 850 and 1050	1190 – 1230	a) Saltbath (550 °C) b) Oil c) Air	at least three times 540 – 570	64 – 66

¹ For cold-forming tools of a complex geometry, a hardening temperature at the lower end of the quoted range is recommended. The stated hardening temperatures apply to saltbath hardening only. For vacuum hardening, we suggest a reduction of 10 to 30 °C.