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Material specification sheet

Saarstahl - 80MnS5

Material No.:

German standard:

International steel grades:

Material group:

Non-alloyed constructional steel

Chemical composition:

(typical analysis at Saarstahl in %)

C	Si	Mn	P	S	Cr	V	N
0,75	0,70	1,30	< 0,015	0,065	0,50	0,07	0,012

Deviation in chemical composition on request

Application:

V-alloyed steel for forged and air-cooled fracture splittable connecting rods with higher strength (without final heat treatment)

Hot forming and heat treatment:

Forging or Hot Rolling:

1150 - 1250°C

Cold shearability max. 255 HB:

740°C/furnace

Mechanical properties:

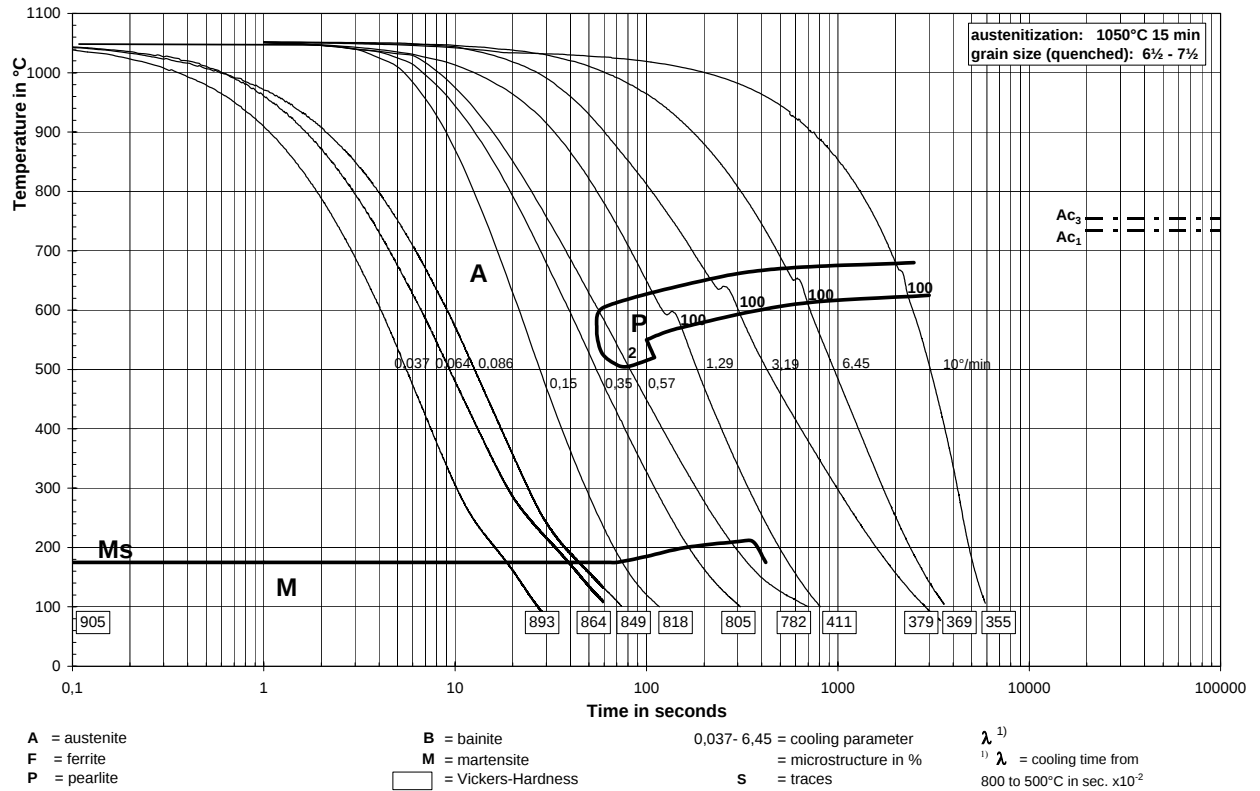
	forged (1250°C/air-cooling)		forged part (connecting rod)	
Diameter/Thickness d [mm]	square 20	square 25		
0,2% Proof stress $R_{p0,2}$ [N/mm ²]	700 - 730	700 - 725		770 - 800
Tensile strength R_m [N/mm ²]	1140 - 1170	1160 - 1190		1220 - 1255
Fracture elongation A_5 [%]	12 - 15	10 - 12		10 - 12
Reduction of area Z [%]	39 - 43	30 - 35		25 - 34
Notch impact energy at RT, ISO-V [J]	10 - 12	9 - 11		
Surface hardness HB30	326 - 335	329 - 335		350 - 370

Microstructure

(state: forged and air-cooled)

100 % fine lamellar pearlite
ASTM-Grain size: 8 and smaller

Time-temperature-transformation diagram for continuous cooling



Material-Datasheet

Saarstahl - C15

Material-No.:

Former brand name:

International steel grades:

1.0401

BS: 080A15, 080M15
AFNOR: AF37C12, XC18
SAE: 1015, 1016, 1017

Material group:

Bright steels according to DIN EN 10277

Chemical Composition: (Typical analysis in %)	C	Si	Mn	P	S
	0,12 0,18	<0,40	0,30 0,60	0,045	0,045

Application:

Bright steels for general technical applications

**Hot forming and
heat treatment:**

**Mechanical
Properties:**

Rolled and peeled (+SH)

Thickness d [mm]	>= 5 - 10	> 10 - 16	> 16 - 40	> 40 - 63	>63 - 100
Hardness [HB]	-	-	98 - 178	98 - 178	98 - 178
Tensile strength R_m [N/mm ²]	-	-	330 - 600	330 - 600	330 - 600

Cold drawn (+C)

Thickness d [mm]	>= 5 - 10	> 10 - 16	> 16 - 40	> 40 - 63	>63 - 100
Proof stress $R_{0,2}$ [N/mm ²]	min. 380	min. 340	min. 280	min. 240	min. 215
Tensile strength R_m [N/mm ²]	500 - 800	480 - 780	430 - 730	380 - 670	340 - 600
Fracture elongation A_5 [%]	min. 7	min. 8	min. 9	min. 11	min. 12

Material specification sheet

Saarstahl - C22

Material No.:

Former brand name:

International steel grades:

1.0402

BS: C22, 070M20, 22HS

AFNOR: C22, AF42C20, XC25

SAE: (M) 1020, M 1023

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	Ni	Cr+Mo+Ni
	0,17 0,24	<0,40	0,40 0,70	<0,045	<0,045	<0,40	<0,10	<0,40	<0,63

Application:

Plain carbon steel for mechanical engineering and automotive components

Hot forming and heat treatment:

Forging or hot rolling:	1100 - 850°C
Normalising:	880 - 920°C/air
Soft annealing:	680 - 710°C/furnace
Hardening:	860 - 900°C/water
Tempering:	550 - 660°C/air

Mechanical Properties:

Treated for cold shearability +S:	Shearable in as rolled condition
Soft annealed +A:	-

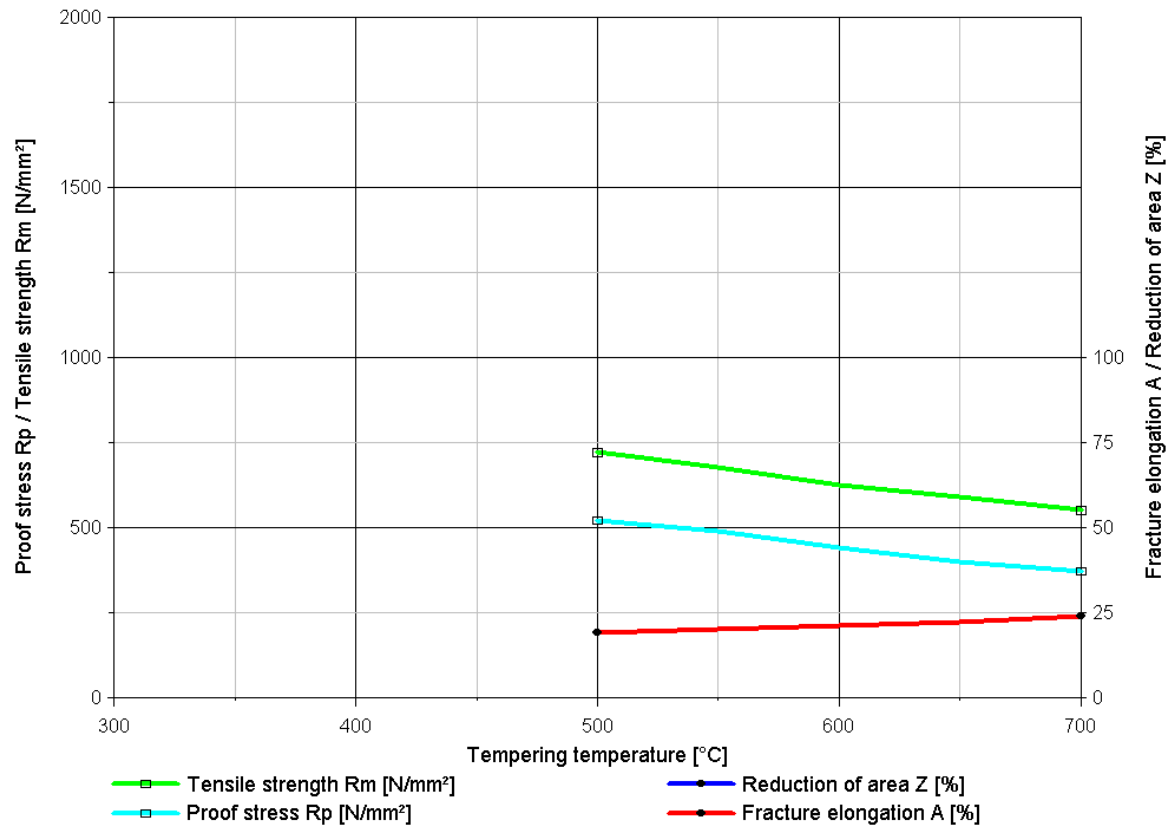
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 340	min. 290	-	-	-
Tensile strength R _m [N/mm ²]	500 - 650	470 - 620	-	-	-
Fracture elongation A ₅ [%]	min. 20	min. 22	-	-	-
Reduction of area Z [%]	min. 50	min. 50	-	-	-

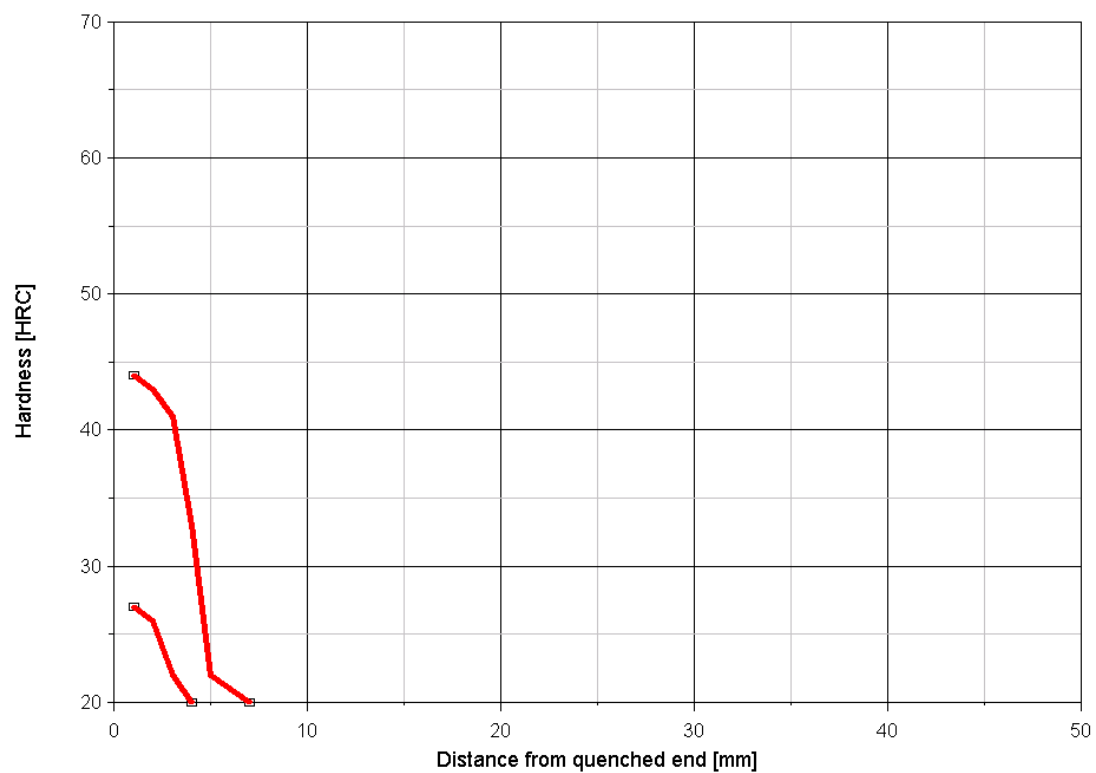
Normalised, +N:

Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 240	min. 210	-		
Tensile strength R_m [N/mm²]	min. 430	min. 410	-		
Fracture elongation A₅ [%]	min. 24	min. 25	-		

Tempering diagram (Typical values for 30 mm diameter)



Hardness scatter band



Material specification sheet

Saarstahl - P295GH (17Mn4)

Material No.:	Former brand name:	International steel grades:	
1.0481	Atrix 100	BS:	3059-440, 1501 Gr.224
		AFNOR:	A48CP
		SAE:	A515-, A516 Gr.70

Material group: High-temperature constructional steel according to DIN EN 10028

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	other
	0,17	0,30	1,10	-	-

Application: High-temperature constructional, weldable steel for forgings and tubes of constructions for steam boilers, pipelines, pressure vessels and plant manufacture.

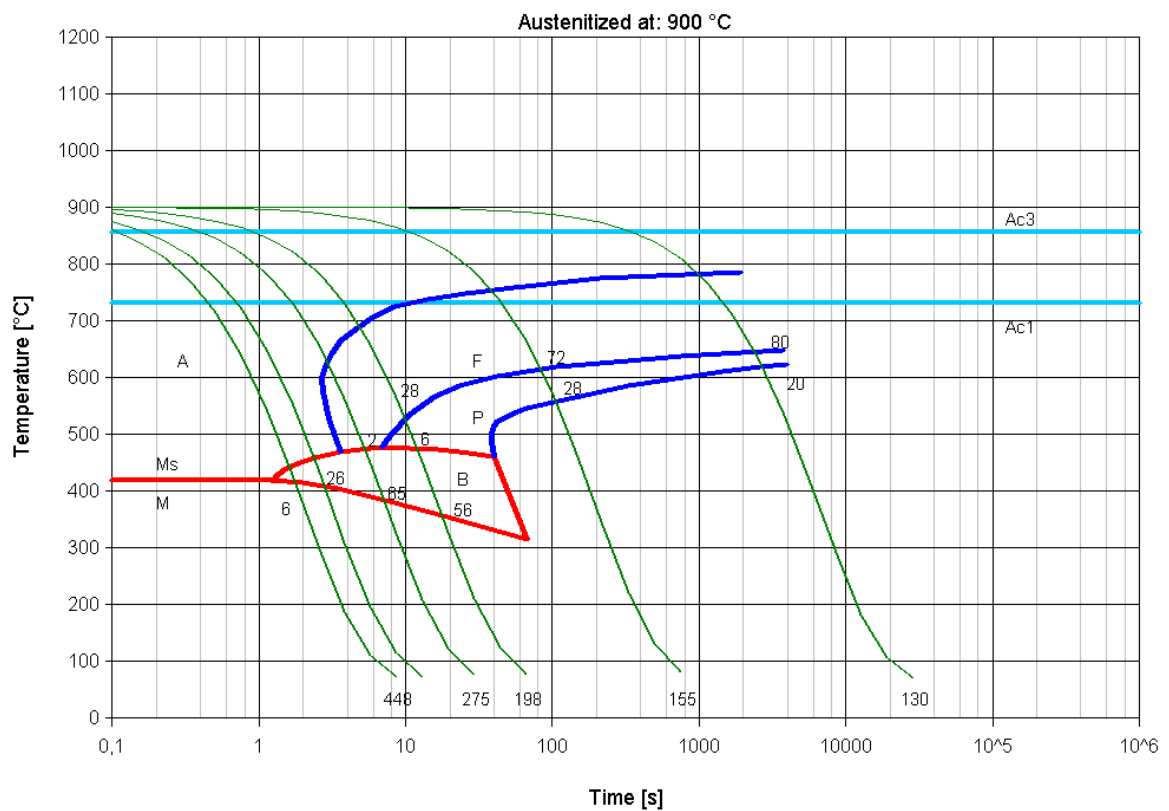
Hot forming and heat treatment: Normalising: 890 - 950°C/air

Mechanical Properties:

Condition of delivery: Normalised

Wall thickness [mm]	<=16	>16 - 40	>40 - 60	>60 - 100	>100 - 150
0,2% proof stress R _{p0,2} [N/mm ²]	min. 295	min. 290	min. 285	min. 260	min. 235
Tensile strength R _m [N/mm ²]	460 - 580	460 - 580	460 - 580	460 - 580	440 - 570
Fracture elongation A ₅ [%]	min. 22	min. 22	min. 22	min. 21	min. 21
Notch impact energy ISO-V [J]	min. 27	min. 27	min. 27	min. 27	min. 27

Time-temperature-transformation diagram for continuous cooling



Hardness HV	448	420	275	198	155	130
Lambda-Value	0,007	0,014	0,043	0,11	1,1	5°/min

Material specification sheet

Saarstahl - C35

Material No.:

1.0501

Former brand name:

International steel grades:

BS: C35, 40CS, 080M36
AFNOR: C35, AF55C35, 1C35
SAE: 1035

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition:

(Typical analysis in %)

C	Si	Mn	P	S	Cr	Mo	Ni	Cr+Mo+Ni
0,32 0,39	<0,40	0,50 0,80	<0,045	<0,045	<0,40	<0,10	0,40	<0,63

Application:

Plain carbon steel for mechanical engineering and automotive components

Hot forming and heat treatment:

Forging or hot rolling: 1100 - 850°C
 Normalising: 860 - 900°C/air
 Soft annealing: 680 - 710°C/furnace
 Hardening: 840 - 880°C/water, oil
 Tempering: 550 - 660°C/air

Mechanical Properties:

Treated for cold shearability +S: Shearable in as rolled condition
 Soft annealed +A: -

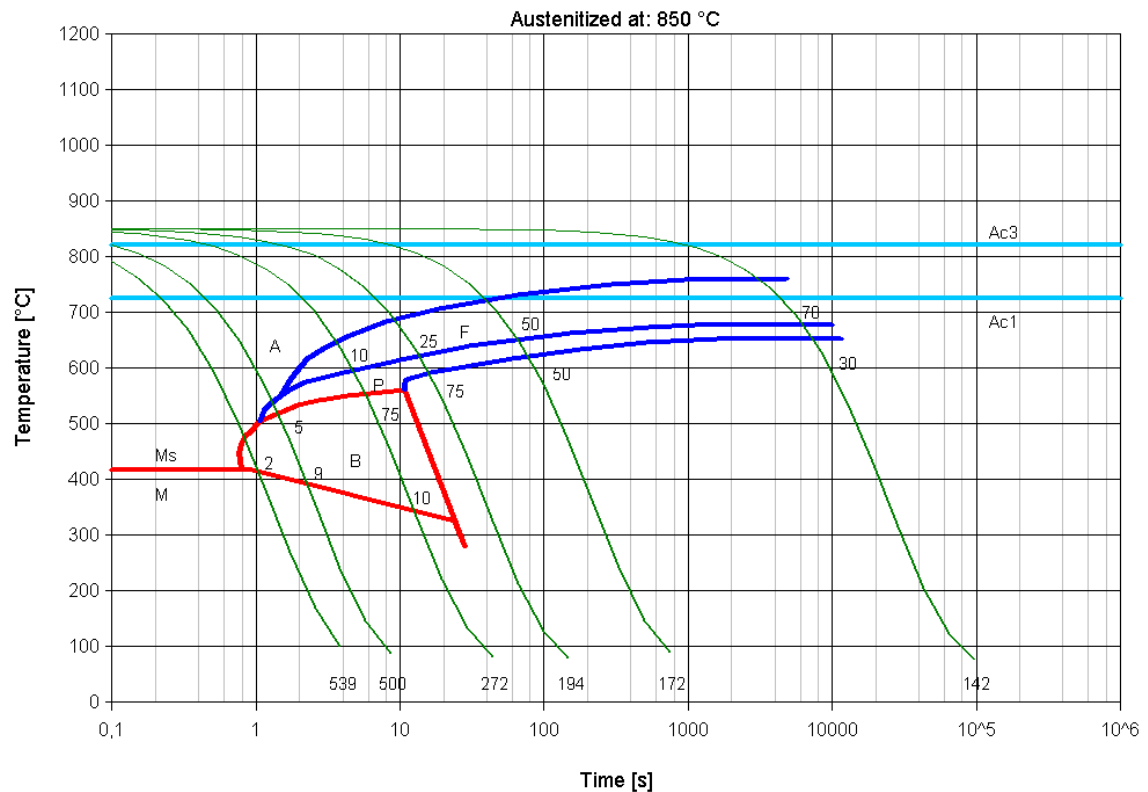
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 430	min. 380	min. 320	-	-
Tensile strength R _m [N/mm ²]	630 - 780	600 - 750	550 - 700	-	-
Fracture elongation A ₅ [%]	min. 17	min. 19	min. 20	-	-
Reduction of area Z [%]	min. 40	min. 45	min. 50	-	-

Normalised, +N:

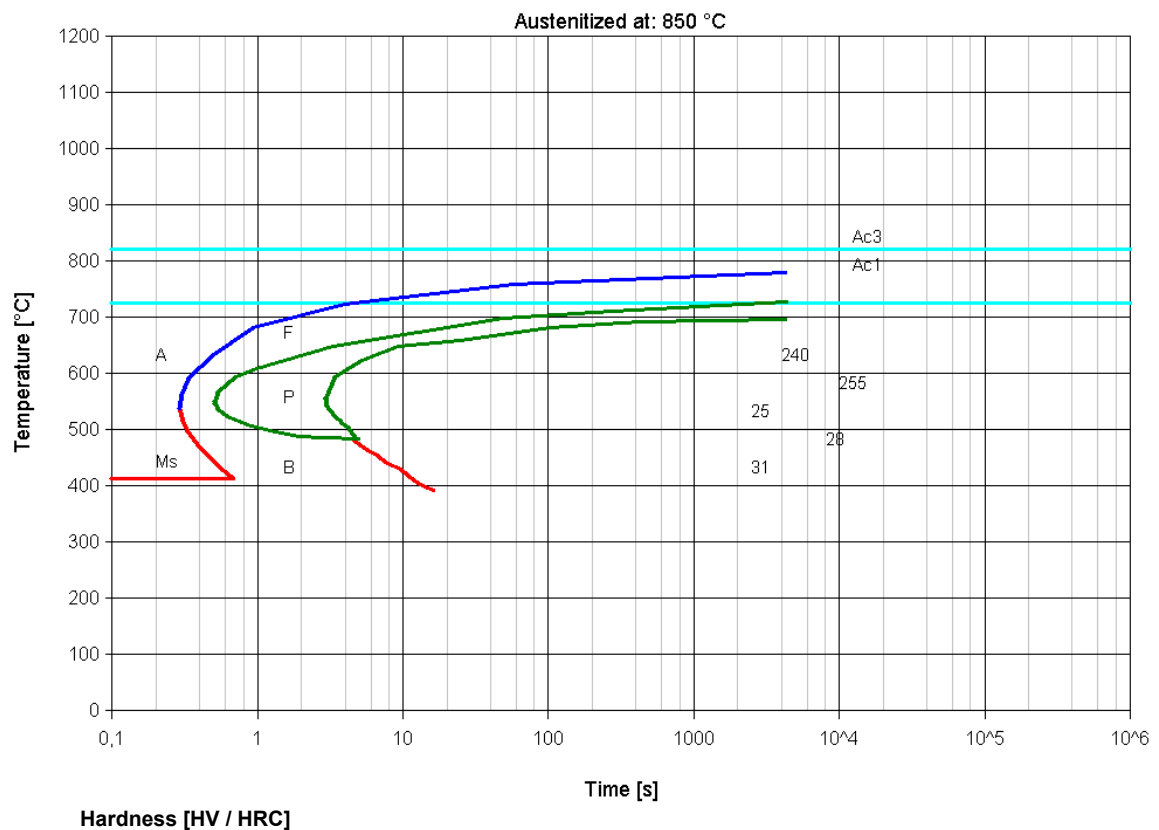
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 280	min. 250	min. 230		
Tensile strength R_m [N/mm²]	min. 510	min. 480	min. 460		
Fracture elongation A₅ [%]	min. 20	min. 21	min. 21		

Time-temperature-transformation diagram for continuous cooling

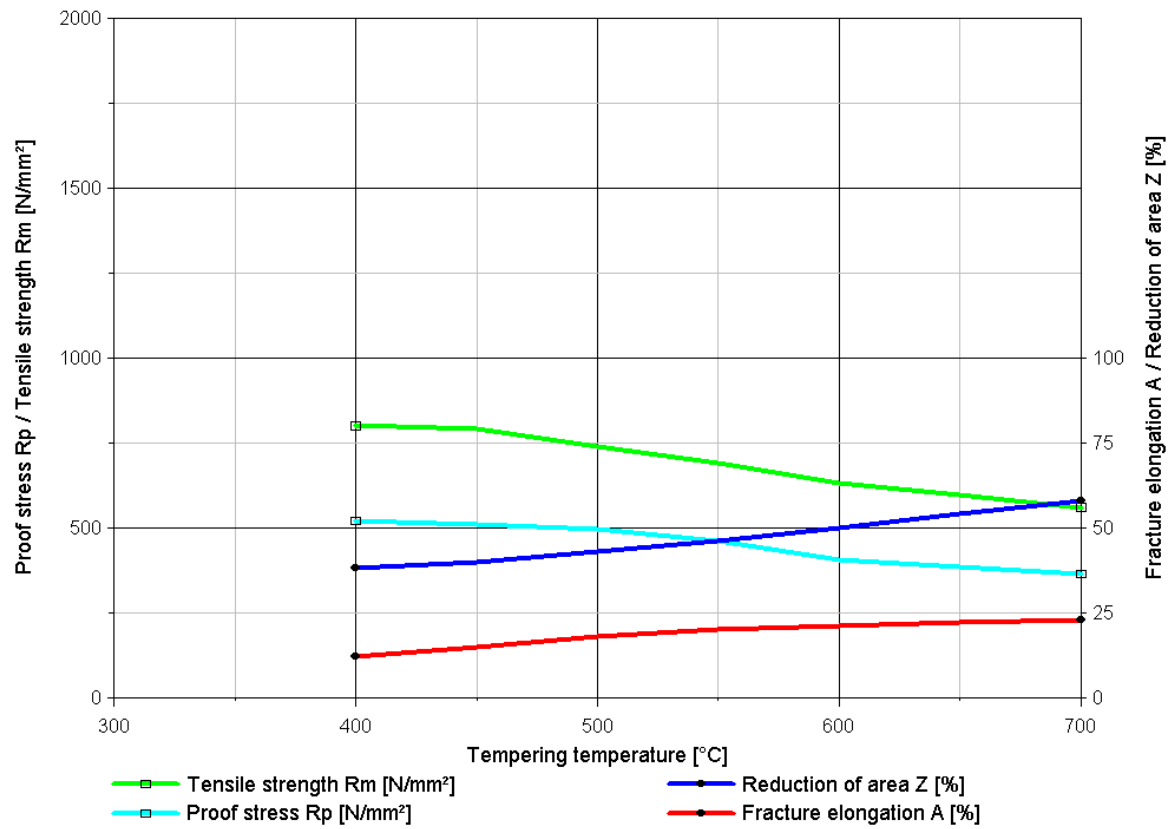


Hardness HV	539	500	272	194	172	142
Lambda-Value	0,007	0,014	0,065	0,21	1,16	1,25°C/min

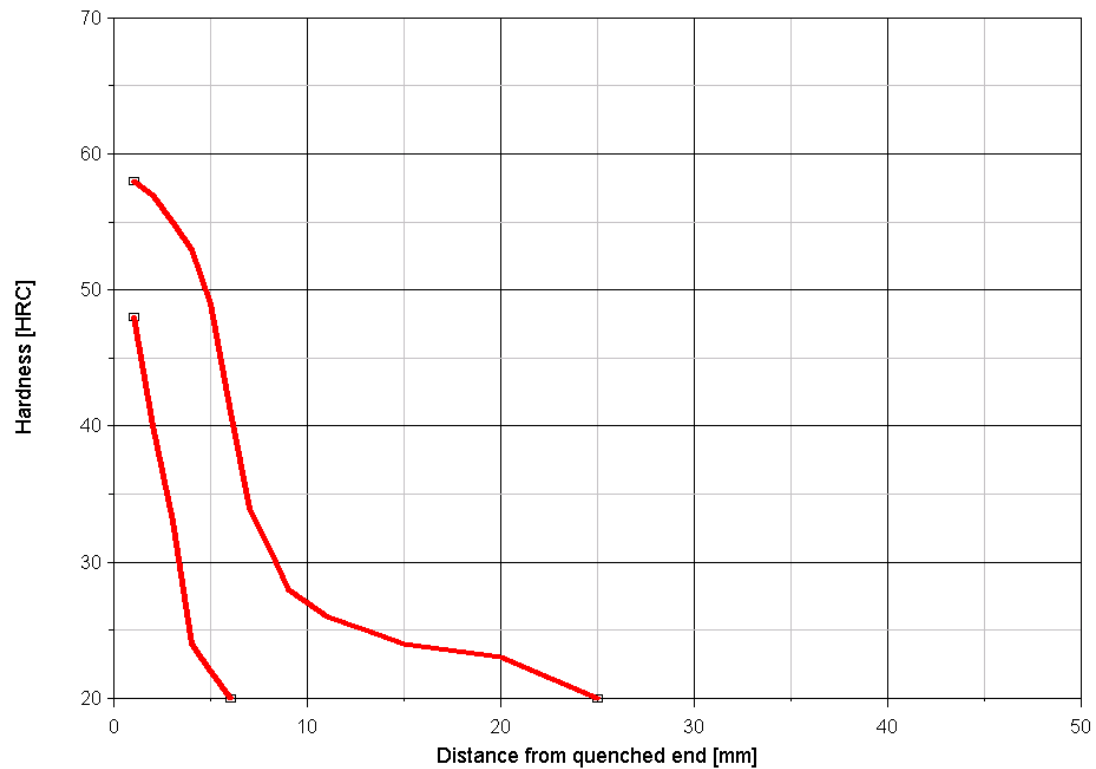
Time-temperature-transformation diagram for isothermal cooling



Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C45

Material No.:

1.0503

Former brand name:

International steel grades:

BS: C45, 50CS, 080M46
AFNOR: C45, AF65C45, 1C45
SAE: 1045

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition:
 (Typical analysis in %)

C	Si	Mn	P	S	Cr	Mo	Ni	Cr+Mo+Ni
0,42 0,50	<0,40	0,50 0,80	<0,045	<0,045	<0,40	<0,10	0,40	<0,63

Application:

Plain carbon steel for mechanical engineering and automotive components

Hot forming and heat treatment:

Forging or hot rolling: 1100 - 850°C
 Normalising: 840 - 880°C/air
 Soft annealing: 680 - 710°C/furnace
 Hardening: 820 - 860°C/water, oil
 Tempering: 550 - 660°C/air

Mechanical Properties:

Treated for cold shearability +S: max. 255 HB
 Soft annealed +A: max. 207 HB

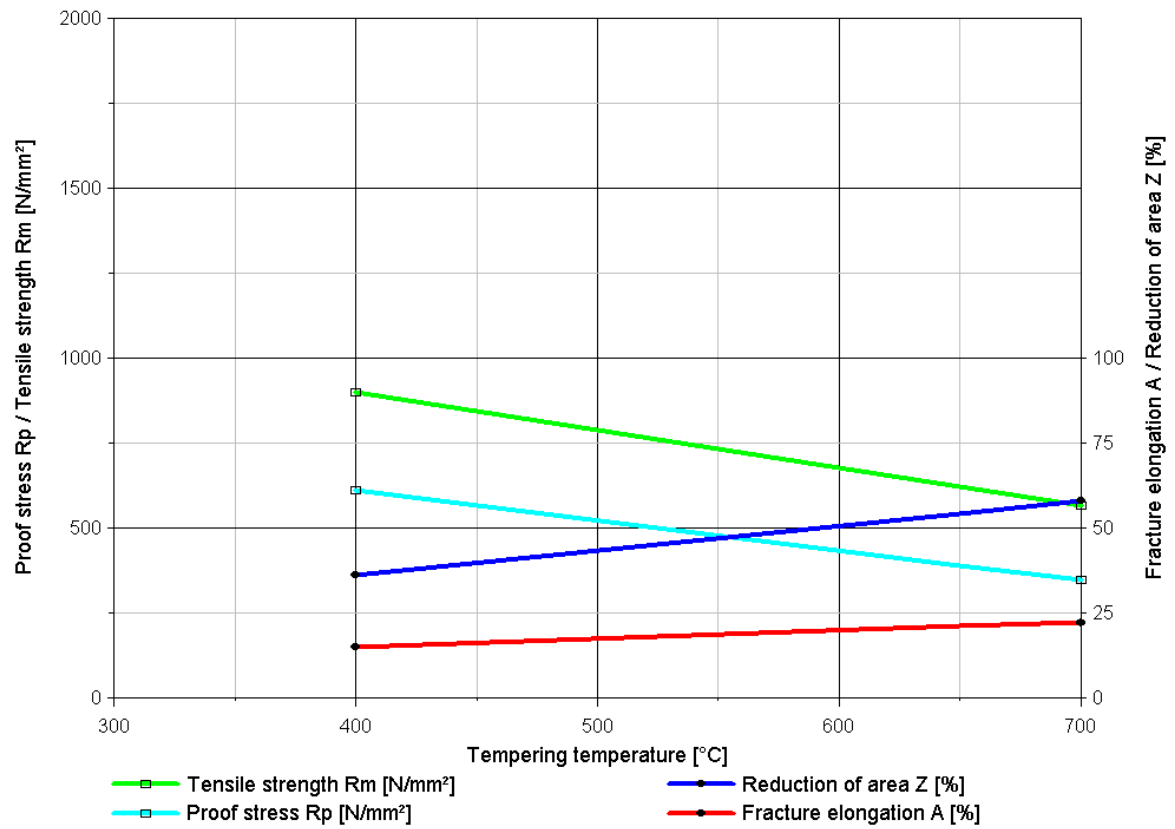
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm²]	min. 490	min. 430	min. 370	-	-
Tensile strength R _m [N/mm²]	700 - 850	650 - 800	630 - 780	-	-
Fracture elongation A ₅ [%]	min. 14	min. 16	min. 17	-	-
Reduction of area Z [%]	min. 35	min. 40	min. 45	-	-

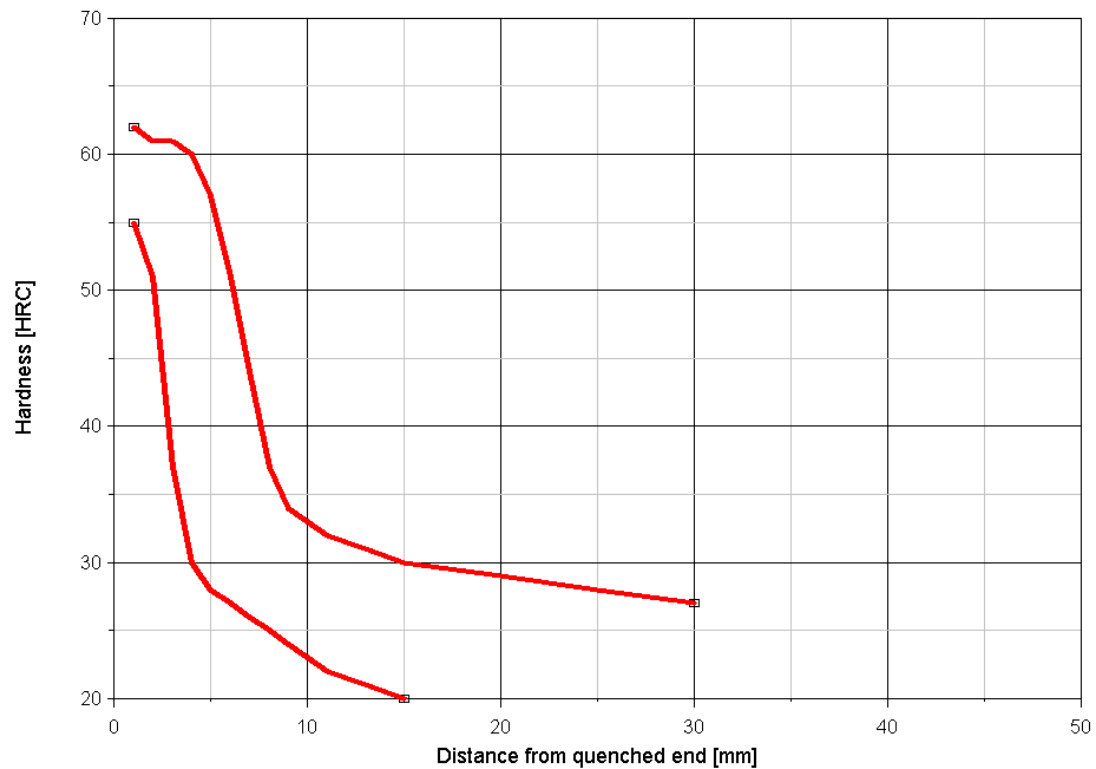
Normalised, +N:

Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 340	min. 305	min. 275		
Tensile strength R_m [N/mm²]	min. 620	min. 580	min. 560		
Fracture elongation A₅ [%]	min. 14	min. 16	min. 16		

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C60

Material No.:

Former brand name:

International steel grades:

1.0601

BS: C60, 60CS, 060A62
AFNOR: C60, AF70C55, 1C60
SAE: 1060

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition:

(Typical analysis in %)

C	Si	Mn	P	S	Cr	Mo	Ni	Cr+Mo+Ni
0,57 0,65	<0,40	0,60 0,90	<0,045	<0,045	<0,40	<0,10	0,40	<0,63

Application:

Plain carbon steel for mechanical engineering and automotive components

Hot forming and heat treatment:

Forging or hot rolling:	1100 - 800°C
Normalising:	820 - 860°C/air
Soft annealing:	680 - 710°C/furnace
Hardening:	800 - 840°C/water, oil
Tempering:	550 - 660°C/air

Mechanical Properties:

Treated for cold shearability +S:	max. 255 HB
Soft annealed +A:	max. 241 HB

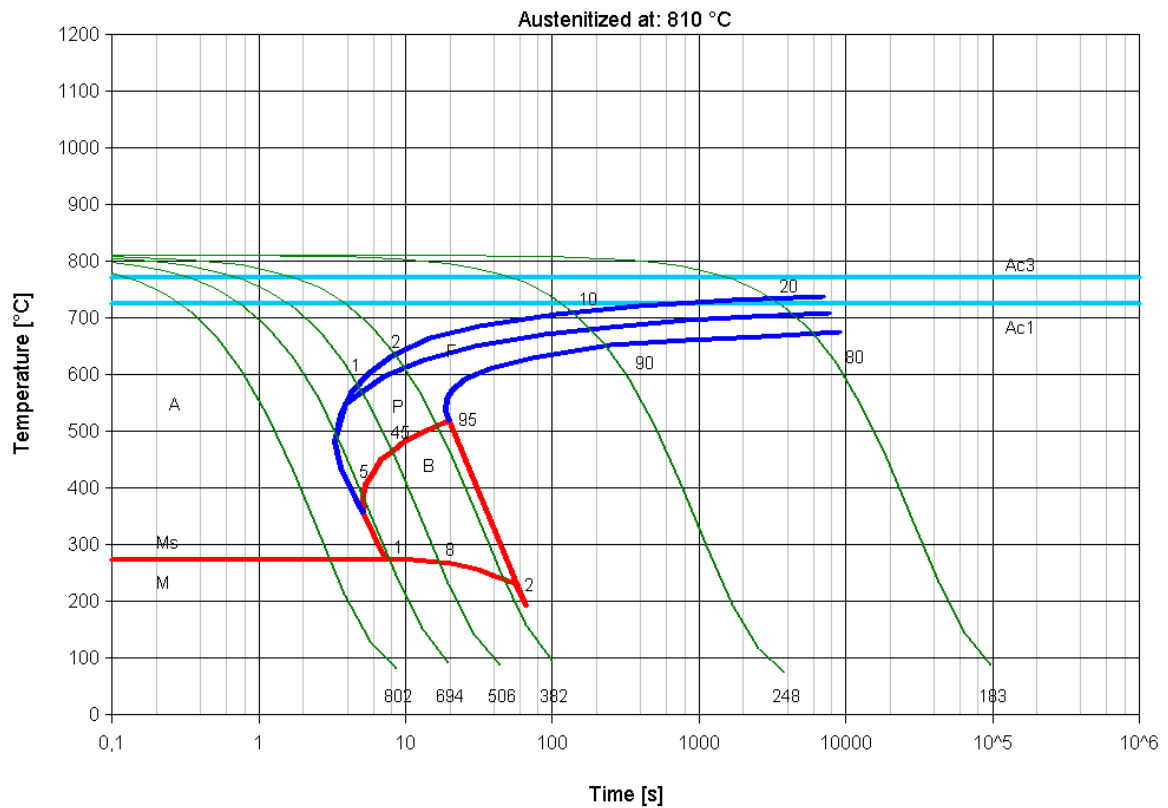
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R_{p0,2} [N/mm²]	min. 580	min. 520	min. 450	-	-
Tensile strength R_m [N/mm²]	850 - 1000	800 - 950	750 - 900	-	-
Fracture elongation A₅ [%]	Min. 11	min. 13	min. 14	-	-
Reduction of area Z [%]	min. 25	min. 30	min. 35	-	-

Normalised, +N:

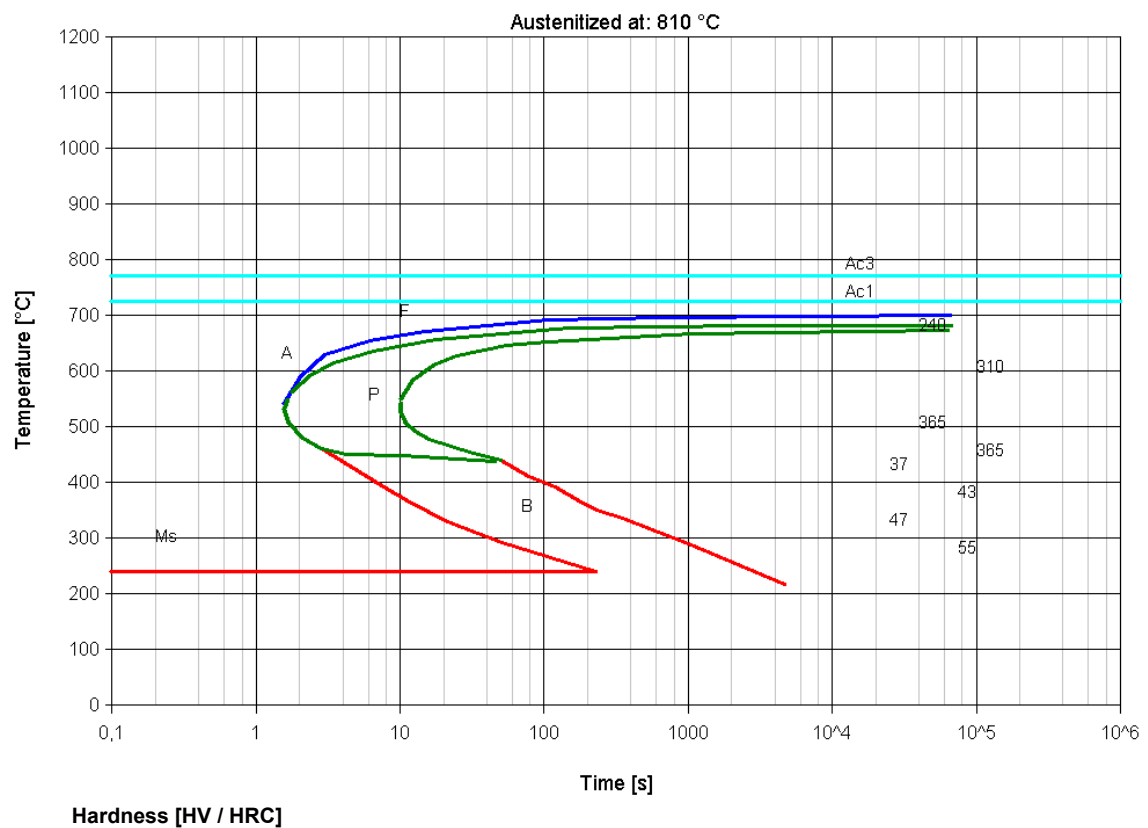
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 380	min. 340	min. 310		
Tensile strength R_m [N/mm²]	min. 710	min. 670	min. 650		
Fracture elongation A₅ [%]	min. 10	min. 11	min. 11		

Time-temperature-transformation diagram for continuous cooling

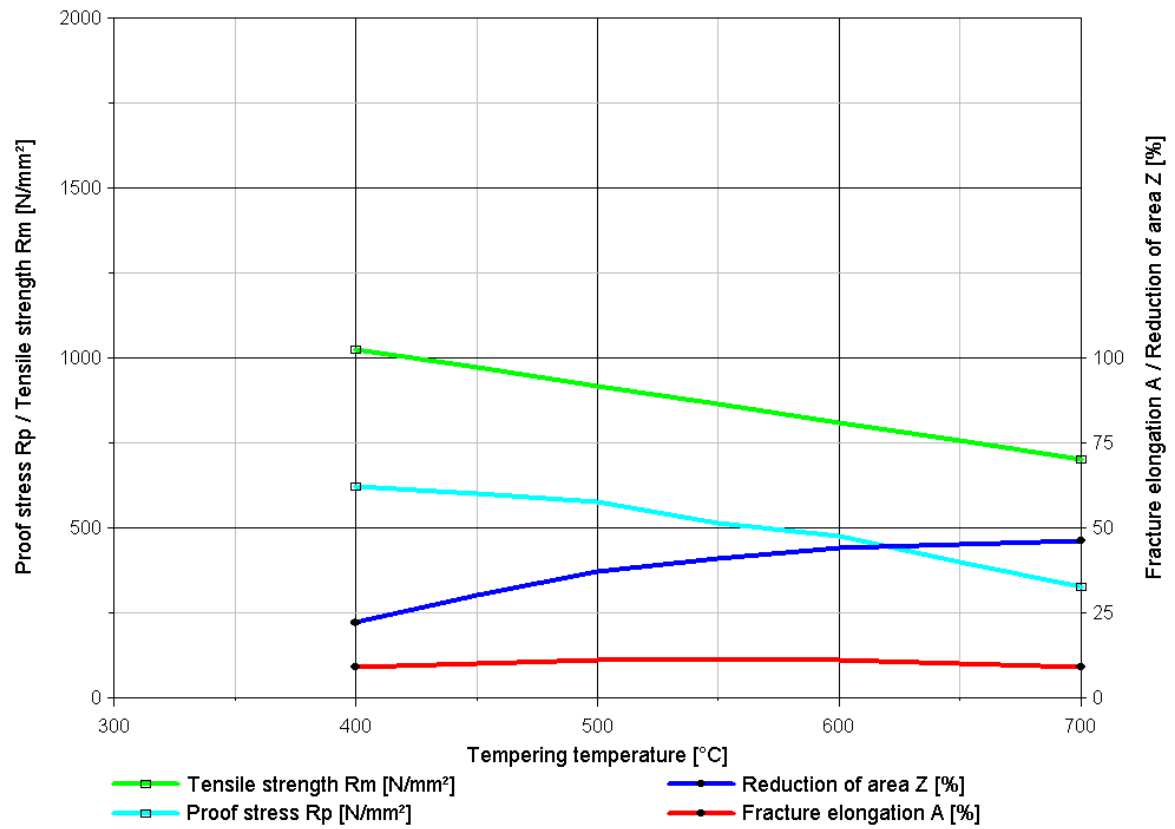


Hardness HV	802	694	506	382	248	183
Lambda-Value	0,01	0,03	0,07	0,17	5°/min	1,25°/min

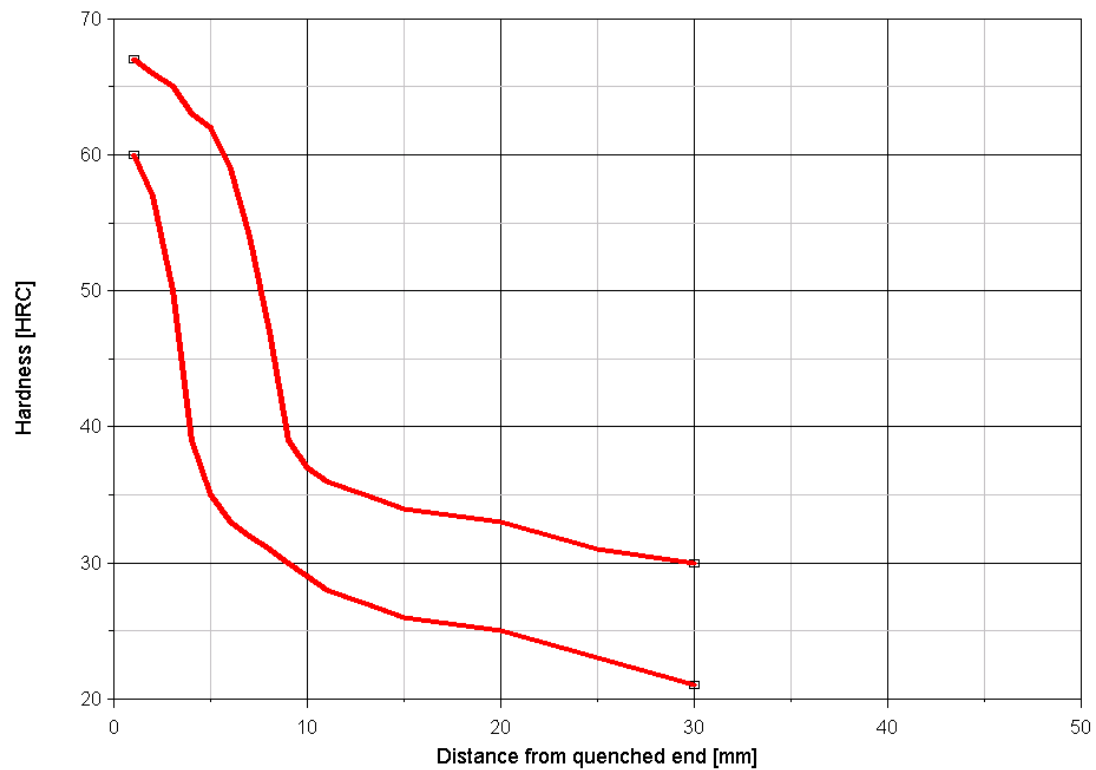
Time-temperature-transformation diagram for isothermal cooling



Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 11SMn30 (9SMn28)

Material No.:	Former brand name:	International steel grades:	
1.0715	9SMn28	BS:	230M07
		AFNOR:	S250
		SAE:	1213

Material group: Free-cutting steel according to DIN EN 10277

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S
	<0,14	0,050	0,90 1,30	0,11	0,27 0,33

Application: Free-cutting steel for bulk applications for joining elements in mechanical engineering and automotive components.

Hot forming and heat treatment:	Normalising:	890 - 920°C
	Soft annealing:	650 - 700°C
	Carburising:	880 - 950°C
	Core hardening:	880 - 920°C
	Case hardening:	770 - 810°C
	Tempering:	150 - 200°C

Mechanical Properties:

Condition of delivery: Rolled and peeled (+SH)

Thickness [mm]	>5 - 10	>10 - 16	>16 - 40	>40 - 63	>63 - 100
Hardness [HB]	-	-	112 - 169	112 - 169	107 - 154
Tensile strength R_m [N/mm ²]	-	-	380 - 570	370 - 570	360 - 520

Condition of delivery: Cold drawn (+C)

Thickness [mm]	>5 - 10	>10 - 16	>16 - 40	>40 - 63	>63 - 100
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 440	min. 410	min. 375	min. 305	min. 245
Tensile strength R_m [N/mm ²]	510 - 810	490 - 760	460 - 710	400 - 650	360 - 630
Fracture elongation A_5 [%]	min. 6	min. 7	min. 8	min. 9	min. 9

Material specification sheet

Saarstahl - 10MnB6

Material No.: Former brand name: International steel grades:

1.1109

Saaramart

BS:
AFNOR:
SAE:

Material group: Carbon-manganese based boron-alloyed steel

Chemical Composition (Typical analysis in %)	C	Mn	S	B + Ti
	0,10	1,50	0,03	additions

Application:

Boron steel on carbon-manganese basis with high tensile strength and good toughness properties for high strength components which can be quenched after hot forming into water directly.

This steel can be used for forging components in automotive construction where high tensile strength and good toughness are required and for lightweight constructions. At the same time a good environmental compatibility is given because no further heat treatment and oil quenching is necessary. Productivity can be increased because of a short turnaround time.

Hot forming and heat treatment:

Furnace temperature before hot forming: 1220 - 1280°C
Quenching: water

No tempering, rehardening possible, no hardening crack sensitivity.

Mechanical Properties:

Treated for cold shearability +S: max. 255 HB
Soft annealed +A: max. 248 HB

As quenched condition after hot forming:

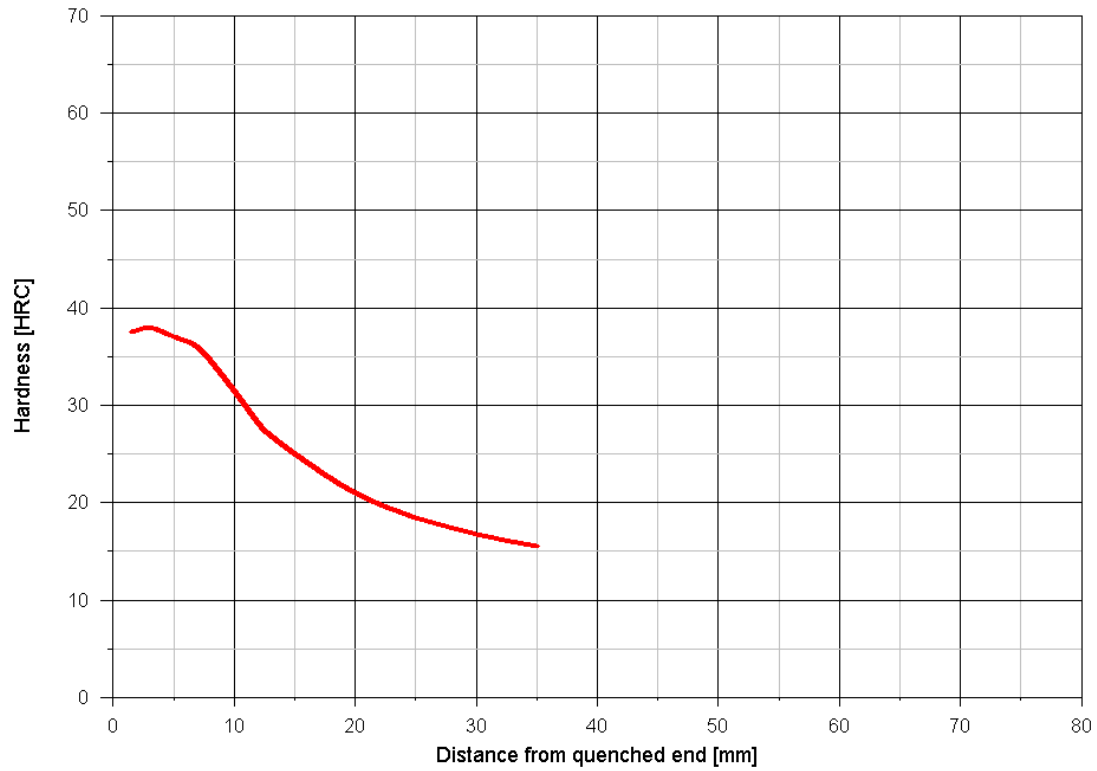
0,2% proof stress $R_{p0,2}$ [N/mm ²]	850 - 950
Tensile strength R_m [N/mm ²]	1100 - 1200
Fracture elongation A_5 [%]	12 - 14
Reduction of area Z [%]	60 - 65
Notch impact energy ISO-V [J]	50 - 60

Microstructure:

100 % martensite up to 30 mm diameter.
Some amount of bainite possible in core of diameter is above 30 mm

Hardness scatter band

Austenitized at: 950°C



Material specification sheet

Saarstahl - C15E2C (Cq15)

Material No.: Former brand name: International steel grades:

1.1132

RKS15

BS:
AFNOR:
SAE:

Material group: Steel for cold extrusion according to DIN EN 10263

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cu
	0,14	0,15	0,40	<0,025	<0,025	<0,25

Application: Plain carbon steel for cold extrusion of screws and bolts

Hot forming and heat treatment: Soft annealing: 650 - 700°C
Hardening: 870 - 900°C/water
Tempering: 530 - 670°C

Mechanical Properties:

Untreated (+U) or untreated + as hot rolled (+PE)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	-	max. 480	max. 480	max. 480
Reduction of area Z [%]	-	min. 58	min. 58	min. 58

Spheroidized annealed (+AC) or spheroidized annealed + peeled (+AC+PE)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	-	max. 430	max. 430	max. 430
Reduction of area Z [%]	-	min. 65	min. 65	min. 65

untreated + cold drawn (+U+C)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm²]	-	max. 570	max. 560	-
Reduction of area Z [%]	-	min. 56	min. 56	-

untreated + cold drawn + spheroidized annealed (+U+C+AC)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm²]	max. 420	max. 410	max. 410	-
Reduction of area Z [%]	min. 67	min. 67	min. 67	-

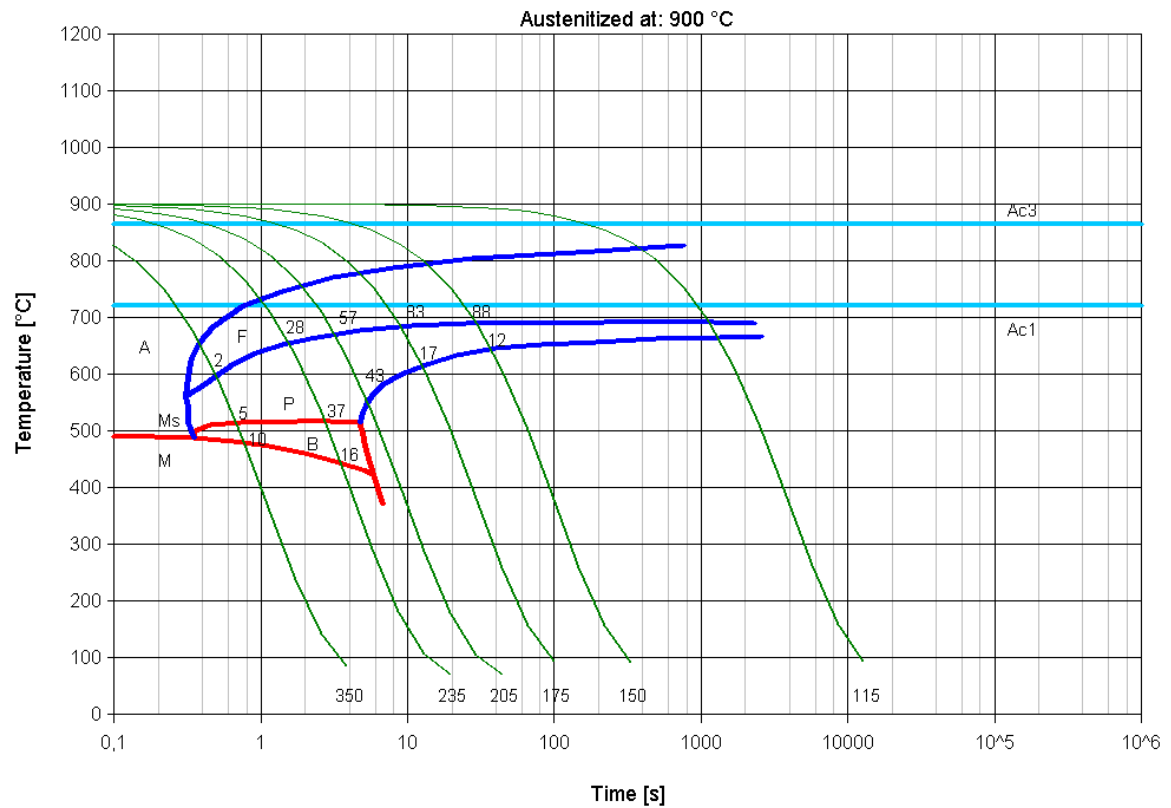
Untreated + cold drawn + spheroidized annealed + stretch reduced by roll drawing (+U+C+AC+LC)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm²]	max. 460	max. 450	max. 450	-
Reduction of area Z [%]	min. 65	min. 65	min. 65	-

Spheroidized annealed + cold drawn (+AC+C)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm²]	-	max. 520	max. 510	-
Reduction of area Z [%]	-	min. 62	min. 62	-

Time-temperature-transformation diagram for continuous cooling



Hardness HV	350	235	205	175	150	115
Lambda-Value	0,007	0,02	0,06	0,18	0,54	10°/min

Material specification sheet

Saarstahl - 20Mn5

Material No.:	Former brand name:	International steel grades:	
1.1133	Atrix 101	BS:	120M19
		AFNOR:	20M5
		SAE:	1022, 1518

Material group: High temperature constructional steel according to DIN EN 10269

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	other
	0,20	0,50	1,15	-	-

Application: High temperature constructional weldable steel for forgings and pipes of boiler plants and for constructions of apparatus, pressure vessels and pipelines.

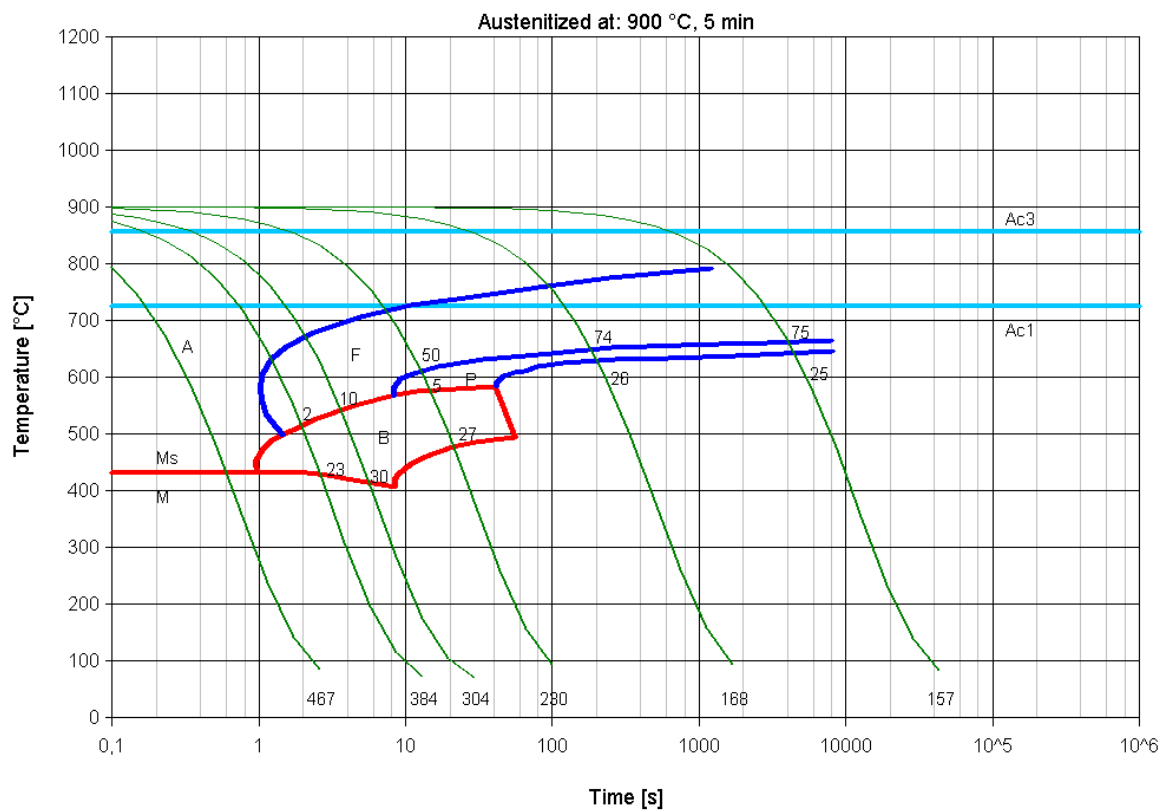
Hot forming and heat treatment:	Hardening:	870 - 900°C
	Tempering:	580 - 680°C

Mechanical Properties:

Condition of delivery: Quenched and tempered

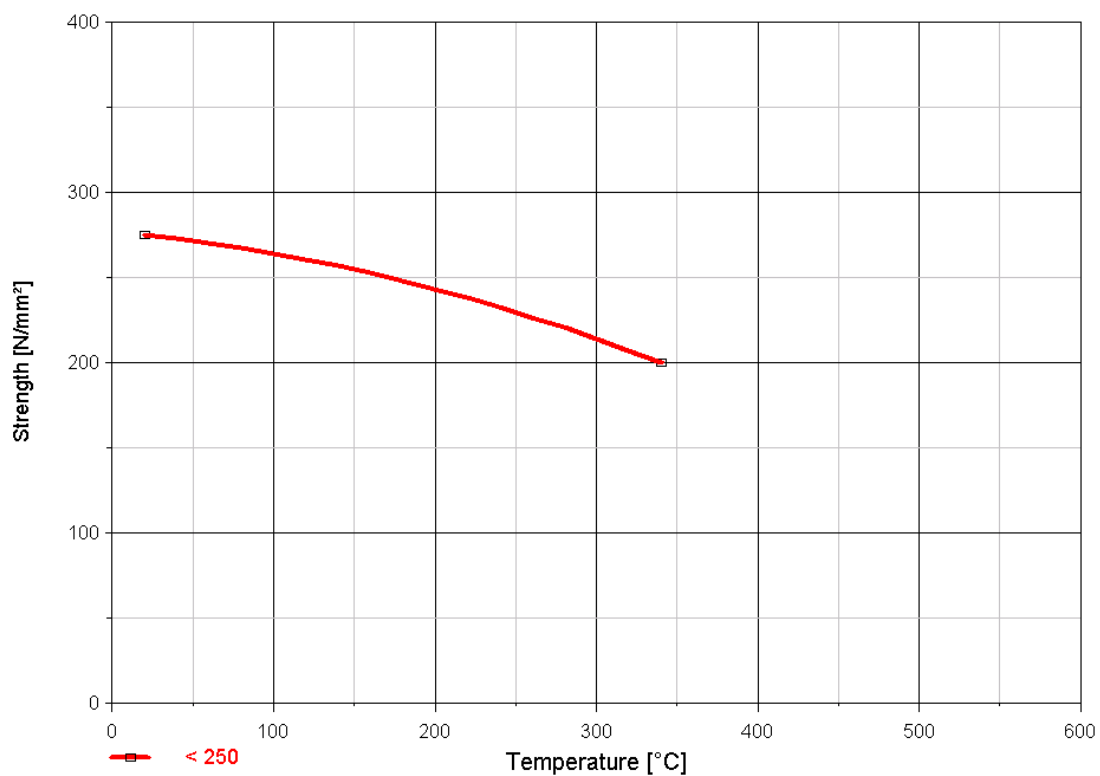
Effective wall thickness [mm]	<=250	250 - 500
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 295	min. 275
Tensile strength R_m [N/mm ²]	490 - 640	490 - 640
Fracture elongation longitudinal A_5 [%]	min. 22	min. 21
Fracture elongation tangential A_5 [%]	min. 19	min. 18
Fracture elongation transverse A_5 [%]	min. 15	min. 14
Notch impact energy longitudinal DVM [J]	min. 48	min. 48
Notch impact energy tangential DVM [J]	min. 34	min. 34
Notch impact energy transverse DVM [J]	min. 24	min. 24

Time-temperature-transformation diagram for continuous cooling

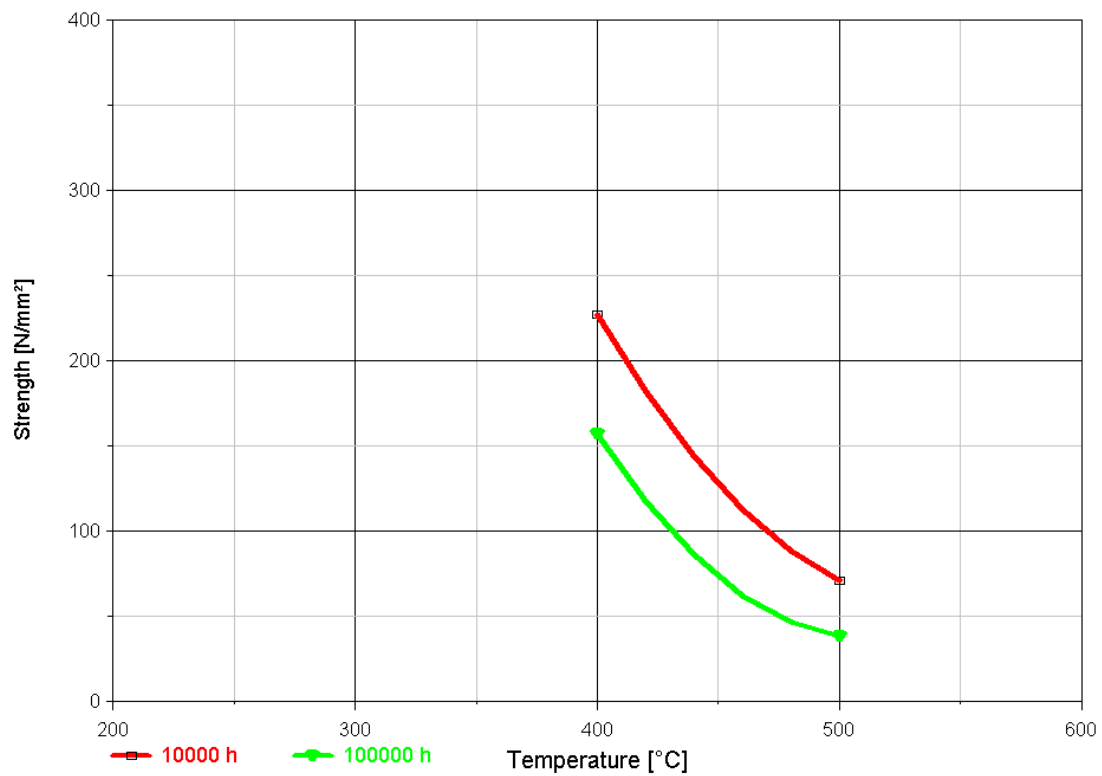


Hardness HV	467	384	304	230	168	157
Lambda-Value	0,004	0,02	0,04	0,17	3,07	2,5°/min

Diagram for yield points at elevated temperatures



Creep strength diagram



Material specification sheet

Saarstahl - C15R (Cm15)

Material No.:	Former brand name:	International steel grades:	
1.1140	R1	BS:	040A15, 080M15
		AFNOR:	C15E, XC12, XC15, XC18
		SAE:	1015

Material group: Case hardening steels DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	S	other
	0,15	0,25	0,40	0,020 0,035	(Pb)

Application: Plain carbon case hardening steel for parts with a required core tensile strength of 600 - 800 N/mm² and good wearing resistance as piston bolts, camshafts, levers and other vehicle and mechanical engineering components. Suitable for direct hardening.

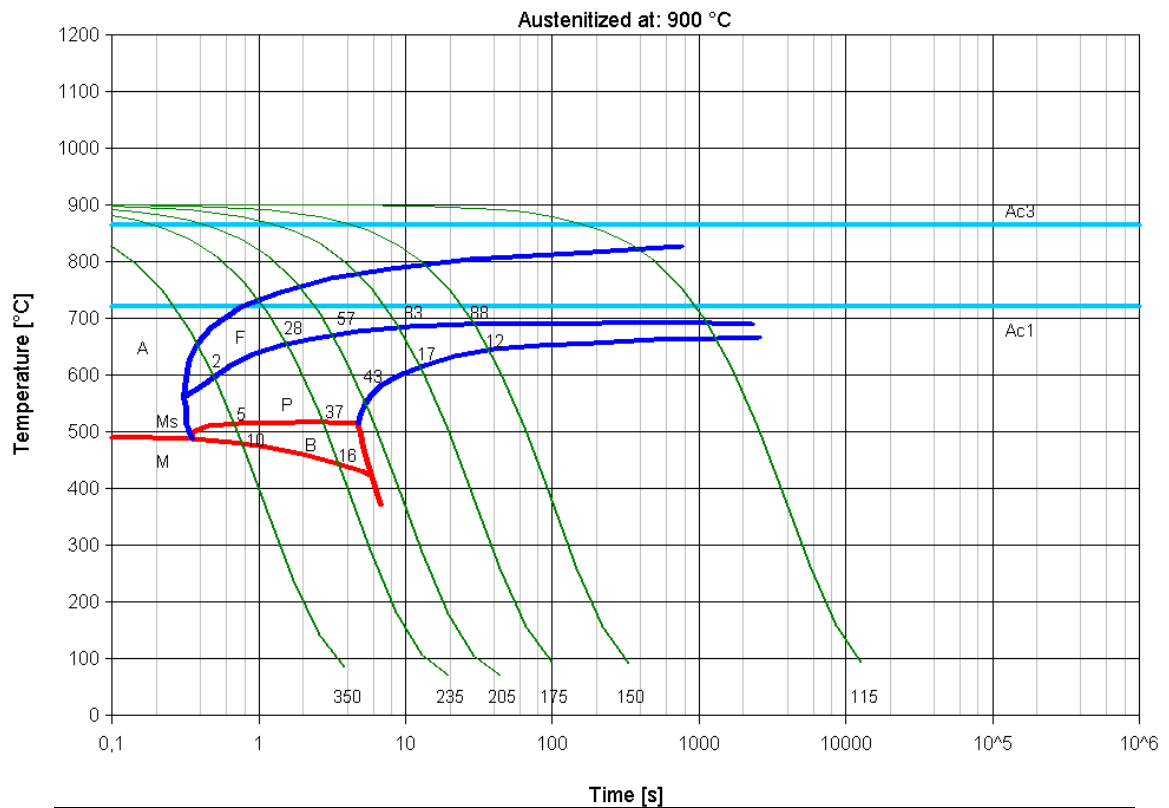
Hot forming and heat treatment:	Forging or hot rolling:	1150 - 900°C
	Normalising:	890 - 920°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	880 - 920°C/water
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C/water
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	-
	Soft annealed, +A:	max. 143 HB
	Treated for strength, +TH:	-
	Treated for ferrite and pearlite structure and hardness range, +FP:	-

after hardening and tempering at 200°C:

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 800	min. 600	-

Time-temperature-transformation diagram for continuous cooling



Hardness HV	350	235	205	175	150	115
Lambda-Value	0,007	0,020	0,054	0,22	0,52	10°/min

Material specification sheet

Saarstahl - C22E (Ck22) - C22R (Cm22)

Material No.:	Former brand name:	International steel grades:	
1.1151	R2	BS:	055M15
		AFNOR:	C22E, C22R, XC25, 2C22
1.1149		SAE:	1020, 1023

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	S	other
	C22E	0,20	0,25	0,50	<0,030	(Pb)
	C22R	0,20	0,25	0,50	0,020 0,035	(Pb)

Application: Plain carbon steel for mechanical engineering and automotive components.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	880 - 920°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	860 - 900°C/water
	Tempering:	550 - 660°C

Mechanical Properties:	Treated for cold shearability +S:	Shearable in as rolled condition
	Soft annealed +A:	-

Quenched and tempered, +QT:

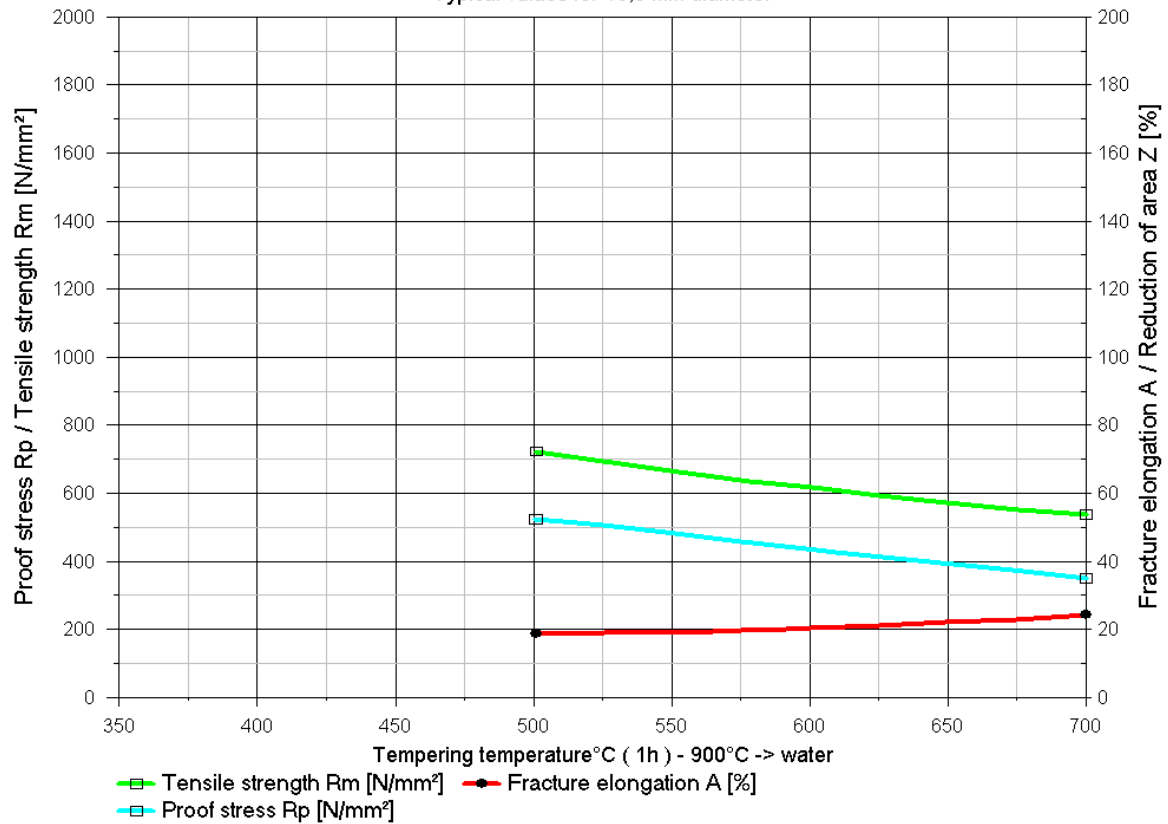
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm²]	min. 340	min. 290	-	-	-
Tensile strength R _m [N/mm²]	500 - 650	470 - 620	-	-	-
Fracture elongation A ₅ [%]	min. 20	min. 22	-	-	-
Reduction of area Z [%]	min. 50	min. 50	-	-	-
Notch impact energy ISO-V [J]	min. 50	min. 50	-	-	-

Normalised, +N:

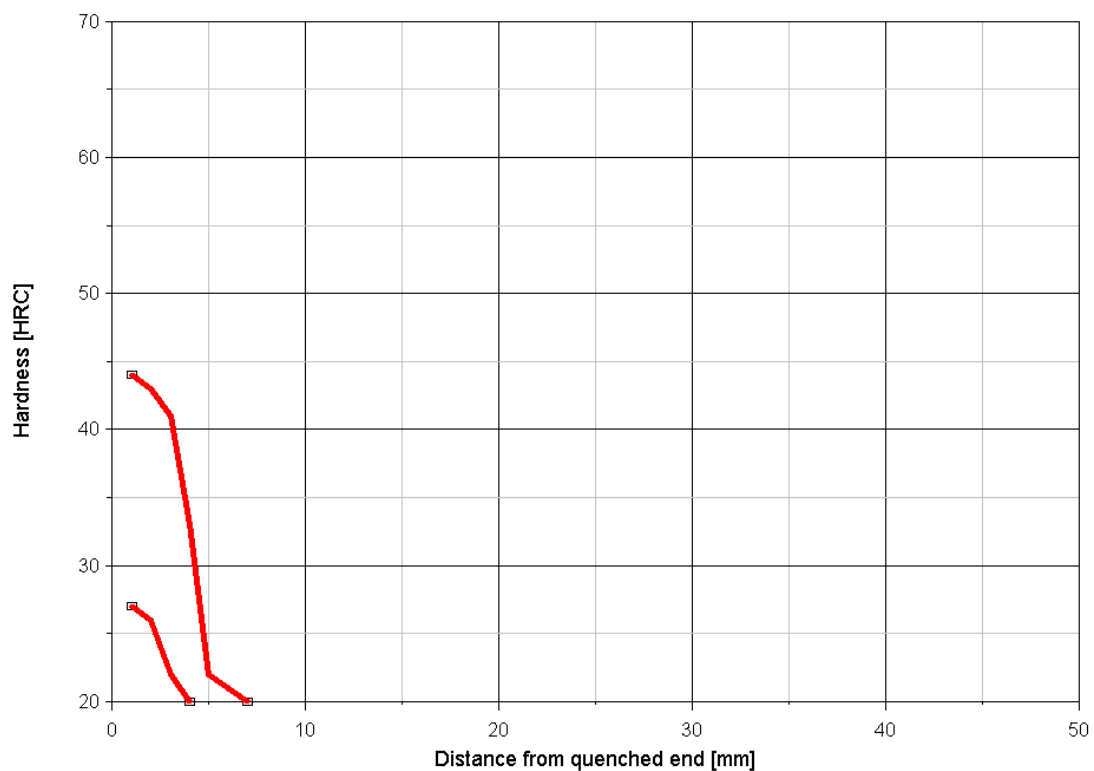
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 240	min. 210	-		
Tensile strength R_m [N/mm²]	min. 430	min. 410	-		
Fracture elongation A₅ [%]	min. 24	min. 25	-		

Tempering diagram

Typical values for 13,8 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - C20E2C (Cq22)

Material No.: Former brand name: International steel grades:

1.1152

RKS20

BS:
AFNOR:
SAE:

Material group: Steel for cold extrusion according to DIN EN 10263

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cu
	0,20	0,20	0,50	<0,025	<0,025	<0,25

Application: Plain carbon cold heading steel for screws and nuts.

Hot forming and heat treatment:

Soft annealing:	680 - 710°C
Hardening:	870 - 900°C/water
Tempering:	530 - 670°C

Mechanical Properties:

Untreated (+U) or untreated + as hot rolled (+PE)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	-	max. 530	max. 530	max. 530
Reduction of area Z [%]	-	min. 58	min. 58	min. 58

Spheroidized annealed (+AC) or spheroidized annealed + peeled (+AC+PE)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	-	max. 470	max. 470	max. 470
Reduction of area Z [%]	-	min. 65	min. 65	min. 65

Untreated + cold drawn (+U+C)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	-	max. 640	max. 630	-
Reduction of area Z [%]	-	min. 56	min. 56	-

Untreated + cold drawn + spheroidized annealed (+U+C+AC)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	max. 460	max. 450	max. 450	-
Reduction of area Z [%]	min. 67	min. 67	min. 67	-

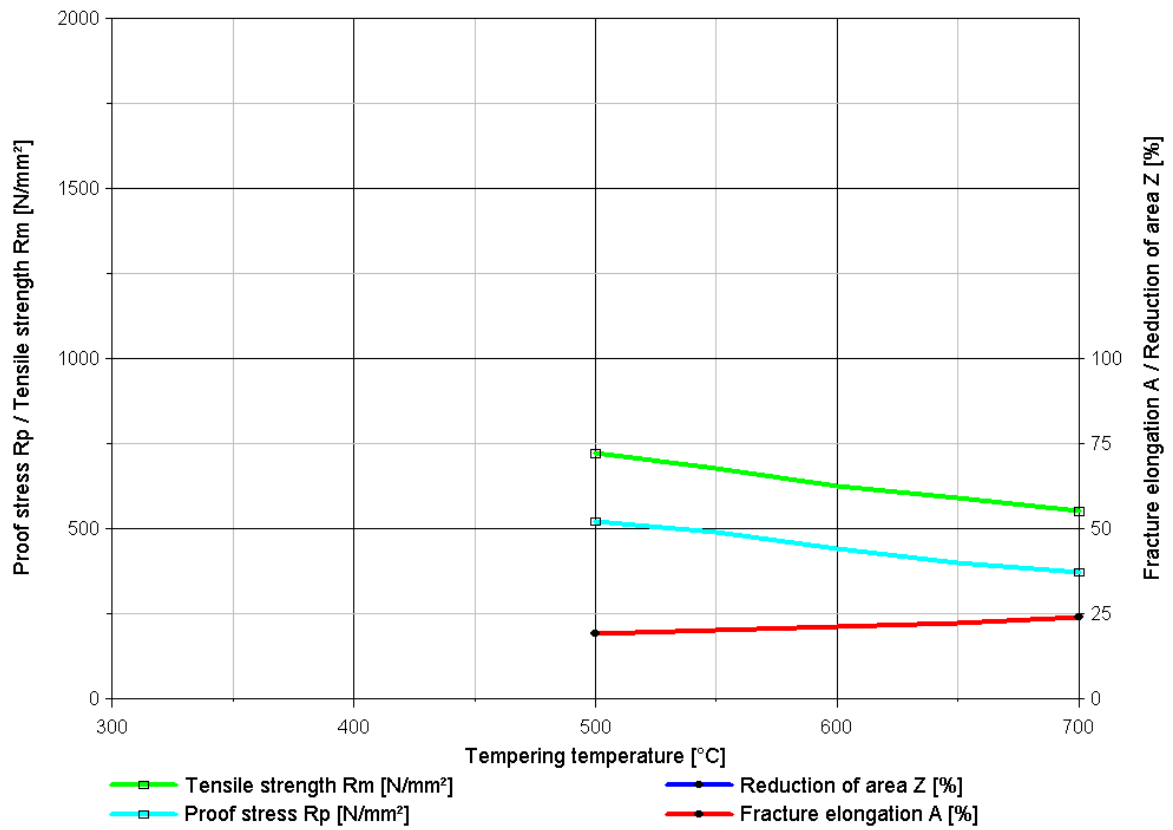
Untreated + cold drawn + spheroidized annealed + stretch reduced by roll drawing (+U+C+AC+LC)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	max. 500	max. 490	max. 490	-
Reduction of area Z [%]	min. 65	min. 65	min. 65	-

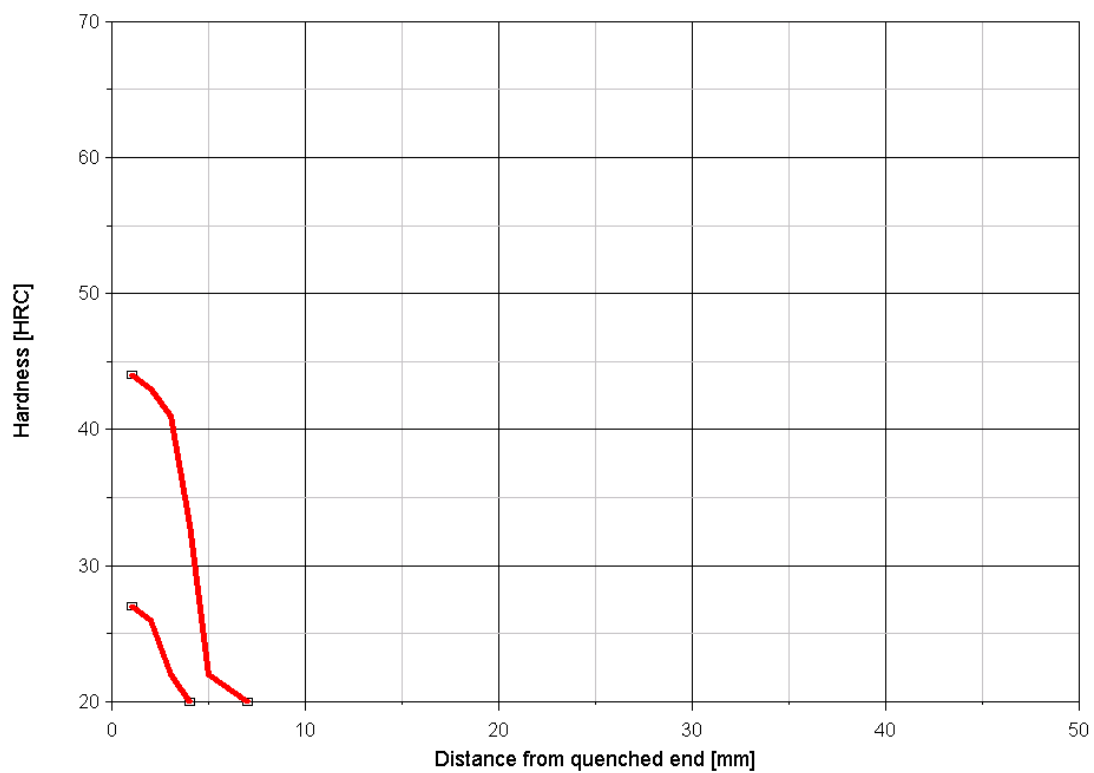
Spheroidized annealed + cold drawn (+AC+C)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40	> 40 - 100
Tensile strength R_m [N/mm ²]	-	max. 580	max. 570	-
Reduction of area Z [%]	-	min. 62	min. 62	-

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 36Mn5

Material No.:	Former brand name:	International steel grades:	
1.1167	VM135	BS:	150M36
		AFNOR:	35M5, 40M5
		SAE:	1335

Material group: Seamless circular tubes made from steels for hardening and tempering according to DIN 17204

Chemical composition: (Typical analysis in %)	C	Si	Mn	other
	0,36	0,25	1,35	(Pb)

Application: Heat treatable steel for a tensile strength range of 700 - 1000 N/mm² for general mechanical engineering components with sufficient weldability .

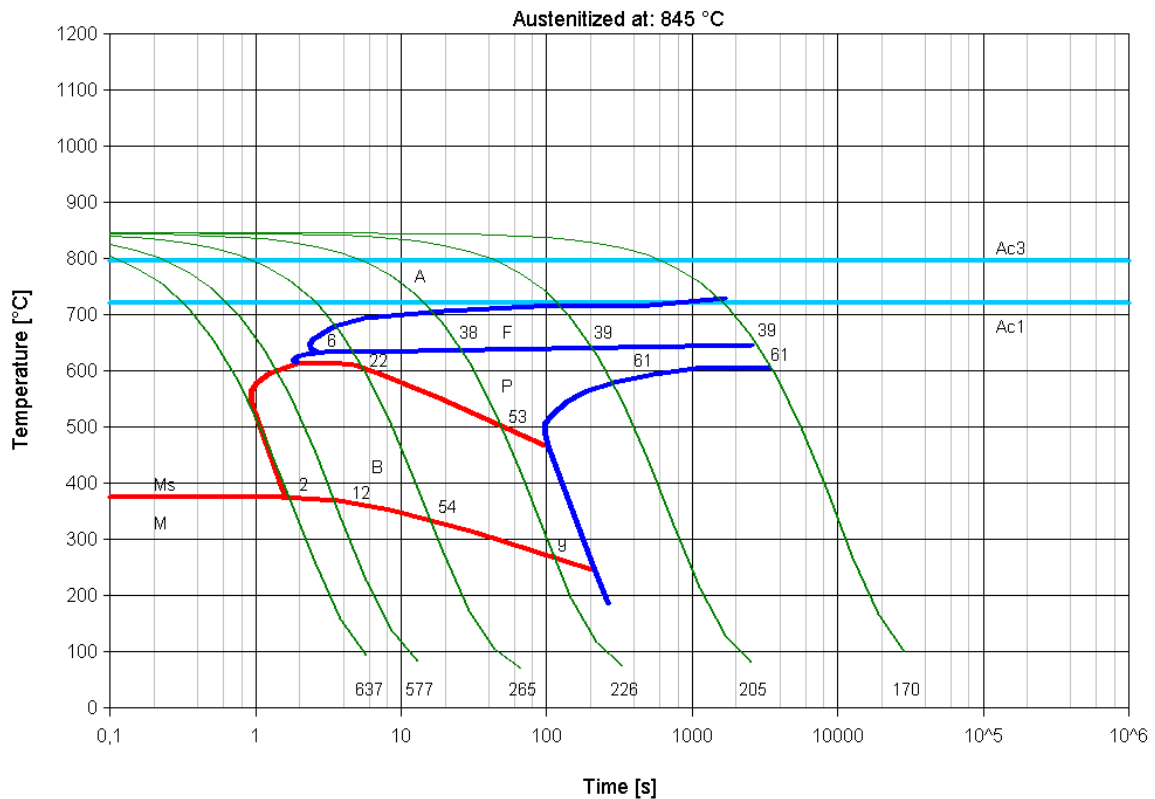
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 700°C/furnace
	Hardening:	820 - 850°C/water
	Tempering:	480 - 650°C/water, oil

Mechanical Properties: Soft annealed +A: max. 217 HB

Condition of heat treatment Quenched and tempered

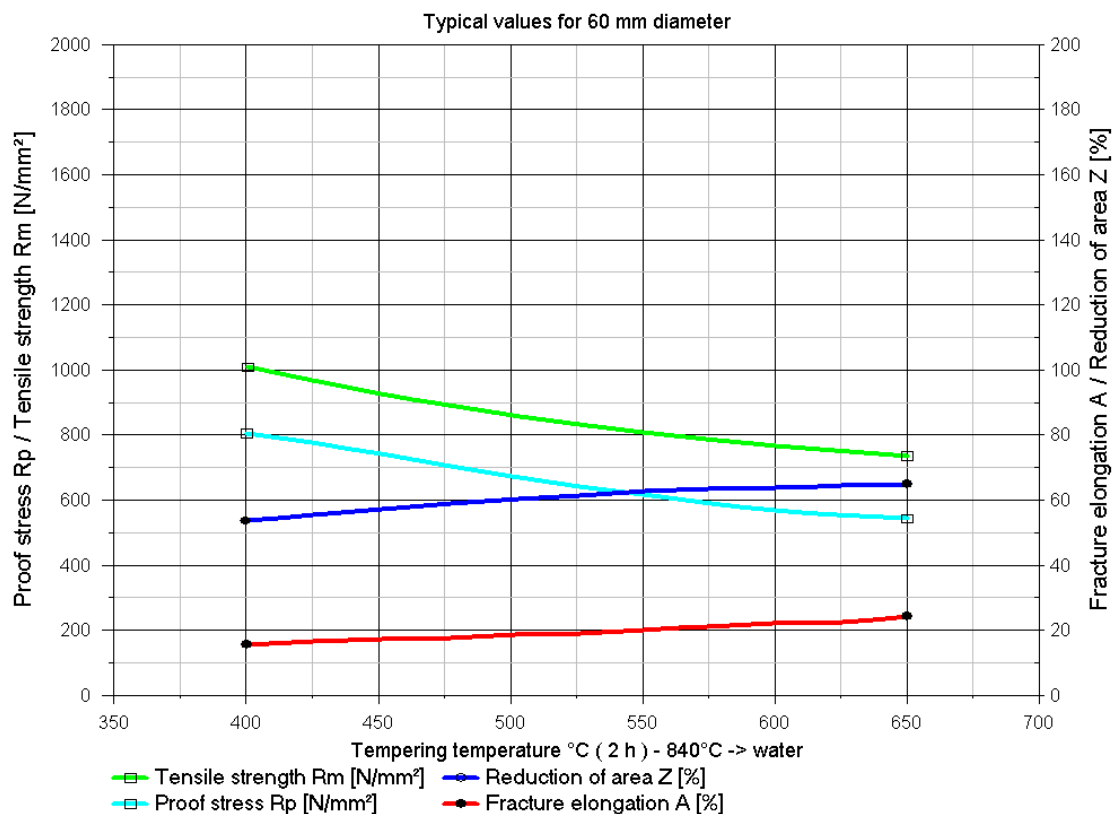
Diameter d [mm]	<40	40 - 100	100 - 250
0,2% proof stress R_{p0,2} [N/mm²]	min. 600	min. 540	min. 440
Tensile strength R_m [N/mm²]	830 - 1000	730 - 900	630 - 800
Fracture elongation A₅ [%]	min. 10	min. 12	min. 15
Notch impact energy ISO-V [J]	min. 25	min. 30	min. 38

Time-temperature-transformation diagram for continuous cooling

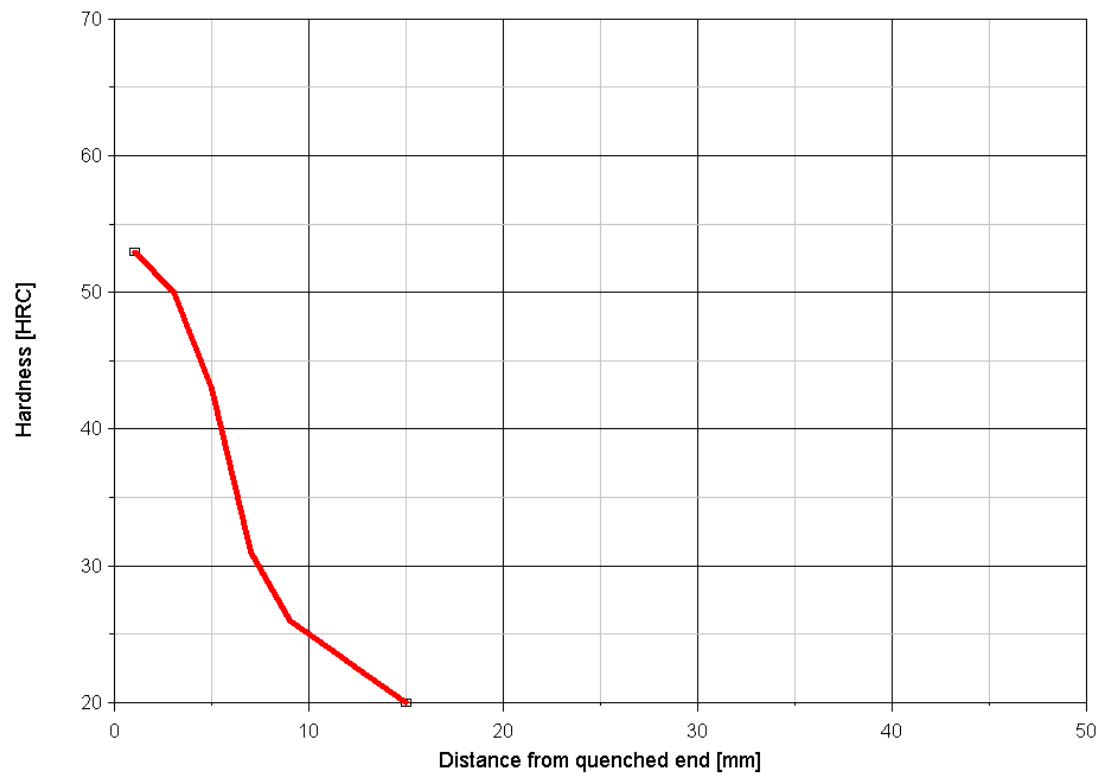


Hardness HV	637	577	265	226	205	170
Lambda-Value	0,01	0,02	0,08	0,44	3,42	5°/min

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 28Mn6

Material No.:	Former brand name:	International steel grades:
1.1170		BS: (150M28), (150M19) AFNOR: 28Mn6, 20M5 SAE: 1330

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	Ni	Cr+Mo+Ni
	0,25 0,32	<0,40	1,30 1,65	<0,035	<0,035	<0,40	<0,10	0,40	<0,63

Application: Heat treatable steel for mechanical engineering and automotive components with sufficient weldability with a typical tensile strength range of 640 - 930 N/mm².

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 890°C/air
	Soft annealing:	650 - 700°C/furnace
	Hardening:	830 - 870°C/water, oil
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 223 HB

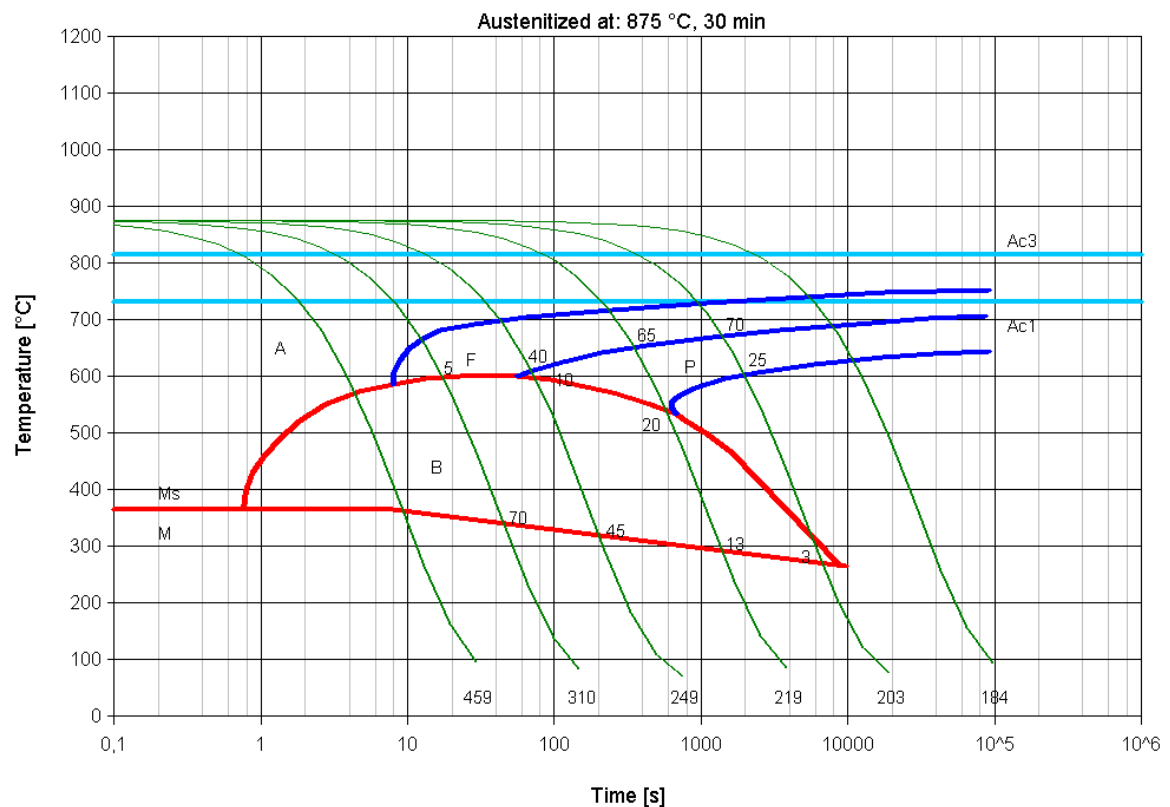
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R_{p0,2} [N/mm²]	min. 590	min. 490	min. 440	-	-
Tensile strength R_m [N/mm²]	800 - 950	700 - 850	650 - 800	-	-
Fracture elongation A₅ [%]	min. 13	min. 15	min. 16	-	-
Reduction of area Z [%]	min. 40	min. 45	min. 50	-	-
Notch impact energy ISO-V [J]	min. 35	min. 40	min. 40	-	-

Normalised, +N:

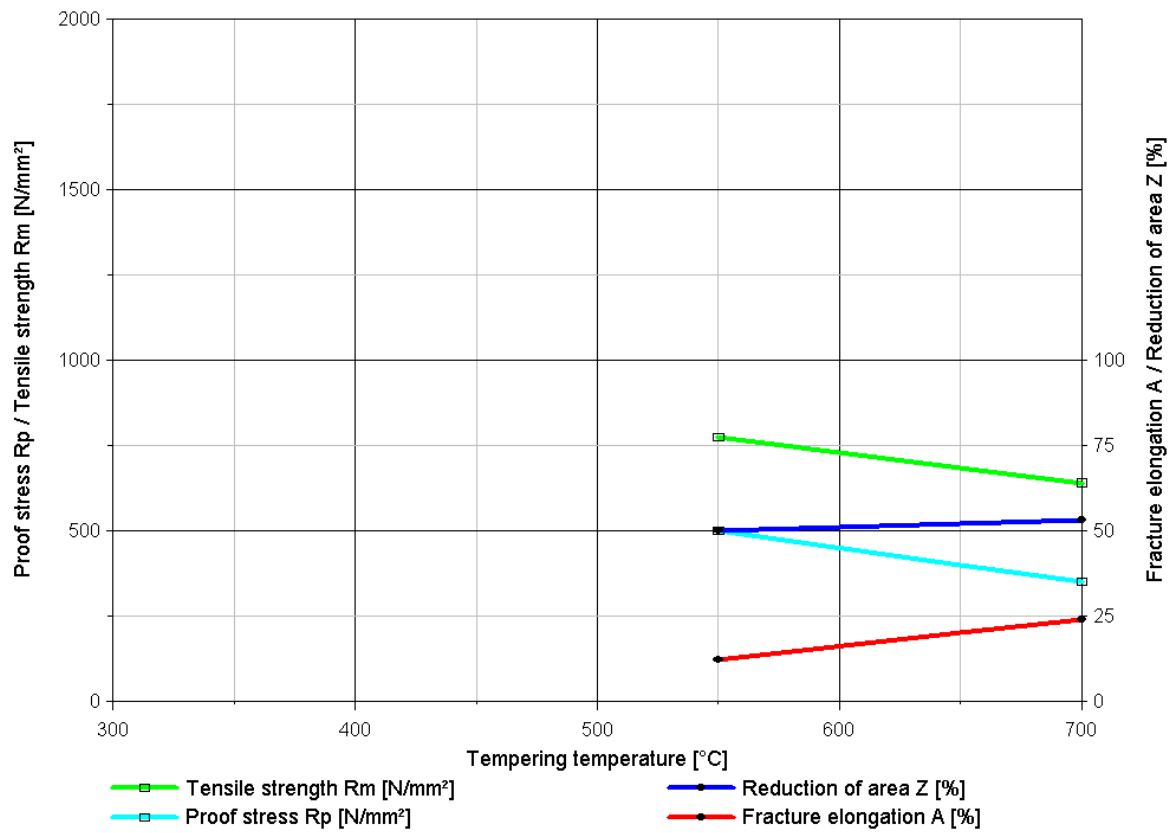
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	<16	16<t<100	100<t<250		
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 345	min. 310	min. 290		
Tensile strength R_m [N/mm ²]	min. 630	min. 600	min. 590		
Fracture elongation A_5 [%]	min. 17	min. 18	min. 18		

Time-temperature-transformation diagram for continuous cooling

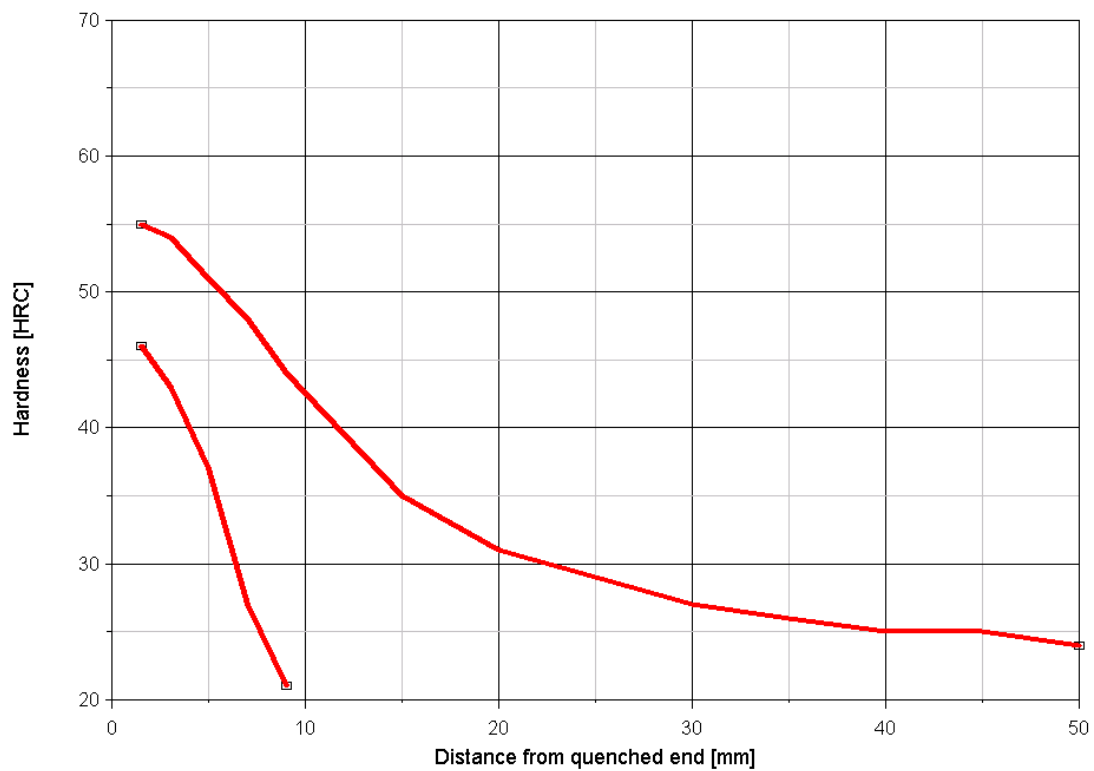


Hardness HV	459	310	249	219	203	184
Lambda-Value	0,05	0,21	0,91	5,54	5°/min	1,25°/min

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C35EC (Cq35)

Material No.:	Former brand name:	International steel grades:
1.1172	RKS32, RKS37	BS: AFNOR: SAE:

Material group: Steel for cold extrusion according to DIN EN 10263

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cu
	0,35	0,20	0,70	<0,025	<0,025	<0,25

Application: Plain carbon cold heading steel for screws and nuts.

Hot forming and heat treatment:	Soft annealing:	680 - 710°C
	Hardening:	860 - 890°C/water
	Tempering:	530 - 670°C

Mechanical Properties:

Spheroidized annealed (+AC) or spheroidized annealed + peeled (+AC+PE)

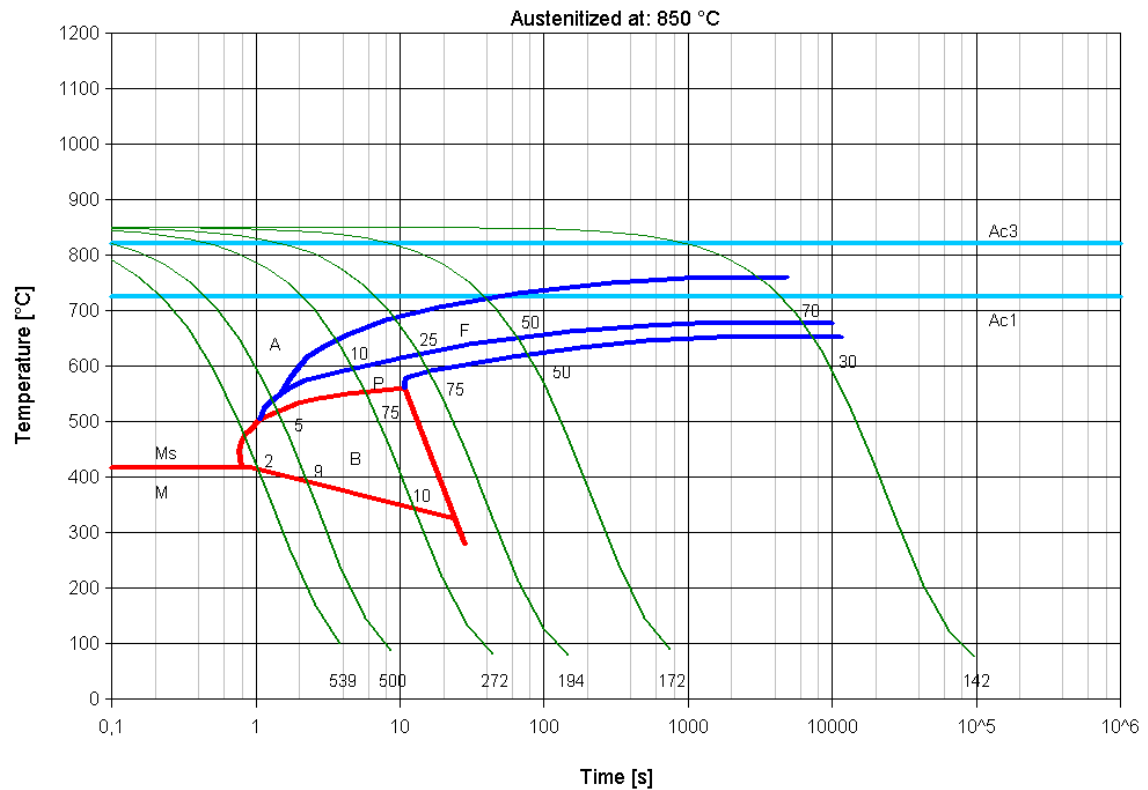
Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R _m [N/mm ²]	-	max. 560	max. 560
Reduction of area Z [%]	-	min. 60	min. 60

Untreated + cold drawn + spheroidized annealed (+U+C+AC)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R _m [N/mm ²]	max. 550	max. 540	max. 540
Reduction of area Z [%]	min. 62	min. 62	min. 62

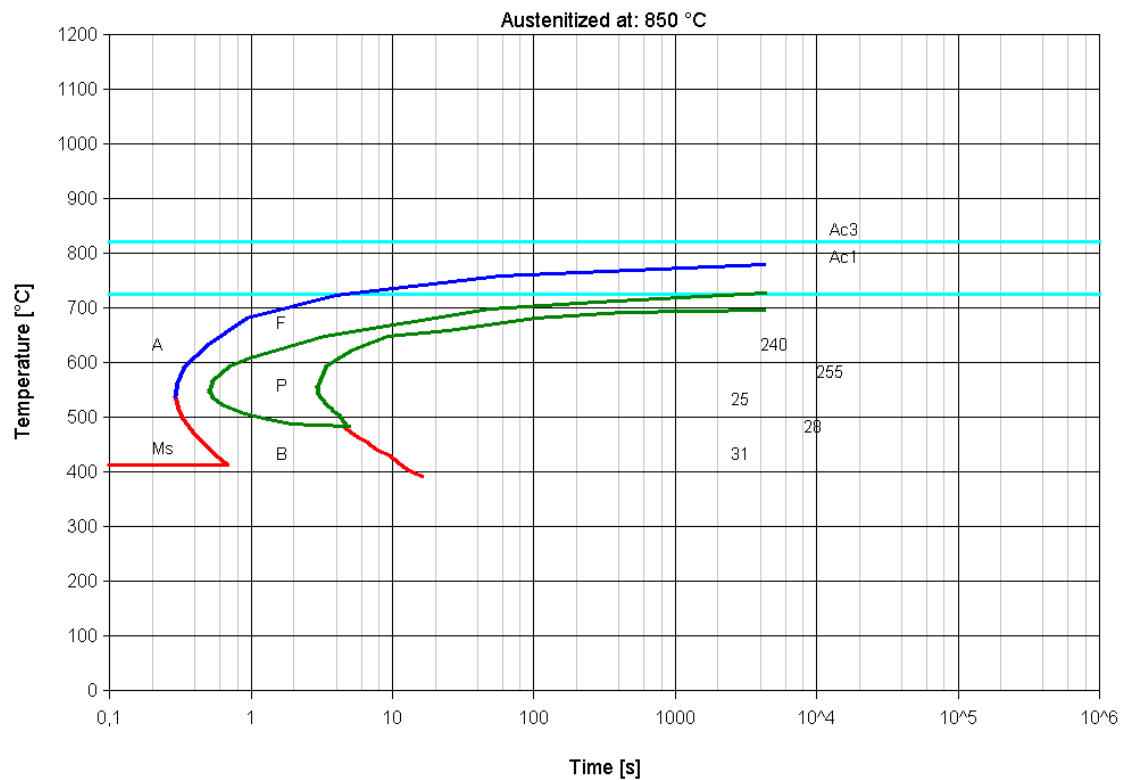
Untreated + cold drawn + spheroidized annealed + stretch reduced by roll drawing (+U+C+AC+LC)			
Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R _m [N/mm ²]	max. 590	max. 580	max. 580
Reduction of area Z [%]	min. 60	min. 60	min. 60
Spheroidized annealed + cold drawn (+AC+C)			
Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R _m [N/mm ²]	-	max. 660	max. 670
Reduction of area Z [%]	-	-	-

Time-temperature-transformation diagram for continuous cooling



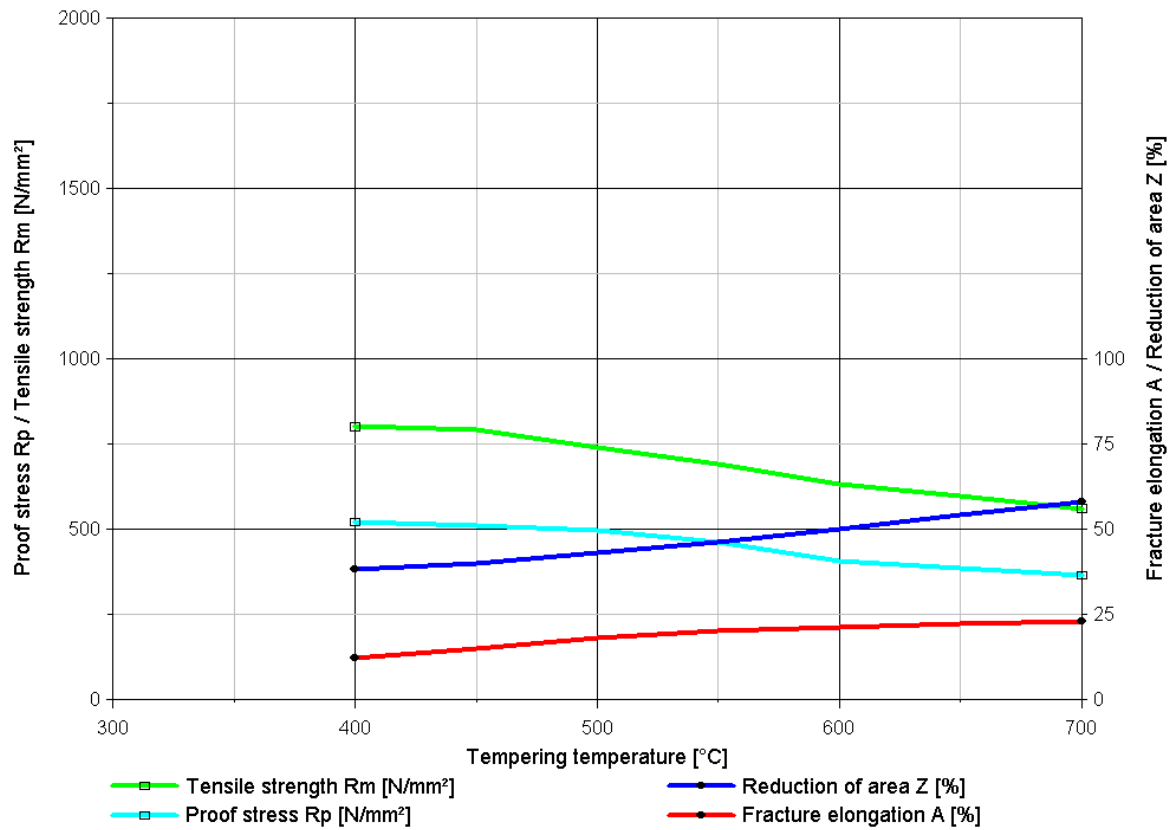
Hardness HV	539	500	272	194	172	142
Lambda-Value	0,007	0,014	0,065	0,21	1,16	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

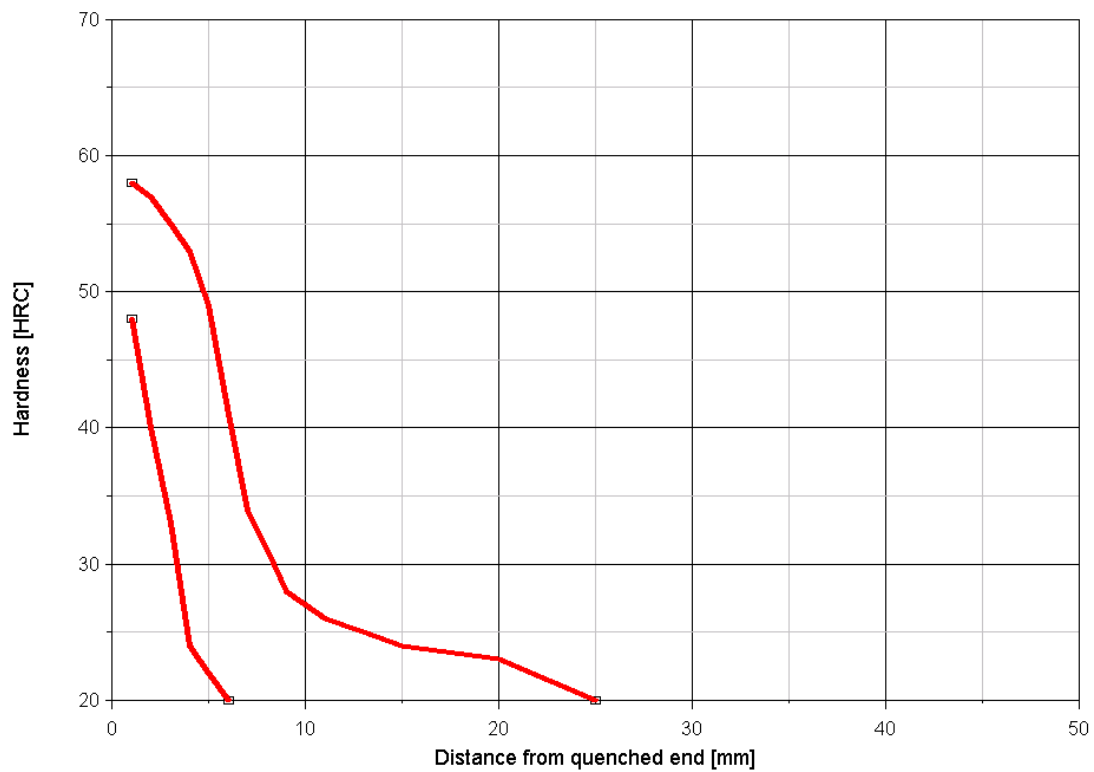


Hardness [HV / HRC]

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C35R (Cm35)

Material No.:	Former brand name:	International steel grades:	
1.1180	R3	BS:	C50R, 080A35
		AFNOR:	C50R, 3C35, XC32
		SAE:	1035

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	S	other
	0,35	0,25	0,65	0,020 0,035	(Pb)

Application: Plain carbon steel for mechanical engineering and automotive components

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	860 - 900°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	840 - 880°C/water, oil
	Tempering:	550 - 660°C/air

Mechanical Properties:	Treated for cold shearability +S:	Shearable in as rolled condition
	Soft annealed +A:	-

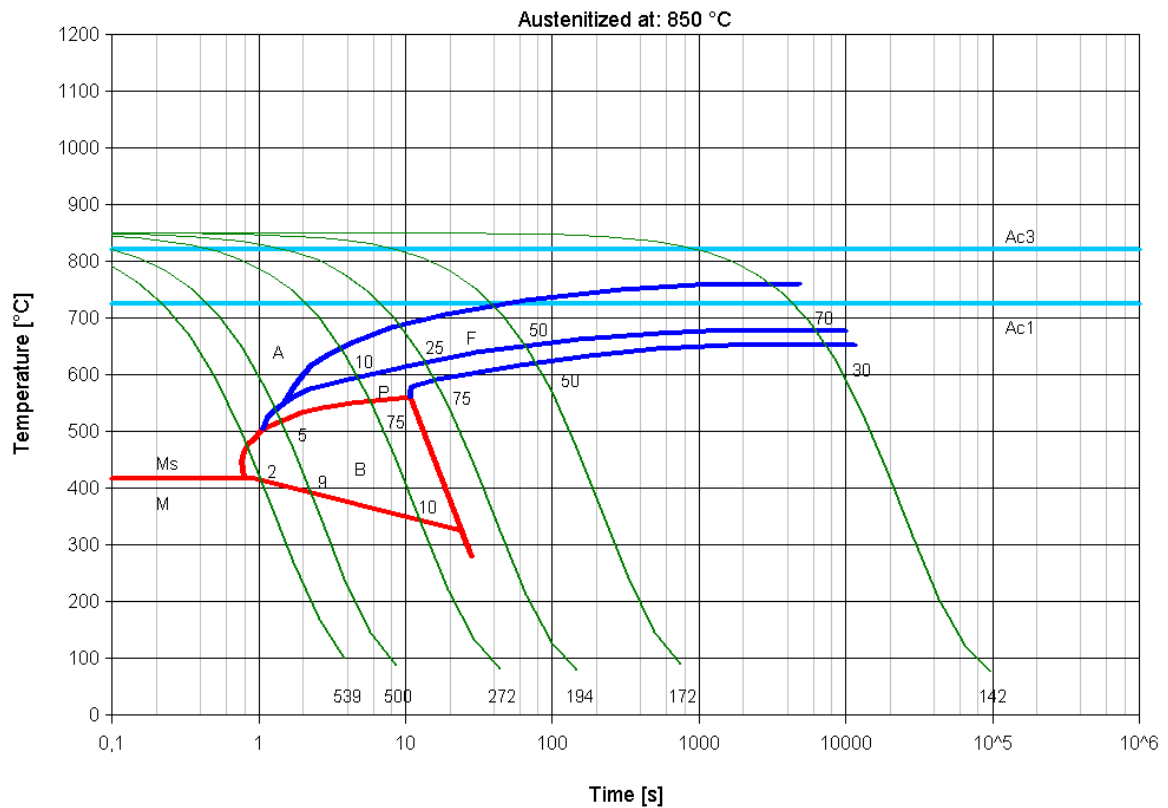
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R_{p0,2} [N/mm²]	min. 430	min. 380	min. 320	-	-
Tensile strength R_m [N/mm²]	630 - 780	600 - 750	550 - 700	-	-
Fracture elongation A₅ [%]	Min. 17	min. 19	min. 20	-	-
Reduction of area Z [%]	Min. 40	min. 45	min. 50	-	-
Notch impact energy ISO-V [J]	min. 35	min. 35	min. 35	-	-

Normalised, +N:

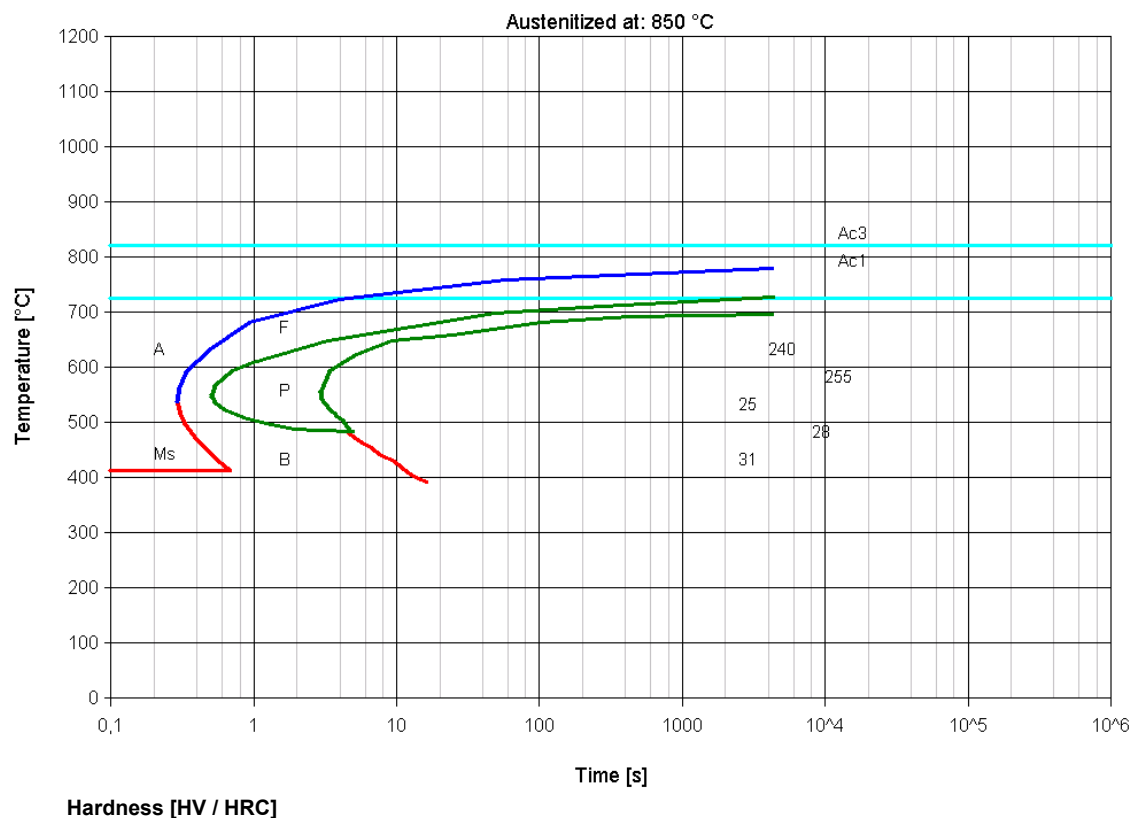
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 300	min. 270	min. 245		
Tensile strength R_m [N/mm²]	min. 550	min. 520	min. 500		
Fracture elongation A₅ [%]	min. 18	min. 19	min. 19		

Time-temperature-transformation diagram for continuous cooling



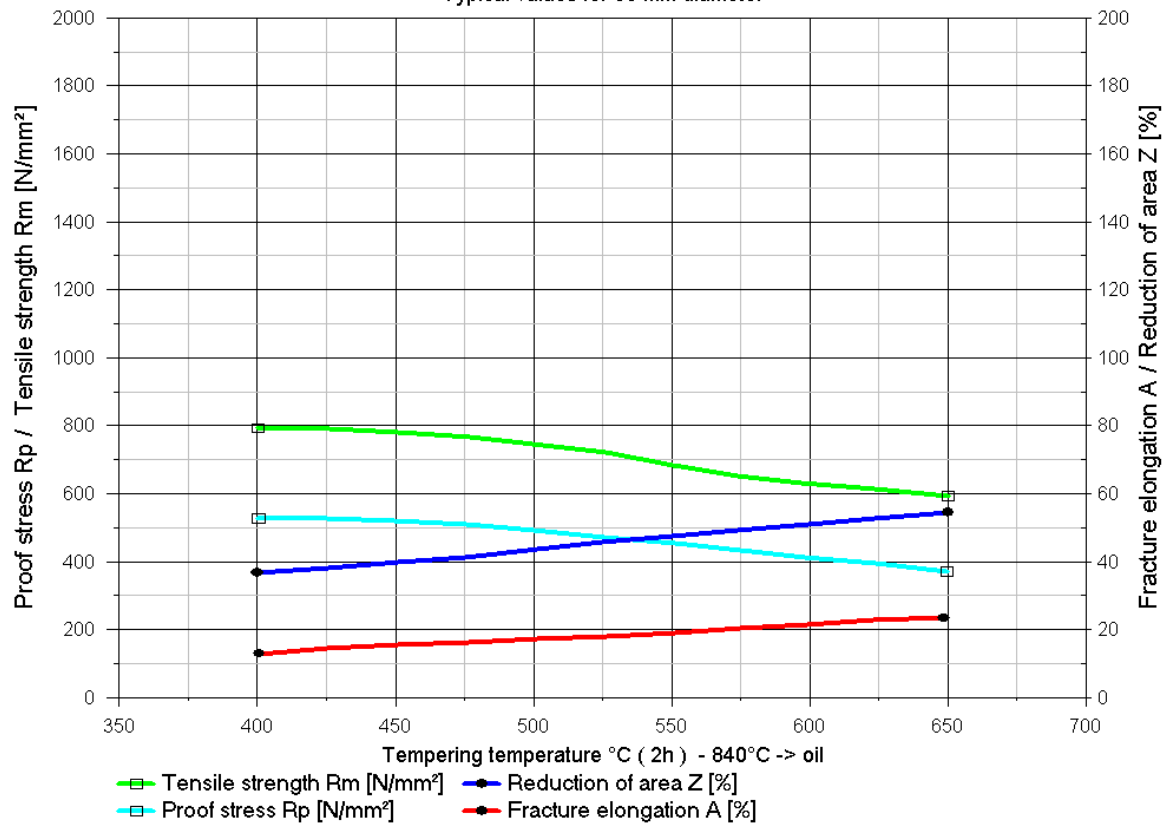
Hardness HV	539	500	272	194	172	142
Lambda-Value	0,006	0,013	0,04	0,22	1,2	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

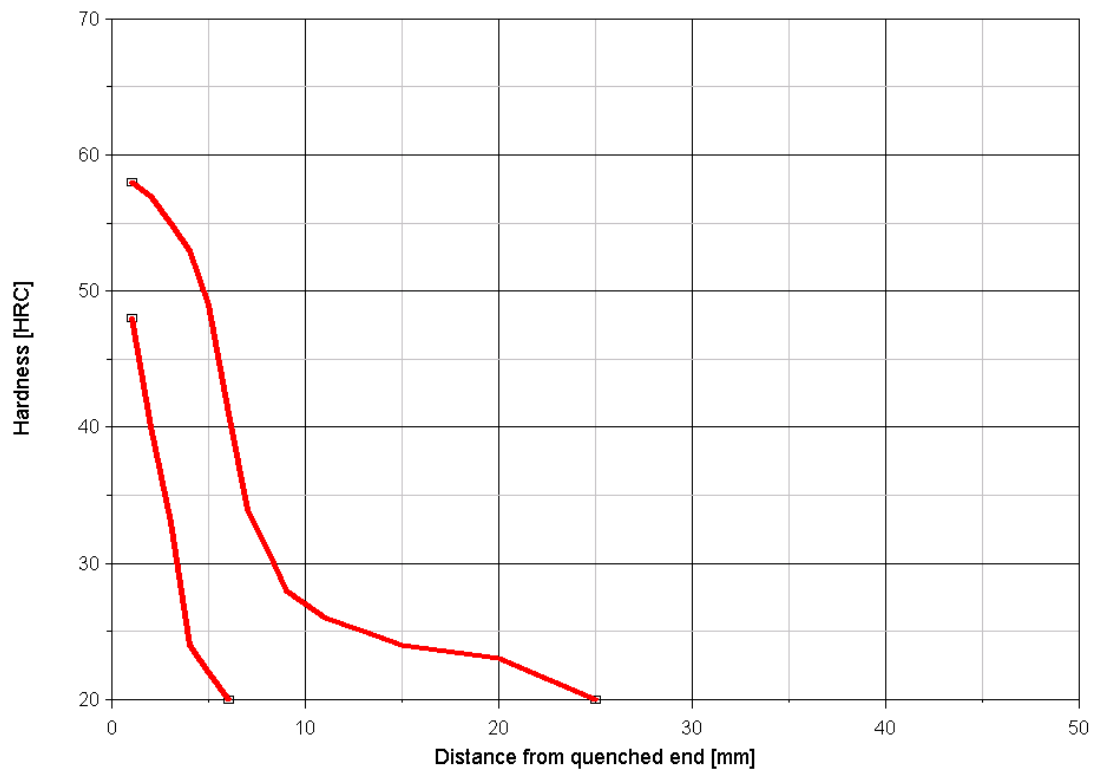


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - C40E (Ck40)

Material No.:

1.1186

Former brand name:

International steel grades:

BS: 080M40, 080A40, 060A40
AFNOR: C40E, 2C40, XC42H1
SAE: 1040

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition:
 (Typical analysis in %)

C	Si	Mn	S	other
0,40	0,25	0,65	≤0,03	(Pb)

Application:

Plain carbon steel for mechanical engineering and automotive components

Hot forming and heat treatment:

Forging or hot rolling: 1100 - 850°C
 Normalising: 850 - 890°C/air
 Soft annealing: 680 - 710°C/furnace
 Hardening: 830 - 870°C/water, oil
 Tempering: 550 - 660°C/air

Mechanical Properties:

Treated for cold shearability +S: Shearable in as rolled condition
 Soft annealed +A: -

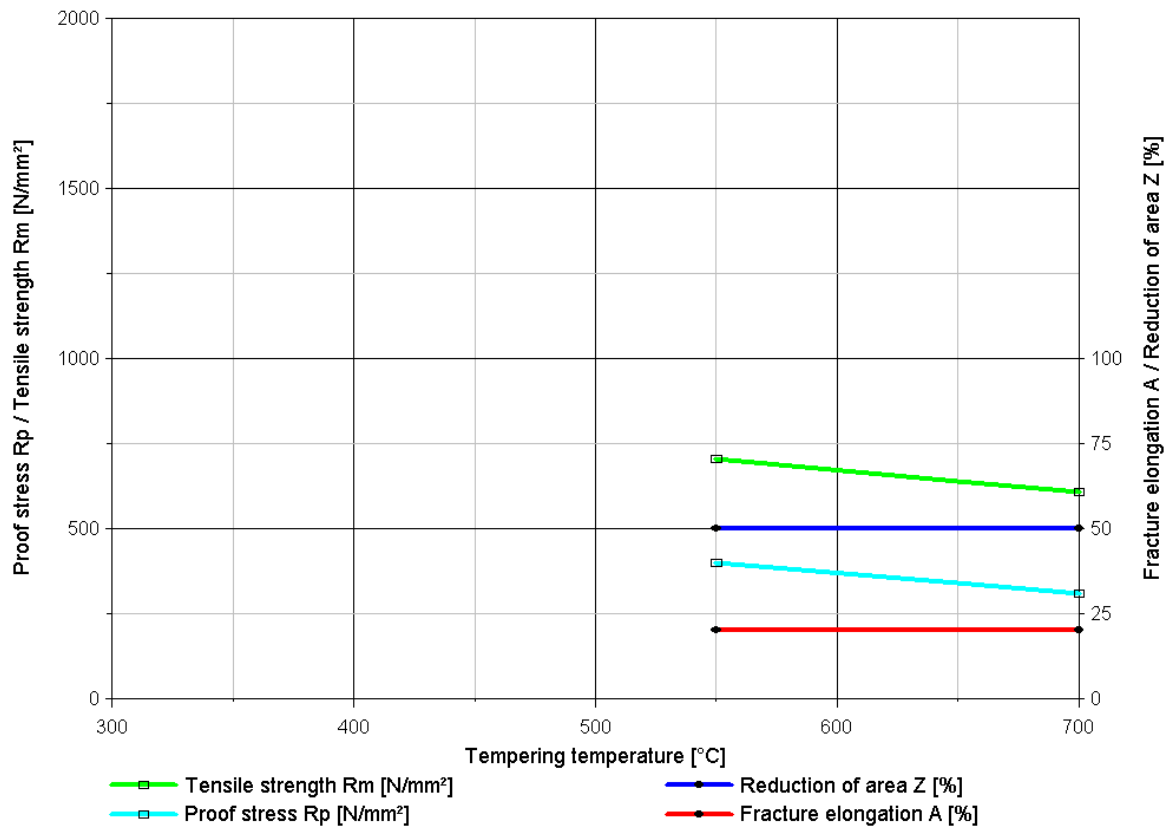
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 460	min. 400	min. 350	-	-
Tensile strength R _m [N/mm ²]	650 - 800	630 - 780	600 - 750	-	-
Fracture elongation A ₅ [%]	min. 16	min. 18	min. 19	-	-
Reduction of area Z [%]	min. 35	min. 40	min. 45	-	-
Notch impact energy ISO-V [J]	min. 30	min. 30	min. 30	-	-

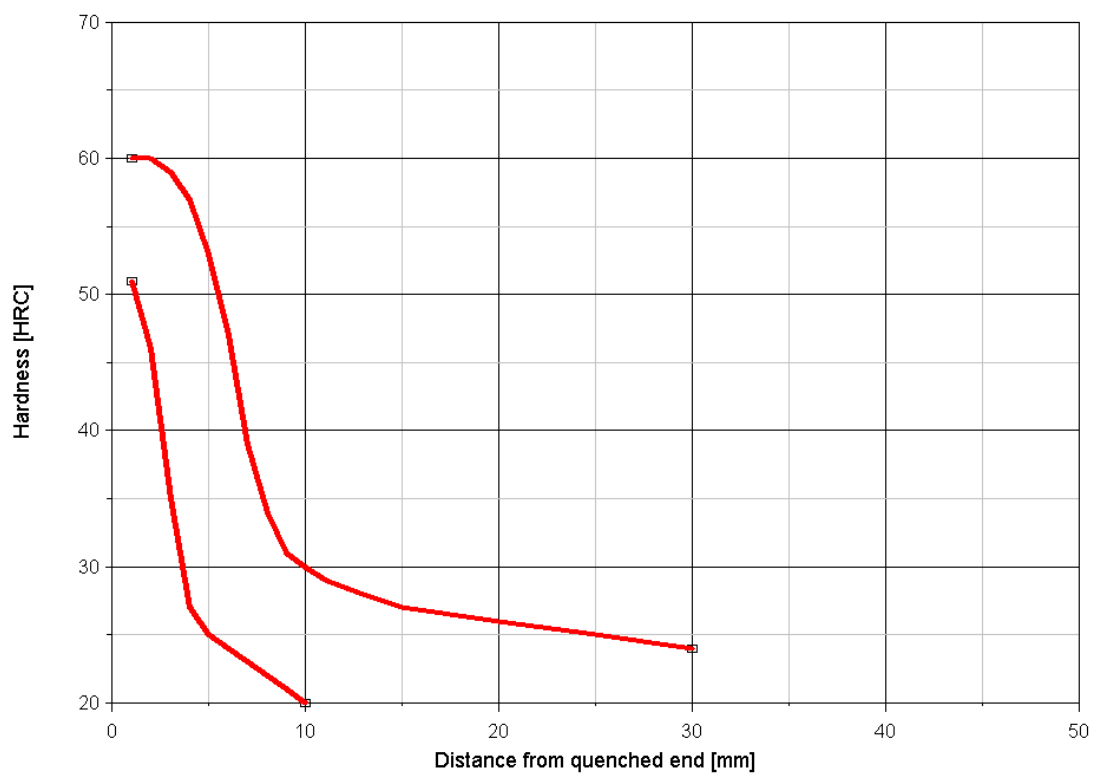
Normalised, +N:

Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 320	min. 290	min. 260		
Tensile strength R_m [N/mm²]	min. 580	min. 550	min. 530		
Fracture elongation A₅ [%]	min. 16	min. 17	min. 17		

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C45E (Ck45) - C45R (Cm45)

Material No.:	Former brand name:	International steel grades:	
1.1191	R4	BS:	080M46, 060A47
1.1201		AFNOR:	2C45, 3C45, XC42H1, XC45, XC48H1
		SAE:	1045, 1049

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	S	other
	C45E	0,45	0,25	0,65	<0,030	(Pb)
	C45R	0,45	0,25	0,65	0,020 0,035	(Pb)

Application: Plain carbon steel for mechanical engineering and automotive components.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	840 - 880°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	820 - 860°C/water, oil
	Tempering:	550 - 660°C

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 207 HB

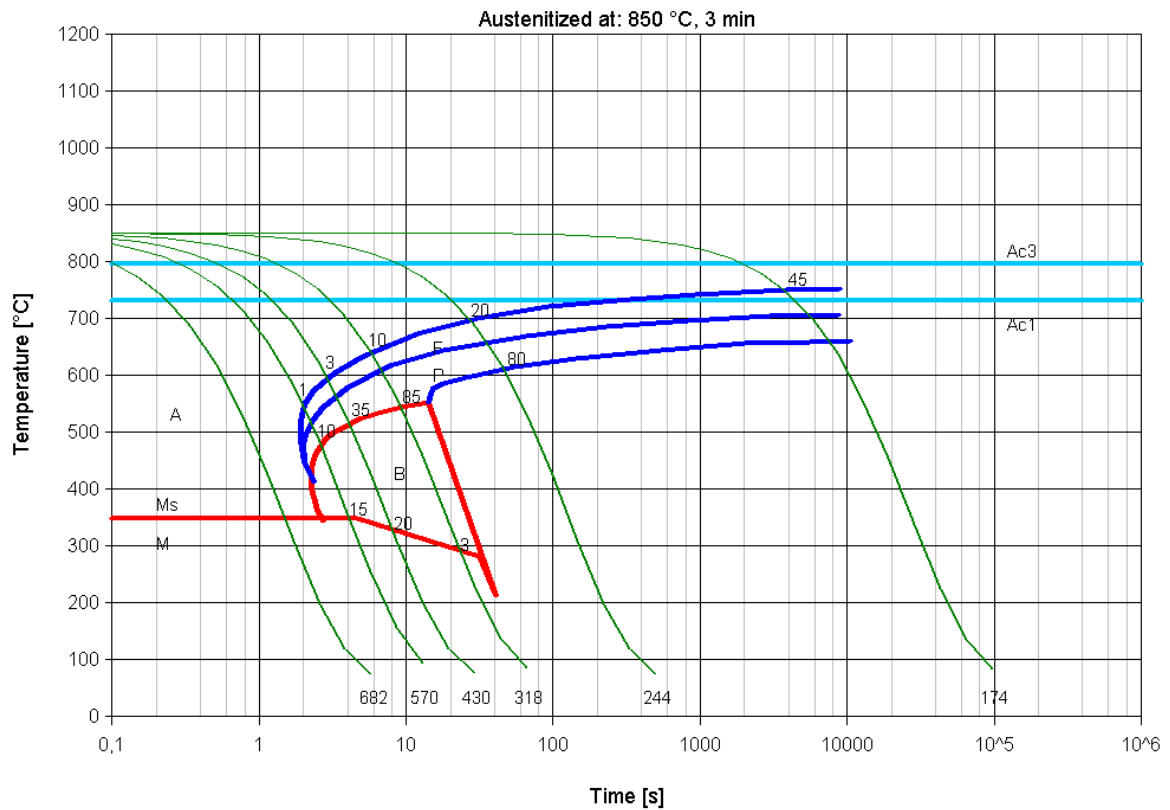
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 490	min. 430	min. 370	-	-
Tensile strength R _m [N/mm ²]	700 - 850	650 - 800	630 - 780	-	-
Fracture elongation A ₅ [%]	min. 14	min. 16	min. 17	-	-
Reduction of area Z [%]	min. 35	min. 40	min. 45	-	-
Notch impact energy ISO-V [J]	min. 25	min. 25	min. 25	-	-

Normalised, +N:

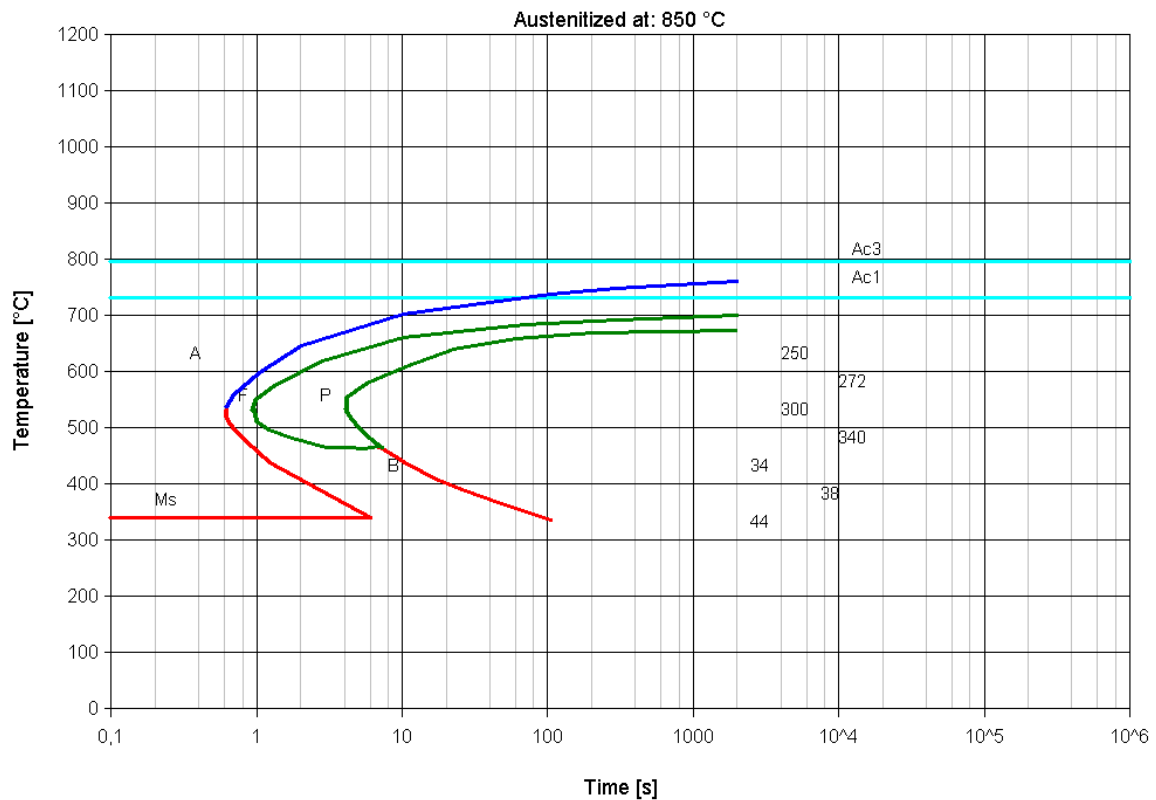
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 340	min. 305	min. 275		
Tensile strength R_m [N/mm²]	min. 620	min. 580	min. 560		
Fracture elongation A₅ [%]	min. 14	min. 16	min. 16		

Time-temperature-transformation diagram for continuous cooling



Hardness HV	682	570	430	318	244	174
Lambda-Value	0,008	0,025	0,04	0,11	0,68	1,25°/min

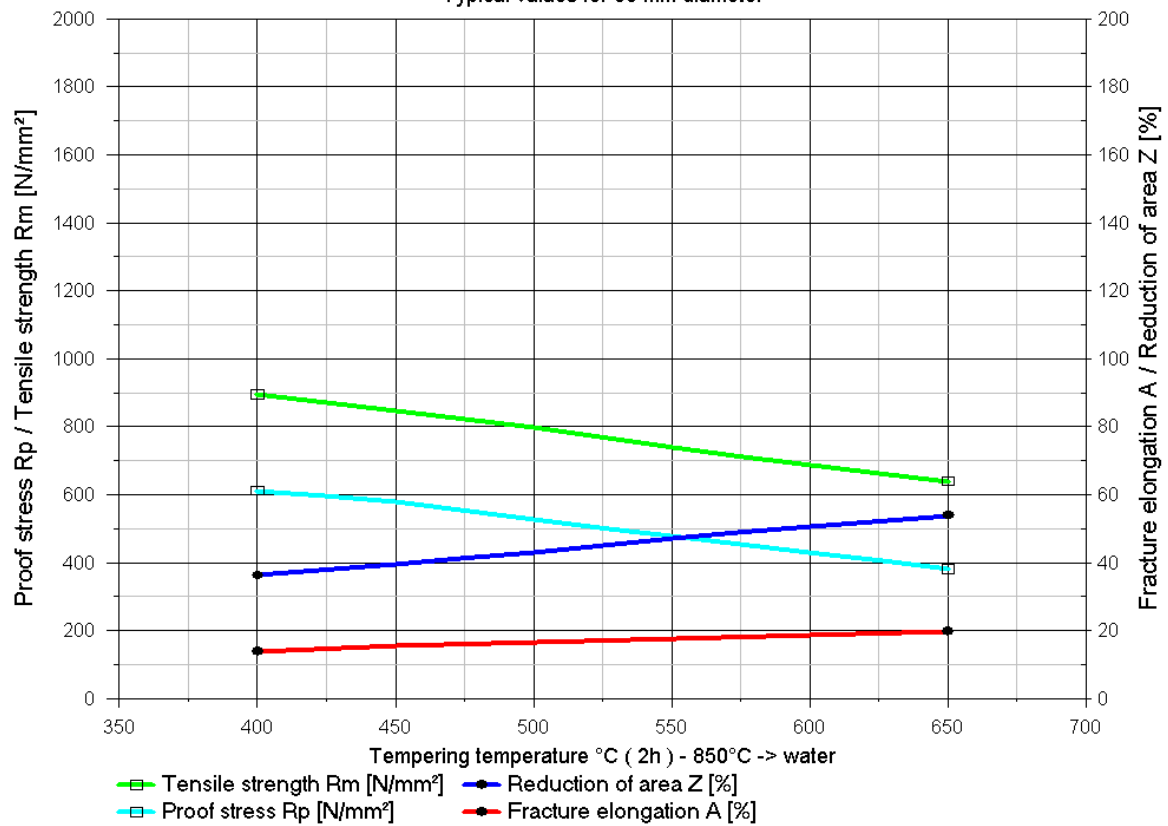
Time-temperature-transformation diagram for isothermal cooling



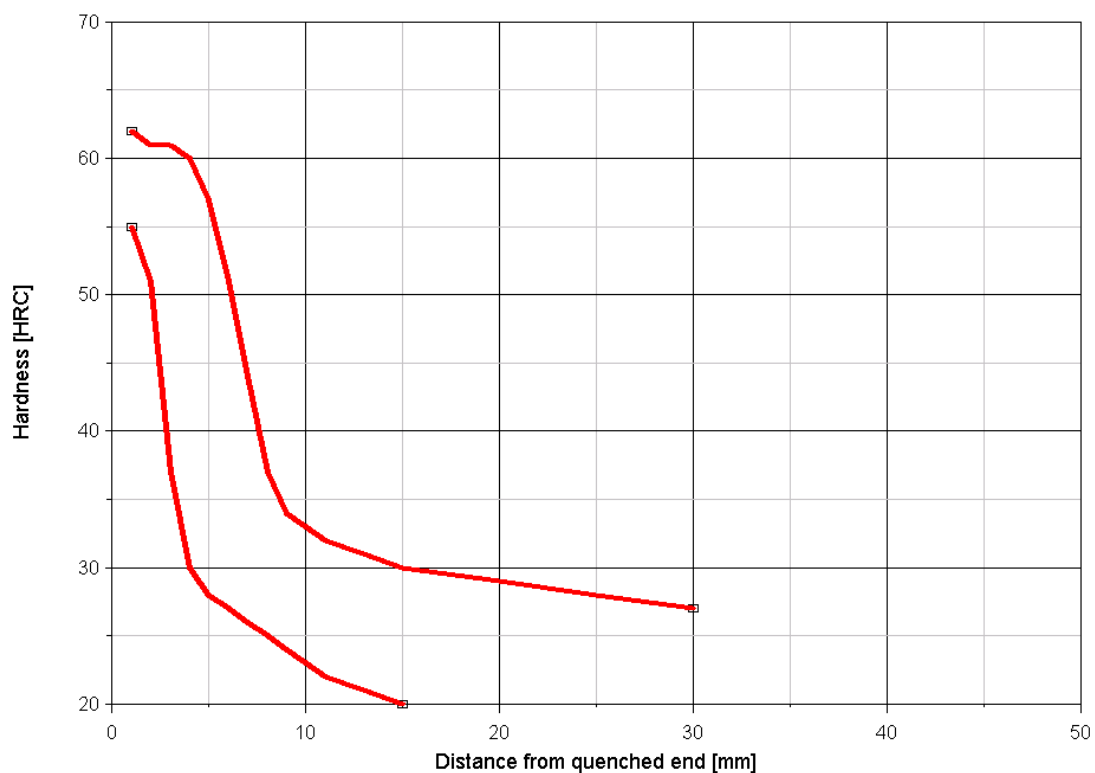
Hardness [HV / HRC]

Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - C45EC (Cq45)

Material No.: Former brand name: International steel grades:

1.1192

RKS45

BS:
AFNOR:
SAE:

Material group: Steel for cold extrusion according to DIN EN 10263

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cu
	0,45	0,20	0,70	<0,025	<0,025	<0,25

Application: Plain carbon cold heading steel for screws and nuts.

Hot forming and heat treatment:	Soft annealing:	680 - 710°C
	Hardening:	820 - 850°C/water
	Hardening:	830 - 860°C/oil
	Tempering:	530 - 670°C

Mechanical Properties:

Spheroidized annealed (+AC) or spheroidized annealed + peeled (+AC+PE)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R_m [N/mm ²]	-	max. 600	max. 600
Reduction of area Z [%]	-	min. 60	min. 60

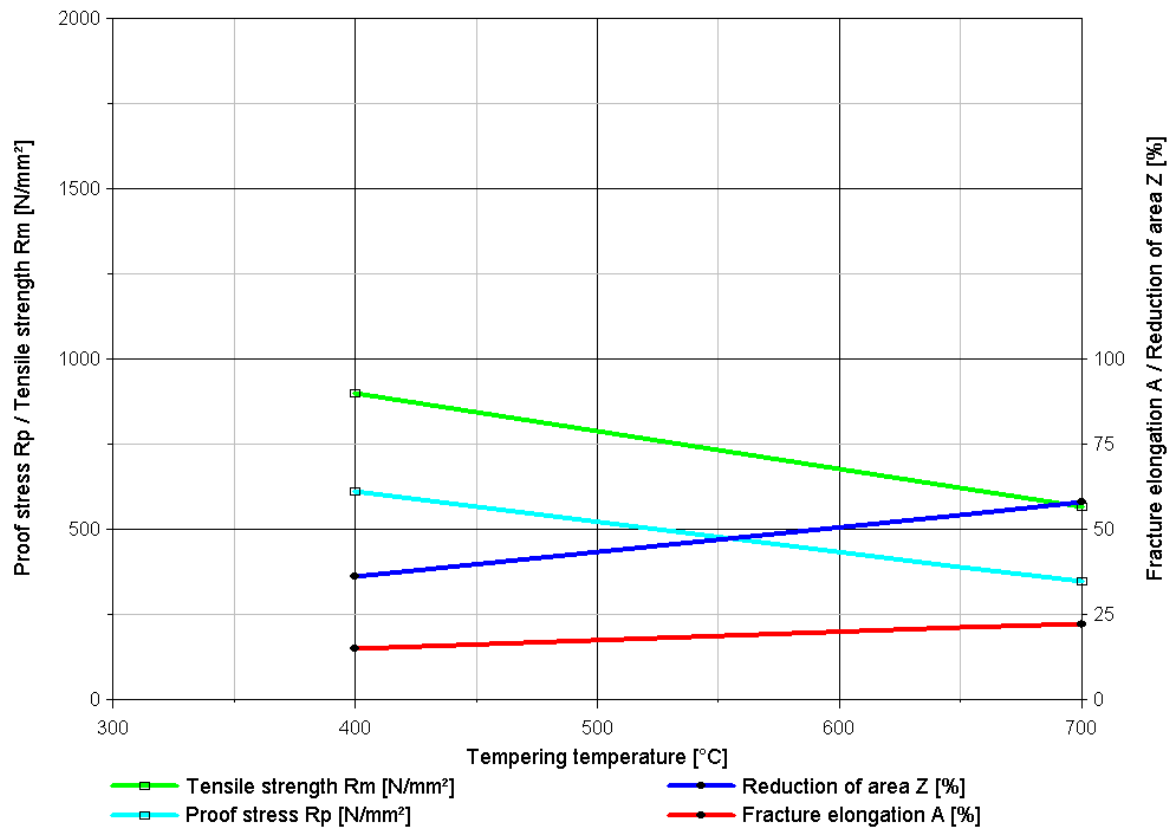
Untreated + cold drawn + spheroidized annealed (+U+C+AC)

Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R_m [N/mm ²]	max. 590	max. 580	max. 580
Reduction of area Z [%]	min. 62	min. 62	min. 62

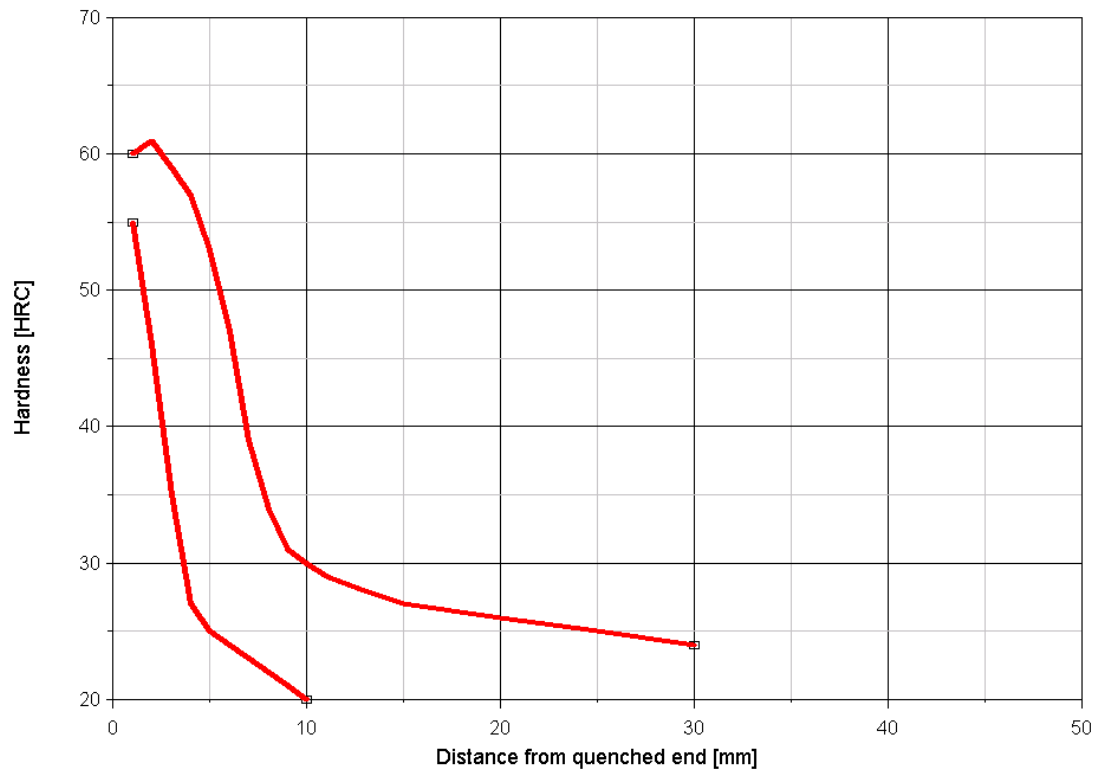
Untreated + cold drawn + spheroidized annealed + stretch reduced by roll drawing (+U+C+AC+LC)			
Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R _m [N/mm ²]	max. 630	max. 620	max. 620
Reduction of area Z [%]	min. 60	min. 60	min. 60
Spheroidized annealed + cold drawn (+AC+C)			
Diameter d [mm]	> 2 - 5	> 5 - 10	> 10 - 40
Tensile strength R _m [N/mm ²]	-	max. 720	max. 710
Reduction of area Z [%]	-	-	-

Hardness [HV / HRC]

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C50E (Ck50)

Material No.:	Former brand name:	International steel grades:
1.1206		BS: 080M50 AFNOR: 2C50, XC48H1, XC50H1 SAE: 1049, 1050

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	S	other
	0,50	0,25	0,75	<0,03	(Pb)

Application: Plain carbon steel for mechanical engineering and automotive components.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	830 - 870°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	810 - 850°C/oil, water
	Tempering:	550 - 660°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 217 HB

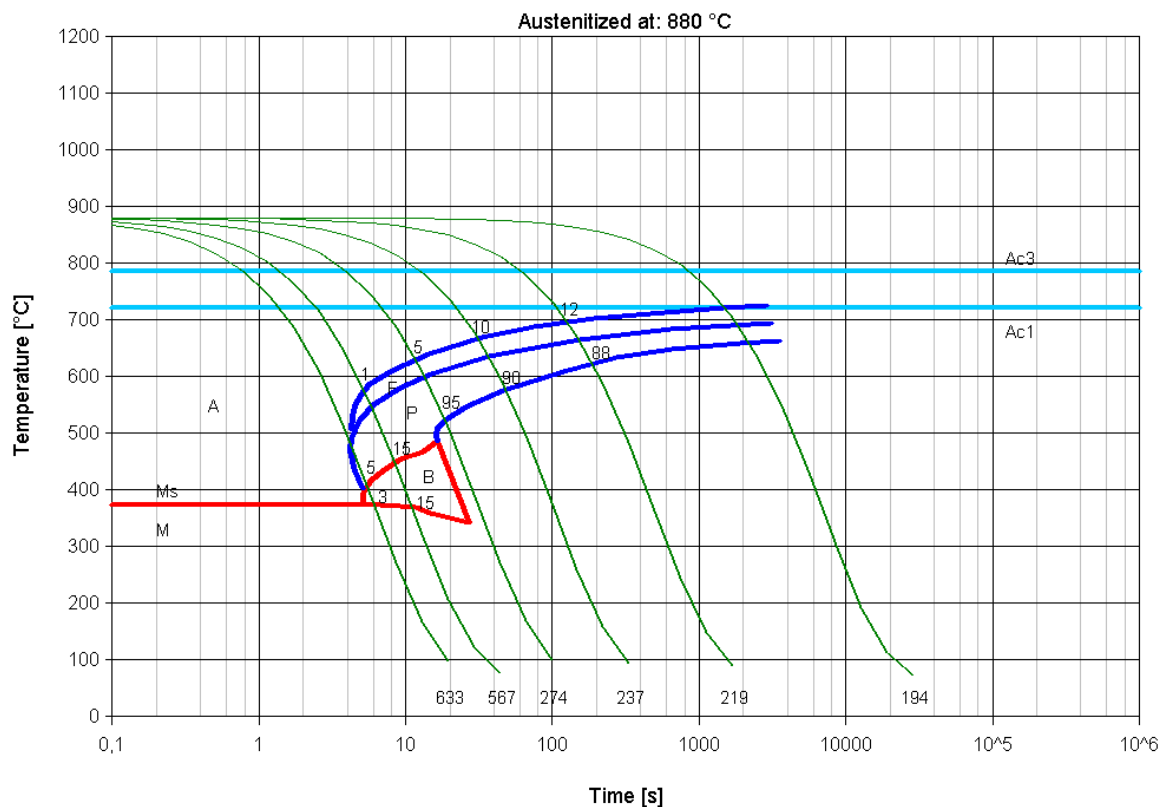
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R_{p0,2} [N/mm²]	min. 520	min. 460	min. 400	-	-
Tensile strength R_m [N/mm²]	750 - 900	700 - 850	650 - 800	-	-
Fracture elongation A₅ [%]	Min. 13	min. 15	min. 16	-	-
Reduction of area Z [%]	min. 30	min. 35	min. 40	-	-
Notch impact energy ISO-V [J]	-	-	-	-	-

Normalised, +N:

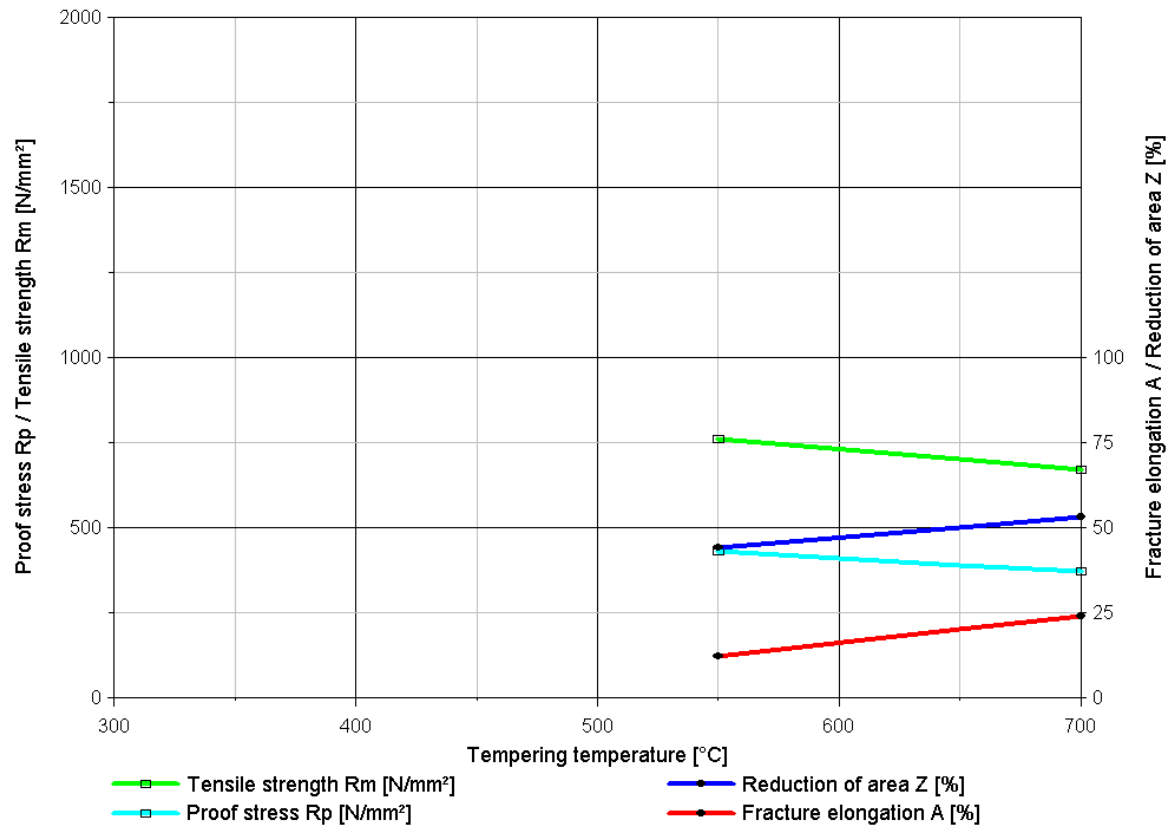
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 355	min. 320	min. 290		
Tensile strength R_m [N/mm ²]	min. 650	min. 610	min. 590		
Fracture elongation A_5 [%]	min. 12	min. 14	min. 14		

Time-temperature-transformation diagram for continuous cooling

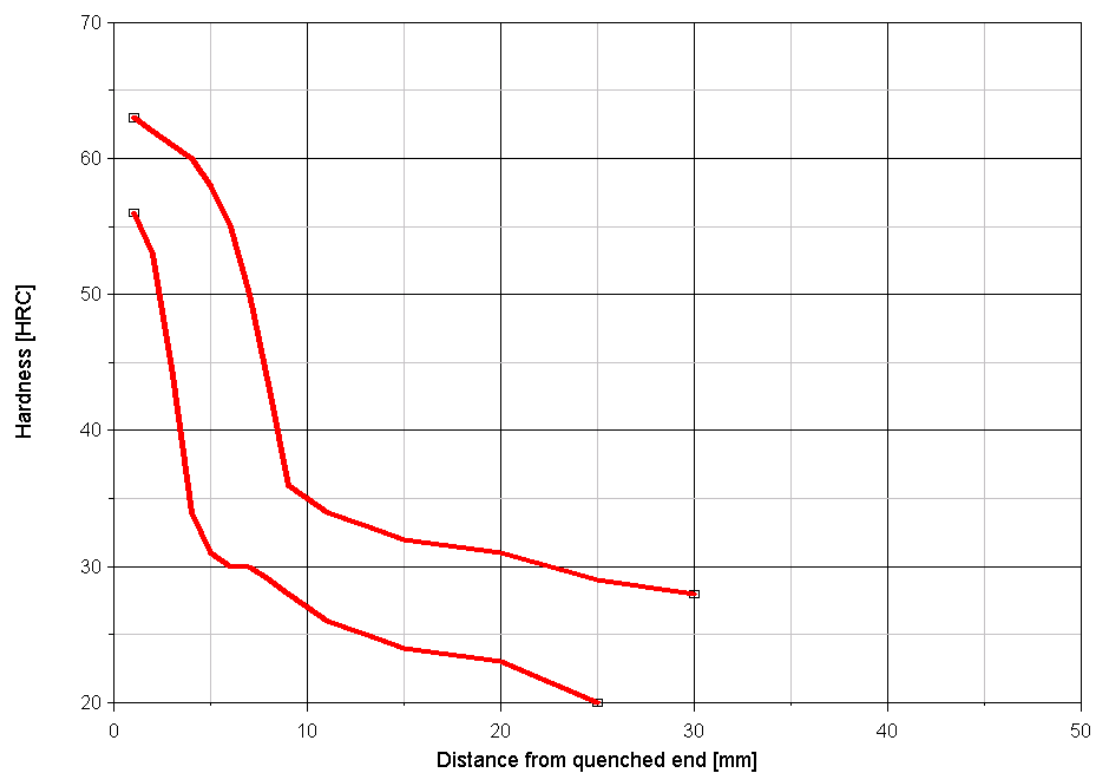


Hardness HV	633	567	274	237	219	194
Lambda-Value	0,03	0,06	0,17	0,53	2,56	5°/min

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - C55R (Cm55)

Material No.:	Former brand name:	International steel grades:	
1.1209	R5	BS:	070M55
		AFNOR:	C55R, 3C55, XC55H1
		SAE:	1055

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	S	other
	0,55	0,25	0,75	0,020 0,035	(Pb)

Application: Plain carbon steel for mechanical engineering and automotive components.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	825 - 865°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	805 - 845°C/oil, water
	Tempering:	550 - 660°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 229 HB

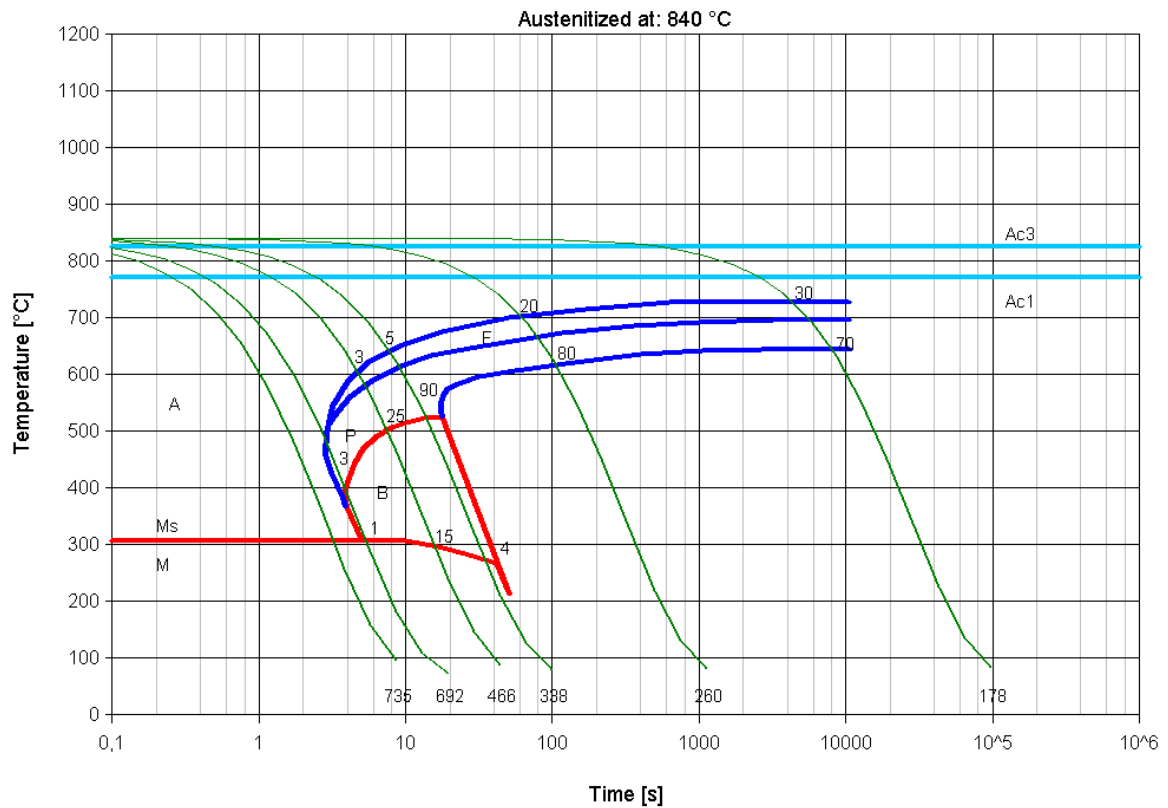
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R_{p0,2} [N/mm²]	min. 550	min. 490	min. 420	-	-
Tensile strength R_m [N/mm²]	800 - 950	750 - 900	700 - 850	-	-
Fracture elongation A₅ [%]	min. 12	min. 14	min. 15	-	-
Reduction of area Z [%]	min. 30	min. 35	min. 40	-	-
Notch impact energy ISO-V [J]	-	-	-	-	-

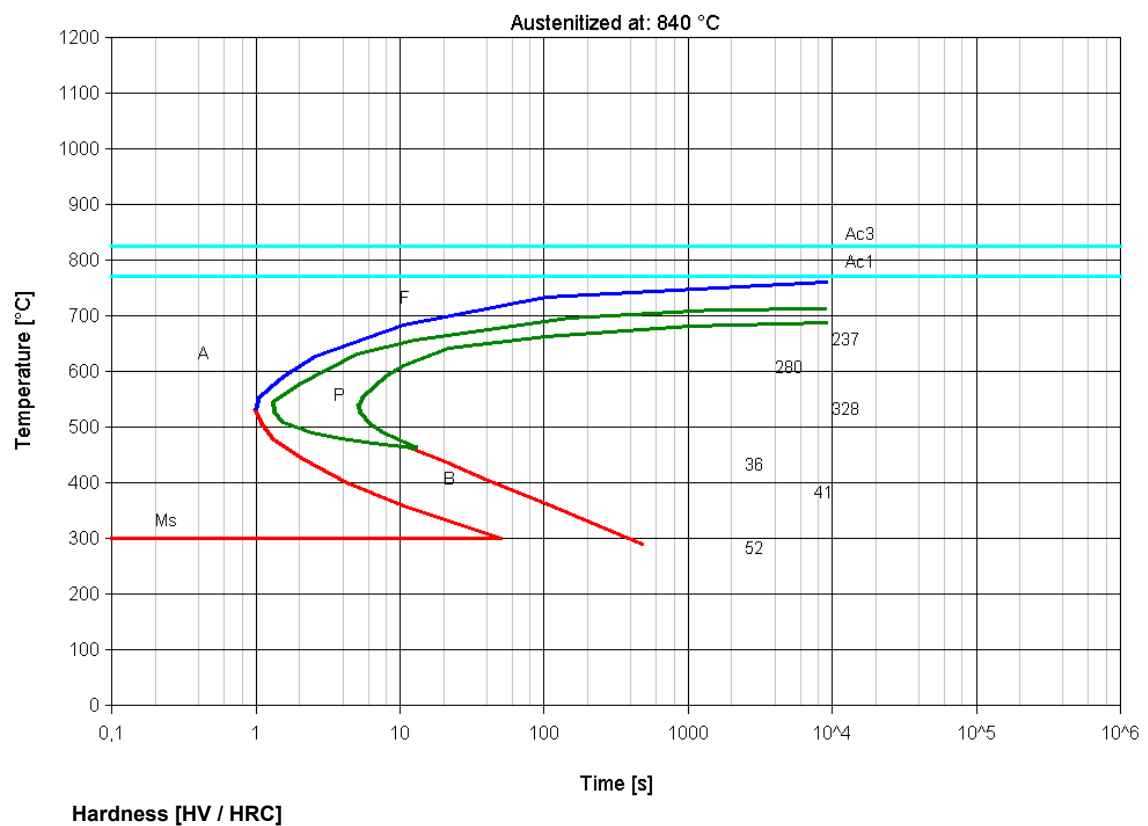
Normalised, +N:

Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 370	min. 330	min. 300		
Tensile strength R_m [N/mm²]	min. 680	min. 640	min. 620		
Fracture elongation A₅ [%]	min. 11	min. 12	min. 12		

Time-temperature-transformation diagram for continuous cooling

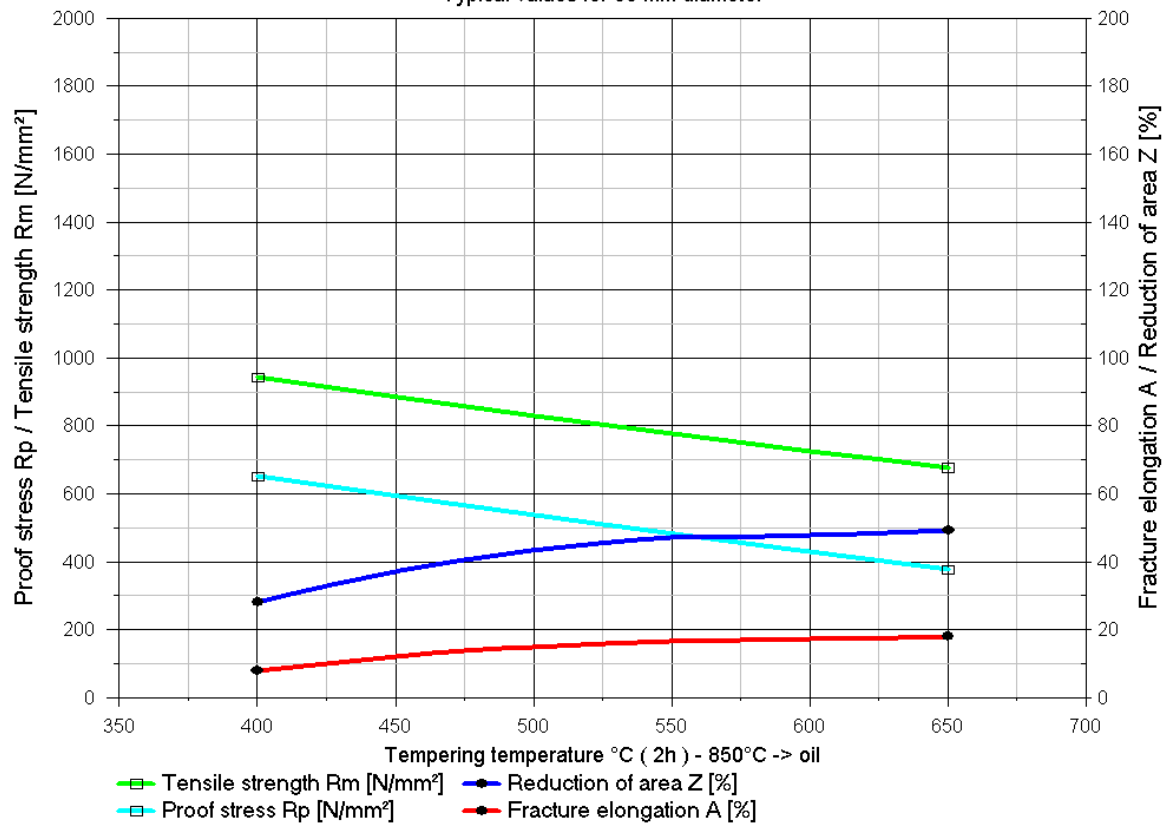


Time-temperature-transformation diagram for isothermal cooling

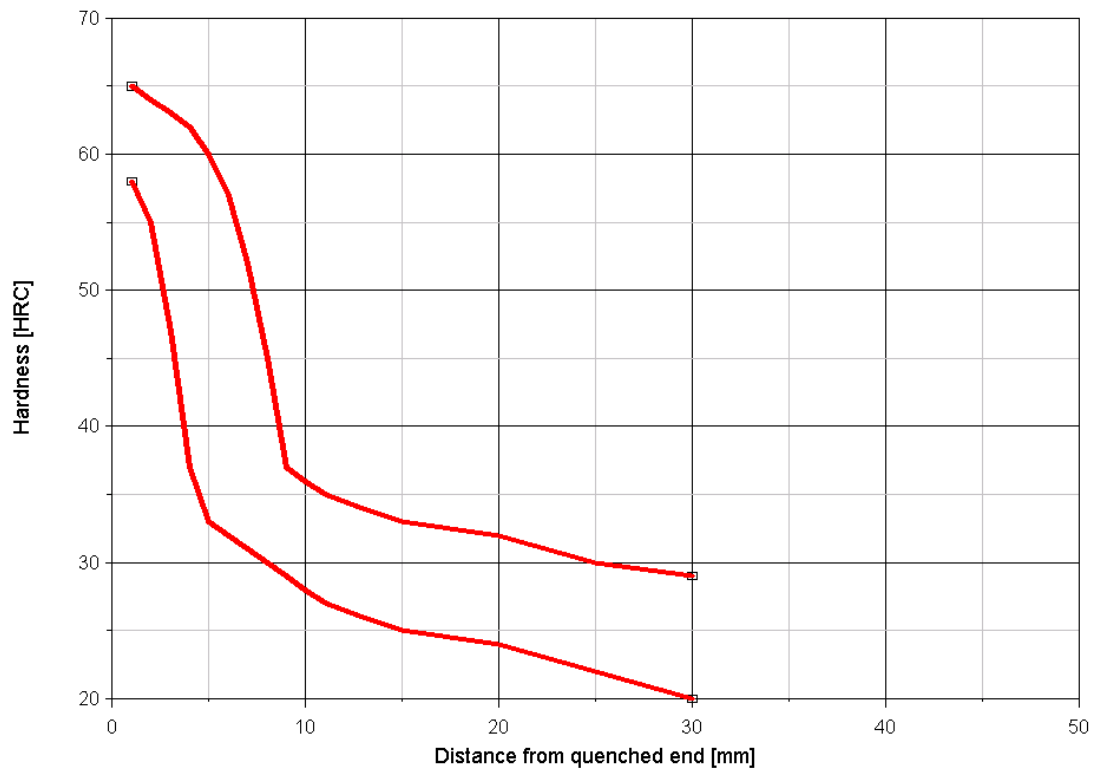


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - C60R (Cm60)

Material No.: Former brand name: International steel grades:

1.1223

R6

BS:
AFNOR:
SAE:

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	S	other
	0,65	0,25	0,75	0,020 0,035	(Pb)

Application: Plain carbon steel for mechanical engineering and automotive components.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 800°C
	Normalising:	820 - 860°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	800 - 840°C/oil, water
	Tempering:	550 - 660°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 241 HB

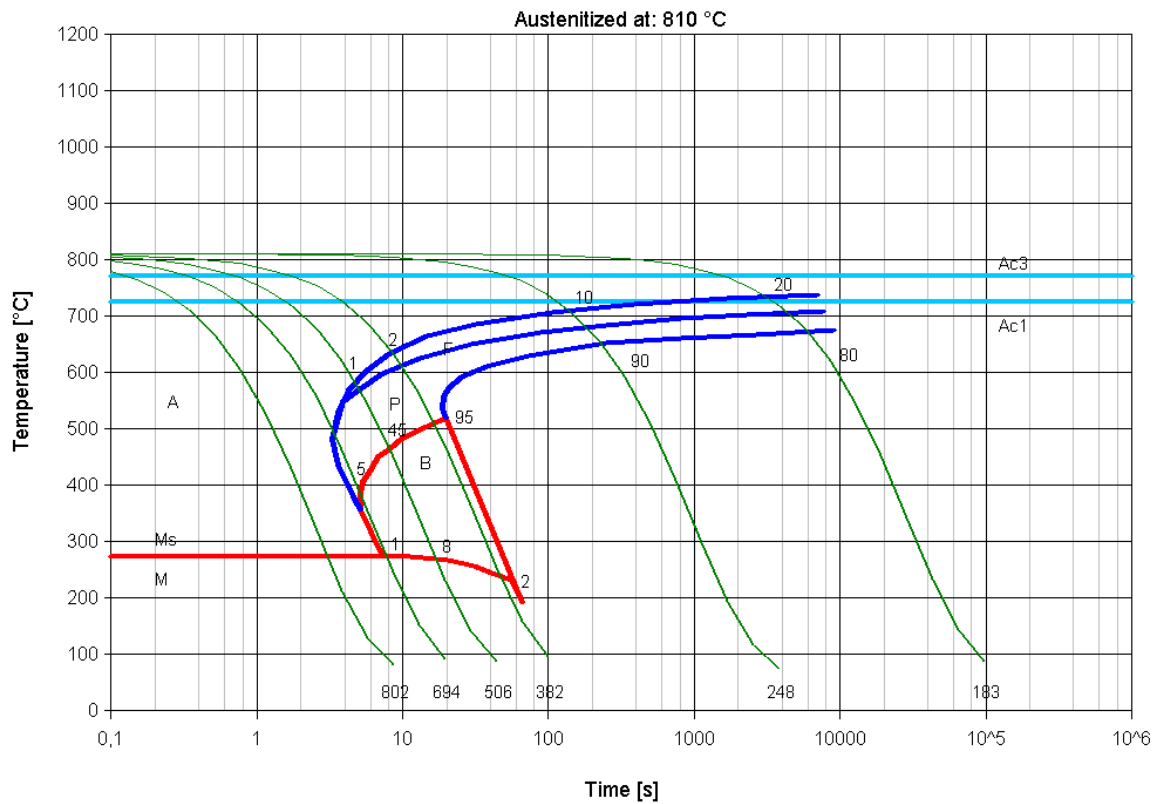
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R_{p0,2} [N/mm²]	min. 580	min. 520	min. 450	-	-
Tensile strength R_m [N/mm²]	850 - 1000	800 - 950	750 - 900	-	-
Fracture elongation A₅ [%]	min. 11	min. 13	min. 14	-	-
Reduction of area Z [%]	min. 25	min. 30	min. 35	-	-
Notch impact energy ISO-V [J]	-	-	-	-	-

Normalised, +N:

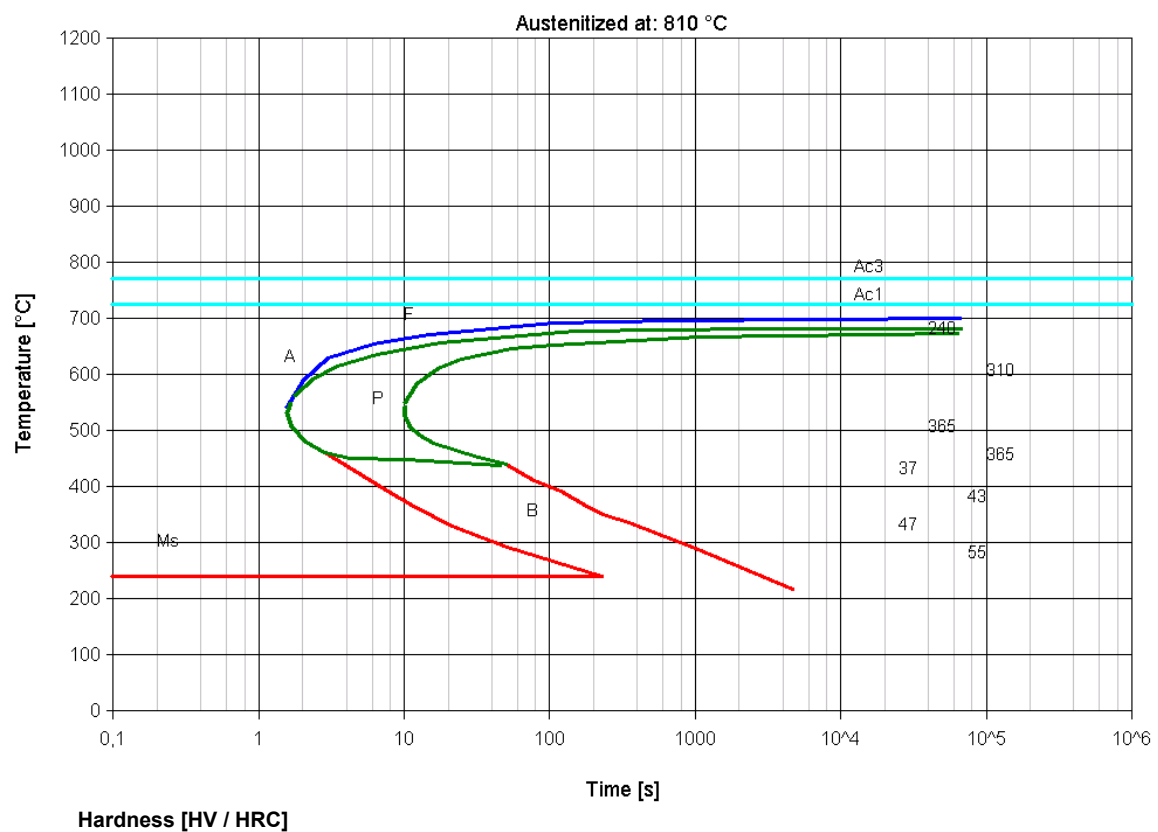
Diameter d [mm]	< 16	>16 – 100	>100 – 250		
Thickness t [mm]	< 16	16<t<100	100<t<250		
0,2% proof stress R_{p0,2} [N/mm²]	min. 380	min. 340	min. 310		
Tensile strength R_m [N/mm²]	min. 710	min. 670	min. 650		
Fracture elongation A₅ [%]	min. 10	min. 11	min. 11		

Time-temperature-transformation diagram for continuous cooling



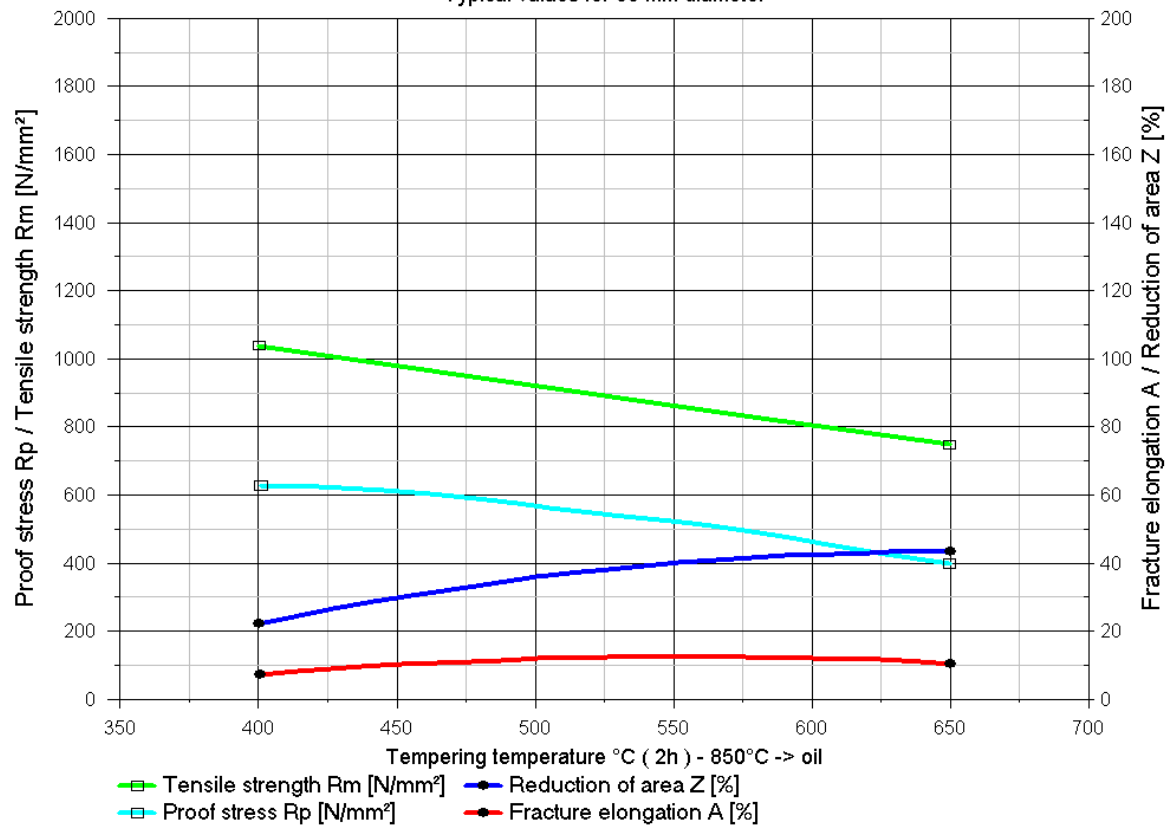
Hardness HV	802	694	506	382	248	183
Lambda-Value	0,01	0,03	0,07	0,15	4,5	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

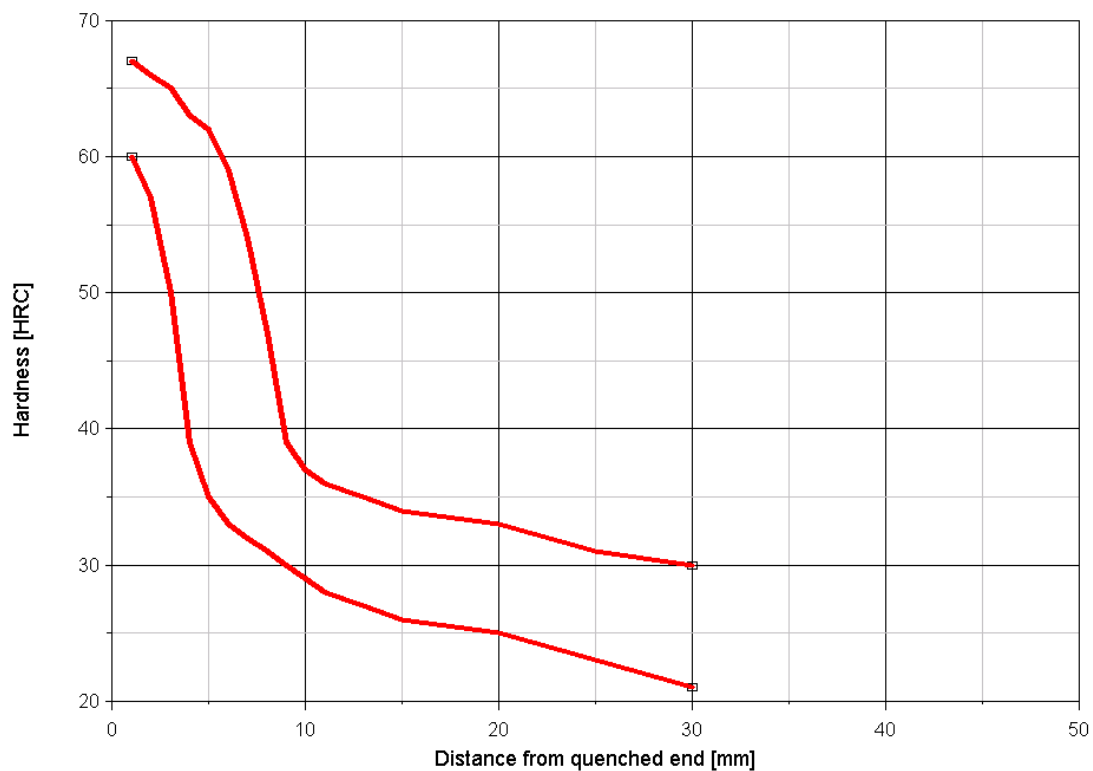


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - C67S

Material No.:	German standard:	International steel grades:
1.1231	DIN EN 10132	SAE: 1070 JIS: S70CM

Material group: Hot rolled spring steel

Chemical composition: (typical analysis at Saarstahl in %)	C	Si	Mn	P	S	Cr	Al
	0,67	0,22	0,75	<0,01	<0,01	0,23	0,03
Deviation in chemical composition on request							

Application: Unalloyed steel for springs as belleville washers, spring plates and stabilizer bars for motor vehicles

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 800°C
	Normalising:	810 - 840°C/air
	Soft annealing:	680 - 710°C/furnace
	Hardening:	815 - 845°C/oil min. 59 HRC or 670 HV as quenched

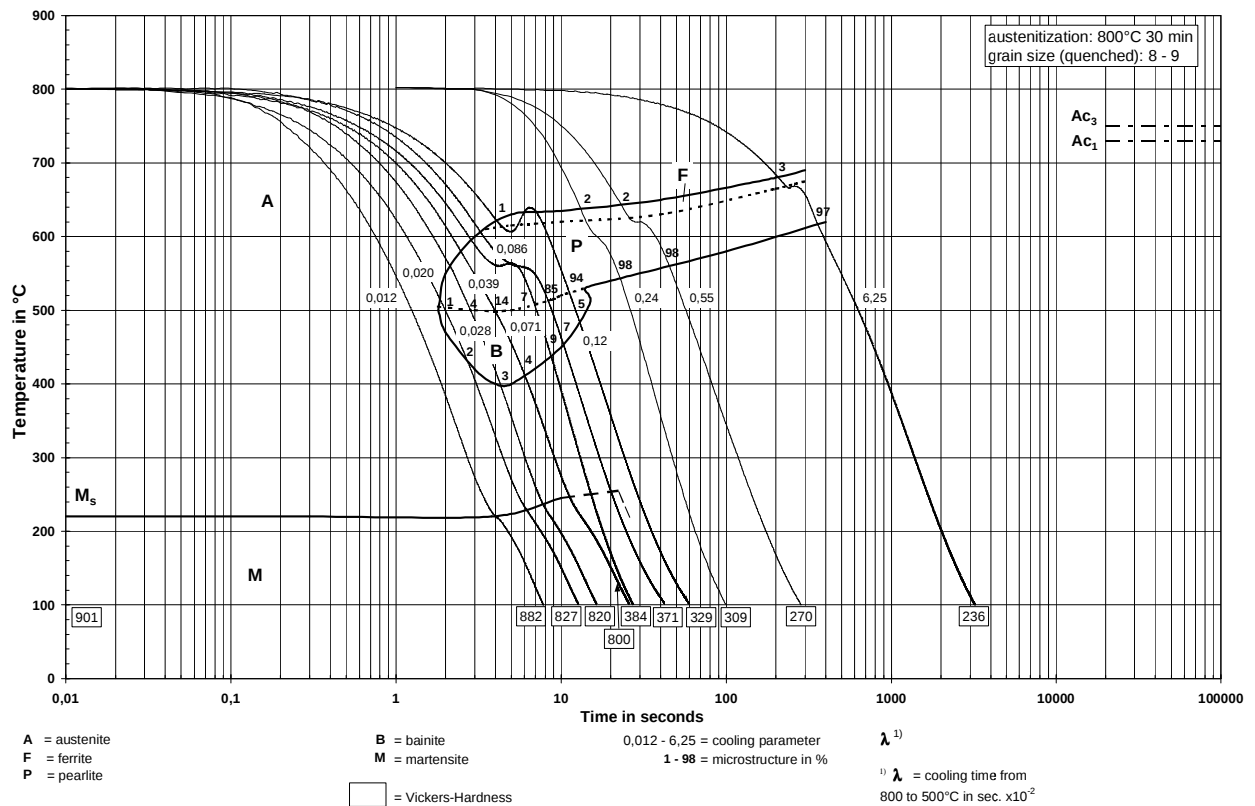
Mechanical properties:

Condition of delivery	Soft annealed (+A) or soft annealed and slightly rerolled (+LC)	Quenched and tempered (+QT)
0,2% proof stress $R_{p0,2}$ [N/mm²]	max. 510	1200 - 1900
Tensile strength R_m [N/mm²]	max. 640	-
Fracture elongation A_{80} [%]	min. 16	-
Hardness [HV]	max. 200	370 - 580
Hardness [HRB]	max. 92	-
Hardness [HRC]	-	38,5 - 54

Typical hardness values (HV) for quenched and tempered materials at different thickness ranges

Effective thickness [mm]	0,30<=0,50	0,50<=0,75	0,75<=1,00	1,00<=1,50	1,50<=2,00	2,00<=3,00
Hardness [HV]	485 - 535	465 - 515	455 - 505	445 - 495	425 - 475	415 - 465

Time-temperature-transformation diagram for continuous cooling



Material specification sheet

Saarstahl - 30MnVS6 (27MnSiVS6)

Material No.:

Former brand name:

International steel grades:

11302 (15232)

BS:

AFNOR:

SAE:

Material group:

Dispersion hardening ferritic-pearlitic steel according to DIN EN 10267

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	V	N
	0,26 0,33	0,15 0,80	1,20 1,60	<0,025	0,020 0,060	<0,30	<0,08	0,08 0,20	0,01 0,02

Application:

This high strength Mn-V-based steel is a low alloy high grade steel with good machinability for controlled cooling from working heat (BY-treatment, condition +P according to DIN EN 10267)

Applicable for automotive components as connecting rods, axle journals and wishbones.

Hot forming and heat treatment:

Furnace temperature before hot forming: 1220 - 1280°C

Separate cooling at air: 1000 - 500°C

Stress relieving (if necessary): ≤ 600°C

Mechanical Properties:

0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 450
Tensile strength R_m [N/mm ²]	700 - 900
Fracture elongation A_5 [%]	min. 14
Reduction of area Z [%]	min. 30

Microstructure:

Pearlite and 30 - 50 % ferrite

Austenitized at: 1130°C, 20 min

Material specification sheet

Saarstahl - 38MnVS6 (38MnSiVS5)

Material No.: Former brand name: International steel grades:

11303 (15231)

BS:
AFNOR:
SAE:

Material group: Dispersion hardening ferritic-pearlitic steel according to DIN EN 10267

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	V	N
	0,34 0,41	0,15 0,80	1,20 1,60	<0,025	0,020 0,060	<0,30	<0,08	0,08 0,20	0,01 0,02

Application: This high strength Mn-V-based steel is a low alloy high grade steel with good machinability for controlled cooling from working heat (BY-treatment, condition +P according to DIN EN 10267)

Applicable for automotive components as crankshafts, push rods, rotating bearings, axle journals, hubs and piston heads.

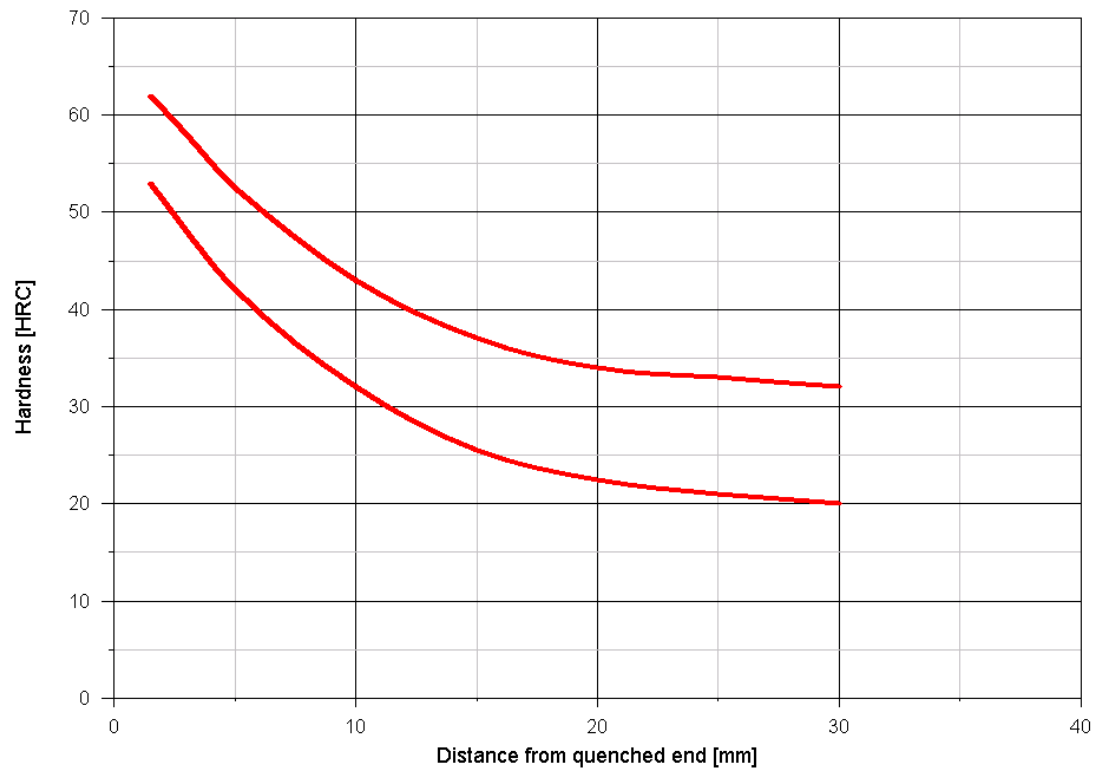
Hot forming and heat treatment: Furnace temperature before hot forming: 1220 - 1280°C
Separate cooling at air: 1000 - 500°C
Stress relieving (if necessary): ≤ 600°C

Mechanical Properties:

0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 520
Tensile strength R_m [N/mm ²]	800 - 950
Fracture elongation A_5 [%]	min. 12
Reduction of area Z [%]	min. 25

Microstructure: Pearlite and 10 - 30 % ferrite

Hardness scatter band



Material specification sheet

Saarstahl - 46MnVS6 (44MnSiVS6)

Material No.:

Former brand name:

International steel grades:

11304 (15233)

BS:

AFNOR:

SAE:

Material group:

Dispersion hardening ferritic-pearlitic steel according to DIN EN 10267

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	V	N
	0,42 0,49	0,15 0,80	1,20 1,60	<0,025	0,020 0,060	<0,30	<0,08	0,08 0,20	0,01 0,02

Application:

This high strength Mn-V-based steel is a low alloy high grade steel with good machinability for controlled cooling from working heat (BY-treatment, condition +P according to DIN EN 10267).

Applicable for automotive components as rear axles, piston rods and hubs.

Hot forming and heat treatment:

Furnace temperature before hot forming: 1220 - 1280°C

Separate cooling at air: 1000 - 500°C

Stress relieving (if necessary): ≤ 600°C

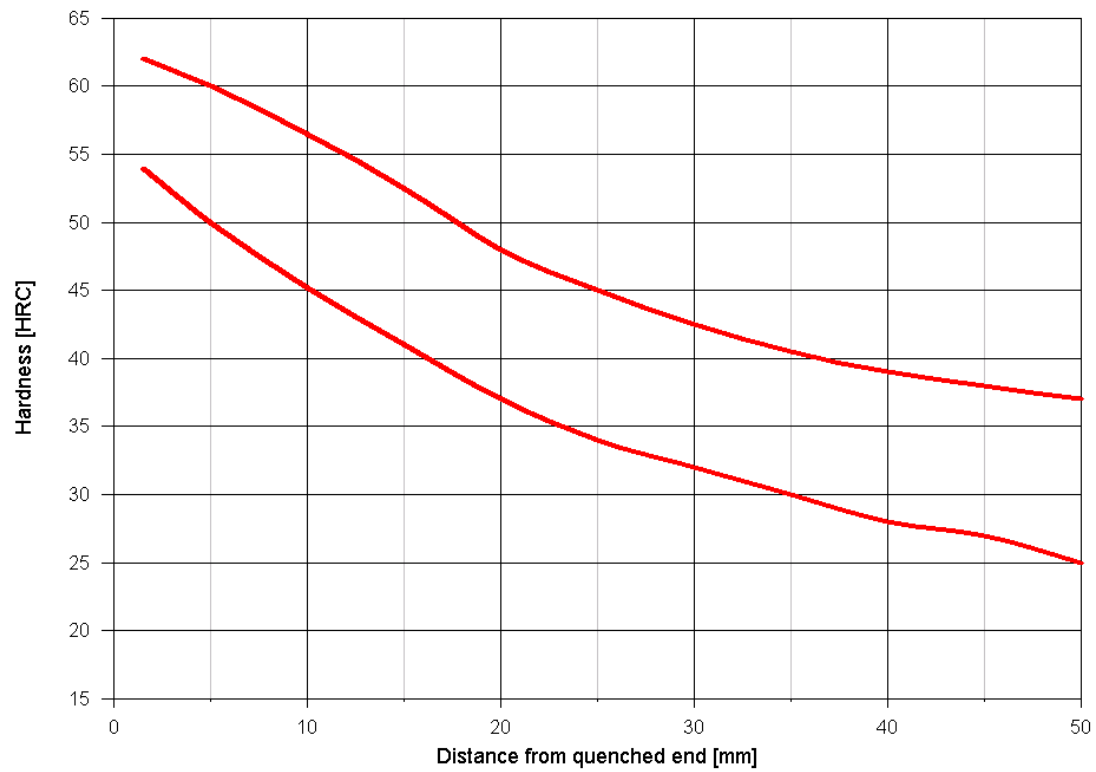
Mechanical Properties:

0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 580
Tensile strength R_m [N/mm ²]	900 - 1050
Fracture elongation A_5 [%]	min. 10
Reduction of area Z [%]	min. 20

Microstructure:

Pearlite and 5 - 25 % ferrite

Hardness scatter band



Material specification sheet

Saarstahl - 31CrV2 (1.2208)

Material No.:

Former brand name:

International steel grades:

1.2208

BS:

AFNOR:

SAE:

Material group:

Alloyed tool steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	V	P	S
	0,28 0,35	0,25 0,40	0,40 0,60	0,40 0,70	0,07 0,12	<0,030	<0,030

Application:

Alloyed tool steel for screw tools.

**Hot forming and
heat treatment:**

Forging or hot rolling:

1050 - 850°C

Soft annealing:

680 - 720°C/furnace

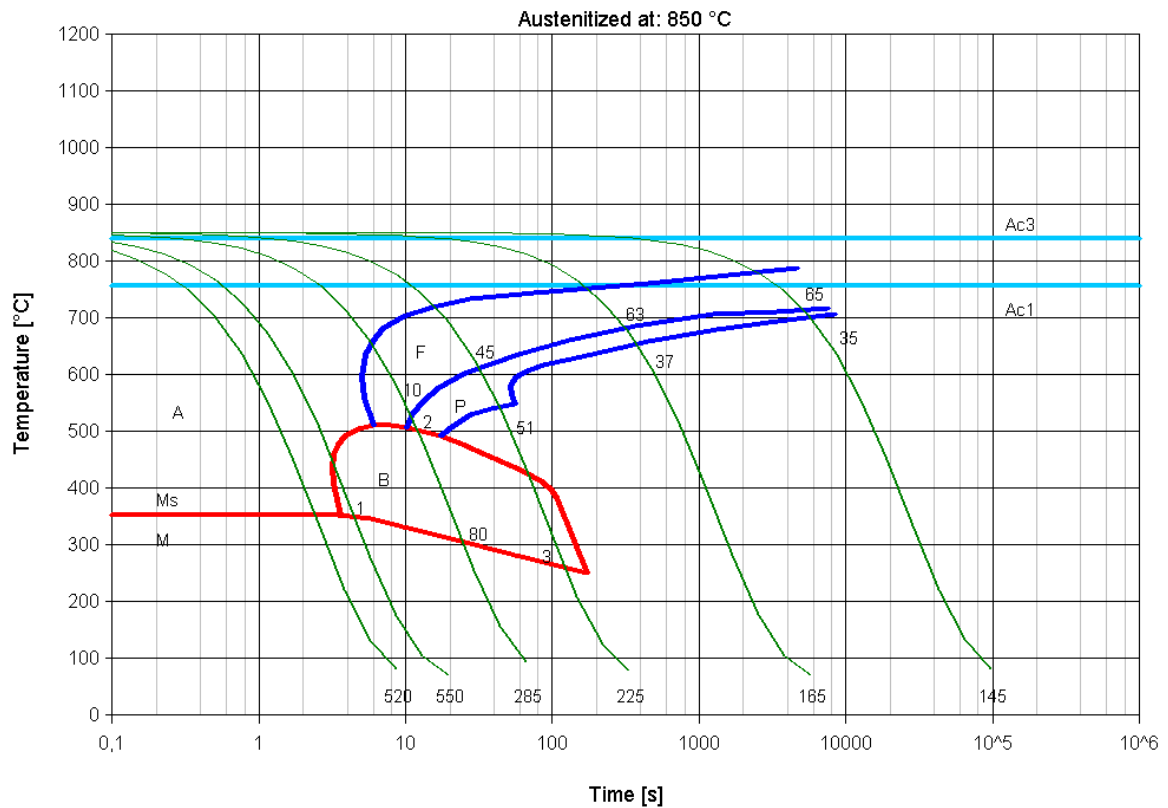
Stress relieving:

650 - 680°C

Hardening:

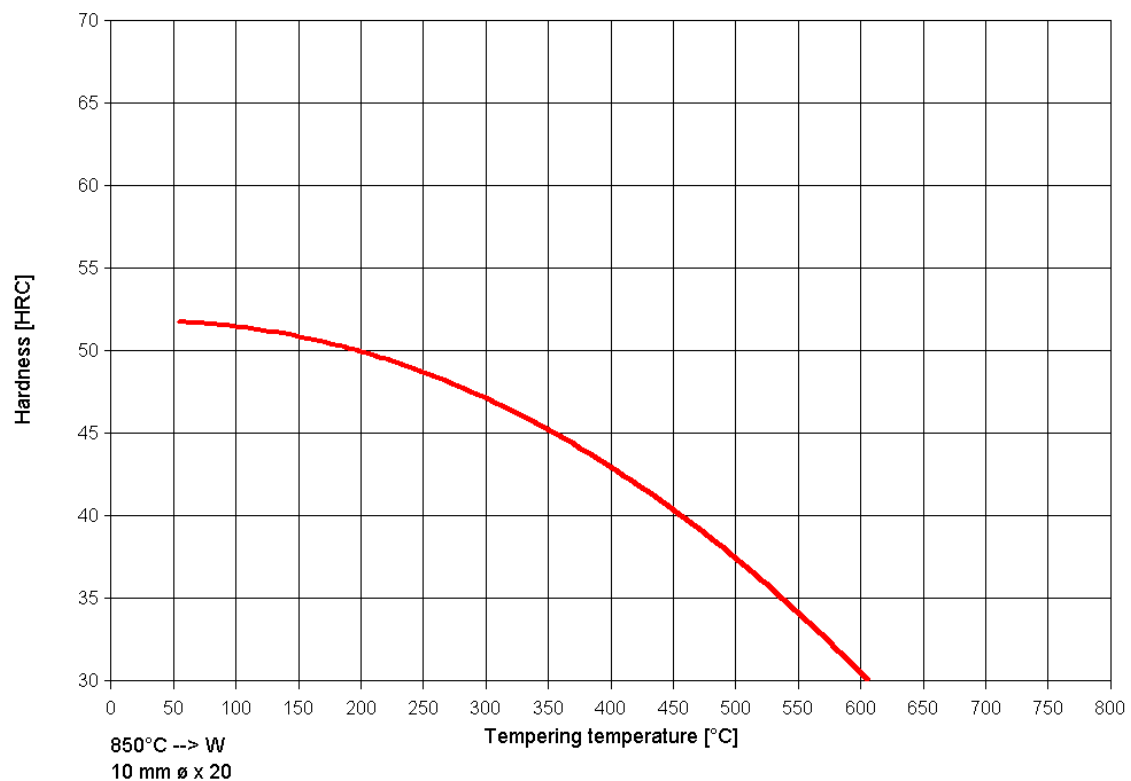
830 - 860°C/water

Time-temperature-transformation diagram for continuous cooling



Hardness HV	520	550	285	225	165	145
Lambda-Value	0,008	0,018	0,14	0,46	6,67	1,25°/min

Tempering diagram



Material specification sheet

Saarstahl - 100Cr6

Material No.:	Former brand name:	International steel grades:
1.3505	RW3	BS: 2S135, 535A99 AFNOR: 100C6 SAE: 52100

Material group: Ball and roller bearing steel according to EN ISO 683-17

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	other
	1,00	0,25	0,35	1,50	-

Application: Ball and roller bearing steel for balls and rollers of any dimension, rings and discs up to 30 mm effective thickness.

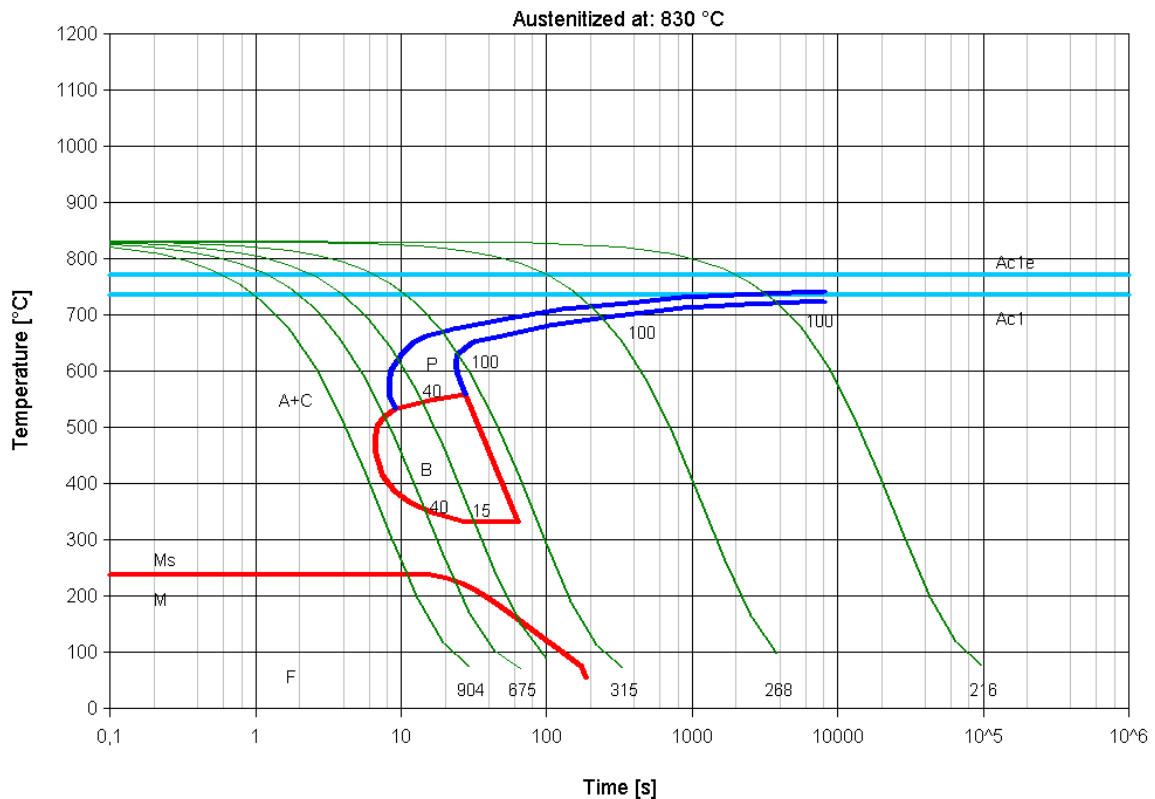
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	870 - 900°C/air
	Soft annealing:	780 - 800°C/furnace
	Hardening:	800 - 830°C/water
	Hardening:	830 - 870°C/oil
	Tempering:	150 - 180°C

Mechanical Properties:	Soft annealed +A:	max. 207 HB
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Heat treatment condition: Hardened and tempered

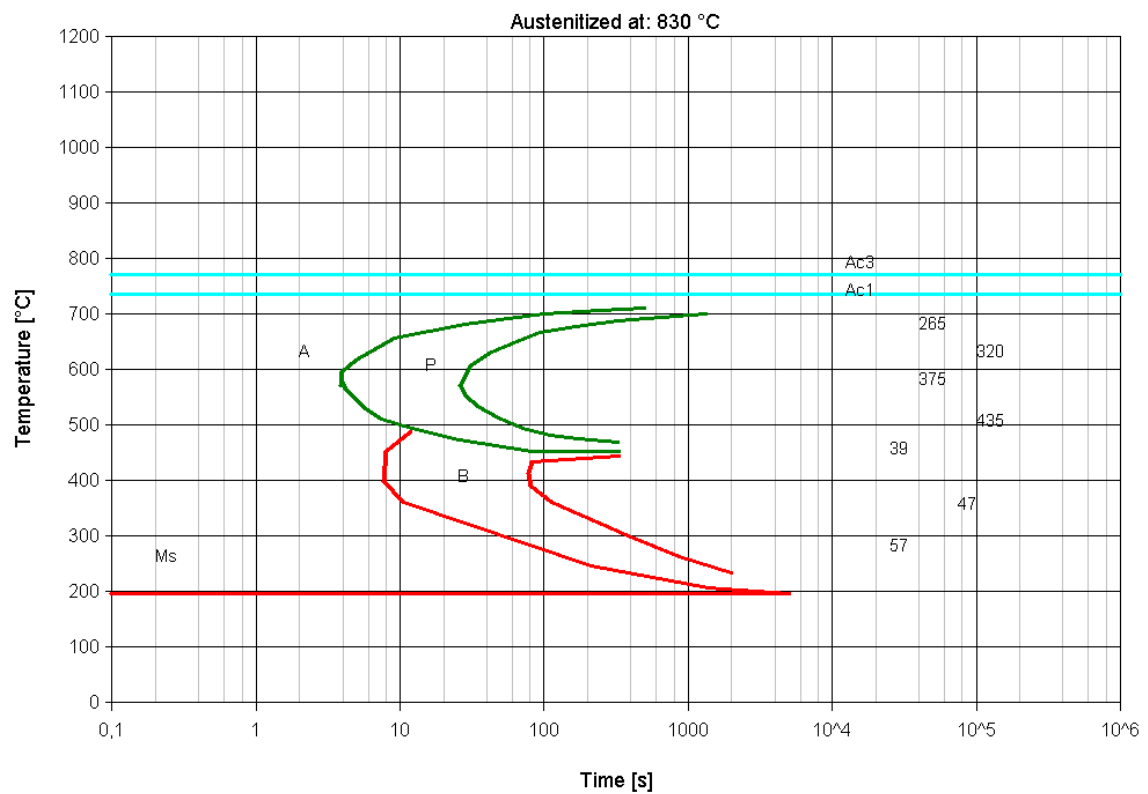
Surface hardness [HRC]: ca. 62

Time-temperature-transformation diagram for continuous cooling



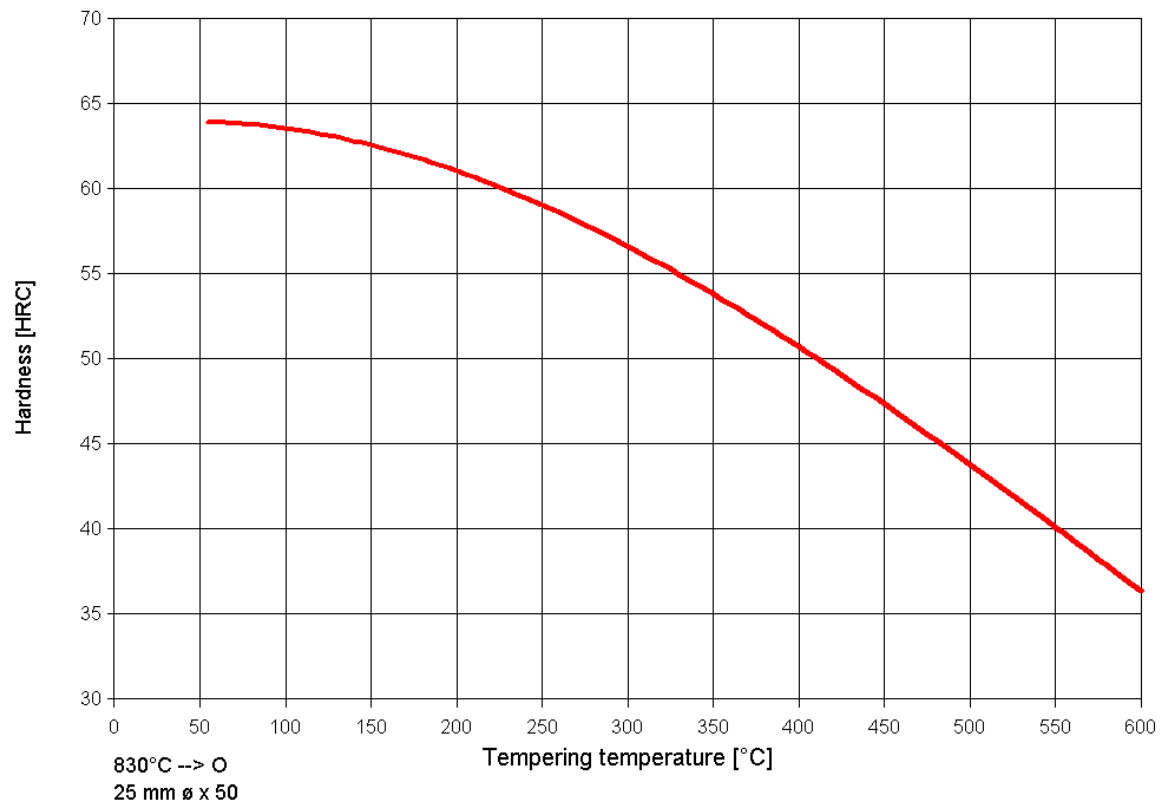
Hardness HV	904	675	441	315	268	216
Lambda-Value	0,04	0,08	0,16	0,43	6,39	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness [HV / HRC]

Tempering diagram



Material specification sheet

Saarstahl - 100CrMnSi6-4 (100CrMn6)

Material No.:	Former brand name:	International steel grades:
1.3520	RW4	BS: AFNOR: SAE:

Material group: Ball and roller bearing steel according to EN ISO 683-17

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	other
	1,00	0,60	1,10	1,50	-

Application: Ball and roller bearing steel for balls and rollers of any dimension, rings and discs over 30 mm effective thickness.

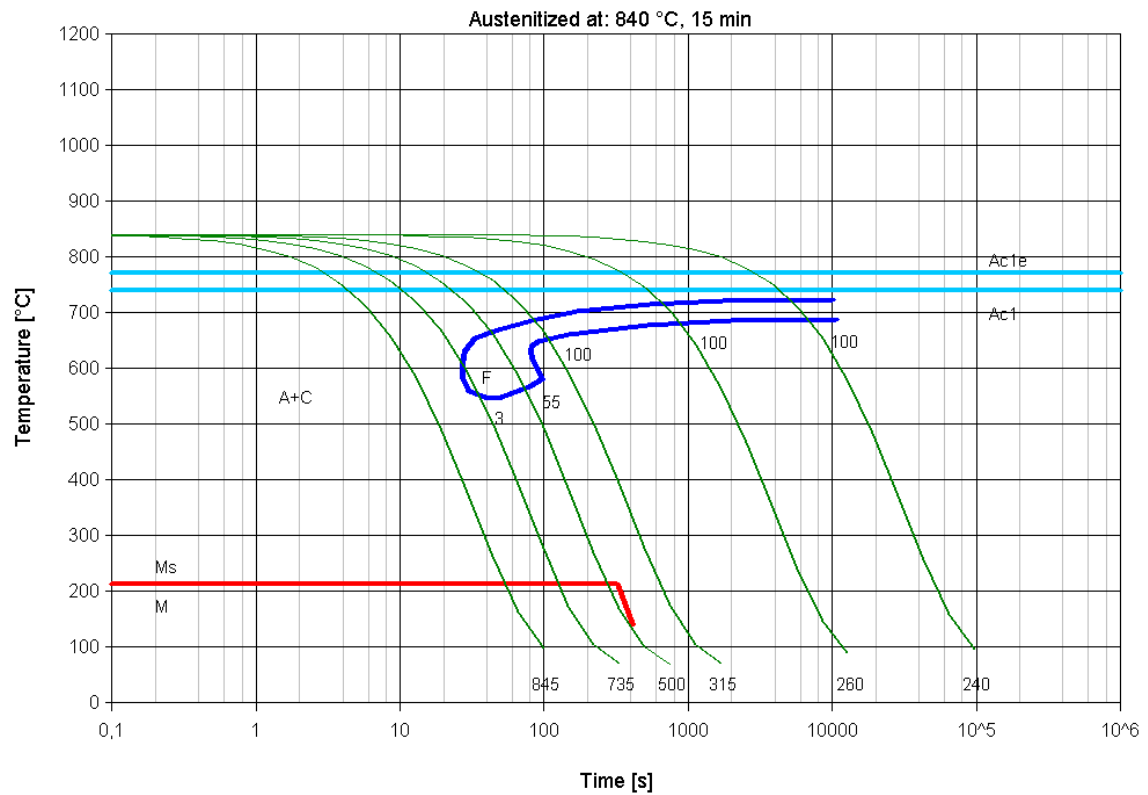
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	860 - 890°C/air
	Soft annealing:	750 - 800°C/furnace
	Hardening:	830 - 870°C/oil
	Tempering:	150 - 180°C

Mechanical Properties:	Soft annealed +A:	max. 217 HB
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Heat treatment condition:	Hardened and tempered
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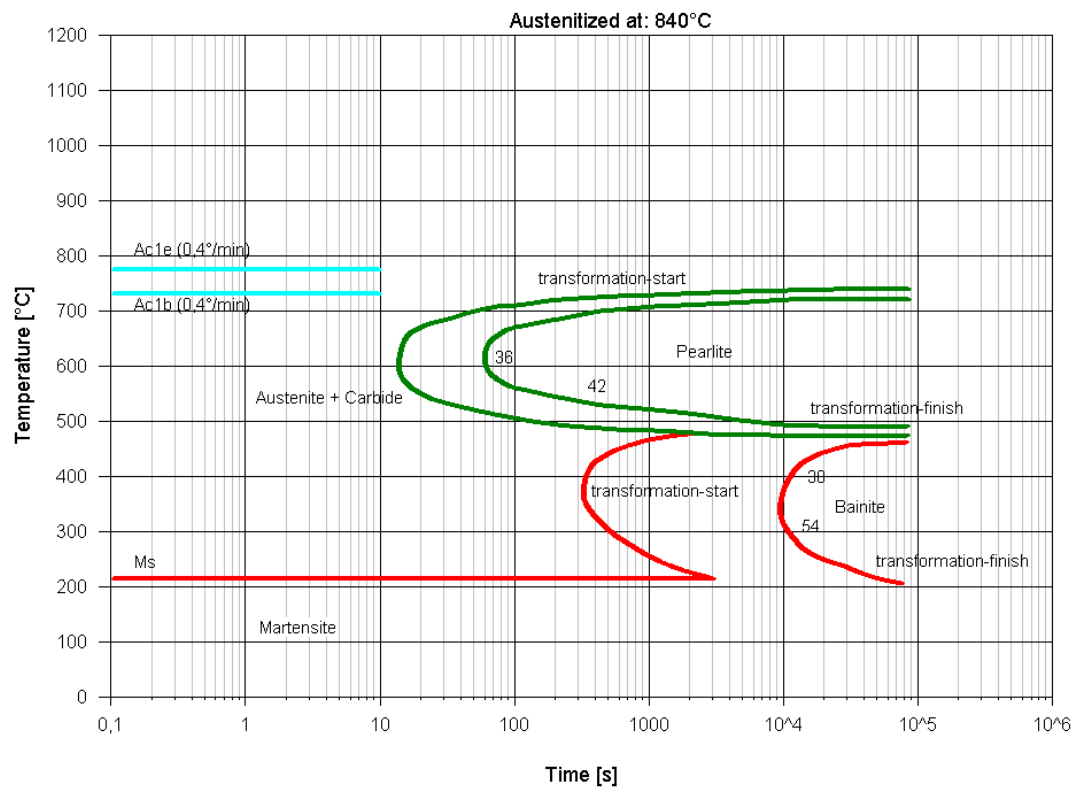
Surface hardness [HRC]:	ca. 62
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Time-temperature-transformation diagram for continuous cooling



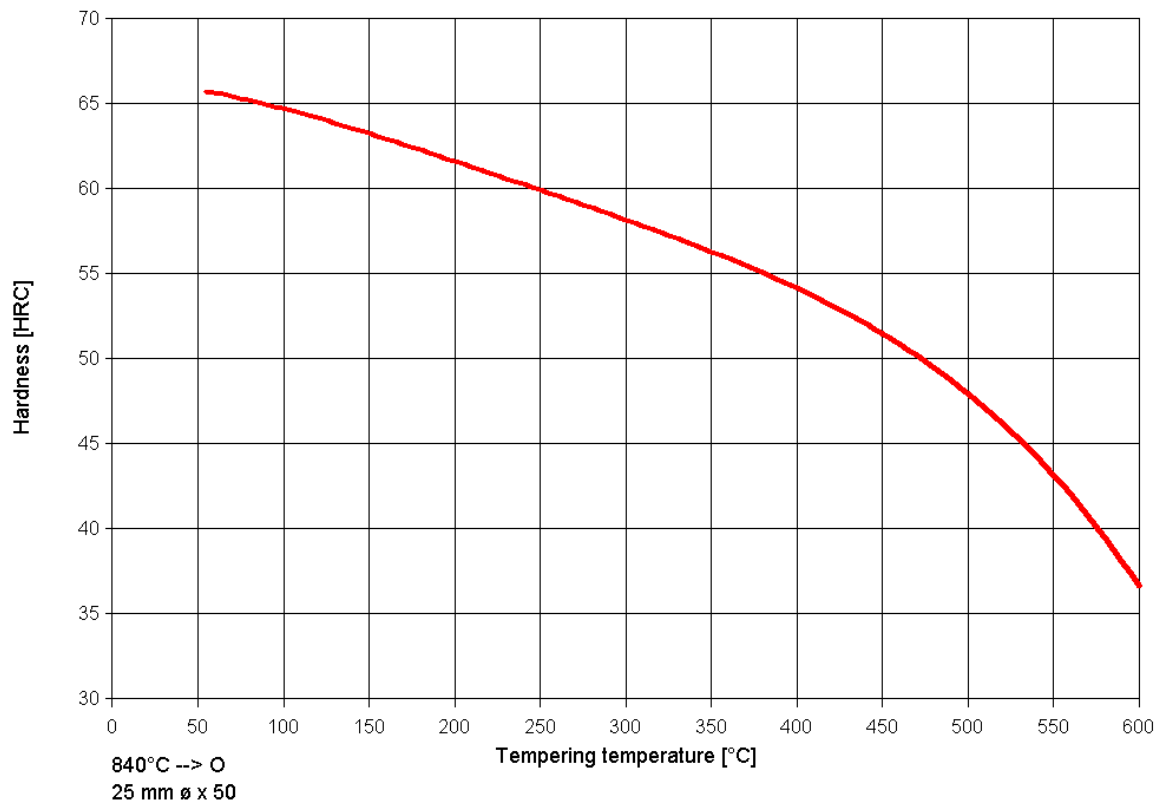
Hardness HV	845	735	500	315	260	240
Lambda-Value	0,15	0,40	0,65	1,6	10°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

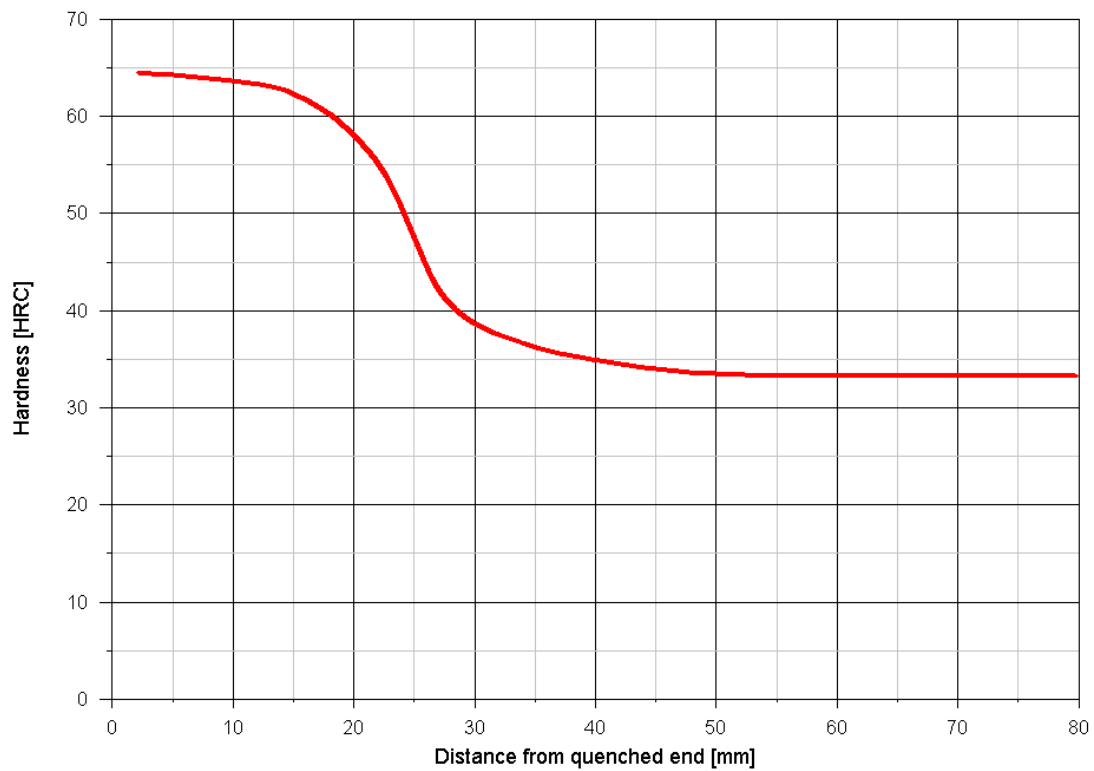


Hardness [HRC]

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 100CrMo7-3

Material No.:	Former brand name:	International steel grades:
1.3536	RW5	BS: AFNOR: SAE:

Material group: Ball and roller bearing steel according to EN ISO 683-17

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo
	1,00	0,30	0,70	1,80	0,30

Application: Ball and roller bearing steel for heavy rings and rollers over 50 mm effective thickness.

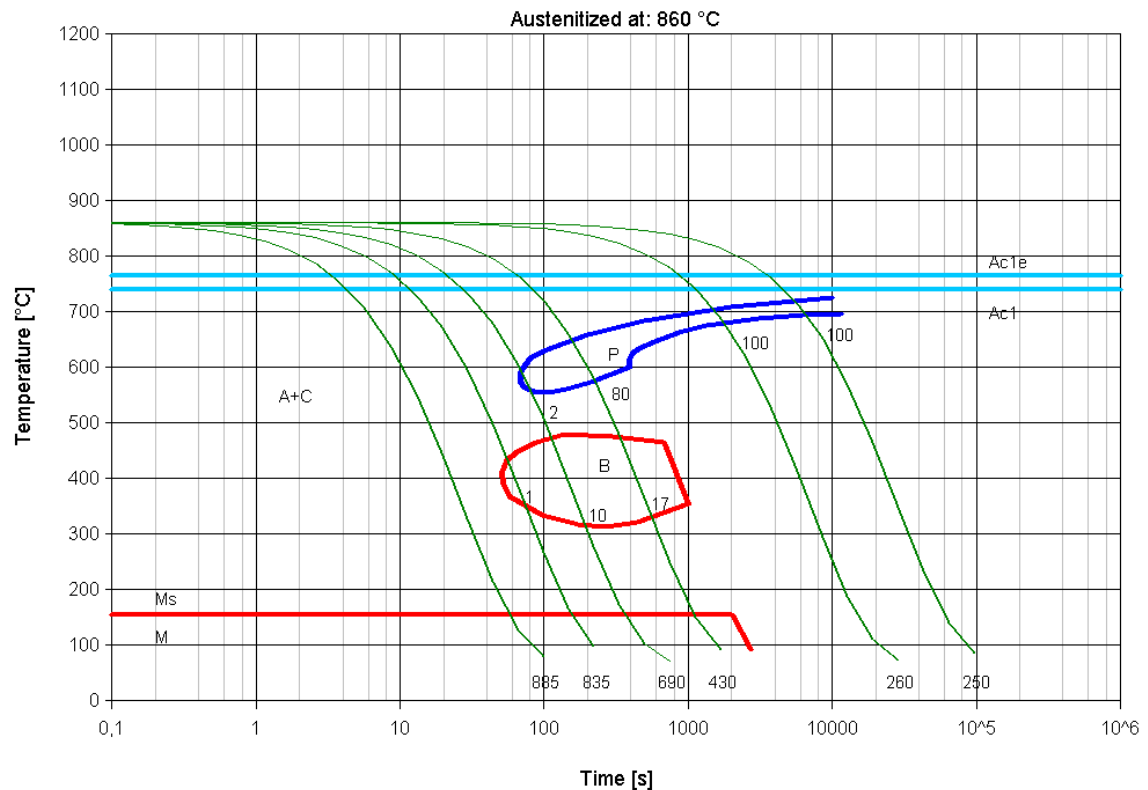
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	880 - 910°C/air
	Soft annealing:	750 - 800°C/furnace
	Hardening:	840 - 880°C/oil
	Tempering:	150 - 180°C

Mechanical Properties:	Soft annealed +A:	max. 217 HB
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Heat treatment condition: Hardened and tempered

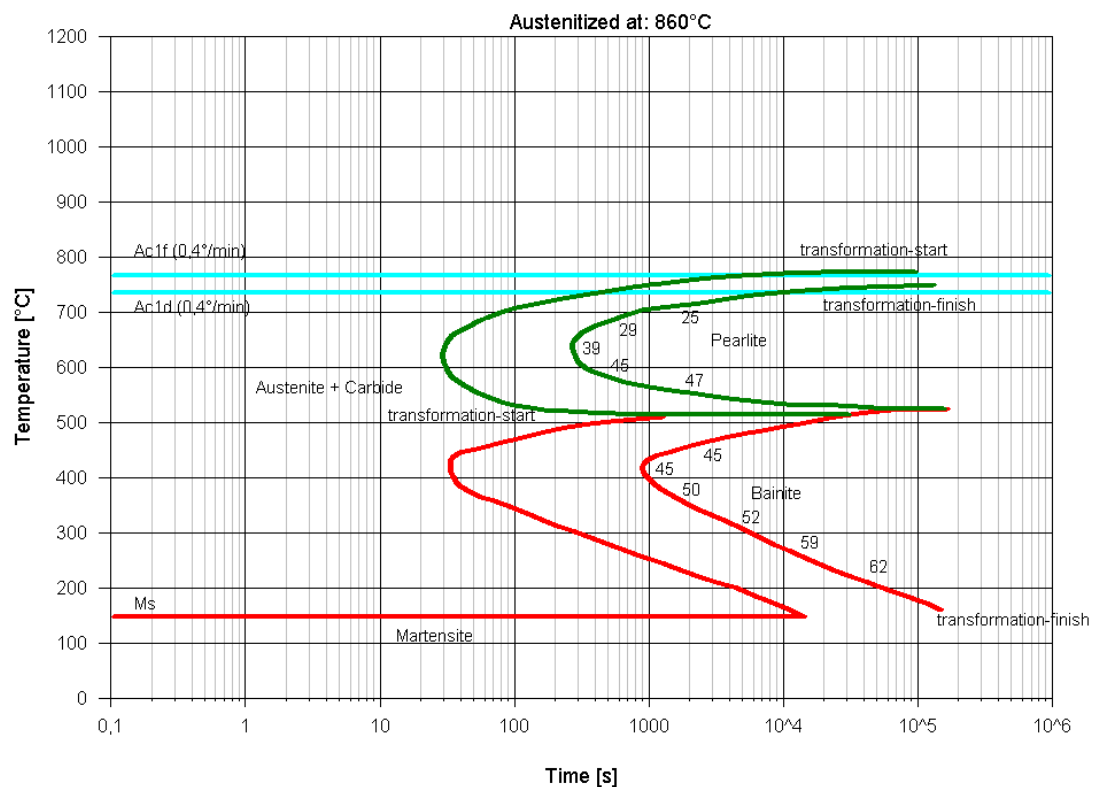
Surface hardness [HRC]: ca. 62

Time-temperature-transformation diagram for continuous cooling



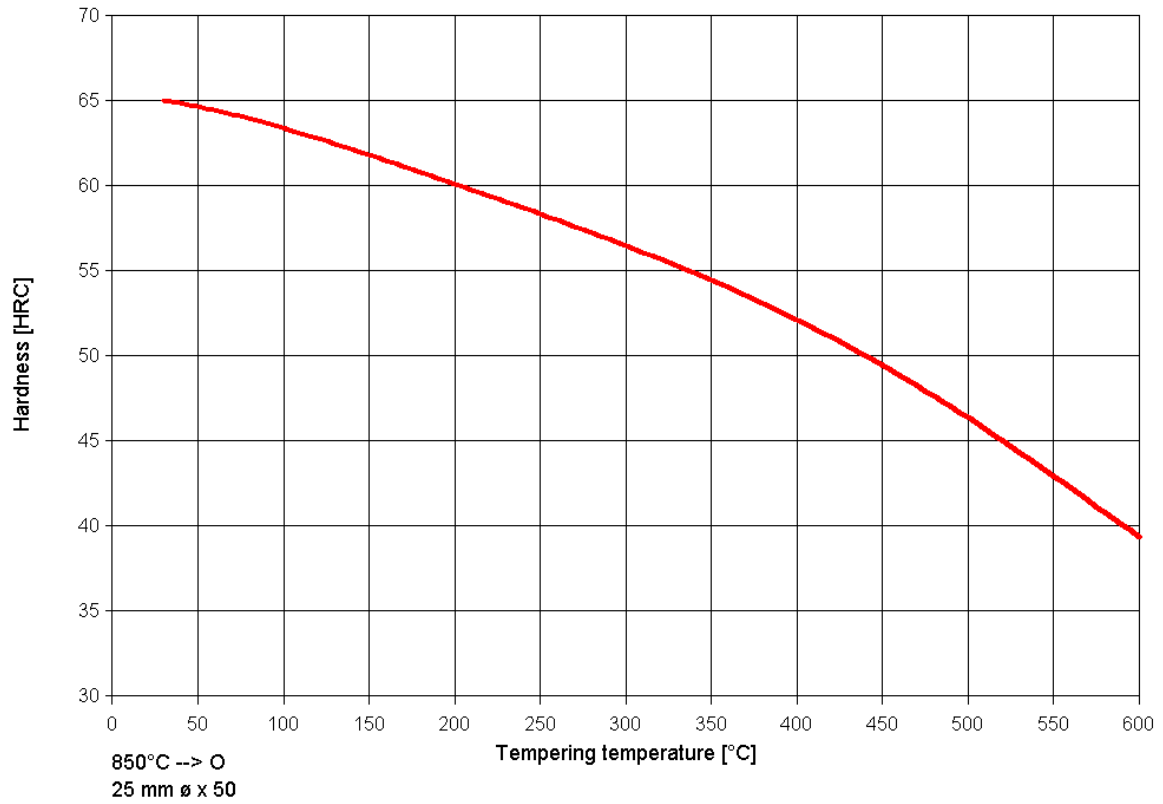
Hardness HV	885	835	690	430	260	250
Lambda-Value	0,13	0,32	0,82	2,5	5°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

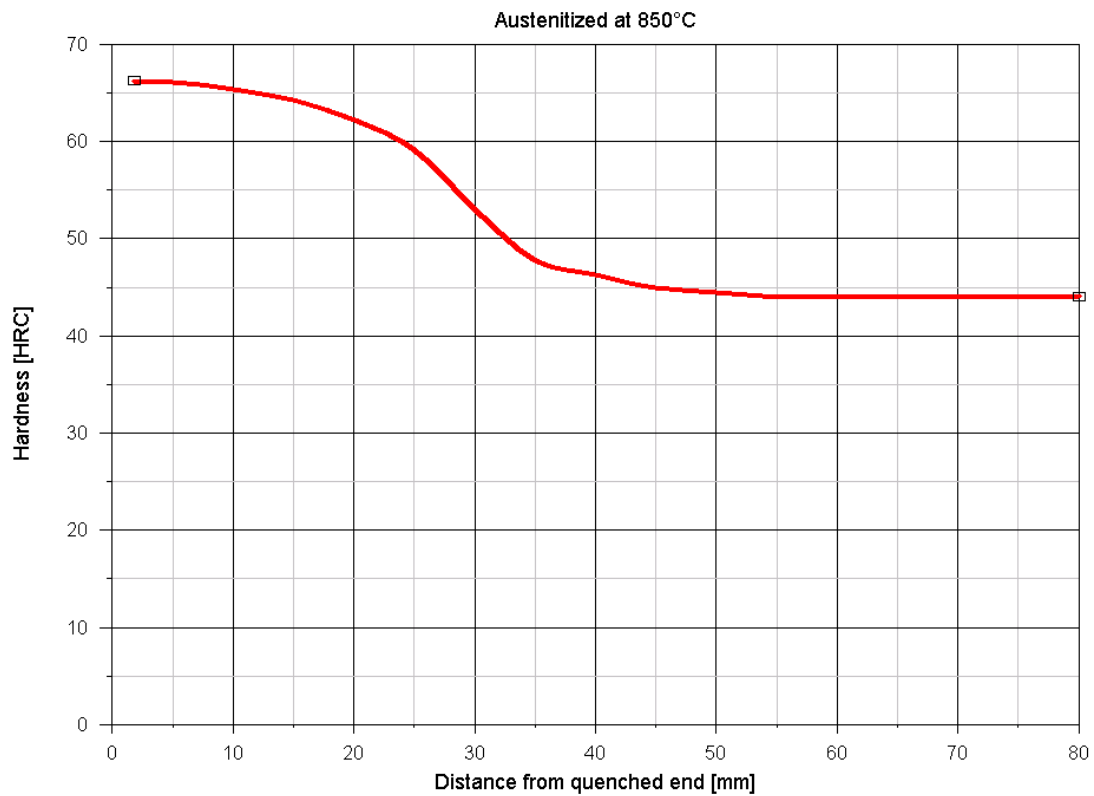


Hardness [HRC]

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 46Si7

Material No.:

Former brand name:

International steel grades:

1.5024

BS:

AFNOR:

SAE:

Material group:

Alloyed heat treatable steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	N
	0,42 0,50	1,50 1,80	0,50 0,80	<0,050	<0,050	<0,007

Application:

Alloyed heat treatable steel for hot formed springs as bellville washers, elliptic springs, buffer springs.

Hot forming and
heat treatment:

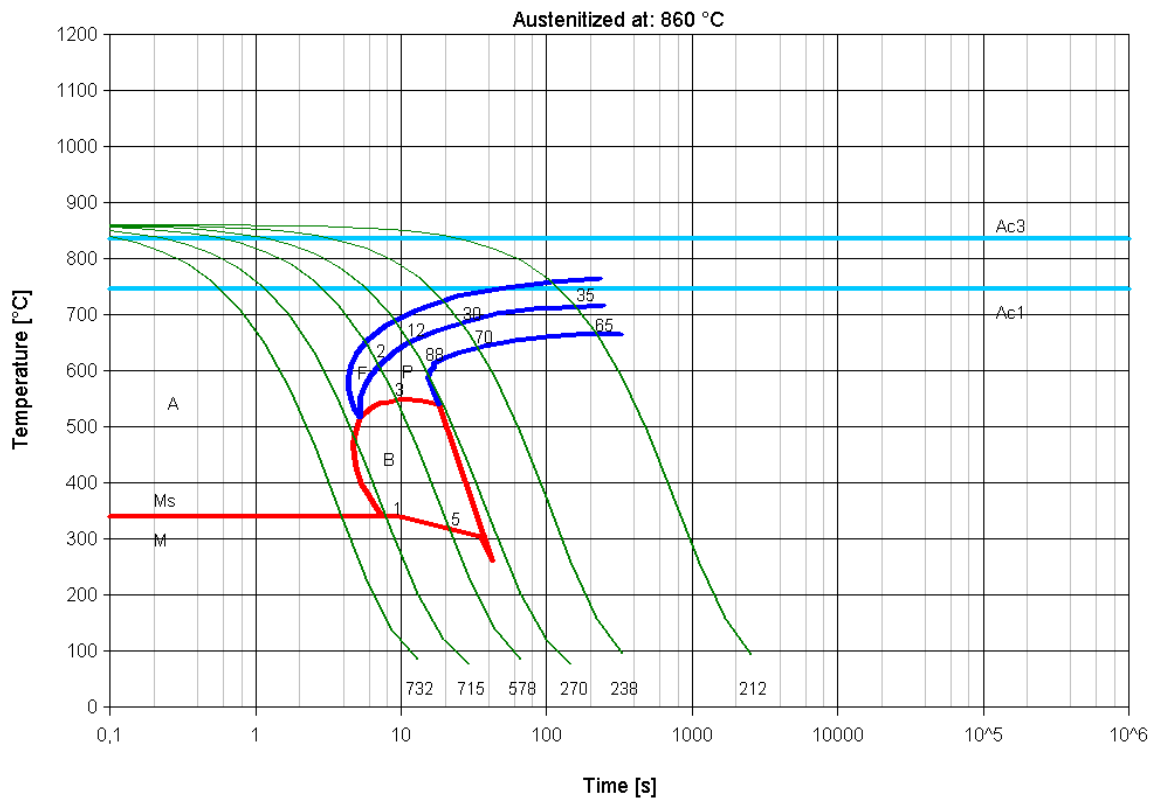
Hot forming:	1100 - 850°C
Hot deformation:	900 - 830°C
Normalising:	850 - 880°C
Soft annealing:	640 - 680°C
Hardening:	850 - 880°C/Wasser
Tempering:	430 - 500°C

Mechanical
Properties:

As hot rolled:	ca. 270 HB
Soft annealed +A:	max. 230 HB

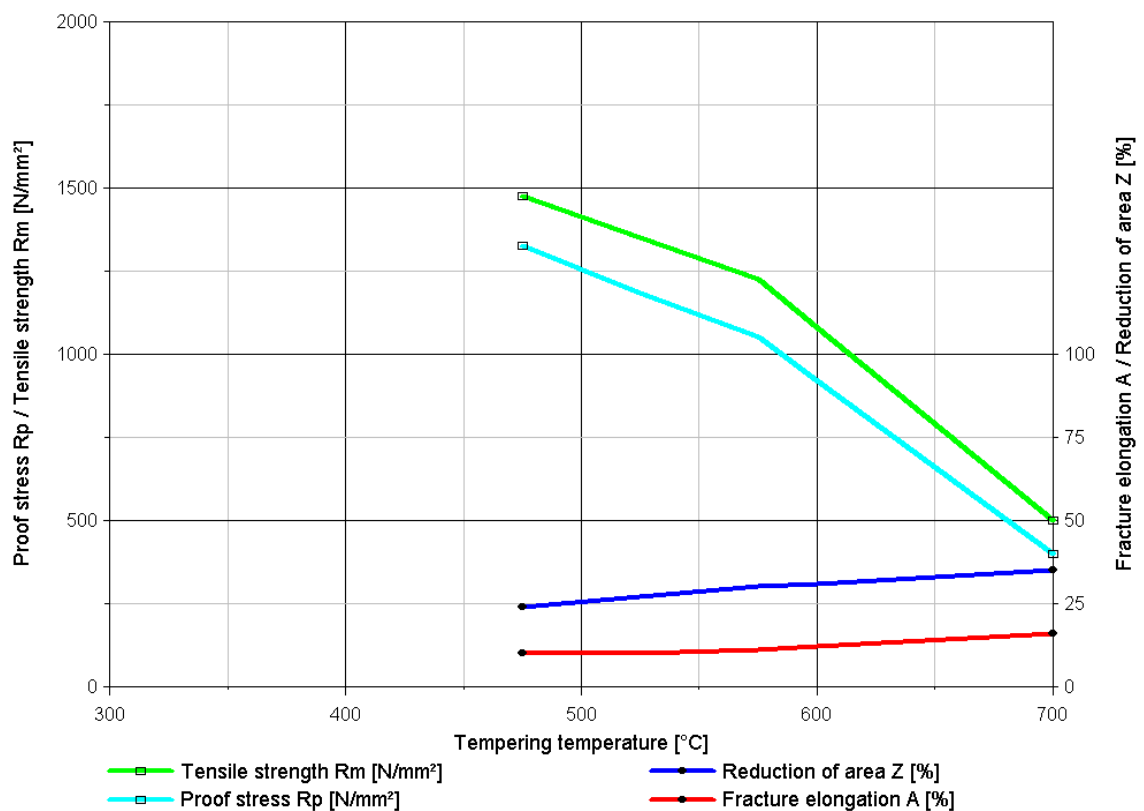
Dimension [mm]	14 mm flat; 20 mm diameter
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 1100
Tensile strength R_m [N/mm ²]	1300 - 1500
Fracture elongation A_5 [%]	min. 6
Reduction of area Z [%]	min. 30
Notch impact energy ISO-V [J]	min. 9

Time-temperature-transformation diagram for continuous cooling



Hardness HV	732	715	578	270	238	212
Lambda-Value	0,02	0,04	0,10	0,20	0,46	4,19

Tempering diagram



Material specification sheet

Saarstahl - 56Si7 (55Si7)

Material No.:	Former brand name:	International steel grades:
1.5026	-	BS: 251A58 AFNOR: 55Si7RR, 56SC7 SAE: 9255

Material group: Spring steel according to DIN EN 10132

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	Ni
	0,52 0,60	1,60 2,00	0,60 0,90	<0,025	<0,025	<0,40	<0,10	<0,40

Application: Steel for different types of springs as leaf springs, helical springs, Belleville washers.

Hot forming and heat treatment:	Hot forming:	1050 - 850°C
	Hot deformation:	900 - 830°C
	Normalising:	850 - 880°C
	Soft annealing:	650 - 690°C
	Hardening:	840 - 870°C/oil min. 55 HRC or 600 HV as quenched

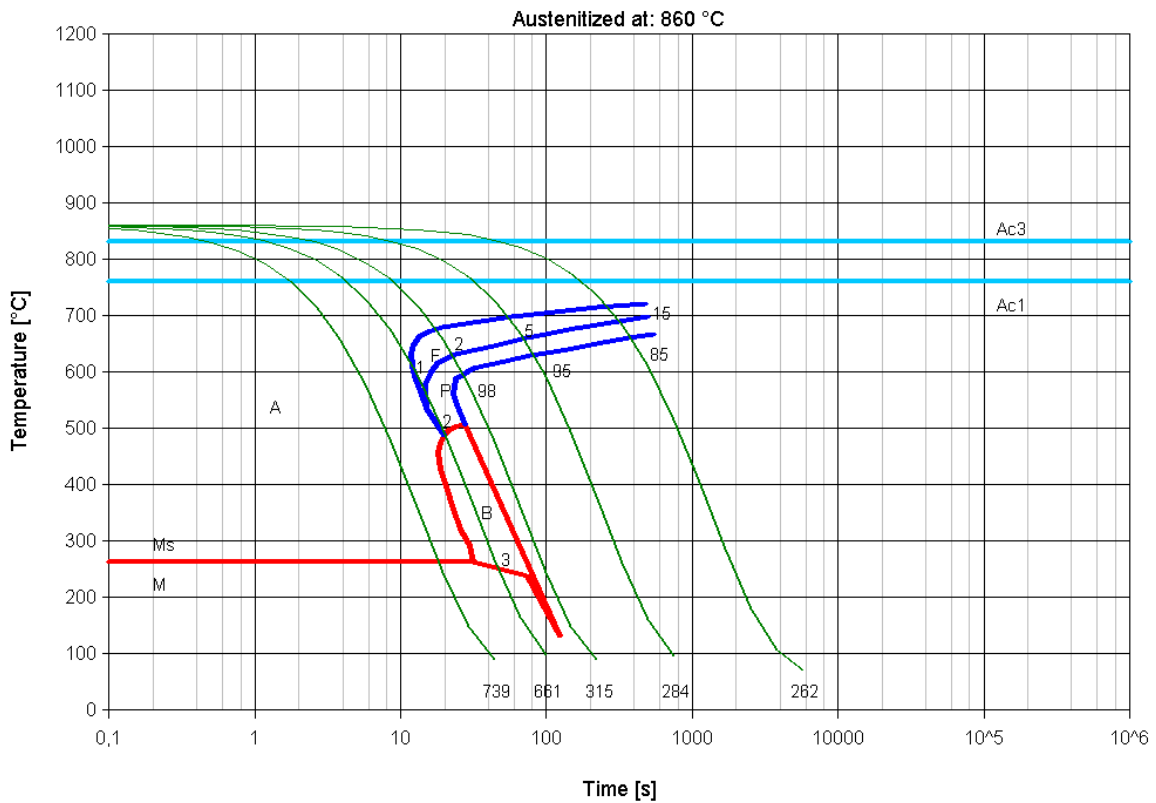
Mechanical Properties:

Condition of delivery	Soft annealed (+A) or soft annealed and slightly rerolled (+LC)	Quenched and tempered (+QT)
0,2% proof stress R_{p0,2} [N/mm²]	max. 600	1200 - 1700
Tensile strength R_m [N/mm²]	max. 740	-
Fracture elongation A₈₀ [%]	min. 12	-
Hardness [HV]	max. 230	370 - 520
Hardness [HRB]	max. 96	-
Hardness [HRC]	-	38,5 - 50,5

Typical hardness values (HV) for quenched and tempered materials at different thickness ranges

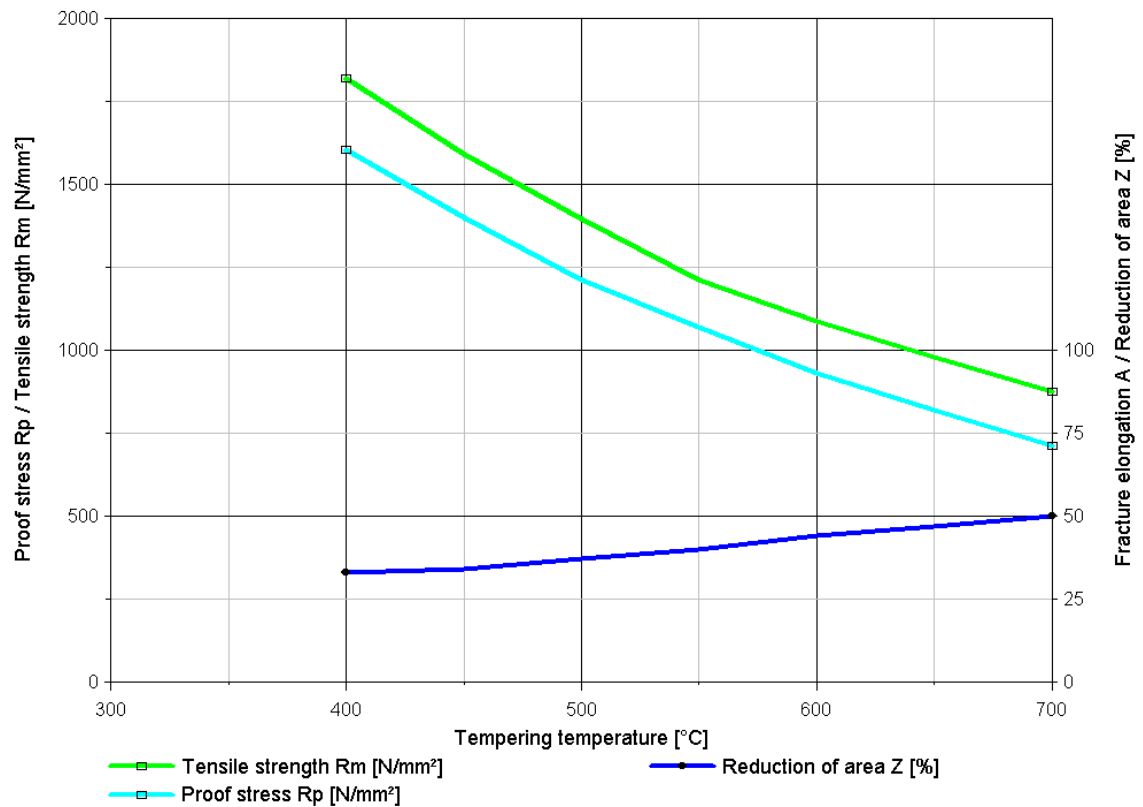
Effective thickness [mm]	0,30<=0,50	0,50<=0,75	0,75<=1,00	1,00<=1,50	1,50<=2,00	2,00<=3,00
Hardness [HV]	485 - 535	465 - 515	455 - 505	445 - 495	425 - 475	415 - 465

Time-temperature-transformation diagram for continuous cooling



Hardness HV	739	730	661	315	284	262
Lambda-Value	0,07	0,11	0,15	0,35	1,20	6,71

Tempering diagram



Material specification sheet

Saarstahl - 37MnSi5

Material No.:	Former brand name:	International steel grades:
1.5122	VMS 135	BS: AFNOR: SAE:

Material group: Alloyed heat treatable steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	other
	0,37	1,25	1,25	(Pb)

Application: Alloyed heat treatable steel with a tensile strength range of 800 - 1500 N/mm² for wear resisting components as gearing parts, bandages, conveying equipment. Suitable for surface hardening. For crankshafts in aircraft applications and diesel engines, gear shafts and gears and for all parts with higher core tensile strength good toughness properties and medium skin hardness simultaneously.

Hot forming and heat treatment:	Forging:	1150 - 850°C
	Normalising:	860 - 890°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	820 - 850°C/water
	Hardening:	830 - 860°C/oil
	Tempering:	480 - 650°C/water (oil)
	Surface hardening:	820 - 850°C
	Stress relieving:	120 - 200°C

**Mechanical
Properties:**

Soft annealed, +A:

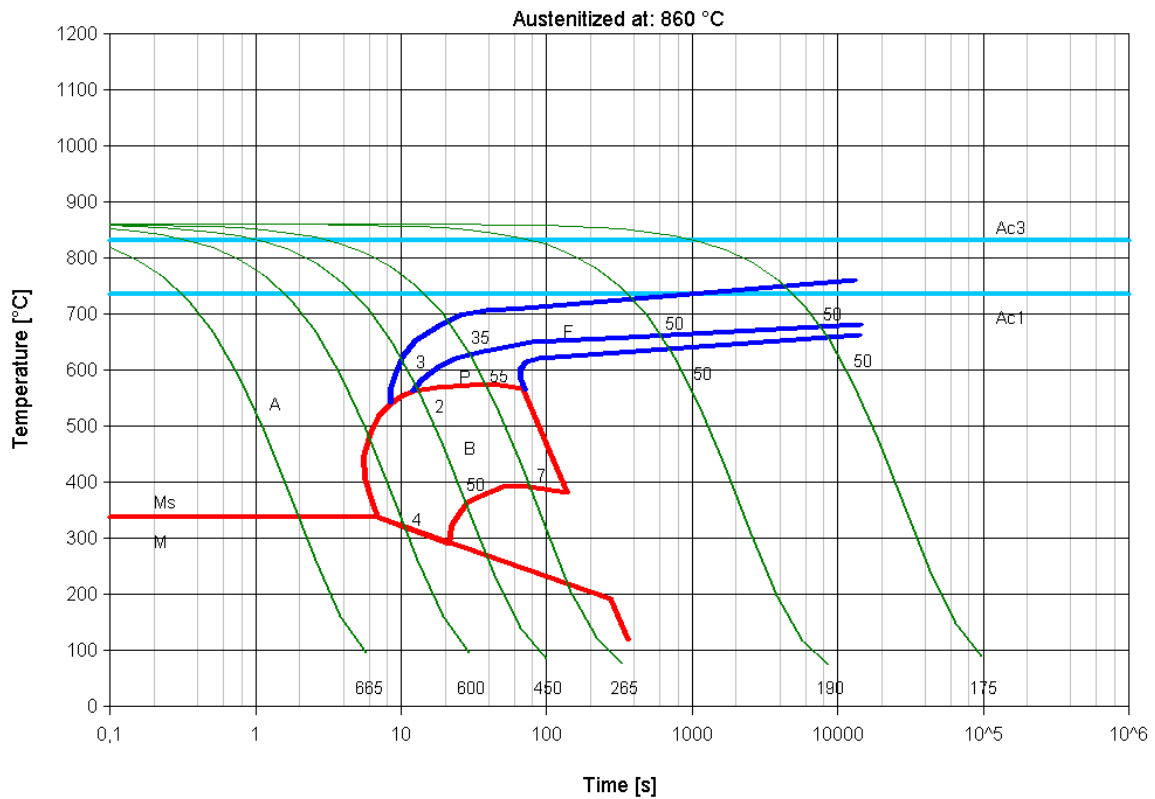
max. 217 HB

Skin hardness:

52 - 58 HRC

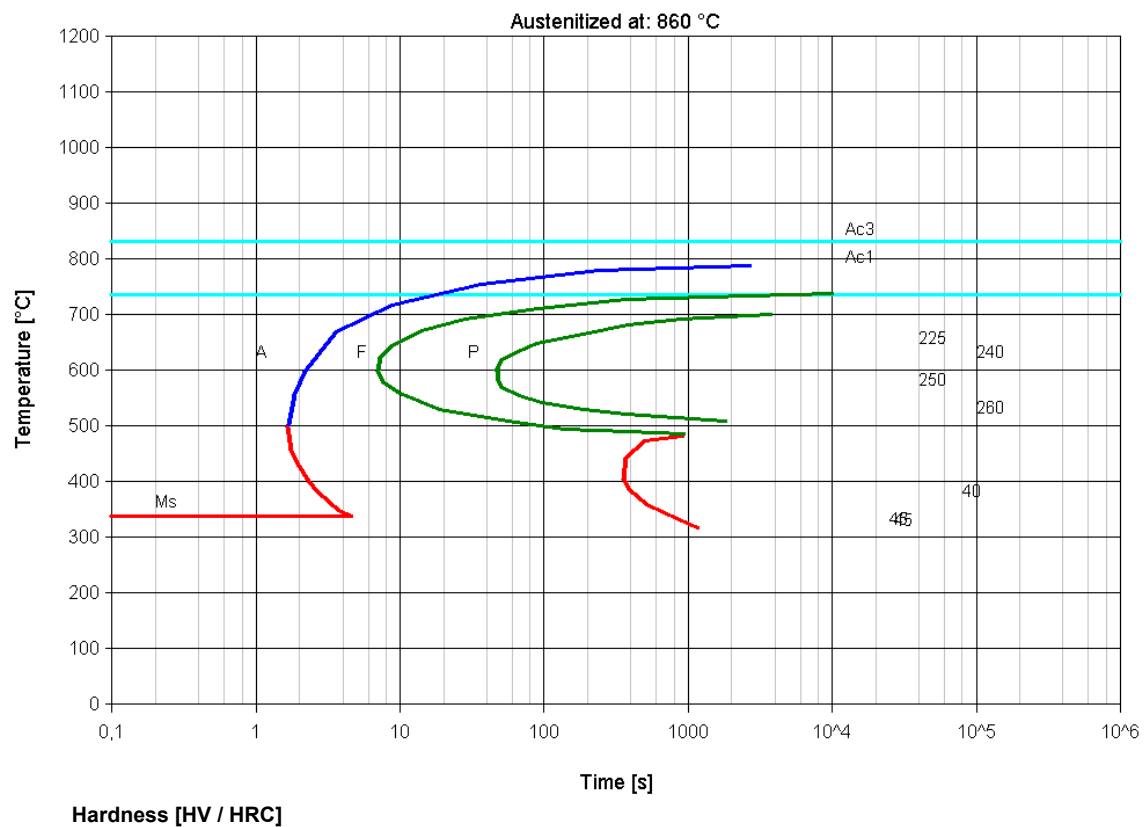
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 - 250
0,2% proof stress $R_{p0,2}$ [N/mm²]	min. 800	min. 650	min. 550	min. 450
Tensile strength R_m [N/mm²]	1000 - 1200	900 - 1050	800 - 950	700 - 850
Fracture elongation A_5 [%]	min. 11	min. 12	min. 14	min. 15
Reduction of area Z [%]	min. 35	min. 40	min. 45	min. 50
Notch impact energy ISO-V [J]	min. 18	min. 25	min. 30	min. 38
Notch impact energy DVM [J]	min. 35	min. 42	min. 50	min. 58

Time-temperature-transformation diagram for continuous cooling



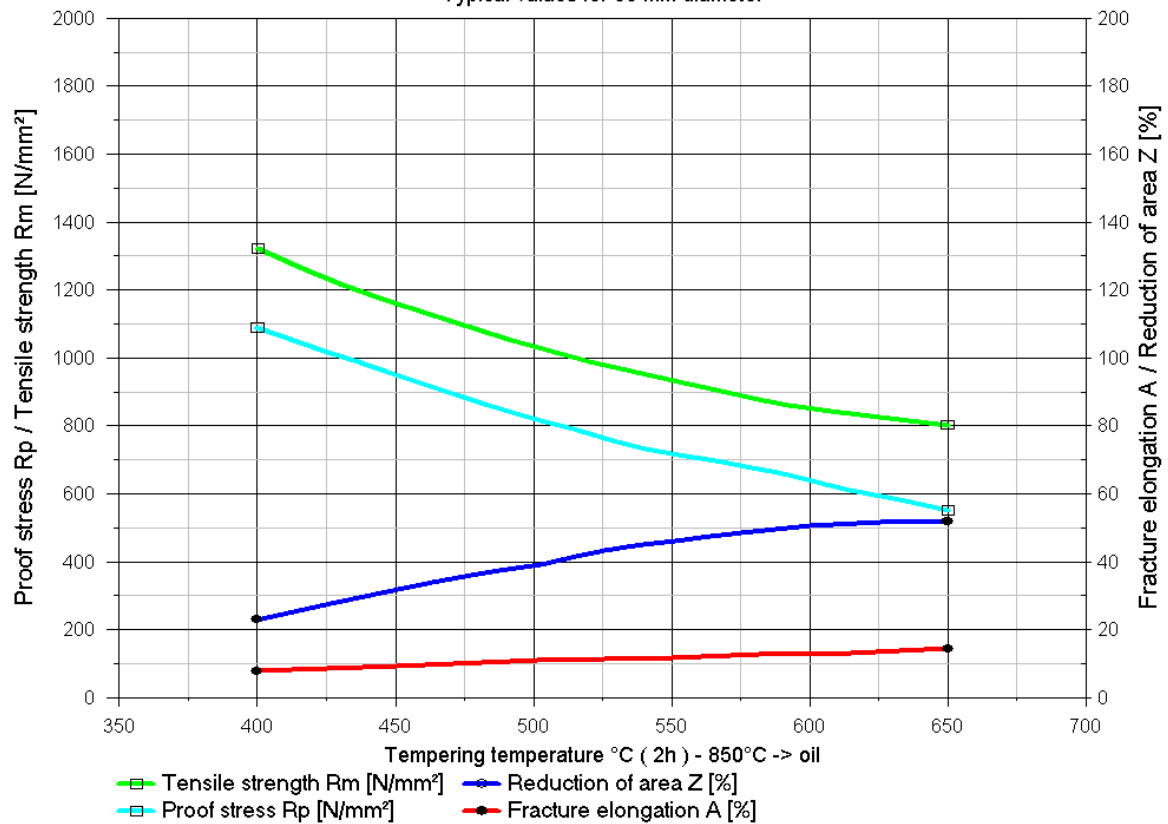
Hardness HV	665	600	450	265	190	175
Lambda-Value	0,01	0,04	0,14	0,45	50,8	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

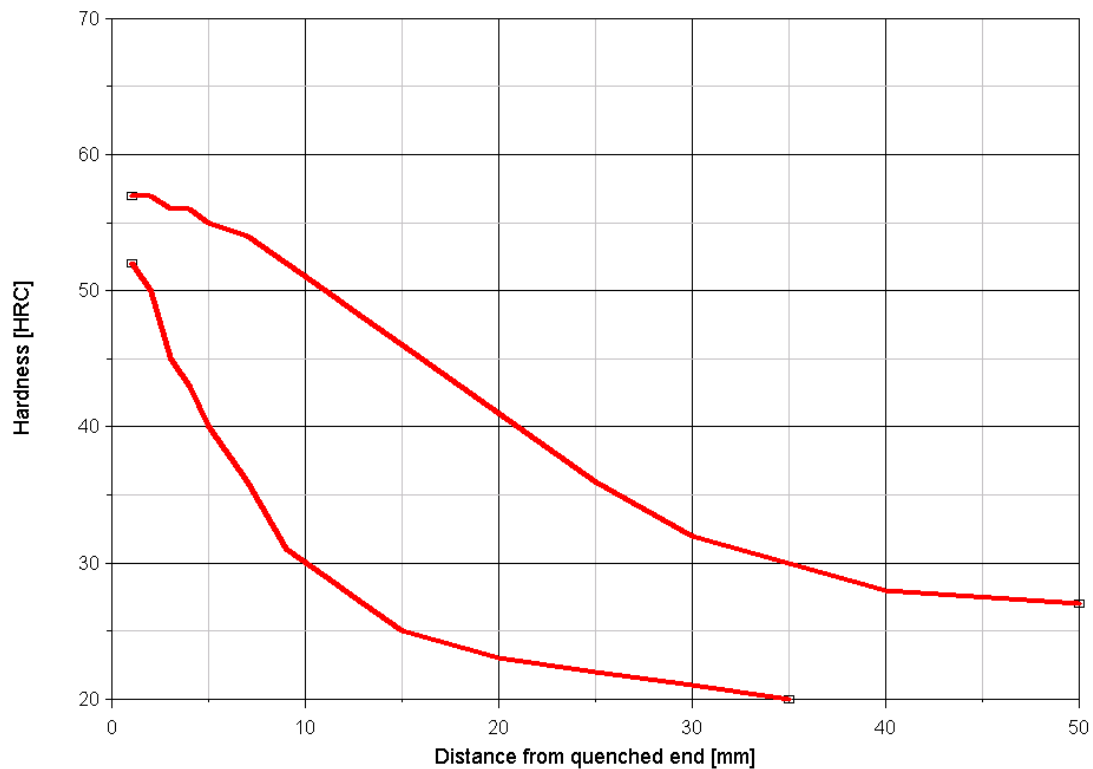


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 17MnB4 - 20MnB4 - 22MnB4 - 23MnB4

Material No.: 1.5520 1.5525 1.5522 1.5535	Former brand name: RKS 21 B	International steel grades: BS: AFNOR: SAE: 15B21H
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Material group: Cold heading and cold extrusion steel according to DIN EN 10269

Chemical composition: (Typical analysis in %)	C	Si	Mn	other
	0,20	0,25	1,00	+B

Application: Manganese und boron-alloyed cold heading and cold extrusion steel for screws and nuts.

Hot forming and heat treatment:	Soft annealing:	650 - 700°C/furnace
	Hardening:	870 - 900°C/water
	Tempering:	500 - 670°C/air

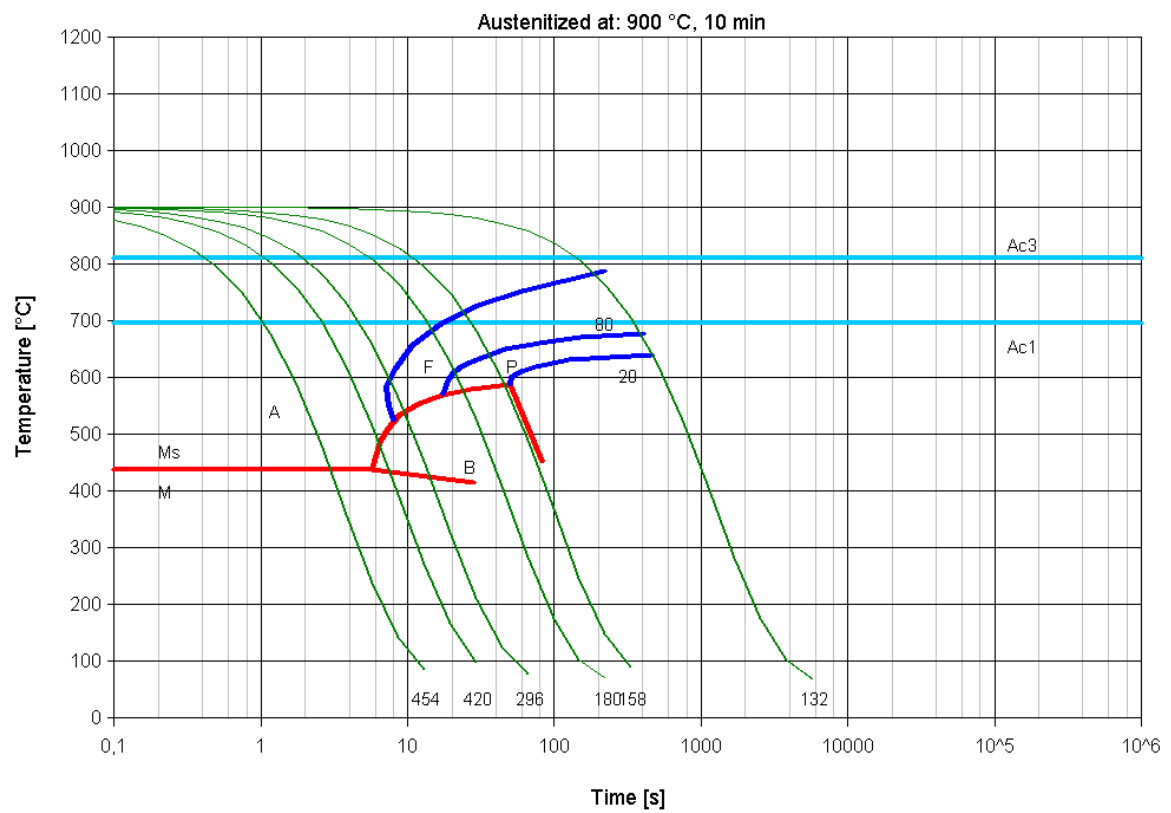
Mechanical Properties:

	Naturally hard	Spheroidized annealed and spheroidized annealed + peeled
Tensile strength R_m [N/mm²]	max. 540	max. 510
Reduction of area Z [%]	min. 55	min. 63

Core hardness after oil-hardening in HRC

Diameter d [mm]	min. 8	min. 16	min. 20
Hardness [HRC]	min. 42	min. 40	min. 36

Time-temperature-transformation diagram for continuous cooling



Hardness HV	454	420	296	180	158	132
Lambda-Value	0,03	0,05	0,09	0,31	0,51	6,80

Material specification sheet

Saarstahl - 22MnB4

Material No.:	Former brand name:	International steel grades:
1.5522	RKS 21 B	BS: AFNOR: SAE: 15B21H

Material group: Cold heading and cold extrusion steel according to DIN EN 10269

Chemical composition: (Typical analysis in %)	C	Si	Mn	other
	0,20	0,25	1,00	+B

Application: Manganese und boron-alloyed cold heading and cold extrusion steel for screws and nuts.

Hot forming and heat treatment:	Soft annealing:	650 - 700°C/furnace
	Hardening:	870 - 900°C/water
	Tempering:	500 - 670°C/air

Mechanical Properties:

	Naturally hard	Spheroidized annealed and spheroidized annealed + peeled
Tensile strength R_m [N/mm ²]	max. 540	max. 510
Reduction of area Z [%]	min. 55	min. 63

Core hardness after oil-hardening in HRC

Diameter d [mm]	min. 8	min. 16	min. 20
Hardness [HRC]	min. 42	min. 40	min. 36

Hardness HV	454	420	296	180	158	132
Lambda-Value	0,03	0,05	0,09	0,31	0,51	6,80

Material specification sheet

Saarstahl - 37MnB5 (40MnB4)

Material No.:

Former brand name:

International steel grades:

1.5538 (1.5527)

BS: 10/1

AFNOR:

SAE:

Material group:

Boron alloyed steel suitable for hardening and tempering

**Chemical
composition:**

(Typical analysis in %)

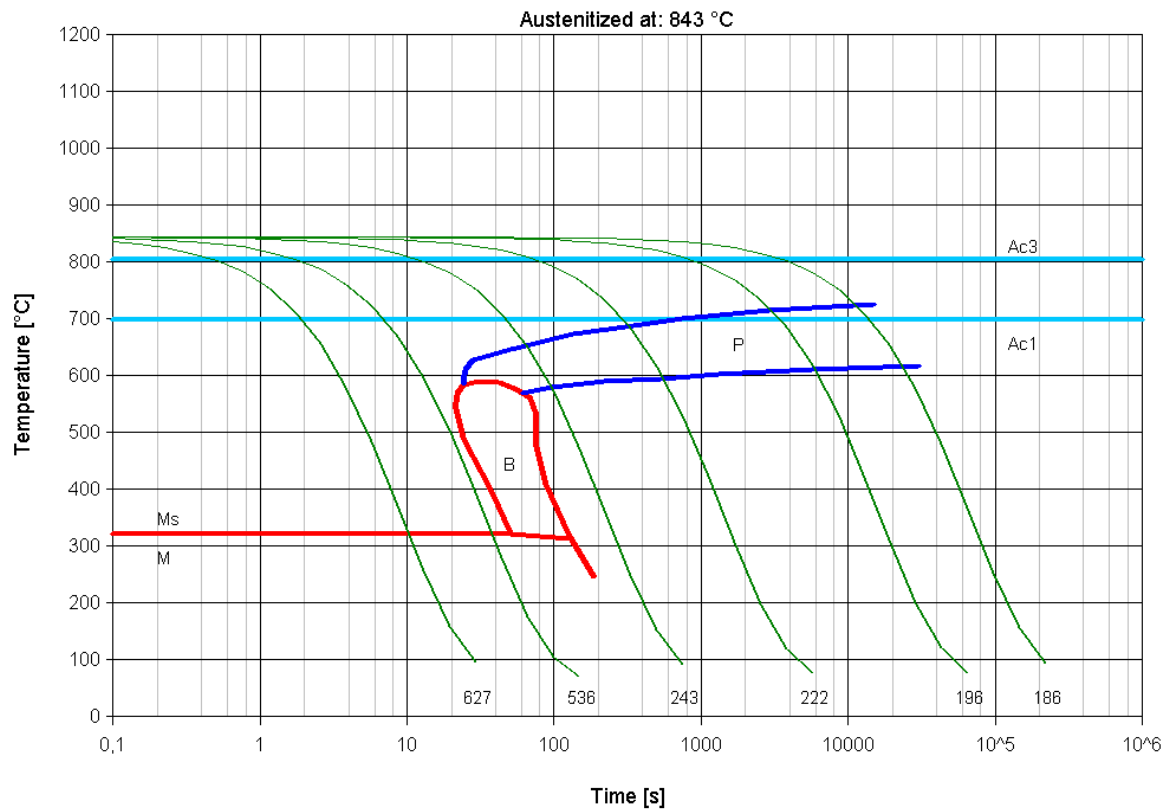
C	Si	Mn	B	P	S
0,37 0,40	<0,40	0,80 1,10	0,0008 0,0050	<0,035	<0,035

Application:

**Hot forming and
heat treatment:**

**Mechanical
Properties:**

Time-temperature-transformation diagram for continuous cooling



Hardness HV	627	536	243	222	196	186
Lambda-Value	0,05	0,19	1,22	7,36	25°/min	0,625°/min

Material specification sheet

Saarstahl - 13NiCr6 (13NiCr6Pb) - 16NiCrS4

Material No.:	Former brand name:	International steel grades:
1.5713	RAE 1	BS:
		AFNOR: 10NC6
1.5715		SAE: 3115

Material group: Alloyed case hardening steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Ni	other
	0,16	0,25	0,80	1,05	1,45	(Pb)

Application: Alloyed case hardening steel for highly strained components and high claims on toughness at core tensile strength in a range of 1000-1200 N/mm². For automotive and gearing components as driving gears, crown wheels, shafts, gears, bolts, mechanical transmission shafts.

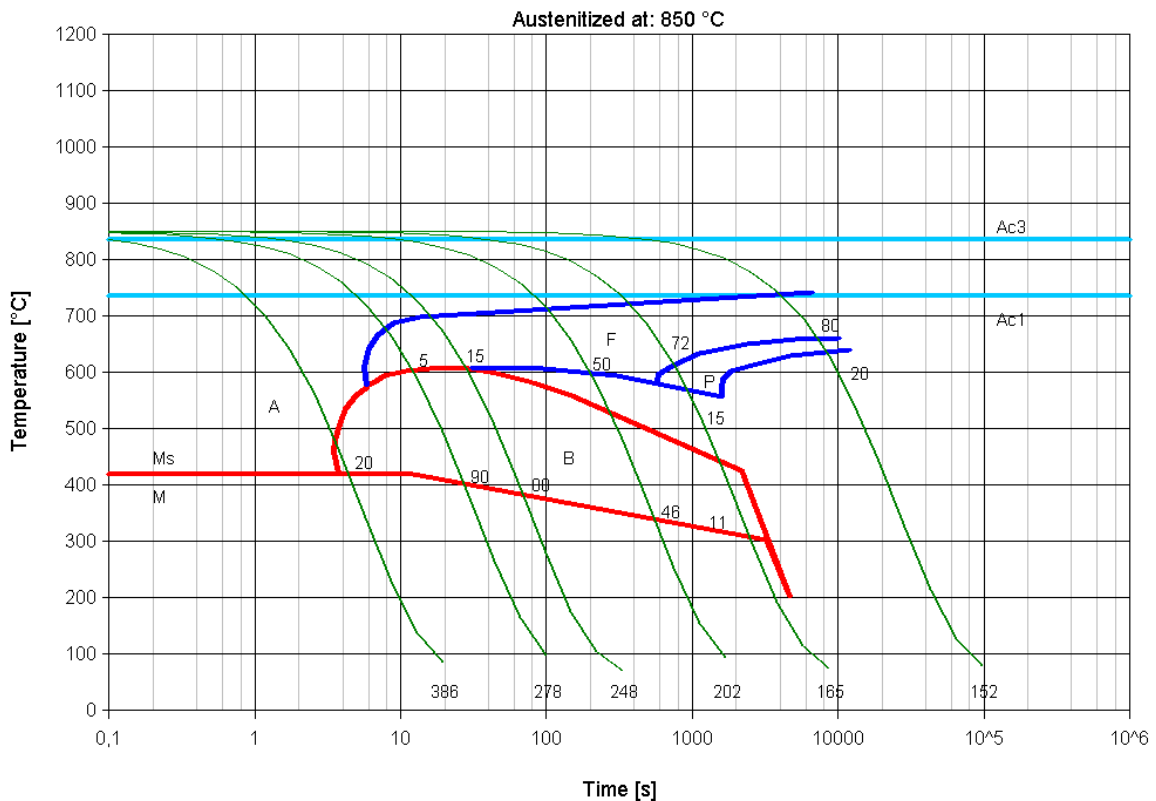
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	620 - 650°C/furnace
	Carburising:	870 - 930°C
	Core hardening:	840 - 870°C/oil
	Intermediate annealing:	620 - 650°C
	Case hardening:	800 - 820°C/oil
	Tempering:	170 - 210°C

Mechanical Properties:	Soft annealed, +A:	max. 190 HB
	Treated for strength, +TH:	175 - 220 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	160 - 200 HB

Core properties after case hardening :

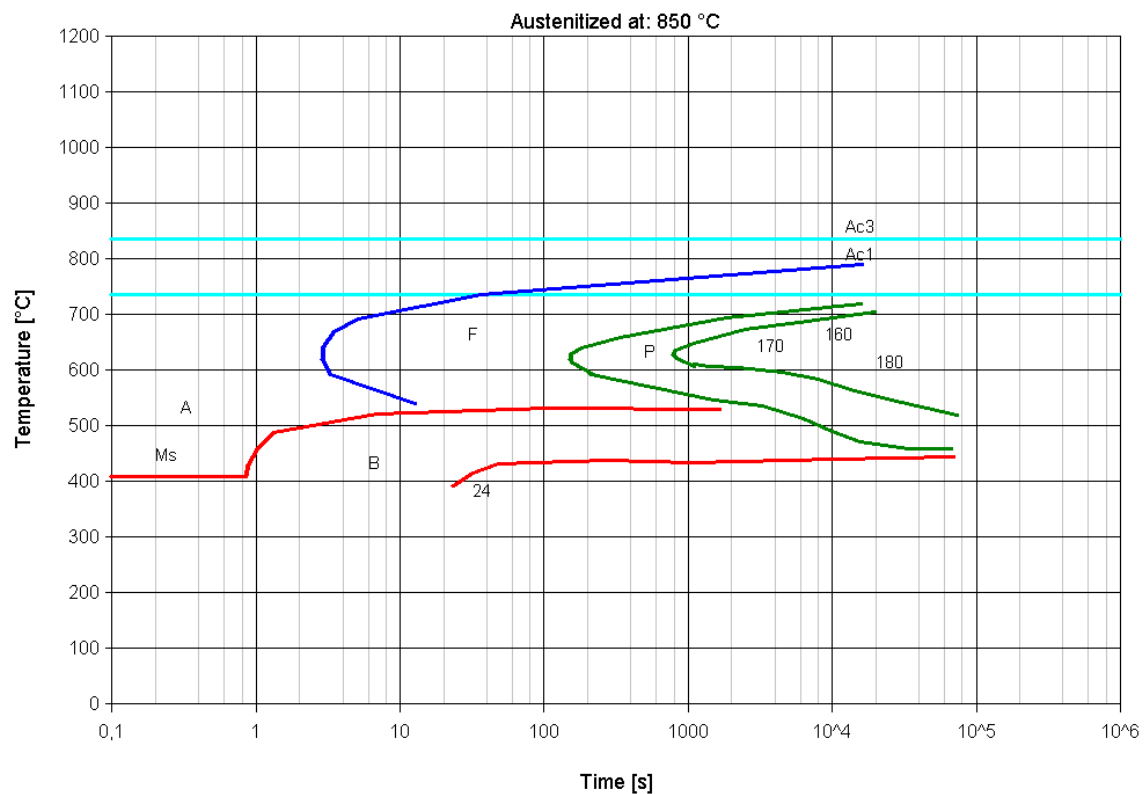
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
0,2% proof stress R_{p0,2} [N/mm²]	min. 835	min. 735	min. 590
Tensile strength R_m [N/mm²]	1080 - 1370	980 - 1270	780 - 1080
Fracture elongation A₅ [%]	min. 9	min. 10	min. 11
Reduction of area Z [%]	min. 35	min. 40	min. 40
Notch impact energy ISO-V [J]	min. 33	min. 42	min. 42
Surface hardness [HRC]	max. 59	max. 59	max. 59

Time-temperature-transformation diagram for continuous cooling



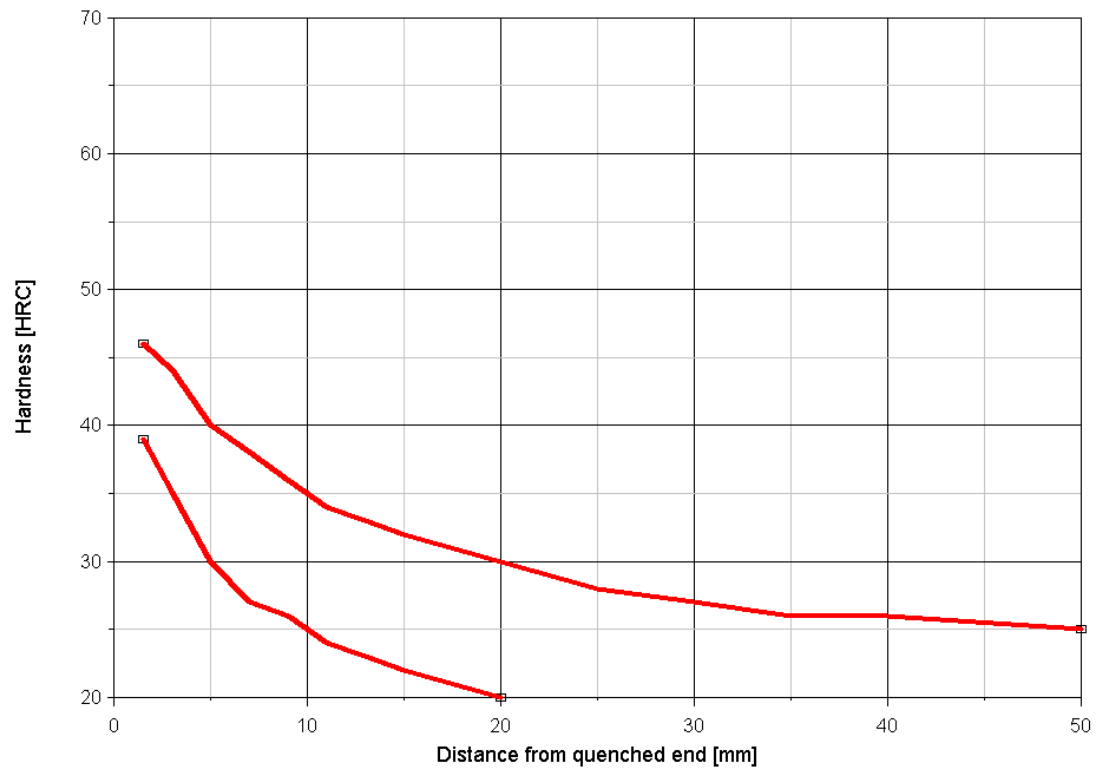
Hardness HV	386	278	248	202	165	152
Lambda-Value	0,03	0,17	0,44	2,7	10°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness [HV / HRC]

Hardness scatter band



Material specification sheet

Saarstahl - 18NiCr5-4 (18NiCr6-4)

Material No.:

Former brand name:

International steel grades:

1.5810

BS:

AFNOR:

SAE:

Material group:

Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Ni
	0,16 0,21	<0,40	0,60 0,90	<0,035	<0,035	0,90 1,20	1,20 1,50

Application:

Alloyed case hardening steel.

Hot forming and
heat treatment:

Forging or hot rolling:	1100 - 850°C
Normalising:	840 - 870°C
Soft annealing:	650 - 700°C
Carburising:	880 - 980°C
Core hardening:	840 - 880°C
Intermediate annealing:	650 - 700°C
Case hardening:	780 - 820°C
Tempering:	150 - 200°C

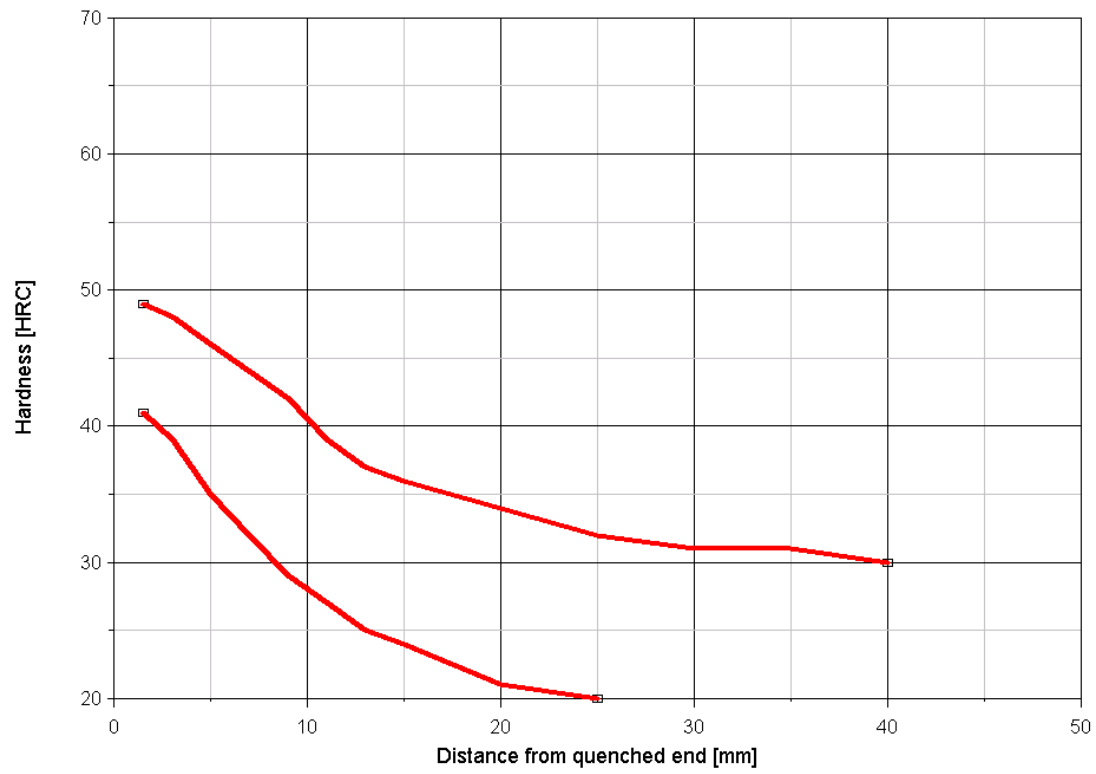
Mechanical
Properties:

Treated for cold shearability, +S:	max. 255 HB
Soft annealed, +A:	max. 223 HB
Treated for strength, +TH:	170 - 223 HB
Treated for ferrite and pearlite structure and hardness range, +FP:	156 - 207 HB

after hardening and tempering at 200°C:

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1200	min. 1100	min. 900

Hardness scatter band



Material specification sheet

Saarstahl - 17CrNi6-6 - 15CrNi6

Material No.:	Former brand name:	International steel grades:
1.5918	RECNW	BS:
		AFNOR: 16NC6
1.5919		SAE: 3115

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Ni	other
	0,15	0,25	0,50	1,55	1,55	(Pb)

Application: Alloyed case hardening steel for highly strained parts and good toughness at core tensile strength of 900 - 1200 N/mm². Driving bevel gears, crown wheels, gears, shafts, bolts for automotive and gear components.

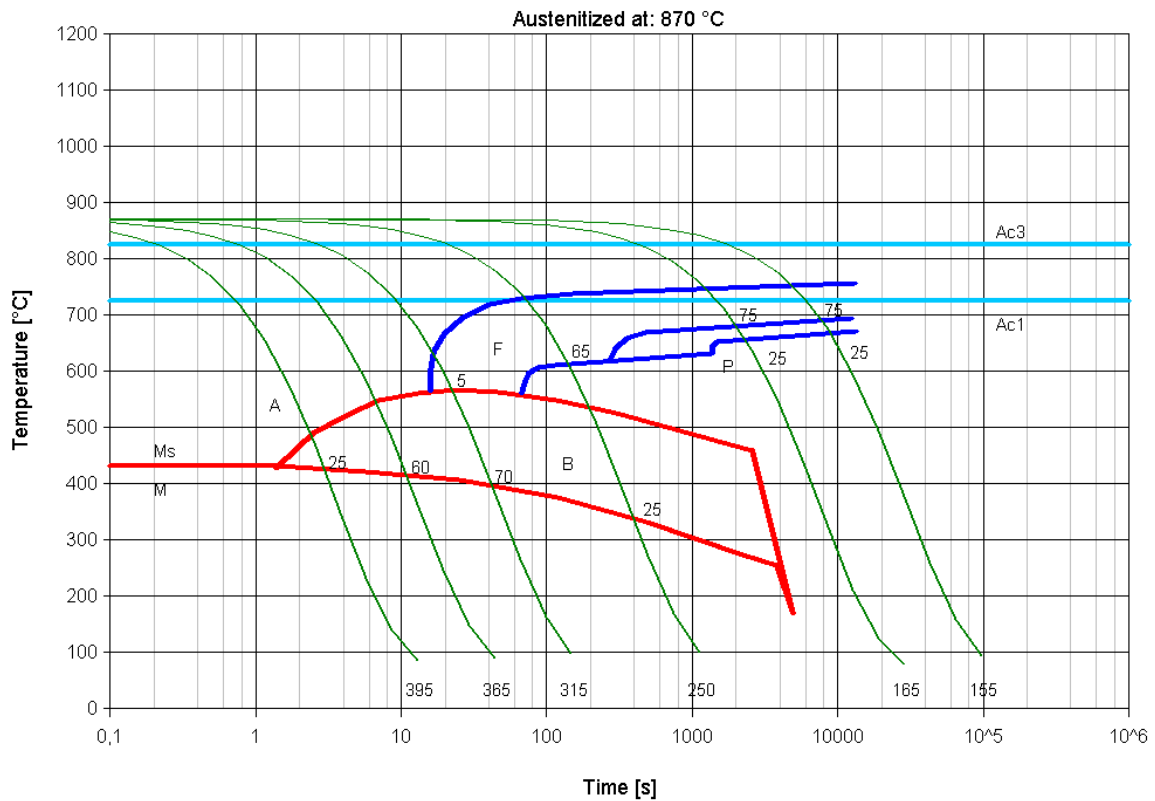
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	830 - 870°C/oil
	Intermediate annealing:	630 - 650°C
	Case hardening:	780 - 820°C/oil
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	max. 255 HB
	Soft annealed, +A:	max. 229 HB
	Treated for strength, +TH:	175 - 229 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	156 - 207 HB

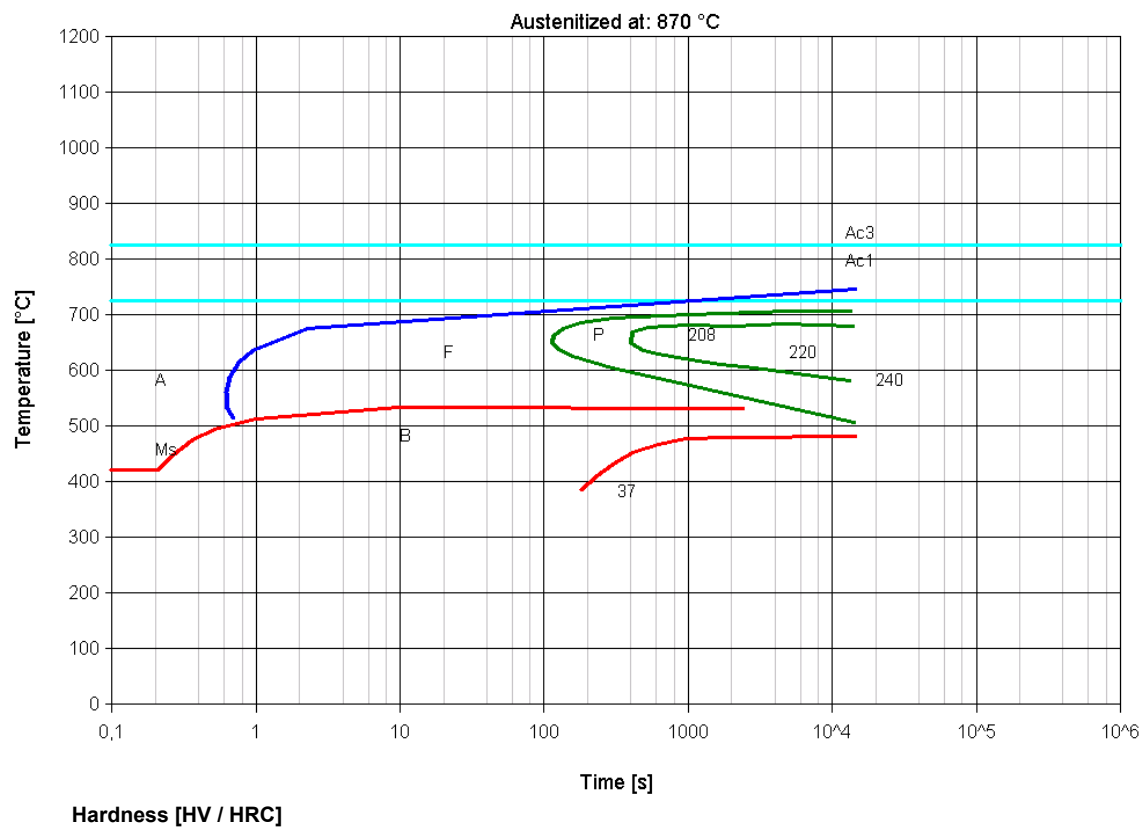
after hardening and tempering at 200°C:

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1200	min. 1100	min. 900

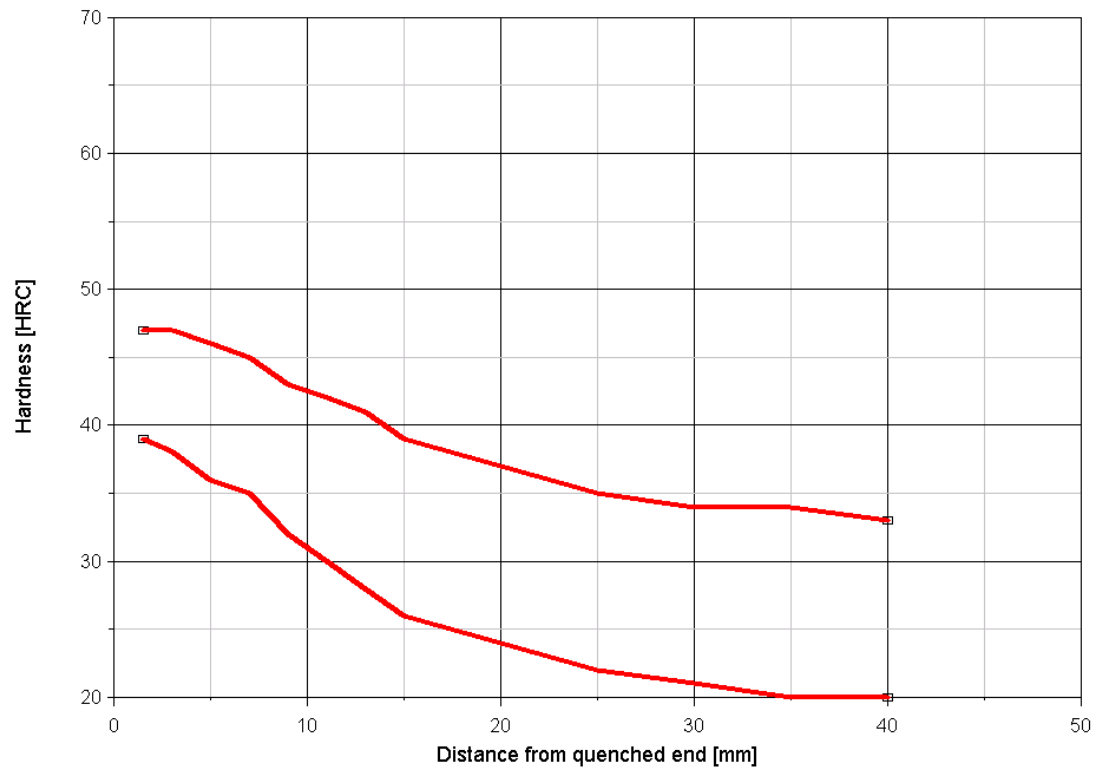
Time-temperature-transformation diagram for continuous cooling



Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 36CrNiMo4

Material No.:	Former brand name:	International steel grades:
1.6511	Monix 10	BS: 817M37 AFNOR: 35NCD5, 40NCD3 SAE: 4340, 9840

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	Ni	other
	0,36	0,25	0,65	1,05	0,20	1,05	(Pb)

Application: Heat treatable steel for high strained automotive and motor construction components with a typical tensile strength range of 900 - 1200 N/mm².

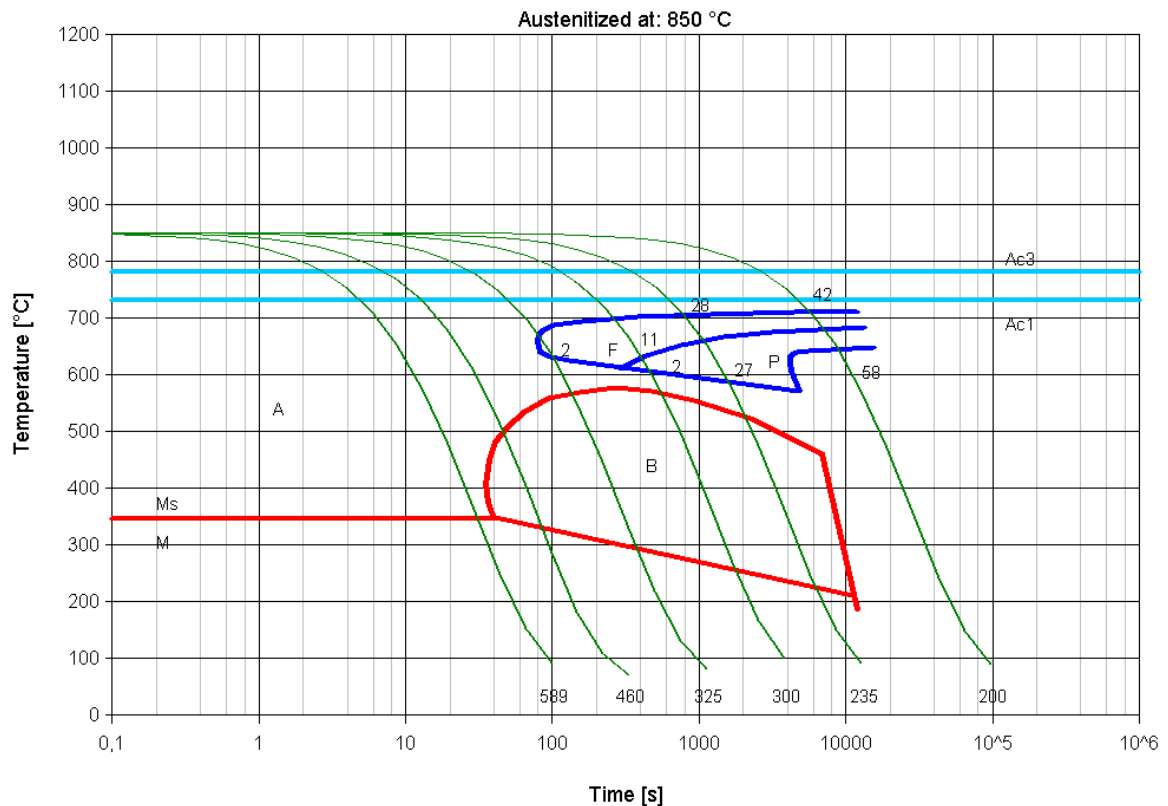
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 680°C/furnace
	Hardening:	820 - 850°C/oil, water
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	See condition A
	Soft annealed +A:	max. 248 HB

Quenched and tempered, +QT:

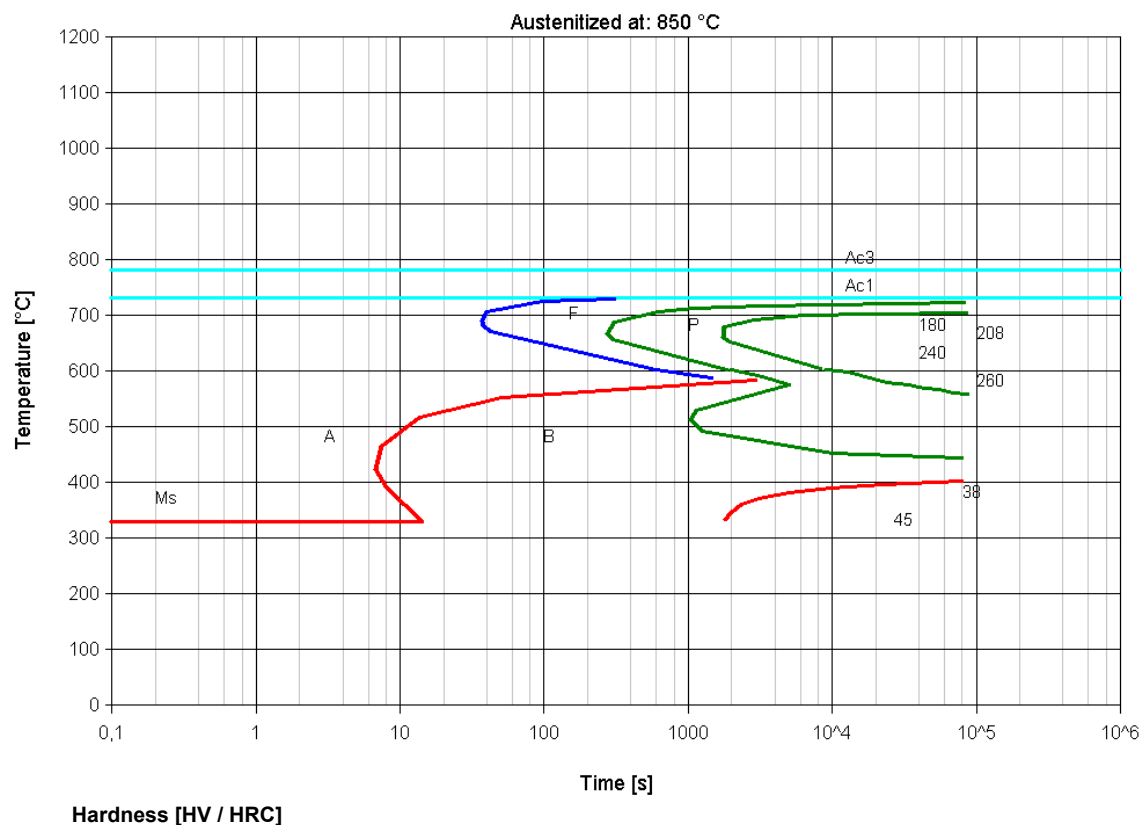
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 900	min. 800	min. 700	min. 600	min. 550
Tensile strength R _m [N/mm ²]	1100 - 1300	1000 - 1200	900 - 1000	800 - 950	750 - 900
Fracture elongation A ₅ [%]	min. 10	min. 11	min. 12	min. 13	min. 14
Reduction of area Z [%]	min. 45	min. 50	min. 55	min. 60	min. 60
Notch impact energy ISO-V [J]	min. 35	min. 40	min. 45	min. 45	min. 45

Time-temperature-transformation diagram for continuous cooling



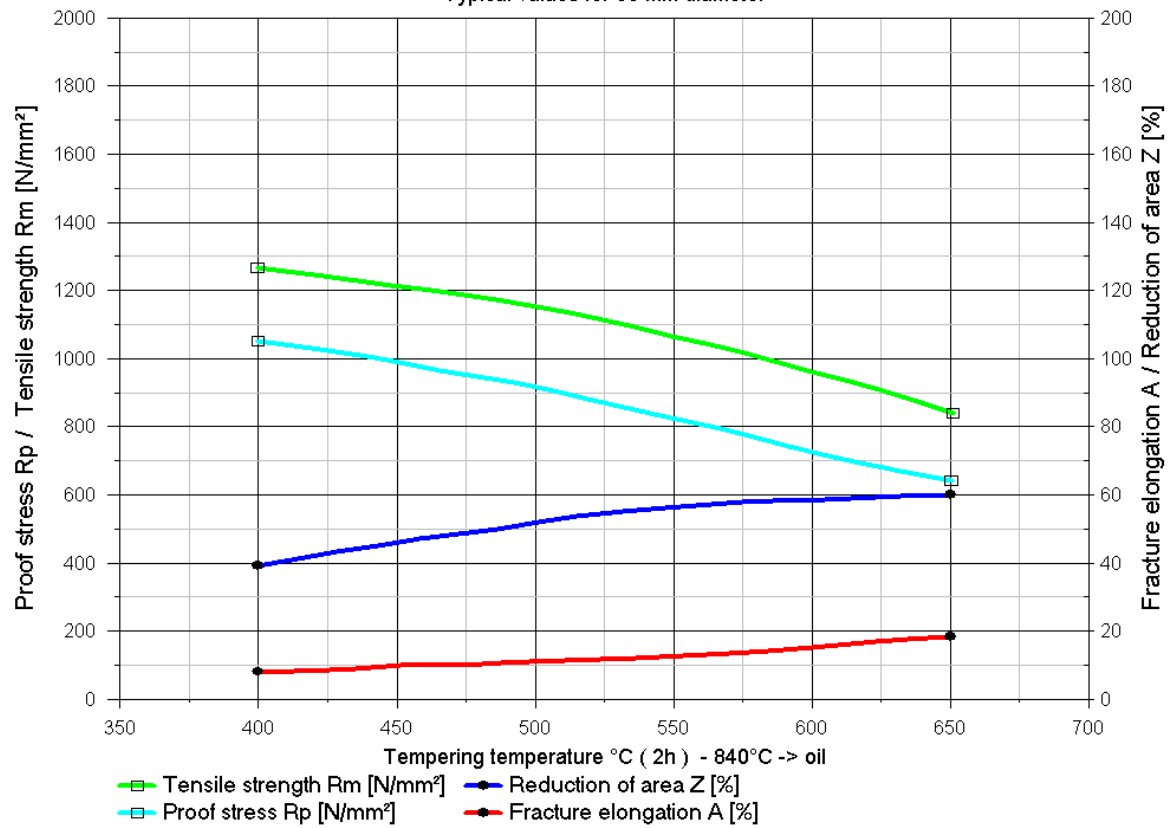
Hardness HV	589	460	325	300	235	200
Lambda-Value	0,15	0,40	1,5	6,5	10°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

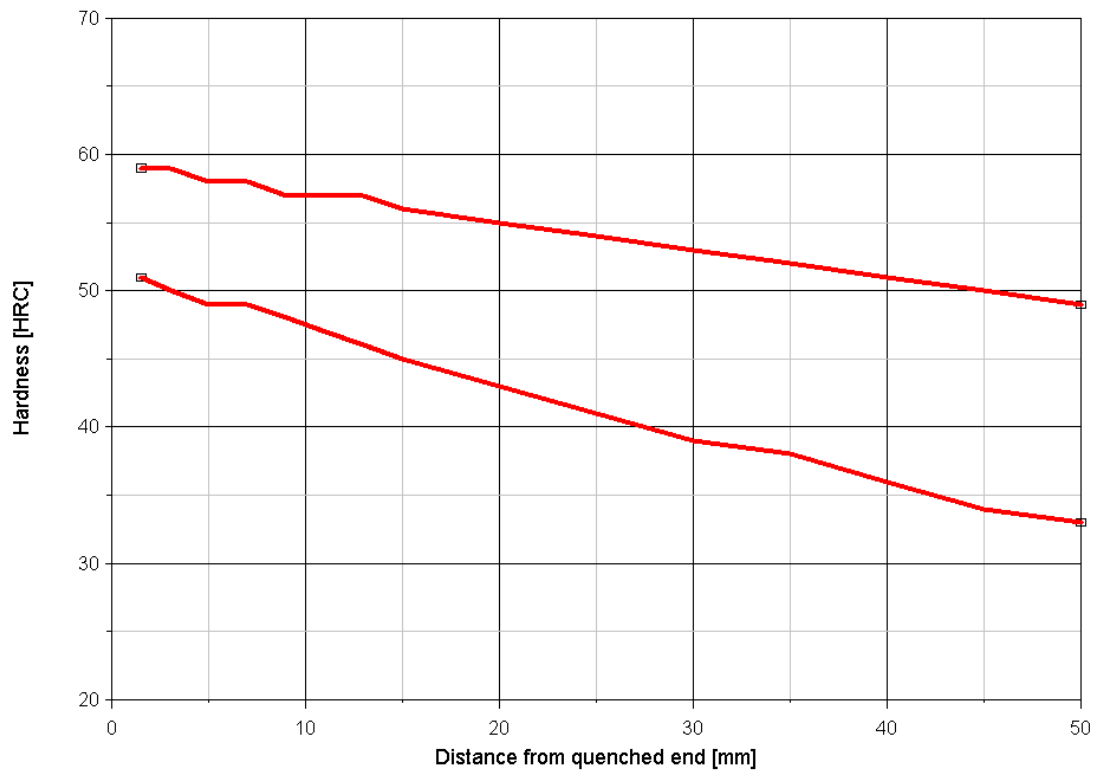


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 20NiCrMo2-2 (21NiCrMo2) - 20NiCrMoS2-2

Material No.:	Former brand name:	International steel grades:	
1.6523	Monix E	BS:	805M20, 806M20
1.6525		AFNOR:	20NCD2, 22NCD2
		SAE:	8620

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	Ni	other
	0,21	0,25	0,75	0,50	0,20	0,55	(Pb)

Application: Alloyed case hardening steel for very high strained parts and good toughness at core tensile strength of 700 - 900 N/mm². Driving bevel gears, crown wheels, gears, shafts, bolts for automotive and gear components. Suitable for direct hardening.

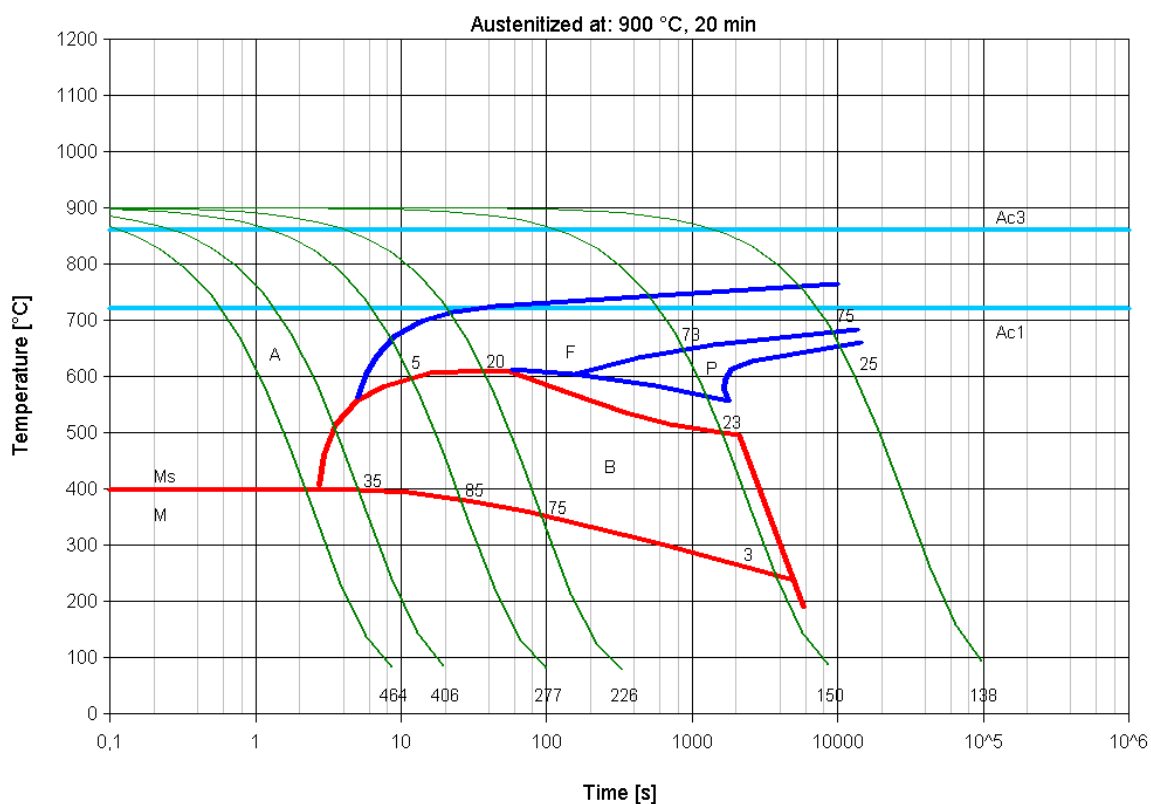
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	860 - 900°C/oil, water
	Intermediate annealing:	630 - 650°C
	Case hardening:	780 - 820°C/oil, water
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	Shearable in as rolled condition
	Soft annealed, +A:	max. 212 HB
	Treated for strength, +TH:	161 - 212 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	149 - 194 HB

after hardening and tempering at 200°C:

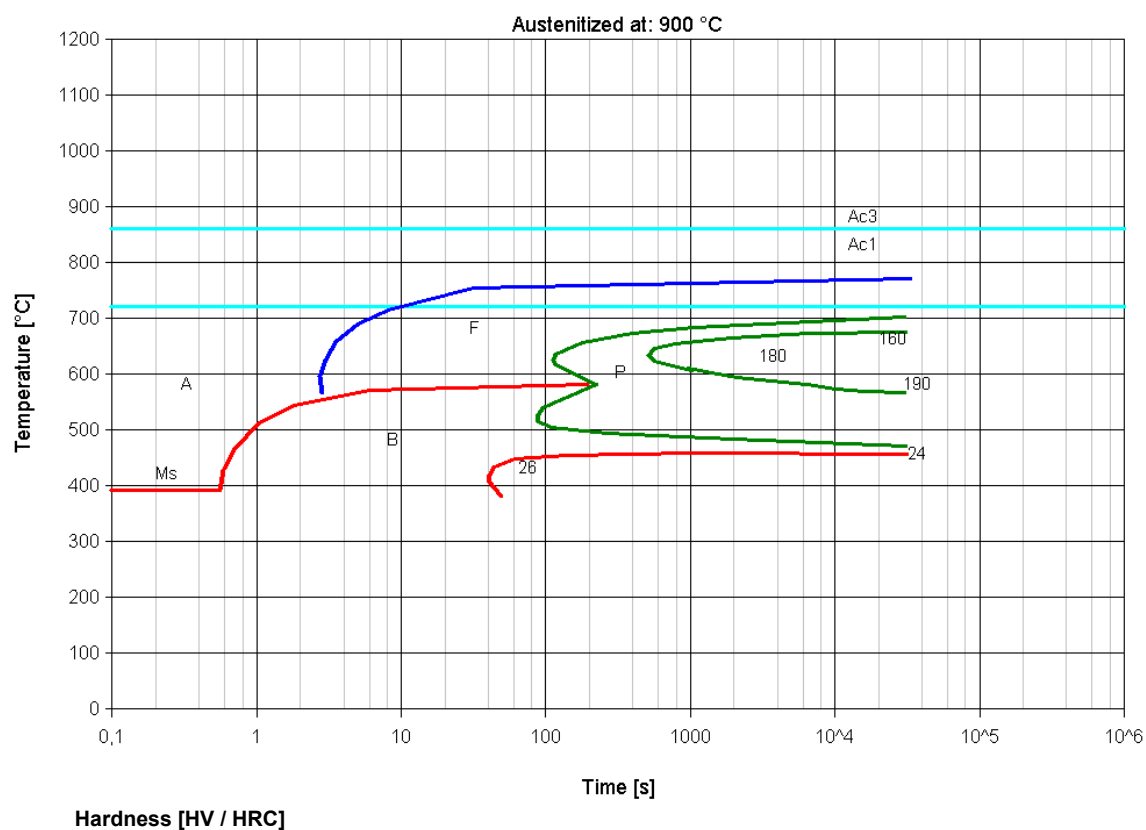
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1100	min. 800	min. 700

Time-temperature-transformation diagram for continuous cooling

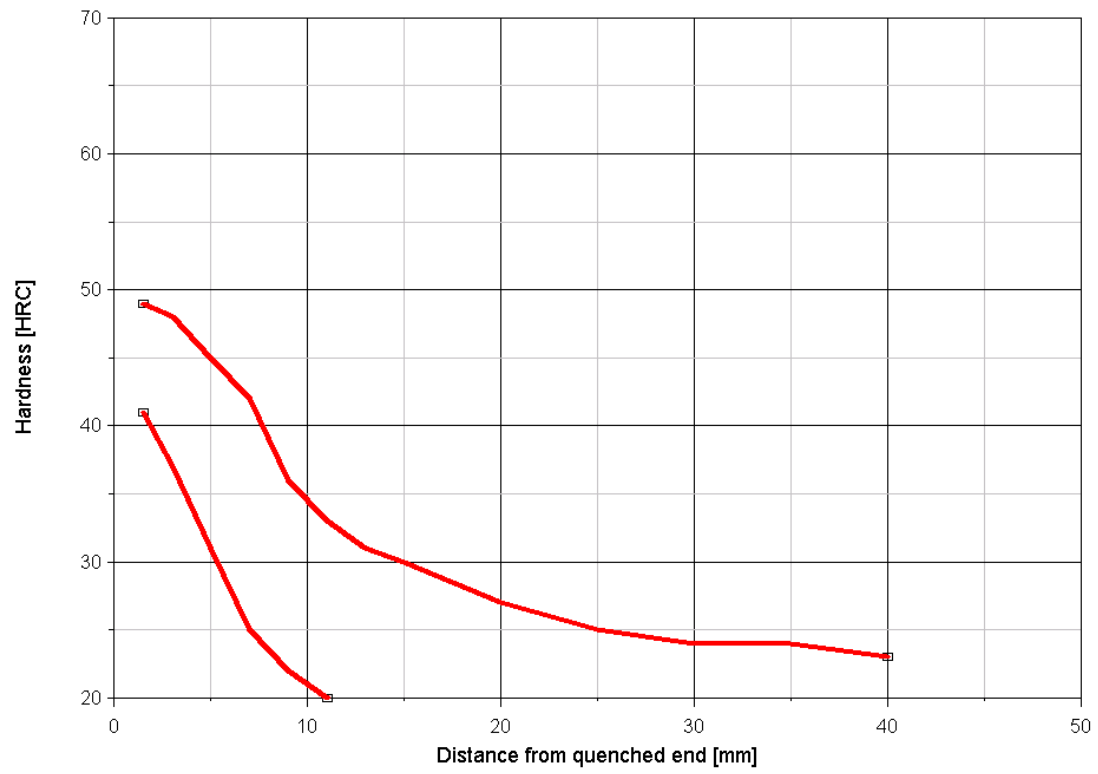


Hardness HV	464	406	277	226	150	138
Lambda-Value	0,013	0,03	0,15	0,50	20°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 23MnNiCrMo5-2

Material No.:

Former brand name:

International steel grades:

1.6541

BS:

AFNOR:

SAE:

Material group:

Steel for welded round link chains according to DIN 17115

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	N	Cr	Cu	Mo	Ni
	0,20 0,26	<0,25	1,10 1,40	<0,020	<0,020	0,012	0,40 0,60	<0,25	0,20 0,30	0,40 0,70

Application:

Hot rolled steel bars, wire rod, or bright steel for processing welded round link chains.

Hot forming and heat treatment:

Soft annealing:

650 - 720°C

Normalising:

860 - 900°C

Hardening:

870 - 890°C/water

Tempering:

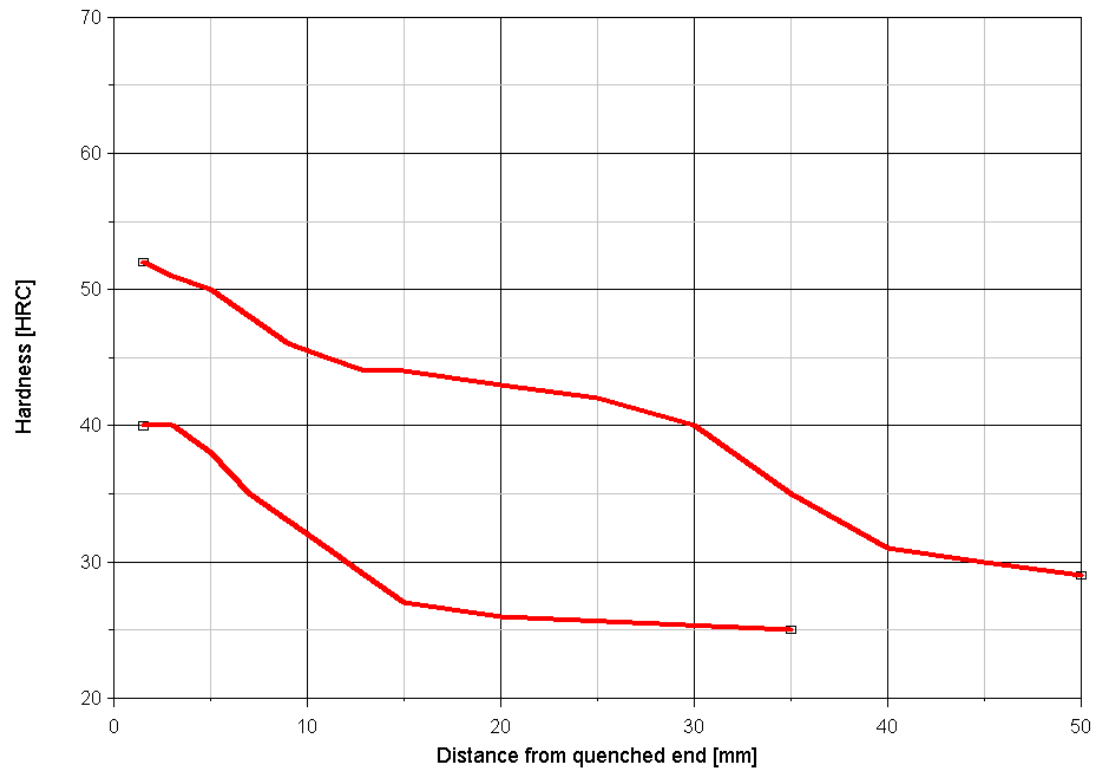
min. 400°C

Mechanical Properties:

Condition of delivery	Treated for cold shearability (C)	Soft annealed (G) or cold drawn + soft annealed (K+G)	Cold drawn + soft annealed + cold drawn (K+G+K)	Spheroidized annealed (GKZ) or cold drawn + spheroidized annealed (K+GKZ)	Cold drawn + spheroidized annealed + cold drawn (K+GKZ+K)
Tensile strength R_m [N/mm ²]	max. 860	max. 790	max. 930	max. 710	max. 850
Hardness [HB30]	max. 255	max. 235	max. 275	max. 210	max. 250
Hardness [HV10]	max. 268	max. 247	max. 289	max. 221	max. 263

Condon of heat treatment	Quenched and tempered (V) for diameters up to max. 20 mm
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 980
Tensile strength R_m [N/mm ²]	min. 1180
Fracture elongation A_5 [%]	min. 10
Reduction of area Z [%]	min. 50
Notch impact energy ISO-V [J]	min. 40

Hardness scatter band



Material specification sheet

Saarstahl - 17NiCrMo6-4 (18NiCrMo6-4) - 17NiCrMoS6-4 - 20NiCrMoS6-4

Material No.: Former brand name: International steel grades:

1.6566

1.6569

1.6571

BS: 17NiCrMo6-4

AFNOR: 17NiCrMo6-4

SAE:

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	Mo	Ni
	0,14 0,20	<0,40	0,60 0,90	<0,035	<0,035	0,80 1,10	0,15 0,25	1,20 1,50

Application: Alloyed case hardening steel.

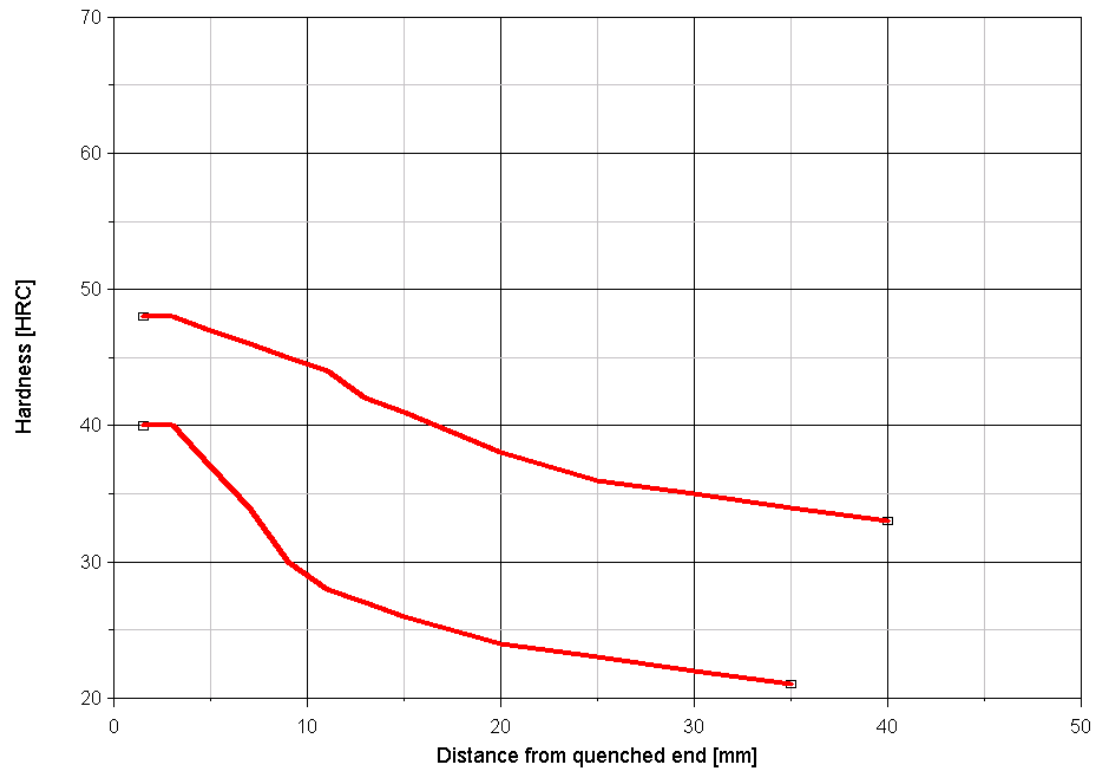
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	830 - 870°C
	Soft annealing:	650 - 700°C
	Carburising:	880 - 980°C
	Core hardening:	830 - 870°C
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	max. 255 HB
	Soft annealed, +A:	max. 229 HB
	Treated for strength, +TH:	179 - 229 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	149 - 201 HB

after hardening and tempering at 200°C:

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm²]	min. 1200	min. 1000	min. 900

Hardness scatter band



Material specification sheet

Saarstahl - 34CrNiMo6

Material No.:	Former brand name:	International steel grades:
1.6582	Monix 15	BS: 817M40, 816M40 AFNOR: 34CrNiMo8, 35NCD6 SAE: 4337, 4340

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	Ni	other
	0,34	0,25	0,50	1,50	0,25	1,55	(Pb)

Application: Heat treatable steel for high strained automotive and motor construction components with a typical tensile strength range of 1000 - 1300 N/mm².

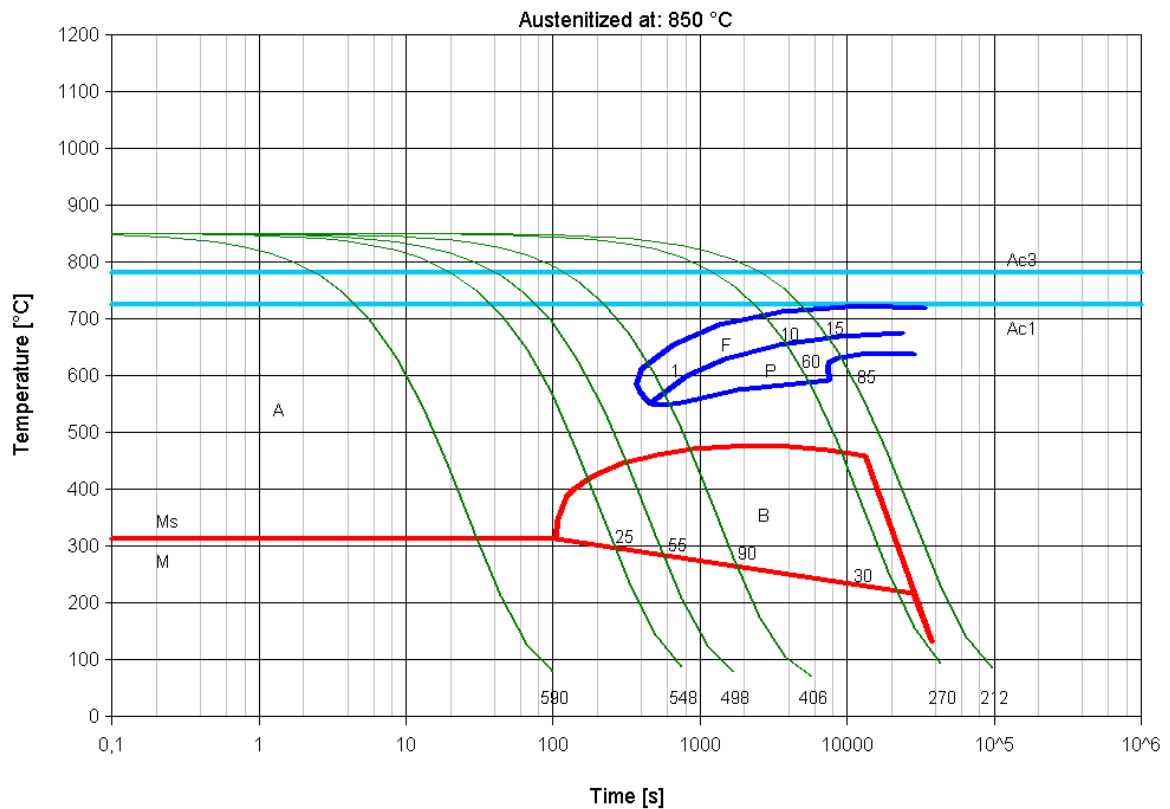
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 680°C/furnace
	Hardening:	830 - 860°C/oil
	Tempering:	540 - 660°C/air

Mechanical Properties:	Treated for cold shearability +S:	See condition A
	Soft annealed +A:	max. 248 HB

Quenched and tempered, +QT:

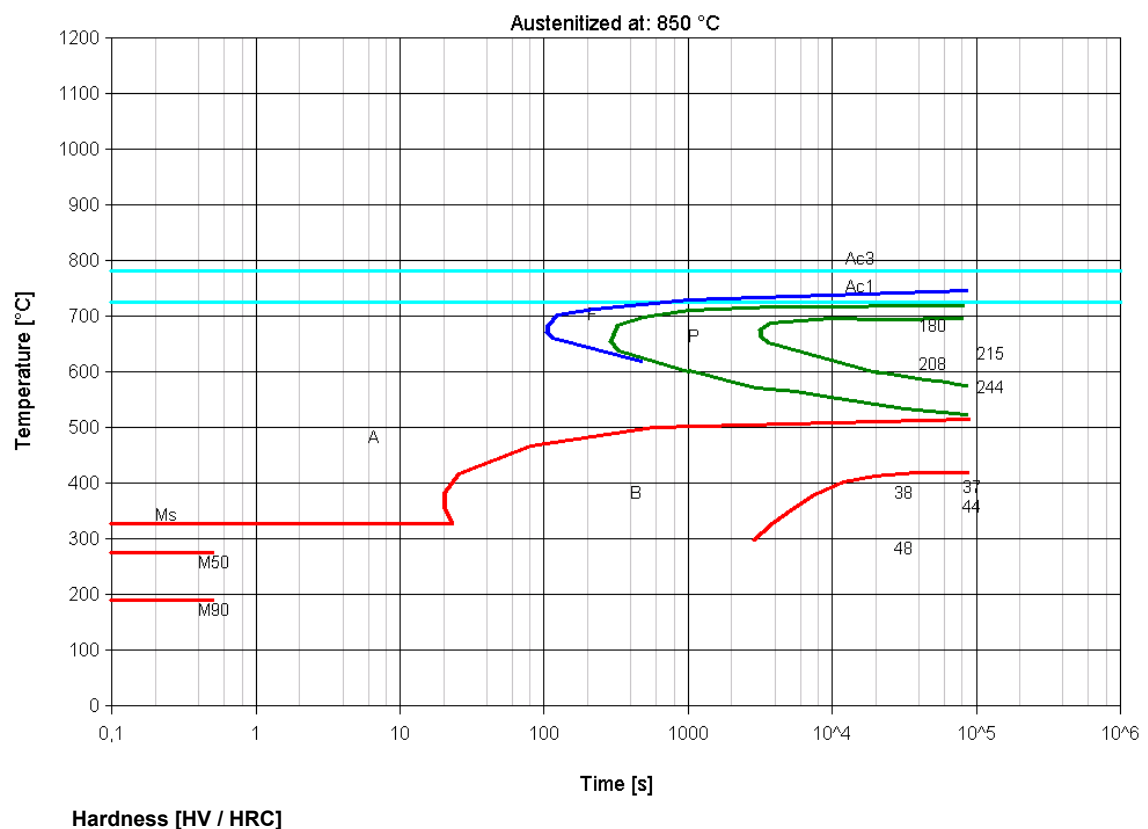
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 1000	min. 900	min. 800	min. 700	min. 600
Tensile strength R _m [N/mm ²]	1200 - 1400	1100 - 1300	1000 - 1200	900 - 1100	800 - 950
Fracture elongation A ₅ [%]	min. 9	min. 10	min. 11	min. 12	min. 13
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 55	min. 55
Notch impact energy ISO-V [J]	min. 35	min. 45	min. 45	min. 45	min. 45

Time-temperature-transformation diagram for continuous cooling



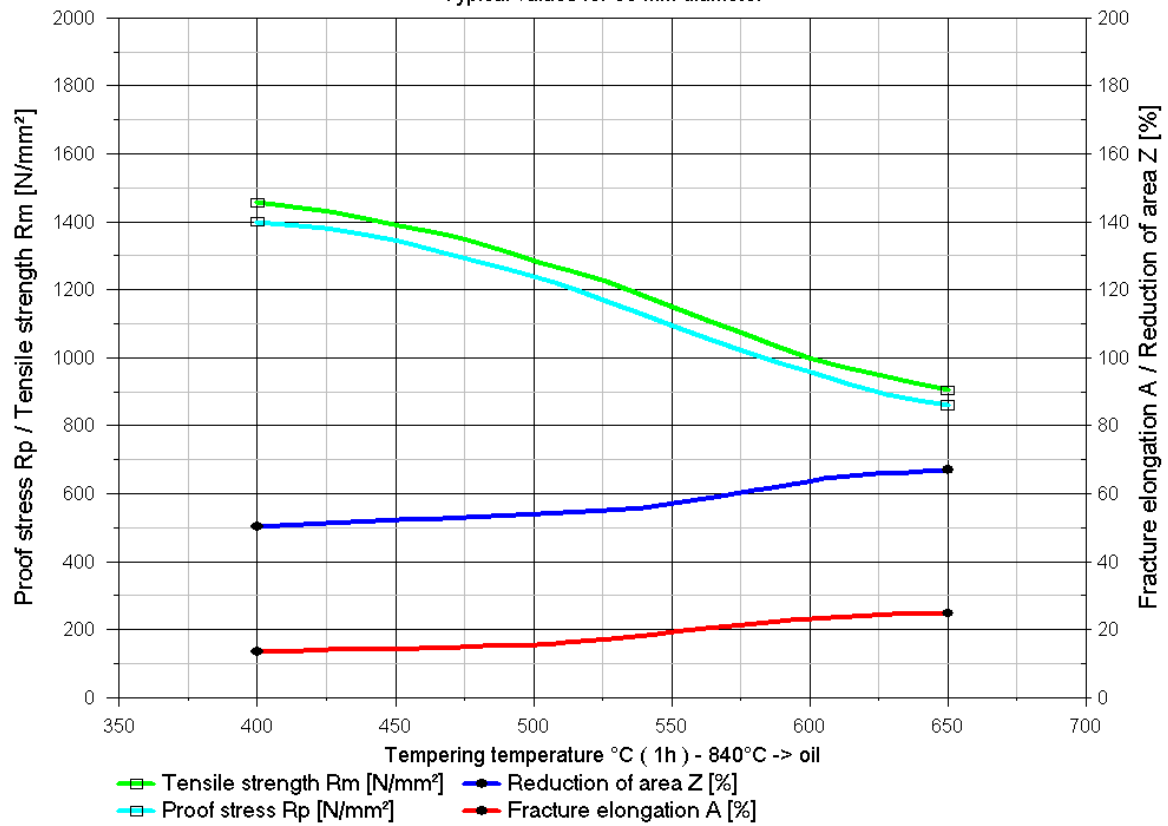
Hardness HV	590	548	498	406	270	212
Lambda-Value	0,15	1,1	2,3	6,8	2,5°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

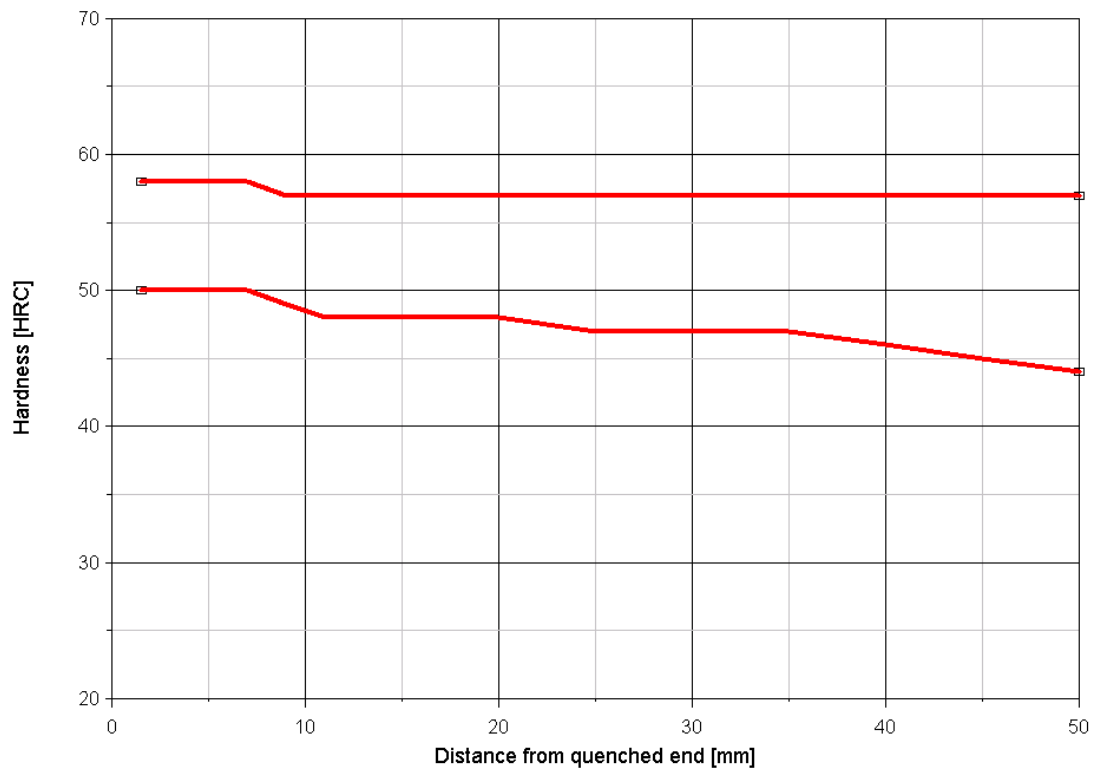


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 18CrNiMo7-6 (17CrNiMo6)

Material No.:	Former brand name:	International steel grades:
1.6587	Monix F	BS: AFNOR: 18NCD6 SAE:

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	Ni	other
	0,17	0,25	0,50	1,65	0,30	1,55	(Pb)

Application: Alloyed case hardening steel for heavy and high strained gear parts with high demands on toughness at core tensile strength of 1050 - 1350 N/mm².

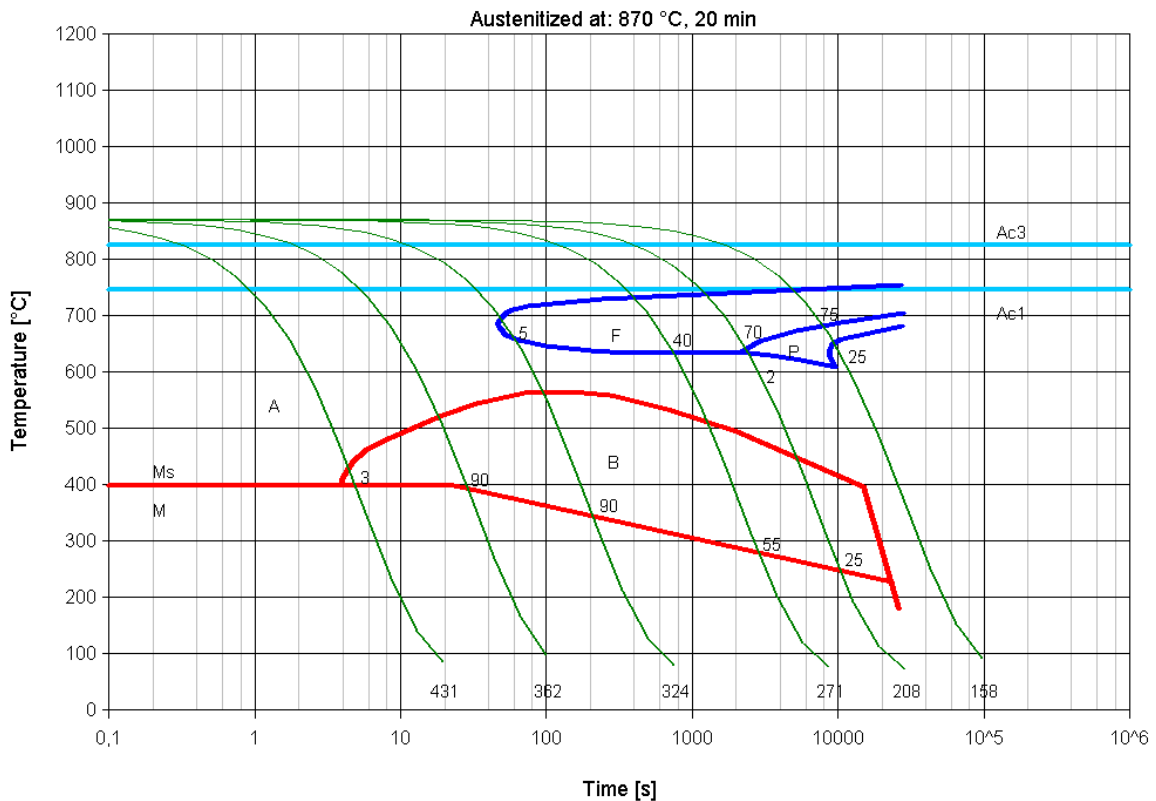
Hot forming and heat treatment:	Forging or hot rolling:	1150 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	830 - 870°C/water
	Intermediate annealing:	630 - 650°C
	Case hardening:	780 - 820°C/water
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	max. 255 HB
	Soft annealed, +A:	max. 229 HB
	Treated for strength, +TH:	179 - 229 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	159 - 207 HB

after hardening and tempering at 200°C:

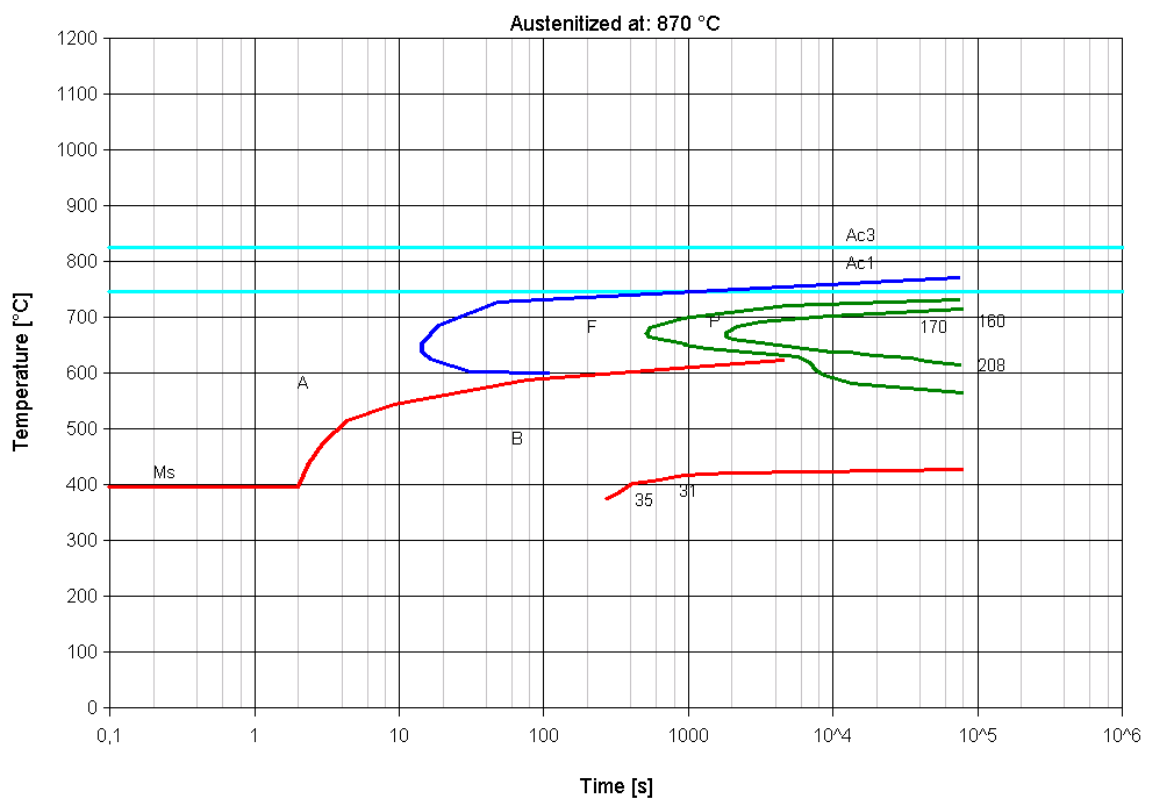
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1200	min. 1100	min. 900

Time-temperature-transformation diagram for continuous cooling



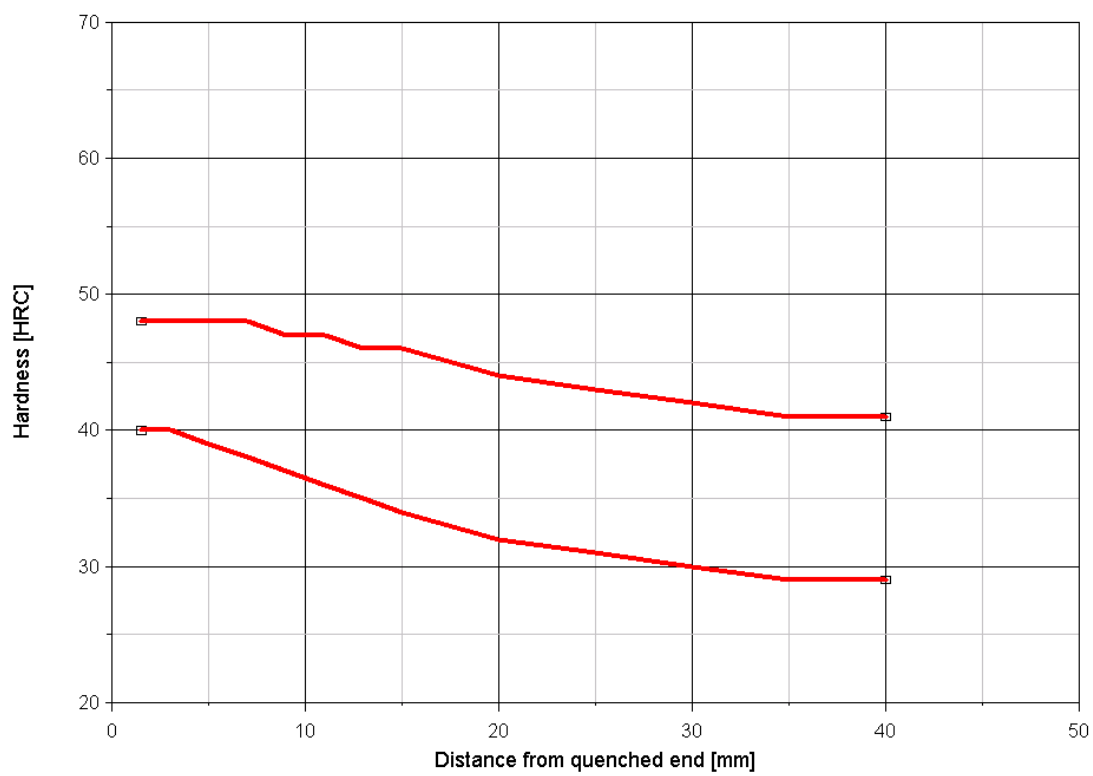
Hardness HV	431	362	324	271	208	158
Lambda-Value	0,03	0,15	1,0	6,5	5°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness [HV / HRC]

Hardness scatter band



Material specification sheet

Saarstahl - 15Cr3

Material No.:	Former brand name:	International steel grades:
1.7015	EC 60	BS: 523M15 AFNOR: 15C2 SAE: 5015

Material group: Alloyed case hardening steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	other
	0,15	0,25	0,50	0,60	(Pb)

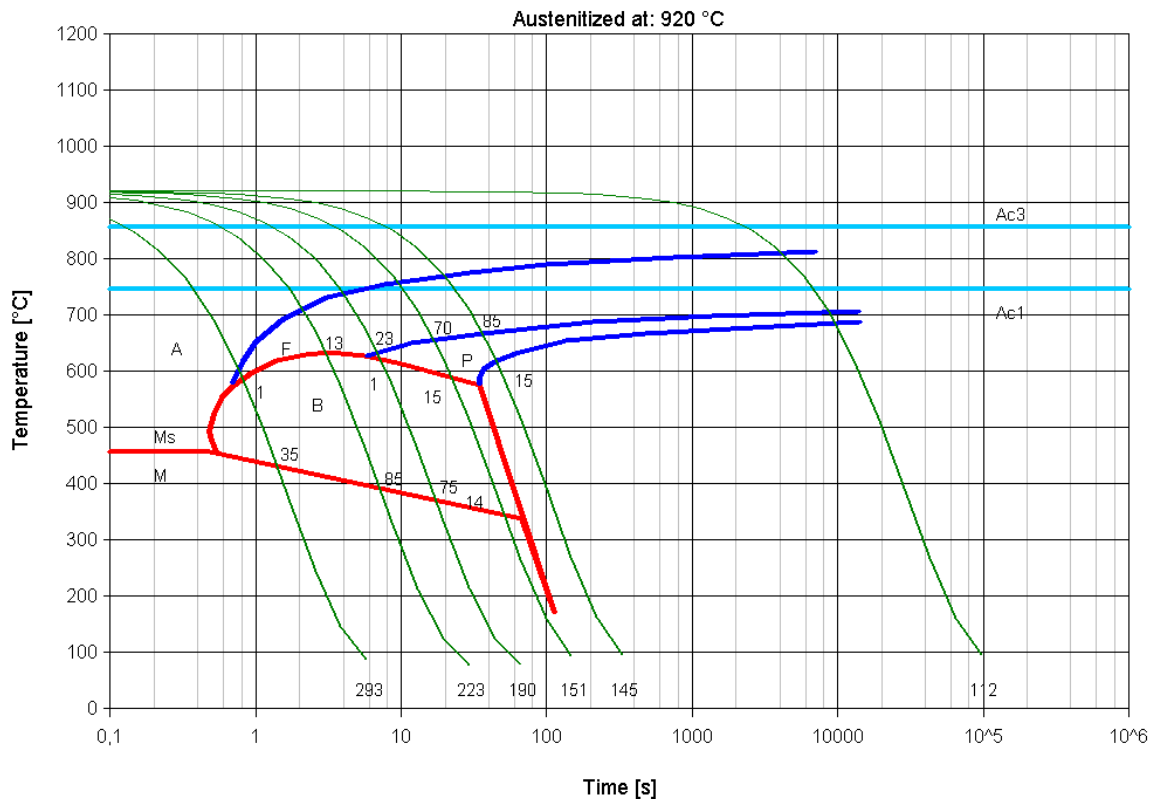
Application: Alloyed case hardening steel for parts with a required core tensile strength of 700 - 900 N/mm² and good wear resistance as bushes, piston pins, spindles, camshafts, gears, shafts, pinions steering and gear components. Suitable for direct hardening.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	870 - 930°C
	Core hardening:	870 - 900°C/water
	Intermediate annealing:	650 - 700°C
	Case hardening:	770 - 800°C/water
	Tempering:	150 - 180°C

Mechanical Properties:	Soft annealed, +A:	max. 174 HB
	Treated for strength, +TH:	126 - 174 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	118 - 160 HB
	Case hardness:	min. 59 HRC

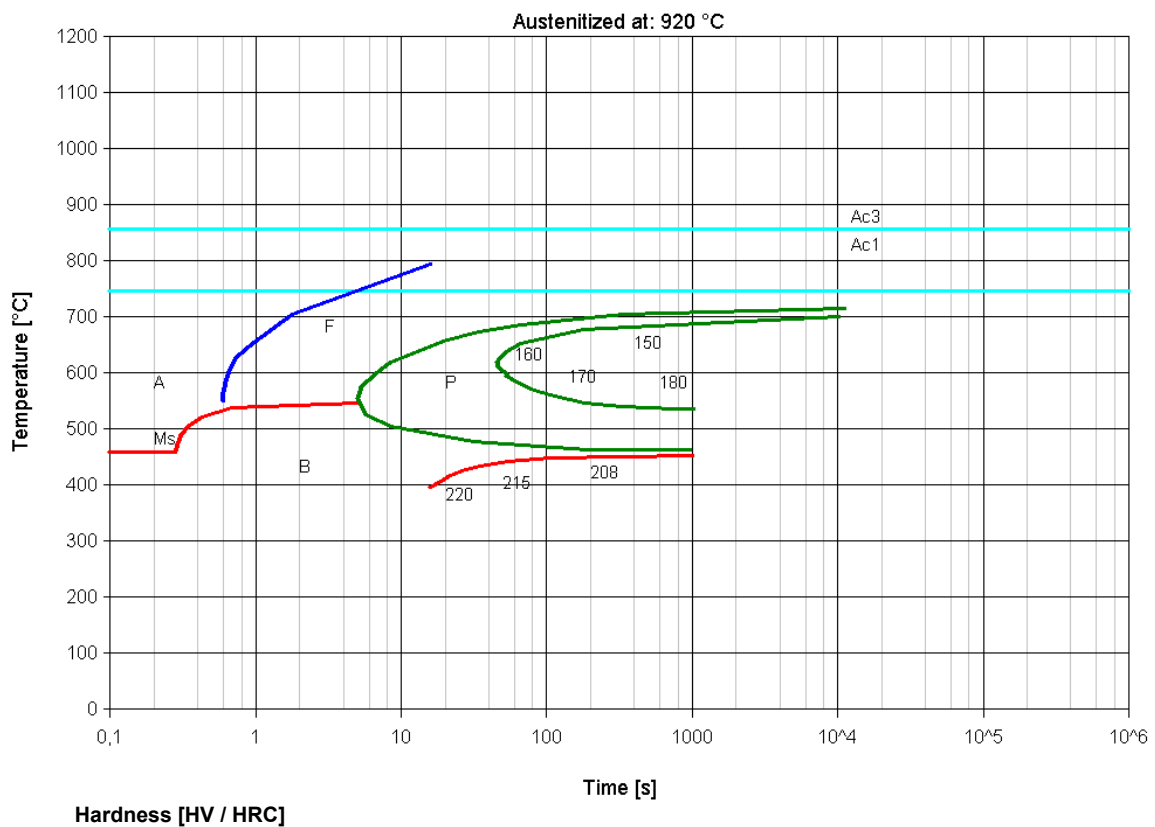
Diameter d [mm]	11	30
0,2% proof stress R _{p0,2} [N/mm ²]	min. 550	min. 440
Tensile strength R _m [N/mm ²]	1000 - 1300	700 - 900
Fracture elongation A _s [%]	min. 10	min. 11
Reduction of area Z [%]	min. 35	min. 40
Notch impact energy ISO-V [J]	min. 30	min. 40

Time-temperature-transformation diagram for continuous cooling

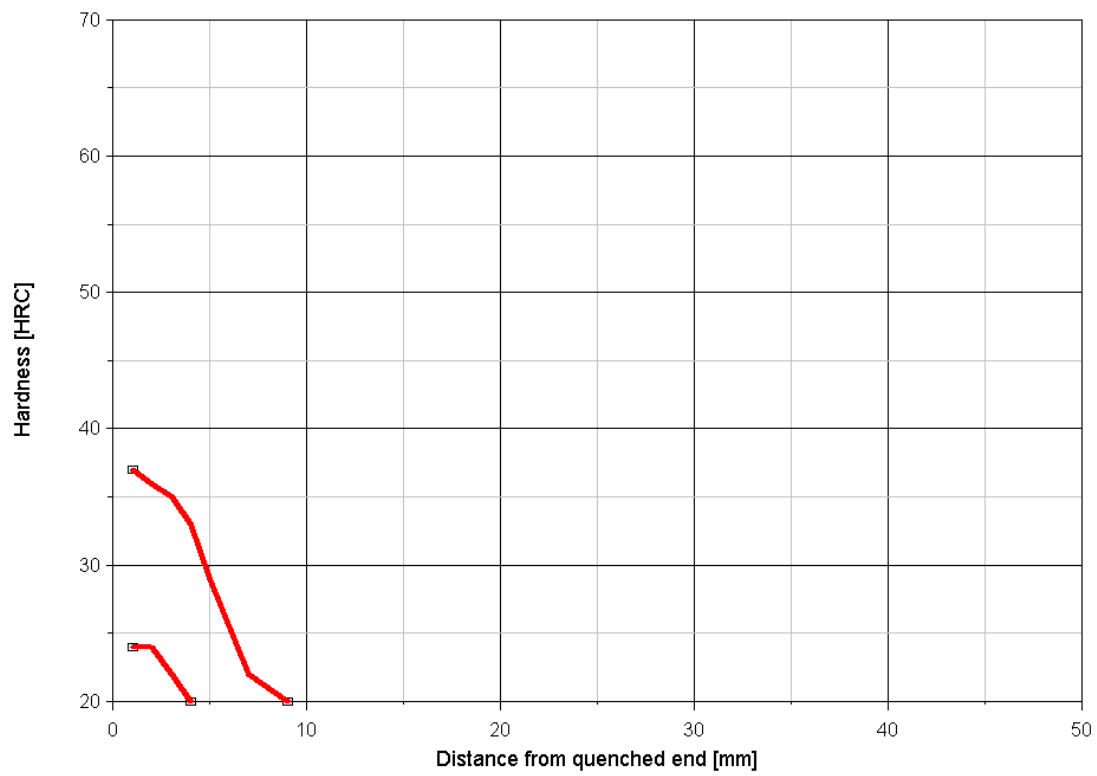


Hardness HV	293	223	190	151	145	112
Lambda-Value	0,008	0,042	0,08	0,23	0,52	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 17Cr3

Material No.:

Former brand name:

International steel grades:

1.7016

BS:

AFNOR: 18C3

SAE: 5117

Material group:

Case hardening steels according to DIN EN 10084

Chemical composition:

(Typical analysis in %)

C	Si	Mn	P	S	Cr
0,14 0,20	<0,40	0,60 0,90	<0,035	<0,035	0,70 1,00

Application:

Alloyed case hardening steel for parts with good wear resistance as boxes, driving gears, camshafts, pinions, spindles, gears.

Hot forming and heat treatment:

Forging or hot rolling:	1150 - 900°C
Normalising:	850 - 880°C
Soft annealing:	650 - 700°C
Carburising:	880 - 980°C
Core hardening:	860 - 900°C
Intermediate annealing:	650 - 700°C
Case hardening:	780 - 820°C
Tempering:	150 - 200°C

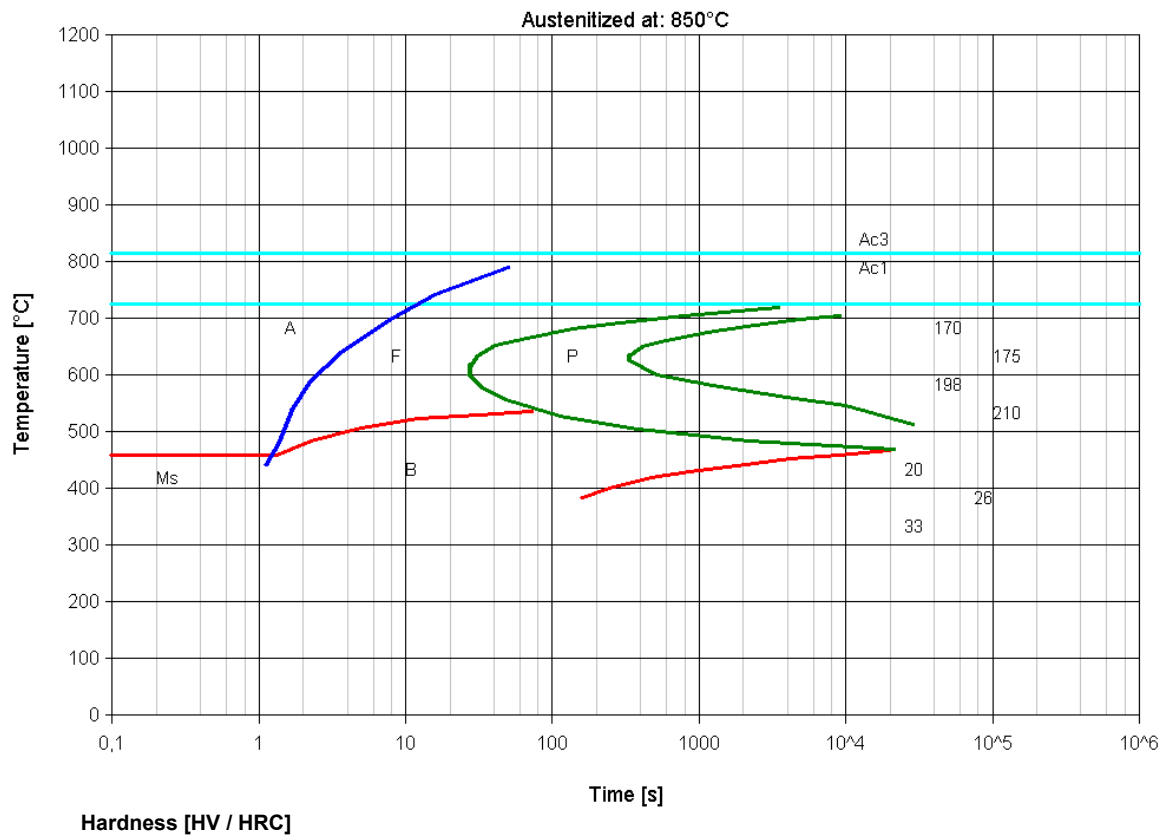
Mechanical Properties:

Treated for cold shearability, +S:	Shearable in as rolled condition
Soft annealed, +A:	max. 174 HB
Treated for strength, +TH:	-
Treated for ferrite and pearlite structure and hardness range, +FP:	-

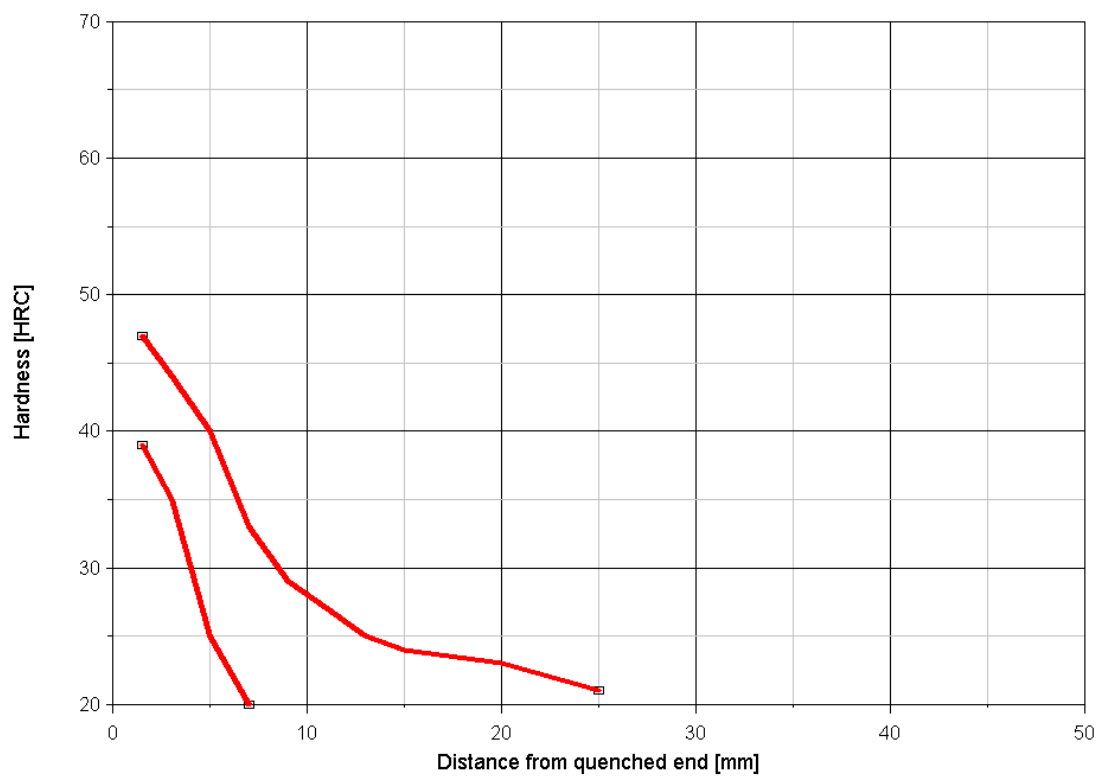
after hardening and tempering at 200°C

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 800	min. 700	-

Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 28Cr4 - 28CrS4

Material No.:	Former brand name:	International steel grades:
1.7030		BS: 530A30
		AFNOR:
1.7036		SAE: 5130

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr
	0,24 0,31	<0,40	0,60 0,90	<0,035	<0,035	0,90 1,20

Application: Alloyed case hardening steel

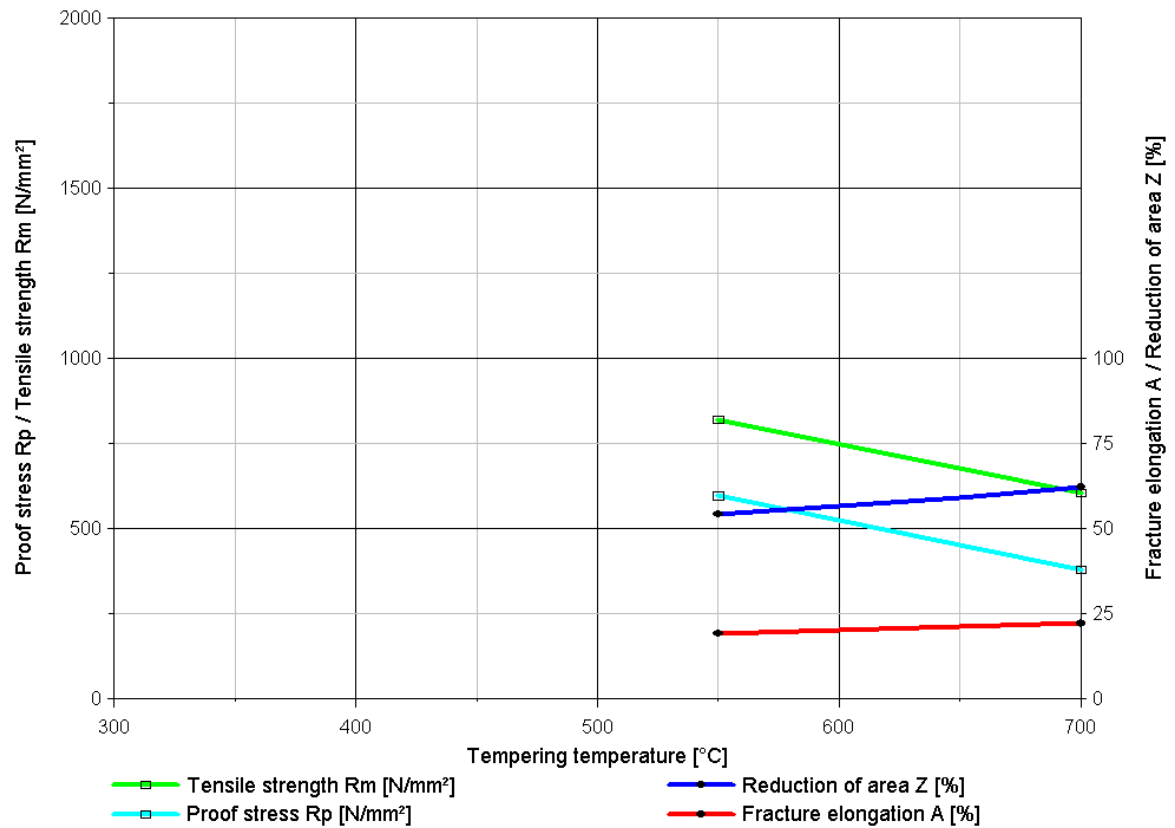
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 900°C
	Normalising:	860 - 900°C
	Soft annealing:	680 - 720°C
	Carburising:	880 - 980°C
	Core hardening:	860 - 900°C
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	max. 255 HB
	Soft annealed, +A:	max. 217 HB
	Treated for strength, +TH:	166 - 217 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	156 - 207 HB

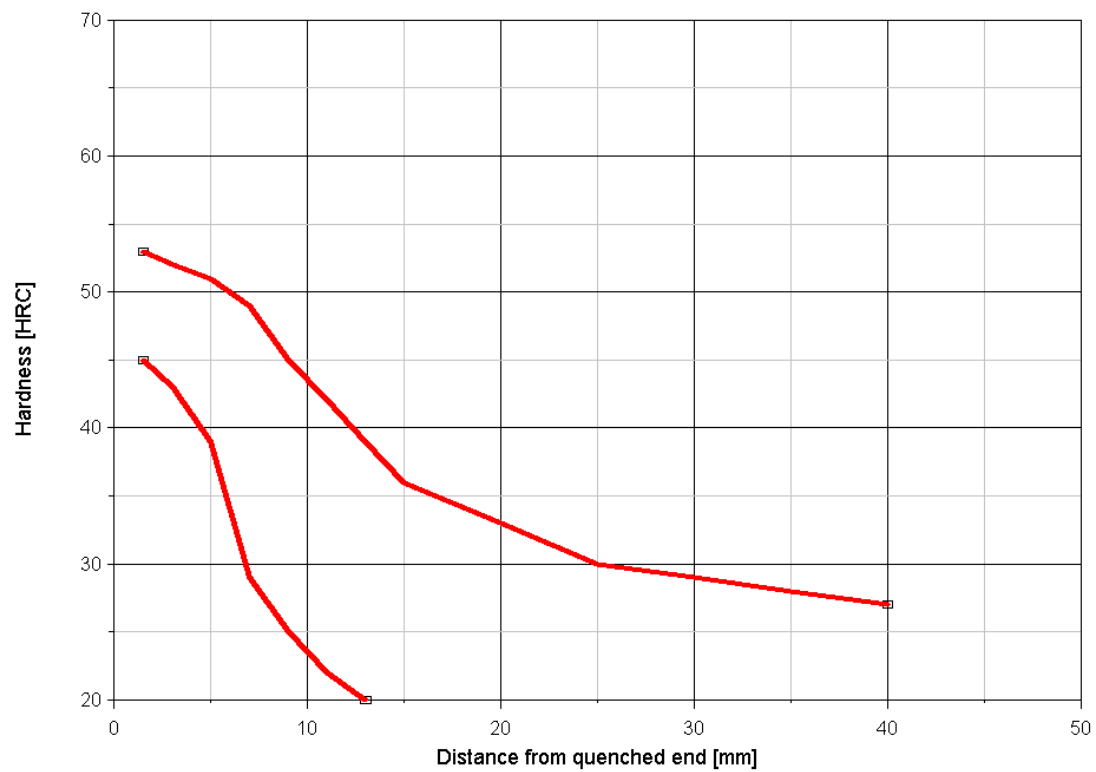
after hardening and tempering at 200°C:

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm²]	min. 900	min. 700	min. 700

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 34Cr4 - 34CrS4

Material No.:	Former brand name:	International steel grades:
1.7033	VC 135	BS: 530M32, 530A32, 530H32 AFNOR: 34Cr4, 32C4 SAE: 5132
1.7037		

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	S	other
	34Cr4	0,34	0,25	0,85	1,05	<0,035	(Pb)
	34CrS4	0,34	0,25	0,85	1,05	0,020 0,035	(Pb)

Application: Alloyed heat treatable steel with a required tensile strength of 700 - 950 N/mm² for driving elements as crankshafts, front vehicle axles, axle journals, steering components.

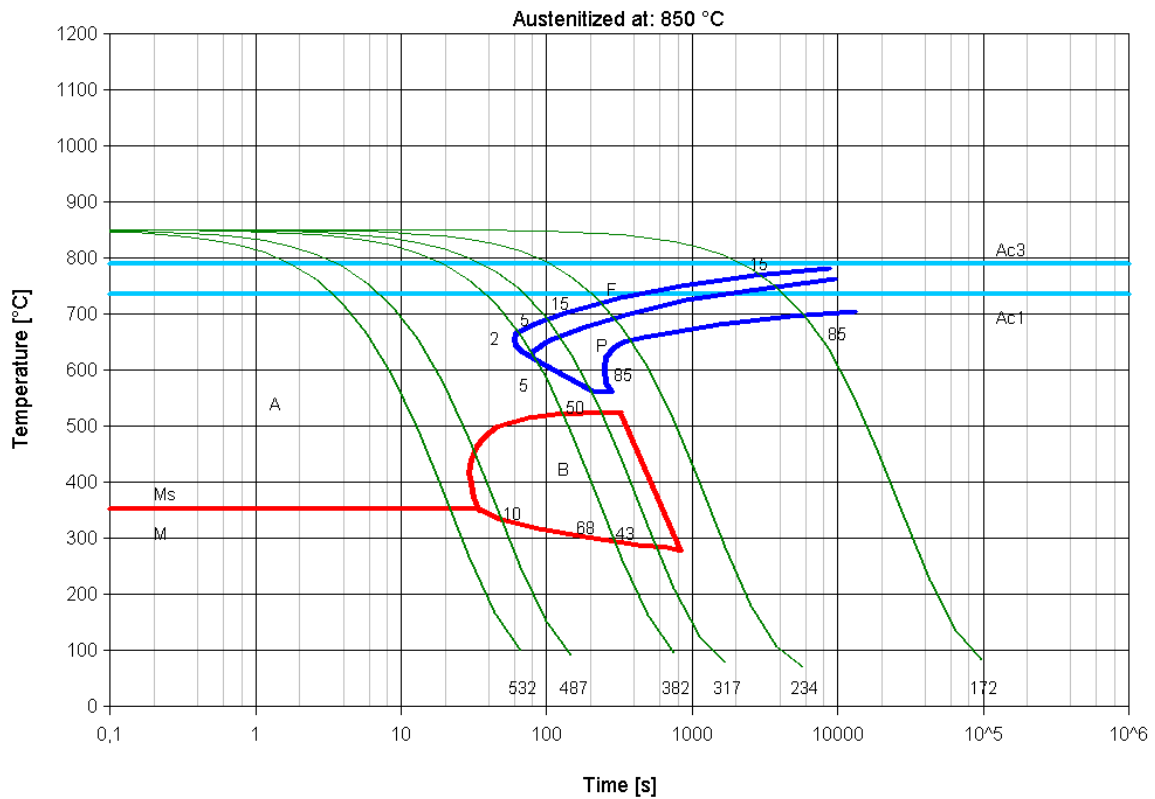
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	830 - 870°C/water, oil
	Tempering:	540 - 680°C

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 223 HB

Quenched and tempered, +QT:

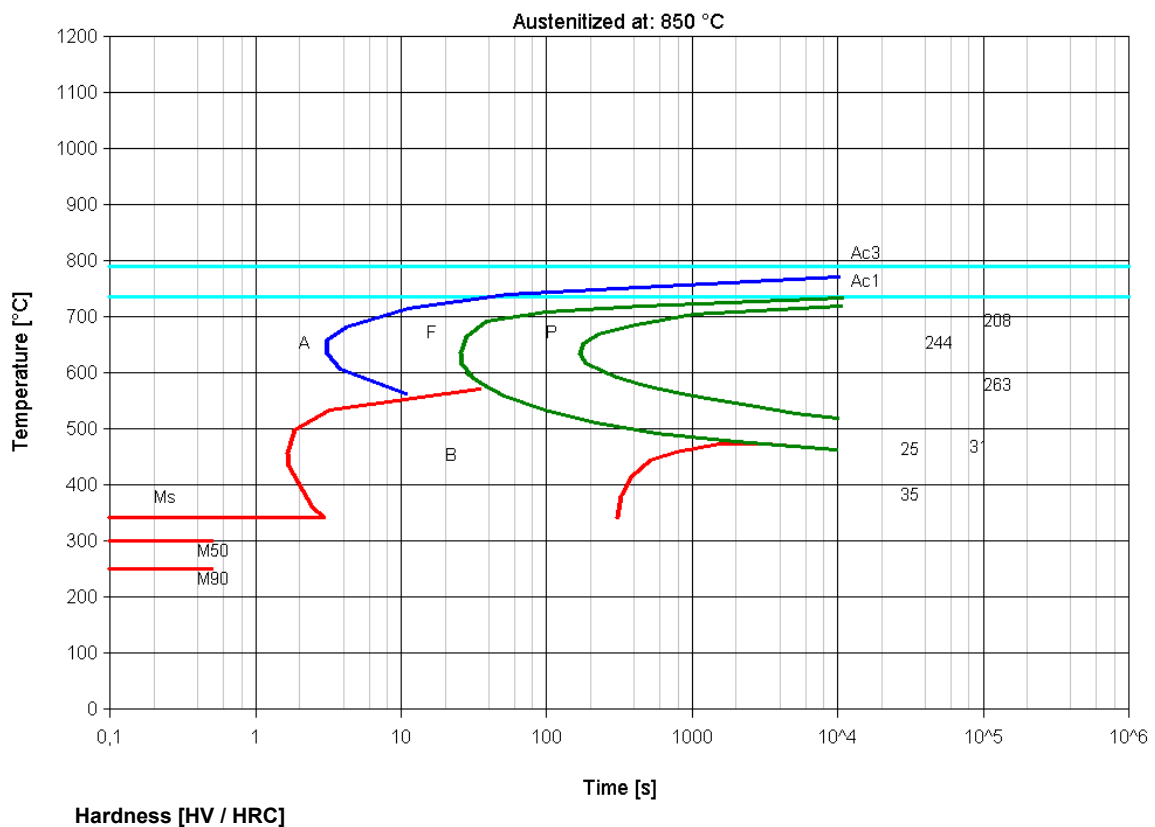
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 700	min. 590	min. 460	-	-
Tensile strength R _m [N/mm ²]	900 - 1100	800 - 950	700 - 850	-	-
Fracture elongation A ₅ [%]	min. 12	min. 14	min. 15	-	-
Reduction of area Z [%]	min. 35	min. 40	min. 45	-	-
Notch impact energy ISO-V [J]	min. 35	min. 40	min. 40	-	-

Time-temperature-transformation diagram for continuous cooling

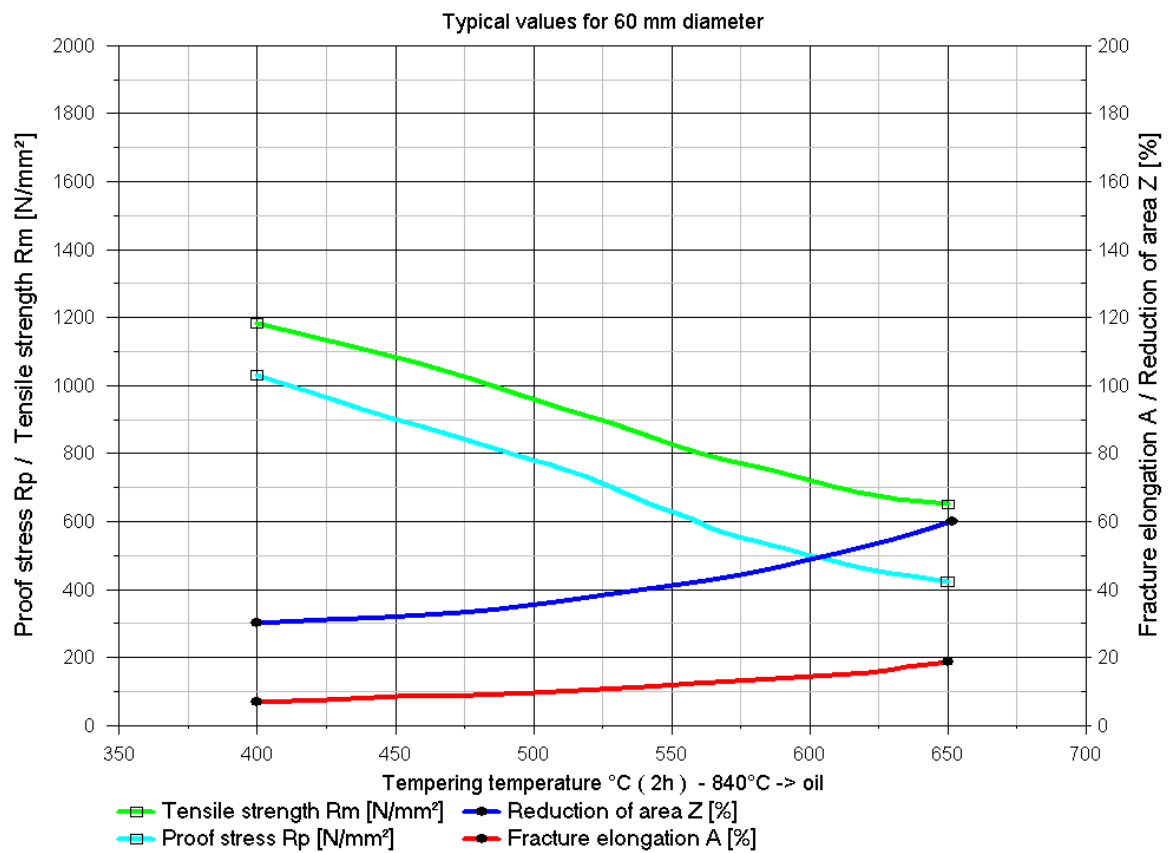


Hardness HV	532	487	382	317	234	172
Lambda-Value	0,12	0,22	1,2	2,3	7,7	1,25°/min

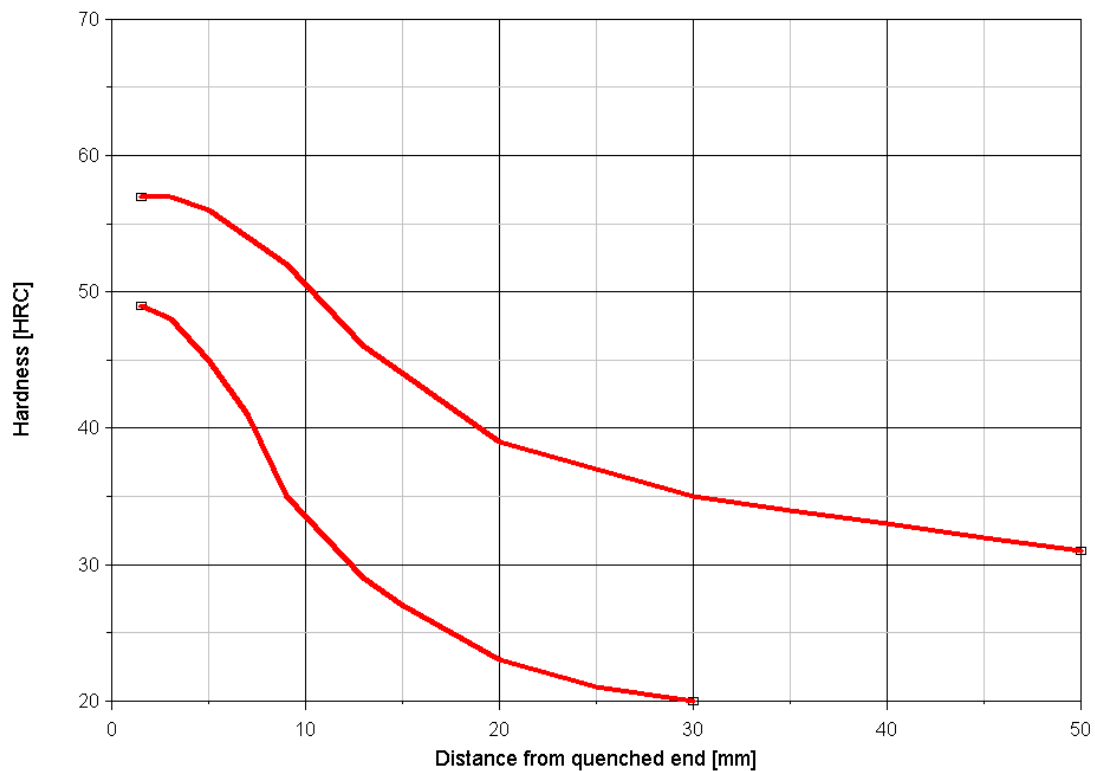
Time-temperature-transformation diagram for isothermal cooling



Tempering diagram (Typical values for 60 mm diameter)



Hardness scatter band



Material specification sheet

Saarstahl - 37Cr4 - 37CrS4

Material No.:	Former brand name:	International steel grades:
1.7034		BS: 530M36, 530A36, 530H36
		AFNOR: 38C4
1.7038		SAE: 5135

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	S
	37Cr4	0,37	0,25	0,70	1,05	<0,035
	37CrS4	0,37	0,25	0,70	1,05	0,020 0,040

Application: Heat treatable steel for driving elements as crankshafts, front vehicle axles, axle journals, steering components.

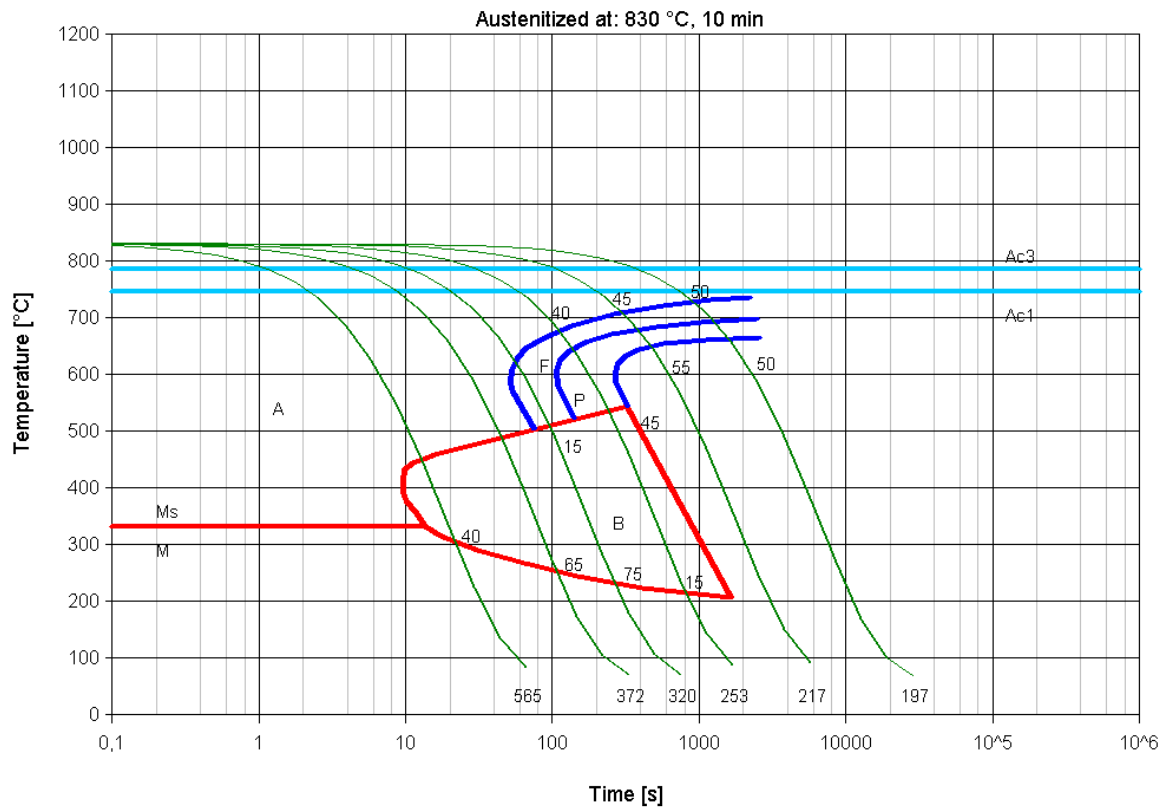
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	-
	Soft annealing:	680 - 720°C/furnace
	Hardening:	825 - 865°C/oil, water
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 235 HB

Quenched and tempered, +QT:

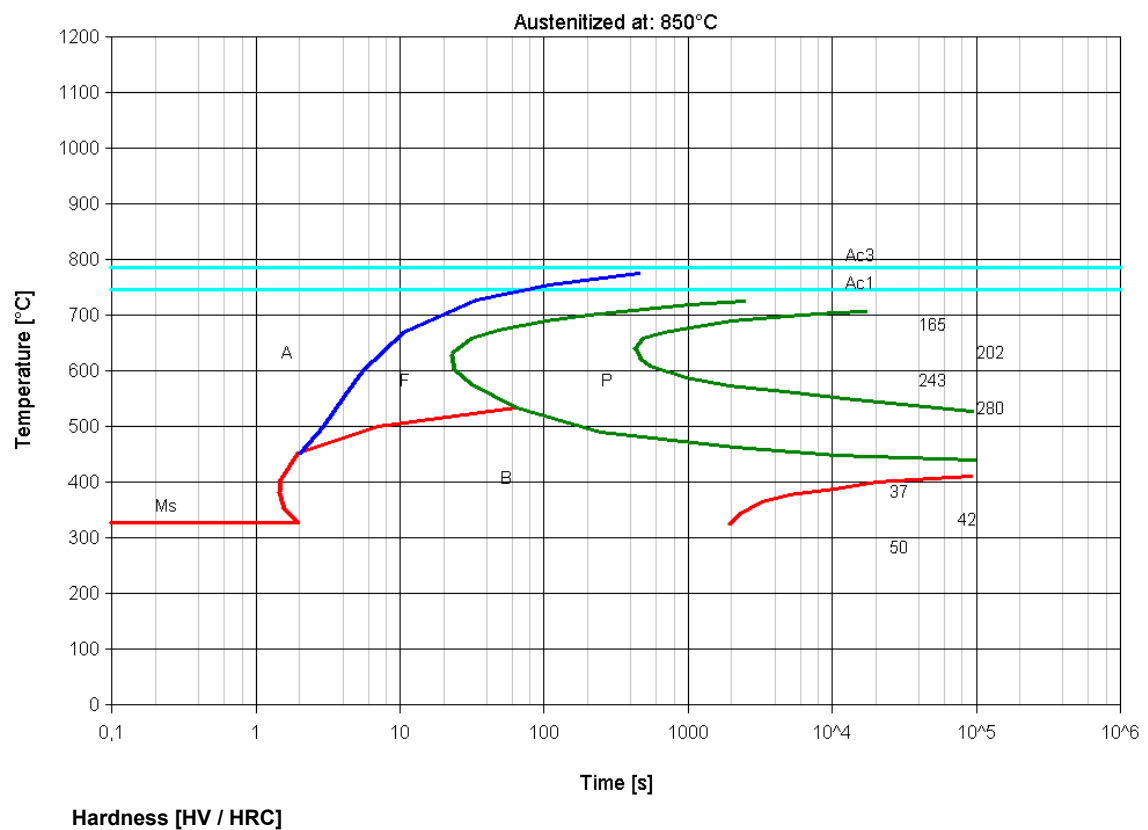
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 750	min. 630	min. 510	-	-
Tensile strength R _m [N/mm ²]	950 - 1150	850 - 1000	750 - 900	-	-
Fracture elongation A ₅ [%]	min. 11	min. 13	min. 14	-	-
Reduction of area Z [%]	min. 35	min. 40	min. 40	-	-
Notch impact energy ISO-V [J]	min. 30	min. 35	min. 35	-	-

Time-temperature-transformation diagram for continuous cooling

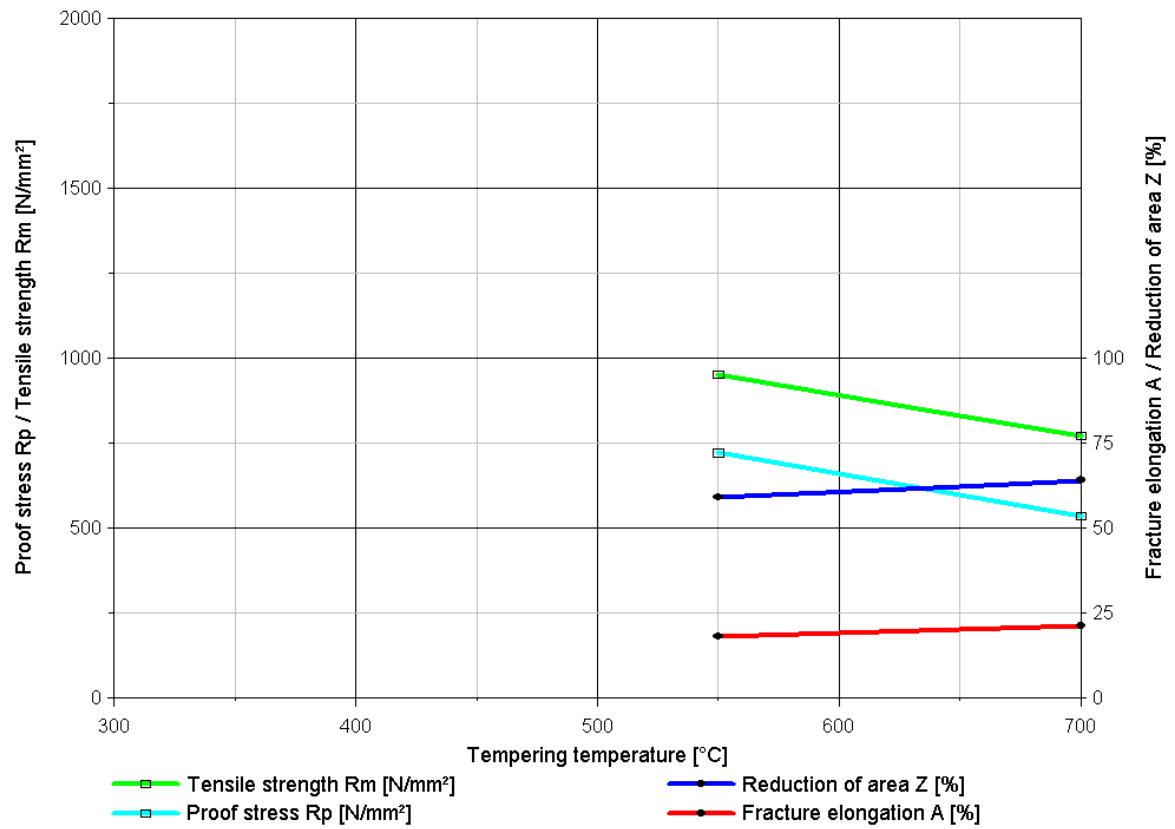


Hardness HV	565	372	320	253	217	197
Lambda-Value	0,10	0,40	0,92	2,59	8,93	5°/min

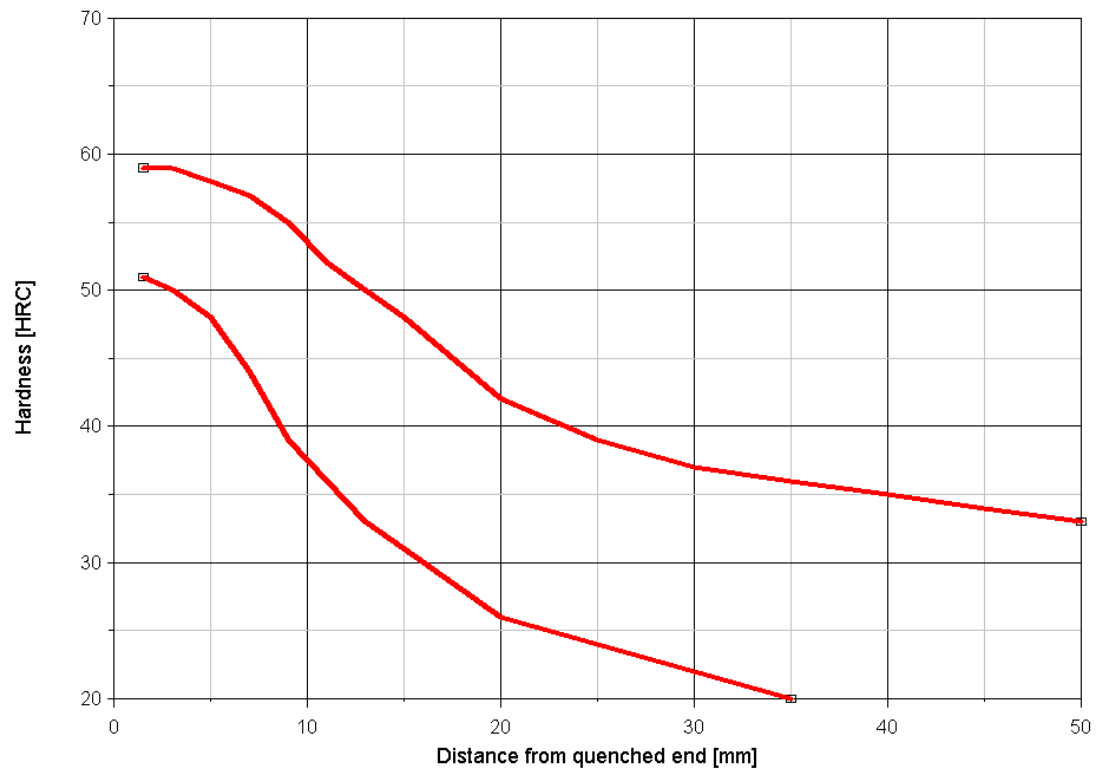
Time-temperature-transformation diagram for isothermal cooling



Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 41Cr4 - 41CrS4

Material No.:	Former brand name:	International steel grades:	
1.7035	VC 140	BS:	530M40, 530A40, 530H40
		AFNOR:	41Cr4, 42C4
1.7039		SAE:	5140

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	S	other
	41Cr4	0,42	0,25	0,70	1,05	<0,035	(Pb)
	41CrS4	0,42	0,25	0,70	1,05	0,020 0,035	(Pb)

Application: Heat treatable steel for driving elements as crankshafts, front vehicle axles, axle journals, steering components.

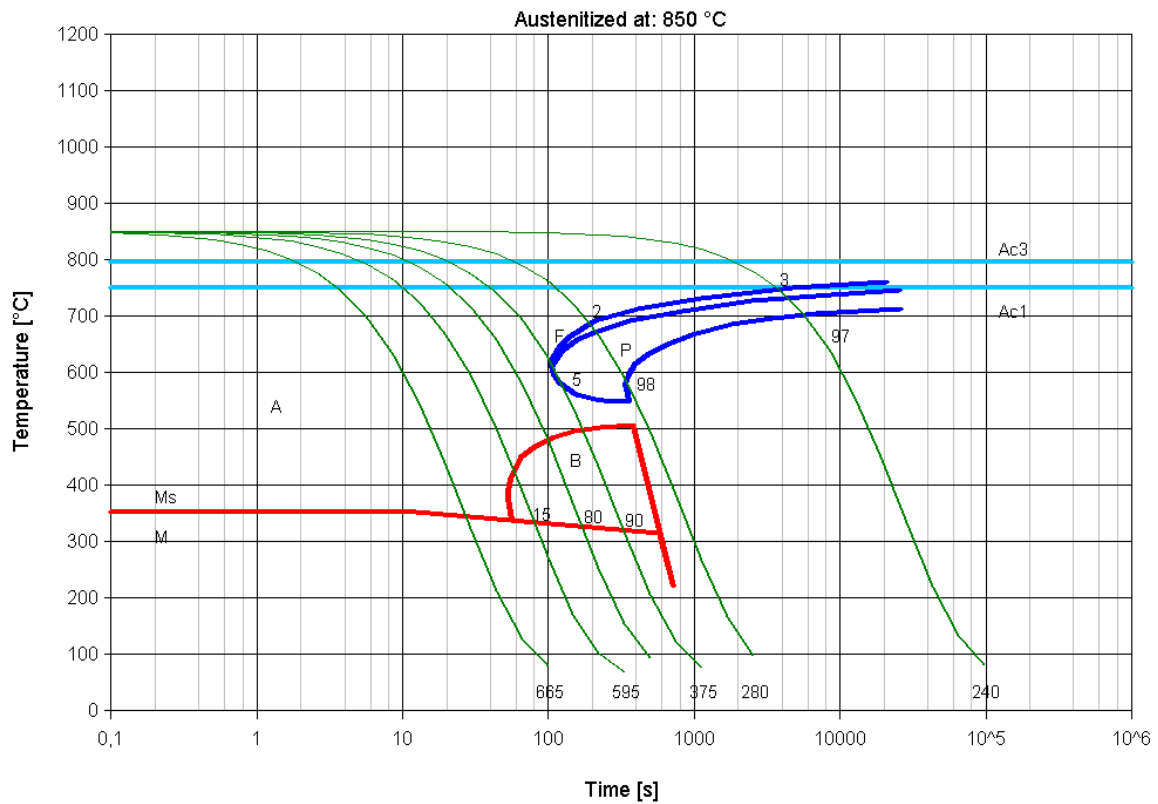
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	820 - 860°C/oil, water
	Tempering:	540 - 680°C

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 241 HB

Quenched and tempered, +QT:

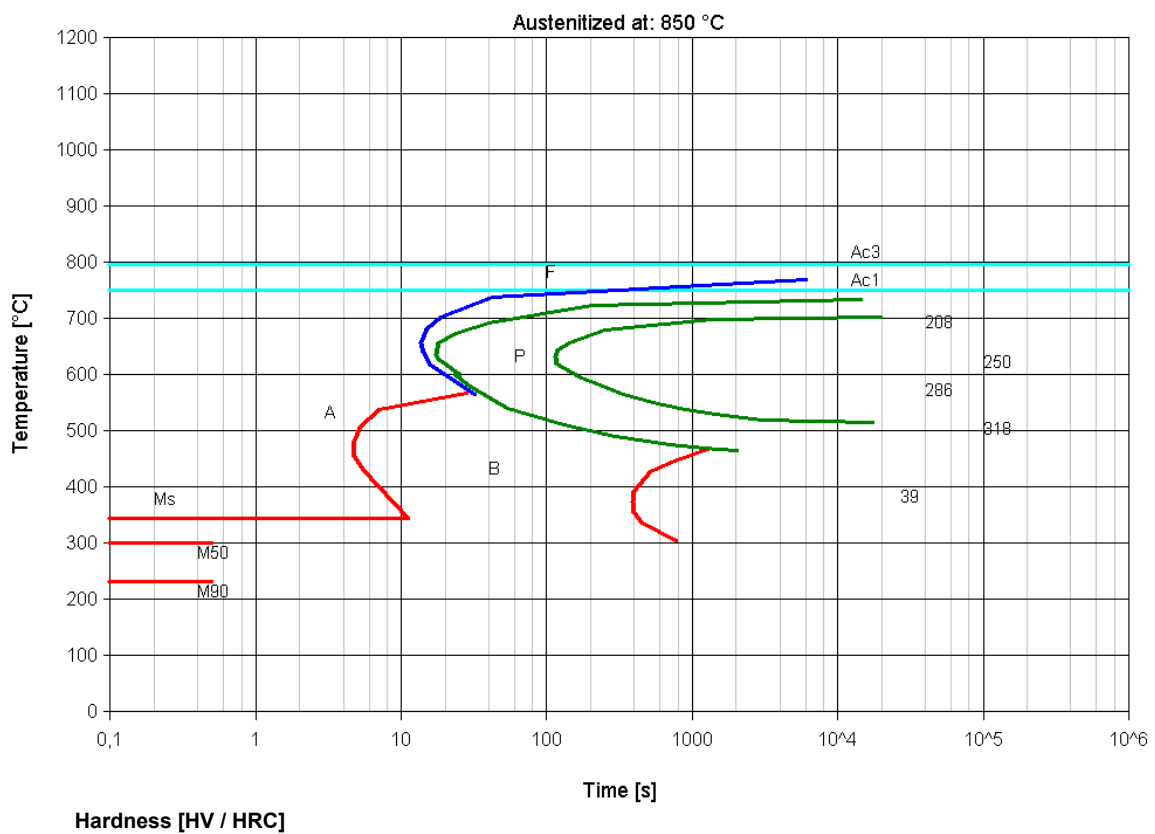
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 800	min. 660	min. 560	-	-
Tensile strength R _m [N/mm ²]	1000 - 1200	900 - 1100	800 - 950	-	-
Fracture elongation A ₅ [%]	min. 11	min. 12	min. 14	-	-
Reduction of area Z [%]	min. 30	min. 35	min. 40	-	-
Notch impact energy ISO-V [J]	min. 30	min. 35	min. 35	-	-

Time-temperature-transformation diagram for continuous cooling



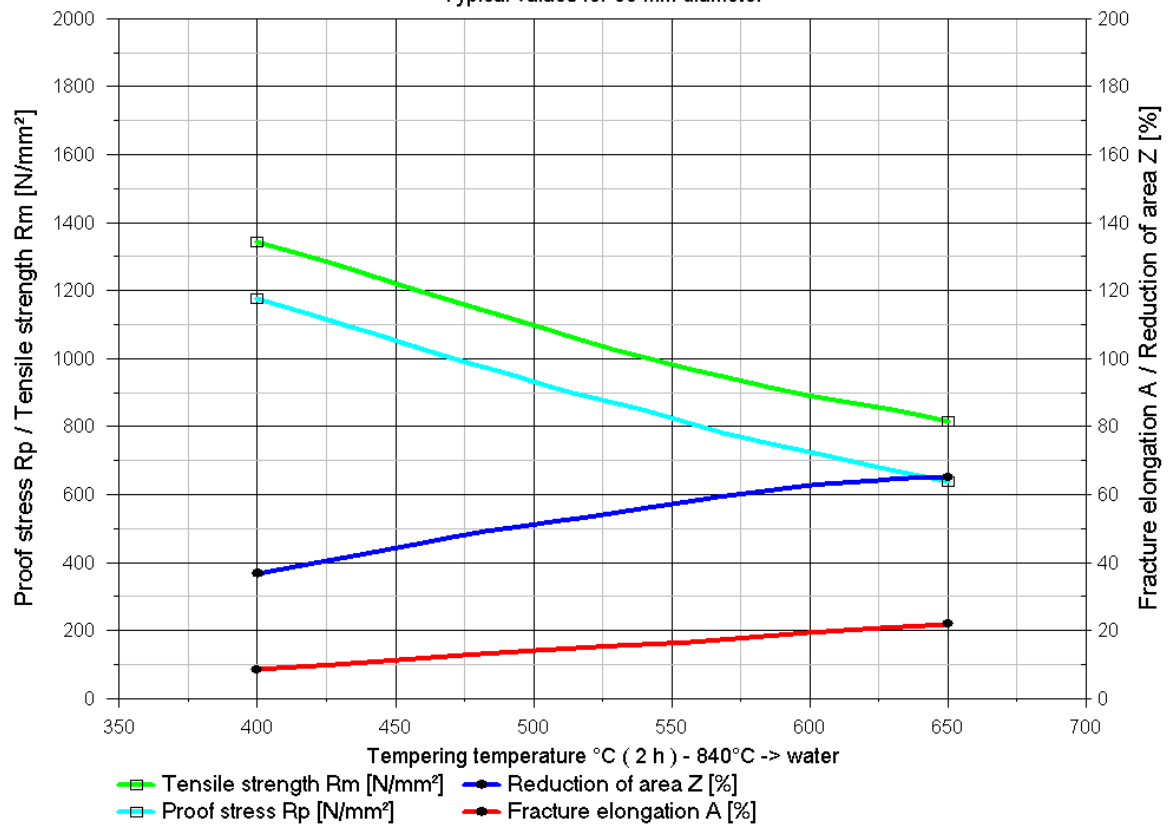
Hardness HV	665	595	480	375	280	240
Lambda-Value	0,15	0,4	0,8	1,5	4,0	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

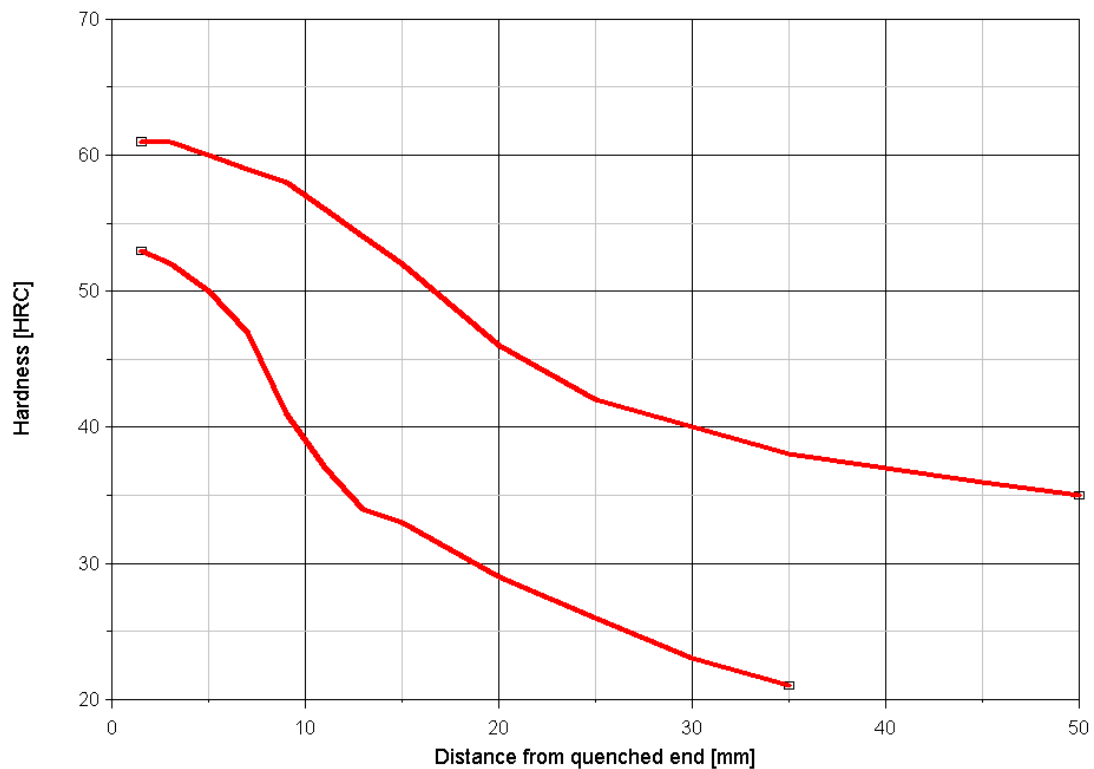


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Werkstoff-Datenblatt

Saarstahl - 38Cr4

Material No.:

Former brand name:

International steel grades:

1.7043

BS:

AFNOR:

SAE:

Material group:

Flame and induction hardening steel according to DIN 17212

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr
	0,34 0,40	0,15 0,40	0,60 0,90	<0,025	<0,035	0,90 1,20

Application:

Alloyed heat treatable steel for crankshafts for vehicle construction and diesel engines and for applications of medium skin hardness.

Hot forming and heat treatment:

Hot forming:	1050 - 850°C
Normalising:	845 - 885°C
Soft annealing:	680 - 720°C
Hardening:	825 - 855°C/water
Hardening:	835 - 865°C/oil
Tempering:	540 - 680°C
Hardening temperature for Jominy test	850°C

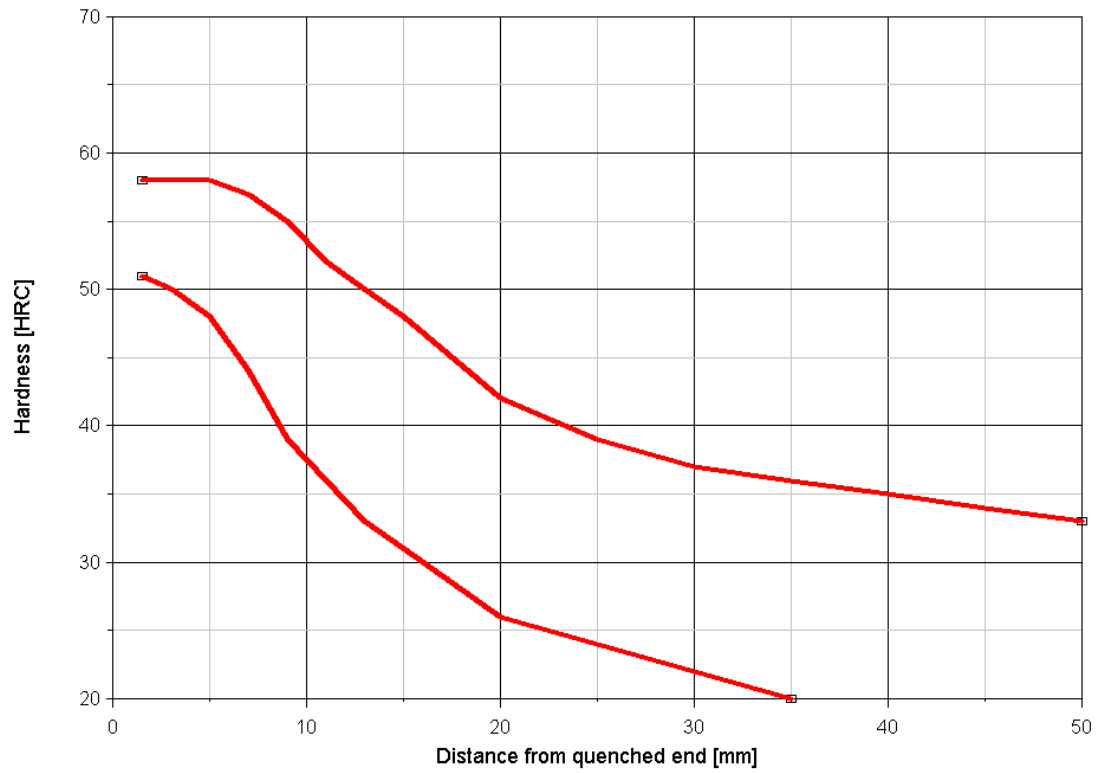
Mechanical Properties:

Soft annealed +A:	max. 217 HB
Skin hardness after quenching and tempering:	min. 53 HRC

Hardened and tempered

Diameter d [mm]	<=16	>16 - 40	>40 - 100	>100 - 160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 740	min. 630	min. 510	min. 740
Tensile strength R _m [N/mm ²]	930 - 1130	830 - 980	740 - 880	930 - 1130
Fracture elongation A ₅ [%]	min. 11	min. 13	min. 14	min. 11
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 40
Notch impact energy ISO-V [J]	min. 35	min. 42	min. 42	min. 35

Hardness scatter band



Material specification sheet

Saarstahl - 54SiCr6

Material No.: German standard: International steel grades:

1.7102

DIN EN 10089

SAE: 9254

JIS: SUP 12

Material group: Hot rolled steel for quenched and tempered springs

Chemical composition:

(typical analysis at Saarstahl in %)

C	Si	Mn	P	S	Cr
0,56	1,45	0,70	<0,01	<0,01	0,65

Deviation in chemical composition on request

Application:

Si alloyed quenched and tempered steel for production of springs with smaller sag tendency, especially of high-stressed automotive suspension springs, produced by cold and hot forming

Hot forming and heat treatment:

Hot rolling:	1050 - 850°C
Hot forming to springs:	940 - 840°C
Normalising:	850 - 880°C/air
Soft annealing:	640 - 680°C/furnace
Hardening:	min. 840°C/oil
Tempering:	375 - 500°C/air

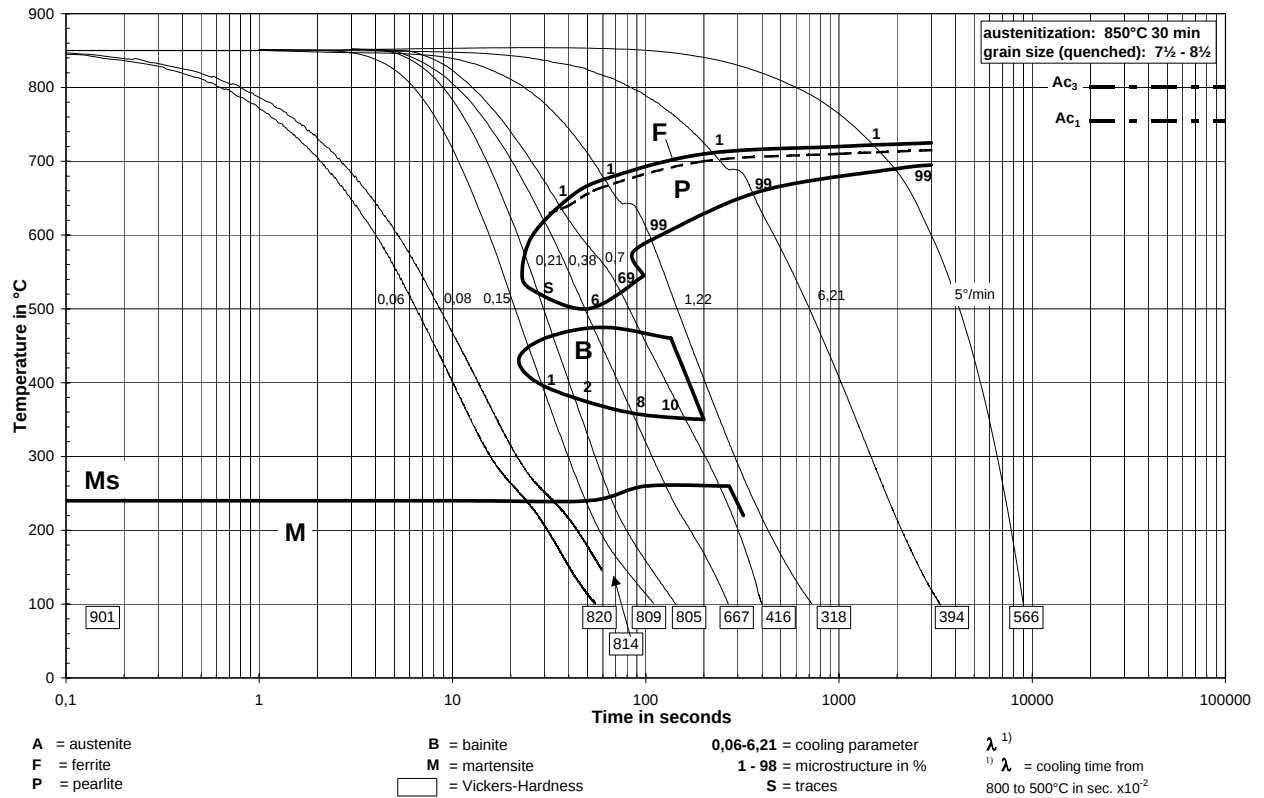
Mechanical properties:

Treated for cold shearability (+S):	max. 280 HB
Soft annealed (+A):	max. 248 HB
Spheroidized annealed (+AC):	max. 230 HB

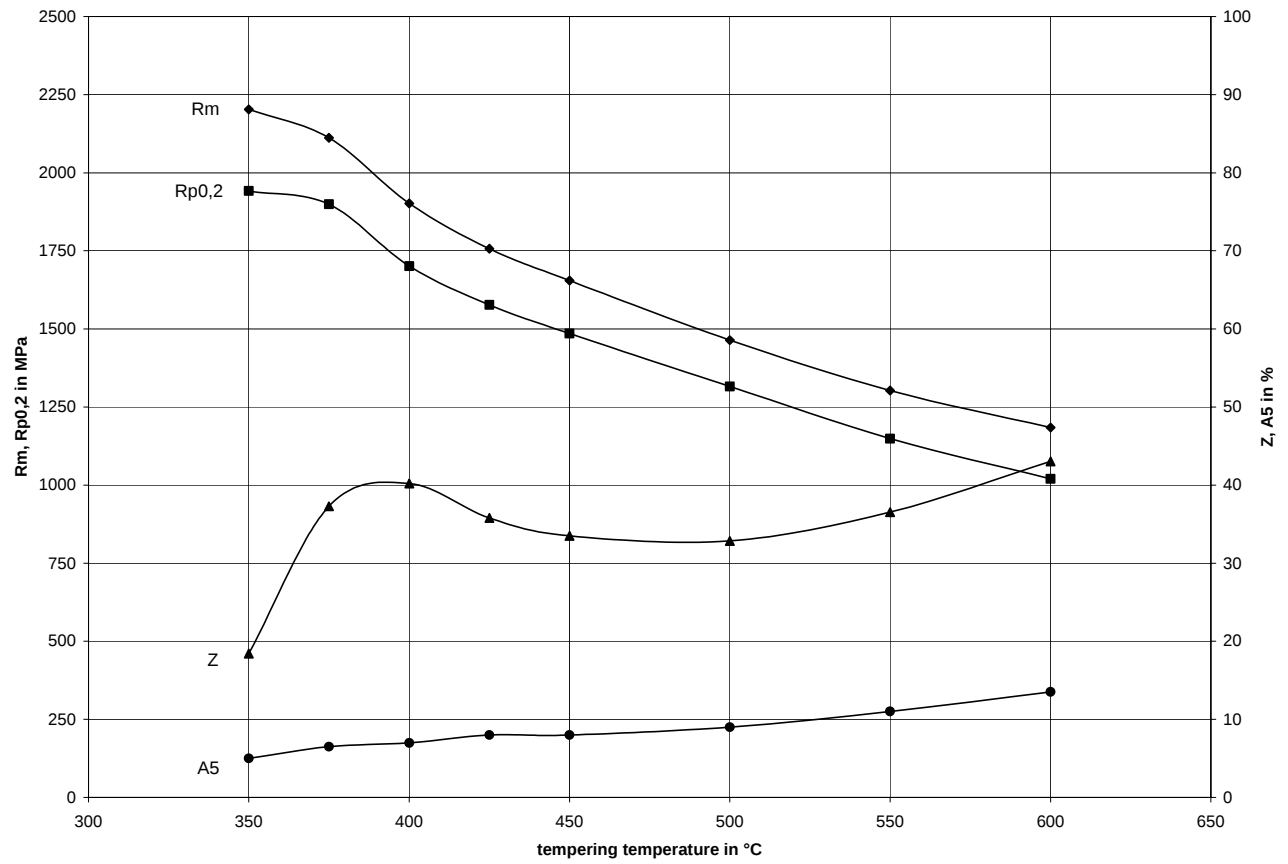
Hardened and tempered (+QT), tempering temperature 375-500°C

0,2% proof stress $R_{p0,2}$ [N/mm²]	min. 1300
Tensile strength R_m [N/mm²]	1450 - 2050
Fracture elongation A_5 [%]	min. 6
Reduction of area Z [%]	min. 25
Notch impact energy ISO-V [J]	min. 8

Time-temperature-transformation diagram for continuous cooling



Tempering diagram



Material specification sheet

Saarstahl - 61SiCr7 (60SiCr7)

Material No.:

1.7108

Former brand name:

International steel grades:

BS:

AFNOR: 60SC7

SAE: 9262

Material group:

Hot rolled steel for springs suitable for quenching and tempering according to DIN 17221

Chemical composition:

(Typical analysis in %)

C	Si	Mn	P	S	Cr
0,57 0,65	1,50 1,80	0,70 1,00	<0,030	<0,030	0,20 0,40

Application:

Hot rolled steel for springs suitable for quenching and tempering, as leaf springs, helical springs, stabiliser at rail-traffic vehicle, torsion bars.

Hot forming and heat treatment:

Hot forming:	1050 - 850°C
Hot deformation:	900 - 830°C
Normalising:	850 - 880°C
Soft annealing:	640 - 680°C
Hardening:	830 - 860°C/oil
Tempering:	350 - 550°C

Mechanical Properties:

Treated for cold shearability +S:	max. 280 HB
Soft annealed +A:	max. 248 HB
Spheroidized annealed - GKZ (+AC)	max. 230 HB
Core hardness after quenching:	min. 54 HRC

Material specification sheet

Saarstahl - 16MnCr5 - 16MnCrS5

Material No.:	Former brand name:	International steel grades:	
1.7131	EC 80	BS:	527M17, 590M17
1.7139		AFNOR:	16MC4, 16MnCr5
		SAE:	5115

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	S	other
	16MnCr5	0,16	0,25	1,15	0,95	<0,035	(Pb)
	16MnCrS5	0,16	0,25	1,15	0,95	0,020 0,035	(Pb)

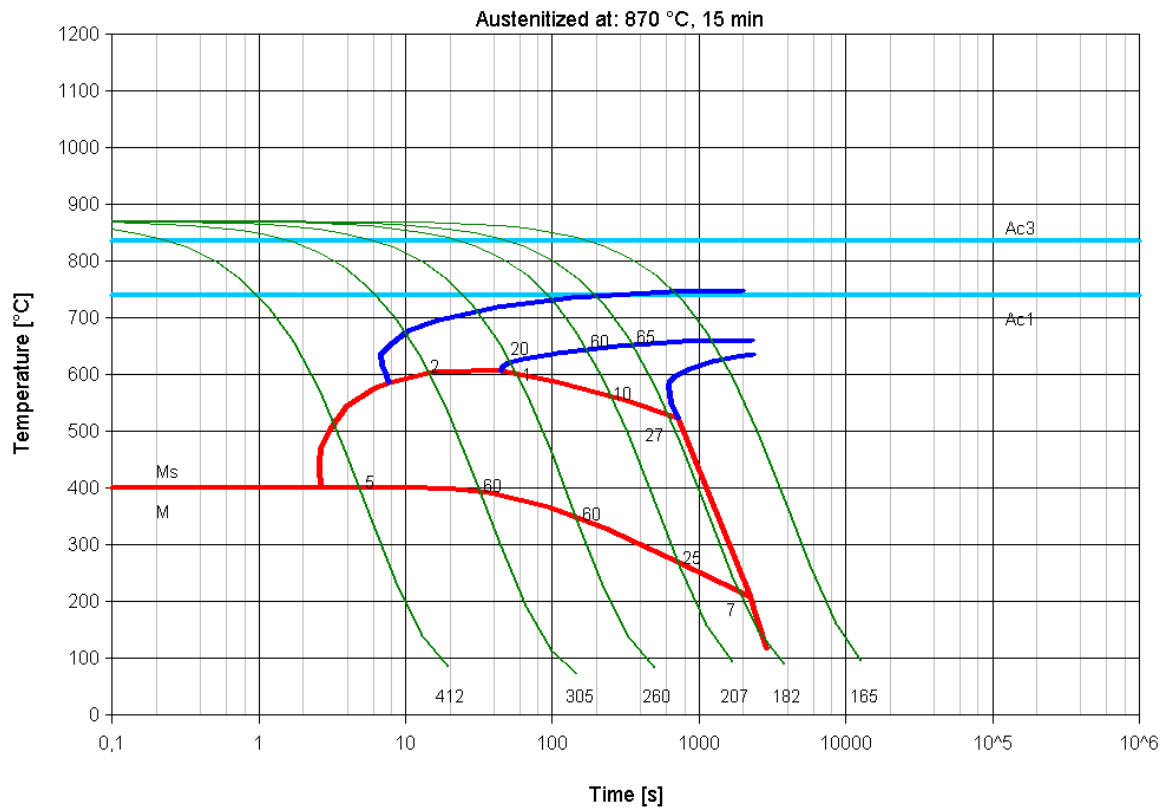
Application: Alloyed case hardening steel for parts with a required core tensile strength of 800 - 1100 N/mm² and good wearing resistance as piston bolts, camshafts, levers and other vehicle and mechanical engineering components.

Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	840 - 870°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	860 - 900°C/oil
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C/oil
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	Shearable in as rolled condition
	Soft annealed, +A:	max. 207 HB
	Treated for strength, +TH:	156 - 207 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	140 - 187 HB
	after hardening and tempering at 200°C:	

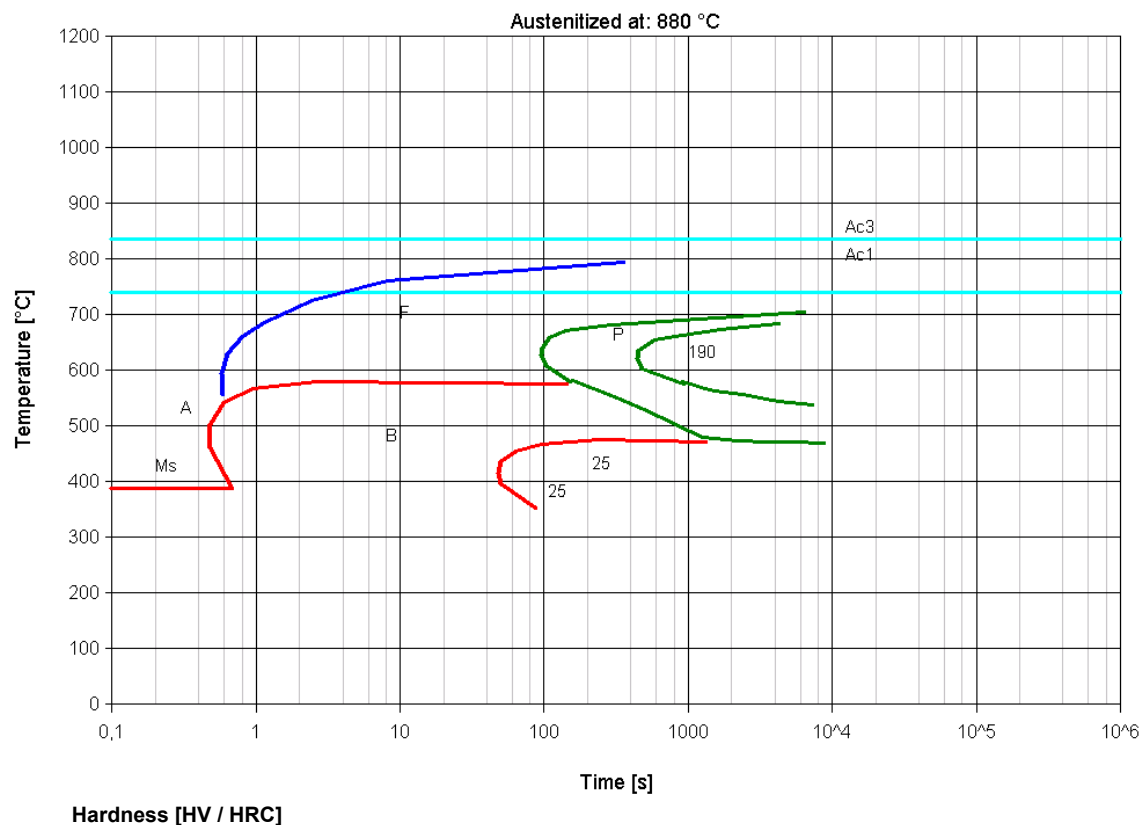
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1000	min. 900	min. 700

Time-temperature-transformation diagram for continuous cooling

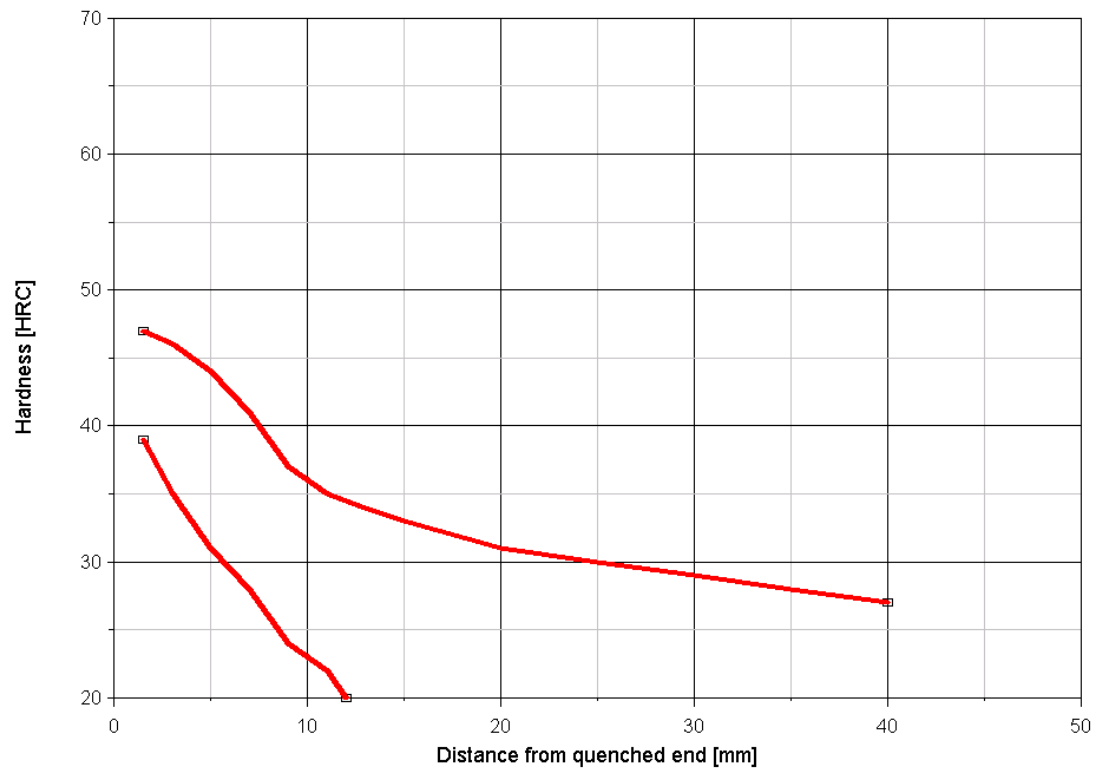


	Time [s]					
Hardness HV	412	305	260	207	182	165
Lambda-Value	0,03	0,19	0,87	2,72	5,75	10°/mi

Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 20MnCr5 - 20MnCrS5

Material No.:	Former brand name:	International steel grades:
1.7147	EC 100	BS:
1.7149		AFNOR: 20MC5
		SAE: 5120

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	S	other
	20MnCr5	0,20	0,25	1,25	1,15	<0,035	(Pb)
	20MnCrS5	0,20	0,25	1,25	1,15	0,020 0,035	(Pb)

Application: Alloyed case hardening steel for parts with a required core tensile strength of 1000 - 1300 N/mm² and good wearing resistance as boxes, piston bolts, spindles, camshafts, gears, shafts and other mechanical controlling parts.

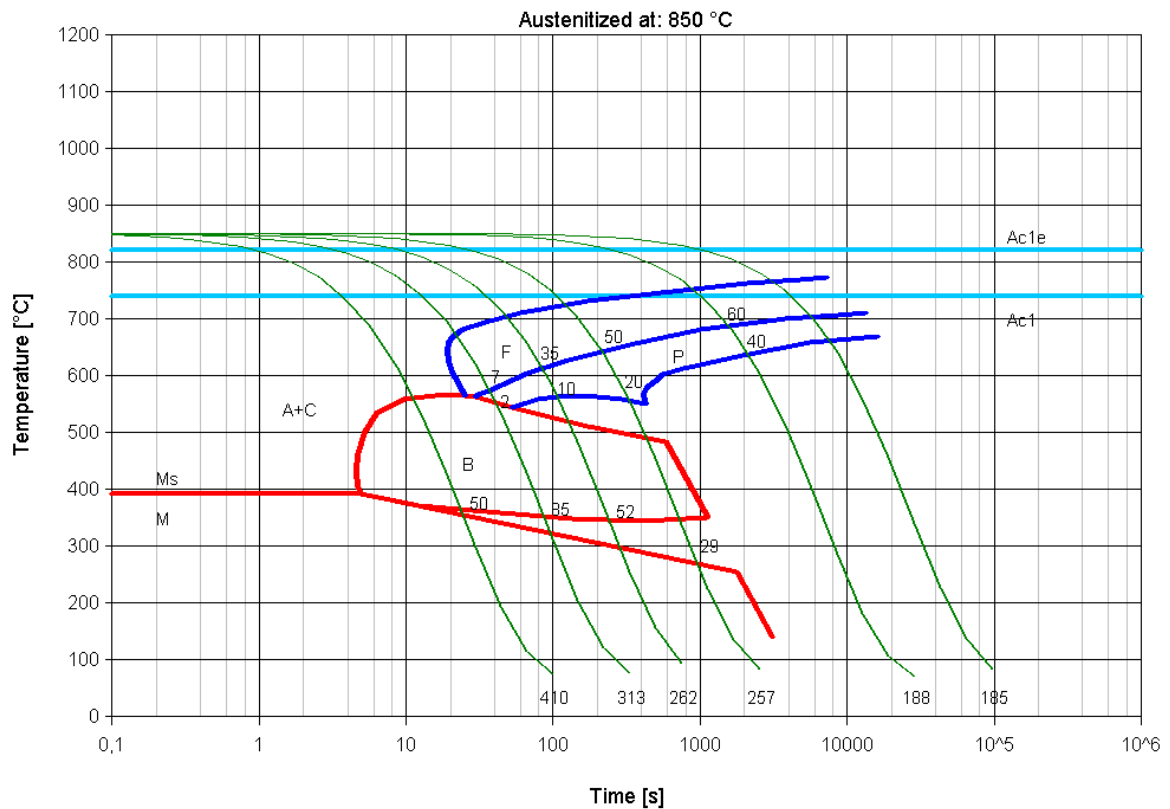
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	840 - 870°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	860 - 900°C/oil
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C/oil
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	max. 255 HB
	Soft annealed, +A:	max. 217 HB
	Treated for strength, +TH:	170 - 217 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	152 - 201 HB

after hardening and tempering at 200°C:

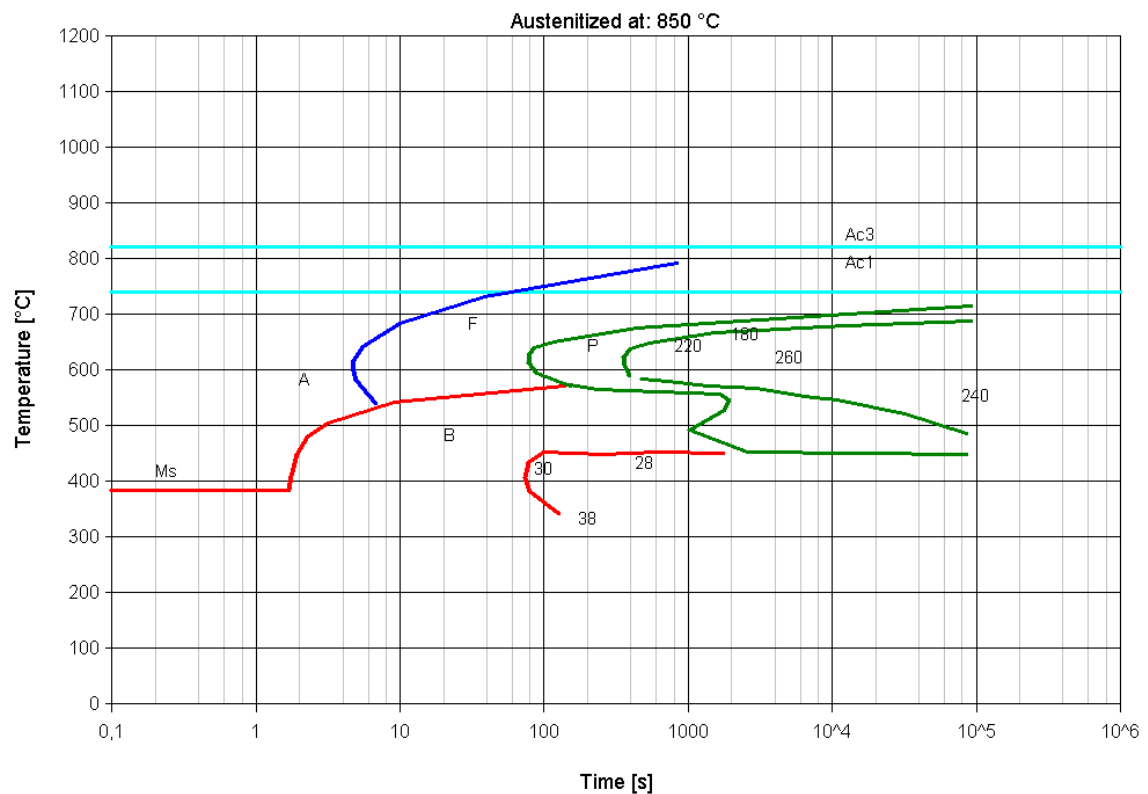
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1200	min. 1000	min. 800

Time-temperature-transformation diagram for continuous cooling



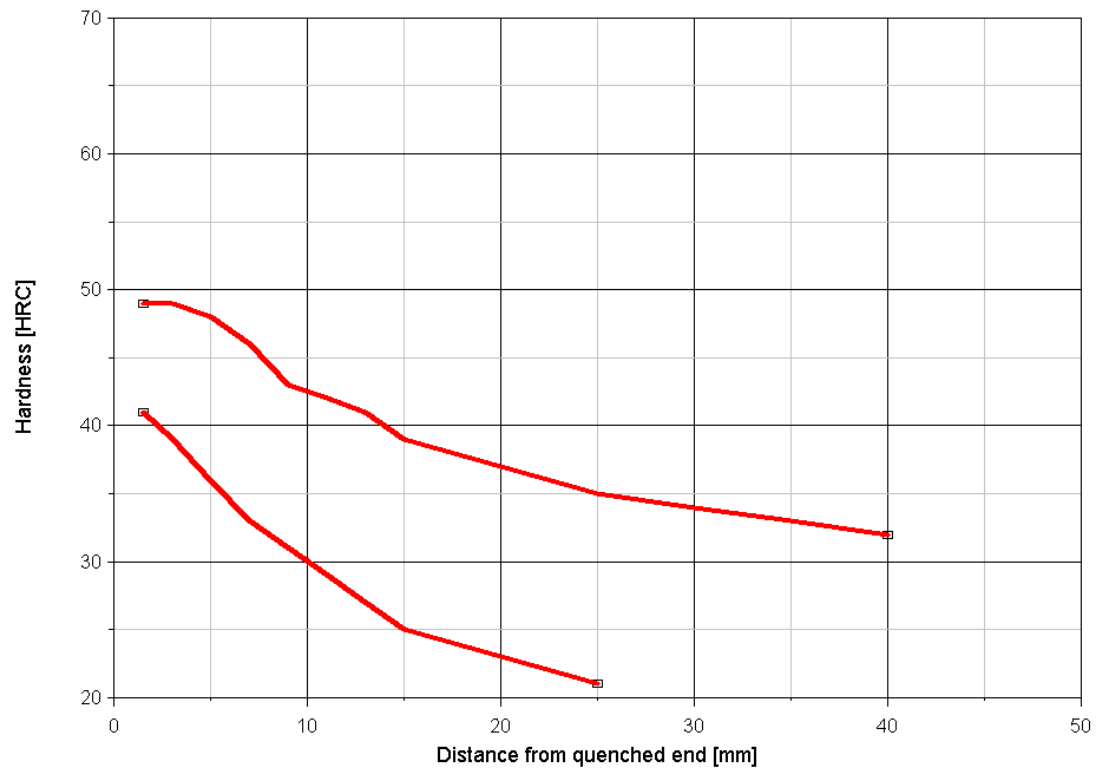
Hardness HV	410	313	262	257	188	185
Lambda-Value	0,13	0,45	1,2	3,6	5°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness [HV / HRC]

Hardness scatter band



Material specification sheet

Saarstahl - 16MnCrB5

Material No.: Former brand name: International steel grades:

1.7160

EC 80 B

BS:
AFNOR:
SAE:

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Sonst.
	0,16	0,25	1,15	0,95	+B (+Pb)

Application: Boron alloyed case hardening steel for parts with a required core tensile strength of 800 - 1000 N/mm² and good wearing resistance as piston bolts, camshafts, levers and other vehicle and mechanical engineering components. Boron increases the hardenability and the toughness of case hardened parts.

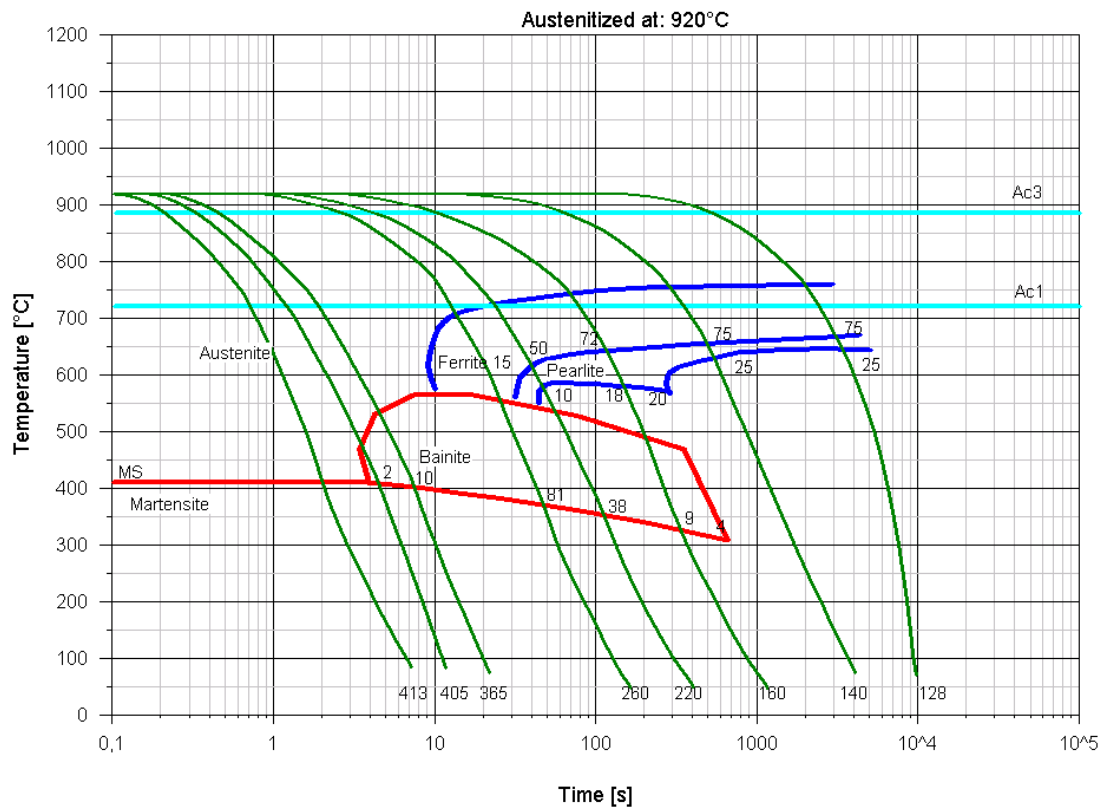
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	840 - 870°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	860 - 900°C/oil
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C/oil
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	Shearable in as rolled condition
	Soft annealed, +A:	max. 207 HB
	Treated for strength, +TH:	156 - 207 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	140 - 187 HB

after hardening and tempering at 200°C:

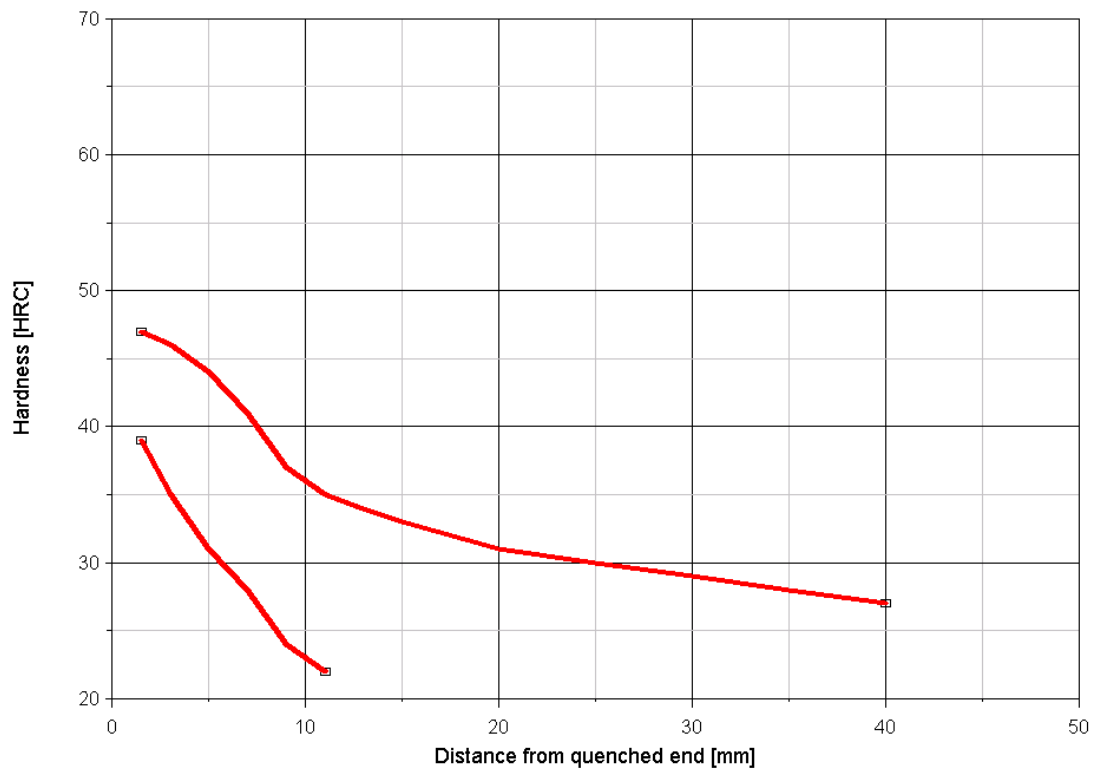
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _m [N/mm ²]	min. 1000	min. 900	min. 700

Time-temperature-transformation diagram for continuous cooling



Hardness HV	413	405	365	260	220	160	140	128
Lambda-Value	0,008	0,023	0,040	0,22	0,49	1,5	6,7	5°/min

Hardness scatter band



Material specification sheet

Saarstahl - 20MnCrB5

Material No.:	Former brand name:	International steel grades:
1.7168	EC 100 B	BS: AFNOR: SAE:

Material group: Boron alloyed case hardening steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	other
	0,20	0,25	1,15	1,15	+B (+Pb)

Application: Boron alloyed case hardening steel for parts with a required core tensile strength of 1000 - 1300 N/mm² and good wearing resistance as bushes, piston bolts, camshafts, spindles, gears, shafts and other mechanical controlling and gearing components. Boron increases the hardenability and the toughness of case hardened parts.

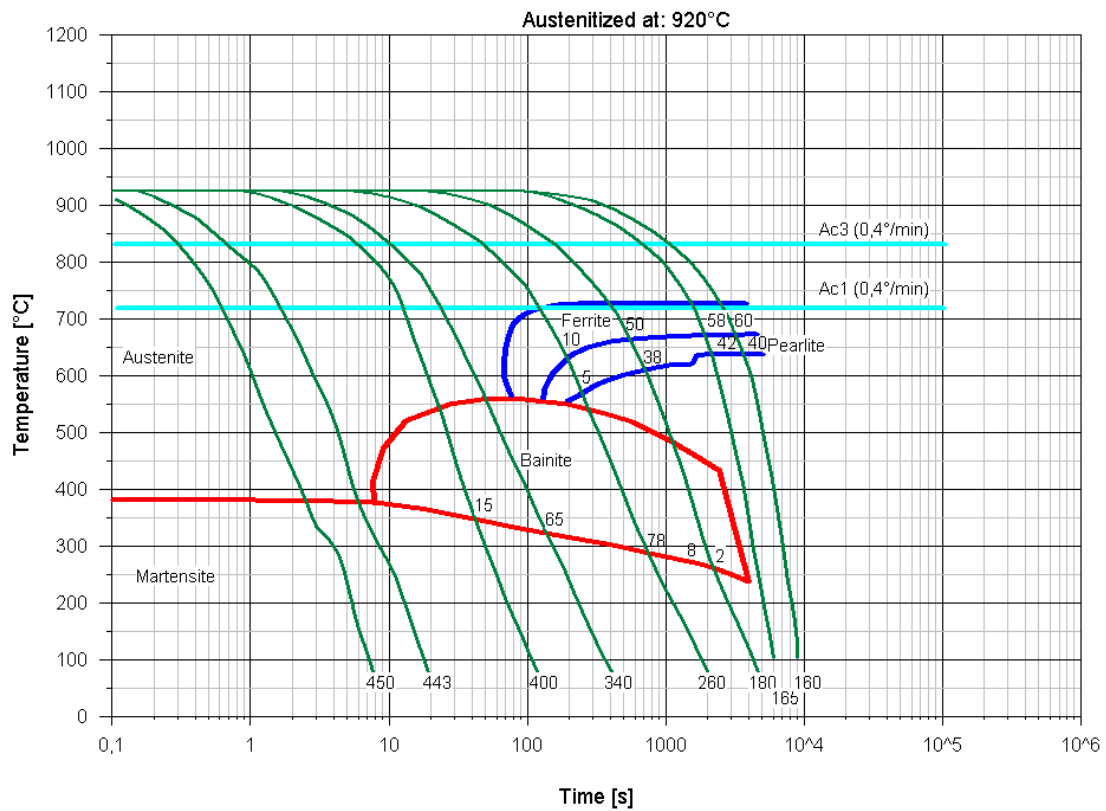
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	840 - 870°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	870 - 930°C/oil
	Core hardening:	850 - 880°C
	Intermediate annealing:	650 - 700°C
	Case hardening:	810 - 840°C/oil
	Tempering:	170 - 210°C

Mechanical Properties:	Treated for hardness range - BF (+TH):	170 - 217 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	152 - 201 HB
	Soft annealed, +A:	max. 217 HB

Condition of heat treatment: blank hardened

Diameter d [mm]	< 11	>11 – 30	>30 – 63
0,2% proof stress R_{p0,2} [N/mm²]	min. 730	min. 680	min. 550
Tensile strength R_m [N/mm²]	1100 - 1400	1000 - 1300	800 - 1100
Fracture elongation A₅ [%]	min. 7	min. 8	min. 10
Reduction of area Z [%]	min. 30	min. 35	min. 35
Notch impact energy ISO-V [J]	min. 15	min. 20	min. 20

Time-temperature-transformation diagram for continuous cooling



Hardness HV	450	443	400	340	260	180	165	160
Lambda-Value	0,009	0,026	0,14	0,42	2,10	6,8	10°/min	5°/min

Material specification sheet

Saarstahl - 55Cr3

Material No.:	Former brand name:	International steel grades:
1.7176	F 1 K	BS: 525A58, 525H60 AFNOR: 55C3 SAE: 5155, 5160

Material group: Hot rolled steel for springs suitable for quenching and tempering according to DIN 17221

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr
	0,57	0,30	0,85	0,80

Application: Hot rolled steel for springs suitable for quenching and tempering, as leaf springs, helical springs, stabiliser at road vehicles.

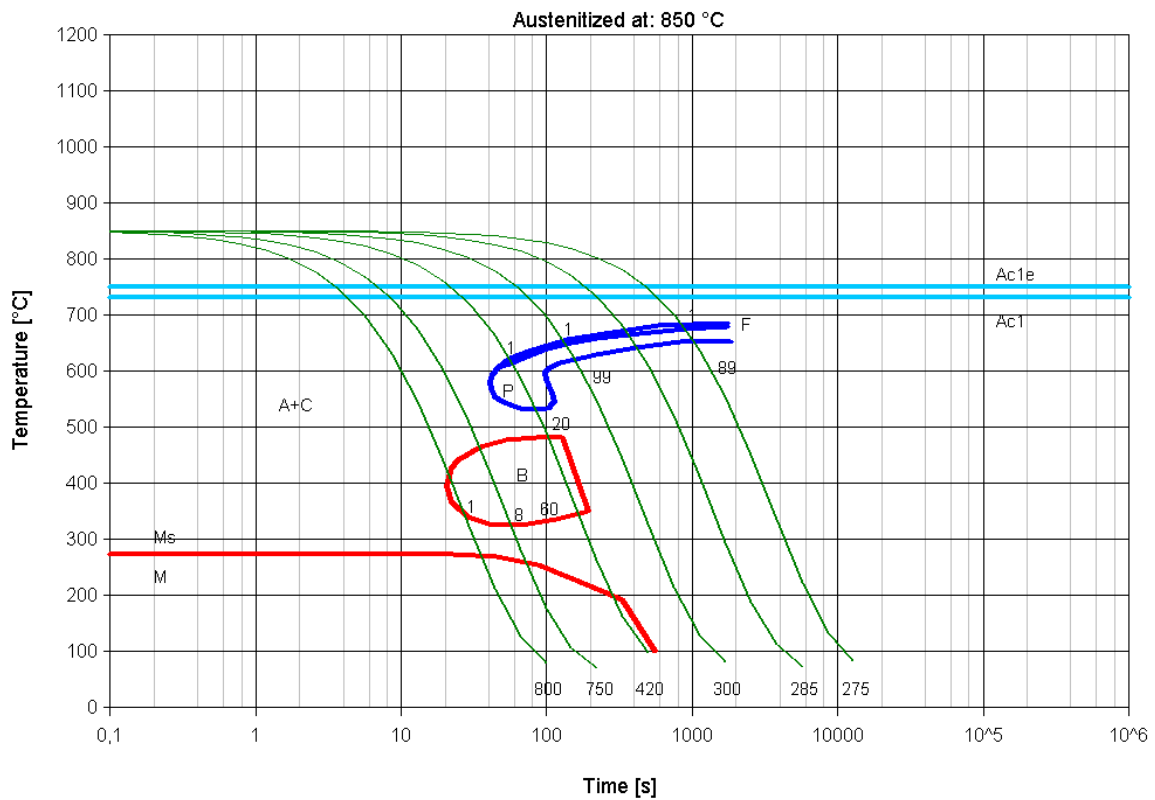
Hot forming and heat treatment:	Hot forming:	1050 - 850°C
	Hot deformation:	920 - 830°C
	Normalising:	850 - 880°C/air
	Soft annealing:	640 - 680°C/furnace
	Hardening:	830 - 860°C/oil
	Tempering:	430 - 500°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 280 HB
	Soft annealed +A:	max. 248 HB
	Spheroidized annealed - GKZ (+AC)	max. 200 HB
	Core hardness after quenching:	min. 54 HRC

Hardened and tempered, H+A, 16 mm flat steel bars, 25 mm bars

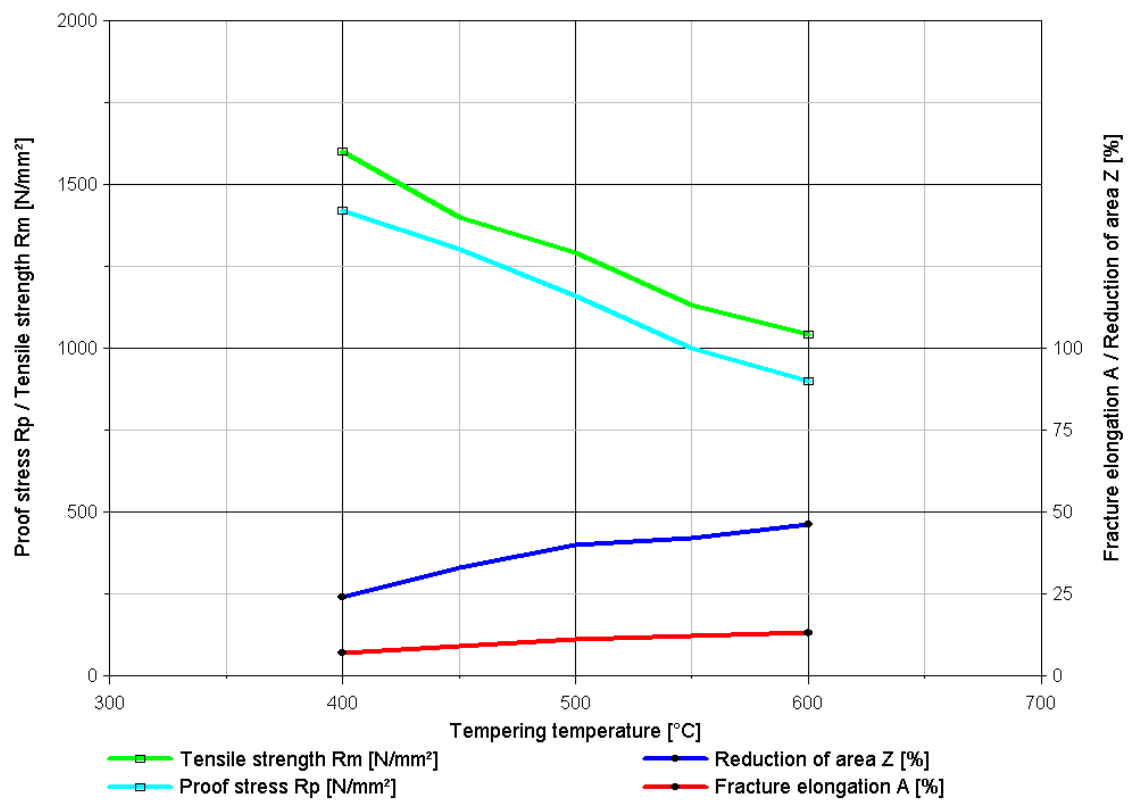
0,2% proof stress R_{p0,2} [N/mm²]	min. 1200
Tensile strength R_m [N/mm²]	1400 - 1650
Fracture elongation A₅ [%]	min. 6
Reduction of area Z [%]	min. 35
Notch impact energy ISO-V [J]	min. 9

Time-temperature-transformation diagram for continuous cooling



Hardness HV	800	750	420	300	285	275
Lambda-Value	0,12	0,20	0,72	2,35	6,0	10°/min

Tempering diagram



Material specification sheet

Saarstahl - 27MnCrB5-2

Material No.:

Former brand name:

International steel grades:

1.7182

BS:

AFNOR:

SAE:

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	P	S	Cr	B
	0,24 0,30	<0,40	1,10 1,40	<0,035	<0,040	0,30 0,60	0,0008 0,0050

Application:

Boron alloyed heat treatable steel for wear resisting parts as dredger buckets, plough shares, chain wheels, mechanical engineering components, axles.

Hot forming and heat treatment:

Forging or hot rolling: 1200 - 850°C
 Normalising: 860 - 890°C
 Soft annealing: 650 - 700°C
 Hardening: 840 - 880°C/water, oil
 Quenching: water max. 52 mm Ø,
 oil max. 43 mm Ø

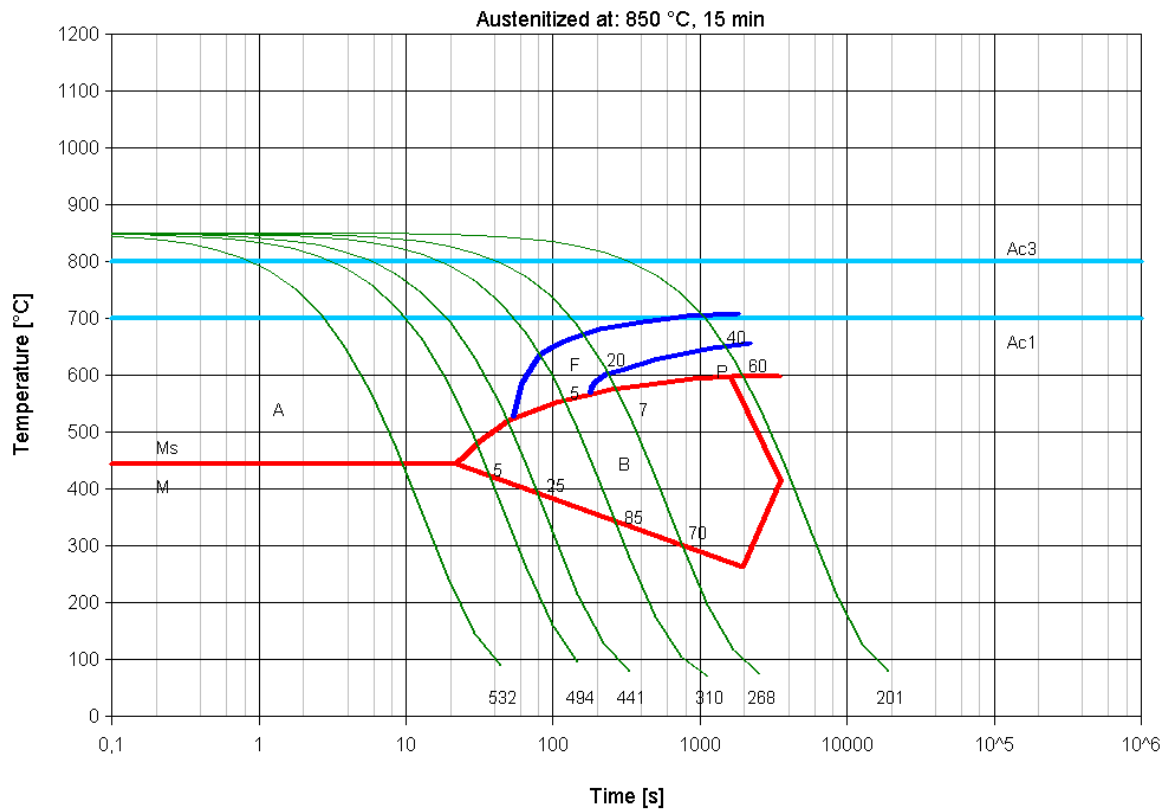
Mechanical Properties:

Core hardness for an amount of 80 % martensite:

38 HRC at 900°C

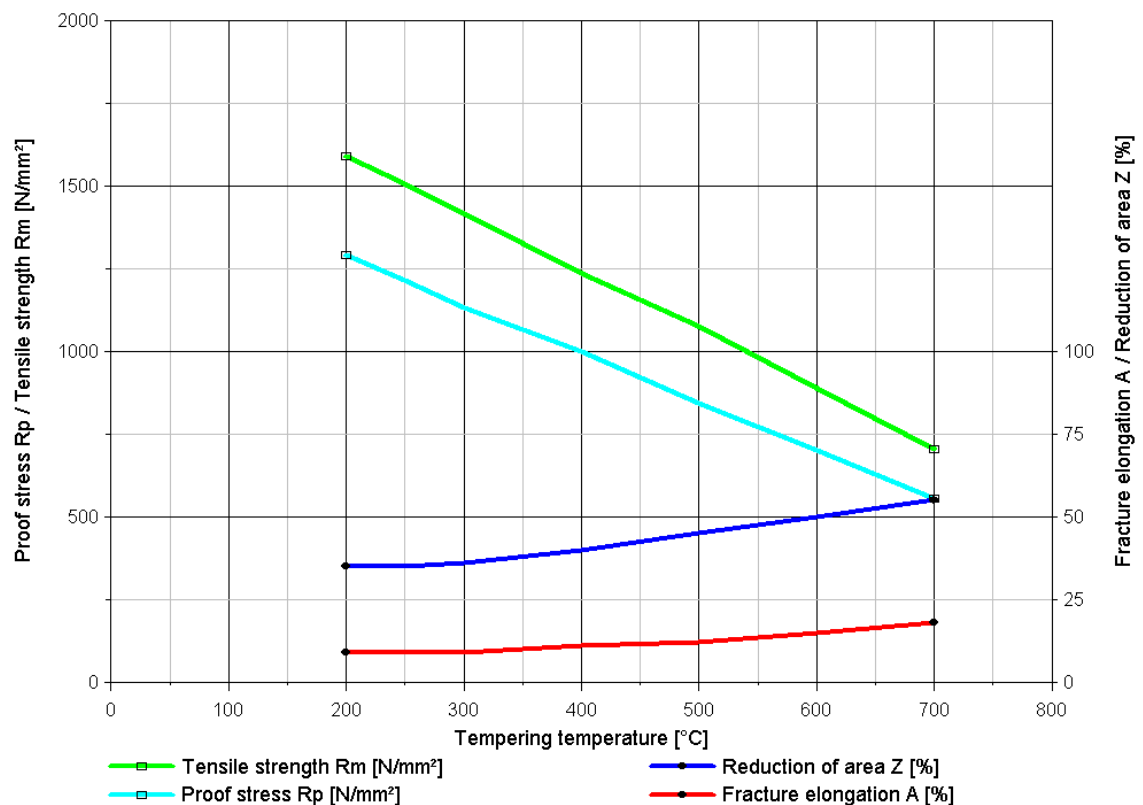
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 700	min. 650	min. 600	min. 550	-
Tensile strength R _m [N/mm ²]	900 - 1100	850 - 1000	800 - 950	750 - 900	-
Fracture elongation A ₅ [%]	min. 12	min. 13	min. 14	min. 15	-
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 50	-
Notch impact energy ISO-V [J]	min. 41	min. 48	min. 48	min. 48	-

Time-temperature-transformation diagram for continuous cooling

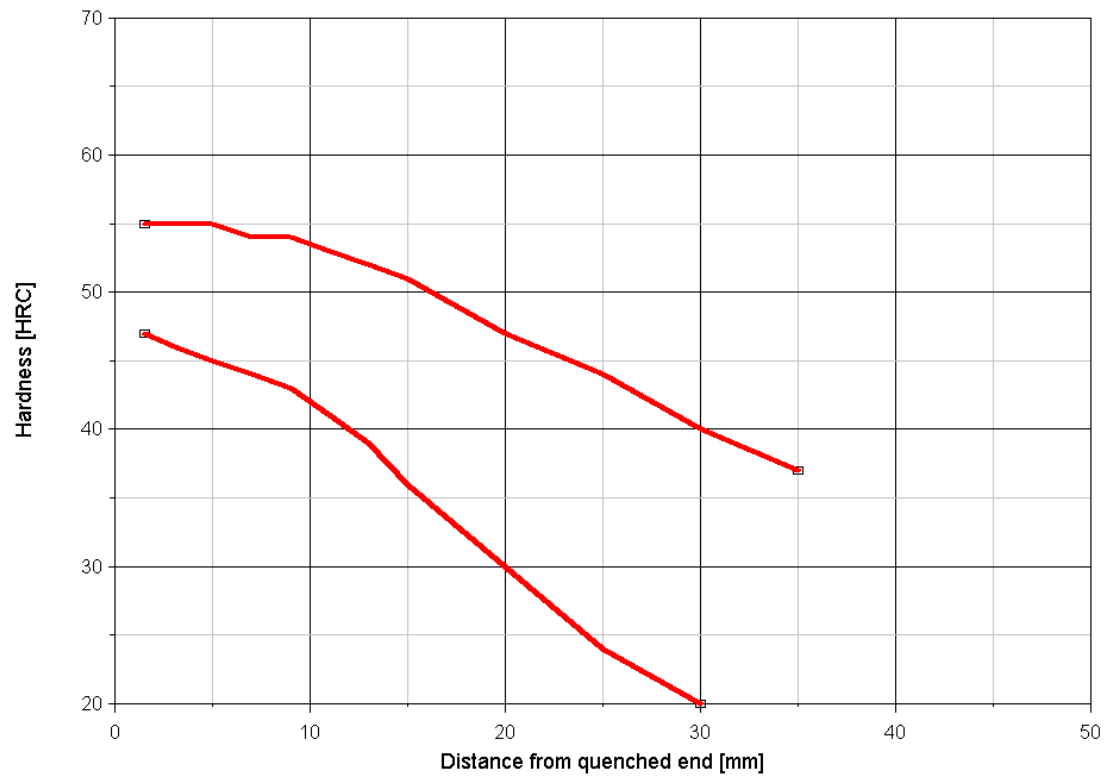


Hardness HV	532	494	441	310	268	201
Lambda-Value	0,07	0,25	0,47	1,33	3,25	25,7

Tempering diagram



Hardness scatter band



Material specification sheet

Saarstahl - 33MnCrB5-2

Material No.:

1.7185

Former brand name:

International steel grades:

BS:

AFNOR:

SAE:

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition:

(Typical analysis in %)

C	Si	Mn	P	S	Cr	B
0,30 0,36	<0,40	1,20 1,50	<0,035	<0,040	0,30 0,60	0,0008 0,0050

Application:

Boron alloyed heat treatable steel

Hot forming and heat treatment:

Forging or hot rolling:

-

Normalising:

-

Soft annealing:

-

Hardening:

880°C

Quenching:

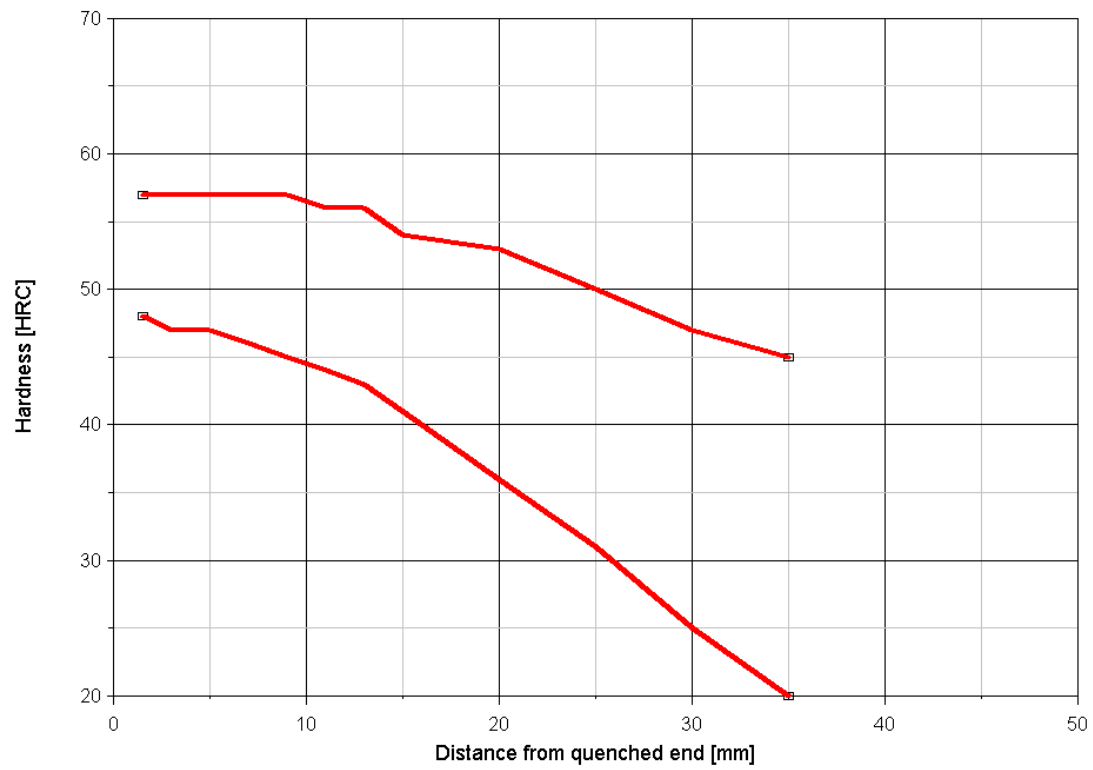
water max. 52 mm Ø,
oil max. 43 mm Ø

Mechanical Properties:

Core hardness for an amount
of 80 % martensite:

42 HRC

Hardness scatter band



Material specification sheet

Saarstahl - 39MnCrB6-2

Material No.:

Former brand name:

International steel grades:

1.7189

BS:

AFNOR:

SAE:

Material group:

Steel for quenching and tempering according to DIN EN 10083

Chemical composition:

(Typical analysis in %)

C	Si	Mn	P	S	Cr	B
0,36 0,42	<0,40	1,40 1,70	<0,035	<0,040	0,30 0,60	0,0008 0,0050

Application:

Boron alloyed heat treatable steel

Hot forming and heat treatment:

Forging or hot rolling:

-

Normalising:

-

Soft annealing:

-

Hardening:

850°C

Quenching:

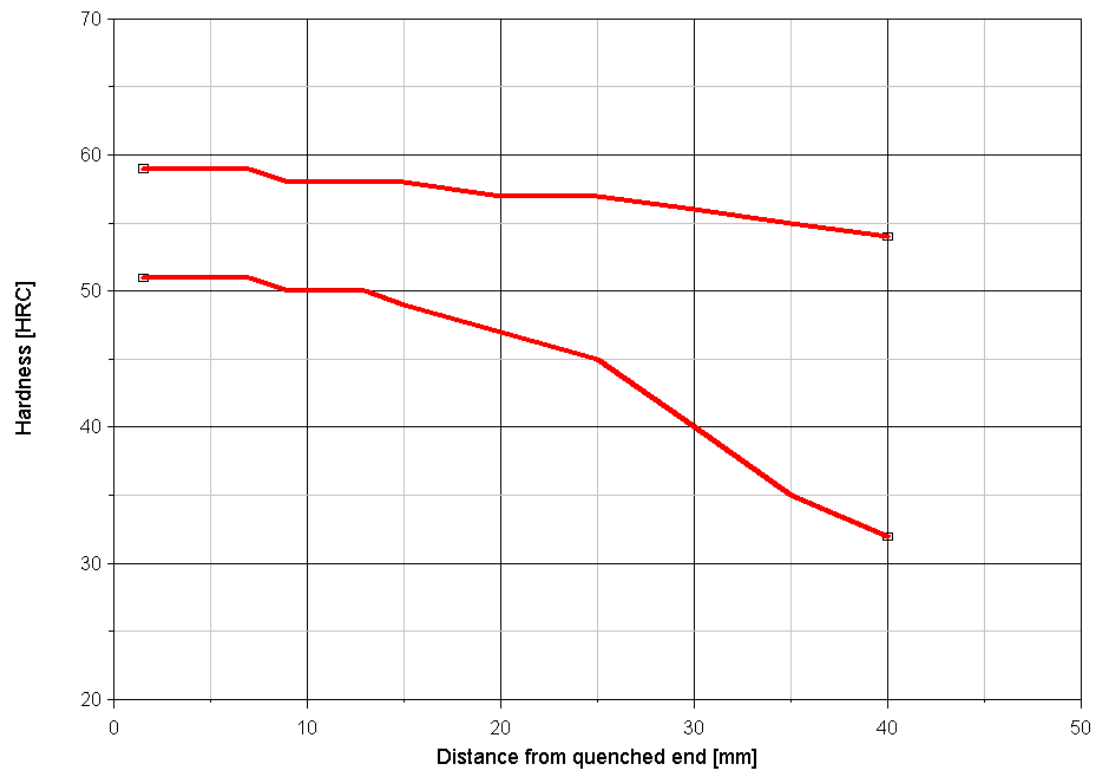
water max. 95 mm Ø,
oil max. 80 mm Ø

Mechanical Properties:

Core hardness for an amount
of 80 % martensite:

45 HRC at 850°C

Hardness scatter band



Material specification sheet

Saarstahl - 25CrMo4

Material No.:	Former brand name:	International steel grades:	
1.7218	Mo 25	BS:	708A25
		AFNOR:	25CD4, 25CrMo4
		SAE:	4130

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	other
	0,25	0,25	0,70	1,05	0,25	(Pb)

Application: Alloyed heat treatable steel with a typical tensile strength of 700 - 950 N/mm² and a good weldability. For automotive and aircraft components with high toughness as axles, axle journals, turbine parts, turbine rotors.

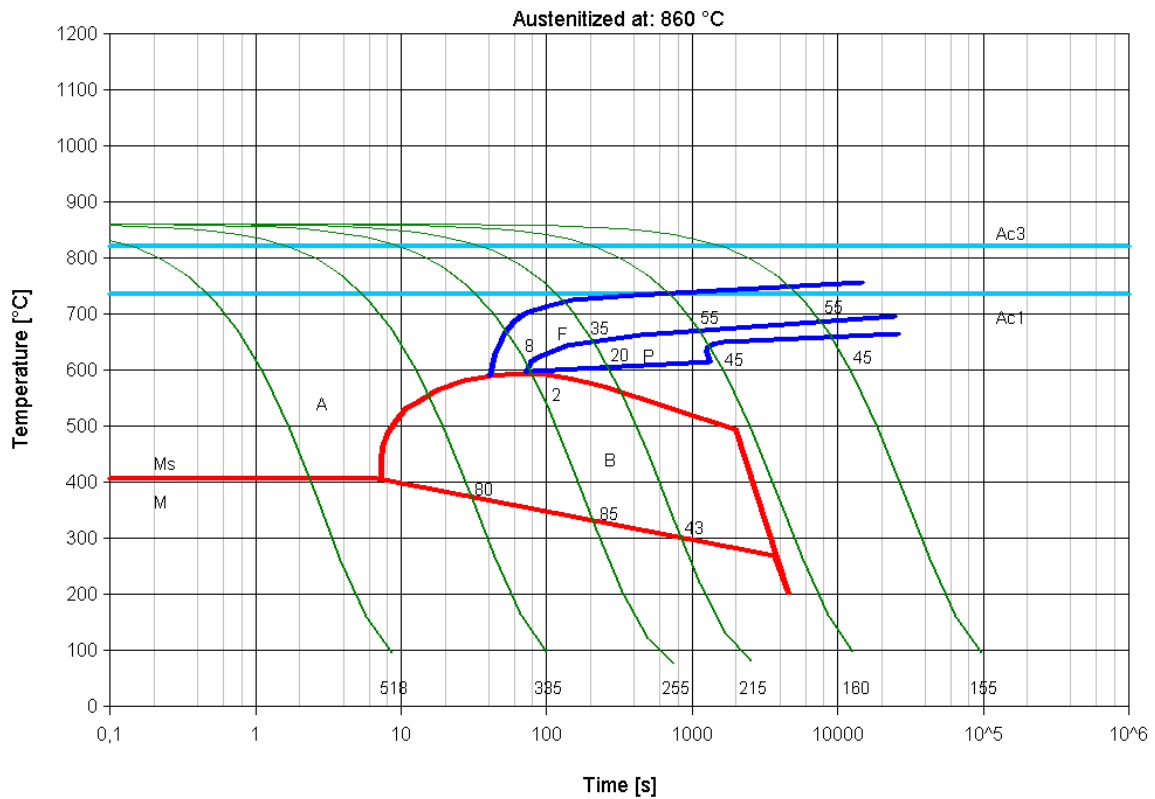
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	860 - 890°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	840 - 880°C/water, oil
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 212 HB

Quenched and tempered, +QT:

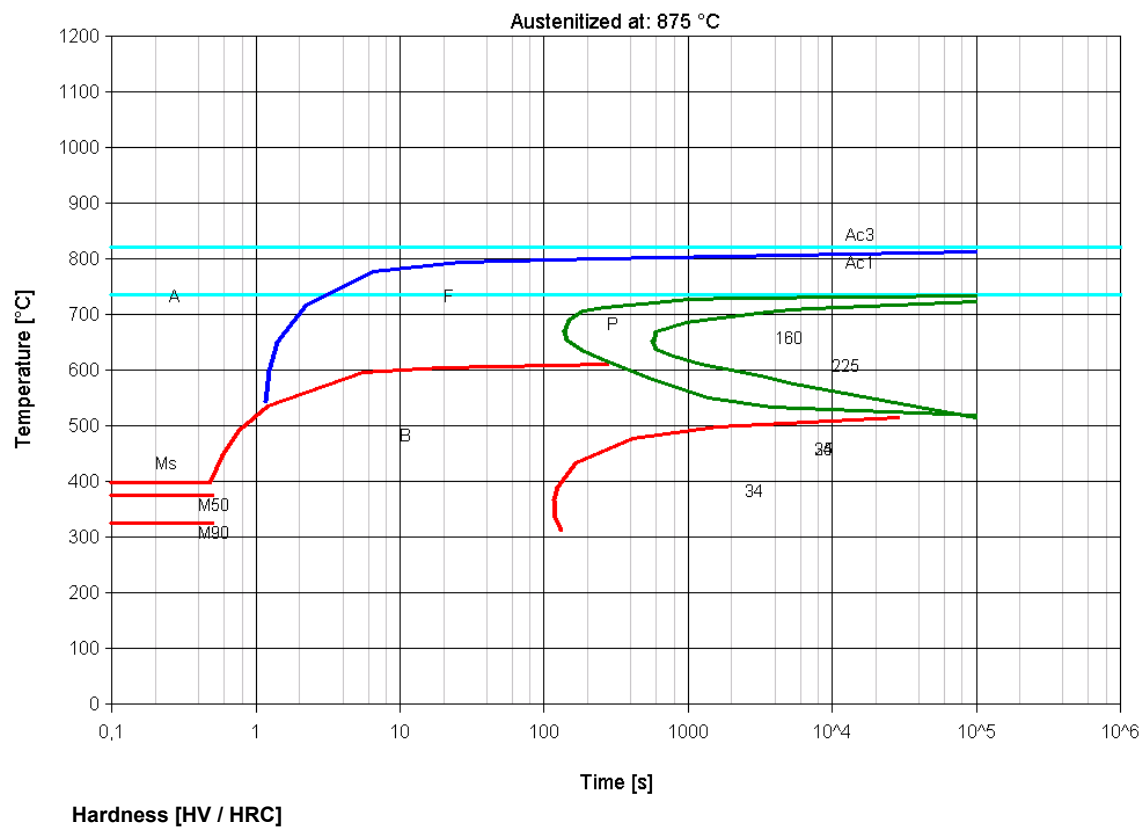
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 700	min. 600	min. 450	min. 400	-
Tensile strength R _m [N/mm ²]	900 - 1100	800 - 950	700 - 850	650 - 800	-
Fracture elongation A ₅ [%]	min. 12	min. 14	min. 15	min. 16	-
Reduction of area Z [%]	min. 50	min. 55	min. 60	min. 60	-
Notch impact energy ISO-V [J]	min. 45	min. 50	min. 50	min. 45	-

Time-temperature-transformation diagram for continuous cooling



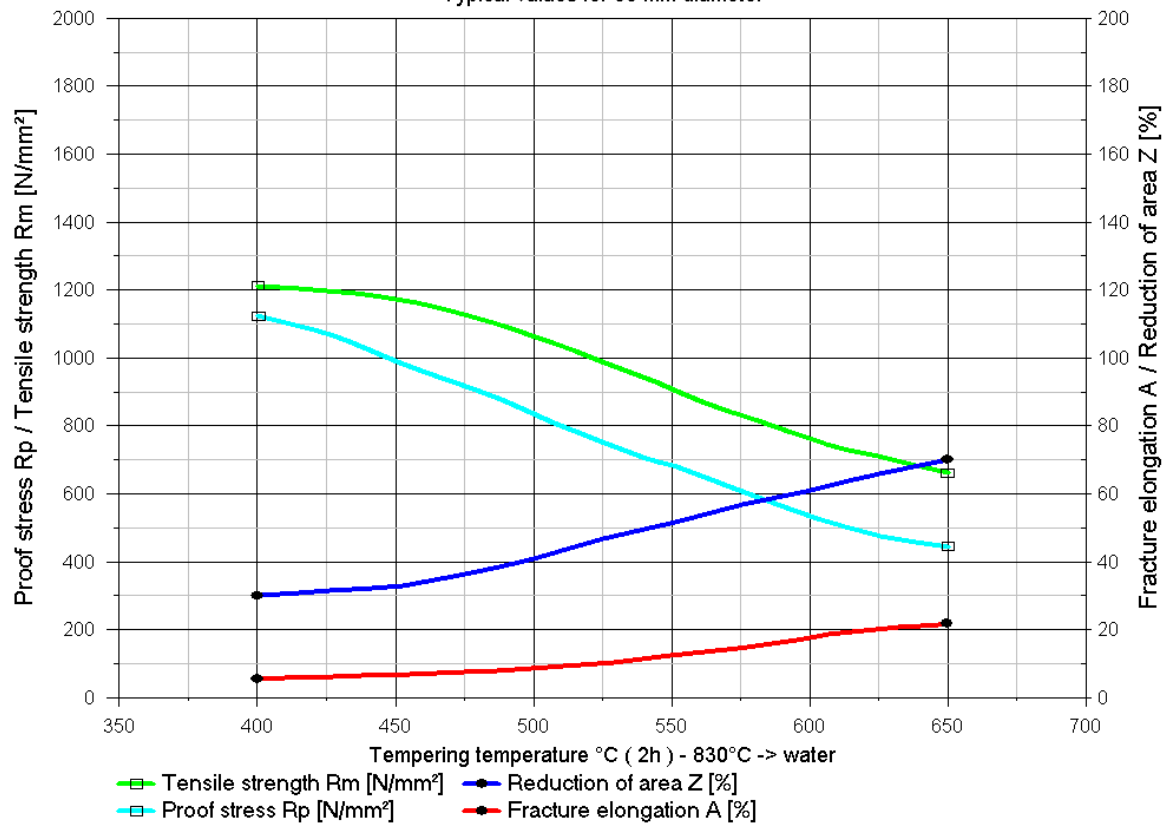
Hardness HV	518	335	255	215	160	155
Lambda-Value	0,015	0,15	1,0	3,0	10°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

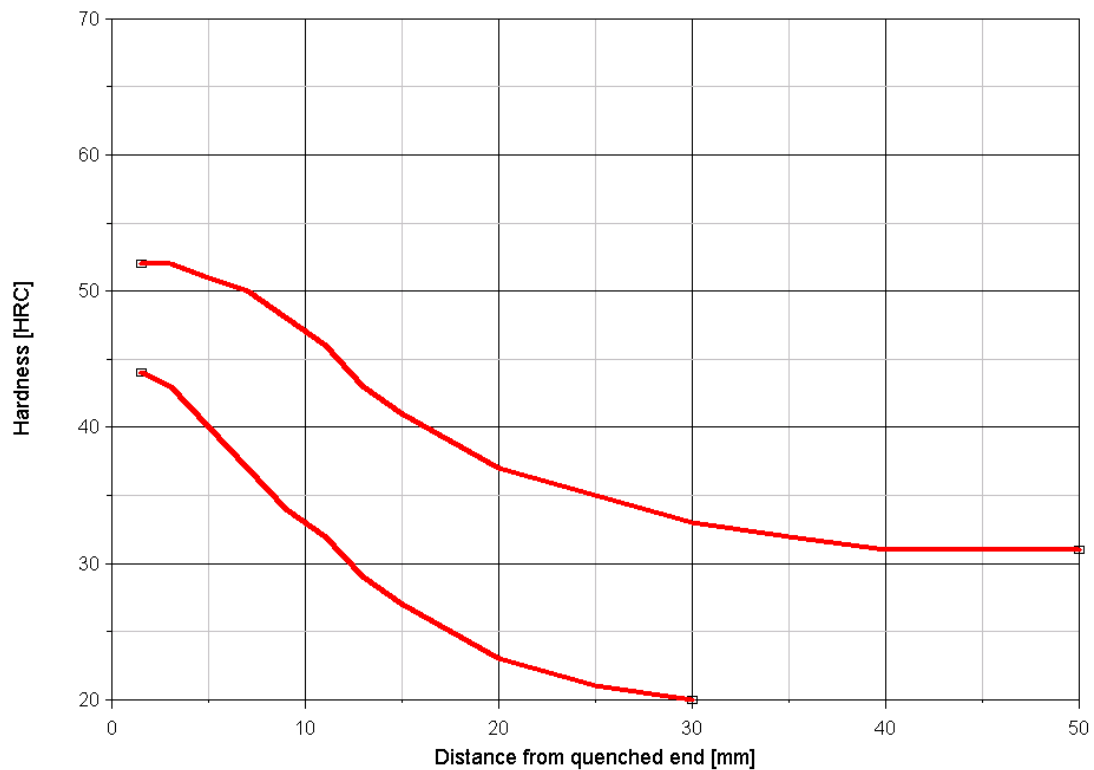


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 34CrMo4 - 34CrMoS4

Material No.:	Former brand name:	International steel grades:	
1.7220	Mo 35	BS:	708A37
1.7226		AFNOR:	34CrMo4, 35CD4
		SAE:	4135, 4137

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	Mo	S	other
	34CrMo4	0,34	0,25	0,70	1,10	0,25	<0,035	(Pb)
	34CrMoS4	0,34	0,25	0,70	1,10	0,25	0,020 0,035	(Pb)

Application: Alloyed heat treatable steel with a typical tensile strength of 800 - 1100 N/mm². For automotive and aircraft components with high toughness as crankshafts, axles, axle journals, tyres.

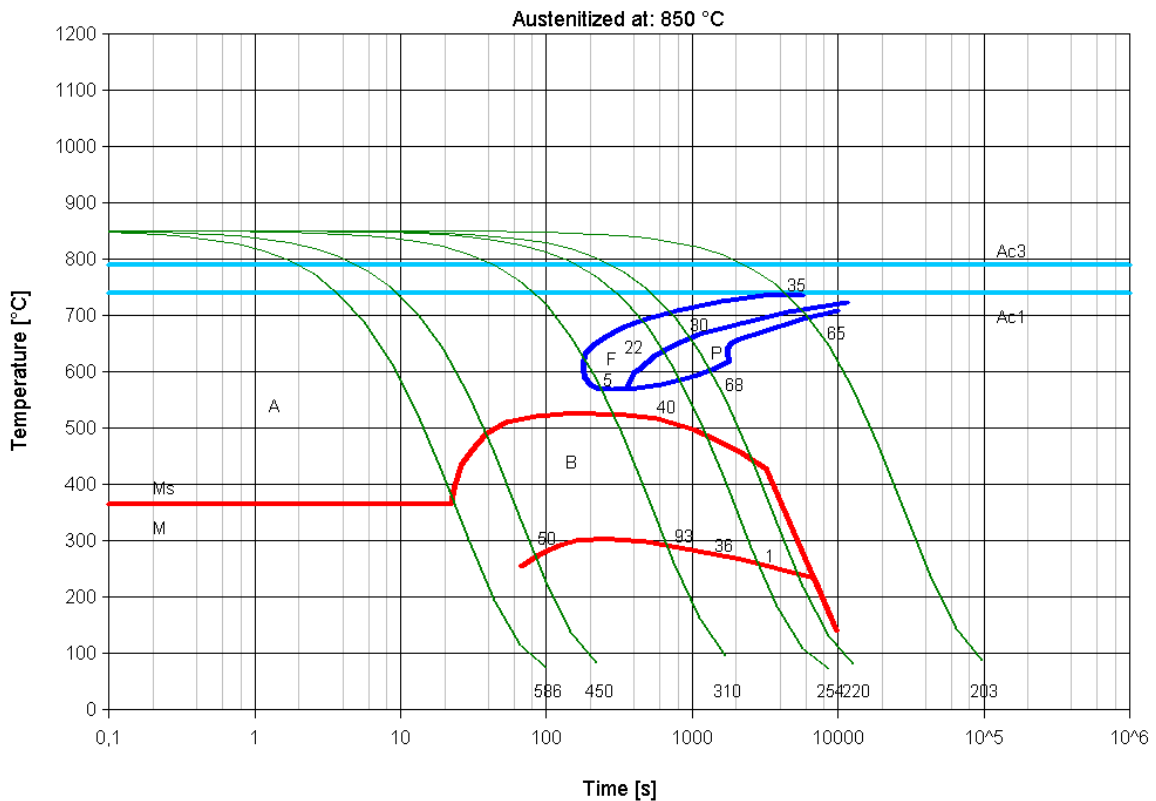
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	830 - 870°C/oil, water
	Tempering:	540 - 680°C

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 223 HB

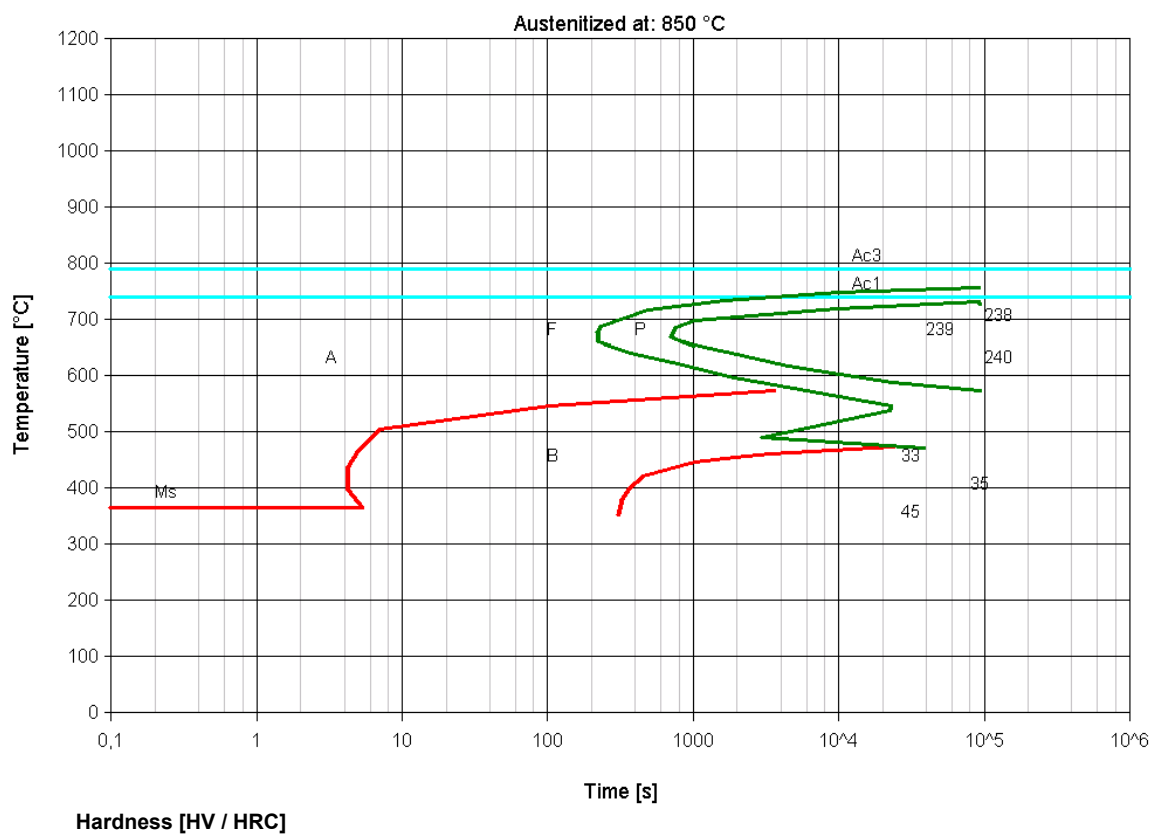
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 800	min. 650	min. 550	min. 500	min. 450
Tensile strength R _m [N/mm ²]	1000 - 1200	900 - 1100	800 - 950	750 - 900	700 - 850
Fracture elongation A ₅ [%]	min. 11	min. 12	min. 14	min. 15	min. 15
Reduction of area Z [%]	min. 45	min. 50	min. 55	min. 55	min. 60
Notch impact energy ISO-V [J]	min. 35	min. 40	min. 45	min. 45	min. 45

Time-temperature-transformation diagram for continuous cooling

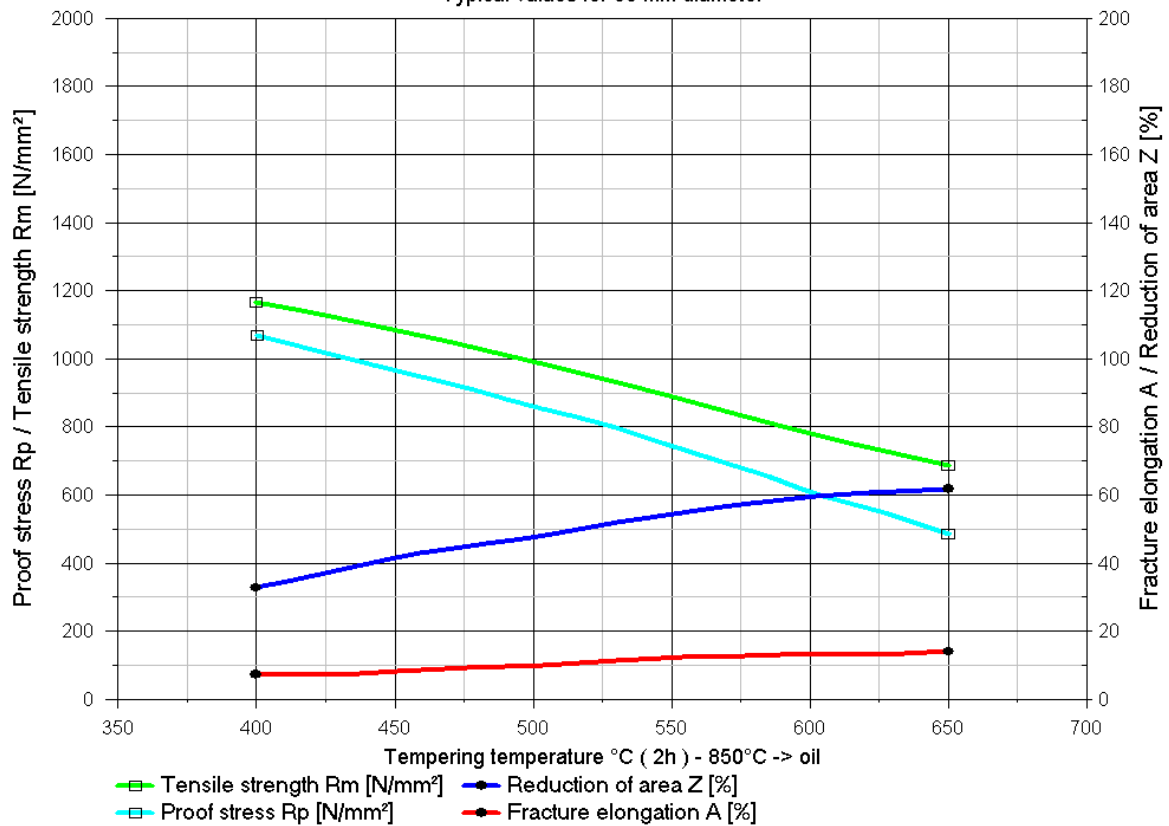


Time-temperature-transformation diagram for isothermal cooling

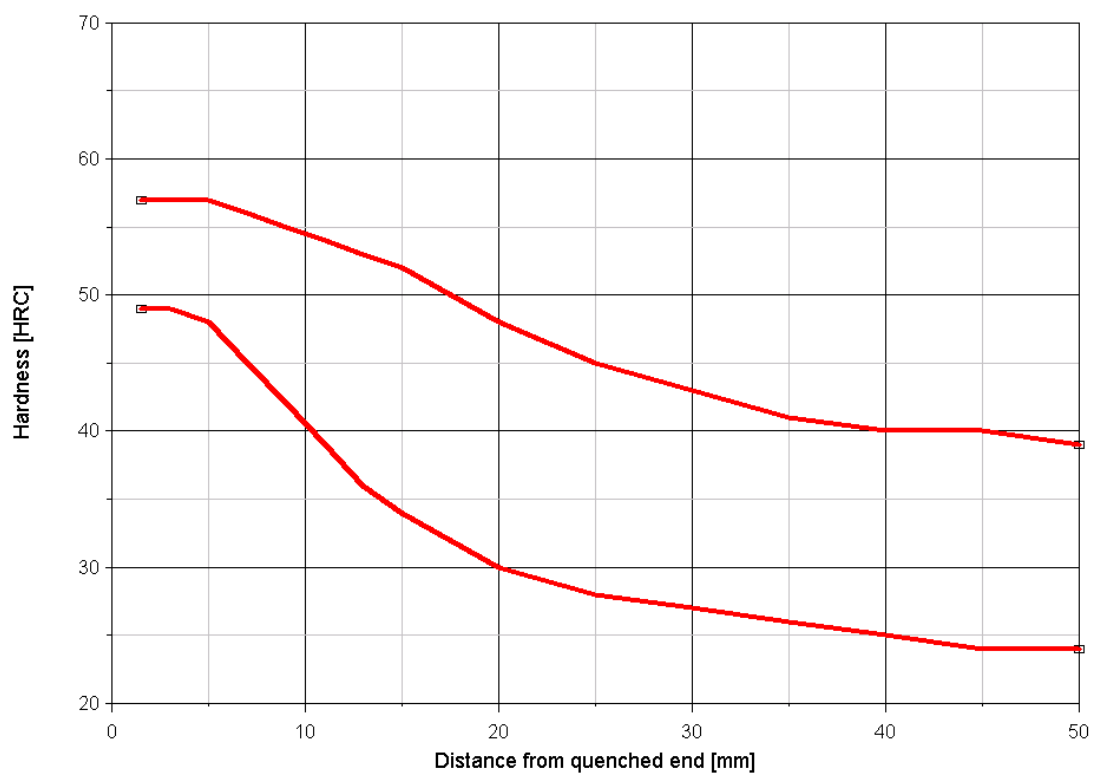


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 42CrMo4 - 42CrMoS4

Material No.:	Former brand name:	International steel grades:	
1.7225	Mo 40	BS:	708M40, 709M40, 708A42
1.7227		AFNOR:	42CD4
		SAE:	4140H, 4140RH

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	Steel	C	Si	Mn	Cr	Mo	S	other
	42CrMo4	0,42	0,25	0,75	1,10	0,22	<0,035	(Pb)
	42CrMoS4	0,42	0,25	0,75	1,10	0,22	0,020 0,035	(Pb)

Application: Alloyed heat treatable steel with a typical tensile strength of 900 - 1200 N/mm². For automotive and aircraft components with high toughness as axle journals, gears, tyres, push rods.

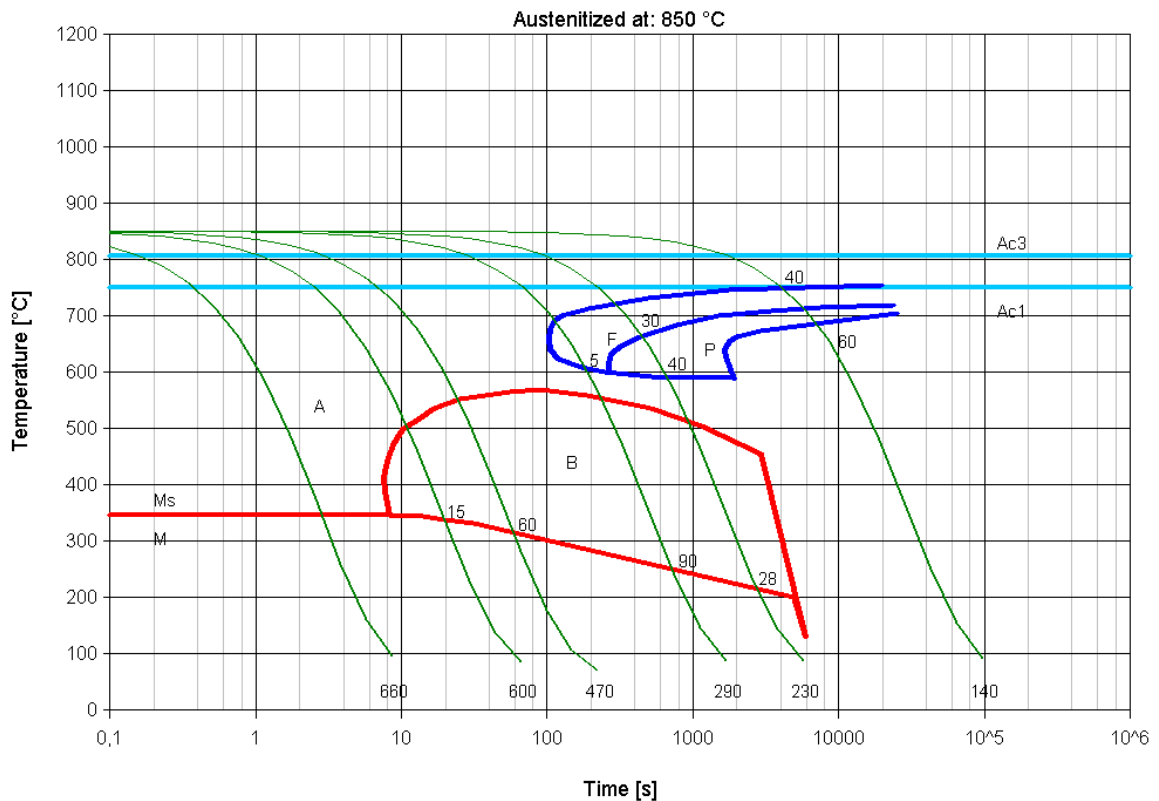
Hot forming and heat treatment:	Forging or hot rolling:	1100 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	820 - 860°C/oil, water
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 255 HB
	Soft annealed +A:	max. 241 HB

Quenched and tempered, +QT:

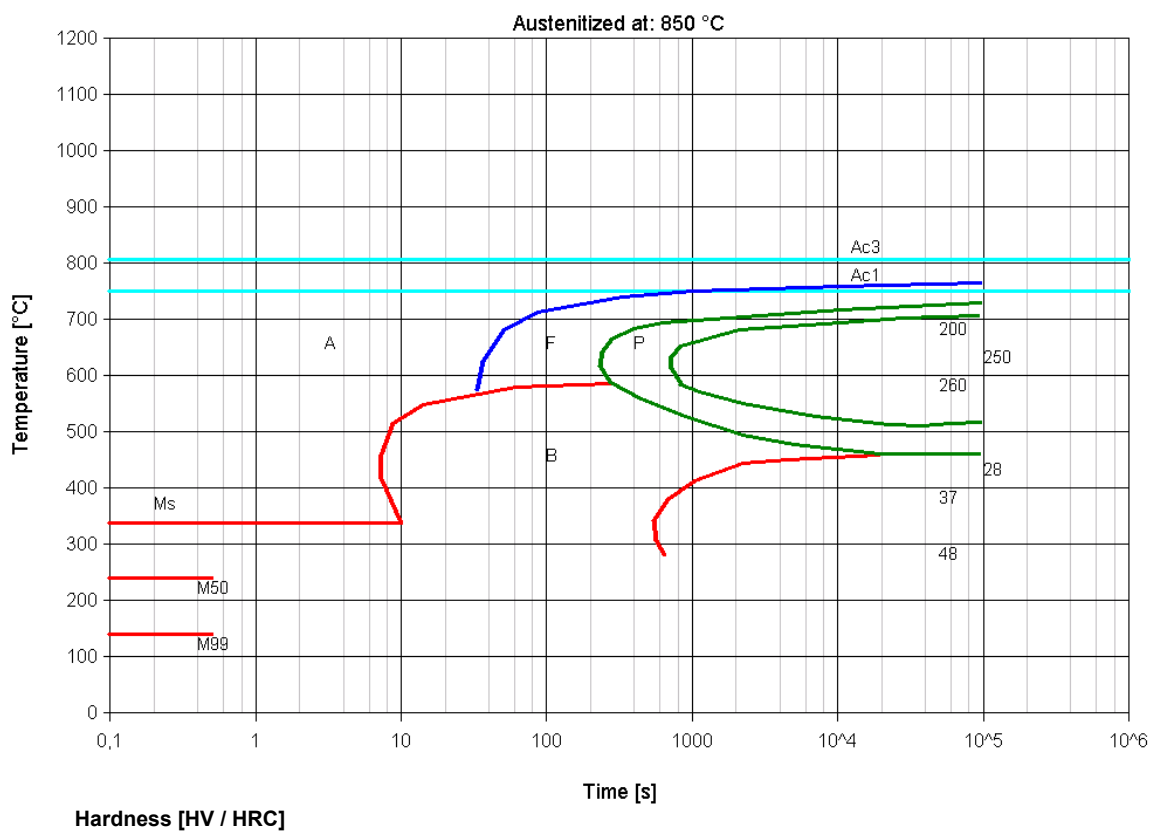
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 900	min. 750	min. 650	min. 550	min. 500
Tensile strength R _m [N/mm ²]	1100 - 1300	1000 - 1200	900 - 1100	800 - 950	750 - 900
Fracture elongation A ₅ [%]	min. 10	min. 11	min. 12	min. 13	min. 14
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 50	min. 55
Notch impact energy ISO-V [J]	min. 30	min. 35	min. 35	min. 35	min. 35

Time-temperature-transformation diagram for continuous cooling



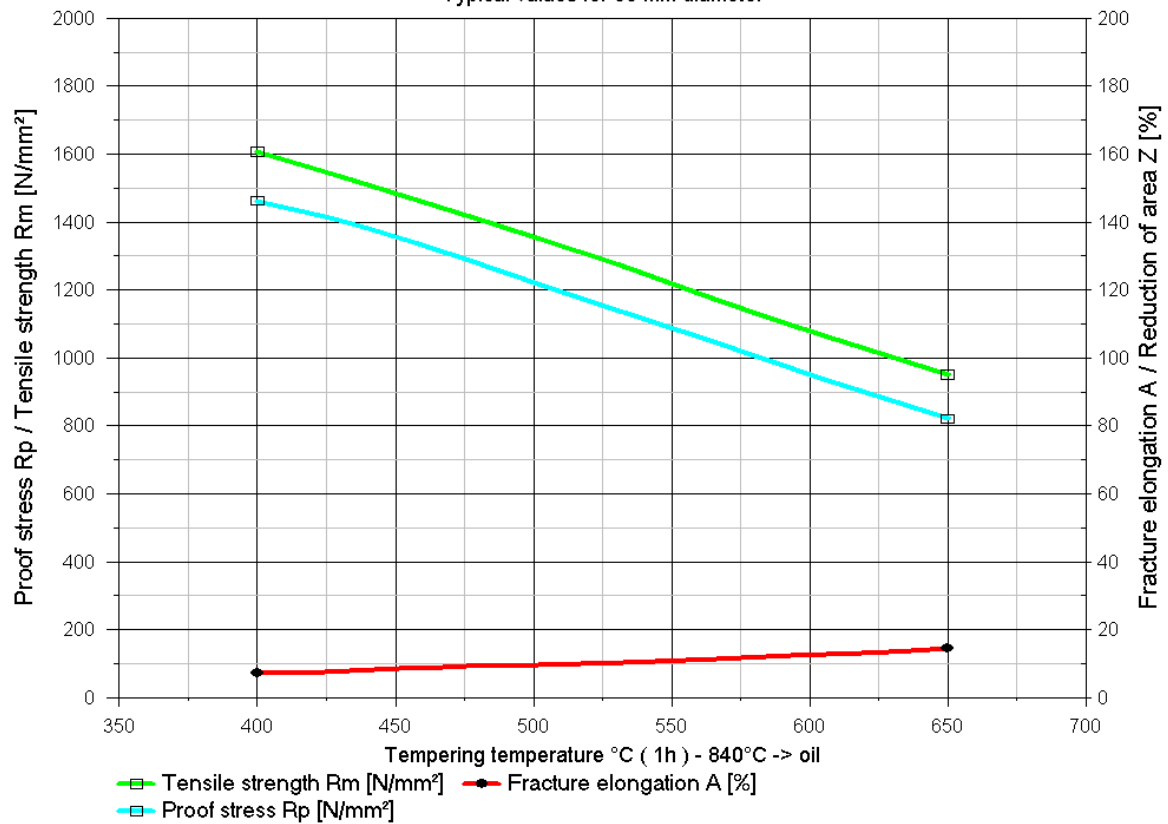
Hardness HV	660	600	470	290	230	140
Lambda-Value	0,012	0,10	0,25	1,5	20°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling

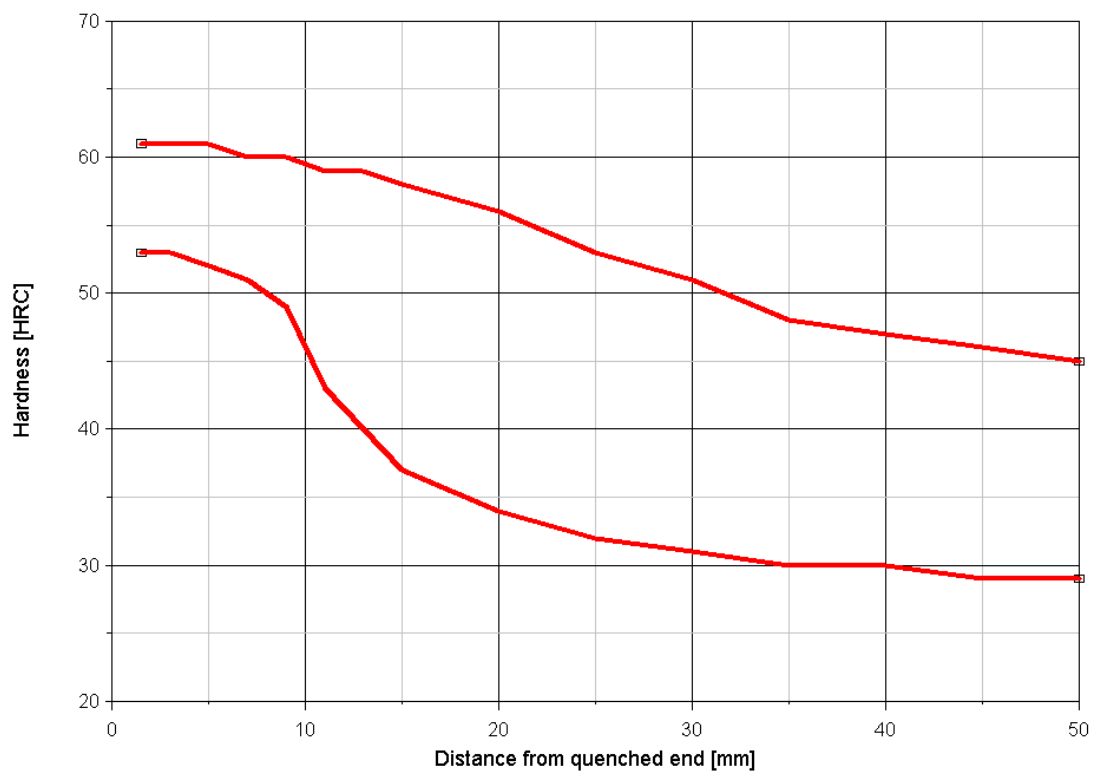


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 50CrMo4

Material No.:	Former brand name:	International steel grades:	
1.7228	Mo 50	BS:	708A47
		AFNOR:	50CrMo4
		SAE:	4150

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	other
	0,50	0,25	0,70	1,10	0,20	(Pb)

Application: Alloyed heat treatable steel with a typical tensile strength of 900 - 1200 N/mm². For automotive and aircraft components with high toughness as tyres, rings, axles, bushes, shafts, steering components.

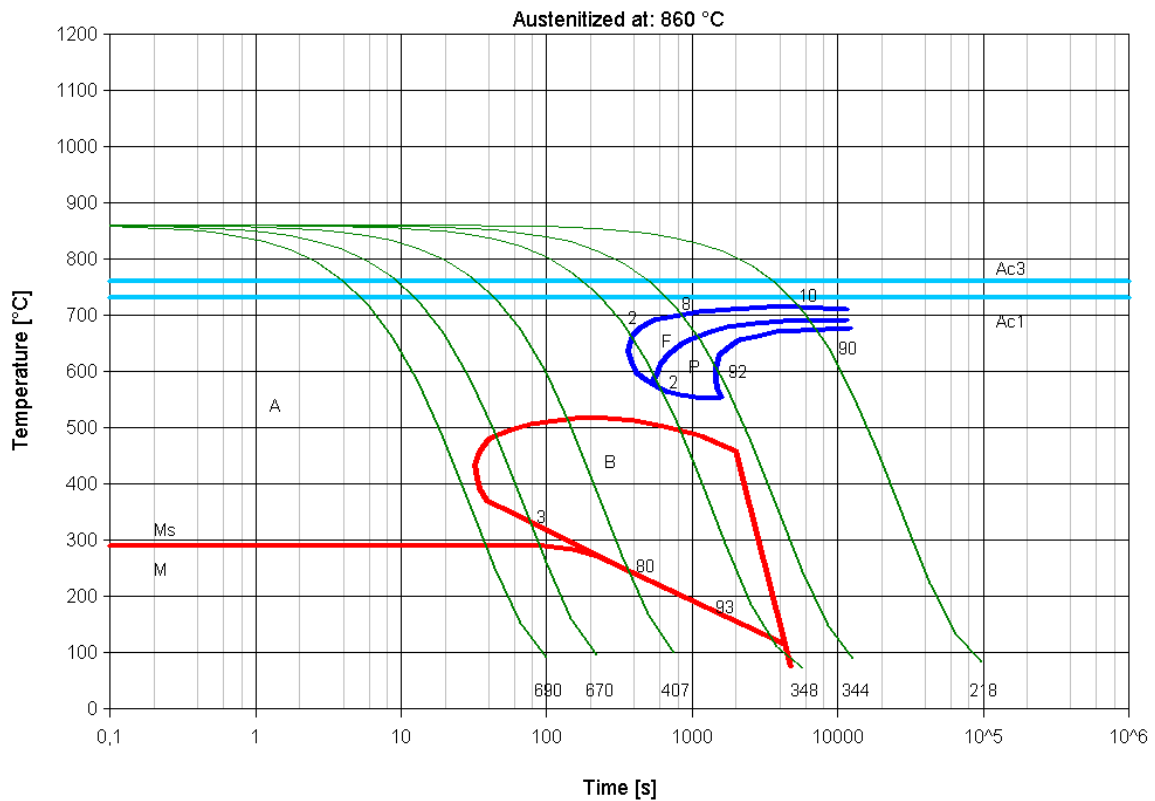
Hot forming and heat treatment:	Forging or hot rolling:	1050 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	820 - 860°C/oil
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	See condition A
	Soft annealed +A:	max. 248 HB

Quenched and tempered, +QT:

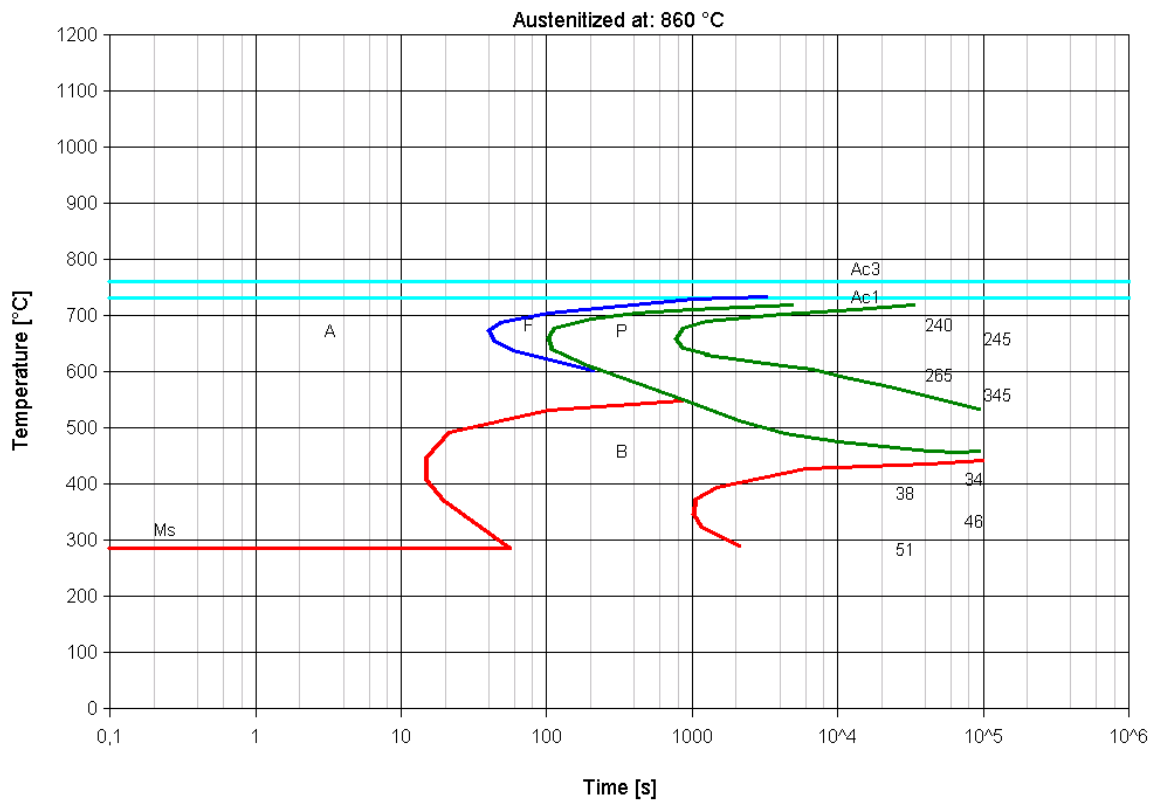
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 900	min. 780	min. 700	min. 650	min. 550
Tensile strength R _m [N/mm ²]	1100 - 1300	1000 - 1200	900 - 1100	850 - 1000	800 - 950
Fracture elongation A ₅ [%]	min. 9	min. 10	min. 12	min. 13	min. 13
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 50	min. 50
Notch impact energy ISO-V [J]	min. 30	min. 30	min. 30	min. 30	min. 30

Time-temperature-transformation diagram for continuous cooling



Hardness HV	690	670	407	348	244	218
Lambda-Value	0,16	0,35	1,3	6,7	10°/min	1,25°/min

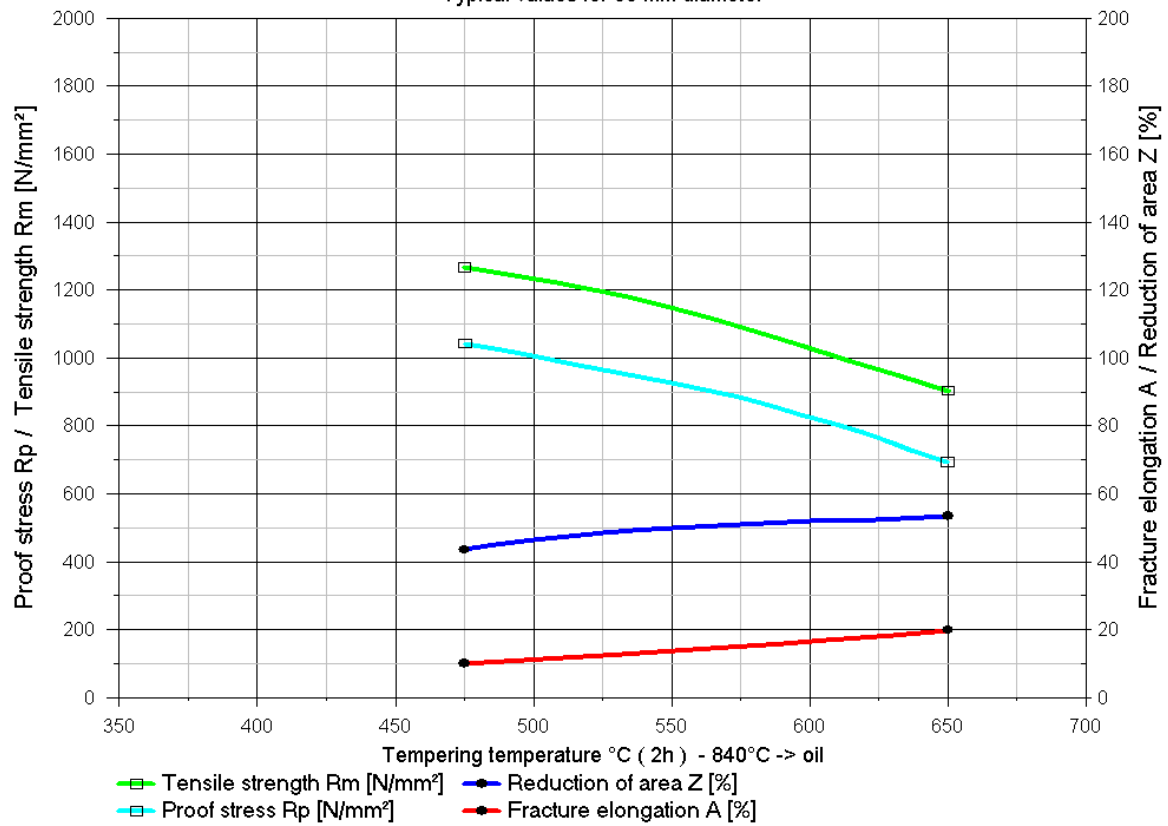
Time-temperature-transformation diagram for isothermal cooling



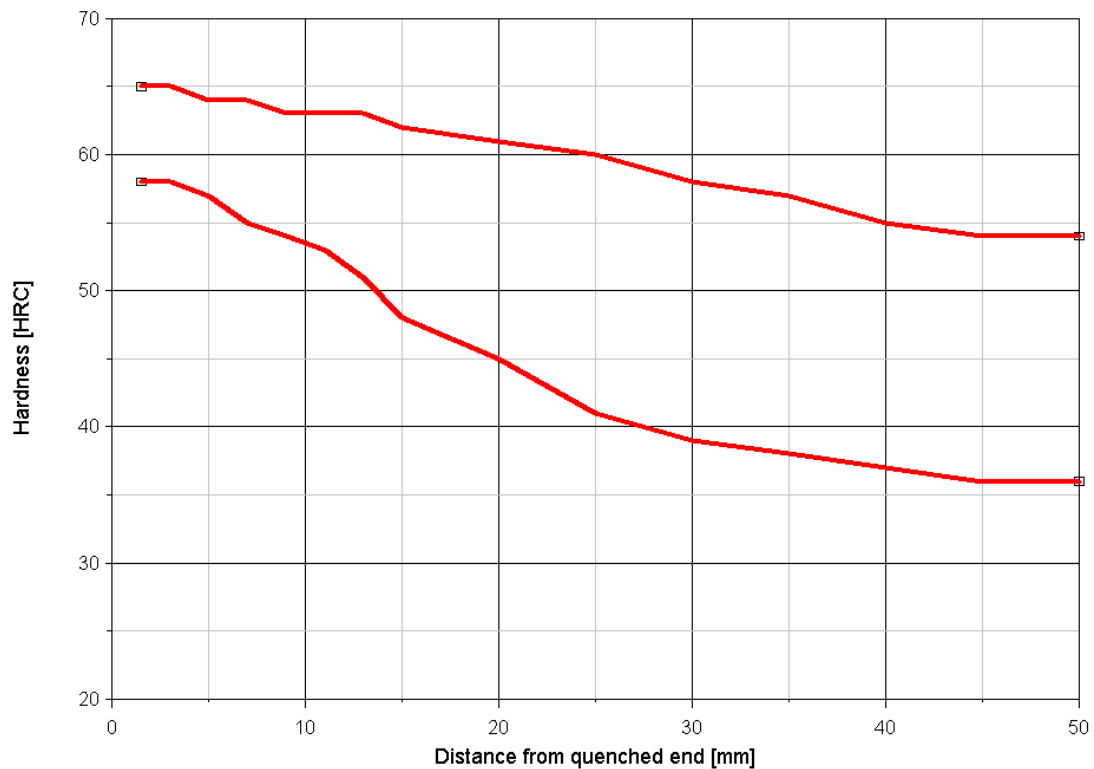
Hardness [HV / HRC]

Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 18CrMo4

Material No.: Former brand name: International steel grades:

1.7243

Mo 18

BS:
AFNOR:
SAE:

Material group: Alloyed case hardening steel

Chemical composition:	C	Si	Mn	Cr	Mo	other
(Typical analysis in %)	0,18	0,25	0,75	1,00	0,25	(Pb)

Application: Alloyed heat treatable steel with a core tensile strength range of 950 - 1200 N/mm² and high demands of toughness for wear resisting components as gearing parts, shafts and intermediate shafts.

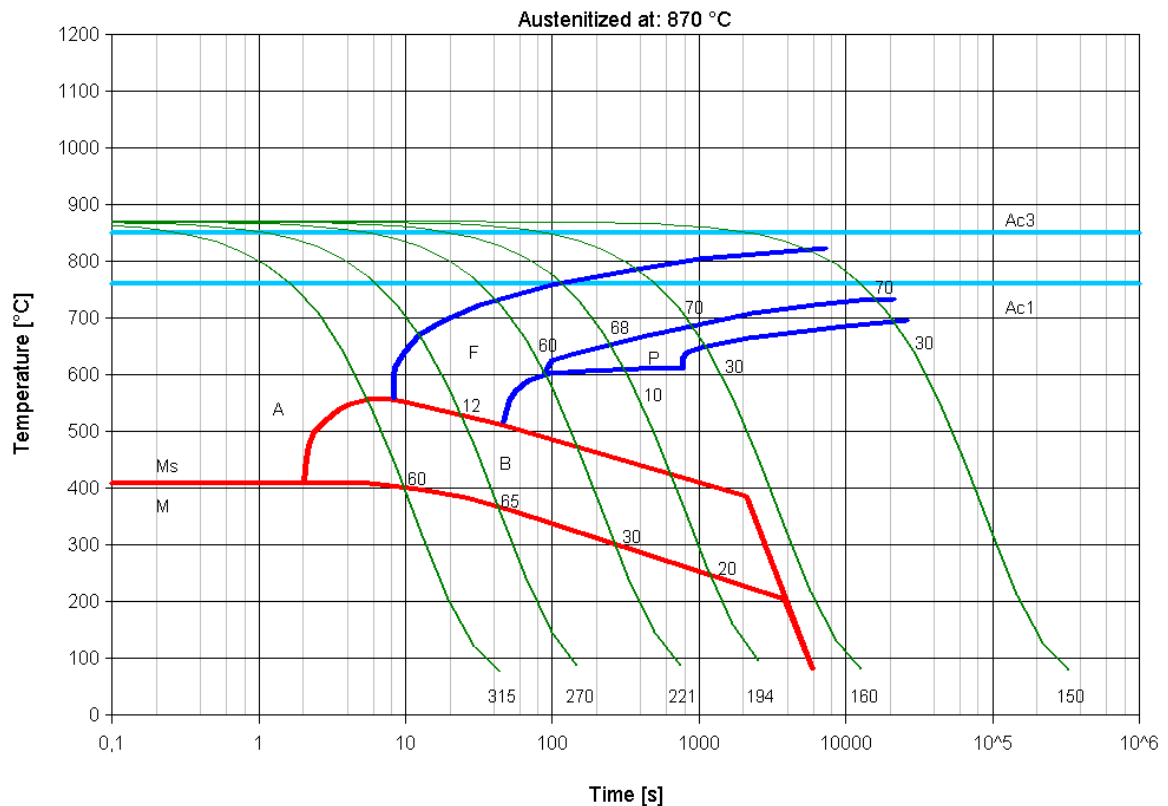
Hot forming and heat treatment:	Forging or hot rolling:	1150 - 850°C
	Normalising:	840 - 870°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	870 - 930°C
	Core hardening:	840 - 870°C/oil
	Intermediate annealing:	650 - 700°C
	Case hardening:	810 - 830°C/oil, water
	Tempering:	170 - 210°C

Mechanical Properties:	Treated for cold shearability, +S:	-
	Soft annealed, +A:	max. 210 HB
	Treated for strength, +TH:	163 - 217 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	152 - 197 HB

Core properties after case hardening
(surface hardness min. 59 HRC)

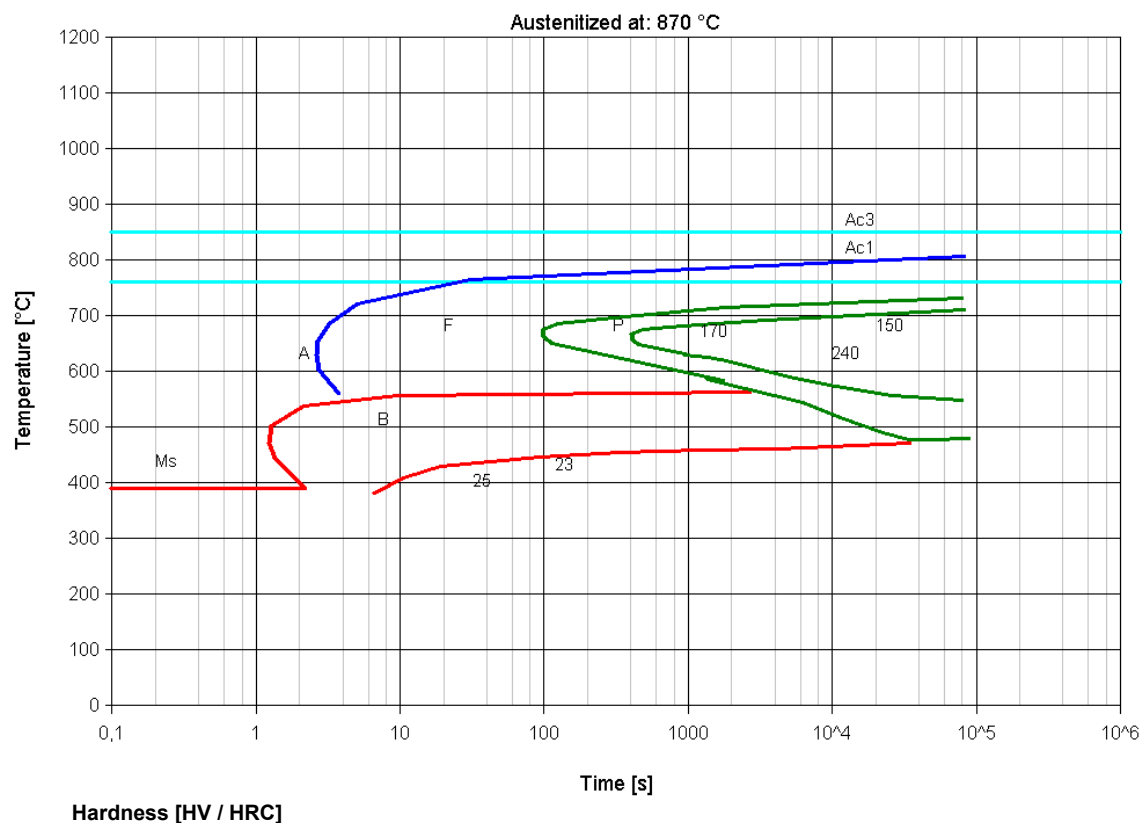
Diameter d [mm]	< 16	>16 – 40	>40 – 100
0,2% proof stress R _{p0,2} [N/mm ²]	min. 835	min. 685	min. 590
Tensile strength R _m [N/mm ²]	1080 - 1370	930 - 1300	800 - 1150
Fracture elongation A ₅ [%]	min. 9	min. 9	min. 10
Reduction of area Z [%]	min. 35	min. 35	min. 40
Notch impact energy ISO-V [J]	min. 25	min. 31	min. 31

Time-temperature-transformation diagram for continuous cooling

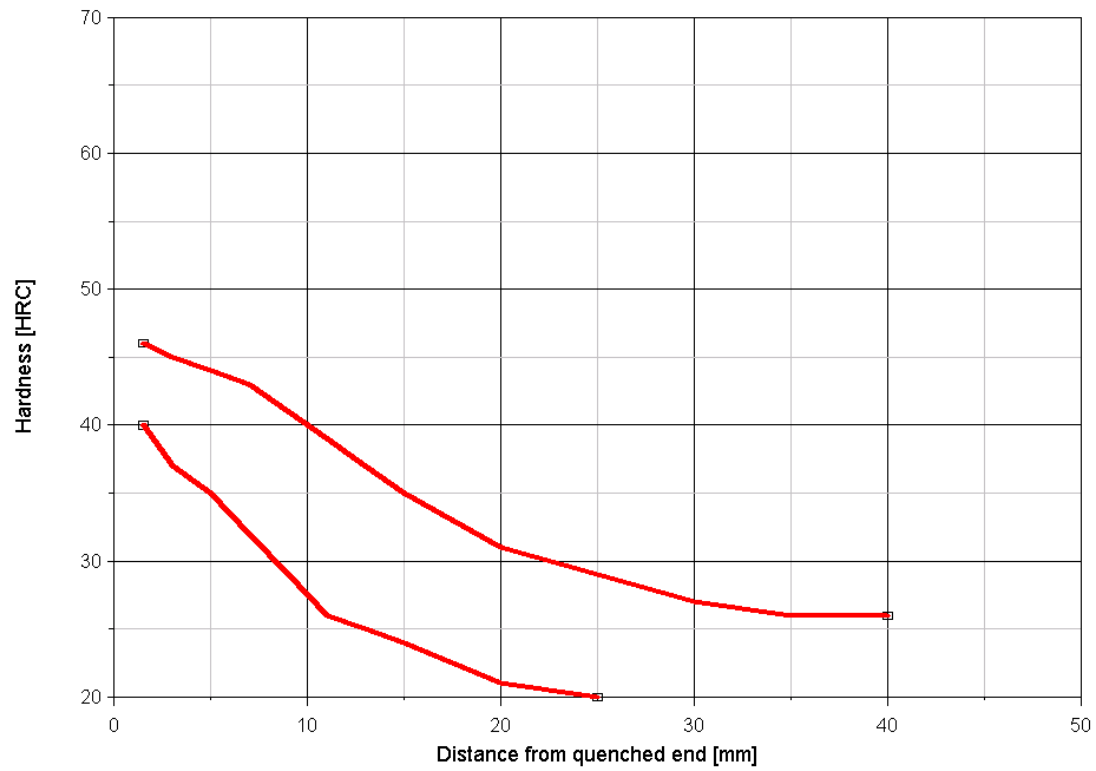


Hardness HV	315	270	221	194	160	150
Lambda-Value	0,07	0,23	1,2	4,2	10°/min	0,4°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 20MoCrS4

Material No.: Former brand name: International steel grades:

1.7323

Mo 20

BS:
AFNOR:
SAE:

Material group: Case hardening steels according to DIN EN 10084

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	S	other
	0,20	0,25	0,75	0,40	0,45	0,020 0,035	(Pb)

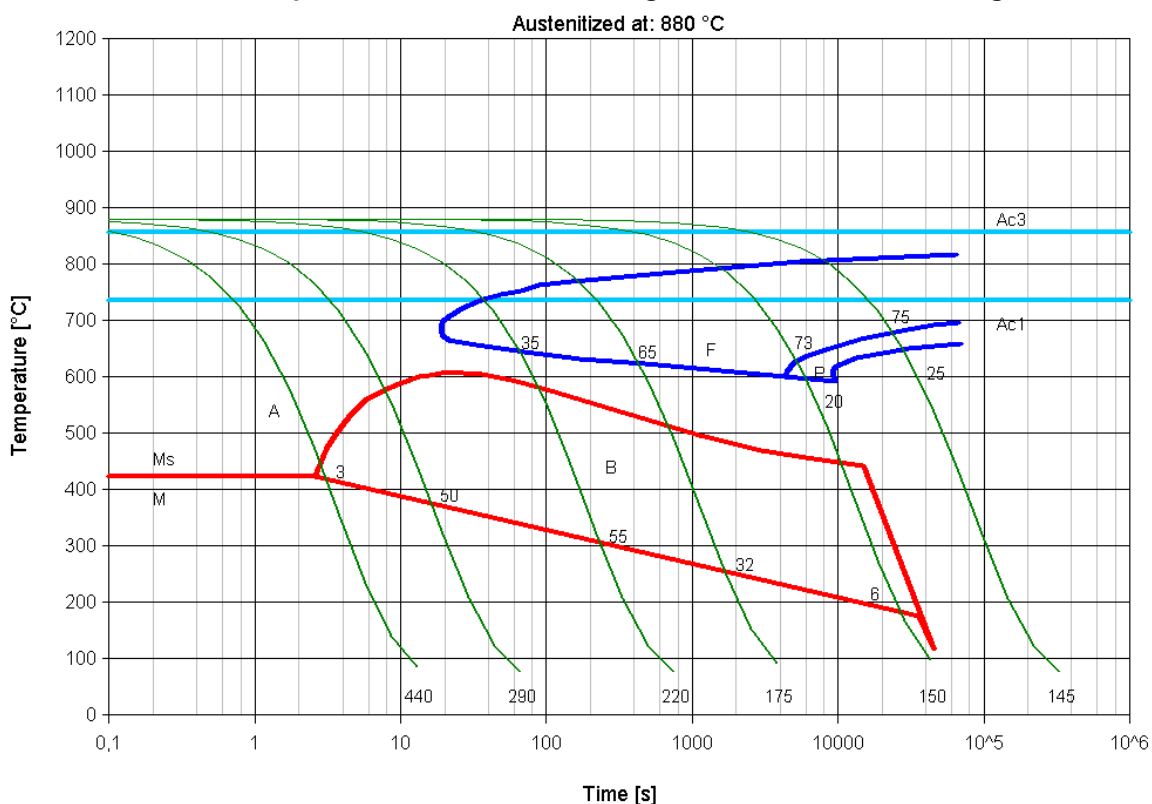
Application: Alloyed case hardening steel for wear resisting automobile and gear parts with a core tensile strength of 800 - 1100 N/mm² and high toughness for gears, crown wheels, primary shafts etc. Suitable for direct hardening.

Hot forming and heat treatment:	Forging or hot rolling:	1150 - 850°C
	Normalising:	840 - 870°C/air
	Soft annealing:	650 - 700°C/furnace
	Carburising:	880 - 980°C
	Core hardening:	860 - 900°C/oil
	Intermediate annealing:	650 - 700°C
	Case hardening:	780 - 820°C/oil
	Tempering:	150 - 200°C

Mechanical Properties:	Treated for cold shearability, +S:	max. 255 HB
	Soft annealed, +A:	max. 207 HB
	Treated for strength, +TH:	156 - 207 HB
	Treated for ferrite and pearlite structure and hardness range, +FP:	140 - 187 HB
	after hardening and tempering at 200°C:	

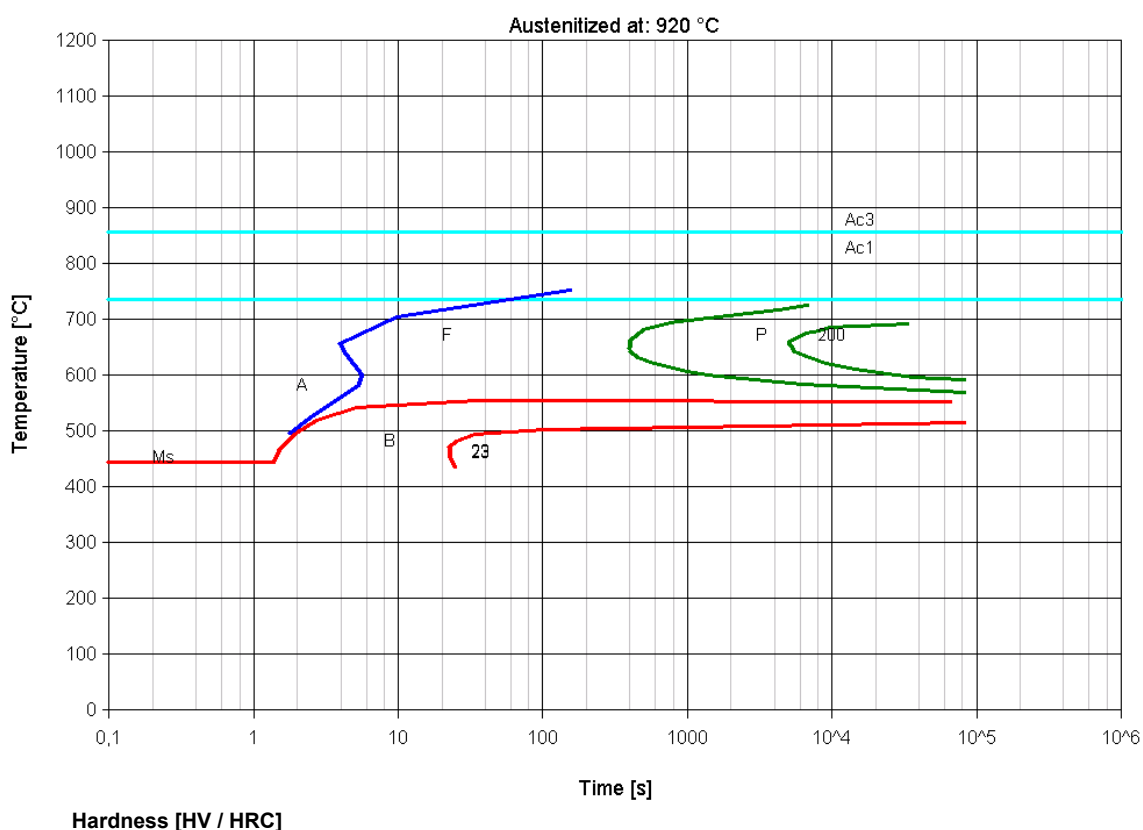
Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _{pm} [N/mm ²]	min. 900	min. 800	-

Time-temperature-transformation diagram for continuous cooling

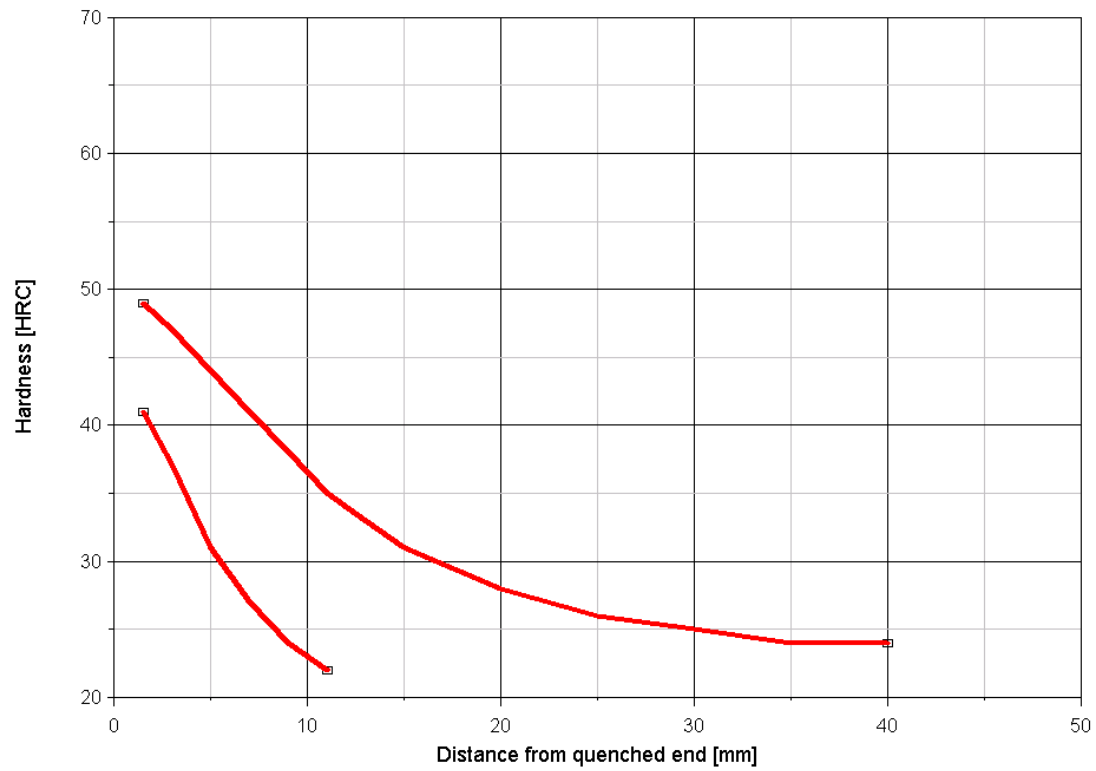


Hardness HV	440	290	220	175	150	145
Lambda-Value	0,02	0,10	1,0	6,5	2,5°/min	0,4°/min

Time-temperature-transformation diagram for isothermal cooling



Hardness scatter band



Material specification sheet

Saarstahl - 22CrMoS3-5

Material No.:

Former brand name:

International steel grades:

1.7333

BS:

AFNOR:

SAE:

Material group:

Case hardening steels according DIN EN 10084

Chemical composition:

(Typical analysis in %)

C	Si	Mn	Cr	Mo	P	S
0,19 0,24	<0,40	0,70 1,00	0,70 1,00	0,40 0,50	<0,035	0,020 0,040

Application:

Alloyed case hardening steel for wear resisting parts at high core tensile strength and good machinability.

Hot forming and heat treatment:

Forging or hot rolling:	1150 - 900°C
Normalising:	840 - 870°C
Soft annealing:	650 - 700°C
Carburising:	880 - 980°C
Core hardening:	860 - 900°C
Intermediate annealing:	650 - 700°C
Case hardening:	780 - 820°C
Tempering:	150 - 200°C

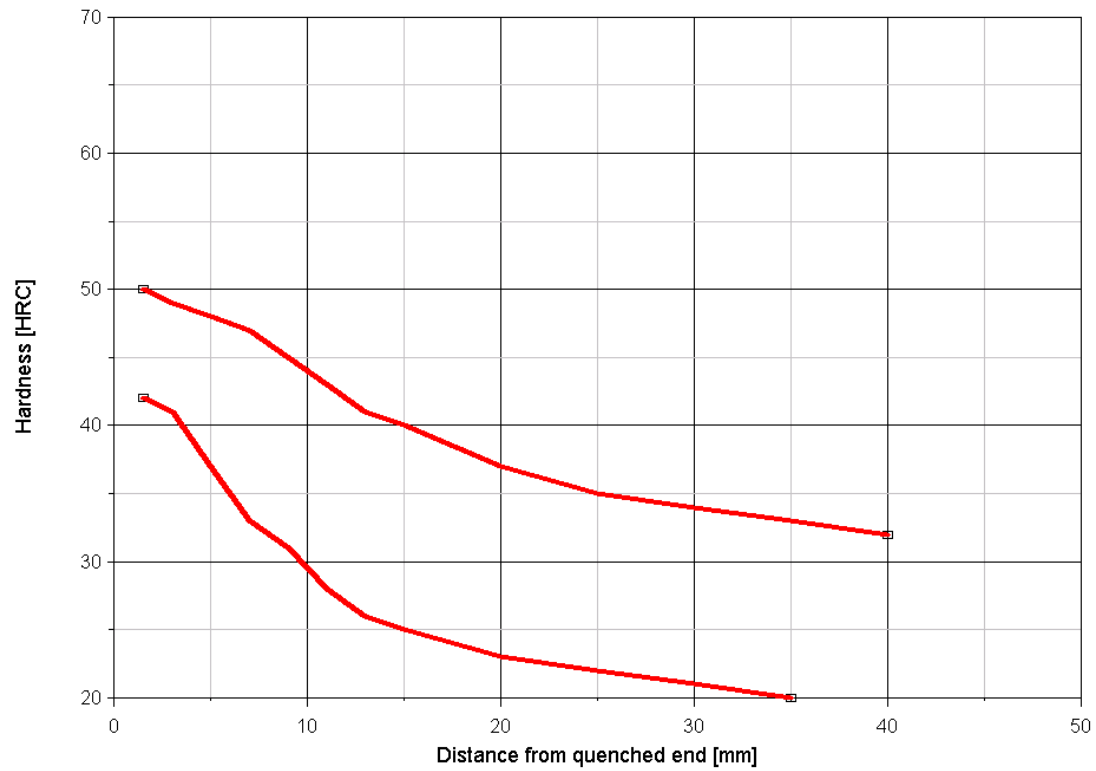
Mechanical Properties:

Treated for cold shearability, +S:	max. 255 HB
Soft annealed, +A:	max. 217 HB
Treated for strength, +TH:	170 - 217 HB
Treated for ferrite and pearlite structure and hardness range, +FP:	152 - 201 HB

after hardening and tempering at 200°C:

Diameter d [mm]	d ≤ 16	16 < d ≤ 40	40 < d ≤ 100
Tensile strength R _{pm} [N/mm ²]	min. 1100	min. 1000	min. 900

Hardness scatter band



Material specification sheet

Saarstahl - 52CrMoV4 (51CrMoV4)

Material No.:	Former brand name:	International steel grades:
1.7701	F4K	BS: AFNOR: 51CDV4 SAE:

Material group: Hot rolled steel for springs suitable for quenching and tempering according to DIN 17221

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	V
	0,50	0,25	0,90	1,10	0,25	0,10

Application: Hot rolled steel for springs for highly strained springs suitable for quenching and tempering, as leaf springs and helical vehicle springs, stabilisers vehicle, torsion bars, cup springs.

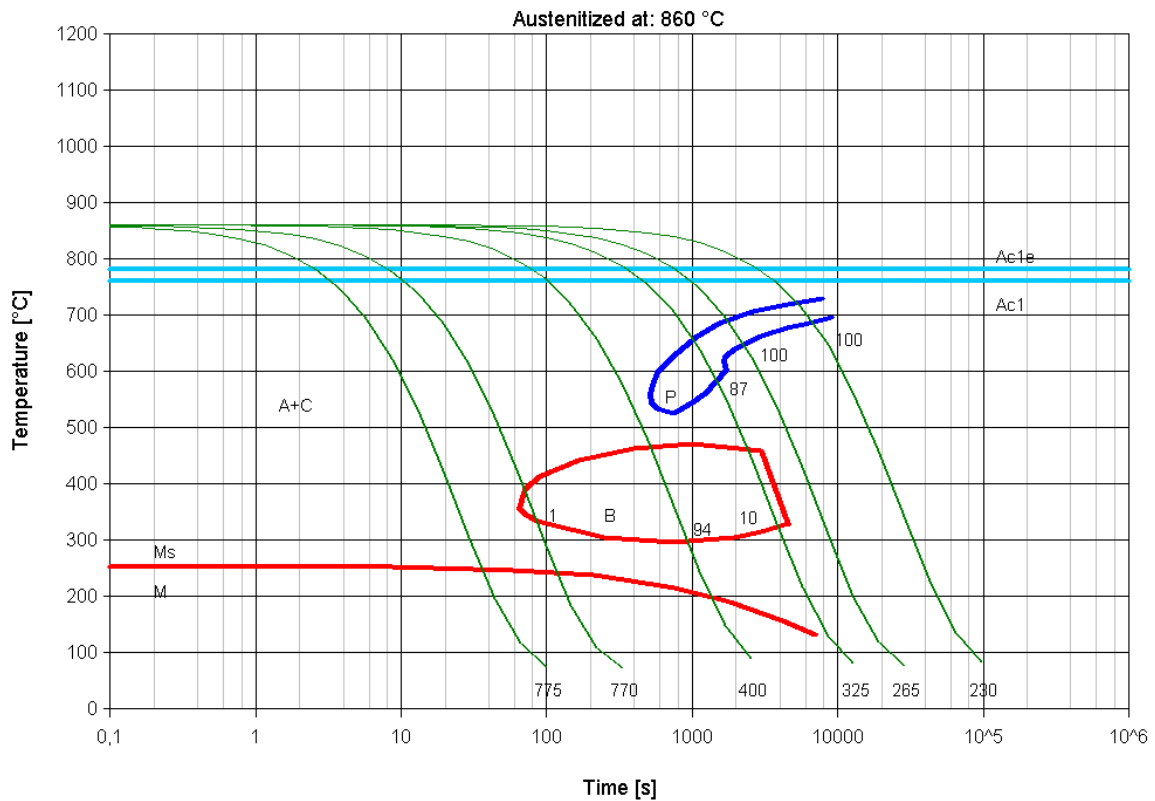
Hot forming and heat treatment:	Hot forming:	1050 - 850°C
	Hot deformation:	920 - 830°C
	Normalising:	850 - 880°C/air
	Soft annealing:	640 - 680°C/furnace
	Hardening:	830 - 860°C/oil
	Tempering:	430 - 500°C/air

Mechanical Properties:	Treated for cold shearability +S:	max. 280 HB
	Soft annealed +A:	max. 248 HB
	Spheroidized annealed - GKZ (+AC)	max. 225 HB
	Core hardness after quenching:	min. 54 HRC

Hardened and tempered, H+A, 16 mm flat steel bars, 25 mm bars

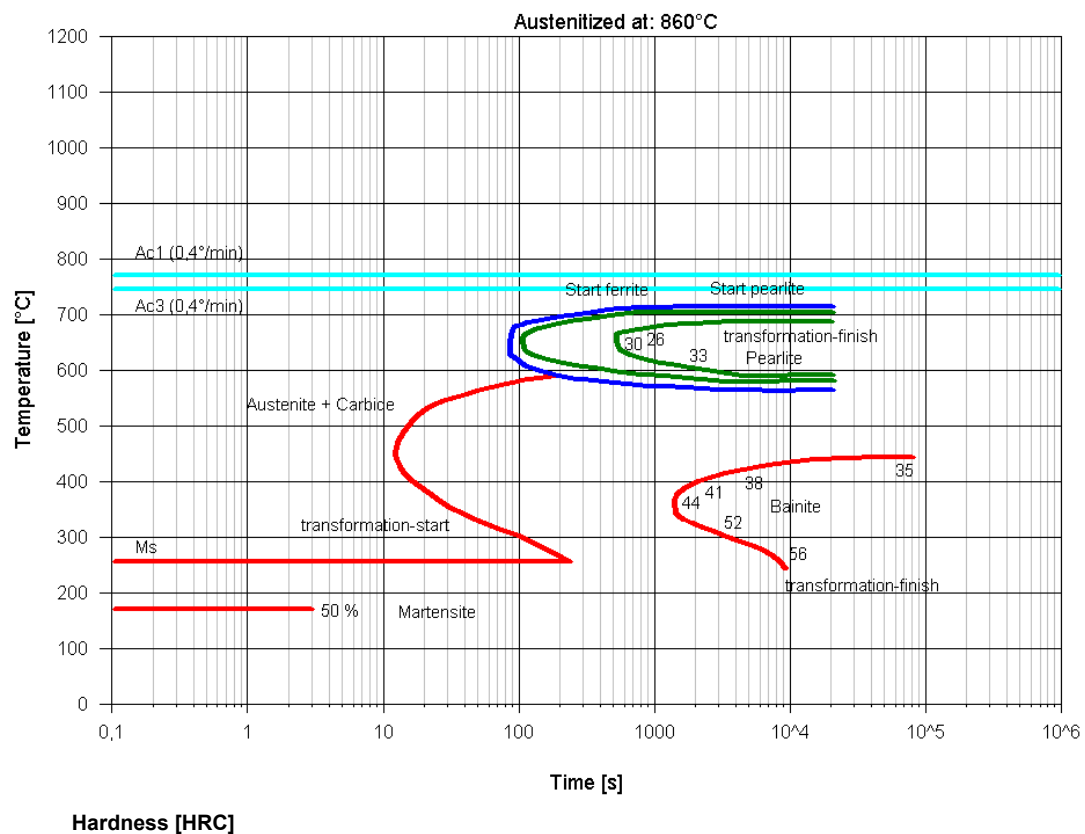
0,2% proof stress R_{p0,2} [N/mm²]	min. 1200
Tensile strength R_m [N/mm²]	1400 - 1700
Fracture elongation A₅ [%]	min. 6
Reduction of area Z [%]	min. 30
Notch impact energy ISO-V [J]	min. 6

Time-temperature-transformation diagram for continuous cooling



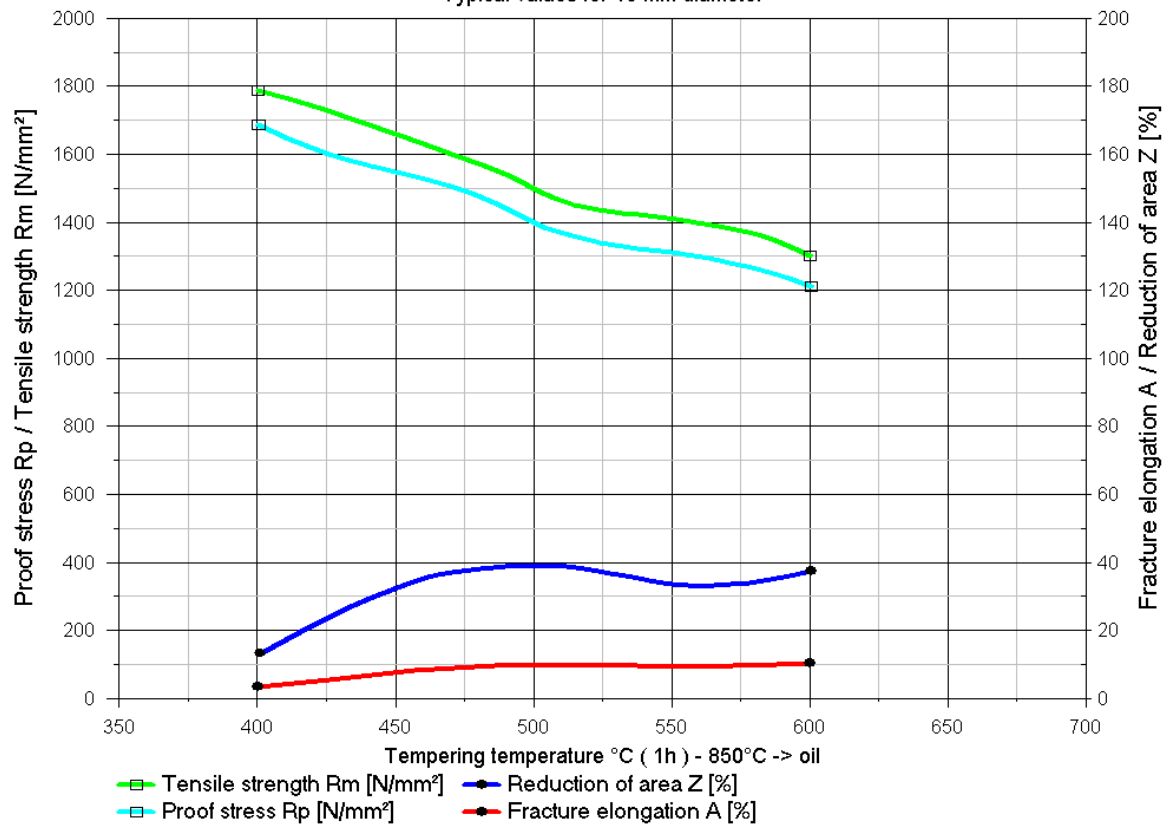
Hardness HV	775	770	400	325	265	230
Lambda-Value	0,14	0,42	4,0	10°/min	5°/min	1,25°/min

Time-temperature-transformation diagram for isothermal cooling



Tempering diagram

Typical values for 40 mm diameter



Material specification sheet

Saarstahl - 32MnCrMo6-4-3

Material No.:

German standard:

International steel grades:

1.7910

Material group:

Hot rolled steel for high strength forging components

Chemical composition:

(typical analysis at Saarstahl in %)

C	Si	Mn	P	S	Cr	Mo
0,28 0,36	<0,50	1,40 1,80	<0,025	<0,040	0,80 1,20	0,25 0,40

Deviation in chemical composition on request

Application:

Air-hardening steel for production of high strength forging components for automotive applications without quenching and tempering treatment

Hot forming and heat treatment:

Forging or hot rolling: 1050 - 1250°C
Normalising: 850 - 880°C/air
Tempering: 500 - 700°C/air

Mechanical properties:

Hot rolled: min. 330 HB
Treated for cold shearability (+S): max. 250 HB

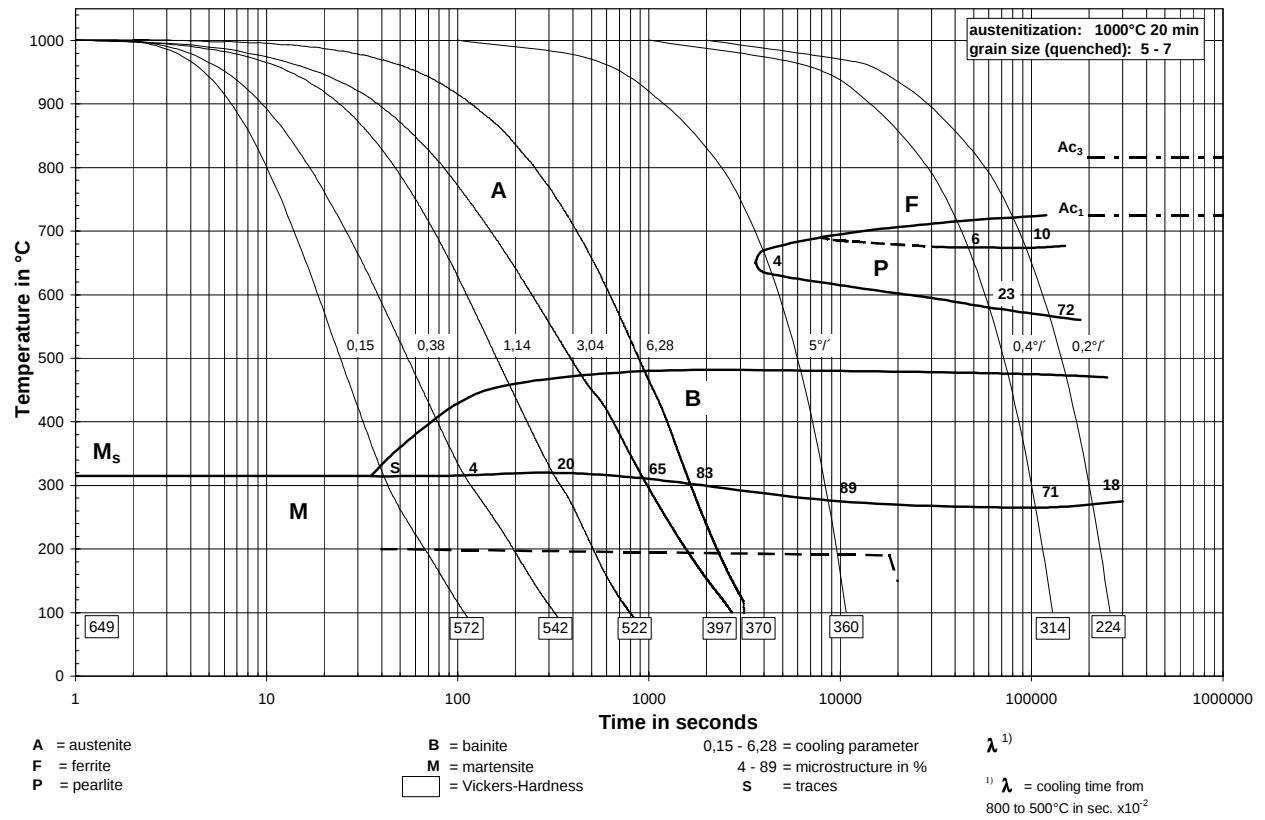
Properties of components

Condition: forged and air hardened

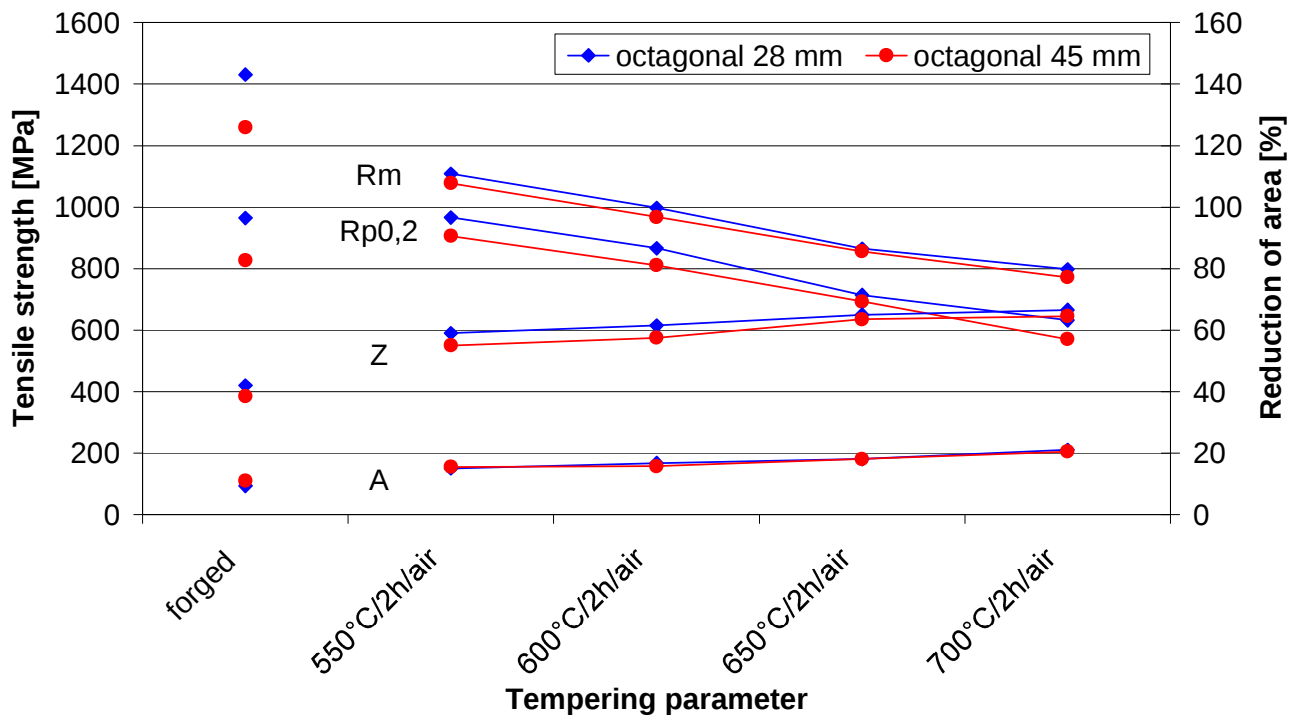
Diameter of components: $\varnothing \leq 50$ mm

0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 800
Tensile strength R_m [N/mm ²]	min. 1150
Fracture elongation A_5 [%]	min. 12
Reduction of area Z [%]	min. 38
Notch impact energy ISO-V [J] at ambient temperature	min. 12

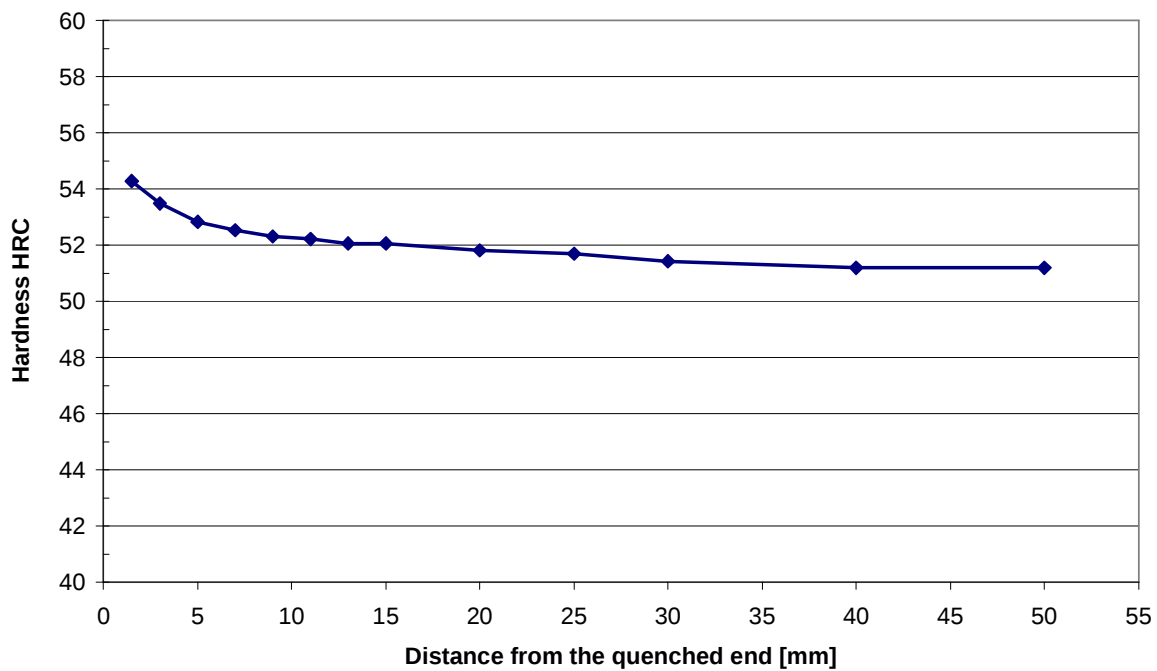
Time-temperature-transformation diagram for continuous cooling



Tempering diagram



Hardenability diagram (end-quench-test)



Material specification sheet

Saarstahl - 21CrMoV5-11

Material No.: Former brand name: International steel grades:

1.8070

Atrix 231

BS:
AFNOR:
SAE:

Material group: High temperature constructional steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	Mo	V
	0,21	0,35	0,40	1,35	1,10	0,30

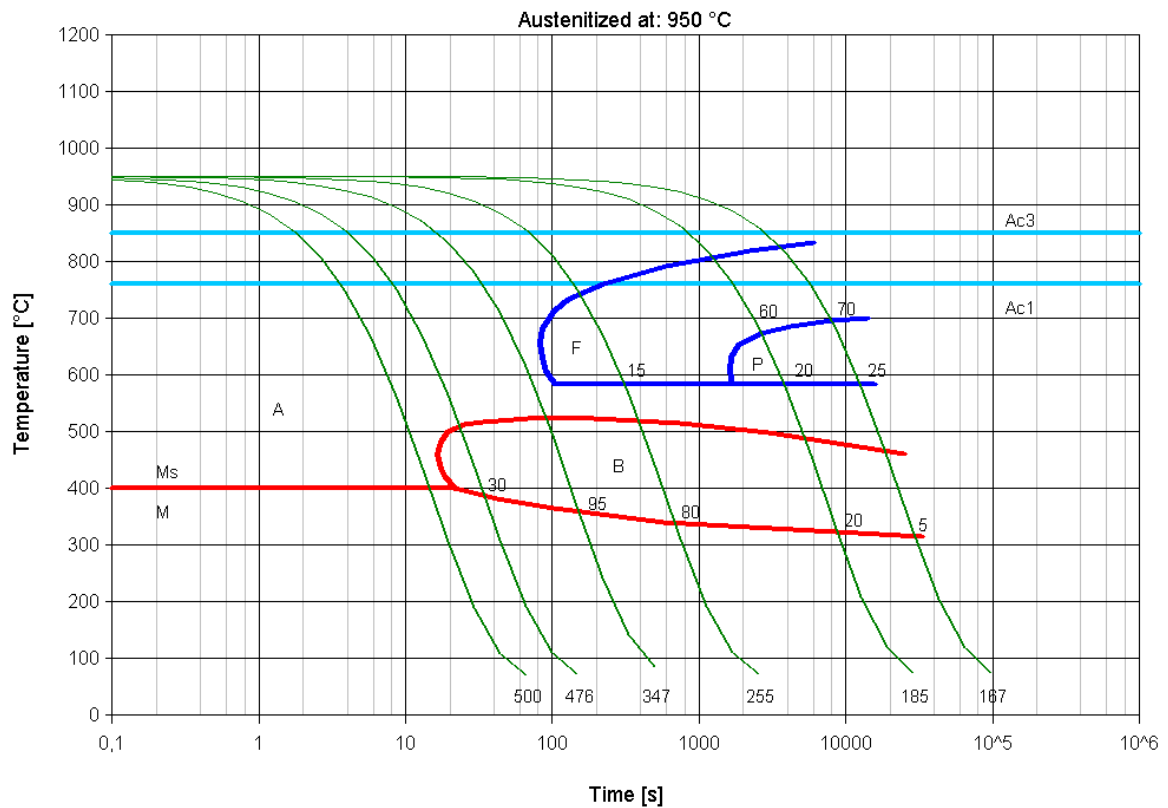
Application: High temperature constructional steel for screws, nuts and for turbine forgings

Hot forming and heat treatment:	Hardening:	900-950°C/oil, air	930-950°C/water, oil
	Tempering:	680-740°C min. 2h	690-730°C
	Stress relieving:	580-650°C	-

Mechanical Properties:

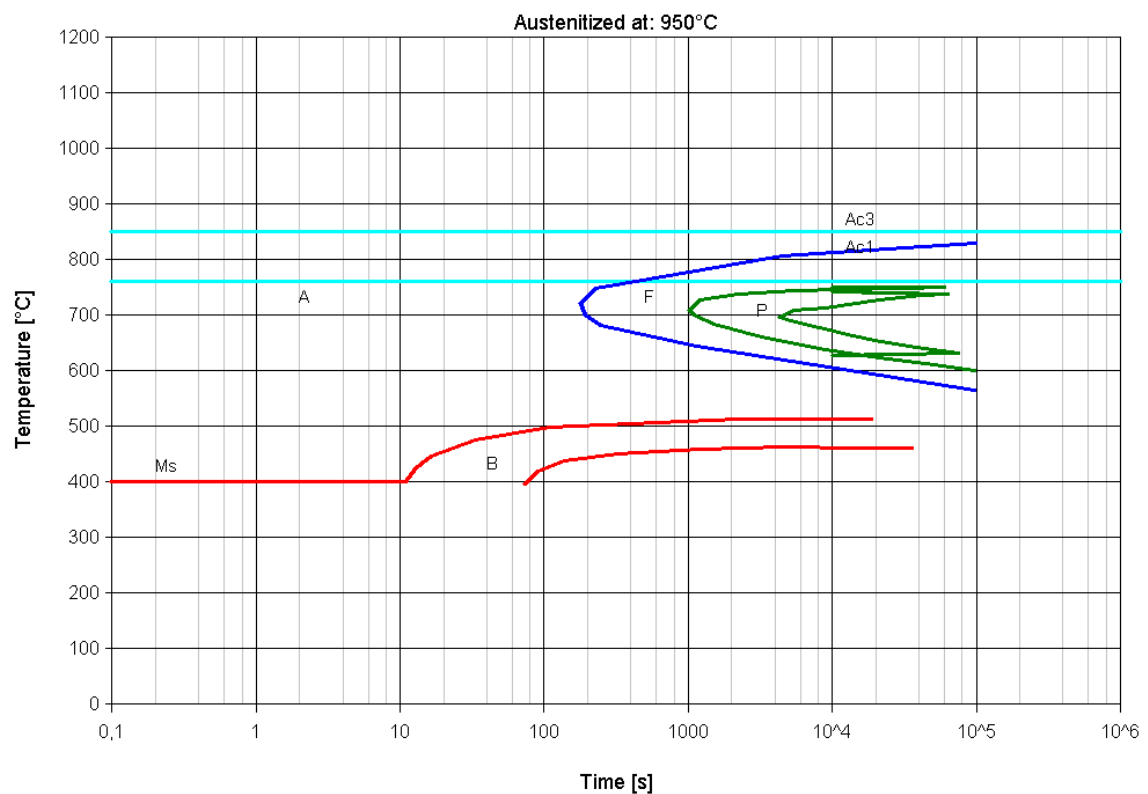
Dimension [mm]	<250	<750
0,2% proof stress $R_{p0,2}$ [N/mm ²]	min. 550	min. 550
Tensile strength R_m [N/mm ²]	700 - 850	700 - 850
Fracture elongation A_5 longitudinal [%]	min. 17	min. 16
Fracture elongation A_5 tangential [%]	min. 15	min. 14
Fracture elongation A_5 transverse [%]	min. 13	min. 12
Notch impact energy ISO-V longitudinal [J]	min. 38	min. 31
Notch impact energy ISO-V tangential [J]	min. 24	min. 24
Notch impact energy ISO-V transverse [J]	min. 19	min. 16

Time-temperature-transformation diagram for continuous cooling

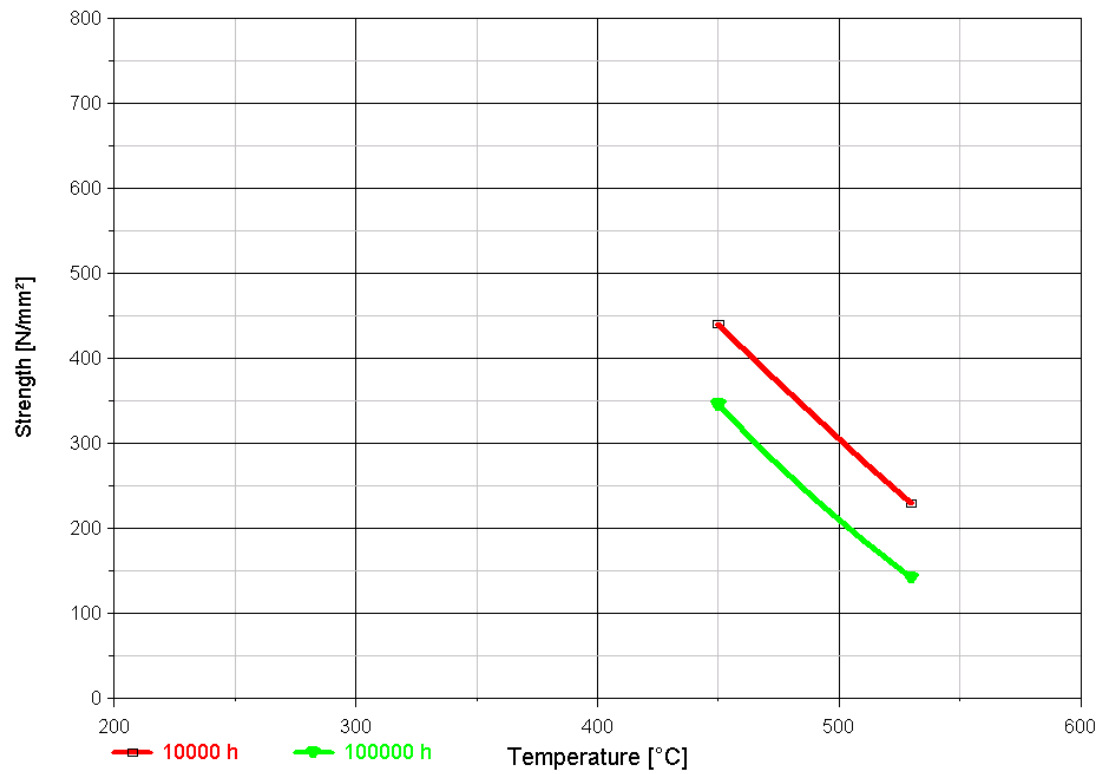


Hardness HV	500	476	347	255	185	167
Lambda-Value	0,08	0,18	0,72	3,00	5°/min	1,25°/min

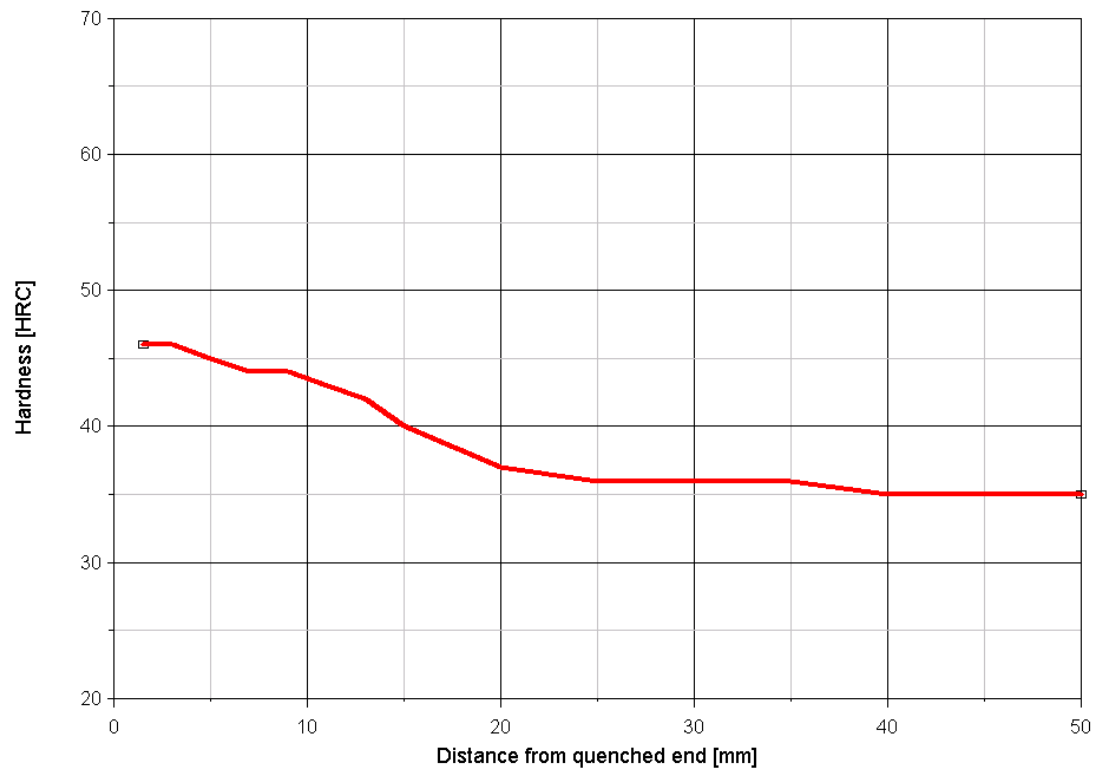
Time-temperature-transformation diagram for isothermal cooling



Creep strength diagram



Hardness scatter band



Material specification sheet

Saarstahl - 60SiCrV7

Material No.:	German standard:	International steel grades:
1.8153	DIN EN 10089	SAE: ~9262 JIS:

Material group: Hot rolled steel for quenched and tempered springs

Chemical composition: (typical analysis at Saarstahl in %)	C	Si	Mn	P	S	Cr	V
	0,60	1,50	0,49	<0,01	<0,01	0,55	0,20

Deviation in chemical composition on request

Application: Si-Cr-V alloyed quenched and tempered steel for production of springs with extraordinary small sag tendency, especially of high-stressed automotive suspension springs, produced by cold and hot forming

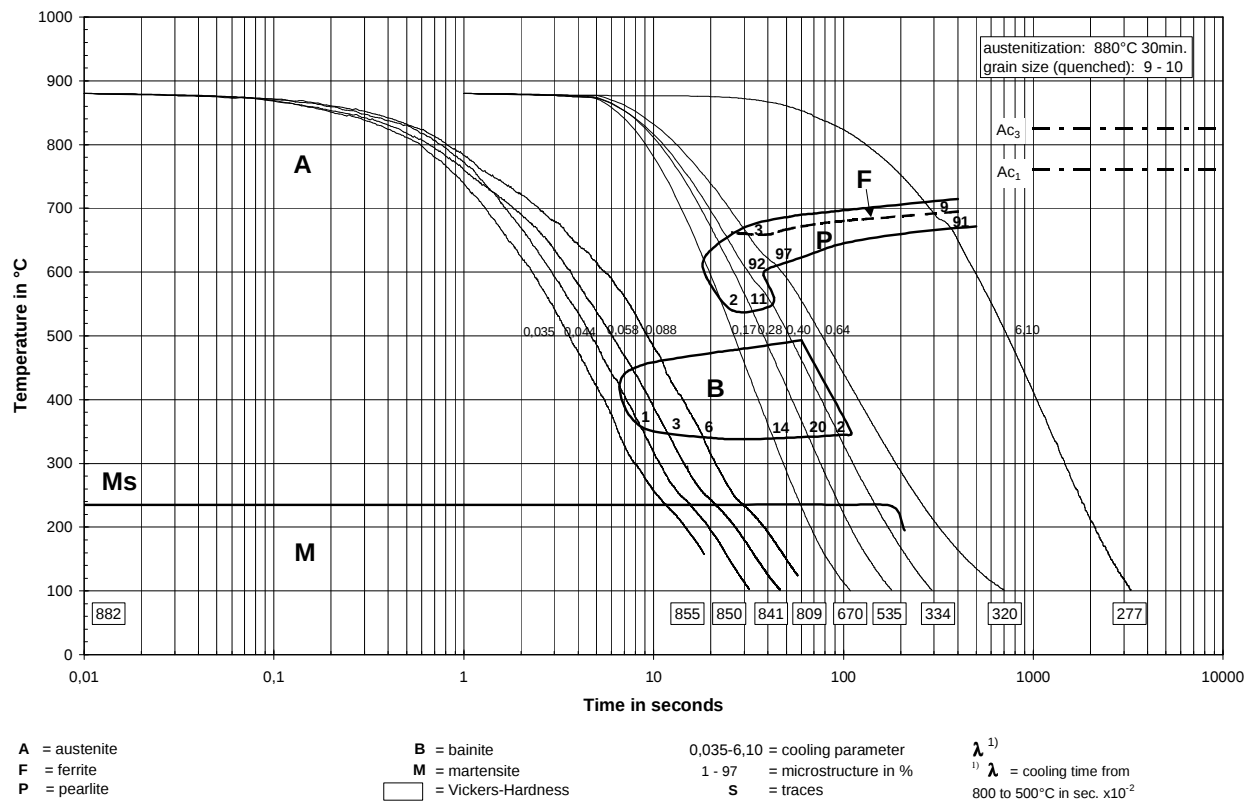
Hot forming and heat treatment:	Hot rolling:	1050 - 850°C
	Hot forming to springs:	940 - 840°C
	Normalising:	850 - 880°C/air
	Soft annealing:	640 - 680°C/furnace
	Hardening:	min. 840°C/oil
	Tempering:	375 - 500°C/air

Mechanical properties:	Treated for cold shearability (+S):	max. 280 HB
	Soft annealed (+A):	max. 248 HB
	Spheroidized annealed (+AC):	max. 230 HB

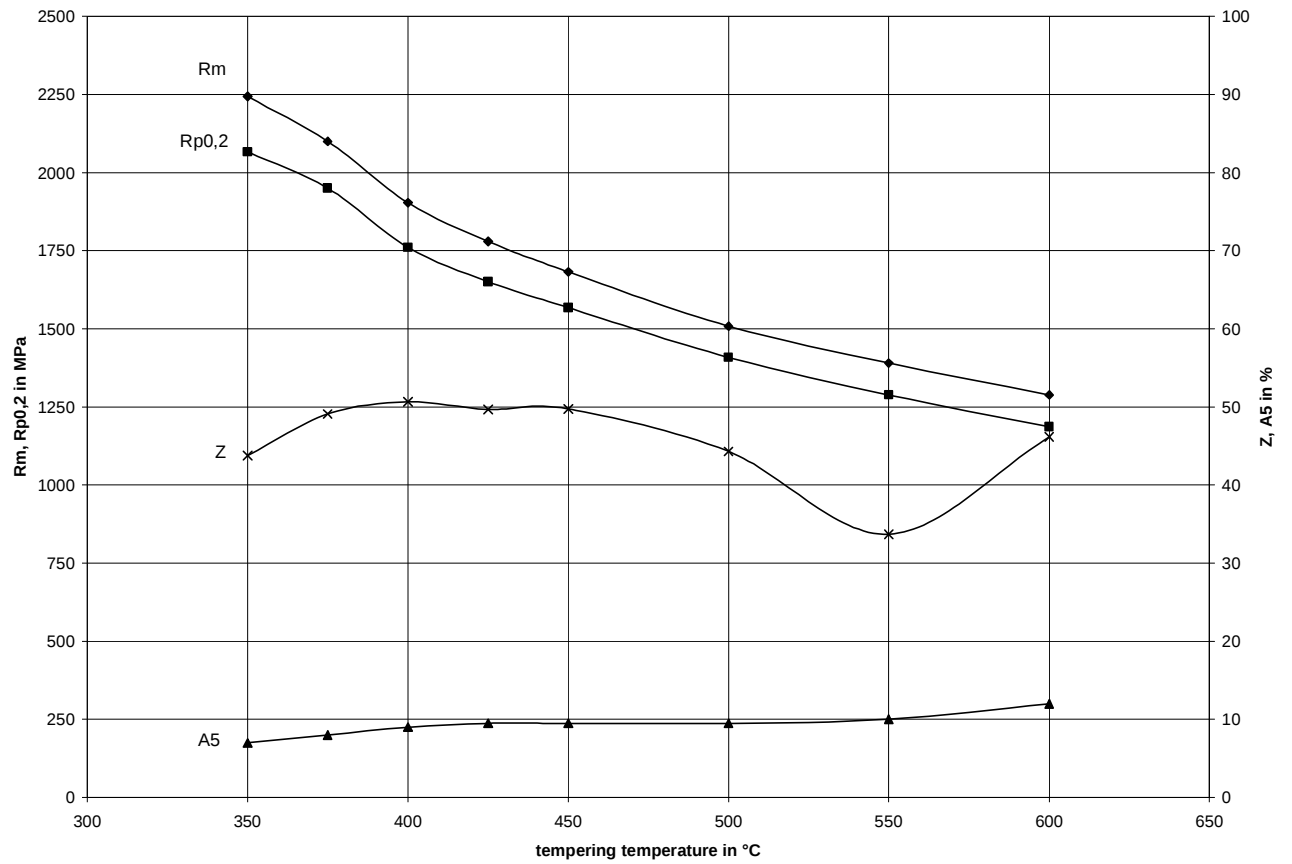
Hardened and tempered (+QT), tempering temperature 375-500°C

0,2% proof stress $R_{p0,2}$ [N/mm²]	min. 1650
Tensile strength R_m [N/mm²]	1700 - 2200
Fracture elongation A_5 [%]	min. 5
Reduction of area Z [%]	min. 30
Notch impact energy ISO-V [J]	min. 5

Time-temperature-transformation diagram for continuous cooling



Tempering diagram



Material specification sheet

Saarstahl - 51CrV4 (50CrV4)

Material No.:	Former brand name:	International steel grades:
1.8159	F2K	BS: 735A51, 735M50, 735H51 AFNOR: 50CrV4, 51CrV4 SAE: 4150

Material group: Steel for quenching and tempering according to DIN EN 10083

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	V	other
	0,50	0,25	0,90	1,10	0,12	(Pb)

Application: Alloyed heat treatable steel with a typical tensile strength of 900 - 1200 N/mm². For automotive and mechanical engineering components as gear parts, pinions, shafts.

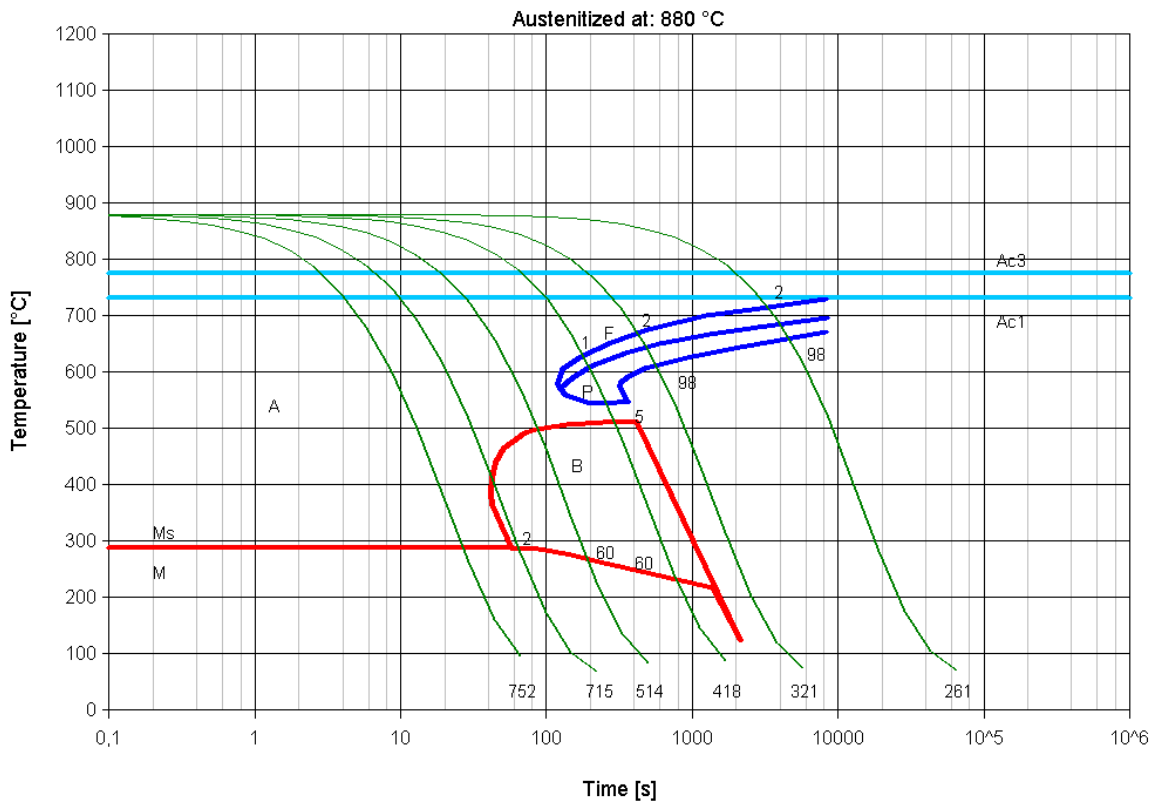
Hot forming and heat treatment:	Forging or hot rolling:	1050 - 850°C
	Normalising:	870 - 900°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	820 - 860°C/oil
	Tempering:	540 - 680°C/air

Mechanical Properties:	Treated for cold shearability +S:	See condition A
	Soft annealed +A:	max. 248 HB

Quenched and tempered, +QT:

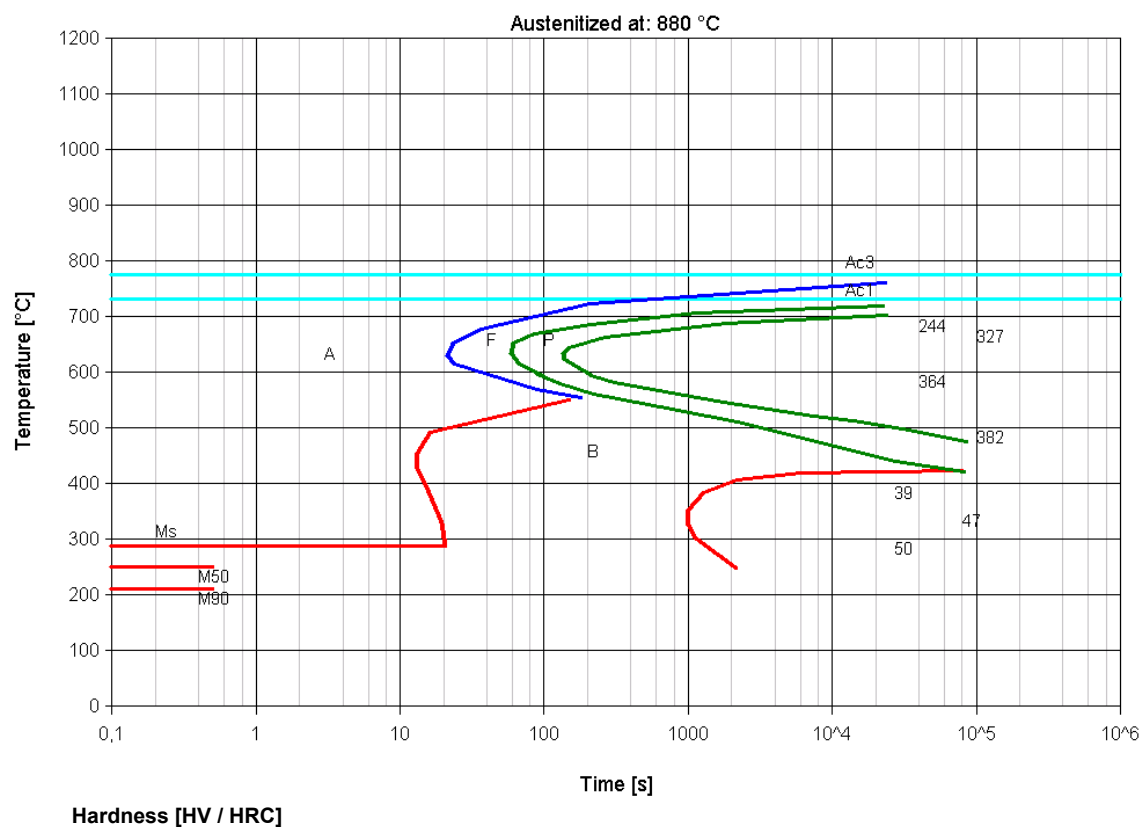
Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
Thickness t [mm]	< 8	8<t<20	20<t<60	60<t<100	100<t<160
0,2% proof stress R _{p0,2} [N/mm ²]	min. 900	min. 800	min. 700	min. 650	min. 600
Tensile strength R _m [N/mm ²]	1100 - 1300	1000 - 1200	900 - 1100	850 - 1000	800 - 950
Fracture elongation A ₅ [%]	min. 9	min. 10	min. 12	min. 13	min. 13
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 50	min. 50
Notch impact energy ISO-V [J]	min. 30	min. 30	min. 30	min. 30	min. 30

Time-temperature-transformation diagram for continuous cooling



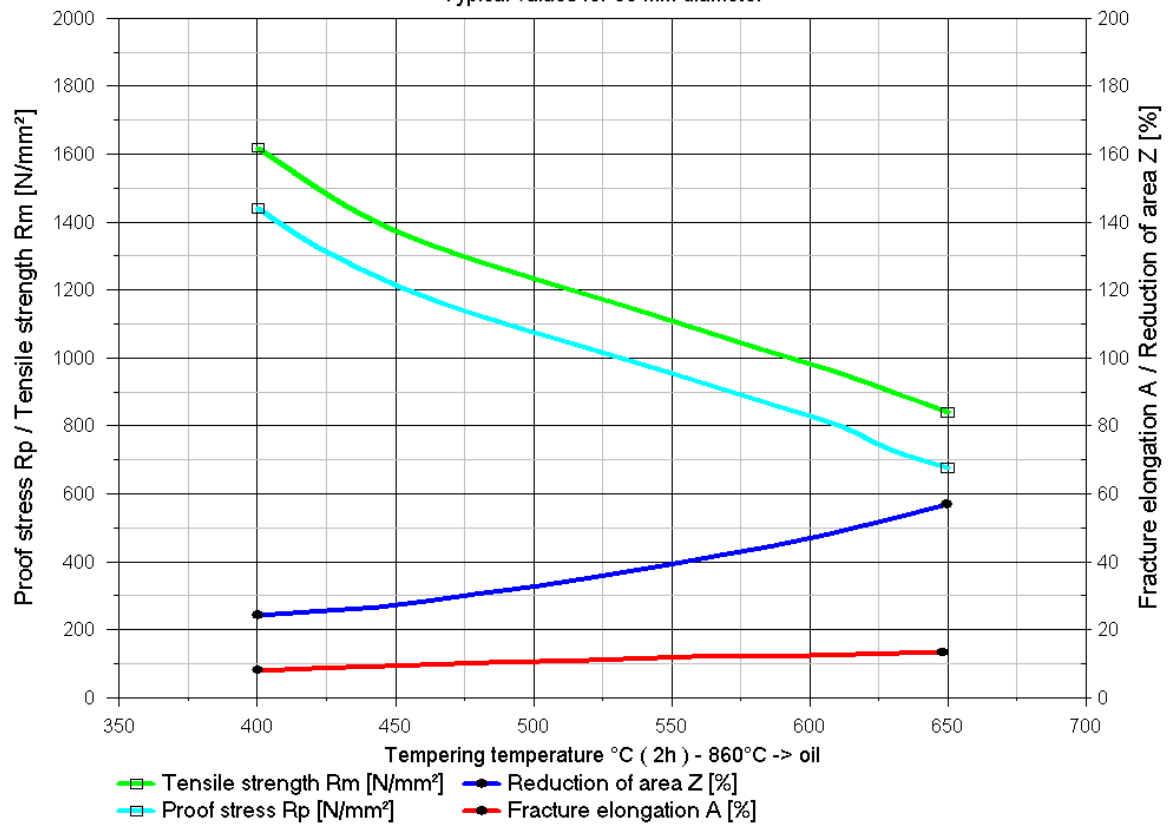
Hardness HV	752	715	514	418	321	261
Lambda-Value	0,10	0,3	0,65	2,4	6,5	2,5°/min

Time-temperature-transformation diagram for isothermal cooling

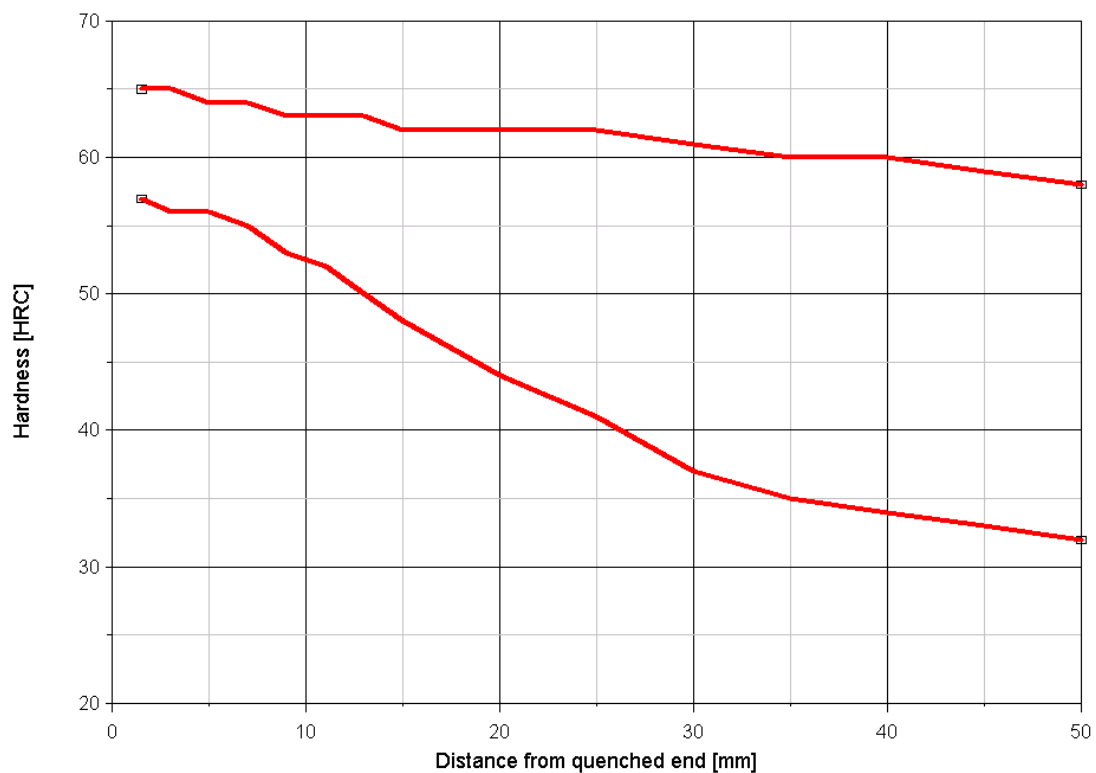


Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band



Material specification sheet

Saarstahl - 58CrV4

Material No.: Former brand name: International steel grades:

1.8161

F2KH

BS:

AFNOR:

SAE:

Material group: Alloyed heat treatable steel

Chemical composition: (Typical analysis in %)	C	Si	Mn	Cr	V	other
	0,58	0,25	0,95	1,10	0,12	(Pb)

Application: Alloyed heat treatable steel with a tensile strength range of 1100 - 1400 N/mm² for mechanical engineering, gearing and automotive components.

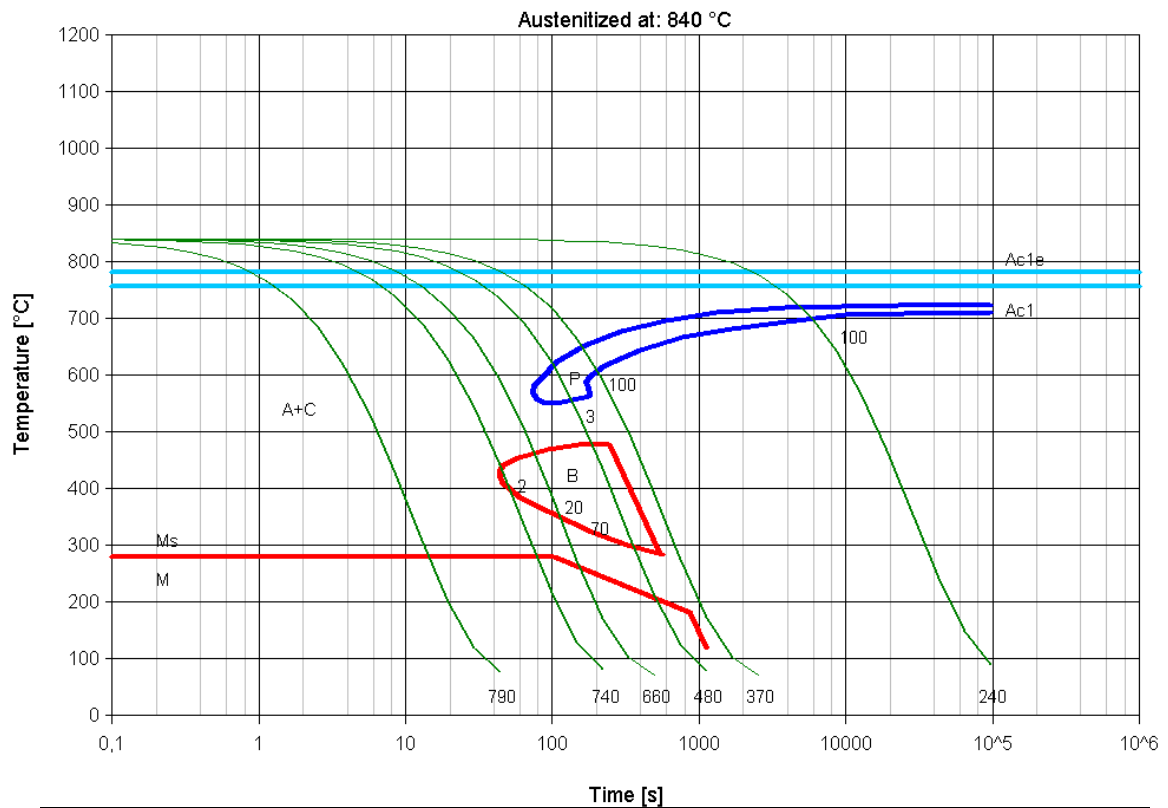
Hot forming and heat treatment:	Forging or hot rolling:	1050 - 850°C
	Normalising:	850 - 880°C/air
	Soft annealing:	680 - 720°C/furnace
	Hardening:	820 - 850°C/oil
	Tempering:	480 - 650°C/oil

Mechanical Properties: Treated for cold shearability +S: max. 255 HB
Soft annealed +A: max. 248 HB

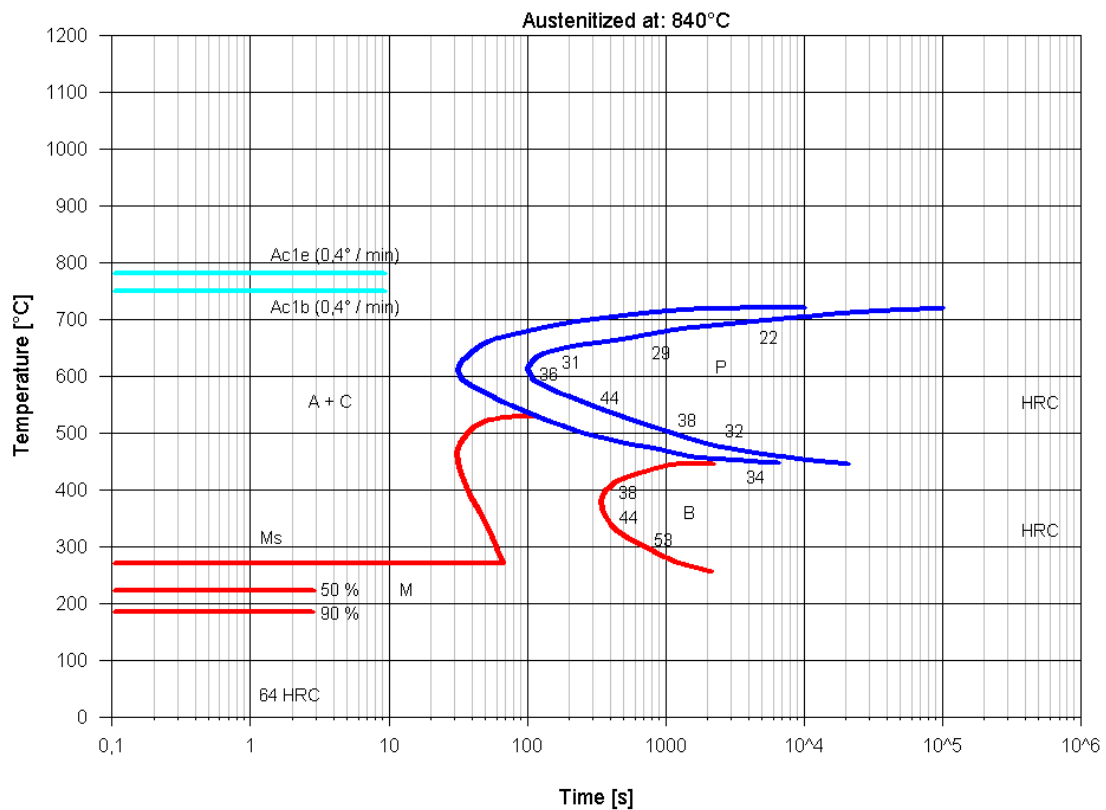
Quenched and tempered, +QT:

Diameter d [mm]	< 16	>16 – 40	>40 – 100	>100 – 160	>160 – 250
0,2% proof stress R _{p0,2} [N/mm ²]	min. 1100	min. 1000	min. 900	min. 750	min. 750
Tensile strength R _m [N/mm ²]	1350 - 1600	1200 - 1400	1100 - 1300	1000 - 1200	1000 - 1200
Fracture elongation A ₅ [%]	min. 7	min. 8	min. 10	min. 12	min. 12
Reduction of area Z [%]	min. 40	min. 45	min. 50	min. 55	min. 55
Notch impact energy ISO-V [J]	min. 13	min. 13	min. 13	min. 13	min. 13

Time-temperature-transformation diagram for continuous cooling

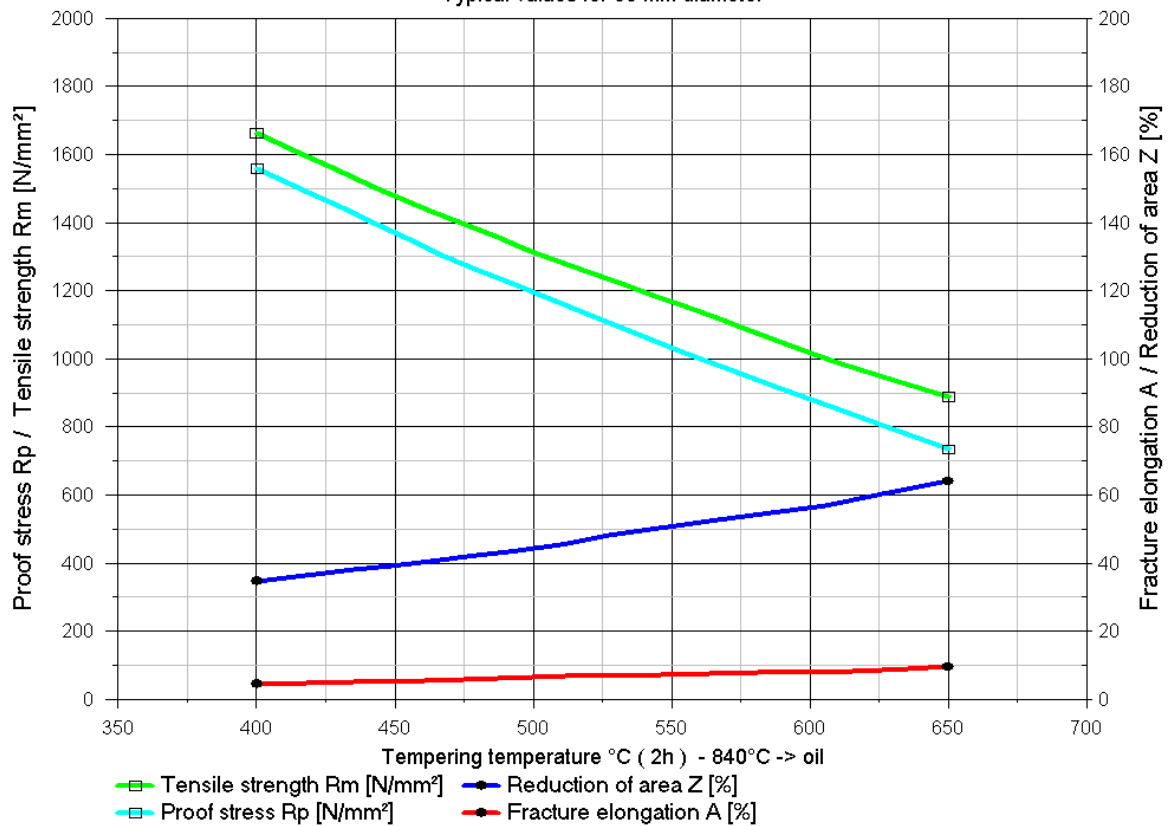


Time-temperature-transformation diagram for isothermal cooling



Tempering diagram

Typical values for 60 mm diameter



Hardness scatter band

