UDDEHOLM SVERKER® SF

UDDEHOLM

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General

Uddeholm Sverker SF is a high-carbon, high-chromium tool steel alloyed with molybdenum and vanadium characterized by:

- High wear resistance
- Good compressive strength
- Good ductility
- Good stability in hardening and in service
- Good through-hardening properties
- Good resistance to tempering-back

Uddeholm Sverker SF offers considerably better resistance to chipping, cracking and galling than conventionally produced high chromium steels like AISI D2. The dimensional stability is also significantly better.

Typical analysis	C 1,50	Si 0,4	Mn 0,4	Cr 12,0	Mo 0,95	V 1,0
Standard specification	AISI D2					
Delivery condition	Soft annealed to ≤235 HB					
Colour code	Yellow/white with a black diagonal band					

Applications

Uddeholm Sverker SF is recommended for tools requiring high wear resistance, combined with moderate toughness (shock-resistance). In addition to the applications listed in the product information brochure for Sverker 3, it is used when cutting thicker, harder materials; when forming with tools subjected to bending stresses and where high impact loads are involved.

Cutting	Material thickness	Material Hardness (HB) <180 HRC	>180 HRC
Tools for: Blanking, fine-blanking, punching, cropping, shearing, trimming, clipping	<3 mm (1/8") 3–6 mm (1/8–1/4")	60–63 58–61	58–62 54–58
Short, cold shears. Shredding knives for waste plastics. Granulator knives			56–63
Circular shears			58–63
Clipping, trimming tools for forgings		Hot Cold	58–63 56–60
Wood milling cutters, reamers, broaches			58–63

Forming	HRC
Tools for: Bending, forming, deep-drawing, rim-rolling, spinning and flow-forming	56–63
Coining dies	56–61
Cold extrusion dies, punches	58–61 56–61
Tube- and section forming rolls; plain rolls	58–63
Dies for moulding of: Ceramics, bricks, tiles, grinding wheels, tablets, abrasive plastics	58–63
Thread-rolling dies	58–63
Cold-heading tools	56–61
Crushing hammers	56–61
Swaging tools	56–61
Gauges, measuring tools, guide rails, bushes, sleeves, knurling tools, sandblast nozzles	58–63

Properties

Physical data

Hardened and tempered to 62 HRC. Data at ambient temperature and elevated temperatures.

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density, kg/m³ lbs/in³	7 700 0,277	7 650 0,276	7 600 0,275
Coefficient of thermal expansion – at low temperature tempering per °C from 20° per °F from 68°F	– –	$12,3 \times 10^{-6}$ $6,8 \times 10^{-6}$	– –
– at high temperature tempering per °C from 20° per °F from 68°F	– –	$11,2 \times 10^{-6}$ $6,2 \times 10^{-6}$	12×10^{-6} $6,7 \times 10^{-6}$
Thermal conductivity W/m °C Btu in/ft² h °F	– –	23 159	25 174
Modulus of elasticity MPa ksi	210 000 30 450	200 000 29 000	180 000 26 100
Specific heat J/kg °C Btu/lb°F	460 0,110	– –	– –

Compressive strength

The figures are to be considered as approximate.

Hardness HRC	Compressive yield strength, Rc0,2 MPa	ksi
63	2500	362
62	2250	326
60	2150	312
55	1900	276
50	1650	239

Heat treatment

Soft annealing

Protect the steel and heat through to 850°C (1560°F). Then cool in the furnace at 10°C (20°F) per hour to 650°C (1200°F), then freely in air.

Stress-relieving

After rough machining the tool should be heated through to 650°C (1200°F), holding time 2 hours. Cool slowly to 500°C (930°F), then freely in air.

Hardening

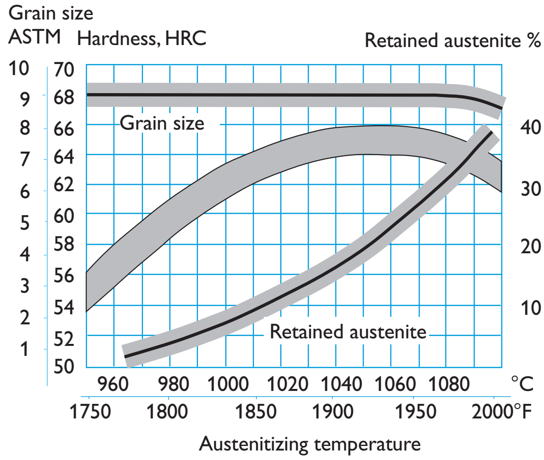
Preheating temperature: 650–750°C (1110–1290°F).
Austenitizing temperature: 960–1080°C (1760–1975°F) but usually 1020–1050°C (1870–1920°F).

Temperature °C	°F	Soaking time* minutes	Hardness before tempering, HRC
960	1760	30	56
1020	1870	30	63,5
1050	1920	30	64,5
1080	1975	30	64

* Soaking time = time at austenitizing temperature after the tool is fully heated through

Protect the part against decarburization and oxidation during hardening.

HARDNESS AS A FUNCTION OF AUSTENITIZING TEMPERATURE



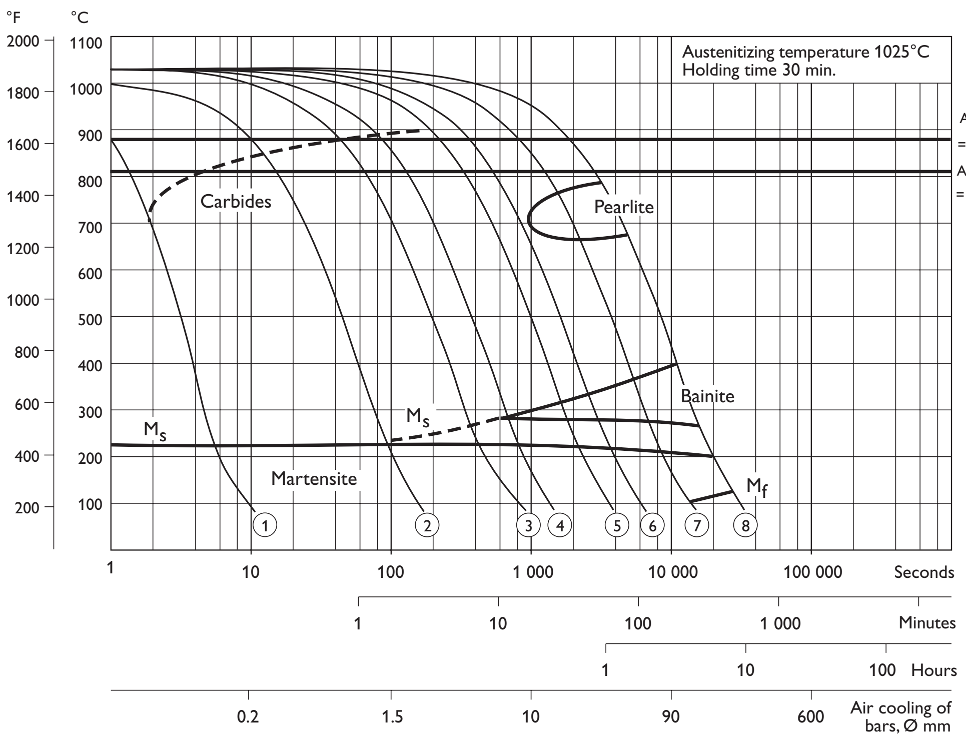
Quenching media

- Oil (Only very simple geometries)
- Vacuum (high speed gas)
- Forced air/gas
- Martempering bath or fluidized bed at 180–500°C (360–930°F), then cooling in air

Note: Temper the tool as soon as its temperature reaches 50–70°C (120–160°F). Uddeholm Sverker SF hardens through in all standard sizes.

CCT GRAPH

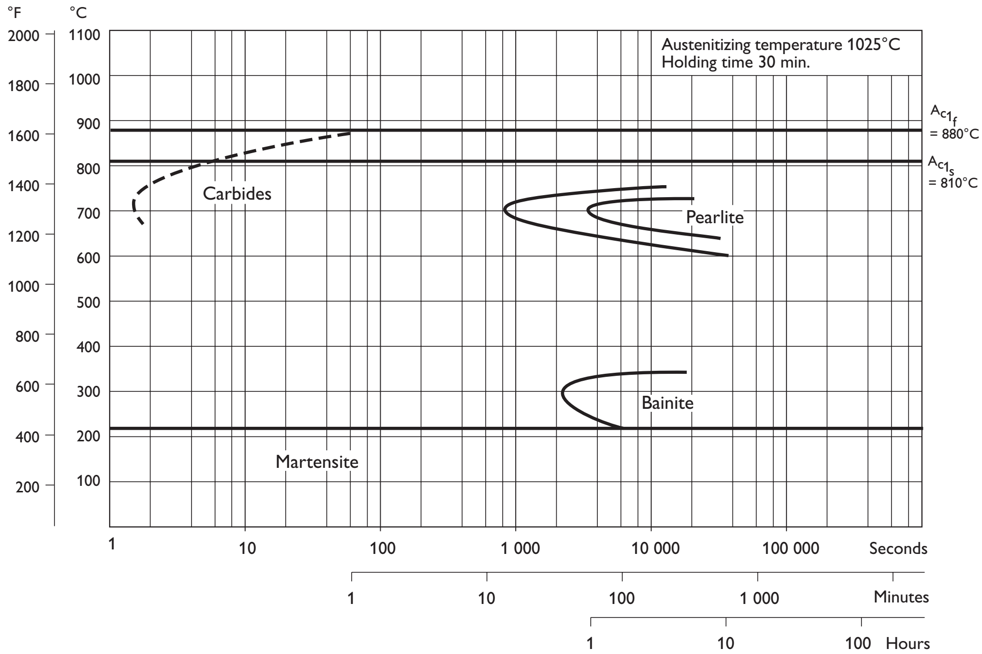
Austenitizing temperature 1025°C (1875°F). Holding time 30 minutes.



Cooling Curve No.	Hardness HV 10	$T_{800-500}$ (sec)
1	824	1
2	824	28
3	813	124
4	803	240
5	782	630
6	752	1030
7	657	2325
8	620	5215

TTT GRAPH

Austenitizing temperature 1025°C (1875°F). Holding time 30 minutes.



Temp. °C	Time hours	Hardn. HV 10
800	15,6	560
750	22,9	225
725	1,2	292
700	1,4	317
675	2,6	351
650	4,7	387
600	15,5	690
400	18,0	824
350	2,3	824
300	5,0	620
250	17,2	613

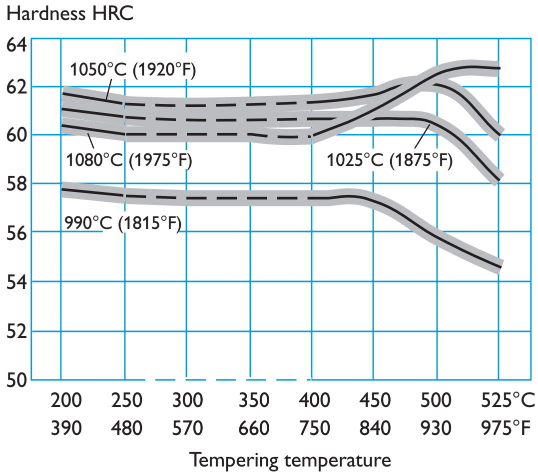
Tempering

Choose the tempering temperature according to the hardness required by referencing the tempering graph. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 200°C (390°F). Holding time at temperature minimum 2 hours.

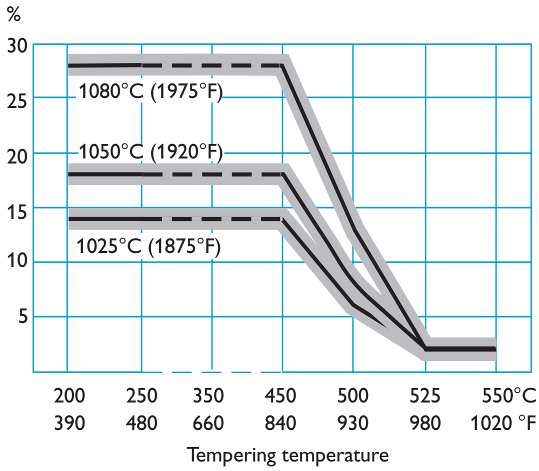
For better dimensional stability and lower residual stress levels, a double temper at 500°C (930°F) or 525°C (975°F) is recommended.

When hardening at 1080°C (1975°F), double tempering at 525°C (975°F) should be used.

HARDNESS AFTER TEMPERING

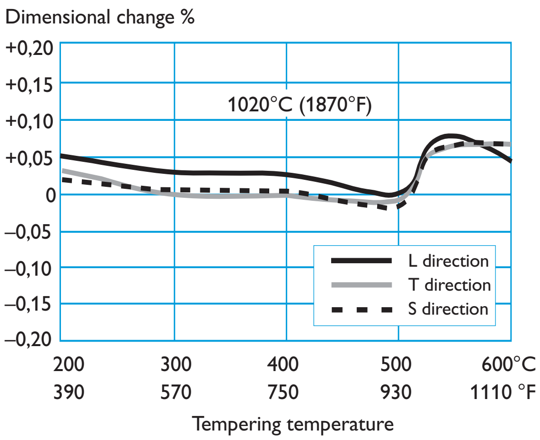


RETAINED AUSTENITE CONTENT AFTER TEMPERING



Dimensional changes after hardening and tempering

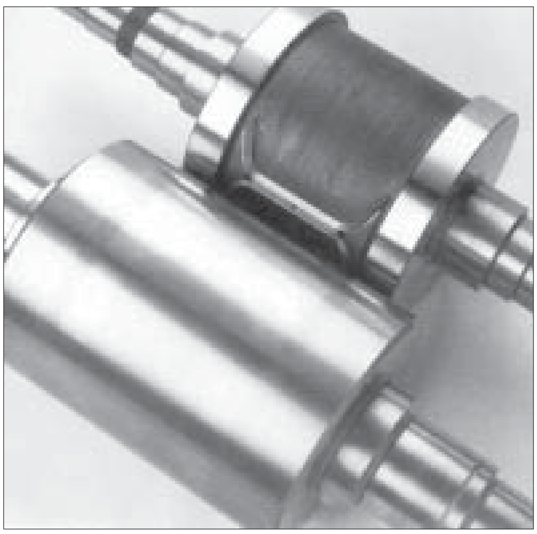
Heat treatment: Austenitizing temperature 1020°C (1870°F), 30 minutes, cooling in vacuum equipment with 2,5 bar overpressure. *Sample:* 79 x 79 x 79 mm. Recommended machining allowance 0,15%.



Sub-zero treatment

Tools requiring maximum dimensional stability in service can be sub-zero treated as follows: Immediately after quenching, the tool should be sub-zero treated to -70 to -80°C (-95 to -110°F), soaking time 1–3 hours, followed by tempering.

The sub-zero treatment leads to a reduction of retained austenite content. This, in turn, will result in a hardness increase of 1–2 HRC in comparison to not sub-zero treated tools if low temperature tempering is used.



For tools tempered at 525°C (975°F) or higher, there will be little or no hardness increase and when referencing the normal tempering curves, a 25 to 50°C (45 to 90°F) lower tempering temperature should be chosen to achieve the required hardness.

Tools that are high temperature tempered, even without a sub-zero treatment, will have a low retained austenite content and in most cases, a sufficient dimensional stability. However, for high demands on dimensional stability in service it is also recommended to use a sub-zero treatment in combination with high temperature tempering.

For the highest requirements on dimensional stability, sub-zero treatment in liquid nitrogen is recommended after quenching and after each tempering.

Nitriding and nitrocarburizing

Nitriding will give a hard surface layer which is very resistant to wear and erosion, and also increases corrosion resistance. A temperature of 525°C (975°F) gives a surface hardness of approx. 1250 HV_1.

Nitriding temperature		Nitriding time	Depth of case approx.	
°C	°F	hours	mm	inch
525	980	20	0,25	0,010
525	980	30	0,30	0,012
525	980	60	0,35	0,014

2 hours Nitrocarburizing at 570°C (1060°F) gives a surface hardness of approx. 950 HV_1. The casedepth having this hardness will be 10–20 µm (0,0004"–0,0008"). The figures refer to hardened and tempered material.

Machining recommendations

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in the Uddeholm publication "Cutting data recommendations".

Turning

Cutting data parameters	Turning with carbide Rough turning	Fine turning
Cutting speed, (v_c) m/min. f.p.m.	90–130 295–426	130–180 426–590
Feed, (f) mm/r i.p.r.	0,2–0,4 0,008–0,016	0,05–0,2 0,002–0,008
Depth of cut, (a_p) mm inch	2–4 0,08–0,16	0,5–2 0,02–0,08
Carbide designation ISO	P15, K20* Coated carbide	K15–K20* Coated carbide

* Use a wear resistant Al_2O_3 coated carbide grade

Drilling

HIGH SPEED STEEL TWIST DRILLS

Drill diameter mm	inch	Cutting speed (v_c) m/min	f.p.m.	Feed (f) mm/r	i.p.r.
–5	–3/16	10–12*	30–40*	0,05–0,15	0,002–0,006
5–10	3/16–3/8	10–12*	30–40*	0,15–0,20	0,006–0,008
10–15	3/8 –5/8	10–12*	30–40*	0,20–0,25	0,008–0,010
15–20	5/8 –3/4	10–12*	30–40*	0,25–0,35	0,010–0,014

* For coated HSS drill v_c = 18–20 m/min. (59–66 f.p.m.)

CARBIDE DRILLS

Cutting data parameters	Type of drill Indexable insert	Solid carbide	Brazed carbide[1]
Cutting speed (v_c) m/min. f.p.m.	130–150 426–495	70–90 230–295	35–45 115–148
Feed (f) mm/r i.p.r.	0,05–0,15[2] 0,002–0,006[2]	0,10–0,25[2] 0,004–0,010[2]	0,15–0,25[2] 0,006–0,010[2]

[1] Drill with internal cooling channels and brazed carbide tip
[2] Depending on drill diameter

Milling

FACE AND SQUARE SHOULDER FACE MILLING

Cutting data parameters	Milling with carbide Rough milling	Fine milling
Cutting speed, (v_c) m/min. f.p.m.	70–110 230–360	110–160 360–525
Feed, (f_z) mm/tooth in/tooth	0,2–0,4 0,008–0,016	0,1–0,2 0,004–0,008
Depth of cut, (a_p) mm inch	2–4 0,08–0,16	–2 –0,08
Carbide designation, ISO	P15, K20* Coated carbide	P15, K20* Coated carbide or cermet

* Use a wear resistant Al_2O_3 coated carbide grade

END MILLING

Cutting data parameters	Type of milling Solid carbide	Carbide indexable insert	High speed steel[1]
Cutting speed (v_c) m/min. f.p.m.	50–80 164–262	80–110 262–360	11–16 36–52
Feed (f_z) mm/tooth in/tooth	0,03–0,2[2] 0,001–0,008[2]	0,08–0,2[2] 0,003–0,008[2]	0,05–0,35[2] 0,002–0,014[2]
Carbide designation ISO	–	P15, K20[3]	–

[1] For coated HSS end mill v_c =20–25 m/min. (66–82 f.p.m.)
[2] Depending on radial depth of cut and cutter diameter
[3] Use a Al_2O_3 coated carbide grade

Grinding

General grinding wheel recommendations are given below. More information can be found in the Uddeholm publication "Grinding of Tool Steel".

Type of grinding	Wheel recommendation Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	A 46 HV
Face grinding segments	A 24 GV	A 36 GV
Cylindrical grinding	A 46 KV	A 60 KV
Internal grinding	A 46 JV	A 60 IV
Profile grinding	A 100 IV	A 120 JV

Welding

Good results when welding tool steel can be achieved if proper precautions are taken during welding (elevated working temperature, joint preparation, choice of consumables and welding procedure).

If the tool is to be polished or photo-etched, it is necessary to work with an electrode type of matching composition.

Welding method	Working temperature	Consumables	Hardness after welding
MMA (SMAW)	200–250°C	Inconel 625-type UTP 67S Castolin 2 Castolin 6	280 HB 55–58 HRC 56–60 HRC 59–61 HRC
TIG	200–250°C	Inconel 625-type UTPA 73G2 UTPA 67S UTPA 696 Castotig 5	280 HB 53–56 HRC 55–58 HRC 60–64 HRC 60–64 HRC

Electrical-discharge machining—EDM

If spark-erosion, EDM, is performed in the hardened and tempered condition, the tool should afterwards be given an additional temper at approx. 25°C (50°F) below the previously used tempering temperature.

Further information can be obtained from the Uddeholm brochure "EDM of tool steel".

Further information

Contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steels, including the publications "Steels for Cold Work Tooling".

Relative comparison of Uddeholm cold work tool steel

Material properties and resistance to failure mechanisms