

SVERKER® 21

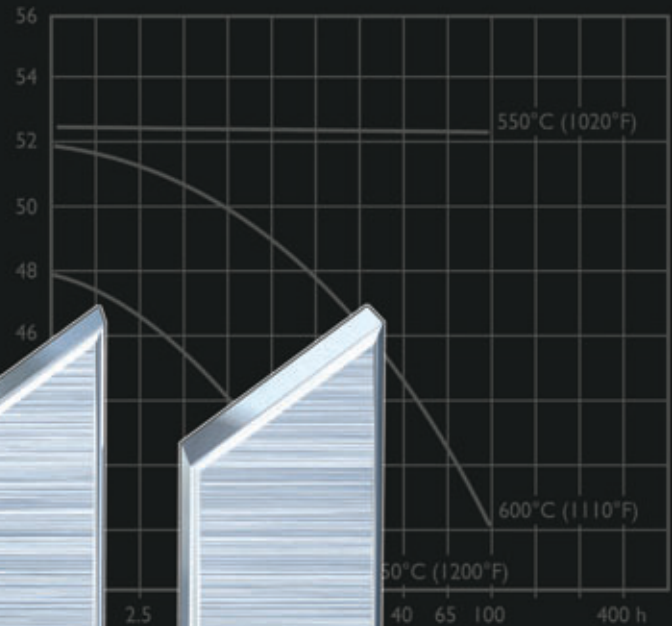
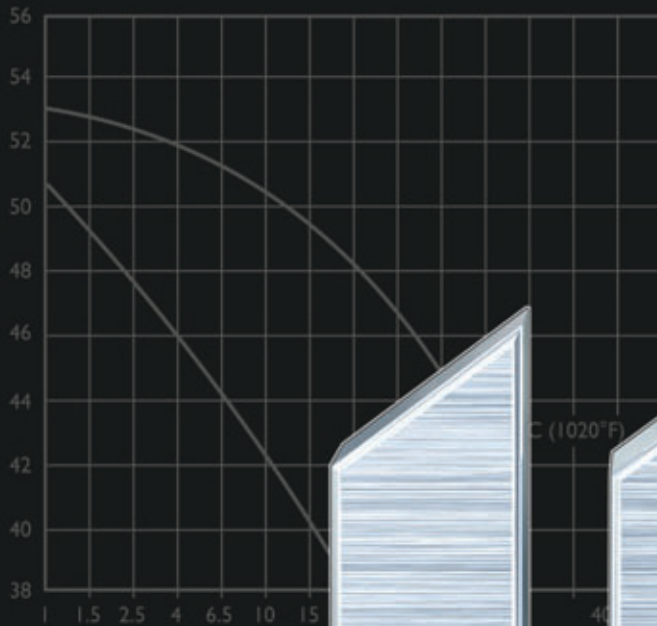
Cold work tool steel

COLD WORK

PLASTIC MOULDING

HOT WORK

HIGH PERFORMANCE STEEL



Typical analysis %	C 2,05
Standard specification	AISI D6, ()
Delivery condition	Soft annealed
Colour code	Red

Typical analysis %	Mn 0,8	Cr 4,5	W 0,2
Standard specification	D3 (W.Nr. 1.2796)		
Delivery condition	to approx. 200 HB		
Colour code			

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m³ lbs/m³	7 770 0,281	7 670 0,277	7 650 0,275
Modulus of elasticity N/mm² psi	194 000 28,1 × 10⁶	188 000 27,3 × 10⁶	178 000 25,8 × 10⁶
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	to 100°C 11,7 × 10⁻⁶ to 212°F 6,5 × 10⁻⁶	to 200°C 12 × 10⁻⁶ to 400°F 6,7 × 10⁻⁶	to 400°C 13,0 × 10⁻⁶ to 750°F 7,3 × 10⁻⁶
Thermal conductivity W/m °C Btu in (ft²h°F)	- -	27 187	32 221
Specific heat K/kg °C Btu/lbs °F	455 0,109	525 0,126	608 0,145

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m³ lbs/m³	7 770 0,281	7 670 0,277	7 650 0,275
Modulus of elasticity N/mm² psi	194 000 28,1 × 10⁶	188 000 27,3 × 10⁶	173 000 25,1 × 10⁶
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	to 100°C 12,3 × 10⁻⁶ to 212°F 6,1 × 10⁻⁶	to 200°C 14 × 10⁻⁶ to 400°F 6,7 × 10⁻⁶	to 400°C 15,1 × 10⁻⁶ to 750°F 7,3 × 10⁻⁶
Thermal conductivity W/m °C Btu in (ft²h°F)	- -	20,5 142	21,5 149
Specific heat K/kg °C Btu/lbs °F	460 0,110	- -	- -

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty for fitness for a particular purpose.

General

Sverker 21 is a high-carbon, high-chromium tool steel alloyed with molybdenum and vanadium characterized by:

- High wear resistance
- High compressive strength
- Good through-hardening properties
- High stability in hardening
- Good resistance to tempering-back.

Typical analysis	C 1,55	Si 0,3	Mn 0,4	Cr 11,8	Mo 0,8	V 0,8
Standard specification	AISI D2, W.-Nr. 1.2379					
Delivery condition	Soft annealed to approx. 210 HB					
Colour code	Yellow/white					

Applications

Sverker 21 is recommended for tools requiring very 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.

Sverker 21 can be supplied in various finishes, including the hot-rolled, pre-machined and fine machined condition. It is also available in the form of hollow bar and rings.

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

Forming	HRC
<i>Tools for:</i> Bending, forming, deep-drawing, rim-rolling, spinning and flow-forming	56–62
Coining dies	56–60
Cold extrusion dies, punches	58–60 56–60
Tube- and section forming rolls; plain rolls	58–62
<i>Dies for moulding of:</i> Ceramics, bricks, tiles, grinding wheels, tablets, abrasive plastics	58–62
Thread-rolling dies	58–62
Cold-heading tools	56–60
Crushing hammers	56–60
Swaging tools	56–60
Gauges, measuring tools, guide rails, bushes, sleeves, knurling tools, sandblast nozzles	58–62

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/m ³ lbs/in ³	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 x 10 ⁻⁶ 6,8 x 10 ⁻⁶	– –
– at high temperature tempering per °C from 20° per °F from 68°F	– –	11,2 x 10 ⁻⁶ 6,2 x 10 ⁻⁶	12 x 10 ⁻⁶ 6,7 x 10 ⁻⁶
Thermal conductivity W/m °C Btu in/ft ² h °F	20,0 139	21,0 146	23,0 159
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
62	2200	319
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: 990–1050°C (1810–1920°F) but usually 1000–1040°C (1830–1905°F).

Temperature		Soaking* time minutes	Hardness before tempering
°C	°F		
990	1815	60	approx. 63 HRC
1010	1850	45	approx. 64 HRC
1030	1885	30	approx. 65 HRC

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

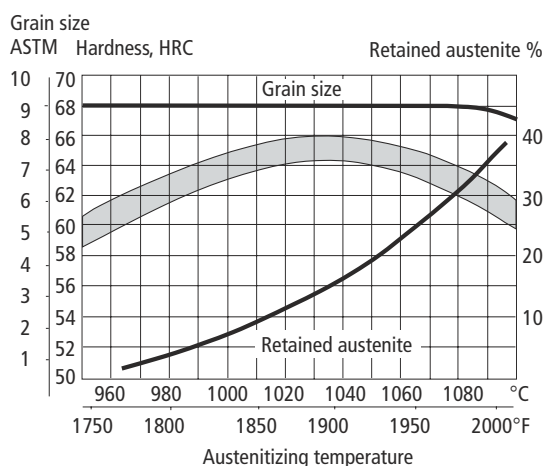
Protect the part against decarburization and oxidation during hardening.

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). Sverker 21 hardens through in all standard sizes.

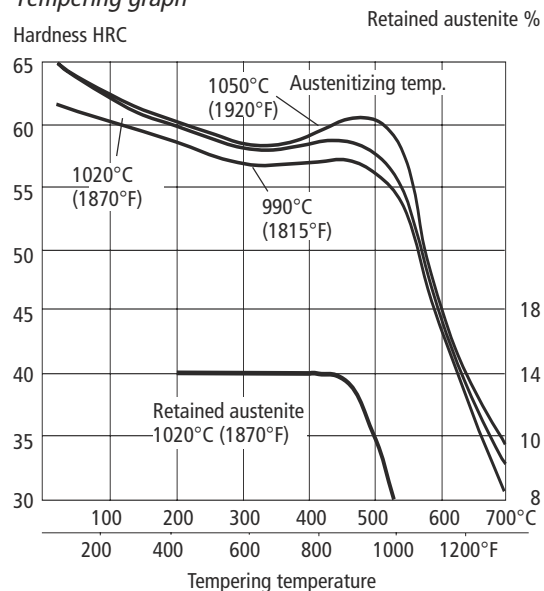
Hardness as a function of austenitizing temperature



TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 180°C (360°F). Holding time at temperature minimum 2 hours.

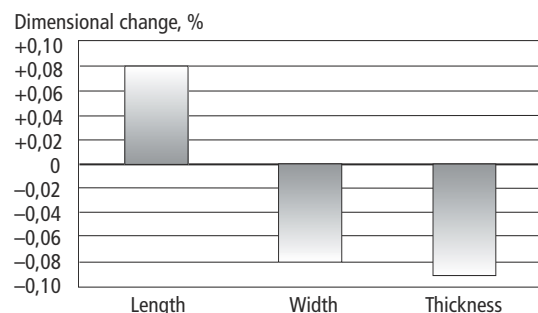
Tempering graph



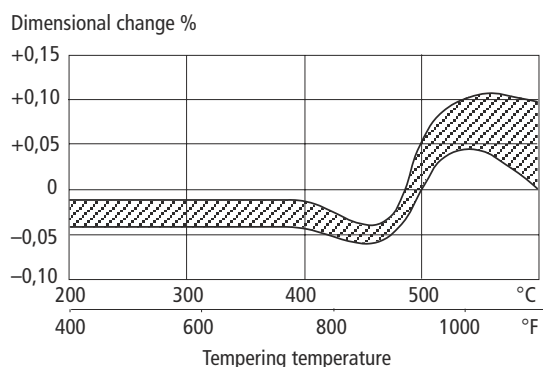
DIMENSIONAL CHANGES DURING HARDENING

Heat treatment: Austenitizing temperature 1020°C, 30 minutes, cooling in vacuum equipment with 2 bar overpressure.

Sample, 80 x 80 x 80 mm.



DIMENSIONAL CHANGES DURING TEMPERING



Note: The dimensional changes on hardening and tempering should be added together. Recommended allowance 0,15%.

SUB-ZERO TREATMENT

Pieces requiring maximum dimensional stability should be sub-zero treated, as volume changes may occur in the course of time. This applies, for example, to measuring tools like gauges and certain structural components.

Immediately after quenching the piece should be sub-zero treated to between -70 and -80°C (-95 to -110°F)—soaking time 3–4 hours— followed by tempering. Sub-zero treatment will give a hardness increase of 1–3 HRC. Avoid intricate shapes as there will be risk of cracking.

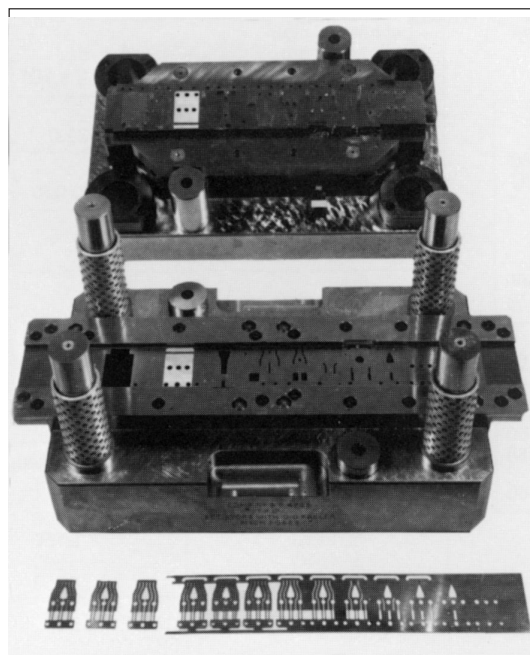
Aging occurs at 110–140°C during 25–100 h.

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 HV₁.

Nitriding temperature °C	Nitriding temperature °F	Nitriding time hours	Depth of case approx.	
			mm	in
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 HV₁. The case-depth having this hardness will be 10–20 µm (0,0004"–0,0008"). The figures refers to hardened and tempered material.



Progressive die made of Sverker 21. Long run tooling for blanking of parts in thin sheets.

Machining

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions.

TURNING

Cutting data parameters	Turning with carbide		Turning with high speed steel Fine turning
	Rough turning	Fine turning	
Cutting speed (v_c) m/min. f.p.m.	100–150 328–492	150–200 492–656	12–15 40–50
Feed (f) mm/r i.p.r.	0,2–0,4 0,008–0,016	0,05–0,2 0,002–0,008	0,05–0,3 0,002–0,012
Depth of cut (a_p) mm inch	2–6 0,08–0,20	–2 –0,08	–2 –0,08
Carbide designation ISO	K15–K20*	K15–K20*	–

* Use a wear resistant Al_2O_3 coated carbide grade

DRILLING

High speed steel twist drills

Drill diameter		Cutting speed (v_c)		Feed (f)	
mm	inch	m/min	f.p.m.	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.	0,05–0,25 ²⁾ 0,002–0,010 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.	90–130 295–426	130–180 426–590
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	K20, P20*	K20, P20*

* 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
Cutting speed (v_c) m/min. f.p.m.	70–100 230–328	80–110 262–360	12–17 ¹⁾ 40–56 ¹⁾
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	–	K15–K20 ³⁾	–

¹⁾ For coated HSS end mill $v_c = 25–30$ m/min. (82–98 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	B151 R75 B3 ¹⁾ A 46 GV ²⁾
Face grinding segments	A 24 GV	3SG 36 HVS ²⁾ A 36 GV
Cylindrical grinding	A 46 KV	B126 R75 B3 ¹⁾ A 60 KV ²⁾
Internal grinding	A 46 JV	B126 R75 B3 ¹⁾ A 60 HV
Profile grinding	A 100 LV	B126 R100 B6 ¹⁾ A 120 JV ²⁾

¹⁾ If possible use CBN wheels for this application.

²⁾ Preferable a wheel type containing sintered Al_2O_3

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

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

Uddeholm grade	Hardness/ Resistance to plastic deformation	Machinability	Grindability	Dimension stability	Resistance to		Fatigue cracking resistance	
					Abrasive wear	Adhesive wear	Ductility/ resistance to chipping	Toughness/ gross cracking
ARNE								
CALMAX								
RIGOR								
SLEIPNER								
SVERKER 21								
SVERKER 3								
VANADIS 4								
VANADIS 6								
VANADIS 10								
VANADIS 23								