# SVERKER® 21

## Cold work tool steel

**COLD** WORK | **PLASTIC** MOULDING | **HOT** WORK | **HIGH** PERFORMANCE STEEL

UDDEHOLM

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

| Forming | HRC |
|---|---|
| *Tools for:*<br>Bending, forming, deep-drawing, rim-rolling, spinning and flow-forming | 56–62 |
| Coining dies | 56–60 |
| Cold extrusion dies,<br>punches | 58–60<br>56–60 |
| Tube- and section forming rolls; plain rolls | 58–62 |
| *Dies for moulding of:*<br>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/m³<br>lbs/in³ | 7 700<br>0,277 | 7 650<br>0,276 | 7 600<br>0,275 |
| Coefficient of thermal expansion<br>– at low temperature tempering<br>per °C from 20°<br>per °F from 68°F | <br><br>–<br>– | <br><br>$12,3 \times 10^{-6}$<br>$6,8 \times 10^{-6}$ | <br><br>–<br>– |
| – at high temperature tempering<br>per °C from 20°<br>per °F from 68°F | <br>–<br>– | <br>$11,2 \times 10^{-6}$<br>$6,2 \times 10^{-6}$ | <br>$12 \times 10^{-6}$<br>$6,7 \times 10^{-6}$ |
| Thermal conductivity<br>W/m °C<br>Btu in/ft² h °F | <br>20,0<br>139 | <br>21,0<br>146 | <br>23,0<br>159 |
| Modulus of elasticity<br>MPa<br>ksi | <br>210 000<br>30 450 | <br>200 000<br>29 000 | <br>180 000<br>26 100 |
| Specific heat<br>J/kg °C<br>Btu/lb°F | <br>460<br>0,110 | <br>–<br>– | <br>–<br>– |

### 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 °C | °F | Soaking* time minutes | Hardness before tempering |
|---|---|---|---|
| 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.*

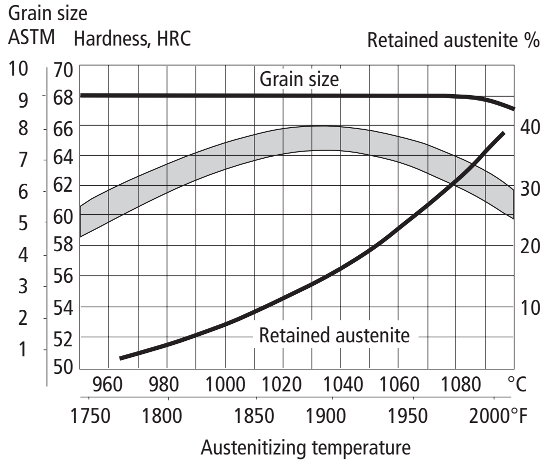
*Protect the part against decarburization and oxidation during hardening.*

### 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.

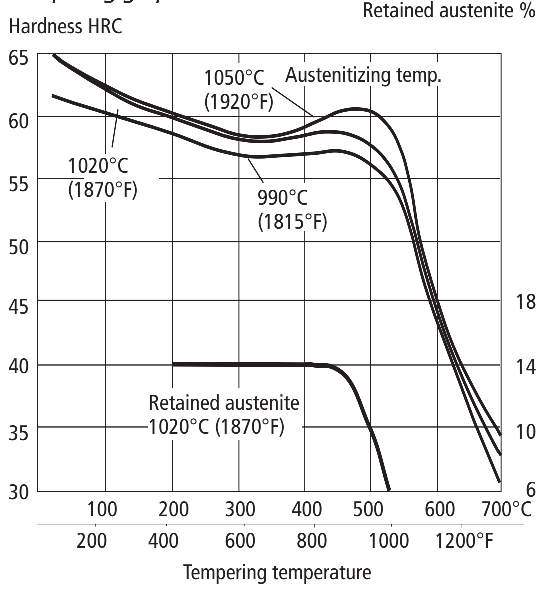
*Hardness as a function of austenitizing temperature*




### 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.

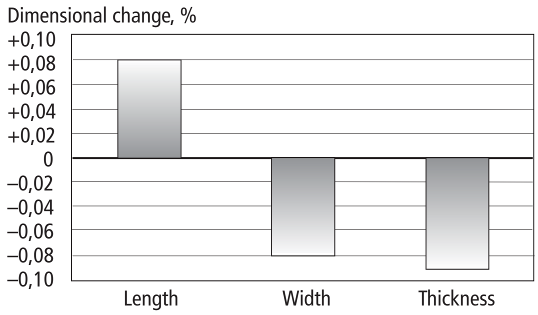
*Tempering graph*



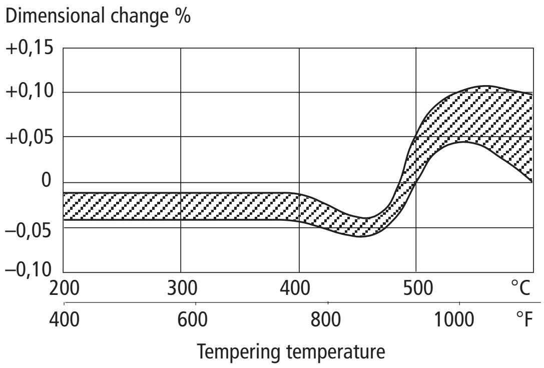
## DIMENSIONAL CHANGES DURING HARDENING

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.

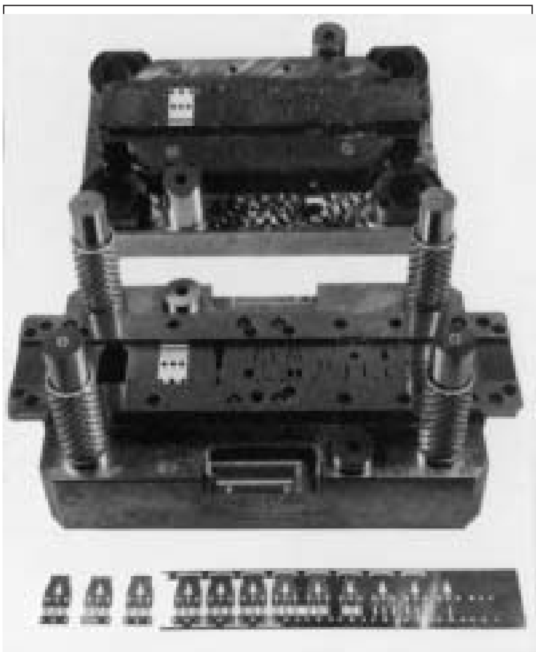
Aging occurs at 110–140°C during 25–100 h.

## 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 $HV_1$.

| Nitriding temperature | | Nitriding time | Depth of case approx. | |
|---|---|---|---|---|
| °C | °F | hours | 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 $HV_1$. 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 |
|---|---|---|---|
| | Rough turning | Fine turning | Fine turning |
| Cutting speed ($v_c$)<br>m/min.<br>f.p.m. | <br>100–150<br>328–492 | <br>150–200<br>492–656 | <br>12–15<br>40–50 |
| Feed (f)<br>mm/r<br>i.p.r. | <br>0,2–0,4<br>0,008–0,016 | <br>0,05–0,2<br>0,002–0,008 | <br>0,05–0,3<br>0,002–0,012 |
| Depth of cut ($a_p$)<br>mm<br>inch | <br>2–6<br>0,08–0,20 | <br>–2<br>–0,08 | <br>–2<br>–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 mm | Drill diameter inch | Cutting speed ($v_c$) m/min | Cutting speed ($v_c$) f.p.m. | Feed (f) mm/r | Feed (f) 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 ($v_c$)<br>m/min.<br>f.p.m. | <br>130–150<br>426–495 | <br>70–90<br>230–295 | <br>35–45<br>115–148 |
| Feed (f)<br>mm/r<br>i.p.r. | <br>0,05–0,25[2)]<br>0,002–0,010[2)] | <br>0,10–0,25[2)]<br>0,004–0,010[2)] | <br>0,15–0,25[2)]<br>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, ($v_c$)<br>m/min.<br>f.p.m. | <br>90–130<br>295–426 | <br>130–180<br>426–590 |
| Feed, ($f_z$)<br>mm/tooth<br>in/tooth | <br>0,2–0,4<br>0,008–0,016 | <br>0,1–0,2<br>0,004–0,008 |
| Depth of cut, ($a_p$)<br>mm<br>inch | <br>2–4<br>0,08–0,16 | <br>–2<br>–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 ($v_c$)<br>m/min.<br>f.p.m. | <br>70–100<br>230–328 | <br>80–110<br>262–360 | <br>12–17[1)]<br>40–56[1)] |
| Feed ($f_z$)<br>mm/tooth<br>in/tooth | 0,03–0,2[2)]<br>0,001–0,008[2)] | 0,08–0,2[2)]<br>0,003–0,008[2)] | 0,05–0,35[2)]<br>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)]<br>A 46 GV[2)] |
| Face grinding segments | A 24 GV | 3SG 36 HVS[2)]<br>A 36 GV |
| Cylindrical grinding | A 46 KV | B126 R75 B3[1)]<br>A 60 KV[2)] |
| Internal grinding | A 46 JV | B126 R75 B3[1)]<br>A 60 HV |
| Profile grinding | A 100 LV | B126 R100 B6[1)]<br>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<br>UTP 67S<br>Castolin 2<br>Castolin 6 | 280 HB<br>55–58 HRC<br>56–60 HRC<br>59–61 HRC |
| TIG | 200–250°C | Inconel 625-type<br>UTPA 73G2<br>UTPA 67S<br>UTPA 696<br>Castotig 5 | 280 HB<br>53–56 HRC<br>55–58 HRC<br>60–64 HRC<br>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.

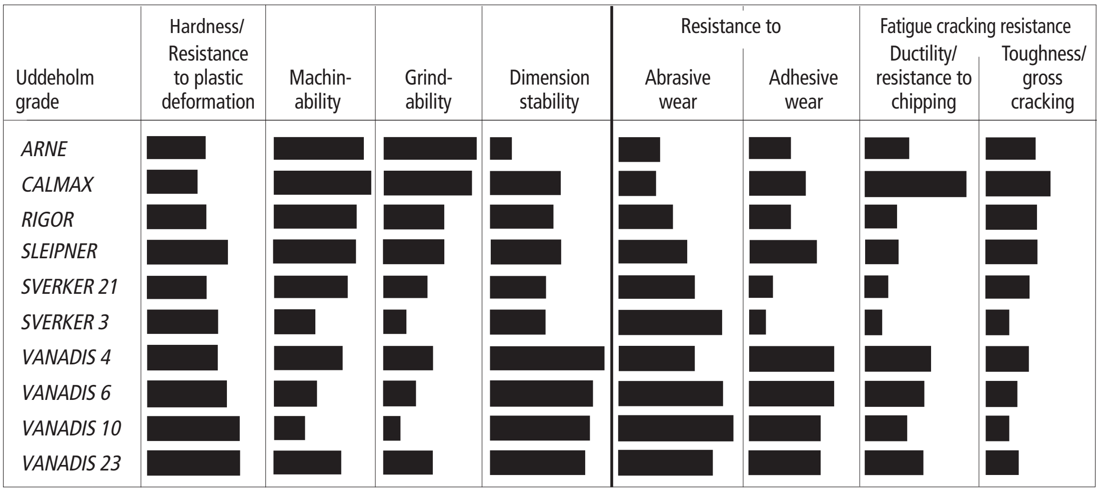
Further information can be obtained from the Uddeholm brochure "EDM of tool steel".

# 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**



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