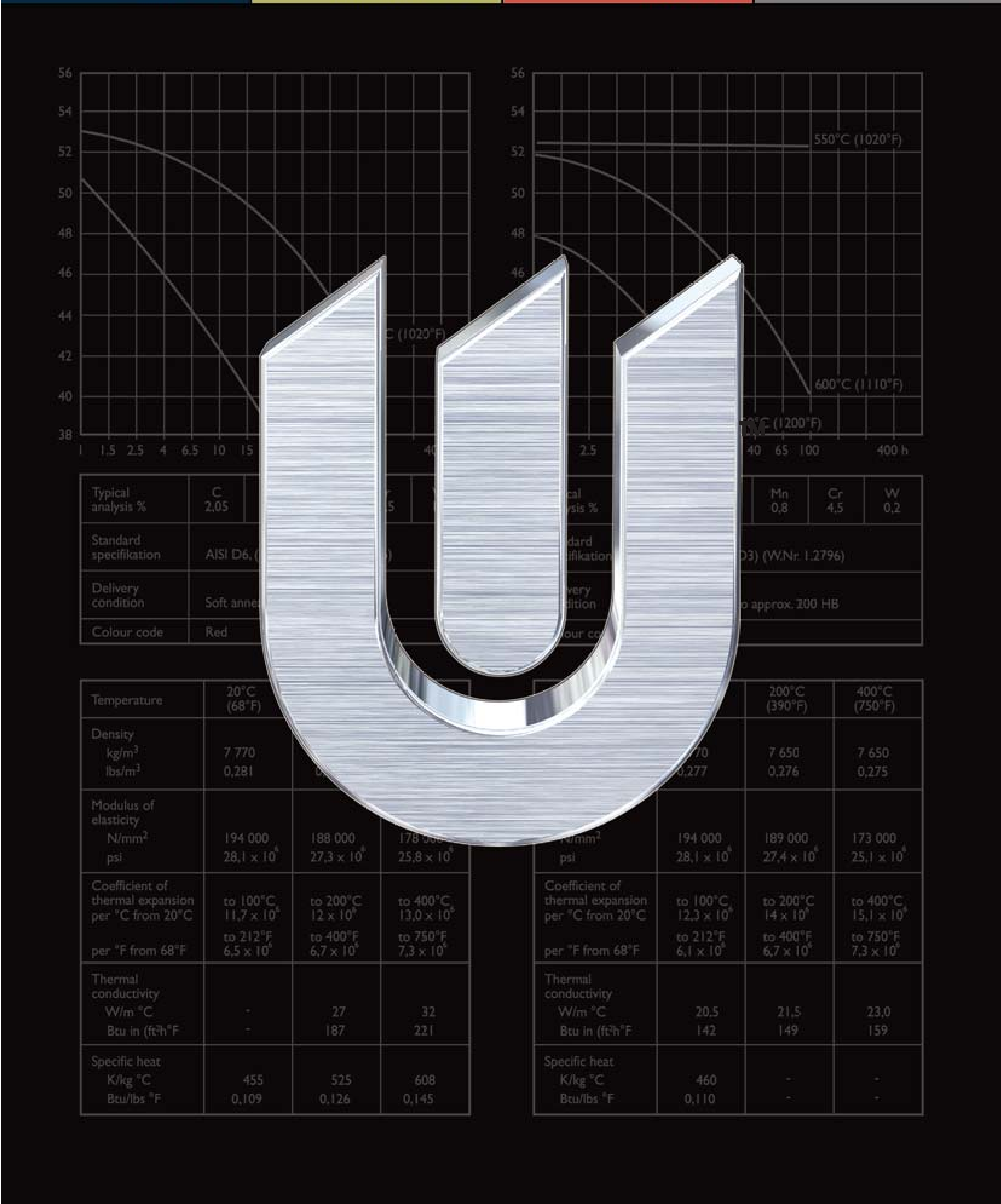
# VANADIS 30™

**SUPERCLEAN[3] Powder Metallurgical Cold Work Tool Steel**

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



# Applications

Vanadis 30 is a cobalt alloyed high performance PM high speed steel. The cobalt addition of approx. 8,5% has a positive influence on the hot strength/ hot hardness, temper resistance and modulus of elasticity. The presence of cobalt has little influence on wear resistance. As cobalt does not form carbides, the wear resistance of Vanadis 30 is more or less the same as for steels with the same base analysis but without cobalt (e.g. Vanadis 23). On the other hand, its presence reduces the toughness and hardenability somewhat but increases compressive strength and high temperature properties.

### FOR COLD WORK

- The combination of high wear resistance and unusually good compressive strength can be put to use in tooling for heavy forming operations.
- In some cold work operations, the active surface (e.g. cutting edge or forming surface) of a tool can reach temperatures in excess of 200°C (390°F). Such conditions can be found in tooling running on high speed presses. Also, development of high temperatures in the tooling can be expected in heavy forming operations.

# General

Vanadis 30 is a W-Mo-V-Co alloyed PM high speed steel characterized by:

- High wear resistance
- High compressive strength at high hardness
- Good through hardening properties
- Good toughness
- Good dimensional stability on heat treatment
- Good grindability and machinability
- Very good temper resistance.

| Typical analysis % | C 1,28 | Cr 4,2 | Mo 5,0 | W 6,4 | V 3,1 | Co 8,5 |
|---|---|---|---|---|---|---|
| Standard specification | (W.-Nr. 1.3207) AISI M2+Co | | | | | |
| Delivery condition | Soft annealed, max. 300 HB<br>Drawn, max. 320 HB | | | | | |
| Colour code | Dark green | | | | | |

*Punches for high performance.*
*A suitable application for Vanadis 30.*

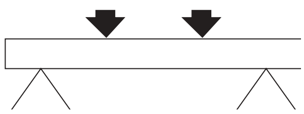
# Properties

### PHYSICAL DATA

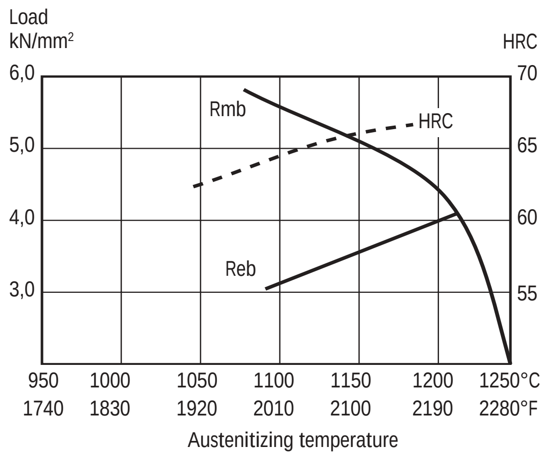
| Temperature | 20°C (68°F) | 400°C (750°F) | 600°C (1112°F) |
|---|---|---|---|
| Density, $kg/m^3$ (1) | 8040 | 7935 | 7880 |
| $lbs/in^3$ (1) | 0,287 | 0,285 | 0,284 |
| Modulus of elasticity MPa (2) | 240 000 | 214 000 | 192 000 |
| ksi (2) | $34 \times 10^3$ | $31 \times 10^3$ | $28 \times 10^3$ |
| Coefficient of thermal expansion per °C from 20°C (2) | – | $11,8 \times 10^{-6}$ | $12,3 \times 10^{-6}$ |
| °F from 68°F (2) | – | $6,5 \times 10^{-6}$ | $6,8 \times 10^{-6}$ |
| Thermal conductivity W/m•°C (2) | 22 | 26 | 25 |
| Btu in/($ft^2$ h°F) (2) | 152 | 180 | 173 |
| Specific heat J/kg °C (2) | 420 | 510 | 600 |
| Btu/lb °F (2) | 0,10 | 0,12 | 0,14 |

(1) = for the soft annealed condition.
(2) = for the hardened and tempered condition.

### BEND STRENGTH AND DEFLECTION

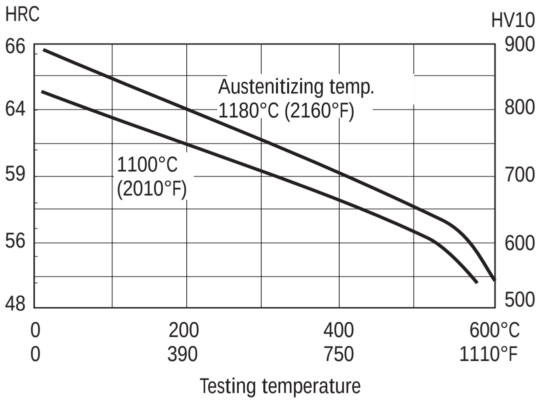


Four-point bend testing.
*Specimen size:* 5 mm (0,2") Ø.
*Loading rate:* 5 mm/min (0,2"/min.).
*Austenitizing temperature:* 1050–1180°C (1920–2160°F).
*Tempering:* 3 x 1 h at 560°C (1040°F), air cooling to room temperature.



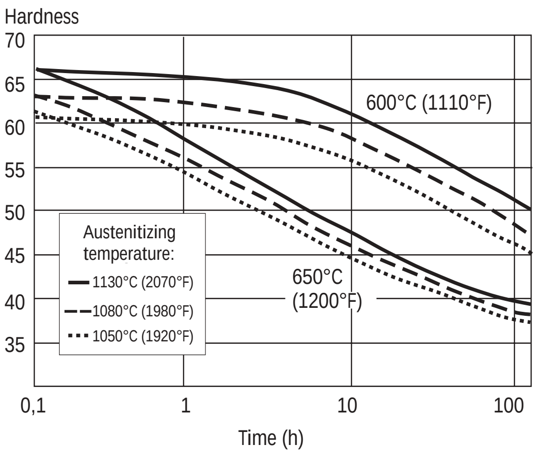

### HIGH TEMPERATURE PROPERTIES

*Vanadis 30 hot hardness*




*Change in hardness versus holding time for different working temperatures*

Austenitizing temperature: 1050–1130°C (1920–2070°F).
Tempering: 3 x 1 h at 560°C (1040F).




# Heat treatment

### SOFT ANNEALING

Protect the steel and heat through to 850–900°C (1560–1650°F). Then cool in the furnace at 10°C/h (20°F/h) to 700°C (1290°F), then freely in air.

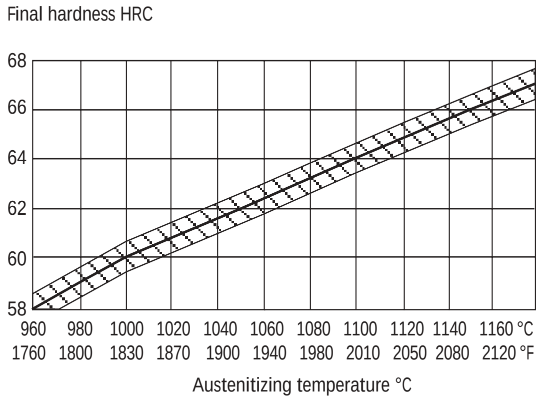
### STRESS RELIEVING

After rough machining the tool should be heated through to 600–700°C (1110–1290°F), holding time 2 hours. Cool slowly to 500°C (930°F), then freely in air.

### HARDENING

*Pre-heating temperature:* 450–500°C (840–930°F) and 850–900°C (1560–1650°F).
*Austenitizing temperature:* 1050–1180°C (1920–2160°F), according to the desired final hardness, see diagram below.
The tool should be protected against decarburization and oxidation during hardening.

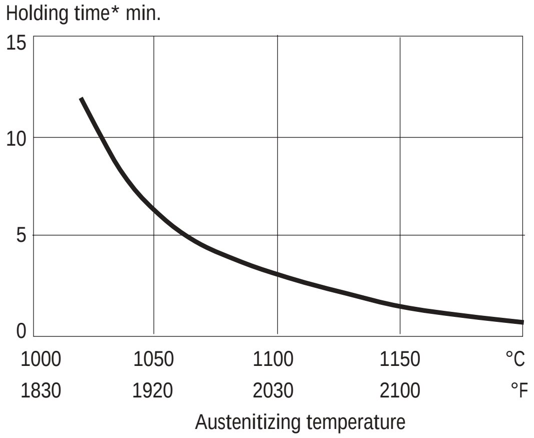
*Hardness after tempering 3 times for one hour at 560°C (1040°F)*




*Hardness for different austenitizing temperatures after tempering 3 times for one hour at 560°C (±1 HRC)*

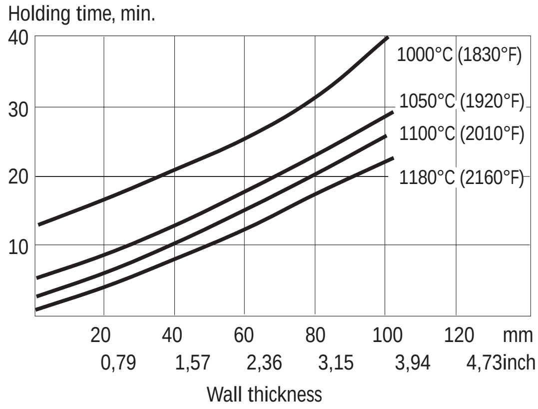
| HRC | °C | °F |
|---|---|---|
| 60 | 1000 | 1832 |
| 62 | 1050 | 1922 |
| 64 | 1100 | 2012 |
| 66 | 1150 | 2102 |
| 67 | 1180 | 2156 |

*Recommended holding time*



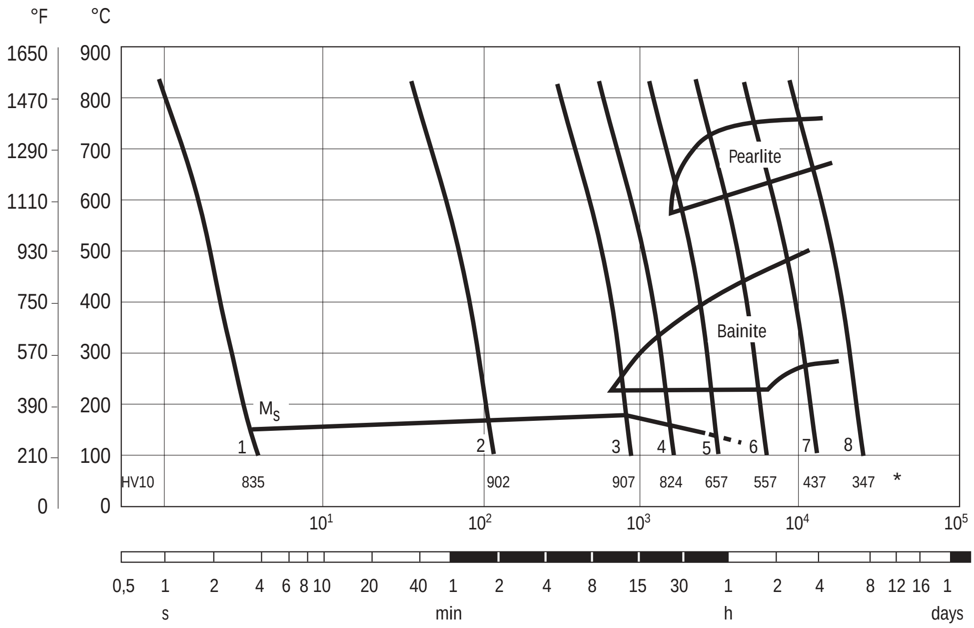

** Holding time = time at austenitizing temperature after the tool is fully heated through.*

*Total soaking time in a salt bath after pre-heating in two stages at 450°C (840°F) and 850°C (1560°F)*




*CCT-graph (continuous cooling)*

Austenitizing temperature 1180°C (2160°F).



### QUENCHING MEDIA

- Martempering bath at approx. 540°C (1004°F)
- Vacuum furnace with high speed gas at sufficient overpressure.

*Note. 1:* Quenching should be continued until the temperature of the tool reaches approx. 50°C (122°F). The tool should then be tempered immediately.

*Note. 2:* In order to obtain a high toughness, the cooling speed in the core should be at least 10°C/sec. (20°F/sec.). This is valid for cooling from the austenitizing temperature down to approx. 540°C (1004°F). After temperature equalization between the surface and core, the cooling rate of approx. 5°C/sec. (10°F/sec.) can be used. The above cooling cycle results in less distortion and residual stresses.

### TEMPERING

Tempering should always be carried out at 560°C (1040°F) irrespective of the austenitizing temperature. Temper three times for one hour at full temperature. The tool should be cooled to room temperature between the tempers. The retained austenite content will be less than 1% after this tempering cycle.

### DIMENSIONAL CHANGES

Dimensional changes after hardening and tempering.
*Heat treatment:* austenitizing between 1050–1140°C (1920–2080°F) and tempering 3 x 1h at 560°C (1040°F).
*Specimen size:* 80 x 80 x 80 mm (2,91 x 2,91 x 2,91 in.) and 100 x 100 x 25 mm (3,94 x 3,94 x 0,99 in.).
*Dimensional changes:* growth in length, width and thickness: +0,03% to +0,13%.

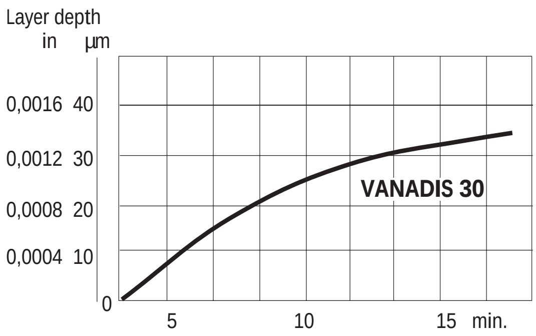
# Surface treatments

Some tools are given a surface treatment in order to reduce friction and increase tool wear resistance. The most commonly used treatments are nitriding and surface coating with wear resistant layers of titanium carbide and titanium nitride (CVD, PVD).

Vanadis 30 has been found to be particularly suitable for titanium carbide and titanium nitride coatings. The uniform carbide distribution in Vanadis 30 facilitates bonding of the coating and reduces the spread of dimensional changes resulting from hardening. This, together with its high strength and toughness, makes Vanadis 30 an ideal substrate for high-wear surface coatings.

### NITRIDING

A brief immersion in a special salt bath to produce a nitrided diffusion zone of 2–20 μm is recommended. This reduces friction on the envelope surface of punches and has various other advantages.




Depth of nitriding layer
after nitrocarburizing at 570°C (1060°F)

### PVD

Physical vapour deposition, PVD, is a method of applying a wear-resistant coating at temperatures between 200–500°C (390–930°F). As Vanadis 30 is high temperature tempered at 560°C (1040°F), there is no danger of dimensional changes during PVD coating.

### CVD

Chemical vapour deposition, CVD, is used for applying wear resistant surface coatings at a temperature of around 1000°C (1830°F). It is recommended that the tools should be separately hardened and tempered in a vacuum furnace after surface treatment.

# Cutting data 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”

**Condition: Soft annealed to approx. 300 HB**

## TURNING

| Cutting data parameters | Turning with carbide | | Turning with HSS |
|---|---|---|---|
| | Rough turning | Fine turning | Fine turning |
| Cutting speed ($v_c$)<br>m/min<br>f.p.m. | <br>80–110<br>262–361 | <br>110–140<br>361–459 | <br>10–15<br>33–49 |
| 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>2–4<br>0,08–0,16 | <br>0,5–2<br>0,02–0,08 | <br>0,5–3<br>0,02–0,12 |
| Carbide designation ISO | K20, P10–P20<br>Coated carbide* | K15, P10<br>Coated carbide* | – |

** Use a wear resistant $Al_2O_3$-coated carbide*

## DRILLING

### High speed steel twist drill

| 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 | 8–10* | 27–33* | 0,05–0,10 | 0,002–0,004 |
| 5–10 | 3/16–3/8 | 8–10* | 27–33* | 0,10–0,20 | 0,004–0,008 |
| 10–15 | 3\|8–5\|8 | 8–10* | 27–33* | 0,20–0,25 | 0,008–0,010 |
| 15–20 | 5\|8–3\|4 | 8–10* | 27–33* | 0,25–0,30 | 0,010–0,012 |

*For coated HSS drill $v_c$ = 14–16 m/min. (46–52 f.p.m.)*

### Carbide drill

| 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>100–130<br>328–435 | <br>50–70<br>164–230 | <br>25–35<br>82–115 |
| Feed, f<br>mm/r<br>i.p.r. | <br>0,05–0,15[2]<br>0,002 –0,006[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 tip.*
*[2] Depending on drill diameter.*

## MILLING

### Face and square shoulder milling

| Cutting data parameters | Milling with carbide | |
|---|---|---|
| | Rough milling | Fine milling |
| Cutting speed ($v_c$)<br>m/min<br>f.p.m. | <br>40–80<br>131–265 | <br>800–110<br>265–361 |
| Feed ($f_z$)<br>mm/tooth<br>inch/tooth | <br>0,2–0,4<br>0,008–0,016 | <br>–0,2<br>–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<br>Coated carbide* | K15–P15<br>Coated carbide*<br>or cermet |

** Use a wear resistant $Al_2O_3$-coated carbide*

### End milling

| Cutting data parameters | Type of mill | | |
|---|---|---|---|
| | Solid carbide | Carbide indexable insert | High speed steel |
| Cutting speed ($v_c$)<br>m/min<br>f.p.m. | <br>35–45<br>115–150 | <br>90–110<br>300–361 | <br>12–16<br>39–52 |
| Feed ($f_z$)<br>mm/tooth<br>inch/tooth | <br>0,01–0,2[1]<br>0,0004–0,008[1] | <br>0,06–0,2[1]<br>0,002–0,008[1] | <br>0,01–0,3[1]<br>0,0004–0,012[1] |
| Carbide designation ISO | – | K15, P10–P20<br>Coated carbide[2] | – |

*[1]Depending on radial depth of cut and cutter diameter.*
*[2] Use a wear resistant $Al_2O_3$-coated carbide*

## GRINDING

General grinding wheel recommendation is given below. More information can be found in the Uddeholm publication “Grinding of Tool Steel”.

| Type of grinding | Annealed condition | Hardened condition |
|---|---|---|
| Face grinding straight wheel | A 46 HV | B151 R50 B3[1]<br>A 46 GV[2] |
| Face grinding segments | A 36 GV | A 46 GV |
| Cylindrical grinding | A 60 KV | B151 R50 B3[1]<br>A 60 JV[2] |
| Internal grinding | A 60 JV | B151 R75 B3[1]<br>A 60 IV[2] |
| Profile grinding | A 100 IV | B126 R100 B6[1]<br>A 100 JV[2] |

*[1] If possible use CBN wheels for this application.*
*[2] Preferable a wheel type containing sintered $Al_2O_3$ (seeded gel)*

## EDM

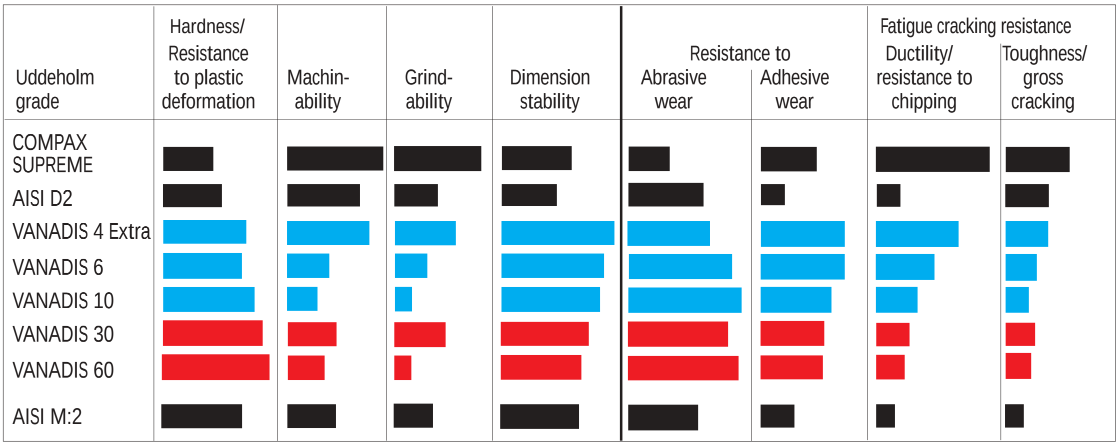
If EDM is performed in the hardened and tempered condition, finish with “finesparking”, i.e. low current, high frequency. For optimal performance the EDM’d surface should then be ground/polished and the tool retempered at approx. 535°C (995°F).

## Further information

Please, contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steels.

## Relative comparison of Uddeholm cold work tool steels

### MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS

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