

# VANADIS 30

High performance powder metallurgical steel for cutting tools

COLD WORK

PLASTIC MOULDING

HOT WORK

HIGH PERFORMANCE STEEL



Typical analysis %	C 2,05	Mn 0,8	Cr 4,5	W 0,2
Standard specification	AISI D6, (DIN 1.2796)	Standard specification (DIN 1.2796)		
Delivery condition	Soft annealed	Delivery condition (approx. 200 HB)		
Colour code	Red	Colour code		

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m <sup>3</sup> lbs/m <sup>3</sup>	7 770 0,281	7 670 0,277	7 650 0,275
Modulus of elasticity N/mm <sup>2</sup> psi	194 000 28,1 × 10 <sup>6</sup>	188 000 27,3 × 10 <sup>6</sup>	173 000 25,1 × 10 <sup>6</sup>
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	to 100°C 11,7 × 10 <sup>-6</sup> to 212°F 6,5 × 10 <sup>-6</sup>	to 200°C 12 × 10 <sup>-6</sup> to 400°F 6,7 × 10 <sup>-6</sup>	to 400°C 13,0 × 10 <sup>-6</sup> to 750°F 7,3 × 10 <sup>-6</sup>
Thermal conductivity W/m °C Btu in (ft <sup>2</sup> h°F)	- -	27 187	32 221
Specific heat K/kg °C Btu/lbs °F	455 0,109	525 0,126	608 0,145

## 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.

*VANADIS 30* is suitable for multi-edge cutting tools as reamers, taps, milling cutters, broaches, hobs, shaper cutters, shaving cutters etc. and for single-edge cutting tools as tool bits, parting-off tools and form tools.

*VANADIS 30* should be used in cutting conditions where the demand for hot hardness is pronounced. e.g. high performance is needed.

## General

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

- High wear resistance
- Good through hardening properties
- Good toughness
- Good dimensional stability on heat treatment
- Good grindability and machinability
- Very good temper resistance. (Hot hardness)

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 / SS 2726)					
Delivery condition	Soft annealed, mx. 300 HB Drawn, max. 320 HB					
Colour code	Dark green					

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 of fitness for a particular purpose.

## Properties

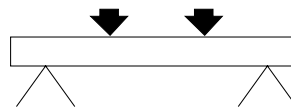
### PHYSICAL DATA

Temperature		20°C (68°F)	400°C (750°F)	600°C (1112°F)
Density				
kg/m <sup>3</sup>	(1)	8040	7935	7880
lbs/in <sup>3</sup>	(1)	0,287	0,285	0,284
Modulus of elasticity				
MPa	(2)	240 000	214 000	192 000
ksi	(2)	34 x 10 <sup>3</sup>	31 x 10 <sup>3</sup>	28 x 10 <sup>3</sup>
Coefficient of thermal expansion per				
°C from 20°C	(2)	–	11,8 x 10 <sup>-6</sup>	12,3 x 10 <sup>-6</sup>
°F from 68°F	(2)	–	6,5 x 10 <sup>-6</sup>	6,8 x 10 <sup>-6</sup>
Thermal conductivity				
W/m•°C	(2)	22	26	25
Btu in/(ft <sup>2</sup> 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



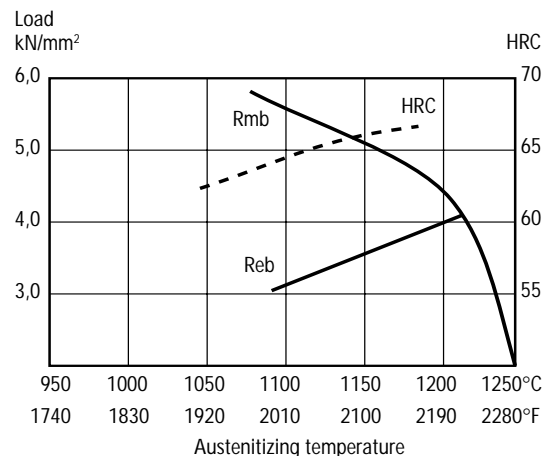
Four-point bend testing.

*Specimen size:* 5 mm (0,2") Ø.

*Loading rate:* 5 mm/min (0,2"/min.).

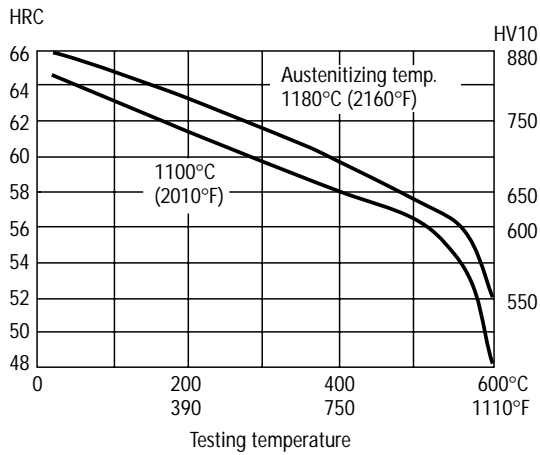
*Austenitizing temperature:* 1050–1180°C (1920–2160°F).

*Tempering:* 3 x 1 h at 560°C (1040°F), air cooling to room temperature.



## HIGH TEMPERATURE PROPERTIES

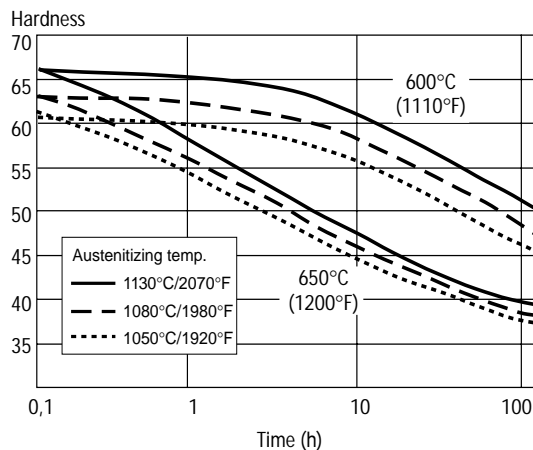
*VANADIS 30 hot hardness.*



*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 (1040°F)



## 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) and 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.

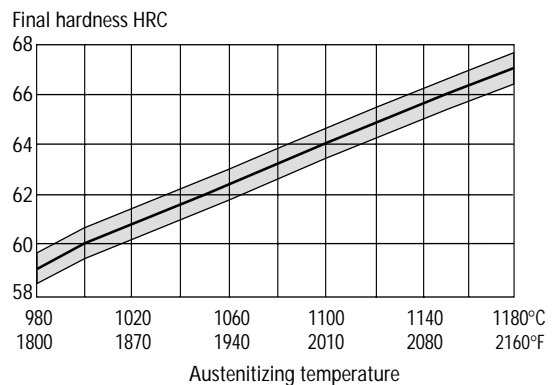
### HARDENING

*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 the figure 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).*

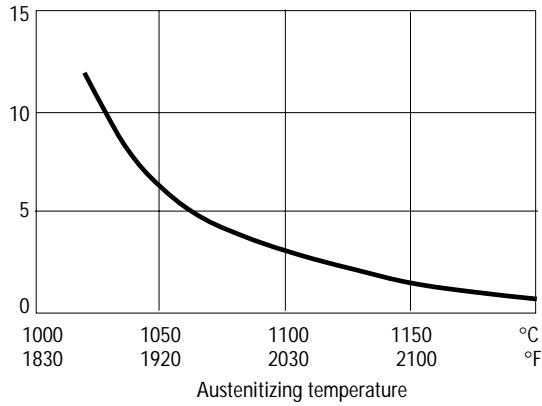


*Hardness for different austenitizing temperatures after tempering 3 times for one hour at 560°C (1040°F) (±1 HRC).*

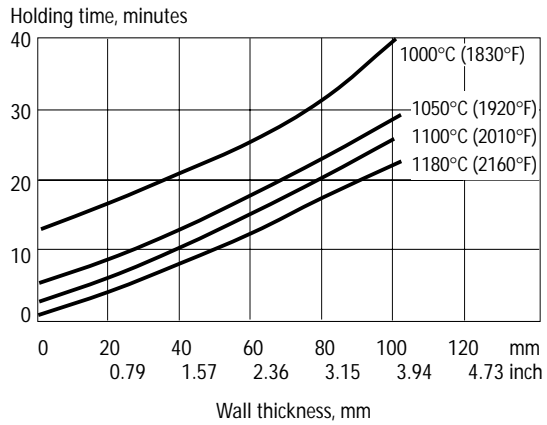
HRC	°C	°F
60	1000	1832
62	1050	1922
64	1100	2012
66	1150	2102
67	1180	2156

**Recommended holding time**

Holding time\* Min.



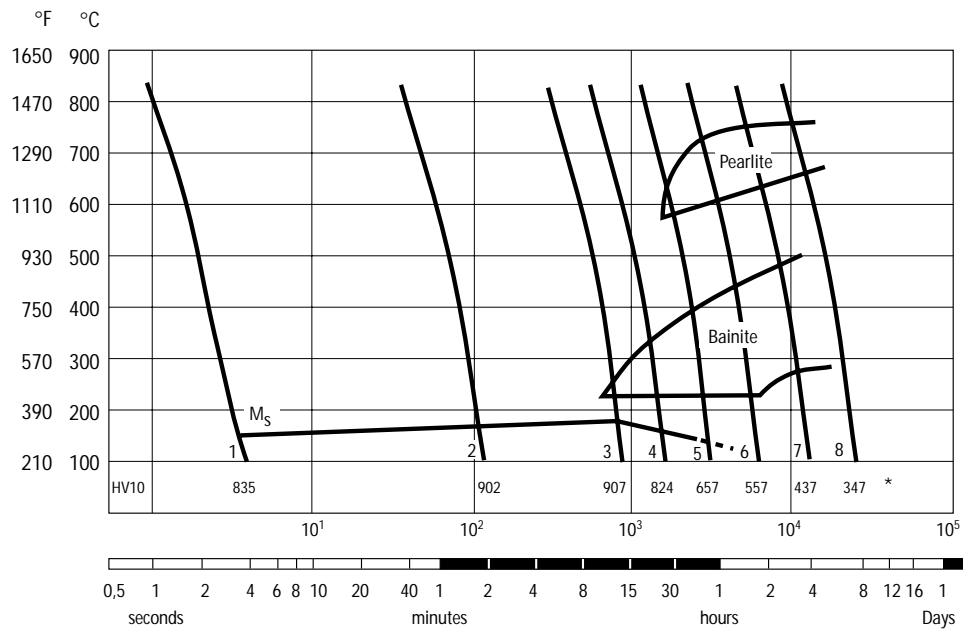
**Total soaking time in a salt bath after pre-heating in two stages at 450°C (840°F) and 850°C (1560°F)**



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

**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

Normally tempering should 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%.

## Some guidelines for hardening

Tool	VANADIS 30		
	Hardening	Tempering 3 times	HRC
<i>Single-edge cutting tools:</i> tool bits, form tools, etc.	1190°C 2175°F	550°C 1025°F	67–68
<i>Rotating multi-edge cutting tools:</i> twist drills, milling cutters, broaches, taps, hobs, shaper cutters, etc.	1150–1180°C 2100–2155°F	560°C 1040°F	66–67

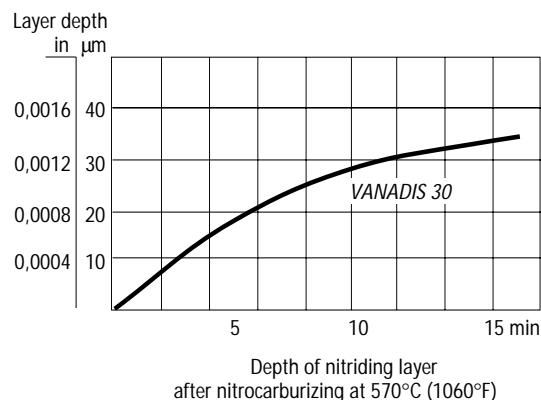
## Surface treatments

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.



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

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

### DRILLING

#### High speed steel twist drill

Drill diameter		Cutting speed $v_c$		Feed f	
mm	inch	m/min.	f.p.m.	mm/r	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 <sup>1)</sup>
Cutting speed, $v_c$ m/min f.p.m.	100–130 328–435	50–70 164–230	25–35 82–115
Feed, f mm/r i.p.r.	0,05–0,15 <sup>2)</sup> 0,002–0,006 <sup>2)</sup>	0,10–0,25 <sup>2)</sup> 0,004–0,010 <sup>2)</sup>	0,15–0,25 <sup>2)</sup> 0,006–0,010 <sup>2)</sup>

<sup>1)</sup> Drill with internal cooling channels and brazed tip.

<sup>2)</sup> Depending on drill diameter.

### MILLING

#### Face and square shoulder milling

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed ( $v_c$ ) m/min f.p.m.	40–80 131–265	800–110 265–361
Feed ( $f_z$ ) mm/tooth inch/tooth	0,2–0,4 0,008–0,016	–0,2 –0,008
Depth of cut ( $a_p$ ) mm inch	2–4 0,08–0,16	–2 –0,08
Carbide designation ISO	K20–P20 Coated carbide*	K15–P15 Coated carbide* 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 ( $v_c$ ) m/min f.p.m.	35–45 115–150	90–110 300–361	12–16 39–52
Feed ( $f_z$ ) mm/tooth inch/tooth	0,01–0,2 <sup>1)</sup> 0,0004–0,008 <sup>1)</sup>	0,06–0,2 <sup>1)</sup> 0,002–0,008 <sup>1)</sup>	0,01–0,3 <sup>1)</sup> 0,0004–0,012 <sup>1)</sup>
Carbide designation ISO	–	K15, P10–P20 Coated carbide <sup>2)</sup>	–

<sup>1)</sup> Depending on radial depth of cut and cutter diameter.

<sup>2)</sup> 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 <sup>1)</sup> A 46 GV <sup>2)</sup>
Face grinding segments	A 36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B151 R50 B3 <sup>1)</sup> A 60 JV <sup>2)</sup>
Internal grinding	A 60 JV	B151 R75 B3 <sup>1)</sup> A 60 IV <sup>2)</sup>
Profile grinding	A 100 IV	B126 R100 B6 <sup>1)</sup> A 100 JV <sup>2)</sup>

<sup>1)</sup> If possible use CBN wheels for this application.

<sup>2)</sup> Preferable a wheel type containing sintered  $Al_2O_3$  (seeded gel)

## EDM

If EDM is performed in the hardened and tempered condition, finish with "fine sparking", 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).

## Relative comparison of Uddeholm PM steels

### 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	Hot hardness
VANADIS 23								
VANADIS 30								
VANADIS 60								
AISI M2								
AISI M35								

## Further information

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