VANADIS 30 – SuperClean™ PM – high speed steel for cold work

UDDEHOLM

Great Tooling Starts Here!

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 to *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
- 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)					
Delivery condition	Soft annealed, max. 300 HB Drawn, max. 320 HB					
Colour code	Dark green					

Cover:
Punches for high performance. A suitable application for VANADIS 30.

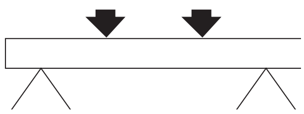
Properties

PHYSICAL DATA

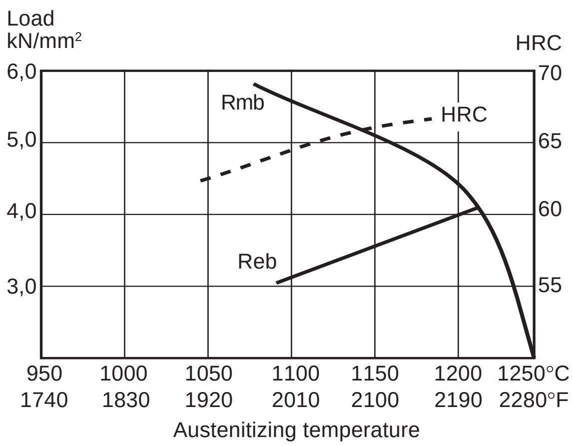
Temperature	20°C (68°F)	400°C (750°F)	600°C (1112°F)
Density, kg/m³ (1)	8040	7935	7880
lbs/in³ (1)	0,287	0,285	0,284
Modulus of elasticity MPa (2)	240 000	214 000	192 000
ksi (2)	34 x 10³	31 x 10³	28 x 10³
Coefficient of thermal expansion per °C from 20°C (2)	–	11,8 x 10⁻⁶	12,3 x 10⁻⁶
°F from 68°F (2)	–	6,5 x 10⁻⁶	6,8 x 10⁻⁶
Thermal conductivity W/m•°C (2)	22	26	25
Btu in/(ft² 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

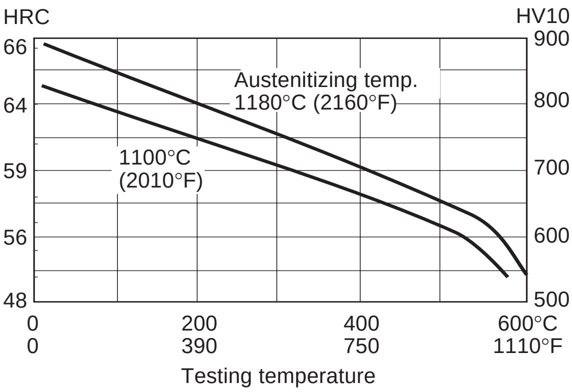


Four-point bend testing.
Specimen size: 5 mm (0,2") Ø.
Loading rate: 5 mm/min (0,2"/min.).
Austenitizing temperature: 1050–1180°C (1920–2160°F).
Tempering: 3 x 1 h at 560°C (1040°F), air cooling to room temperature.



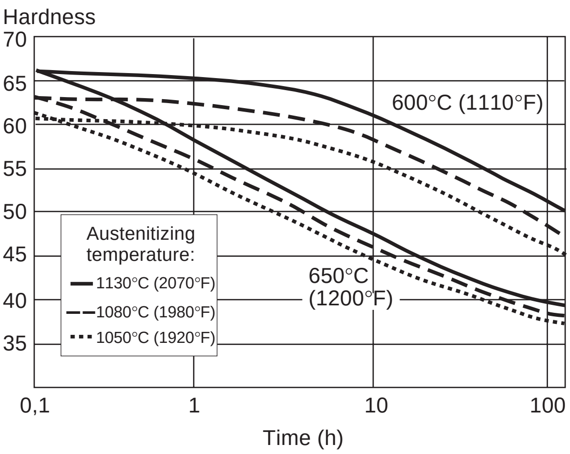
HIGH TEMPERATURE PROPERTIES

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

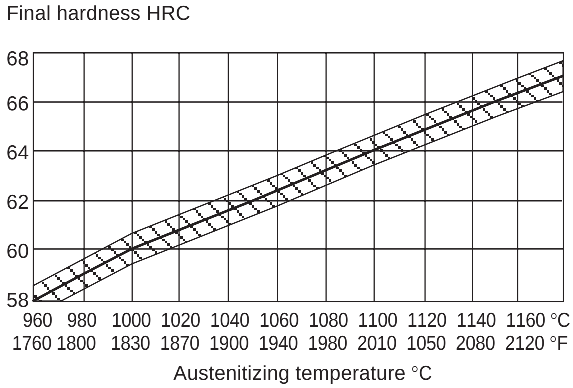
After rough machining the tool should be heated through to 600–700° C (1110–1290° F), holding time 2 hours. Cool slowly to 500° C (930° F), then freely in air.

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.

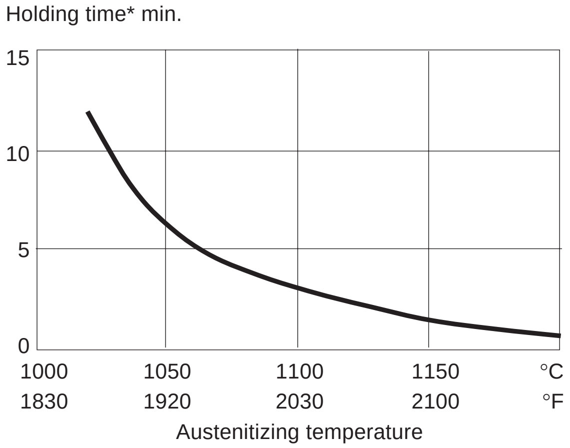
Hardness after tempering 3 times for one hour at 560°C (1040°F).



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

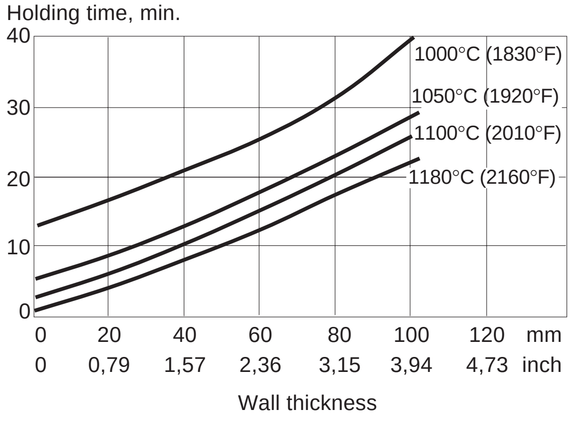
HRC	°C	°F
60	1000	1832
62	1050	1922
64	1100	2012
66	1150	2102
67	1180	2156

Recommended holding time



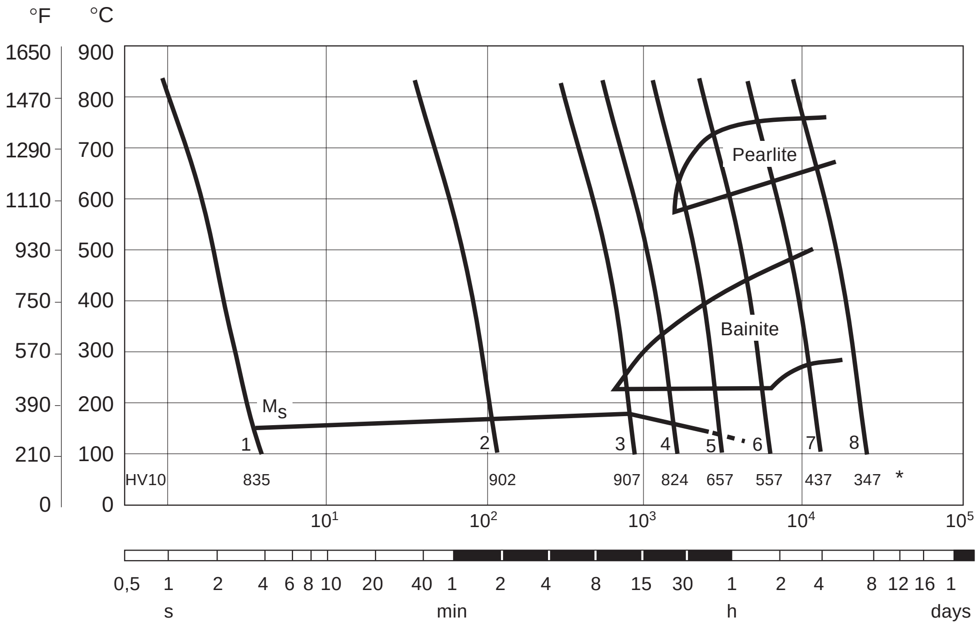
*) *Holding time = time at austenitizing temperature after the tool is fully heated through.*

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

For cold work applications 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%.

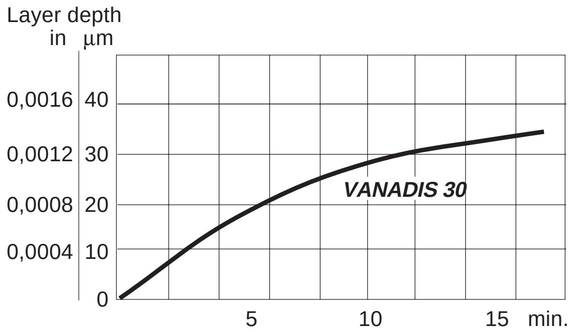
Surface treatments

Some cold work 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 condition.

TURNING

Cutting data parameters	Turning with carbide: Rough turning	Turning with carbide: Fine turning	Turning with HSS: Fine turning
Cutting speed (v_c) m/min	100–130	130–160	10
f.p.m.	335–435	435–535	33
Feed (f) mm/r	0,20–0,40	0,05–0,20	0,05–0,30
i.p.r.	0,008–0,016	0,002–0,008	0,002–0,012
Depth of cut (a_p) mm	2–4	0,5–2	0,5–3
inch	0,08–0,16	0,02–0,08	0,02–0,12
Carbide designation ISO	P10–P20*	P10*	–

* *Use a wear resistant coated carbide grade, for example Sandvik Coromant GC4015 or SECO TP100.*

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	8–12*	27–40*	0,05–0,15	0,002–0,006
5–10	3/16–3/8	8–12*	27–40*	0,15–0,25	0,006–0,010
10–15	3|8–5|8	8–12*	27–40*	0,25–0,35	0,010–0,014
15–20	5|8–3|4	8–12*	27–40*	0,35–0,40	0,014–0,016

* *For TiCN coated HSS drill v_c ~ 20–25 m/min. (70–85 f.p.m.)*

Carbide drill

Cutting data parameters	Type of drill: Indexable insert	Solid carbide	Brazed carbide[1)]
Cutting speed, v_c m/min	110–130	45	35
f.p.m.	335–435	135	115
Feed, f mm/r	0,08–0,14[2)]	0,10–0,15[2)]	0,10–0,20[2)]
i.p.r.	0,003–0,006[2)]	0,004–0,006[2)]	0,004–0,008[2)]

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

MILLING

Face and square shoulder milling

Cutting data parameters	Milling with carbide: Rough milling	Milling with carbide: Fine milling	Milling with HSS: Fine milling
Cutting speed (v_c) m/min	80–100	100–130	10
f.p.m.	265–335	335–435	33
Feed (f_z) mm/tooth	0,20–0,30	0,10–0,20	0,10
inch/tooth	0,008–0,012	0,004–0,008	0,004
Depth of cut (a_p) mm	2–4	1–2	1–2
inch	0,08–0,16	0,04–0,08	0,04–0,08
Carbide designation ISO	K15*	K15*	–

* *Use a wear resistant coated carbide grade, for example Sandvik Coromant GC3015 or SECO T15M.*

End milling

Cutting data parameters	Type of mill: Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c) m/min	40–45	90–120	10[1)]
f.p.m.	135–150	300–400	33[1)]
Feed (f_z) mm/tooth	0,01–0,20[2)]	0,06–0,20[2)]	0,01–0,30[2)]
inch/tooth	0,0004–0,008[2)]	0,002–0,008[2)]	0,0004–0,012[2)]
Carbide designation ISO	K20	P25 Coated carbide	–

[1)] *For coated HSS end mill v_c ~20–25 m/min. (70–85 f.p.m.)*
[2)] *Depending on radial depth of cut and cutter diameter.*

GRINDING

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

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B151 R75 B3[1)] 3SG 46 HVS[2)] A 46 GV
Face grinding segments	A 24 GV	3SG 46 HVS[2)] A 36 HV
Cylindrical grinding	A 60 JV	B126 R75 B3[1)] 5SG 60 KVS[2)] A 60 IV
Internal grinding	A 46 JV	B126 R75 B3[1)] 3SG 60 JVS[2)] A 60 HV
Profile grinding	A 100 LV	B107 R100 V[1)] 5SG 80 KVS[2)] A 120 JV

[1)] *If possible, CBN wheels should be used for these applications.*
[2)] *Grinding wheel from Norton Co.*

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