Datablad

Vanadis 60

Produktfakta og anvendelsesområder

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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.

Applications

VANADIS 60 is a premium high alloyed high performance PM high speed steel with an addition of cobalt.

VANADIS 60 is particularly suitable for single edge cutting tools where the demands on wear resistance and hot hardness are very high.

Other applications are cutting tools as taps, end mills etc. for use in materials very difficult to machine.

General

VANADIS 60 is a W-Mo-V-Co alloyed PM high speed steel characterized by:

- Highest wear resistance
- Maximum compressive strength
- Good through hardening properties
- Good toughness
- Good dimensional stability on heat treatment
- Superior temper resistance. (Hot hardness)

Typical analysis %	C 2,3	Cr 4,2	Mo 7,0	W 6,5	V 6,5	Co 10,5
Standard specification	W.-Nr. 1.3241					
Delivery condition	Soft annealed, max. 340 HB					
Colour code	Gold					

Properties

SPECIAL PROPERTIES

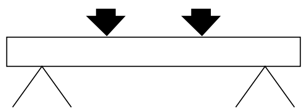
VANADIS 60 can be hardened to a very high hardness and compressive strength. *VANADIS 60* has further the same good dimensional stability during heat treatment as the other *VANADIS* grades. The toughness is despite the very high alloying content very good. The machinability is lower compared to lower alloyed HSS. The grindability of *VANADIS 60* is equal or better than other high alloyed HSS, but somewhat lower than for *VANADIS 30. VANADIS 60* has a very high hot hardness.

PHYSICAL DATA

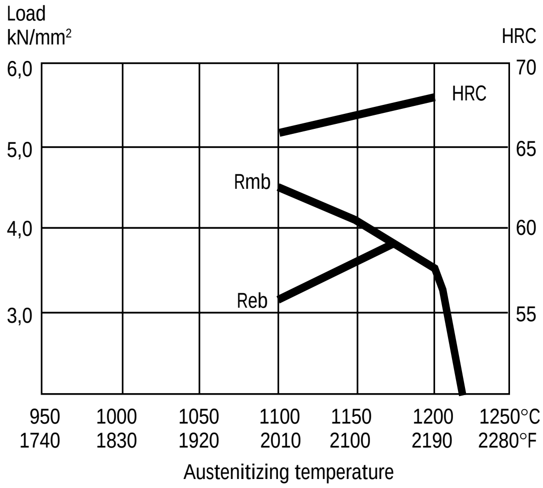
Temperature		20°C (68°F)	400°C (750°F)	600°C (1112°F)
Density, kg/m³	(1)	7960	7860	7810
lbs/in³	(1)	0,286	0,283	0,281
Modulus of elasticity MPa	(2)	250 000	222 000	200 000
ksi	(2)	36 x 10³	32 x 10³	20 x 10³
Coefficient of thermal expansion per °C from 20°C	(2)	–	10,6 x 10⁻⁶	11,1 x 10⁻⁶
°F from 68°F	(2)	–	5,9 x 10⁻⁶	6,1 x 10⁻⁶
Thermal conductivity W/m•°C	(2)	21	25	24
Btu in/(ft² h°F)	(2)	145	173	166
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

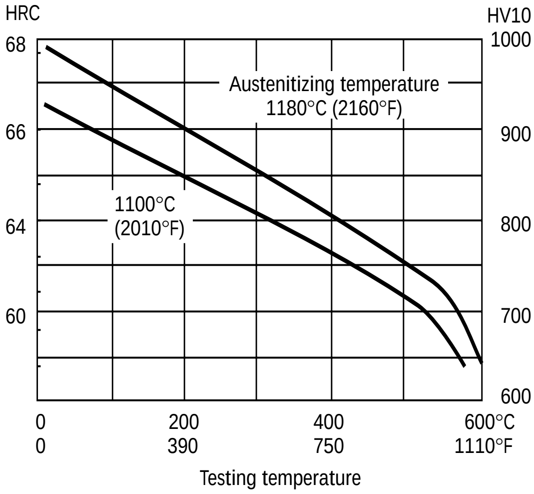


Four-point bend testing.
Specimen size: 5 mm (0,2") Ø
Loading rate: 5 mm/min. (0,2"/min.)
Austenitizing temperature: 1100–1210°C (2010–2210°F)
Tempering: 3 x 1 h at 560°C (1040°F), air cooling to room temperature.



HIGH TEMPERATURE PROPERTIES

VANADIS 60 hot hardness



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

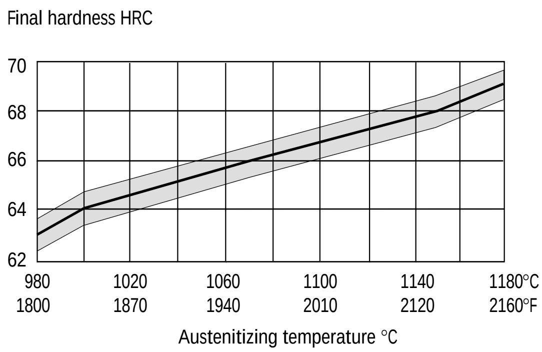
After rough machining the tool should be heated through to 600–700°C (1110–1290°F), holding time 2 hours. Cool slowly to 500°C (930°F), then freely in air.

TEMPERING

Pre-heating temperature: 450–500°C (840–930°F) and 850–900°C (1560–1650°F).
Austenitizing temperature: 1100–1180°C, according to the desired final hardness, see diagram below.

The tool should be protected against decarburization and oxidation during hardening.

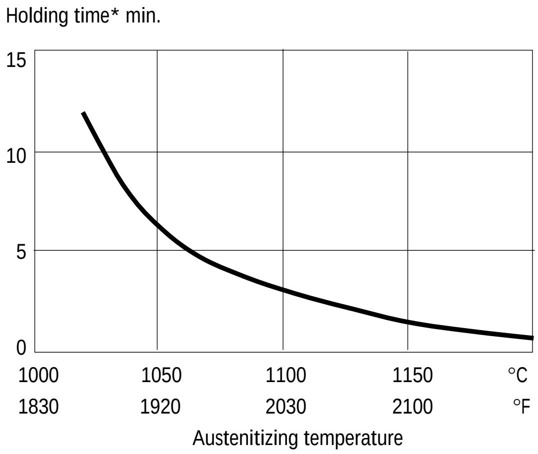
Hardness after tempering 3 times for one hour at 560°C (1040°F).



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

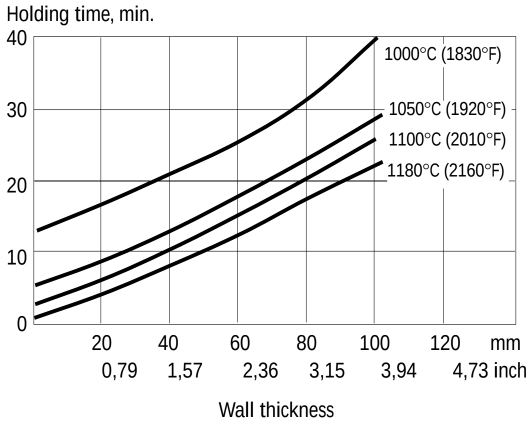
HRC	°C	°F
62	960	1760
64	1000	1832
66	1070	1960
68	1150	2102
69	1180	2156

Recommended holding time



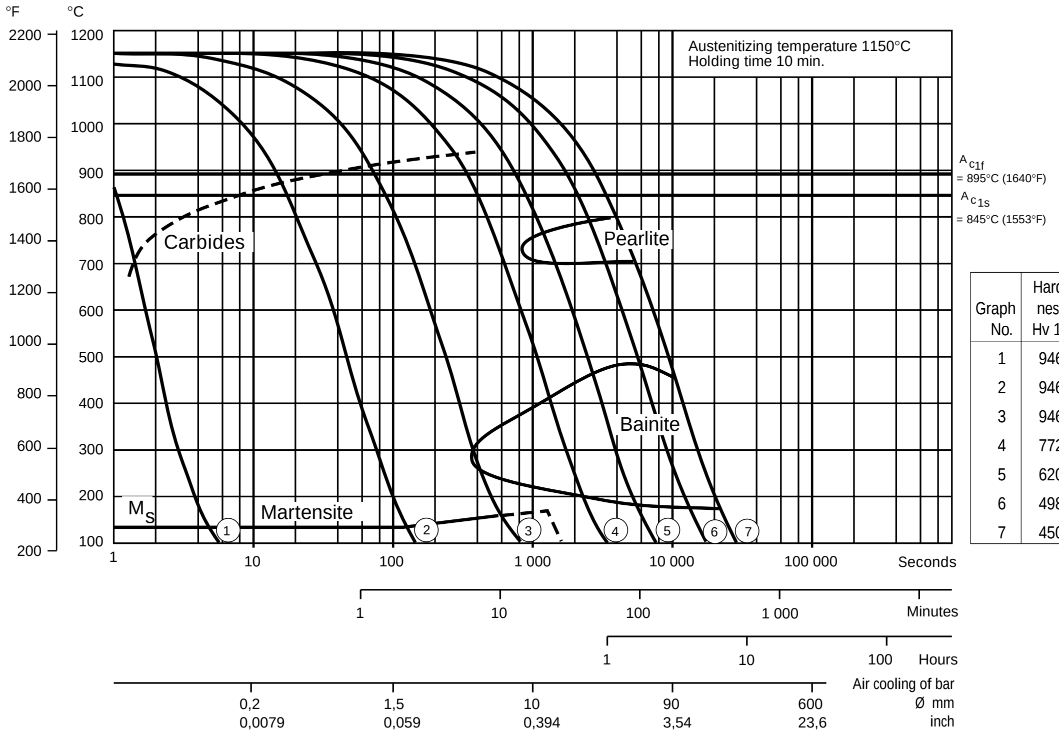
*) *Holding time = time at austenitizing temperature after the tool is fully heated through.*

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 1150°C (1920°F). Holding time 10 minutes.



Graph No.	Hard-ness Hv 10	$T_{800–500}$ (sec.)
1	946	1
2	946	28
3	946	140
4	772	630
5	620	1390
6	498	3205
7	450	5215

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. 25°C (77°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 normally 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 1050–1130°C (1920–2070°F) and tempering 3 x 1 h 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 60		
	Hardening	Tempering 3 times	HRC
Single-edge cutting tools: tool bits	1190°C 2175°F	550°C 1025°F	68–70
Form tools	1180°C 2155°F	560°C 1040°F	67–68
Rotating multi-edge cutting tools: twist drills, milling cutters, broaches, taps, hobs, shaper cutters, etc.	1150–1180°C 2100–2155°F	560°C 1040°F	66–68

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 recommendation".

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) m/min f.p.m.	60–90 200–300	90–110 300–365	6–10 20–33
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 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	6–8*	20–26*	0,05–0,10	0,002–0,004
5–10	3/16–3/8	6–8*	20–26*	0,10–0,20	0,004–0,008
10–15	3|8–5|8	6–8*	20–26*	0,20–0,25	0,008–0,010
15–20	5|8–3|4	6–8*	20–26*	0,25–0,30	0,010–0,012

** For coated HSS drill v_c = 12–14 m/min. (39–46 f.p.m.)*

Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Brazed carbide[1]
Cutting speed, v_c m/min f.p.m.	80–100 265–335	40–60 131–199	20–30 66–98
Feed, f mm/r i.p.r.	0,05–0,15[2] 0,002–0,006[2]	0,10–0,15[2] 0,004–0,006[2]	0,10–0,20[2] 0,004–0,008[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) m/min f.p.m.	40–60 135–200	60–80 200–265
Feed (f_z) mm/tooth inch/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	1–2 0,04–0,08
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	TiCN coated high speed steel
Cutting speed (v_c) m/min f.p.m.	30–40 100–131	40–60 135–200	10–14 33–46
Feed (f_z) mm/tooth inch/tooth	0,01–0,2[1] 0,0004–0,008[1]	0,06–0,2[1] 0,002–0,008[1]	0,01–0,3[1] 0,0004–0,012[1]
Carbide designation ISO	–	K15, P10–P20 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	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B151 R50 B3[1] A 46 GV[2]
Face grinding segments	A 36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B151 R50 B3[1] A 60 JV[2]
Internal grinding	A 60 JV	B151 R75 B3[1] A 60 IV
Profile grinding	A 100 IV	B126 R100 B6[1] A 100 JV[2]

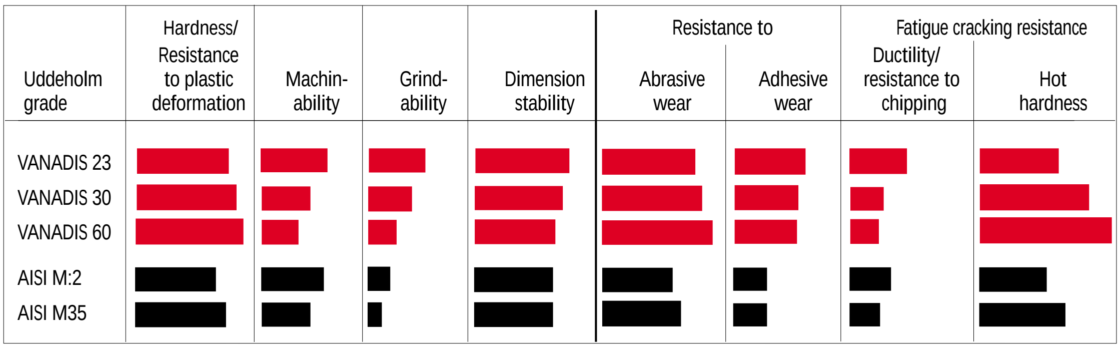
1) If possible, use CBN wheels for this application
2) Preferable a wheel type containing sintered Al_2O_3 (seeded gel)

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).

Relative comparison of Uddeholm PM steels

MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS



Further information

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