UDDEHOLM VANCRON® 40

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UDDEHOLM VANCRON 40

Uddeholm Vancron 40 is a nitrided powder tool steel, which means that a "surface coating" is already integrated into the finished tooling material. The result is a tool surface with very low friction that reduces galling or sticking of the material.

Uddeholm Vancron 40 offers the possibility of eliminating time- and cost-consuming surface coatings like CVD, PVD or TD. This is achieved already in the manufacturing process of Uddeholm Vancron 40 by introducing an extra nitriding operation.

Benefits for the tool user include improved and consistent quality of the manufactured parts, especially regarding the surfaces. More reliable delivery time and higher utilization of the production equipment are also benefits, with fewer disturbances and interruptions in production. Further improvements include simplified maintenance, which can often be made in-house as no surface coating is required; and as well, total tool life is increased.

The tool maker can produce a high quality tool that does not require any surface coating, which means a shorter delivery time and freedom to make adjustments after the heat treatment.

In total this means that the product quality will be uniform from the first part produced to the last and that a tool manufactured in Uddeholm Vancron 40 will make it easier for you to keep your promises!

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.

Classified according to EU Directive 1999/45/EC
For further information see our "Material Safety Data Sheets".

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The latest revised edition of this brochure is the English version, which is always published on our web site www.uddeholm.com

SS-EN ISO 9001
SS-EN ISO 14001

Critical tool steel properties

For good tool performance

In many cold work applications tools are surface coated in order to prevent galling and adhesive wear.

Furthermore it is important to have the correct hardness for the applications as well as a sufficient ductility and toughness in order to prevent premature failure due to chipping/crack formation.

Uddeholm Vancron 40 is a nitrided powder metallurgical tool steel offering an excellent combination of galling resistance and adhesive wear resistance.

For tool making

- Machinability
- Heat treatment
- Grinding
- Dimensional stability in heat treatment
- Surface treatment

Tool making with highly alloyed tool steels means that machining and heat treatment are often more of a problem than with the lower alloy grades. This can, of course, raise the cost of tool making.

The powder manufacturing route used for Uddeholm Vancron 40 means that its machinability is superior to that of similar conventionally produced grades and some highly alloyed cold work tool steels.

The dimensional stability of Uddeholm Vancron 40 in heat treatment is good and predictable compared to conventionally produced high alloy steels.

Uddeholm Vancron 40 is designed to be used without surface coating as it contains a high amount of low friction vanadium rich nitrides in the matrix.

Applications

Uddeholm Vancron 40 is a cold work tool steel with an excellent galling/adhesive wear profile, which makes the steel ideal for severe production conditions and/or long run production in applications where surface coated tool steel is needed. The work materials in these applications are often soft/adherent materials such as austenitic and ferritic stainless steel, mild steel, copper, aluminium, etc.

Uddeholm Vancron 40 should be used in cold work applications where the predominant failure mechanisms are adhesive wear or galling.

Typical applications are:

- Blanking and forming
- Cold extrusion
- Deep drawing
- Powder pressing

General

Uddeholm Vancron 40 is a Cr-Mo-W-V-N alloyed cold work tool steel, which is characterized by

- Very high adhesive wear resistance
- Very high galling resistance
- Good chipping and cracking resistance
- High compressive strength
- Good through hardening properties
- Good dimensional stability in hardening
- Very good resistance to tempering back
- Good WEDM properties

Typical analysis %	C 1.1	N 1.8	Si 0.5	Mn 0.4	Cr 4.5	Mo 3.2	W 3.7	V 8.5
Standard specification	None							
Delivery condition	Soft annealed to approx. 300 HB							
Colour code	Gold/ Dark blue							

Properties

Physical data

After hardening and tempering to 61 HRC

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m³ lbs/in³	7 700 0.278	–	–
Modulus of elasticity MPa ksi	209 000 30 x 10^3	201 500 29 x 10^3	195 000 28 x 10^3
Coefficient of thermal expansion per °C from 20°C °F from 68°F	–	11.1 x 10^{-6} 6.1 x 10^{-6}	11.9 x 10^{-6} 6.6 x 10^{-6}
Thermal conductivity W/m •°C Btu in/ft² h °F	–	21 ±2 145 ±14	25 ±0.5 173 ±3
Specific heat J/kg °C Btu /lb °F	460 0.11	–	–

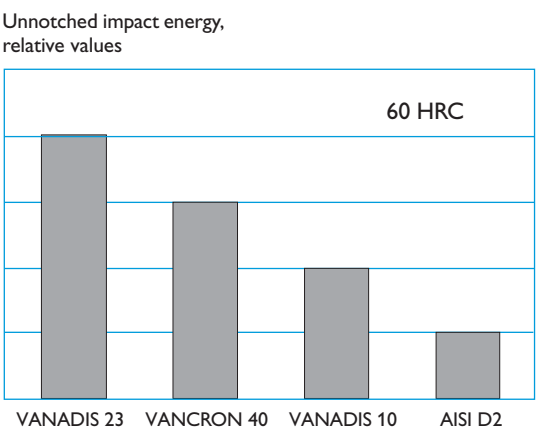
Compressive strength

Approximately compressive strength vs. hardness is shown in the table below.

Hardness HRC	Compressive yield strength $R_{c0.2}$ (MPa)
58	2200
60	2500
62	2700
64	3000

Unnotched impact energy

Unnotched impact energy for Uddeholm Vanadis 23, Uddeholm Vancron 40, Uddeholm Vanadis 10, and AISI D2 is shown below.



Heat treatment

Soft annealing

Protect the steel and heat through to 900°C (1650°F). Then cool in the furnace at 10°C/h (20°F/h) to 650°C (1200°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

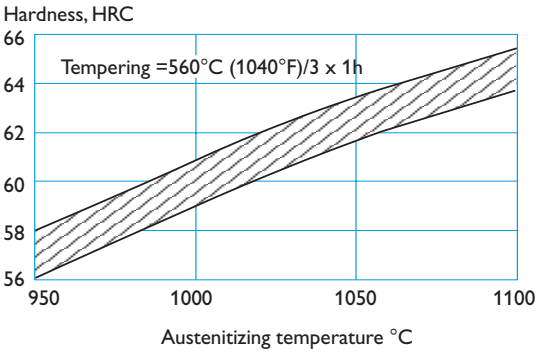
The hardenability for Uddeholm Vancron 40 is equivalent to Uddeholm Vanadis 23, which ensures good through hardening properties at quenching in salt bath or gas quenching in vacuum furnace.

Pre-heating in two stages: 600–650°C (1110–1200°F) and 850–900°C (1560–1650°F).
Austenitizing temperature: 1000–1100°C (1830–2010°F) normally 1020°C (1870°F).
Holding time: 30 minutes (10 minutes at 1100°C (2010°F).

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

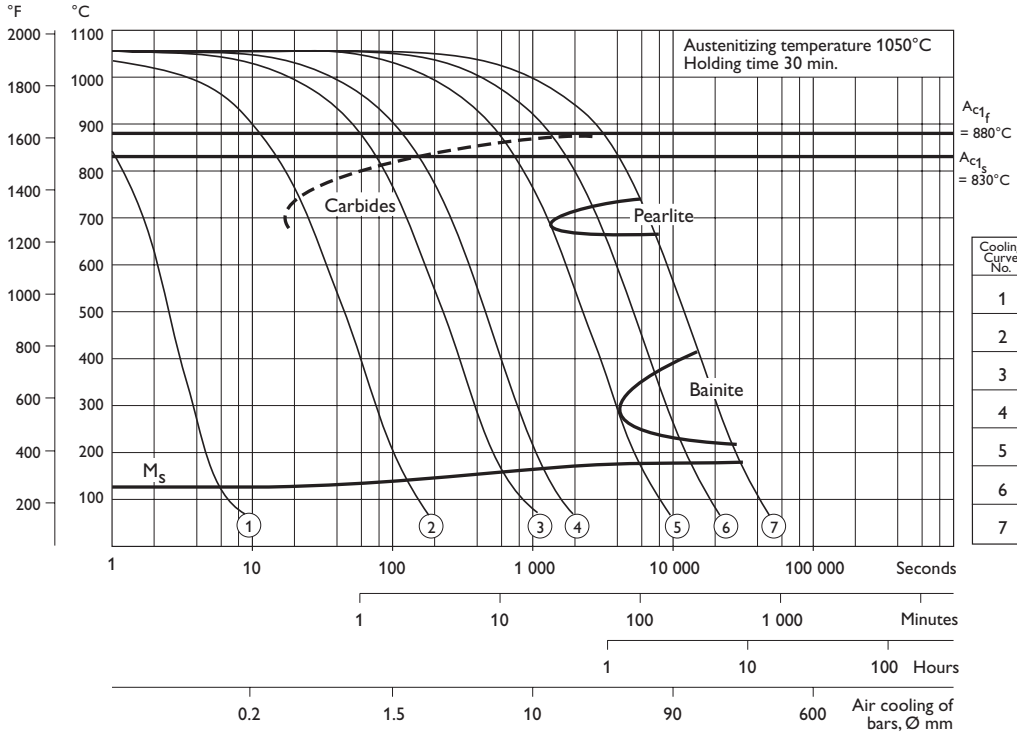
Uddeholm Vancron 40 can be heat treated to give a wide range of hardness. To achieve a hardness between 58–65 HRC the austenitizing temperature is varied in the range 950–1100°C (1740–2010°F). The recommended austenitizing temperature is 1020°C (1865°F) with 30 minutes holding time followed by quenching and tempering at 560°C (1040°F)/ 3 x 1 h resulting in a hardness of 60–62 HRC.

In order to avoid a too low working hardness it is recommended to austenitize at a higher hardening temperature than normal and if the hardness will be too high temper down the hardness to the right hardness level.



CCT-GRAPH (CONTINUOUS COOLING)

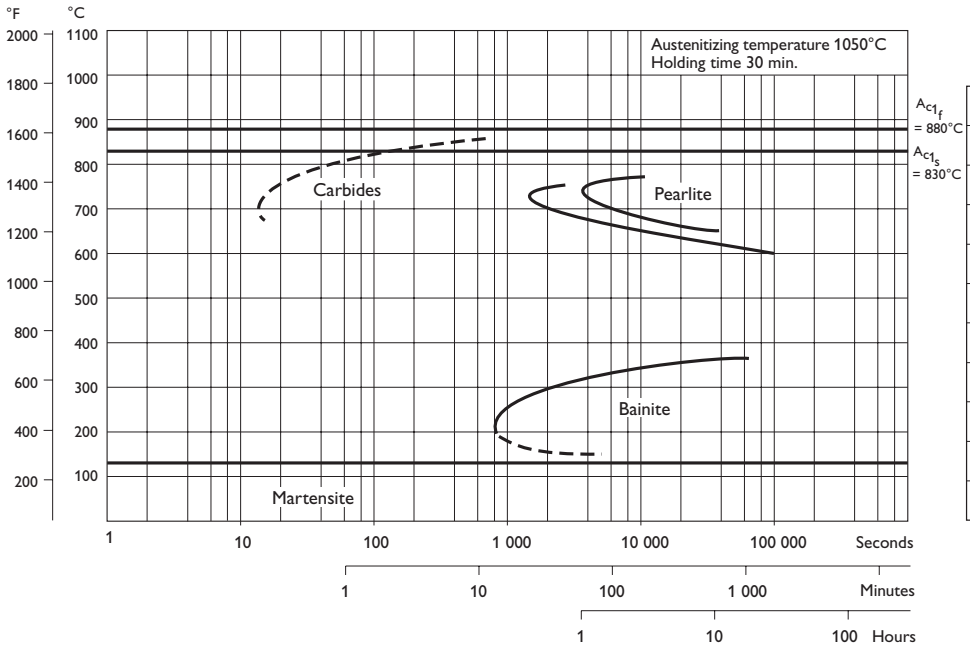
Austenitizing temperature 1050°C (1920°F). Holding time 30 minutes.



Cooling Curve No.	Hardness HV 10	$T_{800-500}$ (sec)
1	882	1
2	882	28
3	882	140
4	882	280
5	882	1390
6	762	3205
7	493	7320

TTT-GRAPH (ISOTHERMAL TRANSFORMATION)

Austenitizing temperature 1050°C (1920°F). Holding time 30 minutes.



Temp. °C	Time hours	Hardn. HV 10
750	4,9	354
725	1,6	383
700	14,1	383
650	14,5	433
600	63,3	613
400	8,1	946
350	6,5	657
300	7,7	620
250	2,0	933
200	20,1	858

Quenching media

- Vacuum furnace with high speed gas at sufficient overpressure (2–5 bar)
- Martempering bath or fluidized bed at approx. 550°C (1020°F)
- Forced air/gas

Note 1: Quenching should be continued until the temperature of the tool reaches approx. 50°C (120°F). The tool should then be tempered immediately.
Note 2: For applications where maximum toughness is required use a martempering bath or a furnace with sufficient overpressure.

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 3% after this tempering cycle.

Dimensional changes

Dimensional changes after hardening and tempering.
Heat treatment: austenitizing between 950–1100°C (1740–2010°F)/30 minutes and tempering 3 x 1 h at 560°C (1040°F).
Specimen size: 50 x 50 x 50 mm (2" x 2" x 2") and 100 x 40 x 20 mm (4" x 1,5" x 1").
Dimensional changes: growth in length, width and thickness +0.04% to +0.20%.

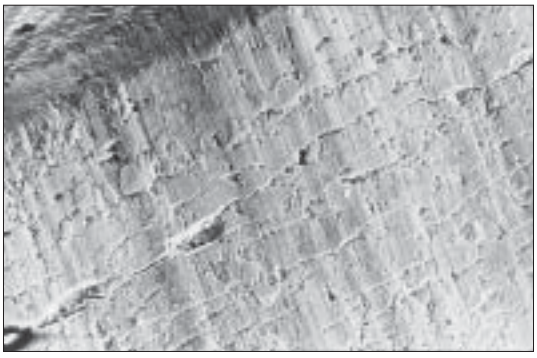
Sub-zero treatment

Tools requiring maximum dimension stability in service can be sub-zero treated as follows:

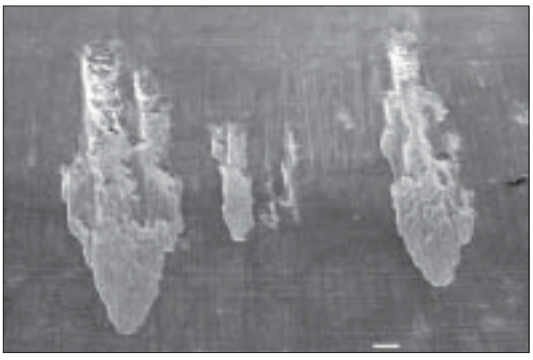
For the highest requirements on dimensional stability sub-zero treatment in liquid nitrogen is recommended after quenching and after each tempering at 560°C.

In less critical cases immediately after quenching, the tool should be sub-zero treated to at least -70°C to -80°C (-95°F to -110°F), soaking time 1 – 3 hours, followed by tempering at 560°C (1040°F) x three times.

The sub-zero treatment leads to a reduction of the retained austenite content. For a high hardening temperature > 1100°C (2010°F), we always recommend sub-zero treatment followed by four temperings at 560°C (1040°F), in order to reduce the retained austenite and improve the dimensional stability.



Adhesive wear.



Galling.

Surface treatments

Note: Uddeholm Vancron 40 is designed to be used without surface coating as it contains a high amount of nitrogen.

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).

Uddeholm Vancron 40 is normally not needed to be surface coated by PVD/CVD or nitriding. However, Uddeholm Vancron 40 can be surface coated like other PM steels.

Nitriding

A brief immersion in a special salt bath to produce a nitrided diffusion zone of 2–20 µm is recommended. This reduces the 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 Uddeholm Vancron 40 is high temperature tempered at 560°C (1040°F) there is no danger of dimensional changes during PVD coating.

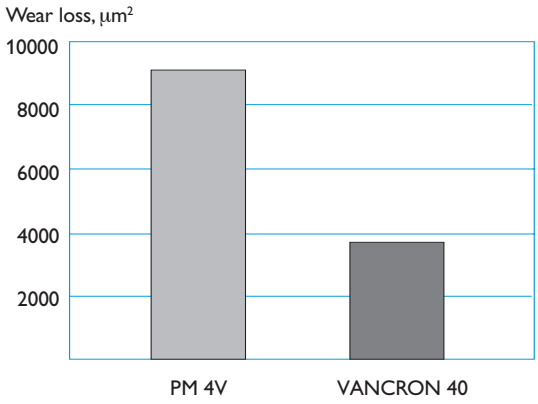
CVD

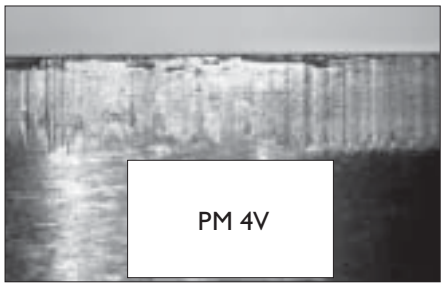
Chemical vapour deposition, CVD, is used for applying wear-resistant surface coatings at a temperature of around 1000°C (1830°F). It is recommended that the tools should be separately hardened and tempered in a vacuum furnace after surface treatment.

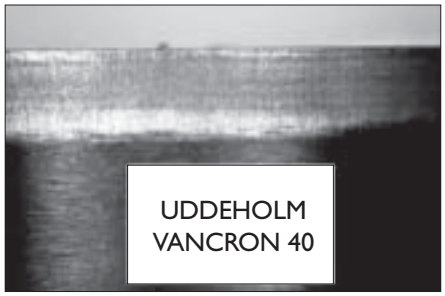
Wear resistance

ADHESIVE WEAR

Wear resistance comparison.
Component: laboratory test strip.
Tool type: blanking punch.
Tool dimension: 10 x 40 mm.
Work material: 18/8 stainless steel SS 2331 1 mm thick.

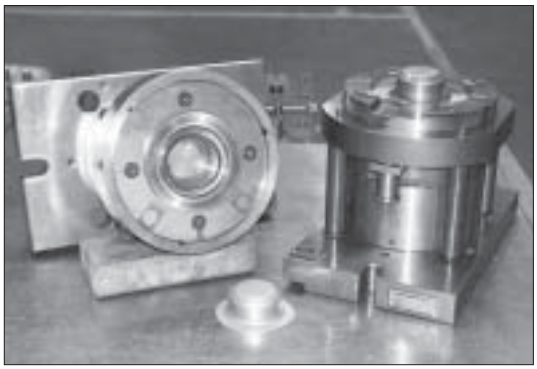






Tribological properties—Case Study

Cold forming die for producing a part of stainless steel for pump housing.
Courtesy: Grundfos A/S, Denmark.



RESULTS

Uddeholm Steel / Surface coating	VANADIS 23 Uncoated	VANADIS 10 Uncoated	VANCRON 40 Uncoated
Part Produced	83 000	1 900 000	>18 000 000
Hardness HRC	62		64
Failure mechanism	Galling		Still running

Uddeholm Steel / Surface coating	VANADIS 23		
	Salt bath nitriding	PVD TiN	CVD TiC/TiN
Part Produced	160 000	130 000	2 000 000
Hardness HRC	62		
Failure mechanism	Galling		Delamination

Cutting data recommendations

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions.

Further information can be found in the Uddeholm publication "Cutting data recommendations".

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.	110–160 361–525	160–200 525–660	20–25 22–83
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* Coated carbide	K15* Coated carbide or cermet	–

* Use a wear resistant Al_2O_3 coated carbide grade

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	12–14*	40–46*	0.05–0.10	0.002–0.004
5–10	3/16–3/8	12–14*	40–46*	0.10–0.20	0.004–0.008
10–15	3/8–5/8	12–14*	40–46*	0.20–0.25	0.008–0.010
15–20	5/8–3/4	12–14*	40–46*	0.25–0.35	0.010–0.014

* For coated HSS drill v_c = 22–24 m/min. (72–79 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.	140–160 462–528	80–100 264–330	50–60 165–197
Feed, f mm/r i.p.r.	0.05–0.15[2] 0.002–0.006[2]	0.10–0.25[2] 0.004–0.010[2]	0.15–0.25[2] 0.006–0.010[2]

[1] Drill with replaceable or brazed carbide 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.	80–100 262–330	100–120 330–396
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	–2 –0.08
Carbide designation ISO	K20* Coated carbide	K15* Coated carbide or cermet

* Use a wear resistant Al_2O_3 coated carbide grade

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.	40–50 132–164	70–90 230–297	12–15[1] 40–50[1]
Feed (f_z) mm/tooth inch/tooth	0.01–0.2[2] 0.0004–0.008[2]	0.06–0.2[2] 0.002–0.008[2]	0.01–0.3[2] 0.0004–0.012[2]
Carbide designation ISO	–	K15[3]	–

[1] For coated HSS end mill v_c = 20–30 m/min. (66–99 f.p.m.)
[2] Depending on radial depth of cut and cutter diameter
[3] Use a wear resistant Al_2O_3 coated carbide grade

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] A 46 HV
Face grinding segments	A 36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B151 R50 B3[1] A 60 KV
Internal grinding	A 60 JV	B151 R75 B3[1] A 60 IV
Profile grinding	A 100 IV	B126 R100 B6[1] A 100 JV

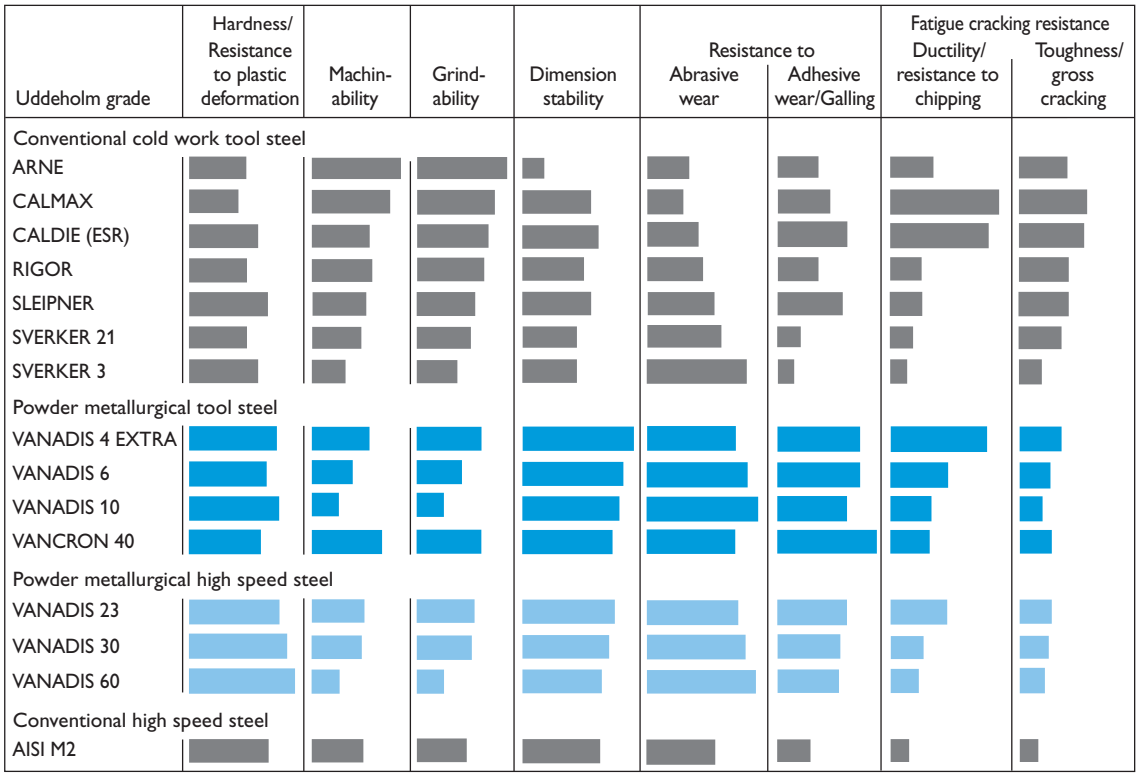
[1] If possible use CBN wheels for this application

Electrical-discharge machining, 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 cold work tool steel

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. For more information, please visit www.uddeholm.com



Network of excellence

UDDEHOLM is present on every continent. This ensures you high-quality Swedish tool steel and local support wherever you are. ASSAB is our wholly-owned subsidiary and exclusive sales channel, representing Uddeholm in various parts of the world. Together we secure our position as the world's leading supplier of tooling materials.

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UDDEHOLM is the world's leading supplier of tooling materials. This is a position we have reached by improving our customers' everyday business. Long tradition combined with research and product development equips Uddeholm to solve any tooling problem that may arise. It is a challenging process, but the goal is clear – to be your number one partner and tool steel provider.

Our presence on every continent guarantees you the same high quality wherever you are. ASSAB is our wholly-owned subsidiary and exclusive sales channel, representing Uddeholm in various parts of the world. Together we secure our position as the world's leading supplier of tooling materials. We act worldwide, so there is always an Uddeholm or ASSAB representative close at hand to give local advice and support. For us it is all a matter of trust – in long-term partnerships as well as in developing new products. Trust is something you earn, every day.

For more information, please visit www.uddeholm.com, www.assab.com or your local website.

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