Uddeholm
Vancron®
SuperClean

UDDEHOLM
a voestalpine company

Uddeholm Vancron® SuperClean

Uddeholm Vancron SuperClean 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 offers the possibility of eliminating time- and cost-consuming surface coatings like PVD or TD. This is achieved already in the manufacturing process of Uddeholm Vancron 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 will make it easier for you to keep your promises.

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

Edition 4, 01.2020

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 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 steel 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 means that its machinability is superior to that of similar conventionally produced grades and some highly alloyed cold work tool steel.

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

Uddeholm Vancron 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 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/ad-herent materials such as austenitic and ferritic stainless steel, mild steel, copper, aluminium, etc.

Uddeholm Vancron 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
- An alternative to tooling when coatings and cemented carbide used to be the only solution

GENERAL

Uddeholm Vancron is a Cr-Mo-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 1.3	N 1.8	Si 0.5	Mn 0.4	Cr 4.5	Mo 1.8	V 10
Standard specification	None						
Delivery condition	Soft annealed to approx. 300 HB						
Colour code	Green/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	 7 440 0.268	 7 397 0.267	 7 342 0.265
Modulus of elasticity MPa psi	 236 000 35.2 x 10^6	 – –	 – –
Coefficient of thermal expansion per °C from 20°C °F from 68°F	 10.9 x 10^{-6} 6.05 x 10^{-6}	 11.4 x 10^{-6} 6.3 x 10^{-6}	 12.3 x 10^{-6} 6.8 x 10^{-6}
Thermal conductivity W/m •°C Btu in/ft² h °F	 – –	 25 146	 27 173
Specific heat J/kg °C Btu /lb °F	 490 0.11	 544 012	 617 0.14

COMPRESSIVE STRENGTH

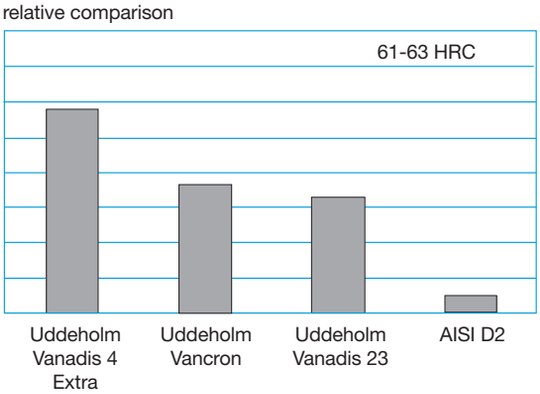
Approximately compressive strength vs. hardness is shown in the table below.

Hardness HRC	Compressive yield strength Rc0.2 (MPa)
58	2200
60	2500
62	2750
64	3000

UNNOTCHED IMPACT ENERGY

Unnotched impact energy for Uddeholm Vanadis 4 Extra, Uddeholm Vanadis 23, Uddeholm Vancron and an AISI D2 type of steel is shown below.

Unnotched impact energy, relative comparison



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 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: 950–1150°C (1740–2100°F) normally 1080°C (1980°F).

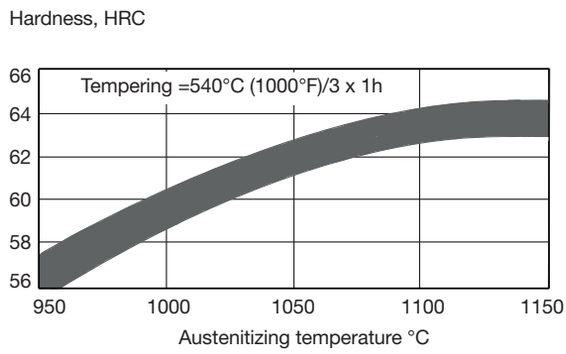
Holding time: 30 minutes (10 minutes at 1100°C (2010°F) and above.

We always recommend a sub-zero treatment when a hardening temperature of 1100°C (2100°F) or above has been used, see chapter *Sub-zero treatment* page 6.

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

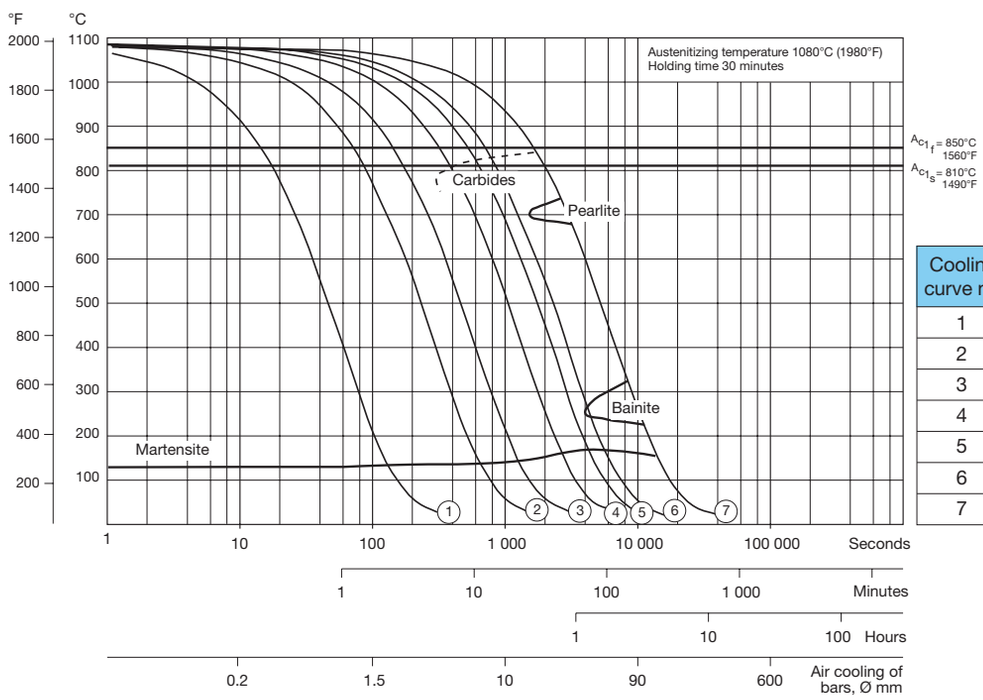
Uddeholm Vancron can be heat treated to give a wide range of hardness. To achieve a hardness between 58–64 HRC the austenitizing temperature is varied in the range 950–1150°C (1740–2100°F).

The recommended austenitizing temperature is 1080°C (1980°F) with 30 minutes holding time followed by quenching and tempering at 540°C (1000°F)/3 x 1 h resulting in a hardness of 63–64 HRC.



CCT-GRAPH (CONTINUOUS COOLING)

Austenitizing temperature 1080°C (1980°F). Holding time 30 minutes.



Cooling curve no.	Hardness HV10	T800-500 (sec)
1	783	28
2	800	140
3	775	280
4	772	630
5	753	1030
6	811	1390
7	705	3205

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 540°C (1000°F) irrespective of the austenitizing temperature. Temper three times for one hour at full tem-perature. The tool should be cooled to room temperature between the tempers.

The retained austenite content will be less than 2% after this tempering cycle.

DIMENSIONAL CHANGES

Dimensional changes after hardening and tempering.

Heat treatment: austenitizing between 950–1150°C (1740–2100°F)/30 minutes and tempering 3 x 1 h at 540°C (1004°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 0.8”).

Dimensional changes: growth in length, width and thickness +0.03% to +0.12%.

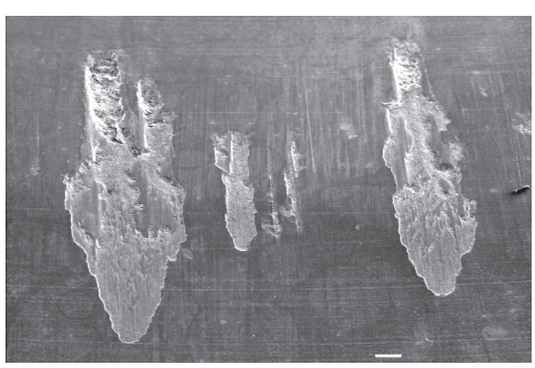
SUB-ZERO TREATMENT

For the highest requirements on dimensional stability sub-zero treatment is recommended after quenching.

The tool should be sub-zero treated immediately after quenching to at least -70°C (-95°F), soaking time 1–3 h, followed by three temperings at 540°C (1000°F) 1 hour.

For a high hardening temperature, >1080°C (1980°F), we always recommend sub-zero treatment followed by three temperings at 520°C (970°F) 1 hour, in order to minimize the retained austenite and improve the dimensional stability.

Adhesive wear.



Galling.

SURFACE TREATMENTS

Note: Uddeholm Vancron is designed to be used without surface coating as it contains a high amount of nitrogen and has already a form of internal surface coating.

Some cold work tools are given a surface treatment in order to reduce friction and increase tool wear resistance.

If extremely good resistance to galling is required in severe forming operations, Uddeholm Vancron can be surface coated.

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 is high temperature tempered at 540°C (1000°F) there is no danger of dimensional changes during PVD coating.

WEAR RESISTANCE

ADHESIVE WEAR

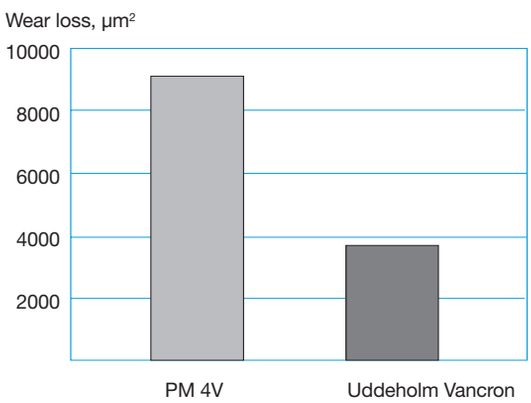
Wear resistance comparison.

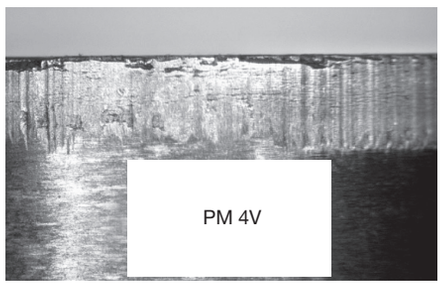
Component: laboratory test strip.

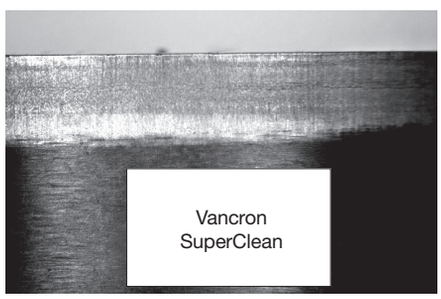
Tool type: blanking punch.

Tool dimension: 10 x 40 mm.

Work material: AISI 304 stainless steel 1 mm thick.

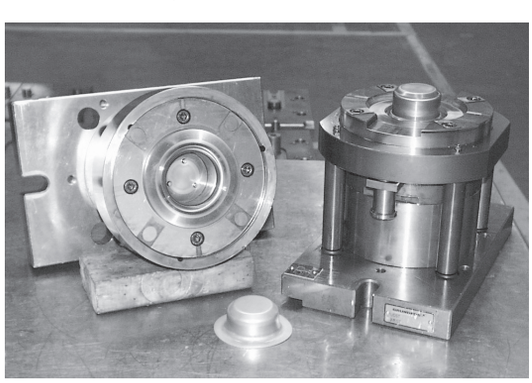






TRIBOLOGICAL PROPERTIES – CASE STUDY

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



RESULTS

Uddeholm Steel /Surface coating	Uddeholm Vanadis 23 Uncoated	PM 10V Uncoated	Uddeholm Vancron Uncoated
Part Produced	83 000	1 900 000	>18 000 000
Hardness HRC	62		64
Failure mechanism	Galling		Still running

Uddeholm Steel /Surface coating	Uddeholm 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” or in the Uddeholm machining app.

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		Cutting speed v_c		Feed f	
mm	inch	m/min.	f.p.m.	mm/r	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[3]	0.15–0.25[2] 0.006–0.010[4]

[1] Drill with replaceable or brazed carbide tip
[2] Feed rate for drill diameter 20–40 mm (0.8”–1.6”)
[3] Feed rate for drill diameter 5–20 mm (0.2”–0.8”)
[4] Feed rate for drill diameter 10–20 mm (0.4”–0.8”)

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

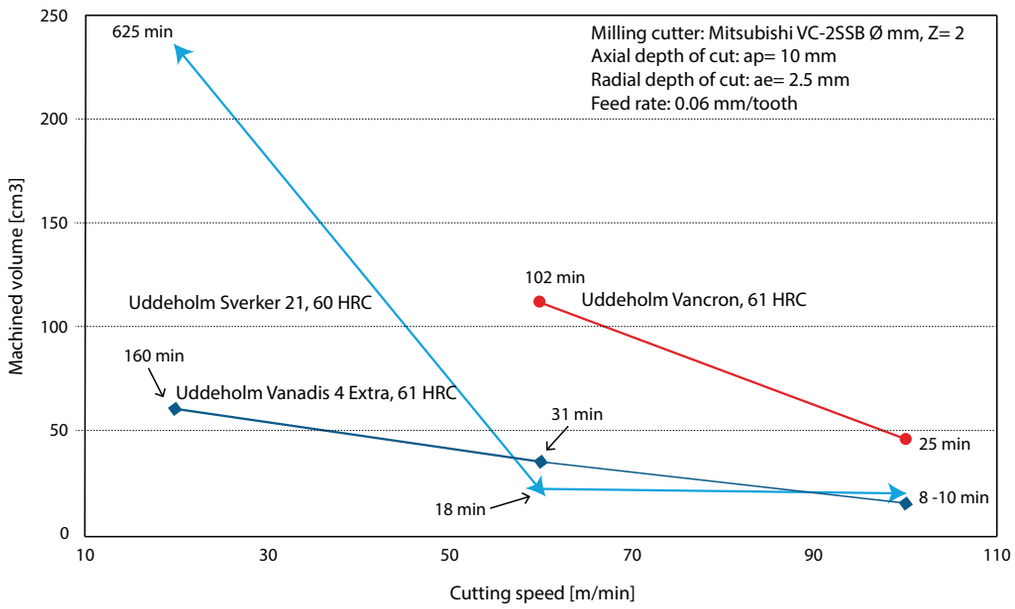
* Use a wear resistant Al_2O_3 coated carbide grade

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

HARD MILLING COMPARISON



GRINDING

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

Tools of Uddeholm Vancron can be produced with Electrical Discharge Machining (EDM) as long as the EDM layer is carefully removed. Fine grinding and polishing, and retempering the tool at approx. 510°C (950°F) is recommended.

Due to the extremely high nitrogen content in the steel, there are some general recommendations to be followed.

POWER SETTINGS

A coarse pass with high power can result in release of nitrogen from the steel causing pitting. As a general rule of thumb the EDM’ing of Uddeholm Vancron should be done with medium or fine passes using lower power setting.

FLUSHING

N-alloyed PM steels put higher demands on the flushing conditions. The On/Off time ratio should be low, i.e. shorter On time and longer Off time.

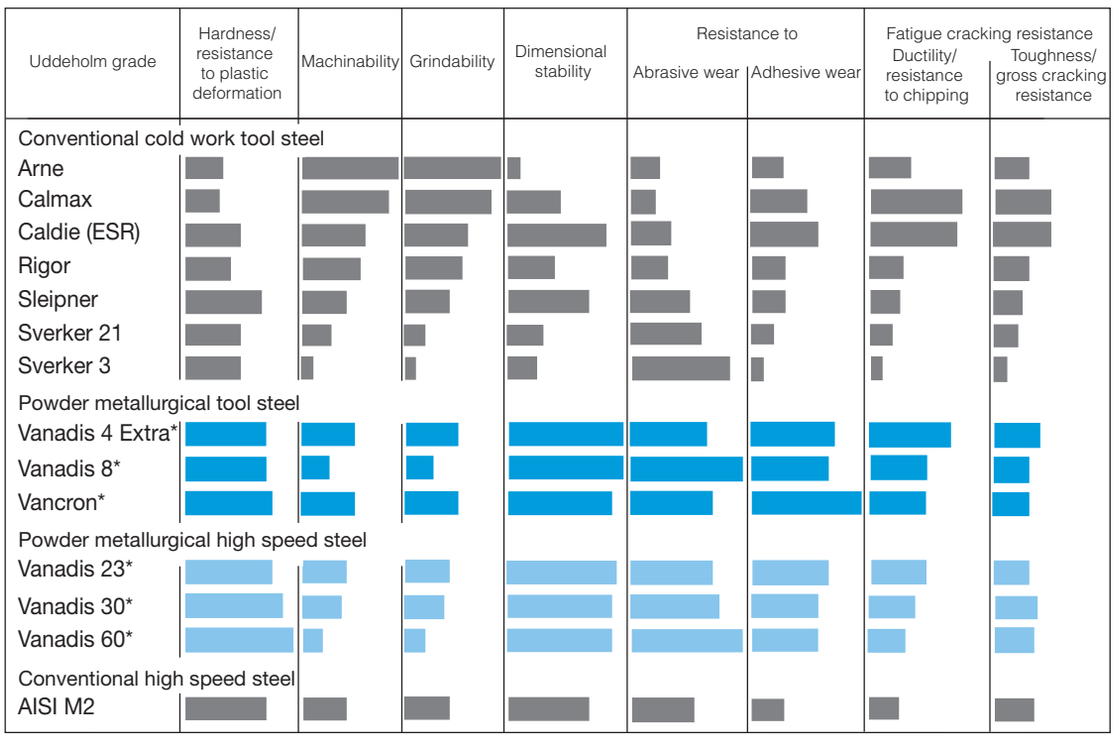
A general rule of thumb is that Off time should be twice the On time. When possible, use flushing through the electrode or through holes in the work piece. Higher viscosity of the dielectric liquid is also preferable due to better transportation of removed particles (can also give shorter EDM time and better surface finish).

ELECTRODES

For rough EDM operations graphite electrodes are recommended, preferably of high quality (small grain size, and/or Cu impregnated). A switched polarity might reduce sticking on electrode if that happens. For fine EDM use Cu or W/Cu electrodes. When Graphite electrodes must be used in fine EDM, high quality (small grain size, and/or Cu impregnated) is recommended.

RELATIVE COMPARISON OF UDDEHOLM COLD WORK TOOL STEEL

MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS



* Uddeholm PM SuperClean tool steels

FURTHER INFORMATION

Please contact your local Uddeholm office for further information on the selection, heat treatment, application and availability of Uddeholm tool steel. For more information, please visit www.uddeholm.com.

Manufacturing solutions for generations to come

SHAPING THE WORLD®

We are shaping the world together with the global manufacturing industry. Uddeholm manufactures steel that shapes products used in our every day life. We do it sustainably, fair to people and the environment. Enabling us to continue shaping the world – today and for generations to come.

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