VANCRON SUPERCLEAN

UDDEHOLM VANCRON SUPERCLEAN

ASSAB

ASSAB	UDDEHOLM a voestalpine company	REFERENCE STANDARD		
		AISI	WNr.	JIS
ASSAB XW-42	SVERKER 21	D2	1.2379	(SKD 11)
CALMAX / CARMO	CALMAX / CARMO		1.2358	
VIKING	VIKING / CHIPPER		(1.2631)	
CALDIE	CALDIE			
ASSAB 88	SLEIPNER			
ASSAB PM 23 SUPERCLEAN	VANADIS 23 SUPERCLEAN	(M3:2)	1.3395	(SKH 53)
ASSAB PM 30 SUPERCLEAN	VANADIS 30 SUPERCLEAN	(M3:2 + Co)	1.3294	SKH 40
ASSAB PM 60 SUPERCLEAN	VANADIS 60 SUPERCLEAN		(1.3292)	
VANADIS 4 EXTRA SUPERCLEAN	VANADIS 4 EXTRA SUPERCLEAN			
VANADIS 8 SUPERCLEAN	VANADIS 8 SUPERCLEAN			
VANCRON SUPERCLEAN	VANCRON SUPERCLEAN			
ELMAX SUPERCLEAN	ELMAX SUPERCLEAN			
VANAX SUPERCLEAN	VANAX SUPERCLEAN			
ASSAB 618 / 618 HH		(P20)	1.2738	
ASSAB 718 SUPREME / 718 HH	IMPAX SUPREME / IMPAX HH	(P20)	1.2738	
NIMAX / NIMAX ESR	NIMAX / NIMAX ESR			
VIDAR 1 ESR	VIDAR 1 ESR	H11	1.2343	SKD 6
UNIMAX	UNIMAX			
CORRAX	CORRAX			
ASSAB 2083		420	1.2083	SUS 420J2
STAVAX ESR	STAVAX ESR	(420)	(1.2083)	(SUS 420J2)
MIRRAX ESR	MIRRAX ESR	(420)		
MIRRAX 40	MIRRAX 40	(420)		
TYRAX ESR	TYRAX ESR			
POLMAX	POLMAX	(420)	(1.2083)	(SUS 420J2)
ROYALLOY	ROYALLOY	(420 F)		
COOLMOULD	COOLMOULD			
ASSAB 2714			1.2714	SKT 4
ASSAB 2344		H13	1.2344	SKD 61
ASSAB 8407 2M	ORVAR 2M	H13	1.2344	SKD 61
ASSAB 8407 SUPREME	ORVAR SUPREME	H13 Premium	1.2344	SKD 61
DIEVAR	DIEVAR			
QRO 90 SUPREME	QRO 90 SUPREME			
FORMVAR	FORMVAR			

20220824

( ) - modified grade

Edition 20230725

VANCRON SUPERCLEAN

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.

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

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.
Vancron SuperClean 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 Vancron SuperClean 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 Vancron SuperClean in heat treatment is good and predictable compared to conventionally produced high alloy steel.

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

APPLICATIONS

Vancron SuperClean 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. Vancron SuperClean 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

Vancron SuperClean is a Cr-Mo-V-N alloyed cold work tool steel, which is characterised 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	200 °C	400 °C
Density, kg/m^3	7 440	7 397	7 342
Modulus of elasticity N/mm^2	236 000	-	-
Coefficient of thermal expansion /°C from 20°C	10.9 x 10^{-6}	11.4 x 10^{-6}	12.3 x 10^{-6}
Thermal conductivity* W/m °C	-	25	27
Specific heat J/kg °C	490	544	617

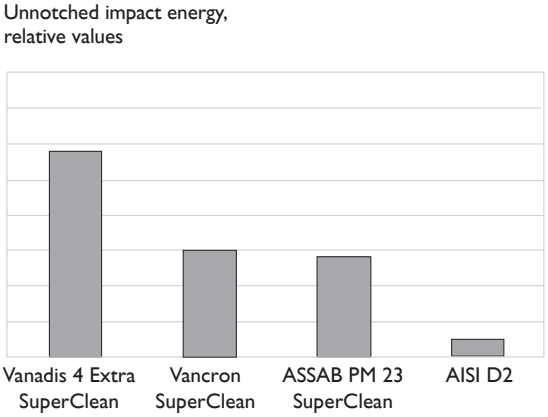
COMPRESSIVE STRENGTH

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

Hardness, HRC	Compressive yield strength, $Rc_{0.2}$, MPa
58	2 200
60	2 500
62	2 750
64	3 000

UNNOTCHED IMPACT ENERGY

Unnotched impact energy for Vanadis 4 Extra SuperClean, ASSAB PM 23 SuperClean, Vancron SuperClean and a AISI D2 type of steel is shown below.



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 900 °C. Then cool in furnace at 10 °C per hour to 650 °C, then freely in air.

STRESS RELIEVING

After rough machining the tool should be heated through to 600-700 °C, holding time 2 hours. Cool slowly to 500 °C, then freely in air.

HARDENING

The hardenability for Vancron SuperClean is equivalent to ASSAB PM 23 SuperClean, 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 and 850–900°C.

Austenitising temperature: 950–1150°C normally 1080°C.

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

We always recommend a sub-zero treatment when a hardening temperature above 1100°C has been used.

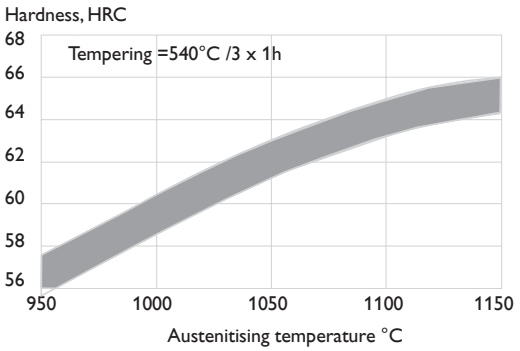
The tool should be protected against decarburisation and oxidation during hardening.

In some cases denitriding should also be considered. To avoid loss of nitrogen, which may lower the surface hardness, a minimum of 10 mbar and up to 400 mbar nitrogen overpressure is recommended during hardening. Alternatively the machining allowance could be increased.

Vancron SuperClean 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 950–1150°C.

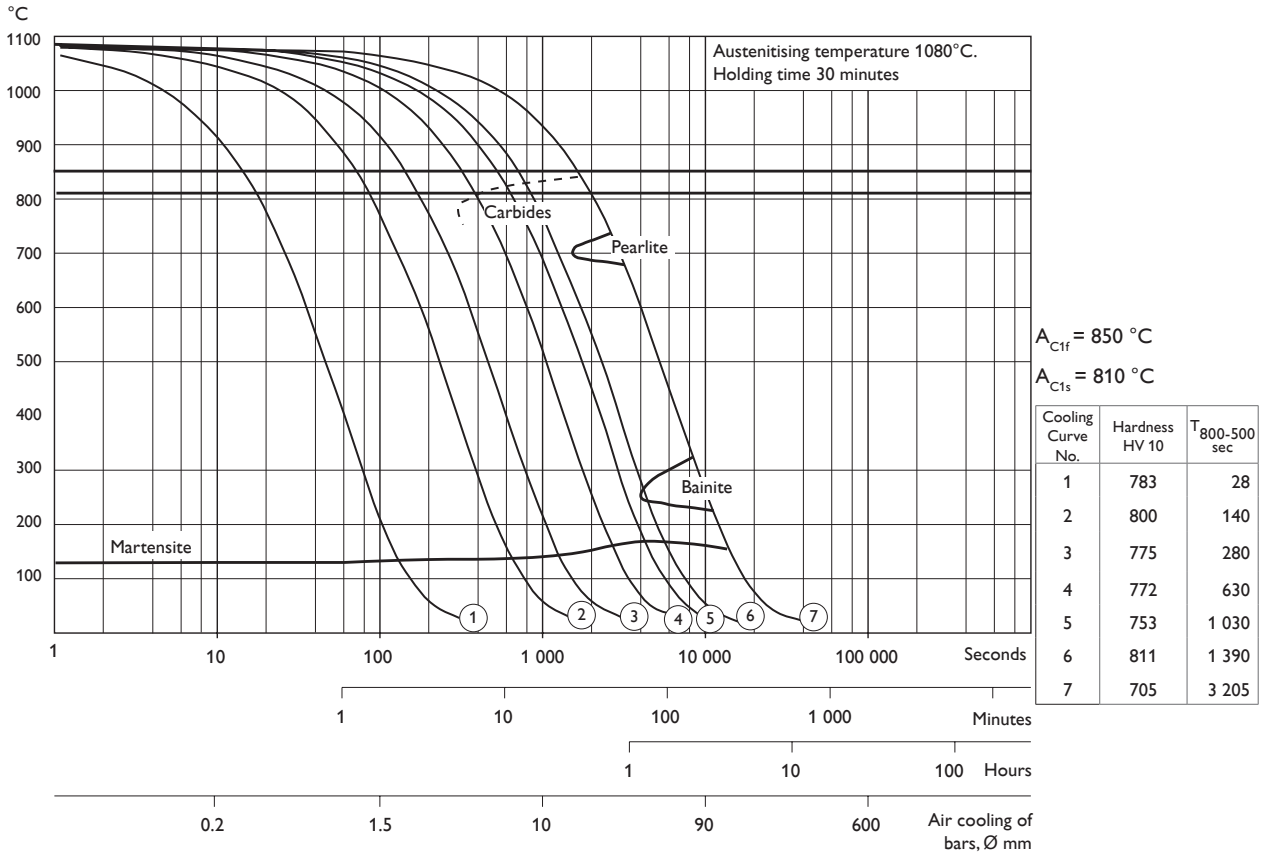
The recommended austenitising temperature is 1080°C with 30 minutes holding time followed by quenching and tempering at 540°C/3 x 1 h resulting in a hardness of 63–64 HRC.

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



CCT-GRAPH (CONTINUOUS COOLING)

Austenitising temperature 1080 °C. Holding time 30 minutes.



A_{C1f} = 850 °C

A_{C1s} = 810 °C

Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	783	28
2	800	140
3	775	280
4	772	630
5	753	1 030
6	811	1 390
7	705	3 205

QUENCHING MEDIA

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

Note 1: Quenching should be continued until the temperature of the tool reaches approx. 50°C. 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 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 2% after this tempering cycle.

DIMENSIONAL CHANGES

Dimensional changes after hardening and tempering:

- Heat treatment: austenitizing between 950–1150°C / 30 minutes and tempering 3 x 1 h at 540°C.
- Specimen size: 50 x 50 x 50 mm and 100 x 40 x 20 mm.
- Dimensional changes: growth in length, width and thickness +0.04% to +0.20%.

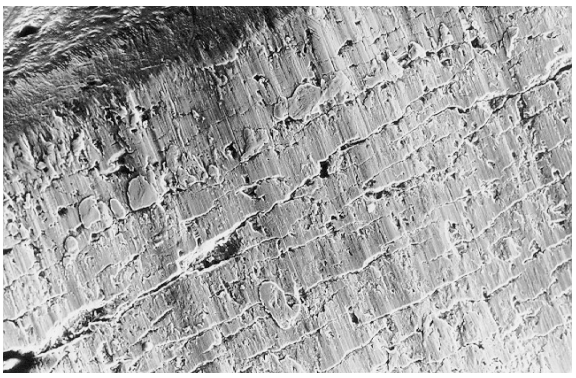
SUB-ZERO TREATMENT

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

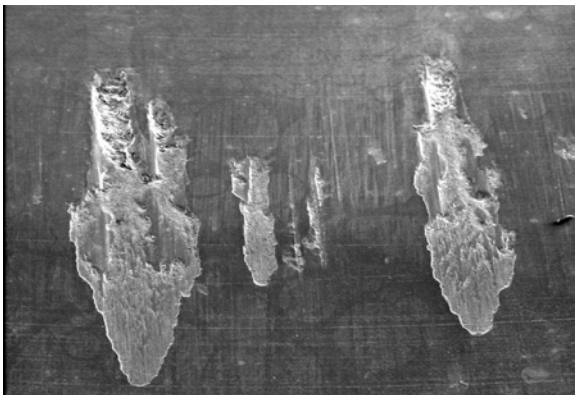
For the highest requirements on dimensional stability sub-zero treatment in liquid nitrogen is recommended after quenching and after each tempering at 540°C.

In less critical cases the tool should be sub-zero treated immediately after quenching to at least -70°C, soaking time 1–3 h, followed by tempering at 540°C 1 hour x three times.

The sub-zero treatment leads to a reduction of the retained austenite content. For a high hardening temperature, >1100°C, we always recommend sub-zero treatment followed by four temperings at 540°C 1 hour, in order to reduce the retained austenite and improve the dimensional stability.



Adhesive wear



Galling

SURFACE TREATMENTS

Note: Vancron SuperClean 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, Vancron SuperClean can be surface coated. Recommended treatment is PVD with Ti(C, N) or TiAlN.

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. As Vancron SuperClean is high temperature tempered at 540°C there is no danger of dimensional changes during PVD coating.

WEAR RESISTANCE

ADHESIVE WEAR

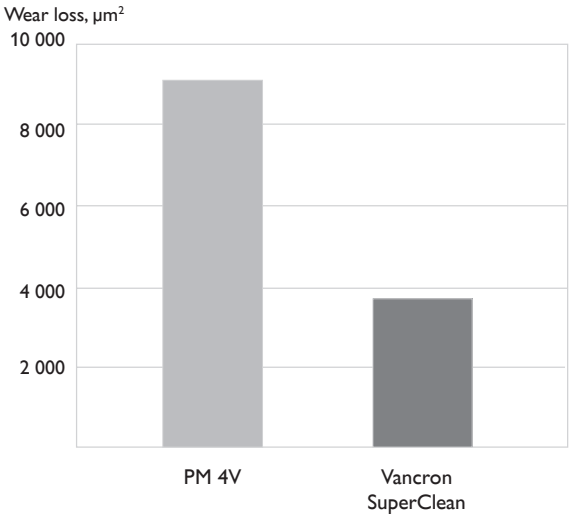
Wear resistance comparison.

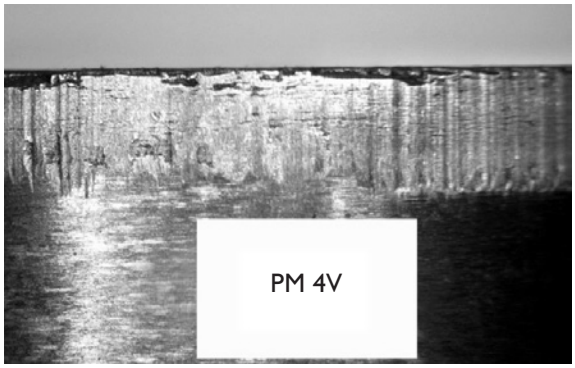
Component: laboratory test strip.

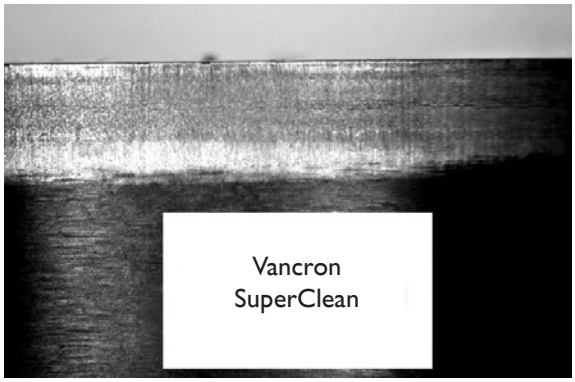
Tool type: blanking punch.

Tool dimension: 10 x 40 mm.

Work material: 18/8 stainless steel SS 2331
1 mm thick.

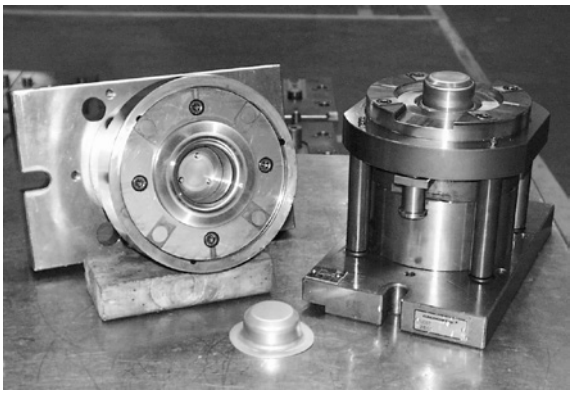






TRIBOLOGICAL PROPERTIES - CASE STUDY

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



RESULTS

ASSAB steel / Surface coating	ASSAB PM 23 uncoated	PM 10V uncoated	Vancron uncoated
Part produced	83 000	1 900 000	>18 000 000
Hardness HRC	62		64
Failure mechanism	Galling		Still running

ASSAB steel / Surface coating	ASSAB PM 23		CVD TiC/TiN
	Salt bath nitriding	PVD 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.

TURNING

Cutting data parameters	Turning with carbide		Turning with High speed steel Fine turning
	Rough turning	Fine turning	
Cutting speed (v_C), m/min	110 – 160	160 – 200	20 - 25
Feed (f) mm/rev	0.2 – 0.4	0.05 – 0.2	0.05 -0.3
Depth of cut (a_p) mm	2 – 4	0.5 – 2	0.5 - 3
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	Cutting speed (v_C) m/min	Feed (f) mm/r
≤ 5	12 – 14 *	0.05 – 0.10
5 – 10	12 – 14 *	0.10 – 0.20
10 – 15	12 – 14 *	0.20 – 0.25
15 – 20	12 – 14 *	0.25 – 0.35

* For coated HSS drill v_c = 22 - 24 m/min.

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1]
Cutting speed (v_C), m/min	140 – 160	80 – 100	50 – 60
Feed (f) mm/r	0.05 – 0.15 [2]	0.10 – 0.25 [3]	0.15 – 0.25 [4]

[1] Drill with replaceable or brazed carbide tip
[2] Feed rate for drill diameter 20 – 40 mm
[3] Feed rate for drill diameter 5 – 20 mm
[4] Feed rate for drill diameter 10 – 20 mm

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min	80 – 100	100 – 120
Feed (f_z) mm/tooth	0.2 – 0.4	0.1 – 0.2
Depth of cut (a_p) mm	2 – 4	< 2
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 milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c), m/min	40 – 50	70 – 90	12 – 15 [1]
Feed (f_z) mm/tooth	0.01 – 0.20 [2]	0.06 – 0.20 [2]	0.01 – 0.30 [2]
Carbide designation ISO	–	K15 [3]	–

[1] For coated HSS end mill, vc = 20 – 30 m/min

[2] Depending on radial depth of cut and cutter diameter

[3] Use a wear resistant Al_2O_3 coated carbide grade

GRINDING

A general grinding wheel recommendation is given below. More information can be found in the 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

Tools of Vancron SuperClean 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. 535°C 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 Vancron SuperClean should be done with medium or fine passes using lower power setting.

FLUSHING

N-alloyed PM steels put higher demands onthe 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 ASSAB COLD WORK TOOL STEEL

MATERIAL PROPERTIES AND RESISTANCE TO FAILLURE MECHANISMS

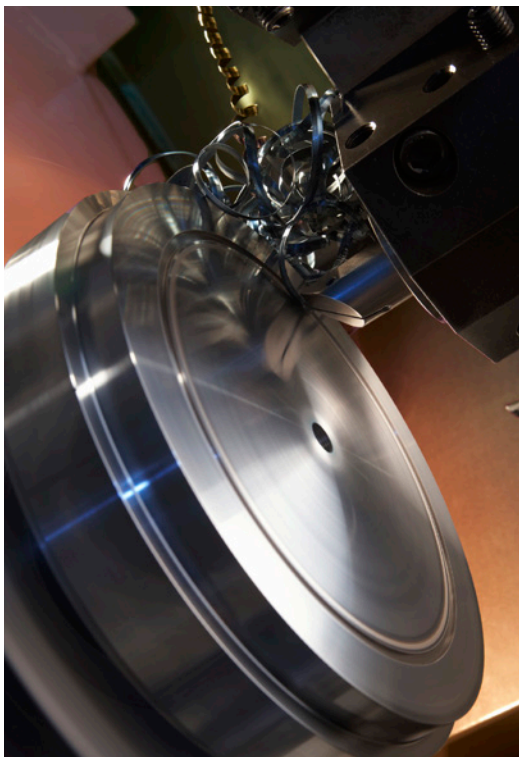
ASSAB Grade	Hardness/ Resistance to plastic deformation	Machinability	Grindability	Dimension stability	Resistance to		Fatigue cracking resistance	
					Abrasive wear	Adhesive wear/Galling	Ductility/ resistance to chipping	Toughness/ gross cracking
Conventional cold work tool steel								
Calmax								
Caldie (ESR)								
ASSAB 88								
ASSAB XW-42								
Powder metallurgical tool steel								
Vanadis 4 Extra*								
Vanadis 8*								
Vancron*								
Powder metallurgical high speed steel								
ASSAB PM 23*								
ASSAB PM 30*								
ASSAB PM 60*								
Conventional high speed steel								
ASSAB M2								

* ASSAB SuperClean PM Tool Steel

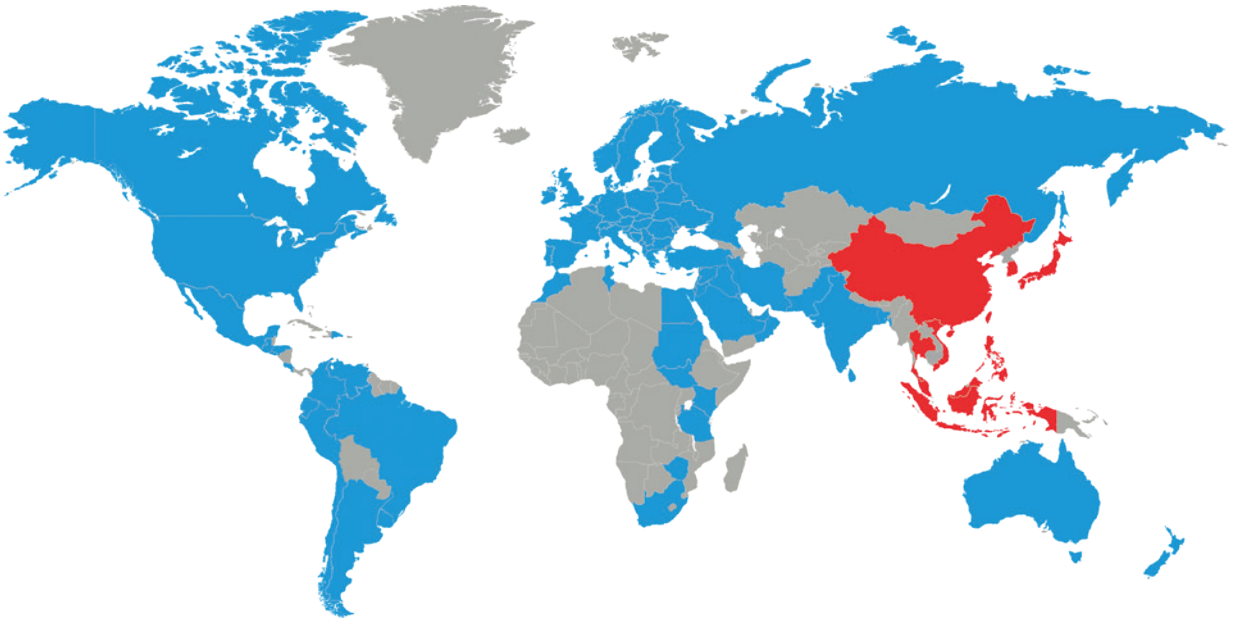
FURTHER INFORMATION

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

ASSAB
SUPERIOR TOOLING SOLUTIONS
A ONE-STOP SHOP



ASSAB is a one-stop product and service provider that offers superior tooling solutions. In addition to the supply of tool steel and other special steel, our range of comprehensive value-added services, such as machining, heat treatment and coating services, span the entire supply chain to ensure convenience, accountability and optimal usage of steel for customers. We are committed to achieving solutions for our customers, with a constant eye on time-to-market and total tooling economy.



Choosing the right steel is of vital importance. ASSAB engineers and metallurgists are always ready to assist you in your choice of the optimum steel grade and the most suitable treatment for each application. ASSAB not only supplies steel products with superior quality, but we also offer state-of-the-art machining, heat treatment, surface treatment services and additive manufacturing (3D printing) to enhance your tooling performance while meeting your requirements in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

In Asia Pacific, ASSAB anchors the distribution network for Uddeholm, a Swedish tool steel manufacturer with more than 350 years of experience in the tool steel industry. The two companies together service leading multinational companies (MNCs) in more than 90 countries.

For more information, please visit
www.assab.com

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