ASSAB PM 23 SUPERCLEAN

UDDEHOLM VANADIS 23 SUPERCLEAN

ASSAB	UDDEHOLM a voestalpine company	REFERENCE STANDARD		
		AISI	WNr.	JIS
ASSAB DF-3	ARNE	O1	1.2510	SKS 3
ASSAB XW-10	RIGOR	A2	1.2363	SKD 12
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 518		P20	1.2311	
ASSAB 618 T		(P20)	(1.2738)	
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			

( ) - modified grade

Edition 20210224

ASSAB PM 23 SuperClean

ASSAB PM 23 SuperClean is a high alloyed powder metallurgical high speed steel corresponding to AISI M3:2 with a very good abrasive wear resistance in combination with a high compressive strength. It is suitable for demanding cold work applications like blanking of harder materials like carbon steel or cold rolled strip steel and for cutting tools.

The machinability and grindability are superior than for conventional high speed steel and so is the dimensional stability after heat treatment. The superclean powder metallurgy process ensures that the cleanliness is on a high level with a low amount of non-metallic inclusions.

CRITICAL TOOL STEEL PROPERTIES

FOR GOOD TOOL PERFORMANCE

- Correct hardness for the application
- High wear resistance
- High toughness to prevent premature failure due to chipping/crack formation

High wear resistance is often associated with low toughness and vice-versa. However, in many cases both high wear resistance and toughness are essential for optimal tooling performance.

ASSAB PM 23 SuperClean is a powder metallurgical cold work tool steel offering anexcellent combination of wear resistance and toughness.

FOR TOOLMAKING

- Machinability
- Heat treatment
- Dimensional stability during heat treatment
- Surface treatment

Toolmaking 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 toolmaking.

The powder manufacturing route used for ASSAB PM 23 SuperClean means that its machinability is superior to that of similar conventionally produced grades and some highly alloy cold work tool steels.

The dimensional stability of ASSAB PM 23 SuperClean in heat treatment is excellent and predictable compared to conventionally produced high alloy steels. This, coupled with its high hardness, good toughness and high temperature tempering, means that ASSAB PM 23 SuperClean is very suitable for surface coating, in particular for PVD.

APPLICATIONS

ASSAB PM 23 SuperClean is especially suitable for blanking and forming of thinner work materials where a mixed (abrasive–adhesive) or abrasive type of wear is encountered and where the risk for plastic deformation of the working surfaces of the tool is high, e.g.:

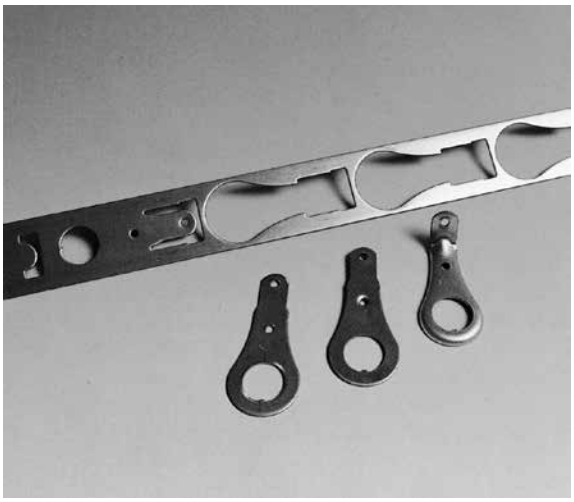
- Blanking of medium to high carbon steel
- Blanking of harder materials such as hardened or cold-rolled strip steel
- Plastics mould tooling subjected to abrasive wear condition
- Plastics processing parts, e.g. feed screws, barrel liners, nozzles, screw tips, non-return check ring valves, pellitizer blades, granulator knives

GENERAL

ASSAB PM 23 SuperClean is a chromiummolybdenum-tungsten-vanadium alloyed high speed steel which is characterised by:

- High wear resistance (abrasive profile)
- High compressive strength
- Very good through-hardening properties
- Good toughness
- Very 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
Standard specification	AISI (M3:2), W.-Nr. 1.3395				
Delivery condition	Soft annealed to approx. 260 HB Drawn max. 320 HB				



Stainless steel fastener stamped with a ASSAB PM 23 SuperClean die and Vanadis 4 Extra SuperClean punch.

PROPERTIES

PHYSICAL DATA

Hardened and tempered condition.

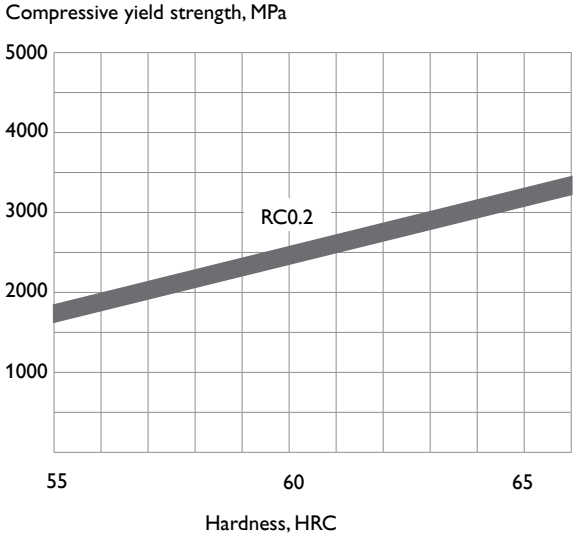
Temperature	20°C	400°C	600°C
Density kg/m³	7 980	7 870	7 805
Modulus of elasticity MPa	230 000	205 000	184 000
Thermal conductivity W/m°C	24	28	27
Specific heat J/kg°C	420	510	600

COEFFICIENT OF THERMAL EXPANSION

Temperature range, °C	Coefficient, °C from 20
20 - 100	10.8×10^{-6}
20 - 200	11.1×10^{-6}
20 - 300	11.4×10^{-6}
20 - 400	11.8×10^{-6}
20 - 500	12.1×10^{-6}
20 - 600	12.3×10^{-6}

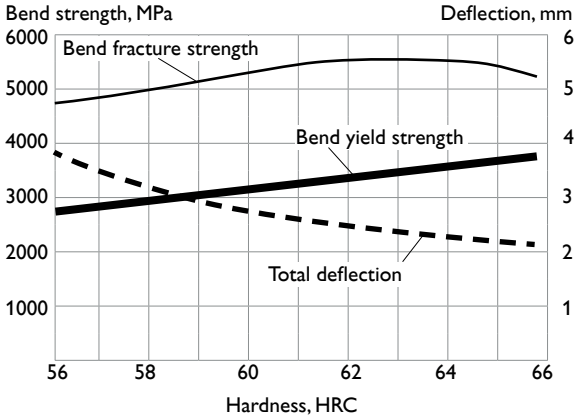
COMPRESSIVE YIELD STRENGTH

Specimen: Hourglass shaped with 10 mm Ø waist



BEND STRENGTH AND DEFLECTION

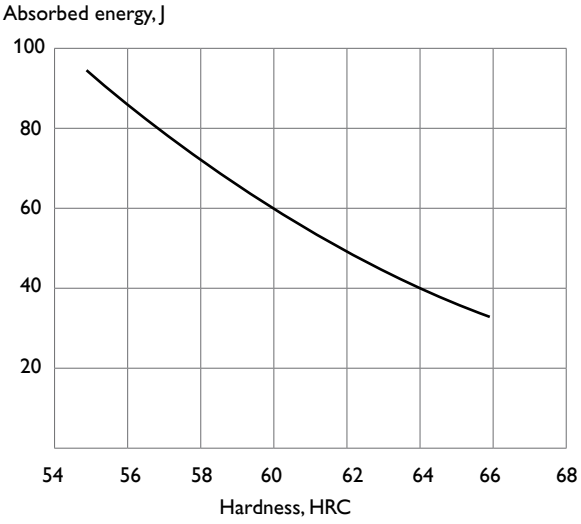
Four-point bend testing
Specimen size: 5 mm
Loading rate: 5 mm/min
Austenitising temperature: 990 - 1180°C
Tempering: 3 x 1 h at 560°C



IMPACT STRENGTH

Specimen size: 7 x 10 x 55 mm
Specimen type: unnotched
Tempering: 3 x 1 h at 560°C
Longitudinal direction.

APPROXIMATE ROOM TEMPERATURE IMPACT STRENGTH AT DIFFERENT HARDNESS LEVELS.



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 850-900°C. Cool in the furnace at 10°C per hour to 700°C, then freely in air.

STRESS RELIEVING

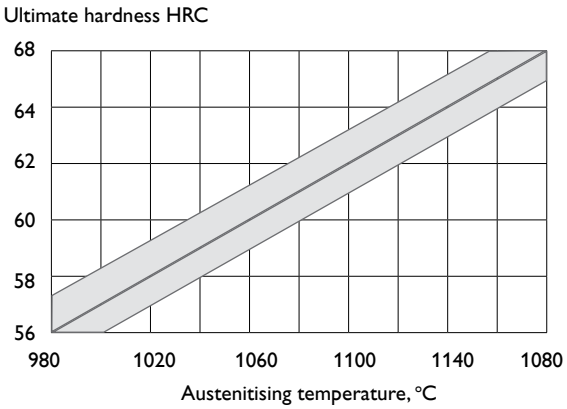
After rough machining the tool should be heated through to 600-700°C, holding time 2 hours. Cool slowly to 500°C, then freely in air.

HARDENING

Pre-heating temperature: 450 – 500°C and 850 – 900°C

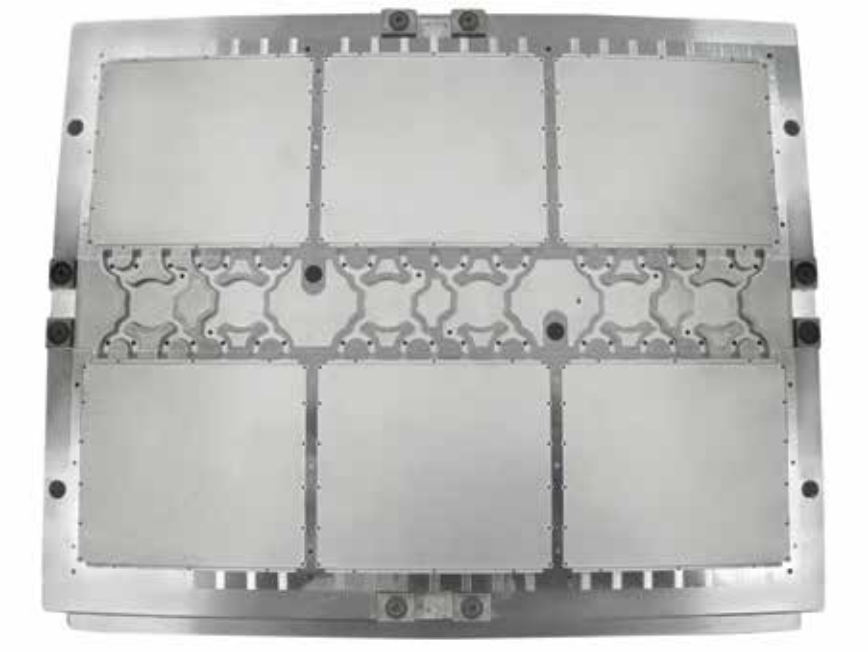
Austenitising temperature: 1050 – 1180°C, according to the desired final hardness.
The tool should be protected against decarburisation and oxidation during hardening.

HARDNESS AFTER TEMPERING 3 TIMES FOR 1 HOUR AT 560°C



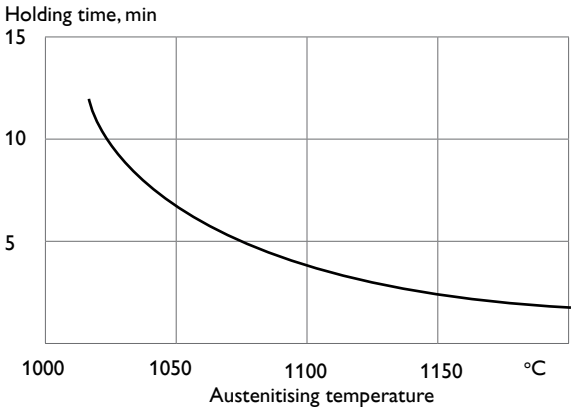
HARDNESS AFTER DIFFERENT HARDENING TEMPERATURES AND TEMPERING 3 TIMES FOR 1 HOUR AT 560°C

Hardness, HRC	Austenitising Temperature, oC
58	1020
60	1060
62	1100
64	1140
66	1180



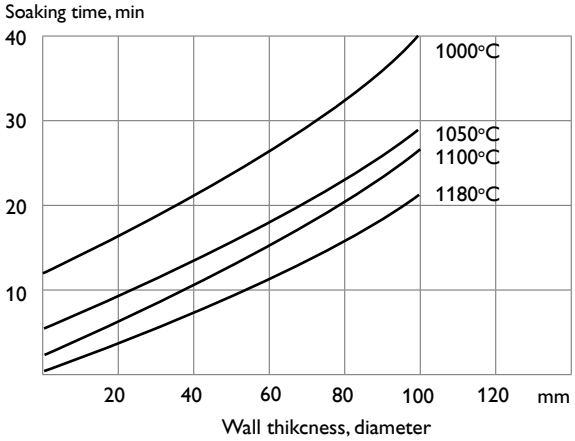
Six cavities IC encapsulation mould

RECOMMENDED HOLDING TIME, FLUIDISED BED, VACUUM OR ATMOSPHERE FURNACE



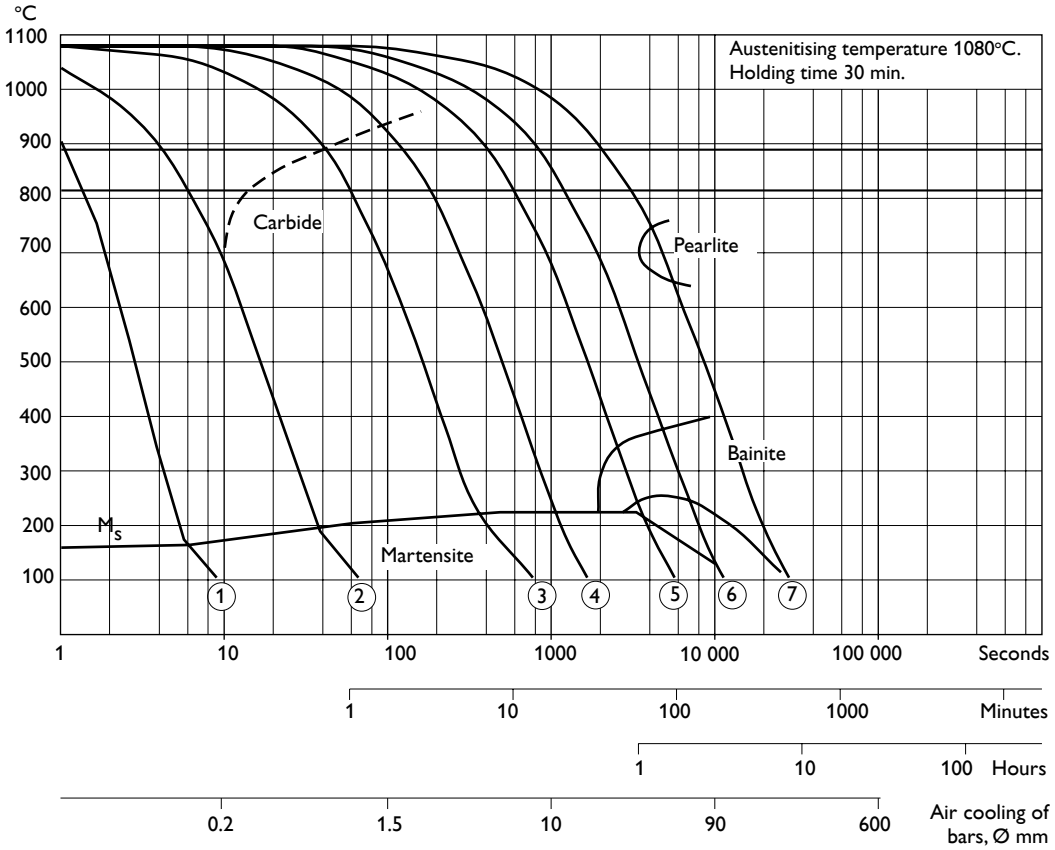
Note: Holding time = time at austenitising temperature after the tool is fully heated through. A holding time that is less than the recommendation mentioned above, will result in loss of hardness.

TOTAL SOAKING TIME IN A SALT BATH AFTER PRE-HEATING IN TWO STAGES AT 450°C AND 850°C



CCT-GRAPH (CONTINUOUS COOLING)

Austenitising temperature 1080°C. Holding time 30 minutes.



A_{c1_f} = 890°C

A_{c1_s} = 815°C

Cooling Curve No.	Hardness HV10	$T_{800-500}$ (sec)
1	907	1
2	894	10
3	894	104
4	858	313
5	803	1041
6	673	2085
7	530	5211

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 560°C irrespective of the austenitising 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 : Austenitising between 1050 – 1130°C and tempering 3 x 1 h at 560°C.

Specimen size: 80 x 80 x 80 mm and 100 x 100 x 25 mm.

Dimensional changes: growth in length, width and thickness +0.03% – +0.13%.

SUB-ZERO TREATMENT

Pieces requiring maximum dimensional stability can be sub-zero treated as follows:

Immediately after quenching the piece should be sub-zero treated to between -70 and -80°C, soaking time 1– 3 hours, followed by tempering.

Sub-zero treatment will give a hardness increase of ~1 HRC. Avoid intricate shapes as there will be risk of cracking.

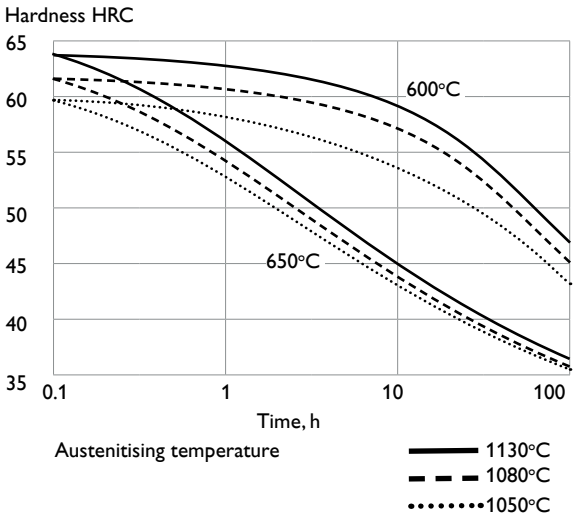
Stainless steel fastener stamped with a ASSAB PM 23 SuperClean die and Vanadis 4 Extra SuperClean punch

HIGH TEMPERATURE PROPERTIES

HARDNESS AS A FUNCTION OF HOLDING TIME AT DIFFERENT WORKING TEMPERATURES

Austenitising temperature: 1050–1130°C

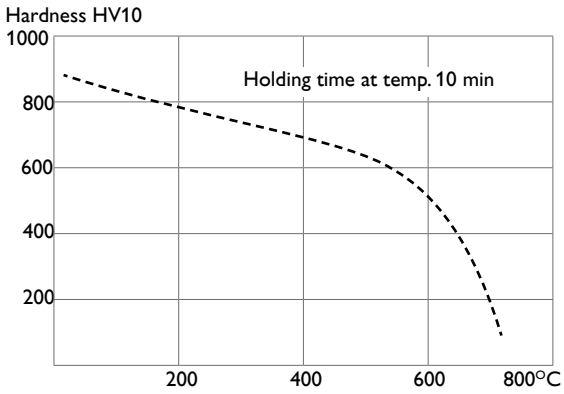
Tempering: 3 x 1 h at 560°C.



HOT HARDNESS

Austenitising temperature: 1180°C

Tempering: 3 x 1 h at 560°C.



SURFACE TREATMENT

Some cold work tool steel are given a surface treatment in order to reduce friction and increase wear resistance. The most commonly used treatments are nitriding and surface coating with wear resistant layers of titanium carbide and titanium nitride (CVD, PVD).

ASSAB PM 23 SuperClean has been found to be particularly suitable for titanium carbide and titanium nitride coatings.

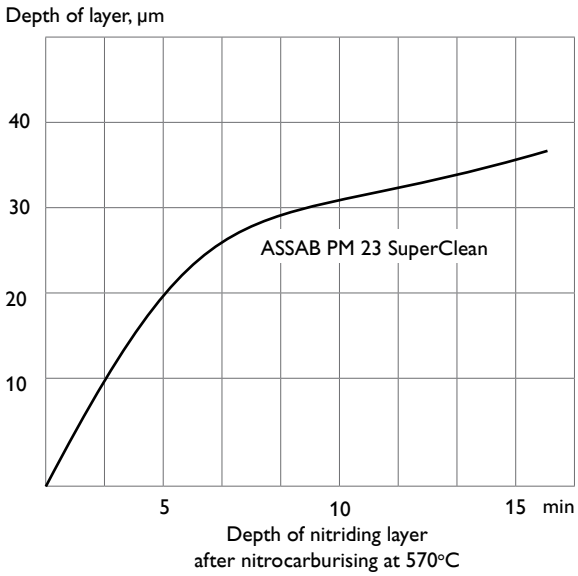
The uniform carbide distribution in ASSAB PM 23 SuperClean facilitates bonding of the coating and reduces the spread of dimensional changes resulting from hardening. This, together with its high strength and toughness, makes ASSAB PM 23 SuperClean an ideal substrate for high-wear surface coatings.

PVD coated tools in ASSAB PM 23 SuperClean for cold forming of tubes.

Punches manufactured by LN's Mekaniska Verkstads AB in Sweden. ASSAB PM 23 SuperClean is a perfect steel for this application.

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 ASSAB PM 23 SuperClean is high temperature tempered at 560°C 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.

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.

Condition: soft annealed to ~260 HB.

TURNING

Cutting data parameter	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (V_c) m/min	110 – 160	160 – 210	12 – 15
Feed (f) mm/rev	0.2 – 0.4	0.06 – 0.2	0.05 – 0.3
Depth of cut (a_p) mm	2 – 4	0.5 – 2	0.5 – 3
Carbide designation ISO	K20, P10 – P20 Coated carbide* or cermet*	P10 Coated carbide* or cermet*	-

* Use a wear resistant CVD coating

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (Vc) m/min	Feed (f) mm/rev
≤ 5	10 – 12*	0.05 – 0.10
5–10	10 – 12*	0.10 – 0.20
10–15	10 – 12*	0.20 – 0.25
15–20	10 – 12*	0.25 – 0.35

* For TiCN coated HSS drill v_c = 16-18 m/min.

CARBIDE DRILL

Cutting data parameter	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1]
Cutting speed (V_c) m/min	120 – 150	60 – 80	30 – 40
Feed. (f) mm/rev	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 parameter	Turning with carbide	
	Rough milling	Fine milling
Cutting speed (V_c) m/min	80 – 130	130 – 160
Feed (f) mm/tooth	0.2 – 0.4	0.1 – 0.2
Depth of cut (a_p) mm	2 – 4	≤ 12
Carbide designation ISO	K20, P20 Coated carbide*	K15, P15 Coated carbide* or cermet*

* Use a wear resistant CVD coating

END MILLING

Cutting data parameter	Type of end mill		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (V_c) m/min	40 – 50	90 – 110	5 – 8 [1]
Feed. (f) mm/tooth	0.01 – 0.2 [2]	0.06 – 0.20 [2]	0.01 – 0.3 [2]
Carbide designation ISO	–	K15 P10–P20 Coated carbide[3] or cermet[3]	–

[1] For coated HSS end mill v_c = 14 – 18 m/min.
[2] Depending on radial depth of cut and cutter diameter
[3] Use a wear resistant CVD coating

GRINDING

A general grinding wheel recommendation is given below. More information can be found in the "Grinding of tool steel" brochure.

Type of grinding	Annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B151 R50 B3* A 46 HV
Face grinding segments	A 36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B151 R50 B3* A60 KV
Internal grinding	A 60 JV	R151 R75 B3* A 60 IV
Profile grinding	A 100 IV	B126 R100 B6* A 100 JV

* 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.

Tooling parts for canning industry

RELATIVE COMPARISON OF ASSAB COLD WORK TOOL STEEL

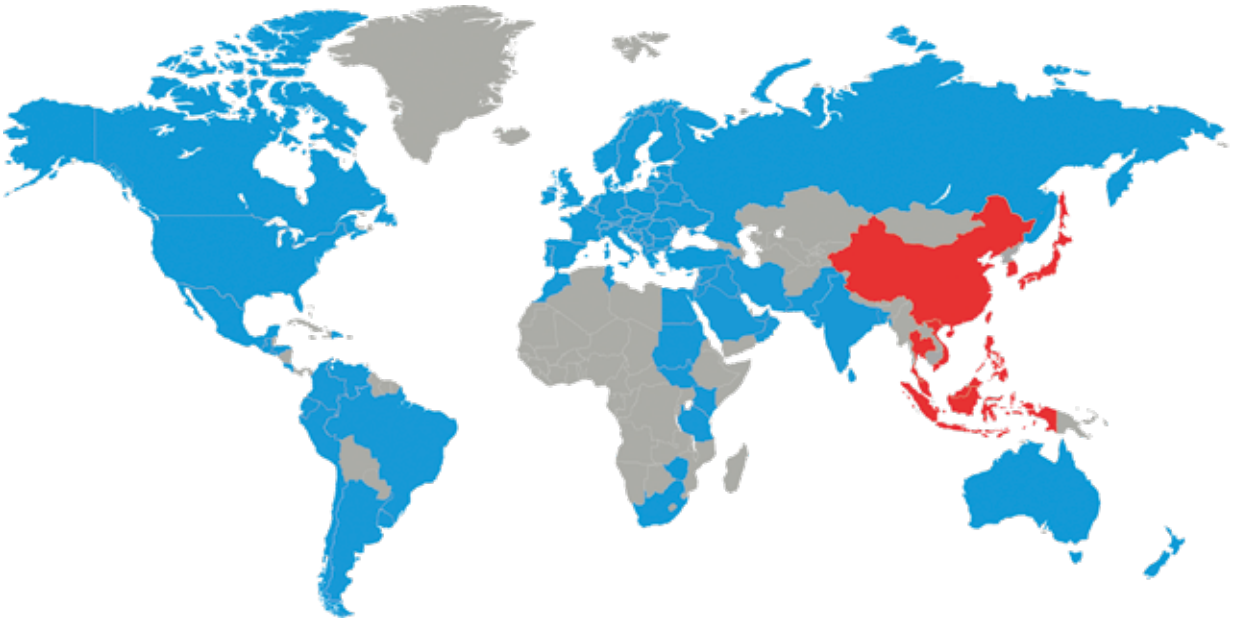
MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS

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								
ASSAB DF-3								
ASSAB XW-10								
ASSAB XW-42								
Calmax								
Caldie (ESR)								
ASSAB 88								
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 PM SuperClean 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.



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 best treatment for each application. ASSAB not only supplies steel products with superior quality, we offer state-of-the-art machining, heat treatment and surface treatment services to enhance steel properties to meet your requirement in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

ASSAB and Uddeholm are present on every continent. This ensures you that high quality tool steel and local support are available wherever you are. Together we secure our position as the world's leading supplier of tooling materials.

For more information, please visit
www.assab.com

UDDEHOLM
a voestalpine company

ASSAB