UDDEHOLM VANADIS® 30

UDDEHOLM

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”.

Edition 6, 05.2011
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

UDDEHOLM VANADIS 30

Uddeholm Vanadis 30 is a Co high alloyed powder metallurgy high speed steel corresponding to AISI M3:2 + Co. The high compressive strength, 67 HRC, and good abrasive wear resistance makes Uddeholm Vanadis 30 suitable for demanding cold work applications and for cutting tools as an alternative to AISI M42 or other Co-alloyed HSS.

The P/M process gives a good machinability and grindability as well as a good dimension stability during heat treatment.

Applications

Uddeholm Vanadis 30 is a cobalt alloyed high performance PM high speed steel. The cobalt addition of approx. 8,5% has a positive influence on the hot strength/hot hardness, temper resistance and modulus of elasticity. The presence of cobalt has little influence on wear resistance. As cobalt does not form carbides, the wear resistance of Uddeholm Vanadis 30 is more or less the same as for steels with the same base analysis but without cobalt (e.g. Uddeholm Vanadis 23). On the other hand, its presence reduces the toughness and hardenability somewhat but increases compressive strength and high temperature properties.

For cold work

- The combination of high wear resistance and unusually good compressive strength can be put o use in tooling for heavy forming operations.
- In some cold work operations, the active surface (e.g. cutting edge or forming surface) of a tool can reach temperatures in excess of 200°C (390°F). Such conditions can be found in tooling running on high speed presses. Also, development of high temperatures in the tooling can be expected in heavy forming operations.

General

Uddeholm Vanadis 30 is a W-Mo-V-Co alloyed PM high speed steel characterized by:

- high wear resistance
- high compressive strength at high hardness
- good through hardening properties
- good toughness
- good dimensional stability on heat treatment
- good grindability and machinability
- very good temper resistance

Typical analysis %	C	Cr	Mo	W	V	Co
	1.28	4.2	5.0	6.4	3.1	8.5
Standard specification	W.-Nr. 1.3294 ~AISI M3:2 +Co					
Delivery condition	Soft annealed, max. 300 HB Drawn, max. 320 HB					
Colour code	Dark green					

Punches for high performance.
A suitable application for Uddeholm Vanadis 30.

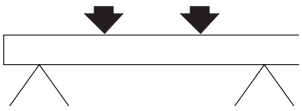
Properties

Physical data

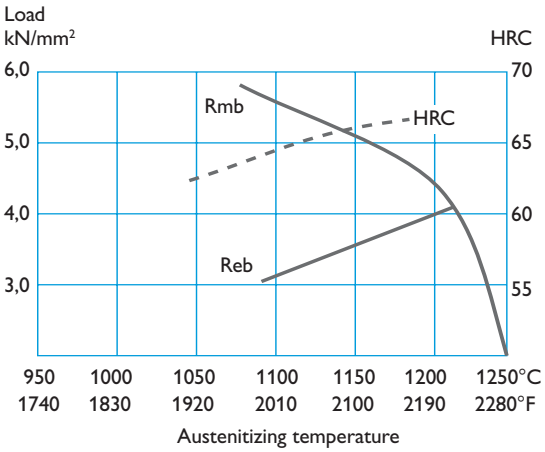
Temperature	20°C (68°F)	400°C (750°F)	600°C (1112°F)
Density, kg/m³ (1)	8040	7935	7880
lbs/in³ (1)	0.287	0.285	0.284
Modulus of elasticity			
MPa (2)	240 000	214 000	192 000
ksi (2)	34 x 10^3	31 x 10^3	28 x 10^3
Coefficient of thermal expansion per			
°C from 20°C (2)	–	11.8 x 10^{-6}	12.3 x 10^{-6}
°F from 68°F (2)	–	6.5 x 10^{-6}	6.8 x 10^{-6}
Thermal conductivity			
W/m•°C (2)	22	26	25
Btu in/(ft² h°F) (2)	152	180	173
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 and deflection

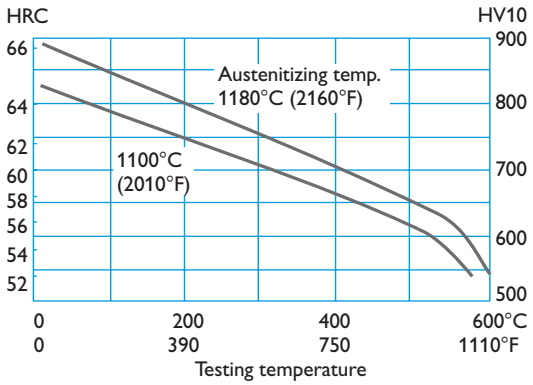


Four-point bend testing.
Specimen size: 5 mm (0.2") Ø.
Loading rate: 5 mm/min (0.2"/min.).
Austenitizing temperature: 1050–1180°C (1920–2160°F).
Tempering: 3 x 1 h at 560°C (1040°F), air cooling to room temperature.



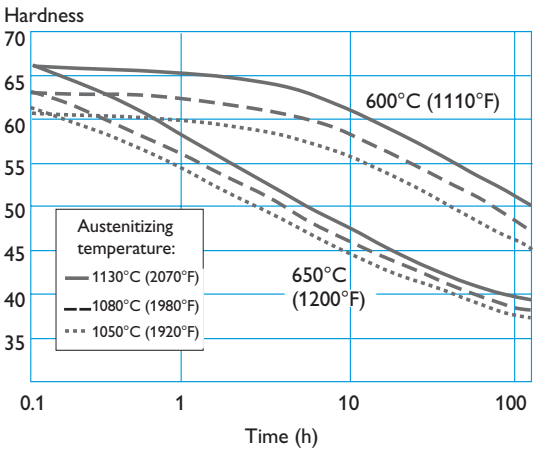
HIGH TEMPERATURE PROPERTIES

Uddeholm Vanadis 30 hot hardness



CHANGE IN HARDNESS VERSUS HOLDING TIME FOR DIFFERENT WORKING TEMPERATURES

Austenitizing temperature: 1050–1130°C (1920–2070°F).
Tempering: 3 x 1 h at 560°C (1040F).



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.

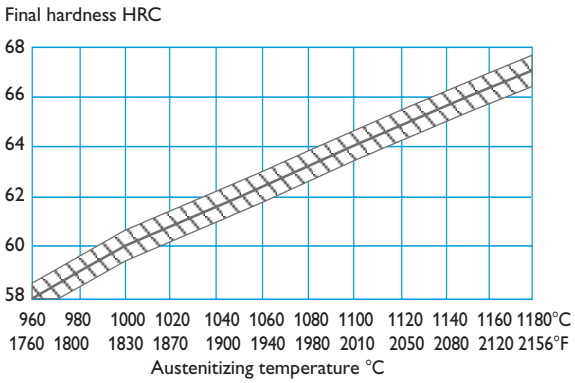
Stress relieving

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.

Hardening

Pre-heating temperature: 450–500°C (840–930°F) and 850–900°C (1560–1650°F).
Austenitizing temperature: 1050–1180°C (1920–2160°F), according to the desired final hardness, see diagram below.
The tool should be protected against decarburization and oxidation during hardening.

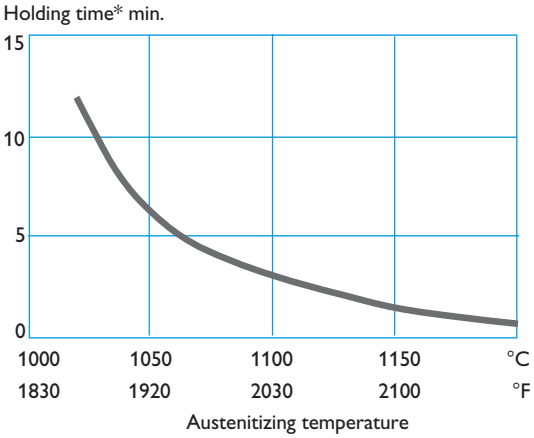
HARDNESS AFTER TEMPERING 3 TIMES FOR ONE HOUR AT 560°C (1040°F)



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

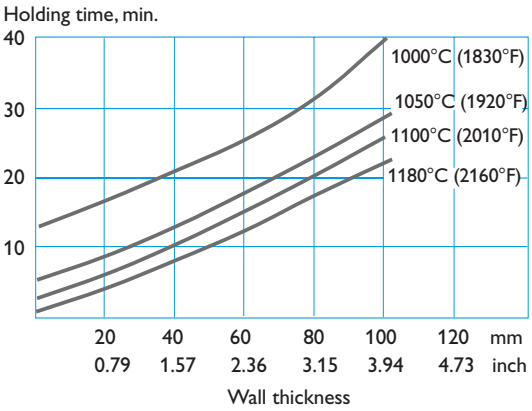
HRC	°C	°F
60	1000	1832
62	1050	1922
64	1100	2012
66	1150	2102
67	1180	2156

RECOMMENDED HOLDING TIME



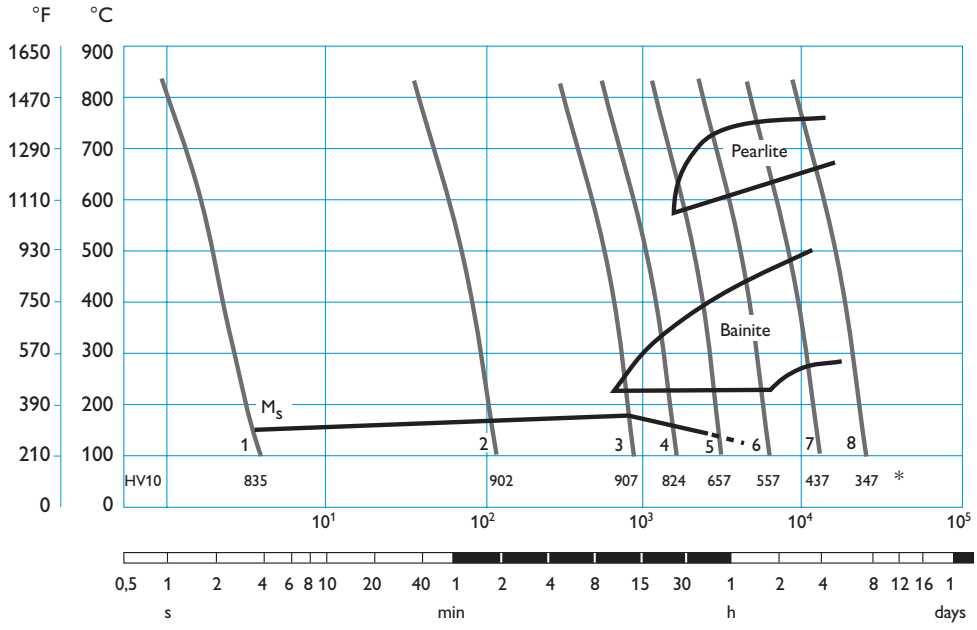
* Holding time = time at austenitizing temperature after the tool is fully heated through.

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 1180°C (2160°F).



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. 50°C (122°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 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 1% after this tempering cycle.

Dimensional changes

Dimensional changes after hardening and tempering.
Heat treatment: austenitizing between 1050–1140°C (1920–2080°F) and tempering 3 x 1h 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%.

Surface treatments

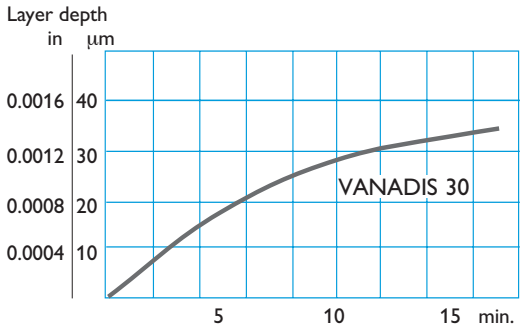
Some tools are given a surface treatment in order to reduce friction and increase tool wear resistance.

The most commonly used treatments are nitriding and surface coating with wear resistant layers of titanium carbide and titanium nitride (CVD, PVD).

Uddeholm Vanadis 30 has been found to be particularly suitable for titanium carbide and titanium nitride coatings. The uniform carbide distribution in Uddeholm Vanadis 30 facilitates bonding of the coating and reduces the spread of dimensional changes resulting from hardening. This, together with its high strength and toughness, makes Uddeholm Vanadis 30 an ideal substrate for high-wear surface coatings.

Nitriding

A brief immersion in a special salt bath to produce a nitrided diffusion zone of 2–20 µm is recommended. This reduces friction on the envelope surface of punches and has various other advantages.



Depth of nitriding layer
after nitrocarburizing at 570°C (1060°F)

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 Vanadis 30 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.

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 recommendations"

Condition: Soft annealed to approx. 300 HB

Turning

Cutting data parameters	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) m/min f.p.m.	80–110 262–361	110–140 361–459	10–15 33–49
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*	–

* Preferably a wear resistant CVD 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	8–10*	27–33*	0.05–0.15	0.002–0.006
5–10	3/16–3/8	8–10*	27–33*	0.15–0.20	0.006–0.008
10–15	3/8–5/8	8–10*	27–33*	0.20–0.25	0.008–0.010
15–20	5/8–3/4	8–10*	27–33*	0.25–0.35	0.010–0.014

* For coated high speed steel drill v_c = 14–16 m/min (46–52 f.p.m.)

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed, v_c m/min f.p.m.	100–130 328–435	50–70 164–230	25–35 82–115
Feed, f mm/r i.p.r.	0.05–0.15[2] 0.002–0.006[2]	0.10–0.25[3] 0.004–0.010[3]	0.15–0.25[4] 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.	40–80 131–265	80–110 265–361
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–P20 Coated carbide*	K15–P15 Coated carbide* or cermet

* Preferably a wear resistant CVD coated carbide grade

END MILLING

Cutting data parameters	Type of mill		
	Solid carbide	Carbide indexable insert	High[2] speed steel
Cutting speed (v_c) m/min f.p.m.	35–45 115–150	70–90 230–300	12–16 39–52
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[3]	–

[1] Depending on radial depth of cut and cutter diameter
[2] A coated high speed steel end mill
[3] Preferably a wear resistant CVD 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[2]
Face grinding segments	A 36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B151 R50 B3[1] A 60 KV[2]
Internal grinding	A 60 JV	B151 R75 B3[1] A 60 IV
Profile grinding	A 100 JV	B126 R100 B6[1] A 120 JV[2]

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

EDM

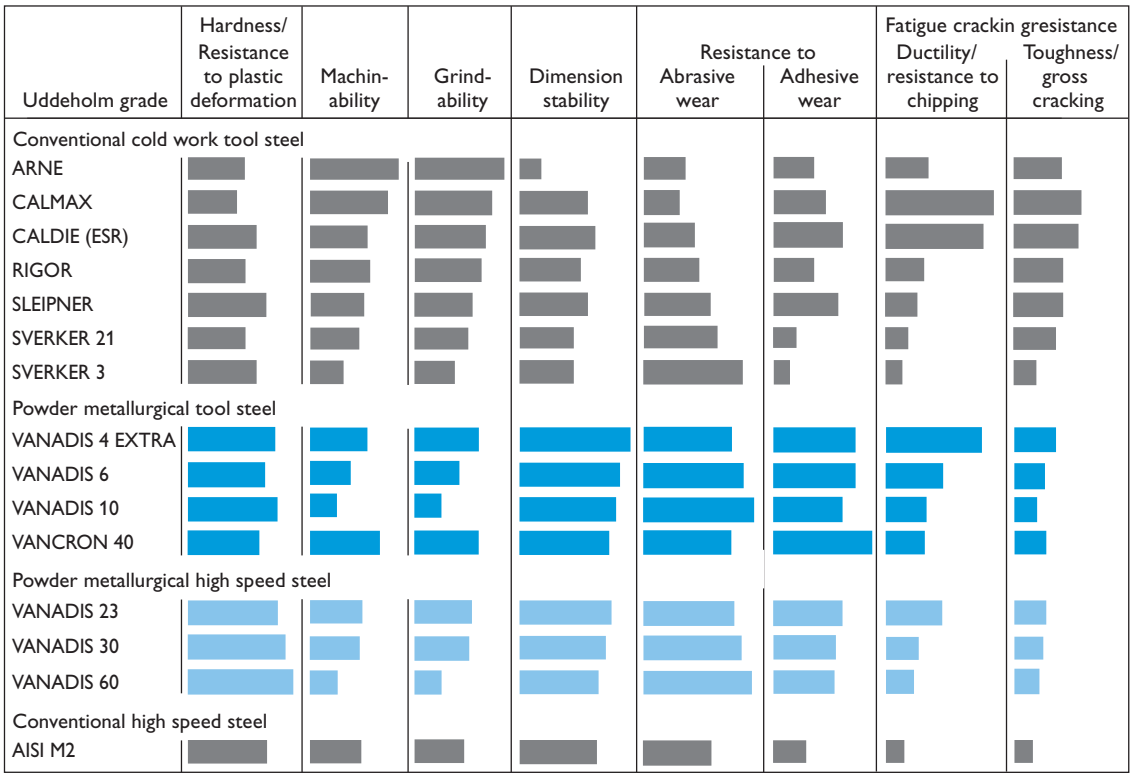
If EDM is performed in the hardened and tempered condition, finish with "finesparking", i.e. low current, high frequency. For optimal performance the EDM'd surface should then be ground/polished and the tool retempered at approx. 535°C (995°F).

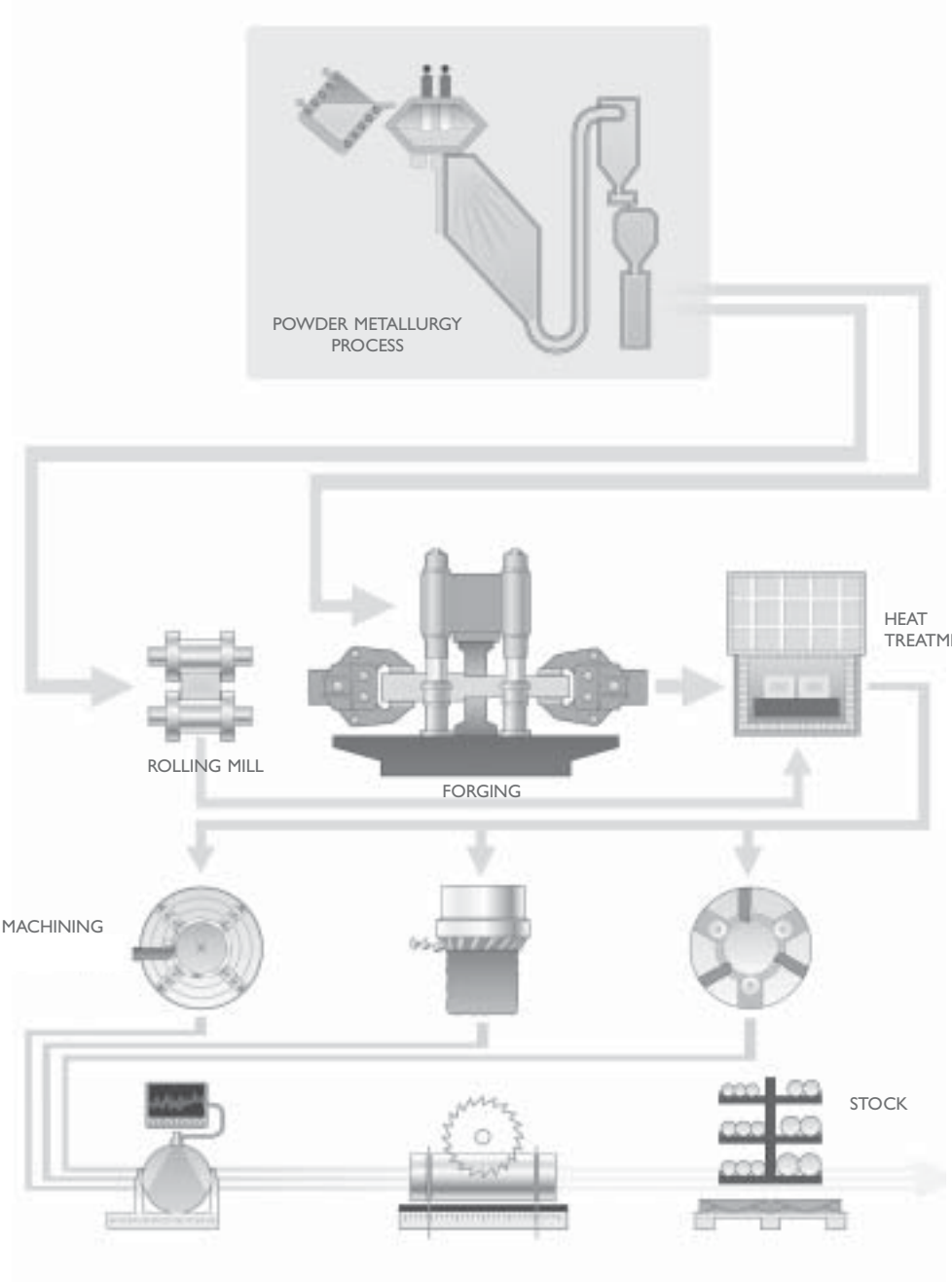
Further information

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

Relative comparison of Uddeholm cold work tool steels

Material properties and resistance to failure mechanisms





The Powder Metallurgy process

In the powder metallurgy process nitrogen gas is used to atomise the melted steel into small droplets, or grains. Each of these small grains solidifies quickly and there is little time for carbides to grow. These powder grains are then compacted to an ingot in a hot isostatic press (HIP) at high temperature and pressure. The ingot is then rolled or forged to steel bars by conventional methods.

The resulting structure is completely homogeneous steel with randomly distributed small carbides, harmless as sites for crack initiation but still protecting the tool from wear.

Large slag inclusions can take the role as sites for crack initiation instead. Therefore, the powder metallurgical process has been further developed in stages to improve the cleanliness of the steel. Powder steel from Uddeholm Tooling is today of the third generation and is considered the cleanest powder metallurgy tool steel product on the market.

HEAT TREATMENT

Prior to delivery all of the different bar materials are subjected to a heat treatment operation, either as soft annealing or hardening and tempering. These operations provide the steel with the right balance between hardness and toughness.

MACHINING

Before the material is finished and put into stock, we also rough machine the bar profiles to required size and exact tolerances. In the lathe machining of large dimensions, the steel bar rotates against a stationary cutting tool. In peeling of smaller dimensions, the cutting tools revolve around the bar.

To safeguard our quality and guarantee the integrity of the tool steel we perform both surface- and ultrasonic inspections on all bars. We then remove the bar ends and any defects found during the inspection.

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.

ASSAB
www.assab.com

UDDEHOLM
www.uddeholm.com

UDDEHOLM | 10503.200 / TRYCKERI KNAPPEN, KARLSTAD 2011-05-08 |

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.

ASSAB

UDDEHOLM