UDDEHOLM ELMAX® SUPERCLEAN

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 7, revised 02.2016, not printed

SS-EN ISO 9001
SS-EN ISO 14001

General

Uddeholm Elmax SuperClean is a high chromium-vanadium-molybdenum-alloyed steel with the following characteristics:

- High wear resistance
- High compressive strength
- Corrosion resistant
- Very good dimensional stability

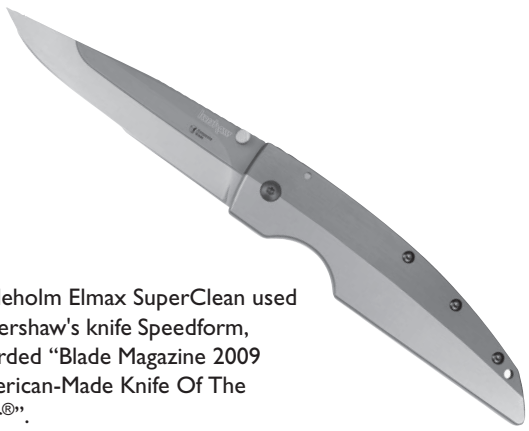
High wear resistance is normally connected to low corrosion resistance and vice versa. In Uddeholm Elmax SuperClean it has however been able to achieve this unique combination of properties by a powder-metallurgy-based production.

Uddeholm Elmax SuperClean offers a possibility to make long-life, low maintenance moulds for the best overall moulding economy.

Typical analysis %	C 1,7	Si 0,8	Mn 0,3	Cr 18,0	Mo 1,0	V 3,0
Delivery condition	Soft annealed approx. 280 Brinell					
Colour code	Blue/black					

Applications

New types of engineering plastics, with high filler contents, place greater demands on the tooling material, in terms of wear resistance and corrosion resistance. Uddeholm Elmax SuperClean has been specially developed for high-tech applications. These include products within the electronic industry such as connectors, plugs, switches, resistors, integrated circuits, etc. Uddeholm Elmax SuperClean can also be used in the food processing industry and for industrial and custom knives, where a combination of corrosion resistance and wear resistance is required.



Uddeholm Elmax SuperClean used in Kershaw's knife Speedform, awarded "Blade Magazine 2009 American-Made Knife Of The Year®".

Properties

Physical data

Hardened and tempered to 58 Rockwell C.

Temperature	20°C (68°F)	200°C (392°F)	400°C (752°F)
Density kg/m³ lbs/in.	 7 600 0,275	 7 560 0,273	 7 500 0,271
Modulus of elasticity N/mm² psi	 230 000 33,4 x 10^6	 210 000 30,5 x 10^6	 200 000 29,0 x 10^6
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	 – –	 10,6 x 10^{-6} 6,0 x 10^{-6}	 11,4 x 10^{-6} 6,4 x 10^{-6}
Thermal conductivity* W/m °C Btu in/ft² h °F	 – –	 15 104	 21 146
Specific heat J/kg °C Btu/lb °F	 460 0,110	 – –	 – –

* Thermal conductivity is difficult to measure. The scatter may be as high as ±15%

Compressive strength

The figures are to be considered approximate.

Hardness	60 HRC	55 HRC	50 HRC
Compressive strength Rm N/mm² tsi psi	 3 000 195 435 000	 2 700 175 390 000	 2 300 150 335 000
Yield point Rp0,2 N/mm² tsi psi	 2 300 150 335 000	 2 150 140 310 000	 1 800 120 260 000

Corrosion resistance

Moulds made from Uddeholm Elmax SuperClean will have good resistance to corrosion when moulding corrosive plastics under normal production conditions.

Heat treatment

Soft annealing

Protect the steel and heat through to 980°C (1800°F), holding time 2h. Then cool in furnace 20°C (40°F)/h to 850°C (1560°F). Holding time 10h. Cool slowly to 750°C (1380°F). Then freely in air.

Stress-relieving

After rough machining the tool should be heated through to 650°C (1200°F), holding time 2 hours. Cool slowly to 500°C (930°F) then freely in air.

Hardening

Preheating temperature: 600–850°C (1110–1560°F).
Austenitizing temperature: 1050–1100°C (1920–2010°F), normally 1080°C (1980°F).

Temperature		Holding* time minutes	Hardness before tempering
°C	°F		
1050	1920	30	60 HRC
1080	1980	30	61 HRC

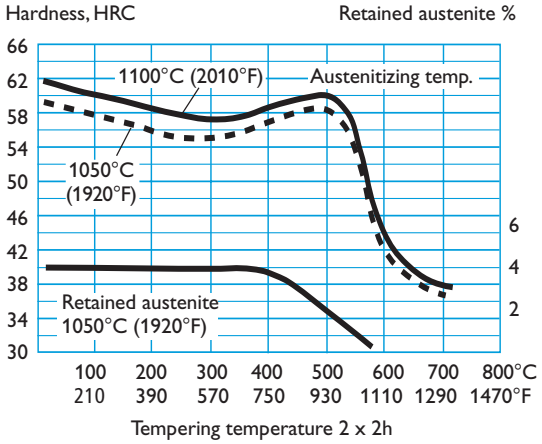
* Holding time = time at austenitizing temperature after the tool is fully heated through

Protect the part against decarburization and oxidation during hardening.

Tempering

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature, the preferred tempering temperature is 250°C (480°F) or higher. In exceptional cases, a minimum tempering temperature of 180°C (350°F) can be used for small simple inserts and parts where toughness is of less importance. Holding time at tempering temperature minimum 2 hours.

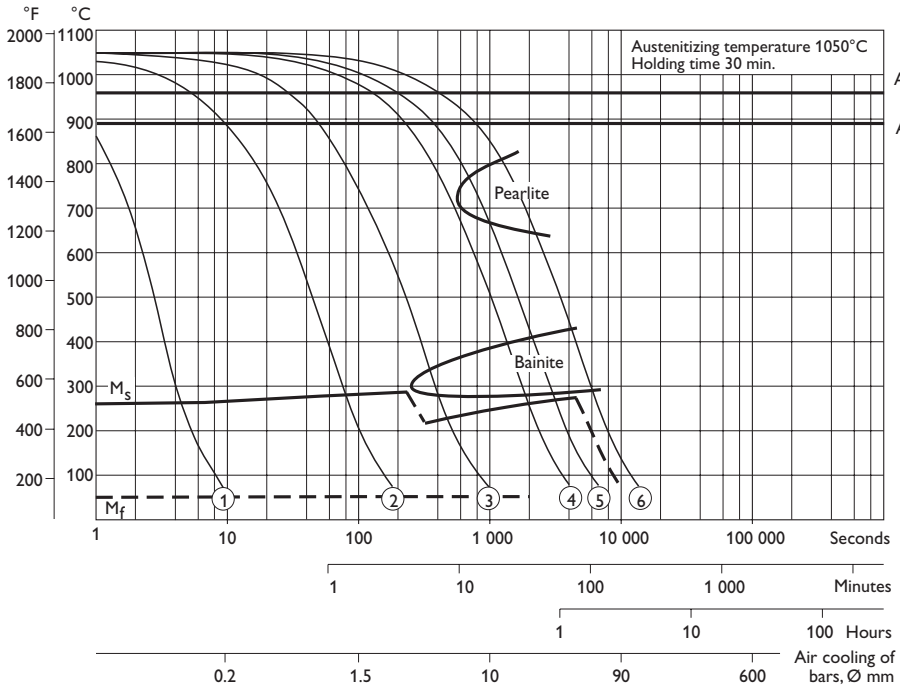
TEMPERING GRAPH



Above tempering curves are obtained after heat treatment of samples with a size of 15 x 15 x 40 mm, cooling in forced air. Lower hardness can be expected after heat treatment of tools and dies due to factors like actual tool size and heat treatment parameters.

CCT-GRAPH

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



Cooling Curve No.	Hardness HV 10	$T_{800-500}$ (sec)
1	792	1
2	782	28
3	690	140
4	665	630
5	542	1030
6	360	2095

Quenching media

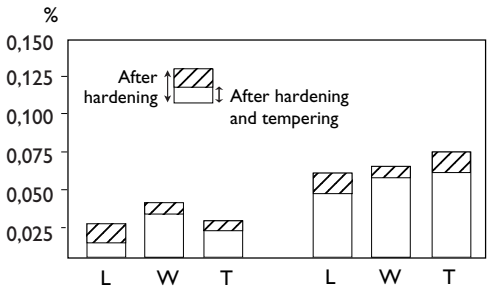
- Forced air/gas
- Fluidized bed or salt bath 200–550°C (390–1020°F), then cool in air

Note: In order to obtain optimum properties, the cooling rate should be as fast as is concomitant with acceptable distortion. Temper immediately the tool reaches 50–70°C (120–160°F).

Dimensional changes during heat treatment

ILLUSTRATION OF THE EFFECT FROM AUSTENITIZING TEMPERATURE AND SUBZERO COOLING

The test has been performed on sample size: 40 x 40 x 40 mm (1,6 x 1,6 x 1,6 in.).



Austenitizing:	1050°C (1920°F) 30 min	1050°C (1920°F) 30 min
Quenching medium:	air	air
Sub-zero treatment:	–	-60°C (-75°F)
Tempering:	230°C (440°F) 2h + 2h	230°C (440°F) 2h + 2h

Sub-zero treatment

Sub-zero treatment falls into the broad categories of cold treatment and cryogenic treatment.

Parts requiring high dimensional stability should be sub-zero treated, otherwise volume changes may arise.

Uddeholm Elmax SuperClean is commonly sub-zero treated between -150°C (-240°F) and -196°C (320°F) (cryo treatment), although occasionally -40°C (-40°F) to -80°C (-112°F) (cold treatment) are used due to constraints of the sub-zero medium and equipment available.

The first sub-zero treatment should be carried out directly after hardening and before any tempering without delay. When maximum dimensional stability is required further sub-zero treatments may be necessary between the tempering operations. In this case it is important to always end with a tempering, as the last operation.

1–3 hours treatment results in an increased hardness of about 1–3 HRC.

Note: Avoid intricate shapes as there is a risk of cracking.

Machining recommendations

The machining recommendations 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
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) m/min. f.p.m.	70–120 230–395	120–140 395–460	10–14 33–46
Feed (f) mm/r i.p.r.	0,2–0,4 0,008–0,016	0,05–0,2 0,002–0,008	0,05–0,2 0,002–0,008
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 US	K20, P10–P20 C2, C7–C6 Coated* carbide	K15, P10 C2, C7 Coated* carbide	–

* Use a wear resistant Al_2O_3 coated carbide grade

Drilling

HIGH SPEED STEEL TWIST DRILLS

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	10–12*	33–39*	0,05–0,15	0,002–0,006
5–10	3/16–3/8	10–12*	33–39*	0,15–0,20	0,006–0,008
10–15	3/8–5/8	10–12*	33–39*	0,20–0,25	0,008–0,010
15–20	5/8–3/4	10–12*	33–39*	0,25–0,35	0,010–0,014

* For coated HSS drills v_C = 18–20 m/min. (60–65 f.p.m.)

CARBIDE DRILLS

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed (v_C) m/min. f.p.m.	90–120 295–395	60–80 195–265	30–35 98–115
Feed (f) mm/r i.p.r.	0,05–0,25[2] 0,002–0,01[2]	0,10–0,25[3] 0,004–0,01[3]	0,15–0,25[4] 0,006–0,01[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

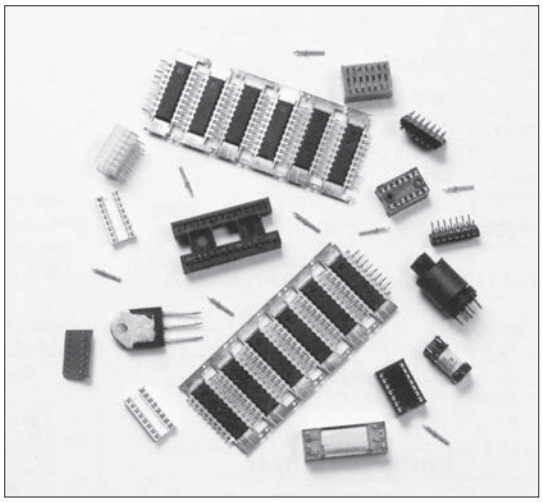
Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_C) m/min. f.p.m.	80–110 265–360	110–140 360–460
Feed (f_Z) mm/tooth in/tooth	0,2–0,4 0,008–0,016	0,1–0,2 0,004–0,008
Depth of cut (a_p) mm in	2–4 0,08–0,16	–2 0,08
Carbide designation ISO US	K20, P20 C2, C6 Coated* carbide	K15, P10 C2, C7 Coated* carbide

* Use a wear resistant Al_2O_3 coated carbide grade

END MILLING

Cutting data parameters	Type of end mill		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_C) m/min. f.p.m.	50–60 165–195	80–110 265–360	5–8[1] 16–26[1]
Feed (f_Z) mm/tooth in/tooth	0,01–0,2[2] 0,0003–0,008[2]	0,06–0,2[2] 0,002–0,008[2]	0,01–0,3[2] 0,0003–0,012[2]
Carbide designation ISO US	–	K15, P10–P20 C2, C7–C6 Coated[3] carbide	–

[1] For coated HSS end mill v_c = 14–16 m/min. (46–52 f.p.m.)
[2] Depending on radial depth of cut and cutter diameter
[3] Use a wear resistant Al_2O_3 coated carbide grade



Different parts produced in tools made from Uddeholm Elmax SuperClean.

Grinding

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

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B 151 R50 B3[1] A 46 GV
Face grinding segments	A36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B 151 R50 B3[1] A 60 JV
Internal grinding	A 60 JV	B 151 R75 B3[1] A 60 IV
Profile grinding	A 100 IV	B 126 R100 B6[1] A 100 JV

[1] If possible use CBN wheels for this application

Electrical-discharge machining

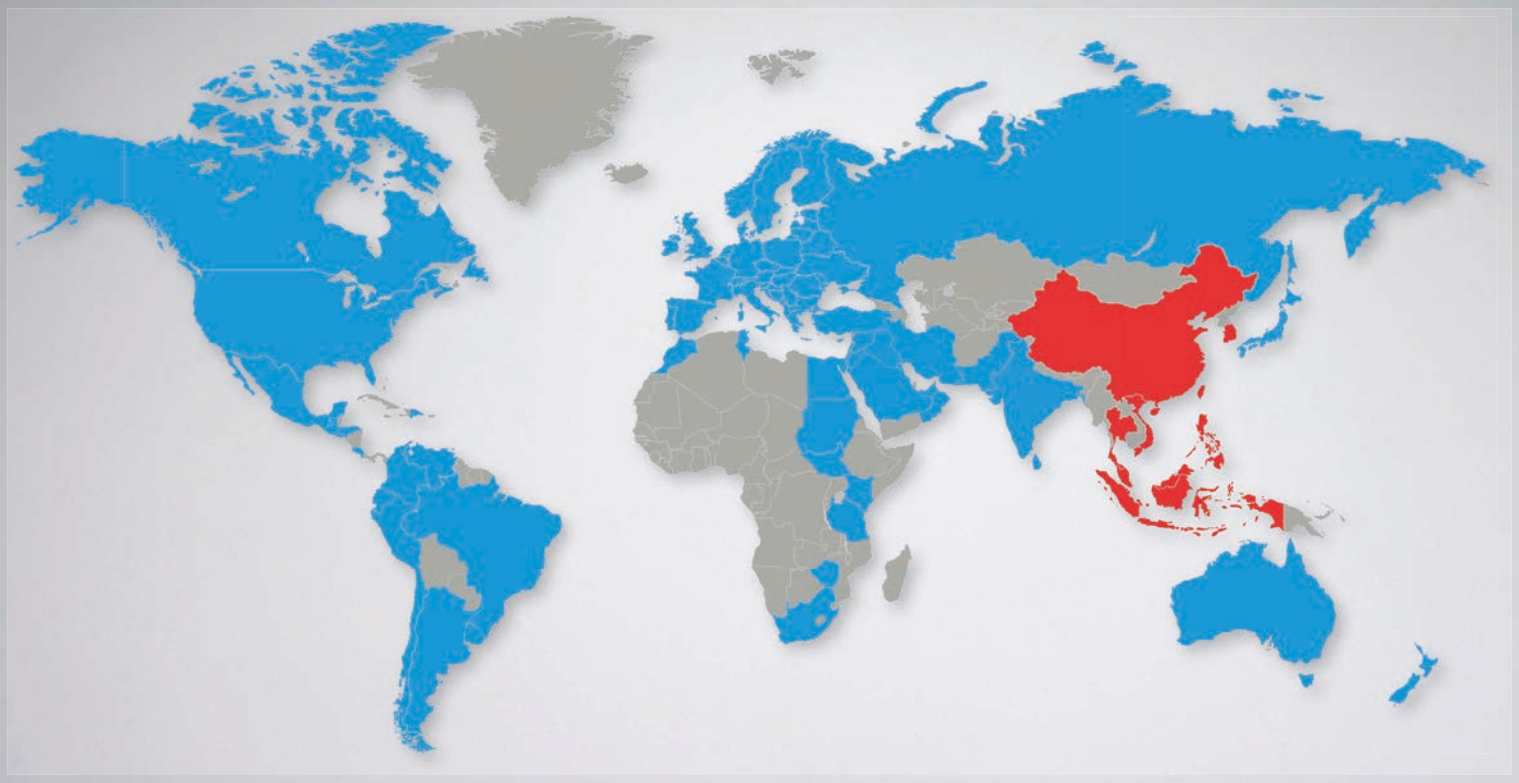
If EDM'ing ("spark-erosion") is performed in the hardened and tempered condition, the tool should then be given an additional temper at about 20°C (50°F) below the previous tempering temperature.

Property comparison chart

Uddeholm steel grade	Wear resistance	Corrosion resistance	Dimensional stability
ELMAX SUPERCLEAN			
RIGOR			
STAVAX ESR			

Further information

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



Network of excellence

Uddeholm is present on every continent. This ensures you high-quality Swedish tool steel and local support wherever you are. We secure our position as the world's leading supplier of tooling materials.

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Uddeholmis 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. We secure our position as the world's leading supplier of tooling materials. We act worldwide. For us it is all a matter of trust – in long-term partnerships as well as in developing new products.

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