UDDEHOLM ELMAX™

UDDEHOLM

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

Edition 5, 02.2009
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

General

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

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

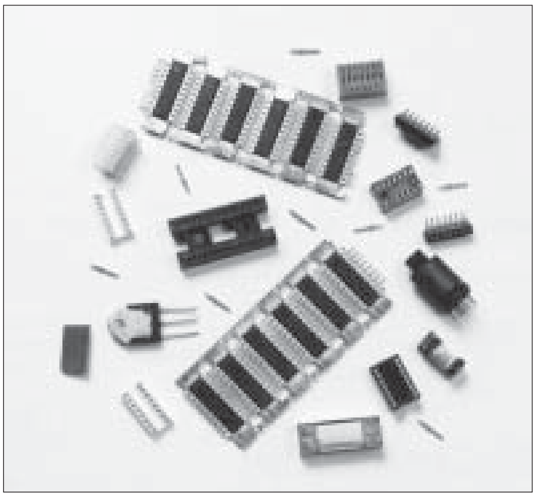
High wear resistance is normally connected to low corrosion resistance and vice versa. In Uddeholm Elmax it has however been able to achieve this unique combination of properties by a powder-metallurgy-based production.

Uddeholm Elmax 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 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 can also be used in the food processing industry, where a combination of corrosion resistance and wear resistance is required for cutting applications.



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/m^3	7 600	7 560	7 500
lbs/in.	0,275	0,273	0,271
Modulus of elasticity N/mm^2	230 000	210 000	200 000
psi	33,4 x 10^6	30,5 x 10^6	29,0 x 10^6
Coefficient of thermal expansion per °C from 20°C	–	10,6 x 10^{-6}	11,4 x 10^{-6}
per °F from 68°F	–	6,0 x 10^{-6}	6,4 x 10^{-6}
Thermal conductivity* W/m °C	–	15	21
Btu in/ft^2 h °F	–	104	146
Specific heat J/kg °C	460	–	–
Btu/lb °F	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 RC	55 RC	50 RC
Compressive strength Rm N/mm^2	3 000	2 700	2 300
tsi	195	175	150
psi	435 000	390 000	335 000
Yield point Rp0,2 N/mm^2	2 300	2 150	1 800
tsi	150	140	120
psi	335 000	310 000	260 000

Corrosion resistance

Moulds made from Uddeholm Elmax 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 °C	Temperature °F	Holding* time minutes	Hardness before tempering
1050	1920	30	60 HRC
1080	1980	30	61 HRC
1100	2010	30	61 HRC

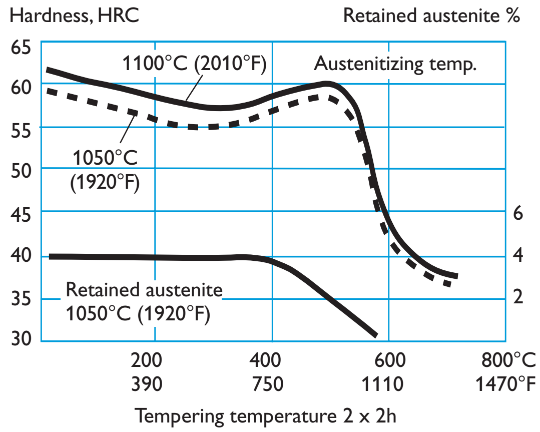
* Holding time = time at austenitizing temperature after the tool is fully heated through

Protect the part against decarburization and oxidation during hardening.

Tempering

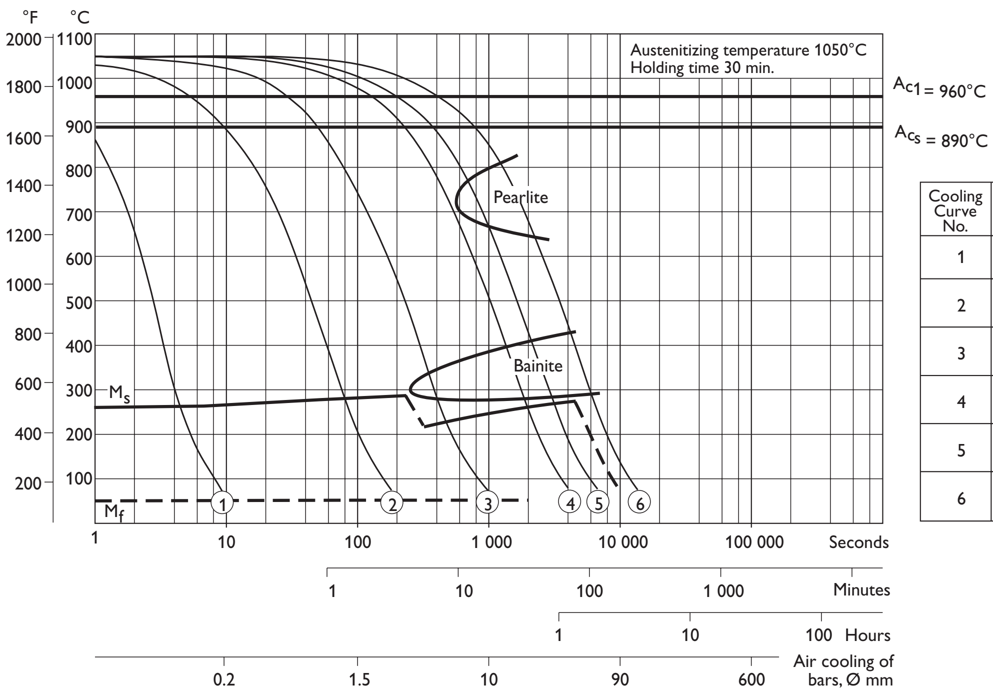
Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature, the preferred tempering temperature is 250°C (480°F) or higher. In exceptional cases, a minimum tempering temperature of 180°C (350°F) can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

TEMPERING GRAPH



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

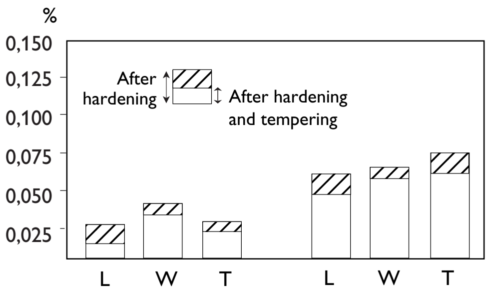
- Forced air/gas
- Fluidized bed or salt bath 200–550°C (390–1020°F), then cool in air

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

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

Immediately after quenching the piece is sub-zero treated, followed by tempering. Uddeholm Elmax is commonly sub-zero treated between -150°C and -196°C (-240°F and -320°F) although occasionally -40°C (-40°F) and lower temperatures are used due to constraints of the sub-zero medium and equipment available. A treatment time of 1–3 hours at temperature will give a hardness increase of 1–3 HRC.

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	Brazed carbide[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[2] 0,004–0,01[2]	0,15–0,25[2] 0,006–0,01[2]

[1] Drills with replaceable or brazed carbide tip
[2] Depending on drill diameter

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

Grinding

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

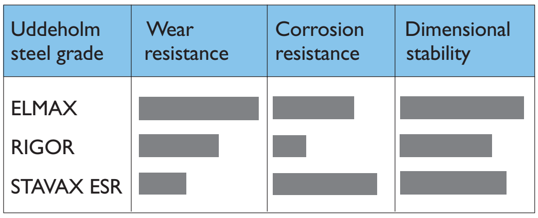
Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B 151 R50 B3[1)] A 46 GV
Face grinding segments	A36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B 151 R50 B3[1)] A 60 JV
Internal grinding	A 60 JV	B 151 R75 B3[1)] A 60 IV
Profile grinding	A 100 IV	B 126 R100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

[1)] If possible use CBN wheels for this application

Electrical-discharge machining

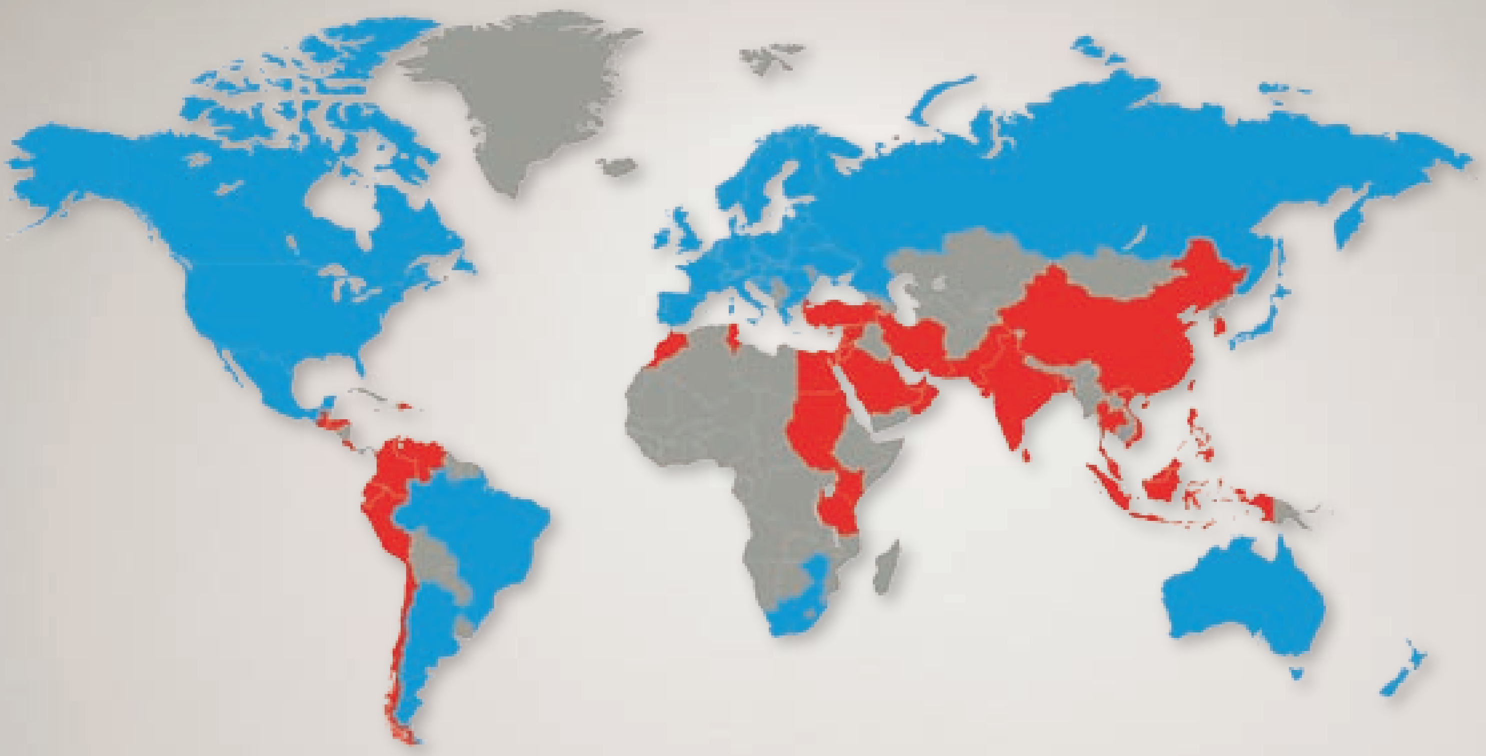
If EDM'ing ("spark-erosion") is performed in the hardened and tempered condition, the tool should then be given an additional temper at about 20°C (50°F) below the previous tempering temperature.

Property comparison chart



Further information

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



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.

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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.