UDDEHOLM VIDAR® 1 ESR

UDDEHOLM

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

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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 Vidar 1 ESR is a chromium-molybdenum-vanadium-alloyed steel which is characterized by:

- good high-temperature strength
- good toughness and ductility
- good machinability and polishability
- good through-hardening properties
- good size stability during hardening

Typical analysis %	C 0.38	Si 1.0	Mn 0.4	Cr 5.0	Mo 1.3	V 0.4
Standard specification	AISI H11, B H11, W.-Nr. 1.2343, EN X37 CrMoV 5-1					
Delivery condition	Soft annealed to approx.185 HB					
Colour code	Orange/Dark blue					

Applications

General hot work and plastic mould applications, specially large plastic moulds with requirements on high toughness in combination with very good polishability and texturing properties.

Properties

Physical data

Specimens hardened and tempered to 44–46 HRC.

Temperature	20°C (68°F)	400°C (750°F)	600°C (1010°F)
Density, kg/m³ lbs/in³	7 800 0.281	7 700 0.277	7 600 0.274
Modulus of elasticity MPa psi	210 000 30.5 x 10^6	180 000 26.1 x 10^6	140 000 20.3 x 10^6
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	– –	12.6 x 10^{-6} 7.0 x 10^{-6}	13.2 x 10^{-6} 7.3 x 10^{-6}
Thermal conductivity W/m °C Btu in/(ft²h°F)	25 176	29 204	30 211

Mechanical properties

Tensile strength at room temperature.

Hardness	44 HRC	48 HRC
Tensile strength, R_m	1 400	1 620
Yield point, $R_{p0,2}$	1 150	1 380

HIGH-TEMPERATURE STRENGTH AT ELEVATED TEMPERATURES

Hardness 48 HRC.

Testing temperature	R_m MPa	$R_{p0,2}$ MPa
200°C (390°F)	1 490	1 250
400°C (750°F)	1 370	1 120
500°C (930°C)	1 190	910
550°C (1020°F)	1 170	790
600°C (1110°F)	880	600

Heat treatment

Soft annealing

Protect the steel and heat through to 850°C (1562°F). Then cool in furnace at 10°C (20°F) per hour to 650°C (1202°F), then freely in air.

Stress relieving

After rough machining the tool should be heated through to 650°C (1202°F), holding time 2 hours. Cool slowly to 500°C (932°F), then freely in air.

Hardening

Preheating temperature: 600–850°C (1112–1562°F) (normally two preheating steps).
Austenitizing temperature: 990–1010°C (1814–1850°F), normally 990–1000°C (1814–1832°F).
Soaking time: 30–45 minutes. Soaking time = time at austenitizing temperature after the tool is fully heated through.

Protect the tool against decarburization and oxidation during austenitizing.

Quenching media

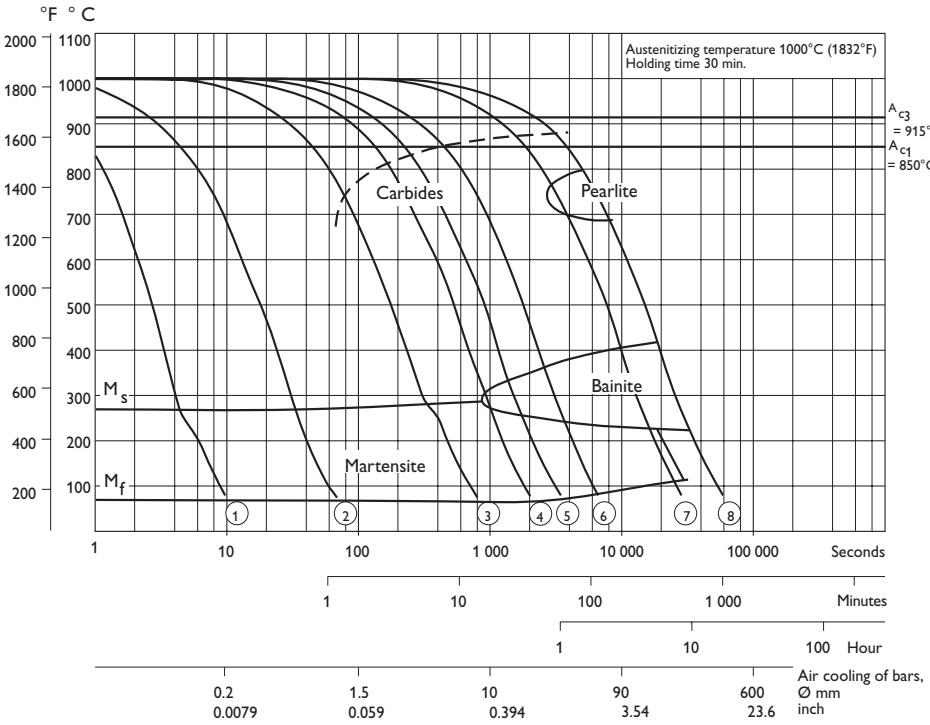
- High speed gas/circulating atmosphere
- Vacuum (high speed gas with sufficient positive pressure)
- Martempering bath (salt or fluidized bed) at 500–550°C (932–1022°F)
- Martempering bath (salt or fluidized bed) at 180–220°C (356–428°F)
- Warm oil

Note 1: Temper the tool as soon as its temperature reaches 50–70°C (122–158°F).

Note 2: In order to obtain the optimum properties for the tool, the cooling rate should be fast, but not at a level that gives excessive distortion or cracks.

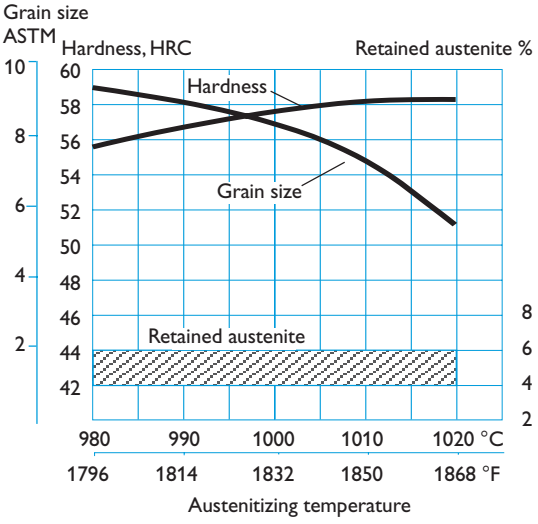
CCT GRAPH

Austenitizing temperature 1000°C (1832°F). Holding time 30 minutes.



Cooling curve No.	Hardness HV 10	$T_{800-500}$ (sec)
1	715	2
2	715	13
3	695	125
4	654	374
5	642	623
6	642	1248
7	559	5200
8	459	10400

HARDNESS, GRAIN SIZE AND RETAINED AUSTENITE AS A FUNCTION OF AUSTENITIZING TEMPERATURE



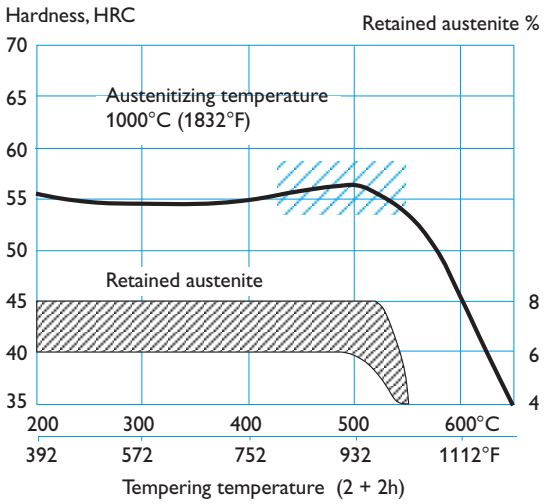
Tempering

Choose the tempering temperature according to the hardness required by reference to the tempering graph below. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 180°C (356°F). Holding time at temperature minimum 2 hours.

Tempering in the range of 425–550°C (797–1022°F) for the intended final hardness will result in a lower toughness.

TEMPERING GRAPH

Air cooling of specimen 15 x 15 x 40 mm (0.6" x 0.6" x 1.6")



Nitriding and nitrocarburizing

Nitriding and nitrocarburizing result in a hard surface layer which is very resistant to wear and galling.

The surface hardness after nitriding is approximately 900–1100 $HV_{0,2}$. The thickness of the layer should be chosen to suit the application in question.

DEPTH OF NITRIDING

Process	Time	Depth* mm	Depth* inch
Gas nitriding at 510°C (950°F)	10 h 30 h	0.12 0.20	0.0047 0.0079
Plasma nitriding at 480°C (895°F)	10 h 30 h	0.14 0.19	0.0055 0.0075
Nitrocarburizing – in gas at 580°C (1075°F) – in salt bath at 580°C (1075°F)	 2.5 h 1 h	 0.12 0,07	 0.0047 0,0028

* Depth of case = distance from surface where hardness is 50 $HV_{0,2}$ over base hardness

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 recommendation".

Turning

Cutting data parameters	Turning with carbide: Rough turning	Turning with carbide: Fine turning	Turning with HSS: Fne turning
Cutting speed (v_c) m/min f.p.m.	200–250 655–820	250–300 820–980	25–30 80–100
Feed (f) mm/rev. i.p.r.	0.2–0.4 0.008–0.016	0.05–0.2 0.002–0.008	0.05–0.3 0.002–0.01
Depth of cut (a_p) mm inch	2–4 0.08–0.16	0.5–2 0.02–0.08	0.5–3 0.02–0.1
Carbide designation ISO	P20–P30 Coated carbide	P10 Coated carbide or cermet	–

Milling

FACE- AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide: Rough milling	Milling with carbide: Fine milling
Cutting speed (v_c) m/min f.p.m.	180–260 590–850	260–300 850–980
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	0.5–2 0.02–0.08
Carbide designation ISO	P20–P40 Coated carbide	P10 Coated carbide or cermet

END MILLING

Cutting data parameters	Type of milling: Solid carbide	Type of milling: Carbide indexable insert	Type of milling: High speed steel
Cutting speed (v_c) m/min f.p.m.	160–200 525–655	170–230 560–755	35–40[1] 115–130[1]
Feed (f_z) mm/tooth inch/tooth	0.01–0.2[2] 0.0004–0.008[2]	0.06–0.2[2] 0.0024–0.008[2]	0.01–0.3[2] 0.0004–0.01[2]
Carbide designation ISO	– 	P20–P30 	–

[1] For coated HSS end mill v_c = 55–60 m/min. (90–100 f.p.m.)

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

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/rev.	Feed (f) i.p.r.
– 5	–3/16	16–18*	52–59*	0.05–0.15	0.002–0.006
5–10	3/16–3/8	16–18*	52–59*	0.15–0.20	0.006–0.008
10–15	3/8–5/8	16–18*	52–59*	0.20–0.25	0.008–0.010
15–20	5/8–3/4	16–18*	52–59*	0.25–0.35	0.010–0.014

* For coated HSS drill v_c = 28–30 m/min. (90–100 f.p.m.)

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Brazed carbide[1]
Cutting speed (v_c) m/min f.p.m.	 220–240 720–790	 130–160 425–525	 80–110 260–360
Feed (f) mm/rev. i.p.r.	 0.03–0.12[2] 0.002–0.005[2]	 0.08–0.20[3] 0.003–0.008[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”)

Grinding

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

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	A 46 HV
Face grinding segments	A 24 GV	A 36 GV
Cylindrical grinding	A 46 LV	A 60 KV
Internal grinding	A 46 JV	A 60 JV
Profile grinding	A 100 KV	A 120 JV

Photo-etching

Uddeholm Vidar 1 ESR is particularly suitable for texturing by the photo-etching method. Its high level of homogeneity and low sulphur content ensures accurate and consistent pattern reproduction.

Polishing

Uddeholm Vidar 1 ESR has good polishability in the hardened and tempered condition. After grinding, polishing is undertaken with aluminium oxide or diamond paste.

Note: Each steel grade has an optimum polishing time which largely depends on hardness and polishing technique. Overpolishing can lead to a poor surface finish (e.g. an “orange peel” effect).

Further information is given in the Uddeholm publication “Polishing of mould steel”.

Electrical-discharge machining

If spark-erosion is performed in the hardened and tempered condition, the white re-cast layer should be removed mechanically e.g. by grinding or stoning. The tool should then be given an additional temper at approx. 25°C (50°F) below the previous tempering temperature.

Welding

Welding of die components can be performed, with acceptable results, as long as the proper precautions are taken during the preparation of the joint, the filler material selection, the preheating of the die, the controlled cooling of the die and the post weld heat treatment processes. The following guidelines summarize the most important welding process parameters. For more detailed information refer to Uddeholm’s “Welding of Tool Steel” brochure.

Welding method	TIG	MMA
Preheating temperature*	Min. 325°C (620°F)	Min. 325°C (620°F)
Filler metals	DIEVAR TIG-WELD QRO 90 TIG-WELD	UTP 673 QRO 90 WELD
Maximum interpass temperature	475°C (880°F)	475°C (880°F)
Post welding cooling	20–40°C/h (35–70°F/h) for the first 2–3 hours and then freely in air.	
Hardness after welding	48–53 HRC	55–58 HRC (673) 48–53 HRC
Heat treatment after welding		
Hardened condition	Temper at 10–20°C (20–40°F) below the highest previous tempering temperature.	
Soft annealed condition	Soft-anneal the material at 850°C (1560°F) in protected atmosphere. Then cool in the furnace at 10°C (20°F) per hour to 650°C (1200°F) then freely in air.	

* Preheating temperature must be established throughout the die and must be maintained for the entirety of the welding process, to prevent weld cracking.

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. ASSAB is our exclusive sales channel, representing Uddeholm in the Asia Pacific area. 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.

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