Datablad

Orvar 2 Microdized

Produktfakta og anvendelsesområder

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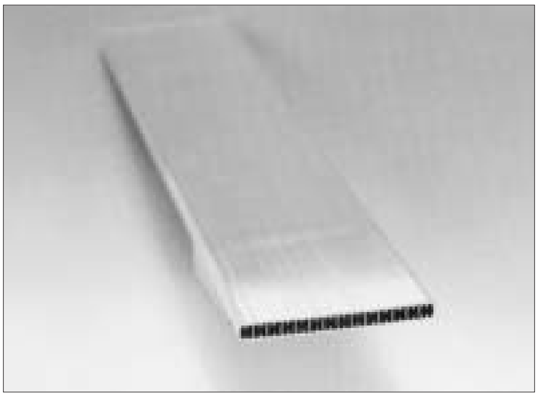
UDDEHOLM

General

Orvar 2 Microdized is a chromium-molybdenum-vanadium-alloyed steel which is characterized by:

- Good resistance to abrasion at both low and high temperatures
- High level of toughness and ductility
- Uniform and high level of machinability and polishability
- Good high-temperature strength and resistance to thermal fatigue
- Excellent through-hardening properties
- Very limited distortion during hardening.

Typical analysis %	C 0,39	Si 1,0	Mn 0,4	Cr 5,3	Mo 1,3	V 0,9
Standard specification	AISI H13, W.-Nr. 1.2344, EN X40CrMoV5-1					
Delivery condition	Soft annealed to approx. 185 HB					
Colour code	Orange/violet					



Applications

TOOLS FOR EXTRUSION

Part	Aluminium, magnesium alloys, HRC	Copper alloys HRC	Stainless steel HRC
Dies	44–50	43–47	45–50
Backers, die-holders, liners, dummy blocks, stems	41–50	40–48	40–48
Austenitizing temperature (approx.)	1020–1030°C (1870–1885°F)	1040–1050°C (1900–1920°F)	

PLASTIC MOULDING APPLICATIONS

Part	Austenitizing temp.	HRC
Injection moulds Compression/ transfer moulds	1020–1030°C (1870–1885°F) Tempering 250°C (480°F)	50–52

OTHER APPLICATIONS

Application	Austenitizing temp.	HRC
Severe cold punching, scrap shears	1020–1030°C (1870–1885°F) Tempering 250°C (480°F)	50–52
Hot shearing	1020–1030°C (1870–1885°F) Tempering 250°C (480°F) or 575–600°C (1070–1110°F)	50–52 45–50
Shrink rings (e.g. for cemented carbide dies)	1020–1030°C (1870–1885°F) Tempering 575–600°C (1070–1110°F)	45–50
Wear-resisting parts	1020–1030°C (1870–1885°F) Tempering 575°C (1070°F) Nitriding	Core 50–52 Surface $\sim 1000HV_1$

For applications requiring extreme levels of toughness and ductility e.g. die-casting dies, forging dies, the premium-grade H13-steel, Orvar Supreme, is recommended.

Properties

PHYSICAL DATA

Unless otherwise is indicated all specimens were hardened 30 minutes at 1025°C (1875°F), quenched in air and tempered 2 + 2 h at 610°C (1130°F). The hardness were 45 ± 1 HRC.

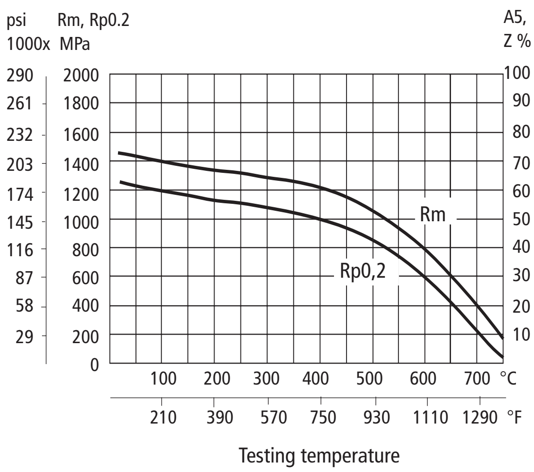
Temperature	20°C (68°F)	400°C (750°F)	600°C (1110°F)
Density kg/m^3 lbs/in^3	 7800 0,281	 7700 0,277	 7600 0,274
Modulus of elasticity N/mm^2 psi	 210 000 $30,5 \times 10^6$	 180 000 $26,1 \times 10^6$	 140 000 $20,3 \times 10^6$
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	 – –	 $12,6 \times 10^{-6}$ $7,0 \times 10^{-6}$	 $13,2 \times 10^{-6}$ $7,3 \times 10^{-6}$
Thermal conductivity W/m °C Btu in/(ft^{2}h°F)	 25 176	 29 204	 30 211

MECHANICAL PROPERTIES

Approximate tensile strength at room temperature.

Hardness	52 HRC	45 HRC
Tensile strength Rm N/mm^2 kp/mm^2 tsi psi	 1820 185 117 263 000	 1420 145 92 206 000
Yield point Rp0,2 N/mm^2 kp/mm^2 tsi psi	 1520 155 98 220 000	 1280 130 83 185 000

Approximate strength at elevated temperatures
Longitudinal direction.



Heat treatment

SOFT ANNEALING

Protect the steel and heat through to 850°C (1560°F). Then cool in the furnace at 10°C (20°F) per hour to 650°C (1200°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

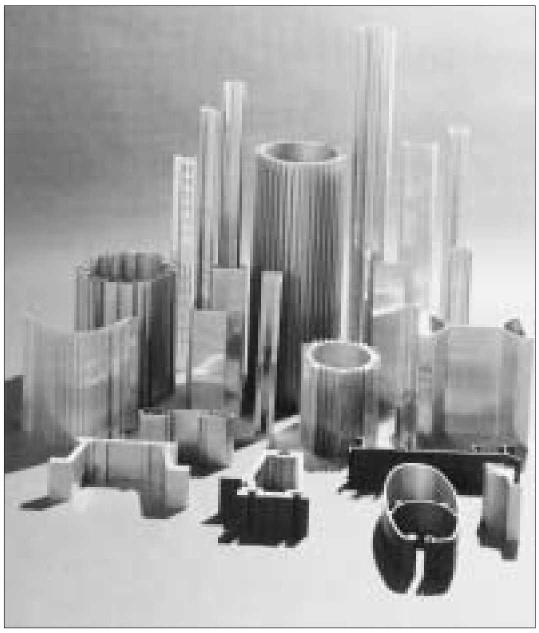
Pre-heating temperature: 600–850°C (1110–1560°F), normally in two pre-heating steps.

Austenitizing temperature: 1020–1050°C (1870–1920°F), normally 1020–1030°C (1870–1885°F).

Temperature °C	Temperature °F	Soaking* time minutes	Hardness before tempering
1025 1050	1875 1920	30 15	53±2 HRC 54±2 HRC

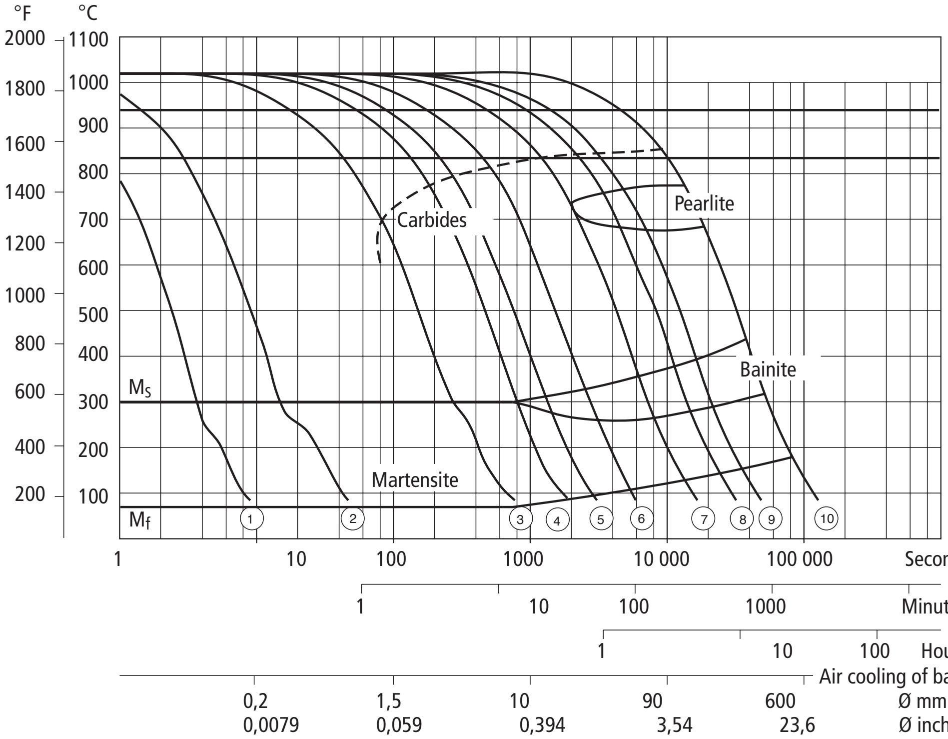
** Soaking time = time at hardening temperature after the tool is fully heated through.*

Protect the part against decarburization and oxidation during hardening.



CCT graph

Austenitizing temperature 1020°C (1870°F). Holding time 30 minutes.



Cooling curve No.	Hard-ness HV 10	$T_{800-500}$ (sec)
1	707	1
2	673	6
3	613	105
4	613	316
5	599	527
6	592	1054
7	560	2772
8	519	5271
9	483	7944
10	222	20768

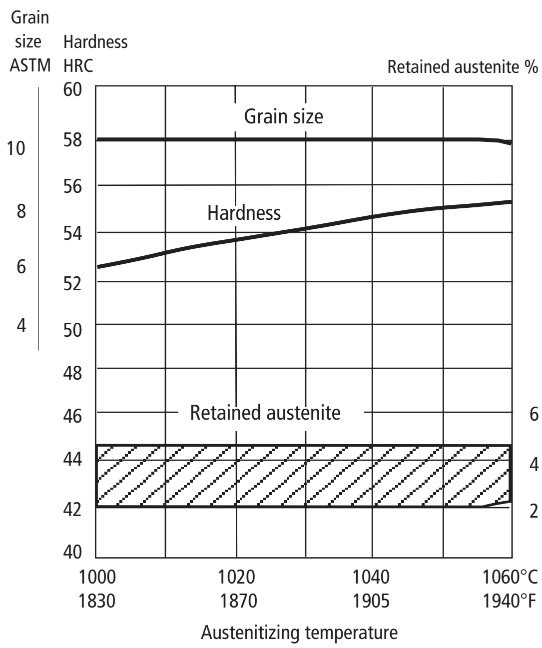
QUENCHING MEDIA

- High speed gas/circulating atmosphere
- Vacuum (high speed gas with sufficient positive pressure). An interrupted quench is recommended where distortion control and quench cracking are a concern
- Martempering bath or fluidized bed at 450–550°C (840–1020°F), then cool in air
- Martempering bath or fluidized bed at approx. 180–220°C (360–430°F) then cool in air
- Warm oil.

Note 1: Temper the tool as soon as its temperature reaches 50–70°C (120–160°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.

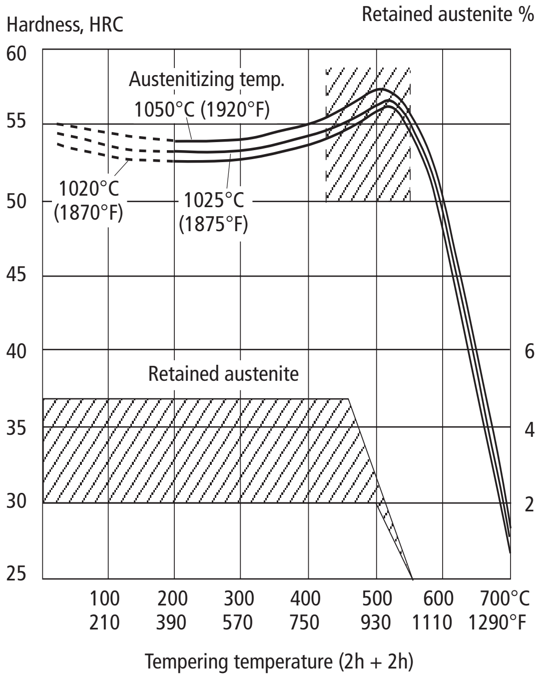
Hardness, grain size and retained austenite as functions of austenitizing temperature



TEMPERING

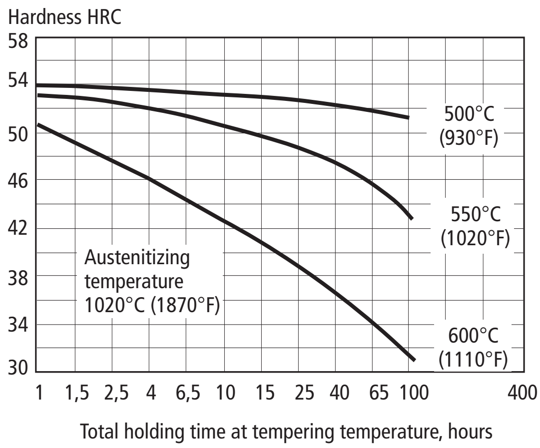
Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 180°C (360°F). Holding time at temperature minimum 2 hours. Do not temper in the range 425–550°C (800–1020°F).

Tempering graph



Tempering within the range 425–550°C (800–1020°F) is not normally recommended due to the reduction in toughness properties.

Effect of time at tempering temperature

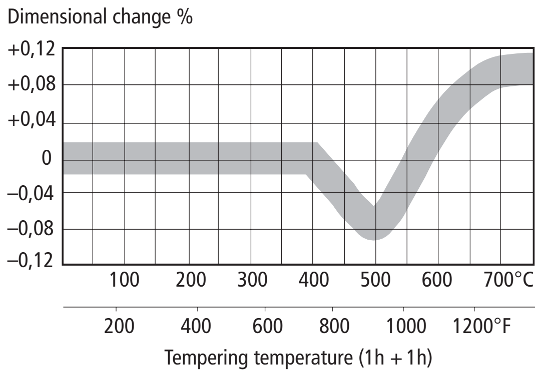


DIMENSIONAL CHANGES DURING HARDENING

Sample plate, 100 x 100 x 25 mm, 4" x 4" x 1".

		Width %	Length %	Thickness %
Oil hardened from 1020°C (1870°F)	Min. Max.	–0,08 –0,15	–0,06 –0,16	±0 +0,30
Air hardened from 1020°C (1870°F)	Min. Max.	–0,02 +0,03	–0,05 +0,02	±0 +0,05
Vac hardened from 1020°C (1870°F)	Min. Max.	+0,01 +0,02	–0,02 –0,04	+0,08 +0,12

DIMENSIONAL CHANGES DURING TEMPERING



Note: The dimensional changes in hardening and tempering should be added.

NITRIDING AND NITROCARBURIZING

Nitriding and nitrocarburizing result in a hard surface layer which is very resistant to wear and erosion. The nitrided layer is, however, brittle and may crack or spall when exposed to mechanical or thermal shock, the risk increasing with layer thickness. Before nitriding, the tool should be hardened and tempered at a temperature at least 25–50°C (45–90°F) above the nitriding temperature.

Nitriding in ammonia gas at 510°C (950°F) or plasma nitriding in a 75% hydrogen/25% nitrogen mixture at 480°C (895°F) both result in a surface hardness of about 1100 $HV_{0,2}$. In general, plasma nitriding is the preferred method because of better control over nitrogen potential; in particular, formation of the so-called white layer, which is not recommended for hot-work service, can readily be avoided. However, careful gas nitriding can give perfectly acceptable results.

Orvar 2 Microdized can also be nitrocarburized in either gas or salt bath. The surface hardness after nitrocarburizing is 900–1000 $HV_{0,2}$.

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	0,12 0,18	0,0047 0,0071
Nitrocarburizing – in gas at 580°C (1075°F)	2,5 h	0,11	0,0043
– in salt bath at 580°C (1075°F)	1 h	0,06	0,0024

Nitriding to case depths >0,3 mm (0,012 inch) is not recommended for hot-work applications.

Orvar 2 Microdized can be nitrided in the soft-annealed condition. The hardness and depth of case will, however, be reduced somewhat in this case.

Machining 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: Sof annealed to approx. 185 HB

TURNING

Cutting data parameters	Turning with carbide Rough turning	Turning with carbide Fine turning	Turning with high speed steel Fine turning
Cutting speed (v_c) m/min f.p.m.	200–250 656–820	250–300 820–984	25–30 82–98
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 0,002–0,01
Depth of cut (a_p) mm inch	2–4 0,08–0,16	0,5–2 0,02–0,08	0,5–3 0,02–0,12
Carbide designation ISO US	P20–P30 C6–C5 Coated carbide	P10 C7 Coated carbide or cermet	– –

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	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. (92–98 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.	220–240 720–785	130–160 425–525	80–110 260–360
Feed (f) mm/r i.p.r.	0,03–0,10[2] 0,001–0,004[2]	0,10–0,25[2] 0,004–0,010[2]	0,15–0,25[2] 0,006–0,010[2]

[1] Drill with internal cooling channels and brazed carbide tip.
[2] Depending on drill diameter.

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.	180–260 591–853	260–300 853–984
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	2–5 0,08–0,2	–2 –0,08
Carbide designation ISO US	P20–P40 C6–C5 Coated carbide	P10–P20 C6–C7 Coated carbide or cermet

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.	160–200 525–660	170–230 560–755	35–40[1] 115–130[1]
Feed (f_z) mm/tooth inch/tooth	0,03–0,20[2] 0,001–0,008[2]	0,08–0,20[2] 0,003–0,008[2]	0,05–0,35[2] 0,002–0,014[2]
Carbide designation ISO	–	P20, P30	–

[1] For coated HSS end mill v_c = 55–60 m/min. (180–195 f.p.m.).
[2] Depending on radial depth of cut and cutter diameter.

GRINDING

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

Wheel recommendation

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 IV
Profile grinding	A 100 LV	A 120 KV

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 tool steel can be performed with good results if proper precautions are taken regarding elevated temperature, joint preparation, choice of consumables and welding procedure.

Welding method	TIG	MMA
Working temperature	325–375°C 620–710°F	325–375°C 620–710°F
Filler metal	QRO 90 TIG-WELD DIEVAR TIG-WELD	QRO 90 WELD
Cooling rate	20–40°C/h (35–70°F/h) the first 2–3 h then freely in air.	
Hardness after welding	50–55 HRC	50–55 HRC
Heat treatment after welding		
Hardened condition	Temper at 25°C (45°F) below the original 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.	

More detailed information can be found in the Uddeholm brochure "Welding of Tool Steel".

Hard-chromium plating

After plating, parts should be tempered at 180°C (360°F) for 4 hours within 4 hours of plating to avoid the risk of hydrogen embrittlement.

Photo-etching

Orvar 2 Microdized 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

Orvar 2 Microdized exhibits good polishability in the hardened and tempered condition. Polishing after grinding can be effected using aluminium oxide or diamond paste.

Typical procedure:

1. Rough grinding to 180–320 grain size using a wheel or stone.
2. Fine grinding with abrasive paper or powder down to 400–800 grain size.
3. Polish with diamond paste grade 15 (15µm grain size) using a polishing tool of soft wood or fibre.
4. Polish with diamond paste 8–6–3 (8–6–3µm grain size) using a polishing tool of soft wood or fibre.
5. When demands on surface finish are high, grade 1 (1µm grain size) diamond paste can be used for final polishing with a fibre polishing pad.

Further information

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

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