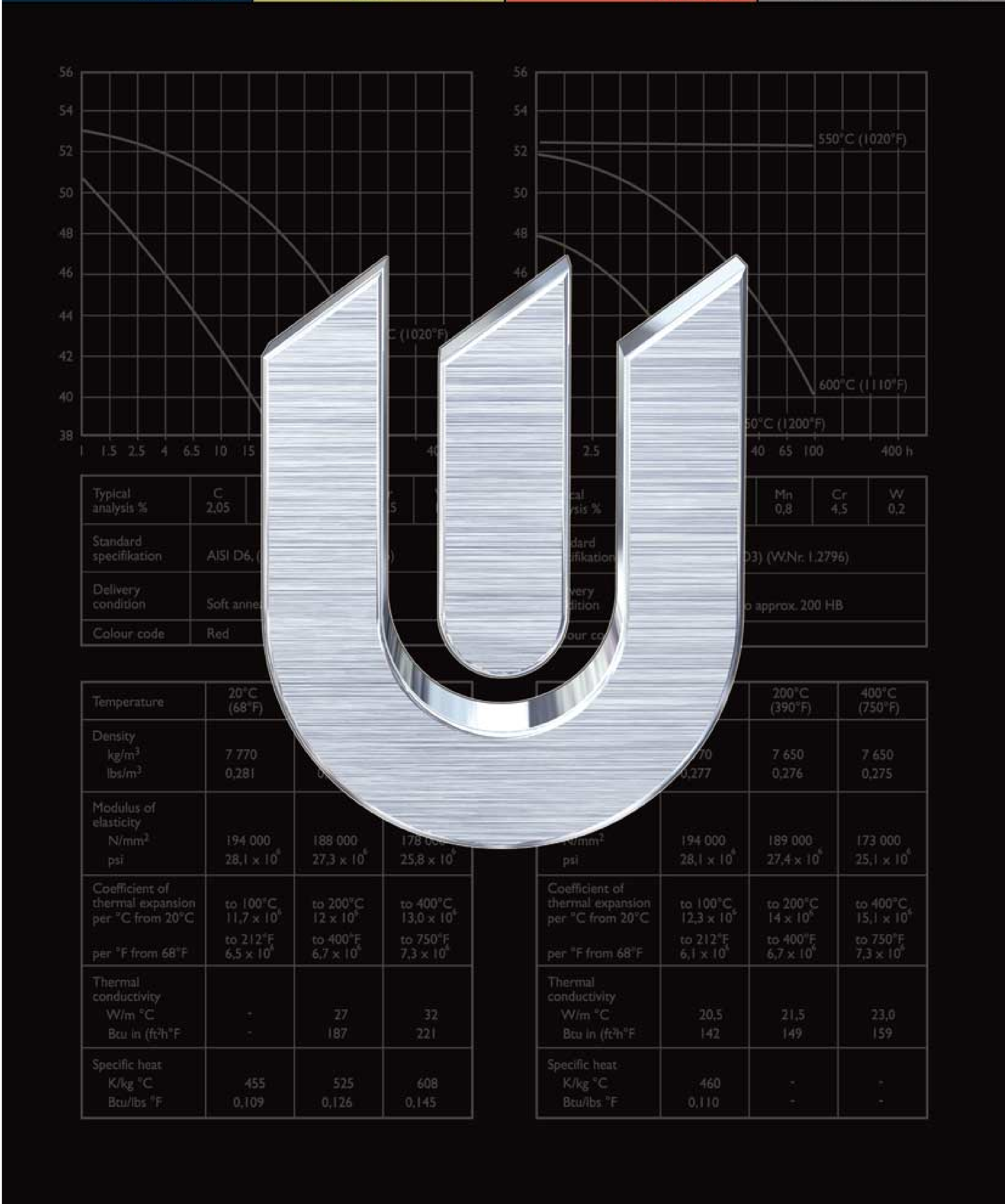
ORVAR 2 Microdized

Hot work tool steel

COLD WORK | **PLASTIC** MOULDING | **HOT** WORK | **HIGH** PERFORMANCE STEEL

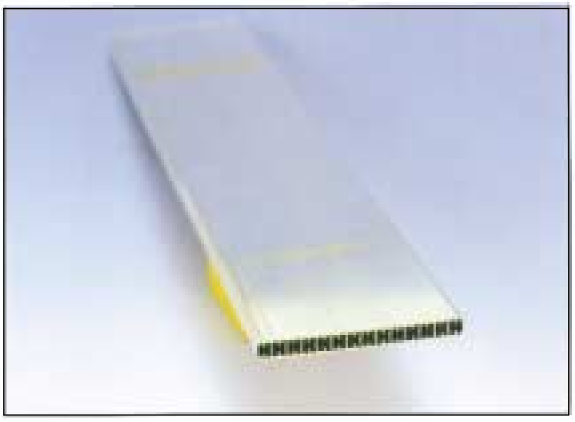


General

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					
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°C (1870°F)	1030°C (1900°F)	1030°C (1900°F)

PLASTIC MOULDING APPLICATIONS

Application	Austenitizing temp. (approx.)	HRC
Injection moulding of thermoplastics: long production runs	1020–1030°C (1870–1900°F) Tempering 250°C (450°F) or 560–580°C (1040–1080°F)	48–50
Moulding of parts in thermosetting plastic with finish requirements	1020–1030°C (1870–1900°F) Tempering 250°C (480°F)	50–52

OTHER APPLICATIONS

Application	Austenitizing temp.	HRC
Severe cold punching, scrap shears	1000–1030°C (1830–1900°F) Tempering 250°C (480°F)	50–52
Hot shearing	1000–1030°C (1830–1900°F) Tempering 250°C (480°F) or 560–620°C (1040–1150°F)	50–52 46–50
Shrink rings (e.g. for hard metal dies)	1020°C (1870°F) Tempering 560–620°C (1040–1150°F)	45–50
Wear resisting parts	1020°C (1870°F) Tempering 560°C (1040°F) Nitriding	Core 50 Surface ~1000 HV_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

Hardened and tempered to 45 HRC.
Data at room and elevated temperatures.

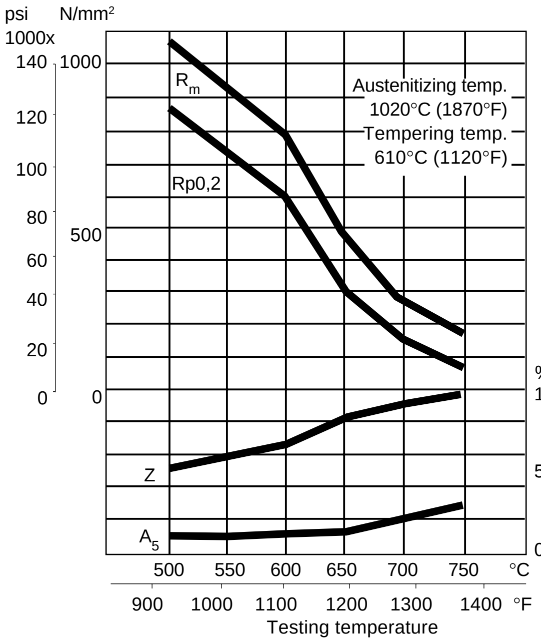
Temperature	20°C (68°F)	400°C (750°F)	600°C (1110°F)
Density kg/m³ lbs/in³	 7800 0,281	 7700 0,277	 7600 0,274
Modulus of elasticity N/mm² psi	 210 000 $30,5 \times 10^6$	 180 000 $26,1 \times 10^6$	 140 000 $20,3 \times 10^6$
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	 – –	 $12,6 \times 10^{-6}$ $7,0 \times 10^{-6}$	 $13,2 \times 10^{-6}$ $7,3 \times 10^{-6}$
Thermal conductivity W/m °C Btu in/(ft²h°F)	 25 176	 29 204	 30 211

MECHANICAL PROPERTIES

Approximate tensile strength at room temperature.

Hardness	52 HRC	45 HRC
Tensile strength Rm N/mm² kp/mm² tsi psi	 1820 185 117 263 000	 1420 145 92 206 000
Yield point Rp0,2 N/mm² kp/mm² tsi psi	 1520 155 98 220 000	 1280 130 83 185 000

High-temp strength at elevated temperatures



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° (1110–1560°F).
Austenitizing temperature: 980–1030°C (1800–1900°F), normally 1020°C (1870°F).

Temperature °C	Temperature °F	Soaking time* minutes	Hardness before tempering HRC
1000	1800	45	51±3
1020	1870	30	53±3

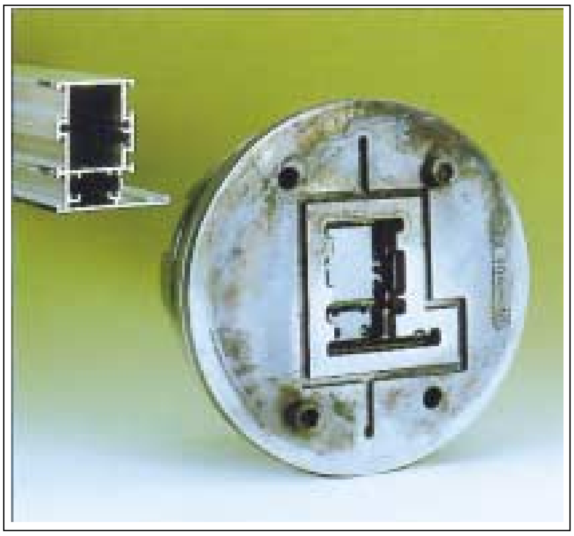
* *Soaking time = time at hardening temperature after the tool is fully heated through.*

Protect the part against decarburization and oxidation during hardening.

QUENCHING MEDIA

- Circulating air/atmosphere
- Positive gas pressure in vacuum furnace
- Mar-tempering bath or fluidized bed at ~200°C (390°F) or 450–550°C (840–1020°F) for 1–100 minutes, then cool in air
- Warm Oil.

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

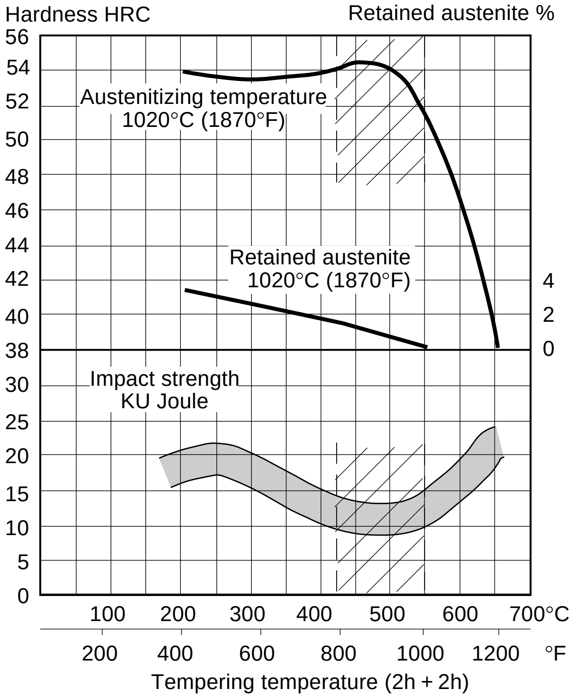


Extrusion die in ORVAR 2 Microdized for extrusion of an aluminium profile.

TEMPERING

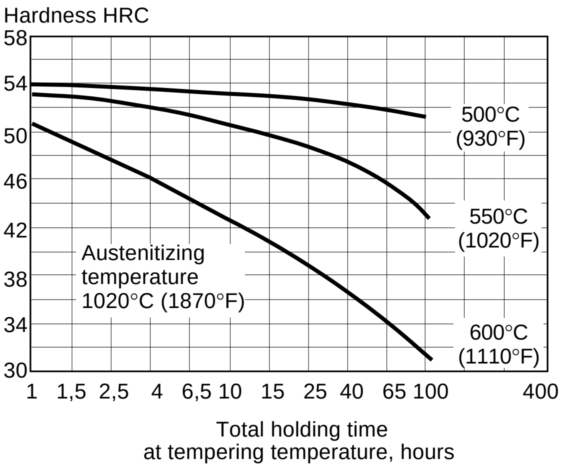
Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 180° C (360° F). Holding time at temperature minimum 2 hours. Do not temper in the range 425–550° C (800–1020°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

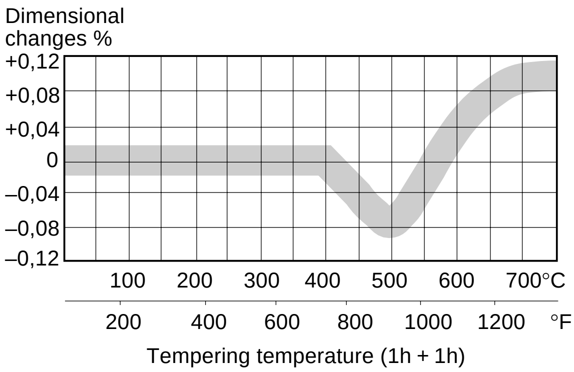


DIMENSIONAL CHANGES DURING HARDENING

Sample plate: 100 x 100 x 25 mm

	Width %	Length %	Thickness %
Oil hardened from 1000°C (1830°F) min.	–0,08	–0,06	0,00
max.	–0,15	–0,16	+0,30
Air hardened from 1020°C (1870°F) min.	–0,02	–0,05	
max.	+0,03	+0,02	+0,05
Vacuum hardened from 1020°C (1870°F) min.	+0,01	–0,02	+0,08
max.	+0,02	–0,04	+0,12

DIMENSIONAL CHANGES DURING TEMPERING



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

NITRIDING

Nitriding results 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 50° C (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 approx. 1100 $HV_{0,2}$. In general, ion nitriding is the preferred method because of better control over nitrogen potentional; 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.

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: 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) mm	Cutting speed (v_c) inch	Feed (f) mm/r	Feed (f) i.p.r.
–5	–3/16	17*	56*	0,05–0,10	0,002–0,004
5–10	3/16–3/8	17*	56*	0,10–0,20	0,004–0,008
10–15	3/8–5/8	17*	56*	0,20–0,25	0,008–0,010
15–20	5/8–3/4	17*	56*	0,25–0,30	0,010–0,012

*) *For coated HSS drill v_c~30 m/min. (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.	 220–20 722–787	 130–160 426–525	 80–110 262–361
Feed (f) mm/r i.p.r.	 0,03–0,12[2)] 0,001–0,005[2)]	 0,12–0,35[2)] 0,004–0,014[2)]	 0,15–0,40[2)] 0,006–0,016[2)]

1) *Drill with internal cooling channels and brazed 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.	 200–260 360–525	 260–300 525–656
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.	 160–200 210	 170–230 328–460	 40[1)] 115–130[1)]
Feed (f_z) mm/tooth inch/tooth	 0,006–0,20[2)] 0,0002–0,008[2)]	 0,06–0,20[2)] 0,002–0,008[2)]	 0,01–0,35[2)] 0,0004–0,014[2)]
Carbide designation ISO US	 K10, P40 C3, C5	 P15, P30 C6–C5	 – –

1) *For coated HSS end mill v_c~55 m/min. (164 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 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

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	QRO 90 WELD
Hardness after welding	50–55 HRC	50–55 HRC
Heat treatment after welding		
Hardened condition	Temper at 25°C (50°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 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 aluminum 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 (15 µm grain size) using a polishing tool of soft wood or fibre.
4. Polish with diamond paste 3 (3 µm grain size) using a polishing tool of soft wood or fibre.
5. When demands on surface finish are high, grade 1 (1 µm 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.