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全球钢号百科!

Global Steel Grade Encyclopedia

涵盖的行业或国家与地区类别

ASTM	GJB	SAE	EU	AISI	DIN	AMS	ISO	JASO
国材料与试验协会	国家军用标准	动力机械工程师协会	前欧洲标准化	美国钢铁学会	德国工业标准	空航天材料规范	国际标准	日本汽车标准组织

EN	JB	UNS	UNI	ASME	SS	GB	JIS
欧洲标准	国机械行业标准	统一编号系统	意大利标准	美国机械工程师协会	瑞典标准	国家标准	日本工业标准

General

Uddeholm Orvar Supreme is a chromium-molybdenum-vanadium-alloyed steel which is characterized by:

- High level of resistance to thermal shock and thermal fatigue
- Good high-temperature strength
- Excellent toughness and ductility **in all directions**
- Good machinability and polishability
- Excellent through-hardening properties
- Good dimensional stability during hardening

Typical analysis %	C 0.39	Si 1.0	Mn 0.4	Cr 5.2	Mo 1.4	V 0.9
Standard specification	Premium AISI H13, W.-Nr. 1.2344					
Delivery condition	Soft annealed to approx. 180 HB					
Colour code	Orange					

Improved tooling performance

The name "Supreme" implies that by special processing techniques and close control, the steel attains high purity and a very fine structure. Further, Uddeholm Orvar Supreme shows significant improvements in isotropic properties compared to conventionally produced AISI H 13 grades.

These improved isotropic properties are particularly valuable for tooling subjected to high mechanical and thermal fatigue stresses, e.g. die casting dies, forging tools and extrusion tooling. In practical terms, tools may be used at somewhat higher working hardnesses (+1 to 2 HRC) without loss of toughness. Since increased hardness slows down the formation of heatchecking cracks, improved tool performance can be expected.

Uddeholm Orvar Supreme meets the North American Die Casting Association (NADCA) #207-2008 for **premium** high quality H-13 die steel.

Applications

Tools for die casting

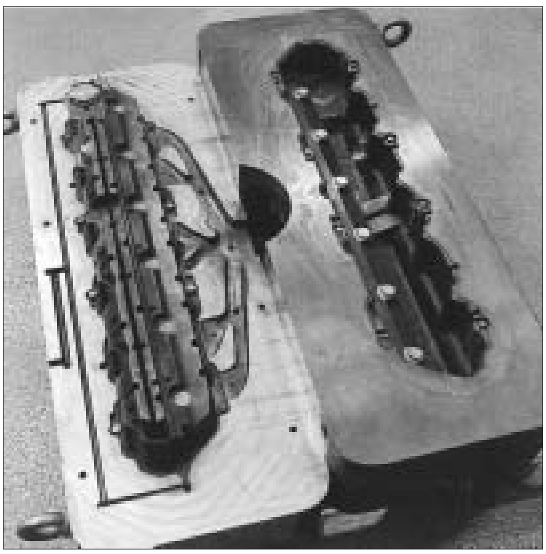
Part	Tin, lead zinc alloys HRC	Aluminium, magnesium alloys, HRC	Copper alloys HRC
Dies	46–50	42–48	(QRO 90 S)
Fixed inserts cores	46–52	44–48	(QRO 90 S)
Sprue parts	48–52	46–48	(QRO 90 S)
Nozzles	35–42	42–48	(QRO 90 S)
Ejector pins (nitrided)	46–50	46–50	46–50
Plunger, shot-sleeve (normally nitrided)	42–46	42–48	(QRO 90 S)
Austenitizing temperature	1020–1030°C (1870–1885°F)		1040–1050°C (1900–1920°F)

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)	

Tools for hot pressing

Material	Aust. temp. (approx.)	HRC
Aluminium, magnesium	1020–1030°C (1870–1885°F)	44–52
Copper alloys	1040–1050°C (1900–1920°F)	44–52
Steel	1040–1050°C (1900–1920°F)	40–50



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Moulds for plastics

Part	Austenitizing temp.	HRC
Injection moulds Compression/ transfer moulds	1020–1030°C (1870–1885°F) Tempering 1. ≥ 550°C (1020°F) or 2. 250°C (480°F)	 40–52 50–53

Other applications

Application	Austenitizing temp.	HRC
Severe cold punching, scrap shears	1020–1030°C (1870–1885°F) Tempering 250°C (480°F)	50–53
Hot shearing	1020–1030°C (1870–1885°F) Tempering 1. 250°C (480°F) or 2. 575–600°C (1070–1110°F)	 50–53 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 ~1000HV1

Properties

All specimens are taken from the centre of a 407 x 127 mm (16" x 5") bar. 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.

Physical data

Data at room and elevated temperatures.

Temperature	20°C (68°F)	400°C (750°F)	600°C (1110°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 30.5×10^6	 180 000 26.1×10^6	 140 000 20.3×10^6
Coefficient of thermal expansion per °C from 20°C °F from 68°F	 – –	 12.6×10^{-6} 7.0×10^{-6}	 13.2×10^{-6} 7.3×10^{-6}
Thermal conductivity W/m °C Btu in/(ft²h°F)	 25 176	 29 204	 30 211

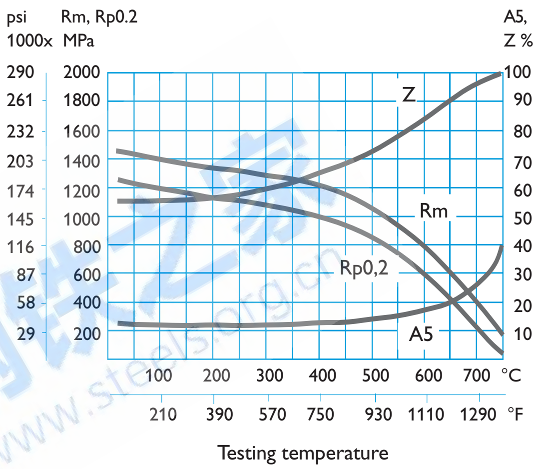
Mechanical properties

Approximate tensile strength at room temperature.

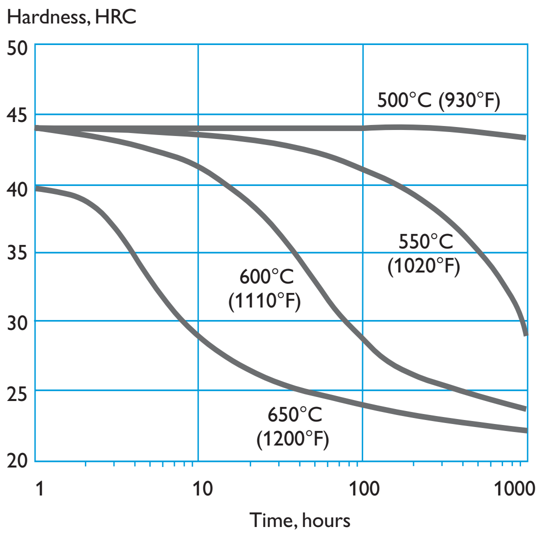
Hardness	52 HRC	45 HRC
Tensile strength Rm	1820 MPa 185 kp/mm² 117 tsi 263 000 psi	1420 MPa 145 kp/mm² 92 tsi 206 000 psi
Yield strength Rp0.2	1520 MPa 155 kp/mm² 98 tsi 220 000 psi	1280 MPa 130 kp/mm² 83 tsi 185 000 psi

APPROXIMATE STRENGTH
AT ELEVATED TEMPERATURES

Longitudinal direction.



EFFECT OF TIME AT
HIGH TEMPERATURES ON HARDNESS



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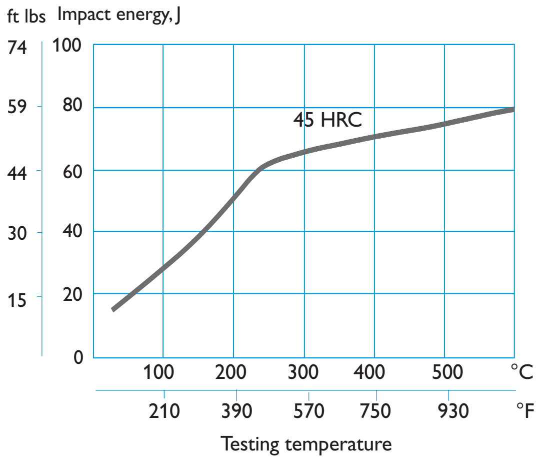
EFFECT OF TESTING TEMPERATURE
ON IMPACT ENERGY

Charpy V specimens, short transverse direction.



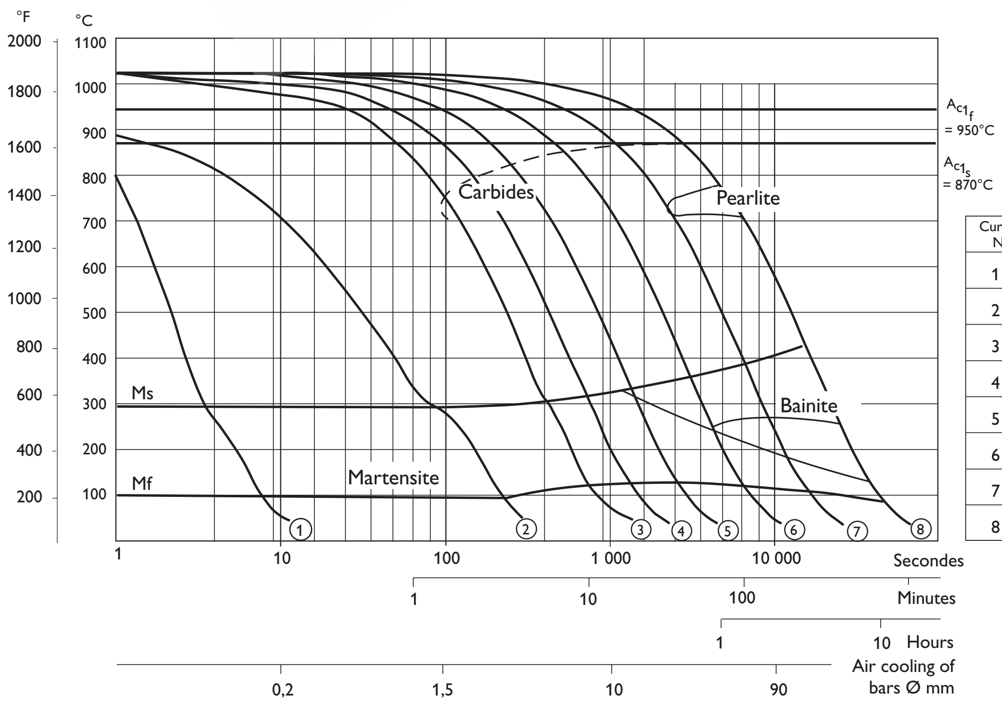
Heat treatment–general recommendations

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.

CCT GRAPH

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



Curve No	Hardness HV 10	$T_{800-500}$ sec.
1	681	1
2	620	37
3	606	160
4	601	280
5	585	560
6	560	1390
7	537	3220
8	473	8360

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

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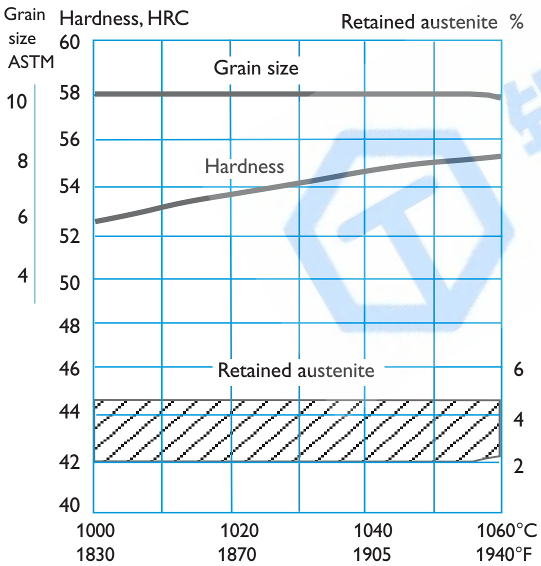
Quenching media

- 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

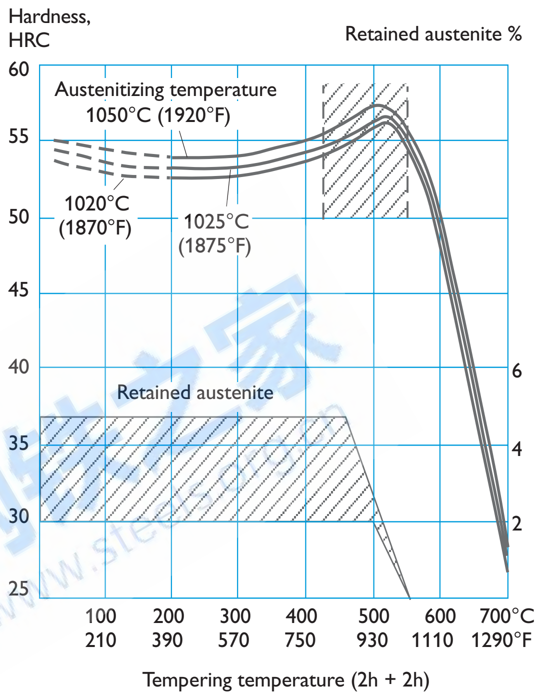


Tempering

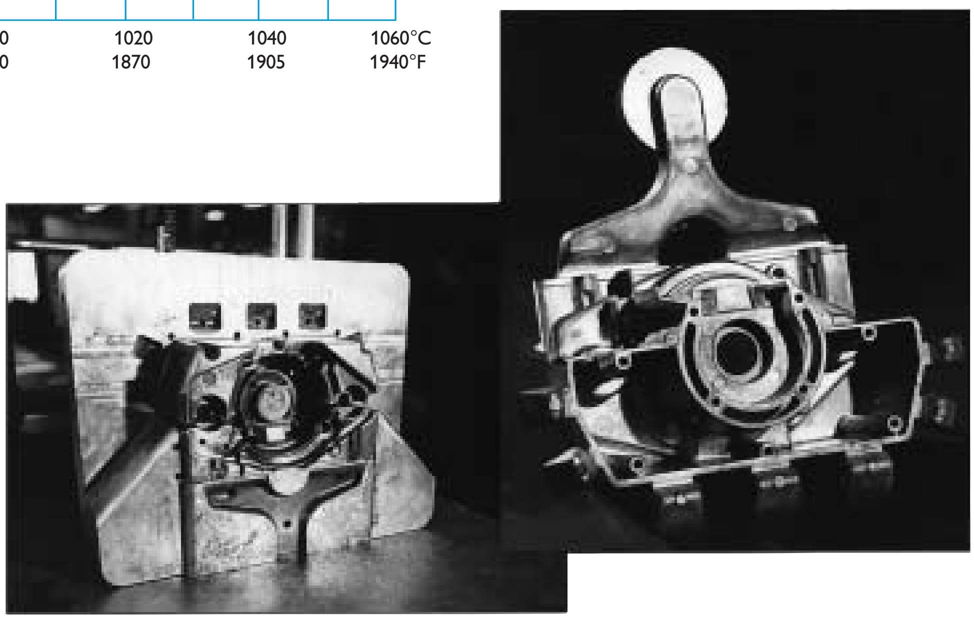
Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper minimum twice with intermediate cooling to room temperature. Lowest tempering temperature 250°C (480°F). Holding time at temperature minimum 2 h.

To avoid "temper brittleness", do not temper in the range 425–550°C (800–1020°F), see graph.

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.



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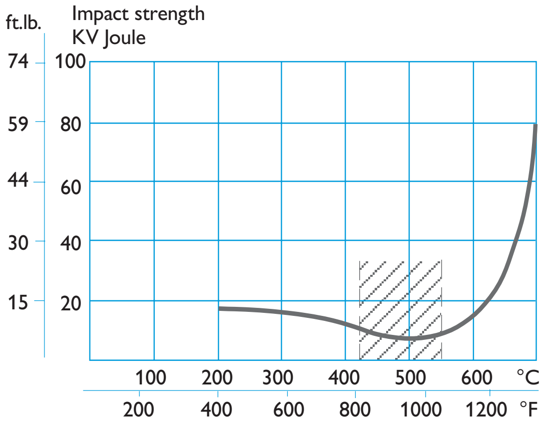
APPROXIMATE IMPACT STRENGTH AT DIFFERENT TEMPERING TEMPERATURES

Charpy V specimens, short transverse direction.



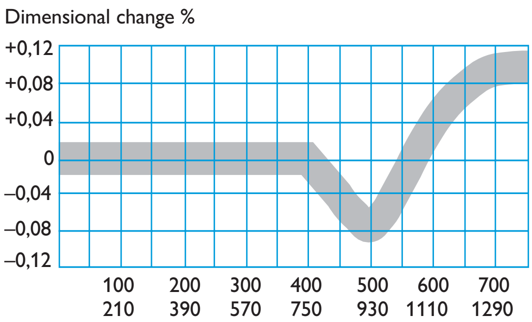
Tempering within the range 425–550°C (800–1020°F) is normally not recommended due to the reduction in toughness properties.

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.	–0.08	–0.06	±0
	Max.	–0.15	–0.16	+0.30
Air hardened from 1020°C (1870°F)	Min.	–0.02	–0.05	±0
	Max.	+0.03	+0.02	+0.05
Vac 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 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.

Uddeholm Orvar Supreme 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	0.12	0.0047
	30 h	0.20	0.0079
Plasma nitriding at 480°C (895°F)	10 h	0.12	0.0047
	30 h	0.18	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.

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

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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 recommendation".

Turning

Cutting data parameters	Turning with carbide Rough turning	 Fine turning	Turning with high speed steel Fine turning
Cutting speed (v_c) m/min f.p.m.	200–250 660–820	250–300 820–985	25–30 82–100
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 0.002–0.012
Depth of cut (a_p) mm inch	2–4 0.08–0.16	0.5–2 0.02–0.08	0.5–2 0.02–0.08
Carbide designation ISO	P20–P30 Coated carbide	P10 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 high speed steel drill v_c = 28–30 m/min (92–98 f.p.m.)

CARBIDE DRILL

Cutting data parameters	Type of drill Indexable insert	 Solid carbide	 Carbide tip[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.	0.03–0.12[2] 0.001–0.005[2]	0.08–0.20[3] 0.003–0.008[3]	0.15–0.25[4] 0.006–0.010[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.	180–260 590–850	260–300 850–985
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 0.08–0.20	–2 –0.08
Carbide designation ISO	P20–P40 Coated carbide	P10–P20 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 high speed steel 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 KV	A 120 KV

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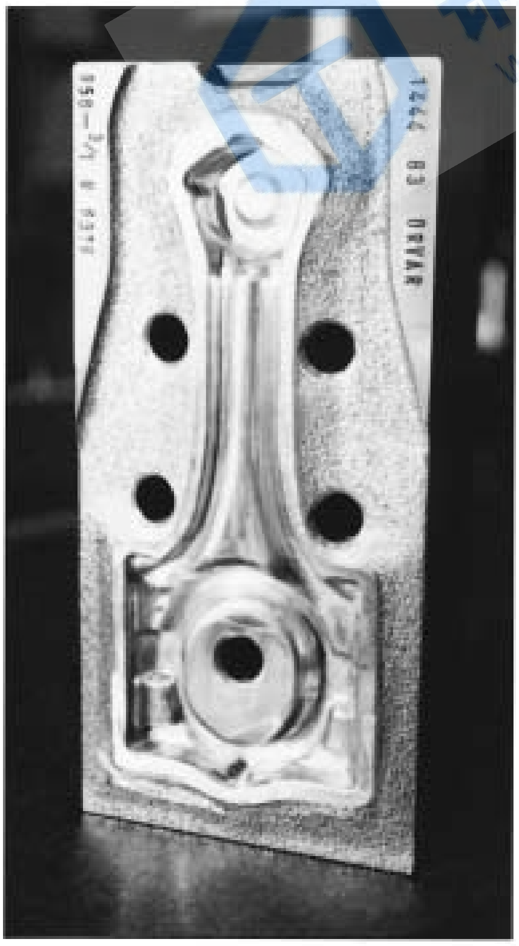
Welding

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 (40–70°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 10–20°C (20–40°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".



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.

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.

Polishing

Uddeholm Orvar Supreme has good polishability in the hardened and tempered condition because of a very homogeneous structure. This coupled with a low level of non metallic inclusions, due to ESR process, ensures good surface finish after polishing.

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, "orange peel" or pitting.

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

Photo-etching

Uddeholm Orvar Supreme 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.

Further information

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

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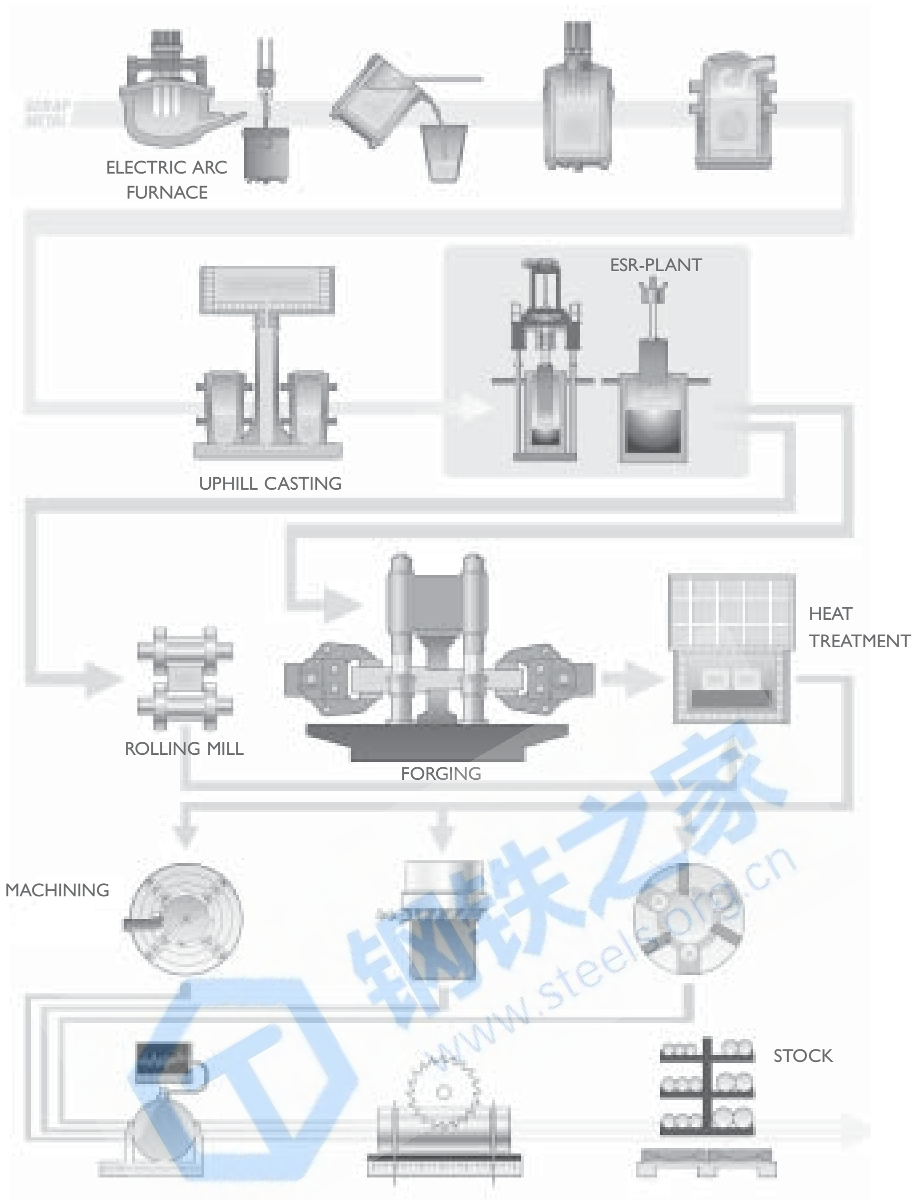

The ESR Tool Steel Process

The starting material for our tool steel is carefully selected from high quality recyclable steel. Together with ferroalloys and slag formers, the recyclable steel is melted in an electric arc furnace. The molten steel is then tapped into a ladle.

The de-slagging unit removes oxygen-rich slag and after the de-oxidation, alloying and heating of the steel bath are carried out in the ladle furnace. Vacuum degassing removes elements such as hydrogen, nitrogen and sulphur.

ESR PLANT

In uphill casting the prepared moulds are filled with a controlled flow of molten steel from the ladle.

From this, the steel can go directly to our rolling mill or to the forging press, but also to our ESR furnace where our most sophisticated steel grades are melted once again in an electro slag remelting process. This is done by melting a consumable electrode immersed in an overheated slag bath. Controlled solidification in the steel bath results in an ingot of high homogeneity, thereby removing macro segregation. Melting under a protective atmosphere gives an even better steel cleanliness.

HOT WORKING

From the ESR plant, the steel goes to the rolling mill or to our forging press to be formed into round or flat bars.

Prior to delivery all of the different bar materials are subjected to a heat treatment operation, either as soft annealing or hardening and tempering. These operations provide the steel with the right balance between hardness and toughness.

MACHINING

Before the material is finished and put into stock, we also rough machine the bar profiles to required size and exact tolerances. In the lathe machining of large dimensions, the steel bar rotates against a stationary cutting tool. In peeling of smaller dimensions, the cutting tools revolve around the bar.

To safeguard our quality and guarantee the integrity of the tool steel we perform both surface- and ultrasonic inspections on all bars. We then remove the bar ends and any defects found during the inspection.

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