UDDEHOLM MIRRAX® 40

UDDEHOLM

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This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty for fitness for a particular purpose.

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 Mirrax 40 is a remelted stainless tool steel supplied prehardened to 40 HRC.

Uddeholm Mirrax 40 is produced using the electroslag remelting (ESR) process—an additional step in the steelmaking process that ensures very clean steel with low sulphur content (0.003% max.) and non-metallic inclusions. Consequently, Uddeholm Mirrax 40 is capable of being polished to a very high surface finish.

Uddeholm Mirrax 40 is characterized by:

- excellent machinability
- excellent polishability
- excellent ductility and toughness
- uniform hardness even in large dimensions
- good indentation resistance
- good corrosion resistance

These properties combine to give a steel with outstanding production performance.

The practical benefits of good corrosion resistance can be summarized as follows.

- **Lower mould maintenance cost**
  The surface of cavity impressions retain their original finish over an extended service life. Moulds stored or operated in humid conditions require no special protection.
- **Lower production costs**
  Since cooling channels are less likely to be affected by corrosion (unlike conventional mould steel), heat transfer characteristics and therefore cooling efficiency are constant throughout the mould life, ensuring consistent cycle times.

The benefit of the prehardened condition can be summarized as follows.

- No hardening risks
- No hardening costs
- Time saving, e.g. no waiting for heat treatment
- Lower tool cost (e.g. no distortion to rectify)
- Modifications easily carried out

In addition, the combination of high hardness with a high toughness results in a mould with good resistance to indentations and minimize the risk of unexpected failures, leading to a safer mould and a prolonged tool life.

Typical analysis %	C 0.21	Si 0.9	Mn 0.45	Cr 13.5	Mo 0.2	Ni 0.6	V 0.25	N +
Standard specification	AISI 420 modified							
Delivery condition	Prehardened to 360–400 HB							
Colour code	Orange/green							

Applications

- Injection moulds for corrosive and non-corrosive plastics
- Plastic moulding of high surface finish products (e.g., Bezels and casings for TV and computers)
- Blow moulding of corrosive plastics or high surface finish transparent products (e.g. PET bottles)
- Extrusion dies
- Constructional parts

Properties

Physical data

Hardened and tempered to 360 HB. Data at room and elevated temperatures.

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m^3 lbs/in^3	7 700 0.278	–	–
Modulus of elasticity MPa psi	215 000 31.2 x 10^6	210 000 30.4 x 10^6	195 000 28.3 x 10^6
Coefficient of thermal expansion /°C from 20°C /°F from 68°F	–	10.6 x 10^{-6} 5.9 x 10^{-6}	11.4 x 10^{-6} 6.3 x 10^{-6}
Thermal conductivity W/m °C Btu in/(ft^{2}h °F)	–	20 139	21 145
Specific heat J/kg °C Btu/lb, °F	460 0.110	–	

Mechanical data

TENSILE STRENGTH

All specimens have been taken from a bar with the dimension 508 x 306 mm (20" x 12"), hardness 360 HB.

Testing temperature	20°C (68°F)	200°C (390°F)
Tensile strength, R_m MPa	1 150	1 060
psi	163 800	153 700
Yield strength, $R_{p0.2}$ MPa	1 020	930
psi	147 900	134 800
Reduction of area, Z %	35	38
Elongation, A5 %	13	11

COMPRESSIVE STRENGTH

Compressive yield strength at room temperature $R_{c0.2}$, N/mm²	1 100
psi	159 500

Corrosion resistance

Moulds made from Uddeholm Mirrax 40 will have good resistance to rusting caused by humid working and storage conditions and when moulding corrosive plastics under normal production conditions.

Heat treatment

Uddeholm Mirrax 40 is intended for use in the as-delivered condition i.e. hardened and tempered to 360–400 HB.

When the steel is to be heat treated to higher hardness, instructions below are to be followed.

Soft annealing

Protect the steel and heat through to 780°C (1430°F). Cool at 10°C (50°F) per hour to 600°C (1110°F), then freely in air.

Stress relieving

After rough machining, the tool should be heated through to max. 550°C (1020°F), holding time 2 hours, then cool freely in air.

Hardening

Note: It is recommended to do soft annealing before hardening.
Preheating temperature: 500–600°C (930–1110°F).
Austenitizing temperature: 1000–1025°C (1830–1880°F) but usually 1020°C (1870°F).

The steel should be heated through to the austenitizing temperature and held at temperature for 30 minutes.

Protect the tool against decarburization and oxidation during the hardening process.

Quenching media

- Vacuum with sufficient positive pressure
- High speed gas/circulating atmosphere

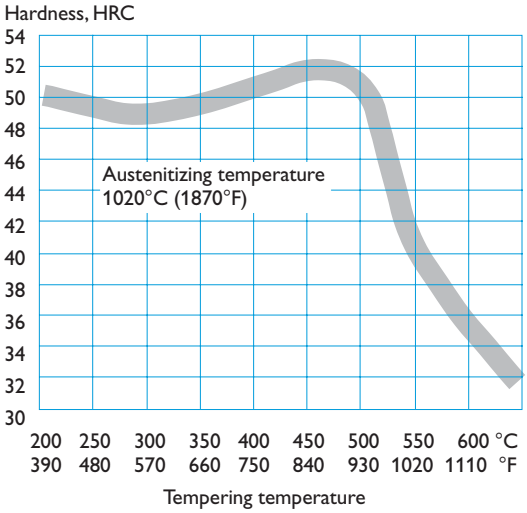
In order to obtain the optimum properties, the cooling rate should be as fast as possible within acceptable distortion limits. Temper the tool as soon as its temperature reaches 50–70°C (120–160°F).

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 hours.

TEMPERING GRAPH

The tempering curve is approximate.



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.

Machining recommendations

The cutting data below are to be considered as guidelines and may require adjustments based on equipment, selection of cutting tools, etc. More information can be found in the technical report "Cutting data recommendation".

The recommendations, in following tables, are valid for Uddeholm Mirrax 40 hardness approx. 380 HB.

Turning

Cutting data parameter	Turning with carbide		Turning with HSS
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) m/min f.p.m.	80–130 260–430	130–180 430–590	10–15 33–49
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 0.02–0.1
Carbide designation ISO US	P20–P30 C6–C5 Coated carbide	P10 C7 Coated carbide or cermet	– –

HSS = High Speed Steel

Milling

FACE AND SQUARE SHOULDER MILLING

Cutting data parameter	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min f.p.m.	80–120 260–390	120–150 390–490
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 inch	2–5 0.08–0.2	–2 0.02–0.08
Carbide designation ISO US	P20–P40 C6–C5 Coated carbide	P10–P20 C7–C6 Coated carbide or cermet

END MILLING

Cutting data parameter	Type of end mill		
	Solid carbide	Carbide indexable insert	HSS
Cutting speed (v_c) m/min f.p.m.	60–100 200–330	80–120 260–390	20–25[1] 66–82
Feed (f_z) mm/tooth in/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 US	– –	P15–P40 C6–C5	–

[1] For coated HSS end mill v_c = 25–30 m/min (82–98 f.p.m.)
[2] Depending on radial depth of cut and cutter diameter

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*	0.25–0.30	0.010–0.014

* For coated HSS drill v_c = 16–18 m/min (52–59 f.p.m.)

CARBIDE DRILL

Cutting data parameter	Type of drill		
	Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed, (v_c) m/min f.p.m.	100–120 330–390	80–100 260–333	70–80 230–260
Feed, (f) mm/r i.p.r.	0.05–0.25[2] 0.002–0.010[2]	0.10–0.25[3] 0.004–0.010[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")

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	Delivery condition
Face grinding straight wheel	A 46 HV
Face grinding segments	A 36 GV
Cylindrical grinding	A 60 KV
Internal grinding	A 60 JV
Profile grinding	A 120 JV

Welding

Good results when welding tool steel can be achieved if proper techniques are used. Precautions such as preheating, heat treatment, post weld heat treatment, joint preparation, selection of consumables, etc. are required.

For best result after polishing and photo-etching use consumables with a matching chemical composition to the mould steel.

Welding method	TIG
Working temperature	200–250°C (390–480°F)
Welding consumables	MIRRAX TIG-WELD
Hardness after welding	54–56 HRC
Heat treatment * after welding	Temper 560°C (1040°F), 2 h. Weld metal hardness after tempering 38–42 HRC.

* Post treatment is recommended to reduce the risk of cracking and to achieve an even hardness profile.

Small repairs can be made at room temperature.

LASER WELDING

For laser welding Uddeholm Stavax laser weld rods are available. See the information leaflet "Uddeholm Laser Welding Rods".

Further information is given in the Uddeholm brochure "Welding of Tool Steel" or nearest Uddeholm sales office.

Polishing

Uddeholm Mirrax 40 has a very good polishability in the hardened and tempered condition.

A slightly different technique, in comparison with other Uddeholm mould steel, should be used. The main principle is to use smaller steps at the fine-grinding/polishing stages and not to start polishing on too rough of a surface. It is also important to stop the polishing operation *immediately after* the last scratch from the former grit size has been removed.

More detailed information on polishing techniques is given in the brochure "Polishing of tool steel".

Photo-etching

Uddeholm Mirrax 40 has a very low inclusion content and a homogeneous microstructure. The high cleanliness level provides for good photo-etching/texturing characteristics.

The special photo-etching process that might be necessary because of Uddeholm Mirrax 40's good corrosion resistance is familiar to all the leading photo-etching companies.

Further information is given in the Uddeholm brochure "Photo-etching of tool steel".

Electrical-discharge machining

If spark-erosion, EDM, is performed in the as delivered condition, the tool should then be given an additional temper at approx. 550°C (1020°F). If the steel has been rehardened, the additional tempering temperature should be 25°C (50°F) lower than the last tempering temperature used. However, the best is to remove the affected layer completely by polishing or stoning.

Further information can be obtained from the Uddeholm brochure "EDM of tool steel".

Further information

Please contact your local Uddeholm office for further information on the selection, heat treatment and application of Uddeholm tool steel, including the publication "Steel for moulds".