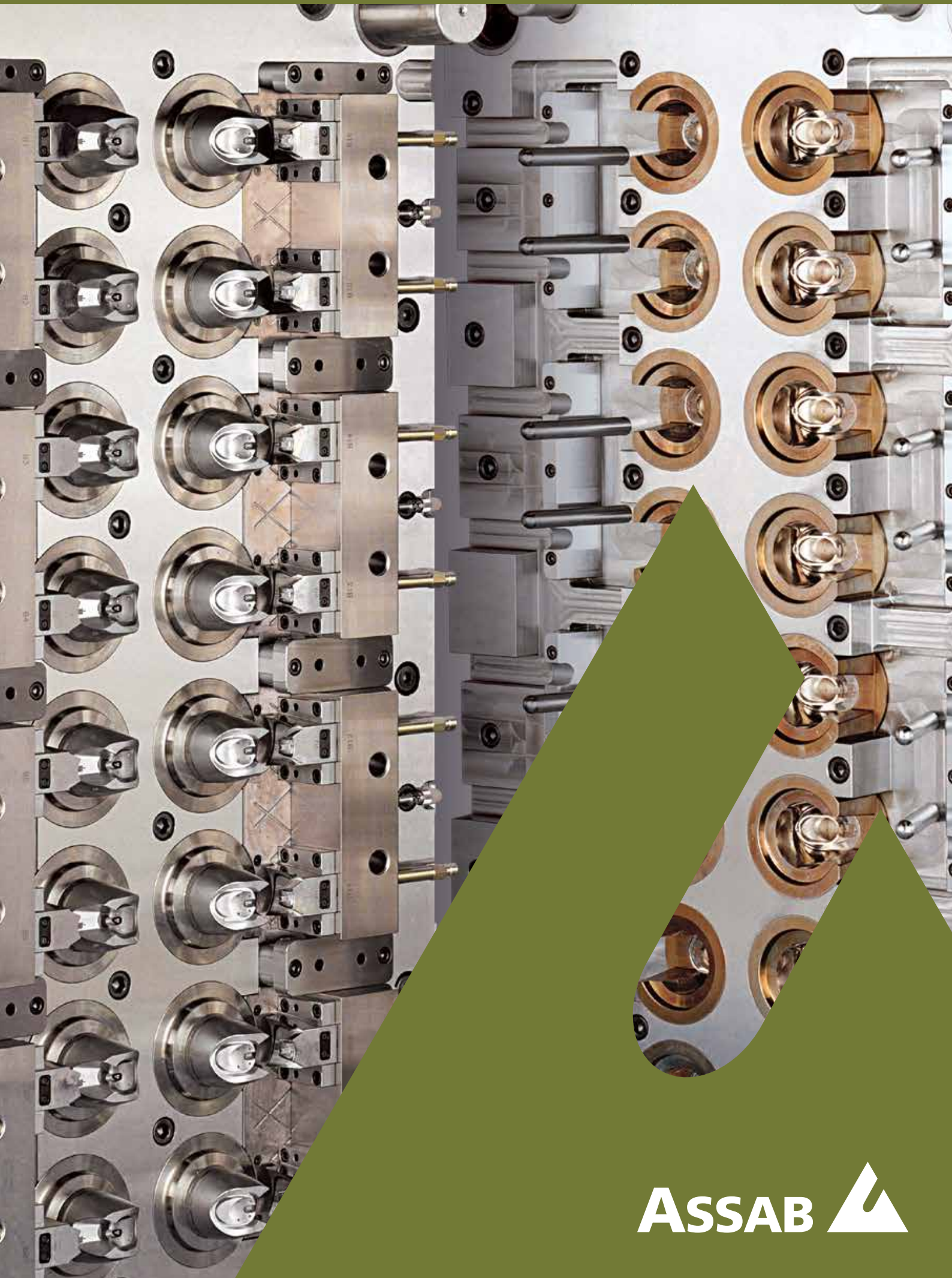
MIRRAX 40



ASSAB

ASSAB	UDDEHOLM	REFERENCE STANDARD		
		AISI	WNr.	JIS
ASSAB DF-2	ARNE	O1	(1.2510)	(SKS 3)
ASSAB DF-3		O1	(1.2510)	(SKS 3)
ASSAB XW-5	SVERKER 3	D6 (D3)	(1.2436)	(SKD 2)
ASSAB XW-10	RIGOR	A2	1.2363	SKD 12
ASSAB XW-41	SVERKER 21	D2	1.2379	SKD 11
ASSAB XW-42		D2	1.2379	SKD 11
CARMO	CARMO		1.2358	
CALMAX	CALMAX		1.2358	
CALDIE	CALDIE			
ASSAB 88	SLEIPNER			
ASSAB PM 23 SUPERCLEAN	VANADIS 23 SUPERCLEAN	(M3:2)	1.3395	SKH 53
ASSAB PM 30 SUPERCLEAN	VANADIS 30 SUPERCLEAN	(M3:2 + Co)	1.3294	SKH 40
ASSAB PM 60 SUPERCLEAN	VANADIS 60 SUPERCLEAN		(1.3292)	
VANADIS 4 EXTRA SUPERCLEAN	VANADIS 4 EXTRA SUPERCLEAN			
VANADIS 6 SUPERCLEAN	VANADIS 6 SUPERCLEAN			
VANADIS 10 SUPERCLEAN	VANADIS 10 SUPERCLEAN			
VANCRON 40 SUPERCLEAN	VANCRON 40 SUPERCLEAN			
ELMAX SUPERCLEAN	ELMAX SUPERCLEAN			
ASSAB 518		P20	1.2311	
ASSAB 618		P20 Mod.	1.2738	
ASSAB 618 HH		P20 Mod.	1.2738	
ASSAB 618 T		P20 Mod.	1.2738 Mod.	
ASSAB 718 SUPREME	IMPAX SUPREME	P20 Mod.	1.2738	
ASSAB 718 HH	IMPAX HH	P20 Mod.	1.2738	
NIMAX	NIMAX			
MIRRAX 40	MIRRAX 40	420 Mod.		
VIDAR 1 ESR	VIDAR 1 ESR	H11	1.2343	SKD 6
UNIMAX	UNIMAX			
CORRAX	CORRAX			
ASSAB 2083		420	1.2083	SUS 420J2
STAVAX ESR	STAVAX ESR	420 Mod.	1.2083 ESR	SUS 420J2
MIRRAX ESR	MIRRAX ESR	420 Mod.		
POLMAX	POLMAX			
RAMAX HH	RAMAX HH	420 F Mod.		
ROYALLOY	ROYALLOY			
PRODAX				
ASSAB PT18				
ASSAB MMXL				
ASSAB MM40				
ALVAR 14	ALVAR 14		1.2714	SKT 4
ASSAB 2714			1.2714	SKT 4
ASSAB 8407 2M	ORVAR 2M	H13	1.2344	SKD 61
ASSAB 8407 SUPREME	ORVAR SUPREME	H13 Premium	1.2344 ESR	SKD 61
DIEVAR	DIEVAR			
HOTVAR	HOTVAR			
QRO 90 SUPREME	QRO 90 SUPREME			
FORMVAR	FORMVAR			
ASSAB 705		4340	1.6582	SNCM8
ASSAB 709		4140	1.7225	SCM4
ASSAB 760		1050	1.1730	S50C

Edition 150216

General

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

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, Mirrax 40 is capable of being polished to a very high surface finish.

Mirrax 40 is characterised 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 summarised as follows:

- **Lower mould maintenance costs**
  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 steels), heat transfer characteristics, and therefore cooling efficiency, are constant throughout the mould life, ensuring consistent cycle times.

The benefits of the prehardened condition can be summarised as follows:

- No hardening risks.
- No hardening costs.
- Time saving (i.e., 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 minimise 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	Hardened and tempered to 360 - 400 HB							
Colour code	Orange / Green							

Applications

- Injection moulds for both 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 PROPERTIES

Hardened and tempered to 360 HB.

Temperature	20°C	200°C	400°C
Density kg/m³	7 700	–	–
Modulus of elasticity MPa	215 000	210 000	195 000
Coefficient of thermal expansion per °C from 20°C	–	10.6×10^{-6}	11.4×10^{-6}
Thermal conductivity W/m °C	–	20	21
Specific heat J/kg °C	460	–	

**Thermal conductivity is very difficult to measure. The scatter can be as high as ±15%*

MECHANICAL PROPERTIES

Tensile strength

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

Temperature	20°C	200°C
Tensile strength, R_m	1150 MPa	1060 MPa
Yield strength, $R_p0.2$	1020 MPa	930 MPa
Reduction of area, Z	35%	38%
Elongation, A_5	13%	11%

Compressive strength

Approximate compressive strength at room temperature.

Compressive yield strength, $R_c0.2$	1100 MPa

CORROSION RESISTANCE

Moulds made from 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

Mirrax 40 is intended for use in the as-delivered condition (i.e., prehardened to 360 - 400 HB).

In case a higher hardness is required, soft anneal and reharden according to the following recommendations.

SOFT ANNEALING

Protect the steel and heat through to 780°C.
Cool at 10°C per hour to 600°C, then freely in air.

STRESS RELIEVING

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

HARDENING

Direct rehardening of prehardened steel is normally not recommended. Prehardened steel should be fully soft annealed prior to rehardening.

Preheating temperature: 500 - 600°C

Austenitising temperature: 1000 - 1025°C, but normally 1020°C

Soaking time: 30 minutes

Soaking time = Time at austenitising temperature after the tool is fully heated through.

Protect the tool against decarburisation and oxidation during austenitising.

QUENCHING MEDIA

- Sufficient overpressure gas (e.g., N_2) quenching in vacuum furnace
- High-speed gas/circulating atmosphere
- Warm oil, approx. 80°C

In order to obtain optimum properties, the cooling rate should be as fast as possible within acceptable distortion limits. When heating in a vacuum furnace, a minimum of 4 - 5 bars overpressure is recommended.

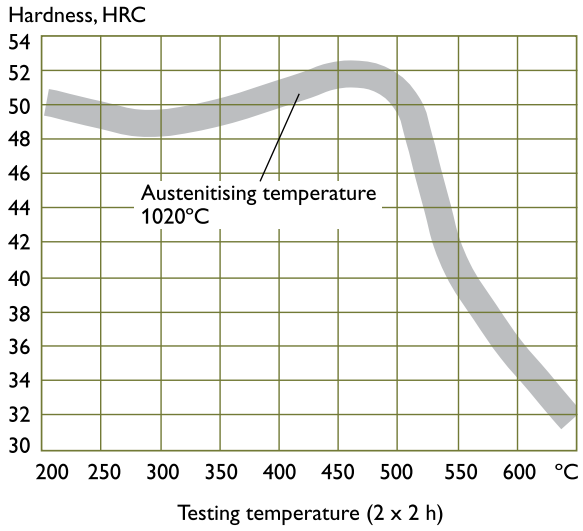
Note: Temper the tool as soon as its temperature reaches 50 - 70°C.

TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper at least twice with intermediate cooling to room temperature. The lowest tempering temperature which should be used is 250°C. The minimum holding time at temperature is 2 hours.

Tempering graph

The tempering curve is approximate.



Machining recommendations

The cutting data below are to be considered as guiding values and as starting points for developing your own best practice.

Condition: Prehardened condition ~380 HB

TURNING

Cutting data parameters	Turning with carbide		Turning with HSS†
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) m/min	80 - 130	130 - 180	10 - 15
Feed (f) mm/r	0.2 - 0.4	0.05 - 0.2	0.05 - 0.3
Depth of cut (a_p) mm	2 - 4	0.5 - 2	0.5 - 3
Carbide designation ISO	P20 - P30 Coated carbide	P10 Coated carbide or cermet	–

† *High-speed steel*

DRILLING

High-speed steel twist drill

Drill diameter mm	Cutting speed (v_c) m/min	Feed (f) mm/r
≤ 5	10 - 12*	0.05 - 0.15
5 - 10	10 - 12*	0.15 - 0.20
10 - 15	10 - 12*	0.20 - 0.25
15 - 20	10 - 12*	0.25 - 0.30

** For coated HSS drill, v_c = 16 - 18 m/min*

Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed (v_c) m/min	100 - 120	80 - 100	70 - 80
Feed (f) mm/r	0.05 - 0.25[2]	0.10 - 0.25[3]	0.15 - 0.25[4]

[1] Drill with replaceable or brazed carbide tip
[2] Feed rate for drill diameter 20 - 40mm
[3] Feed rate for drill diameter 5 - 20mm
[4] Feed rate for drill diameter 10 - 20mm

MILLING

Face and square shoulder milling

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min	80 - 120	120 - 150
Feed (f_z) mm/tooth	0.2 - 0.4	0.1 - 0.2
Depth of cut (a_p) mm	2 - 5	≤ 2
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	60 - 100	80 - 120	20 - 25[1]
Feed (f_z) mm/tooth	0.03 - 0.20[2]	0.08 - 0.20[2]	0.01 - 0.35[2]
Carbide designation ISO	–	P15 - P40	–

[1] For coated HSS end mill, v_c = 25 - 30 m/min
[2] Depending on radial depth of cut and cutter diameter

GRINDING

Wheel recommendation

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

Electrical discharge machining

If EDM is performed in the as-delivered condition, the surface layer is rehardened and consequently in a brittle state. This may result in cracking and shorten tool life. To avoid this problem, finish the EDM operation by "fine" sparking (i.e., low current, high frequency). The affected surface layer should be removed completely by polishing or stoning. As an added precautionary measure, the tool should then be retempered at max. 550°C. If EDM is performed in the rehardened condition, the tool should be retempered at approx. 25°C below the tempering temperature used following the rehardening process.

Welding

GAS TUNGSTEN ARC WELDING (GTAW) / TIG WELDING

There is a general tendency for tool steel to crack after welding. When welding is required, take proper precautions with regards to joint preparation, filler material selection, preheating, welding procedure and postweld heat treatment to ensure good welding results.

For best result after polishing and photo-etching, use the recommended filler materials as shown in the table below.

Welding method	TIG
Preheating temperature[1]	200 - 250°C
Filler material	STAVAX TIG-WELD
Maximum interpass temperature[2]	375°C
Postweld cooling	20 - 40°C/h for the first 2 hours, then freely in air < 70°C
Hardness after welding	54 - 56 HRC
Heat treatment after welding	
Temper at 560°C for 2 h	

[1] Preheating temperature must be established throughout the tool and must be maintained for the entire welding process, to prevent weld cracking. Minor repairs can be made at room temperature.

[2] The temperature of the tool in the weld area immediately before the second and subsequent pass of a multiple pass weld. When exceeded, there is a risk of distortion of the tool or soft zones around the weld.

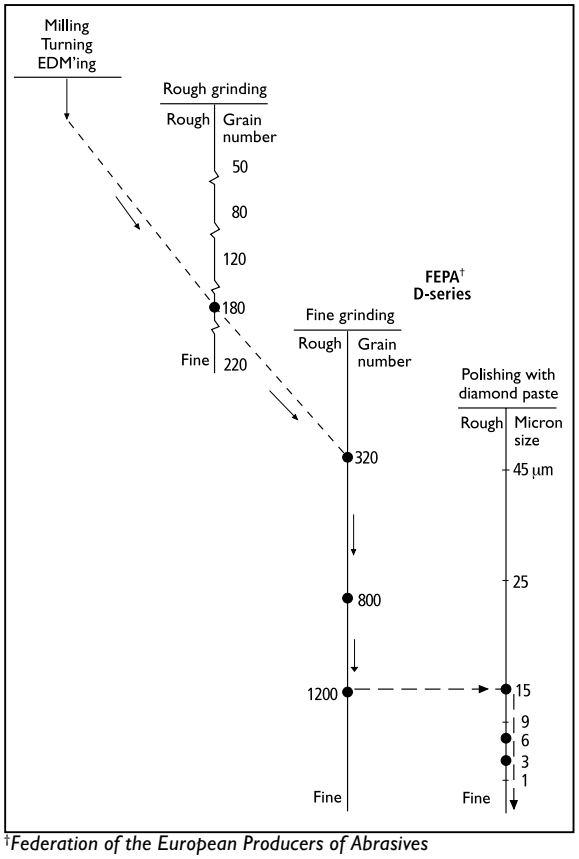
LASER WELDING

For laser welding, STAVAX LASER WELD rods are available. For further information, please contact our ASSAB office nearest to you.

Polishing

Mirrax 40 has a good polishability. A slightly different technique, in comparison with other ASSAB mould steels, should be used. The main principle is to use smaller steps at the fine grinding and polishing stages. It is important to grind to as fine a surface finish as possible (e.g., 15 µm or equivalent to FEPA† 1200) before starting the polishing operation. It is also important to stop the polishing operation immediately after the last scratch from the former grit size has been removed.

A typical polishing sequence is shown below. A change to a smaller grain size of the abrasive medium is not recommended when changing from "fine grinding" to "polishing with diamond paste".



†*Federation of the European Producers of Abrasives*

Photo-etching

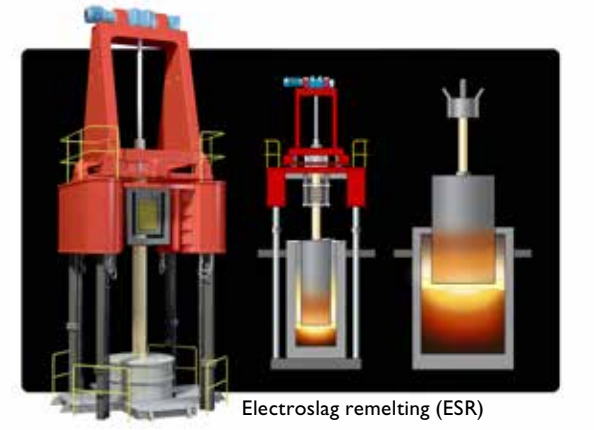
Mirrax 40 has a very low inclusion content and a homogeneous microstructure. The high cleanliness level provides for good photo-etching/texturing characteristics.

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

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 trapped into a ladle.

The deslagging unit removes oxygen-rich slag. Then deoxidation, alloying and heating of the steel bath are carried out in the ladle furance. Vacuum degassing removes elements such as hydrogen, nitrogen and sulphur.



Electroslag remelting (ESR)

ESR PLANT

In uphill casting, a controlled flow of molten steel from the ladle filled the prepared moulds and solidfies into ingots.

Subsequently, the steel can go directly to our rolling mill or to the forging press. Our premium steel grades go to our ESR furnace, where they are melted once again in an electroslag 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 macrosegregation. 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 bar materials are heat treated to either soft-annealed condition, or hardened and tempered condition.

MACHINING

Before putting into stock, flat-bar profiles are machined to the required size and exact tolerance. Whilst larger round dimensions are turned in lathe, where the steel bars rotate against a stationary cutting tool. Peeling is performed on smaller round dimensions via cutting tools that revolve around the bars for removal of surface defects.

To safeguard the quality and integrity of our tool steels, we perform surface inspection and ultrasonic testing on all bars. We then cut off and discard the bar ends and any defects that are found during inspection.

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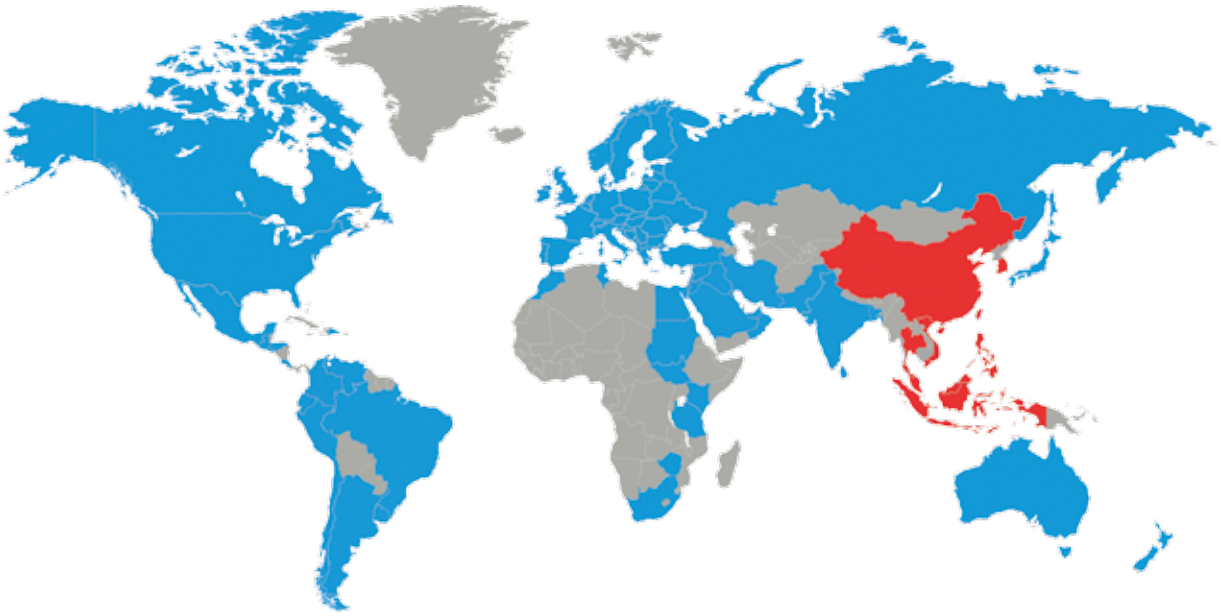

Choosing the right steel is of vital importance. ASSAB engineers and metallurgists are always ready to assist you in your choice of the optimum steel grade and the best treatment for each application. ASSAB not only supplies steel products with superior quality, we offer state-of-the-art machining, heat treatment and surface treatment services to enhance steel properties to meet your requirement in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

ASSAB and Uddeholm are present on every continent. This ensures you that high-quality tool steels and local support are available wherever you are. Together we secure our position as the world's leading supplier of tooling materials.

For more information, please visit www.assab.com

UDDEHOLM

ASSAB