STAVAX ESR

UDDEHOLM STAVAX ESR

ASSAB	UDDEHOLM a voestalpine company	REFERENCE STANDARD		
		AISI	WNr.	JIS
ASSAB XW-42	SVERKER 21	D2	1.2379	(SKD 11)
CALMAX / CARMO	CALMAX / CARMO		1.2358	
VIKING	VIKING / CHIPPER		(1.2631)	
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 8 SUPERCLEAN	VANADIS 8 SUPERCLEAN			
VANCRON SUPERCLEAN	VANCRON SUPERCLEAN			
ELMAX SUPERCLEAN	ELMAX SUPERCLEAN			
VANAX SUPERCLEAN	VANAX SUPERCLEAN			
ASSAB 618 / 618 HH		(P20)	1.2738	
ASSAB 718 SUPREME / 718 HH	IMPAX SUPREME / IMPAX HH	(P20)	1.2738	
NIMAX / NIMAX ESR	NIMAX / NIMAX ESR			
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)	(1.2083)	(SUS 420J2)
MIRRAX ESR	MIRRAX ESR	(420)		
MIRRAX 40	MIRRAX 40	(420)		
TYRAX ESR	TYRAX ESR			
POLMAX	POLMAX	(420)	(1.2083)	(SUS 420J2)
ROYALLOY	ROYALLOY	(420 F)		
COOLMOULD	COOLMOULD			
ASSAB 2714			1.2714	SKT 4
ASSAB 2344		H13	1.2344	SKD 61
ASSAB 8407 2M	ORVAR 2M	H13	1.2344	SKD 61
ASSAB 8407 SUPREME	ORVAR SUPREME	H13 Premium	1.2344	SKD 61
DIEVAR	DIEVAR			
QRO 90 SUPREME	QRO 90 SUPREME			
FORMVAR	FORMVAR			

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( ) - modified grade

Edition 20220921

STAVAX ESR

Stavax ESR is a premium stainless mould steel for small and medium inserts and cores. Stavax ESR combines corrosion and wear resistance with excellent polishability, good machinability and stability in hardening.

Mould maintenance requirement is reduced by assuring that core and cavity surfaces retain their original finish over extended operating periods. When compared with non stainless mould steel, Stavax ESR offers lower production costs by maintaining rust free cooling channels, assuring consistent cooling and cycle time.

This classic stainless tool steel is the right choice when rust in production is unacceptable and where requirements for good hygiene are high, as within the medical industry, optical industry and for other high quality transparent parts.

GENERAL

Stavax ESR is a premium grade stainless tool steel with the following properties:

- Good corrosion resistance
- Excellent polishability
- Good wear resistance
- Good machinability
- Good stability in hardening

The combination of these properties gives a steel with outstanding production performance. The practical benefits of good corrosion resistance in a plastics mould can be summarised as follows:

- LOWER MOULD MAINTENANCE COSTS

The surface of cavity impressions retain their original finish over extended running periods.
Moulds stored or operated in humid conditions require no special protection.

- LOWER PRODUCTION COSTS

Since water cooling channels are unaffected by corrosion (unlike conventional mould steel), heat transfer characteristics, and therefore cooling efficiency, are constant throughout the mould life, ensuring consistent cycle times.

These benefits, coupled with the high wear resistance of Stavax ESR, offer the moulder low-maintenance, long-life moulds for the greatest overall moulding economy.

Note: Stavax ESR is produced using the Electro-Slag-Refining (ESR) technique, resulting in a very low inclusion content.

Typical analysis %	C 0.38	Si 0.9	Mn 0.5	Cr 13.6	V 0.3
Standard specification	AISI 420 modified				
Delivery condition	Soft annealed		approx. 190 HB.		
	Pre-hardened		27-35 HRC		

APPLICATIONS

Stavax ESR is recommended for all types of moulding tools and its special properties make it particularly suitable for moulds with the following demands:

- CORROSION/STAINING RESISTANCE

i.e. for moulding of corrosive materials, e.g. PVC, acetates, and for moulds subjected to humid working/storage conditions.

- WEAR RESISTANCE

i.e. for moulding abrasive/filled materials, including injection-moulded thermosetting grades. Stavax ESR is recommended for moulds with long production runs, e.g. disposable cutlery and containers.

- HIGH SURFACE FINISH

i.e. for the production of optical parts, such as camera and sunglasses lenses, and for medical containers, e.g. syringes, analysis phials.

Type of mould	Recommended hardness HRC
Injection mould for:	
– thermoplastic materials	45 – 52
– thermosetting materials	45 – 52
Compression/transfer moulds	45 – 52
Blow moulds for PVC, PET, etc.	45 – 52
Extrusion, pultrusion dies	45 – 52

Stavax ESR core to make disposable polystyrene beakers. Millions of close tolerance mouldings with a very high surface finish have been produced.

PROPERTIES

PHYSICAL DATA

Hardened and tempered to 50 HRC. Data at room and elevated temperatures.

Temperature	20 °C	200 °C	400 °C
Density, kg/m³	7 800	7 750	7 700
Modulus of elasticity N/mm²	200 000	190 000	180 000
Coefficient of thermal expansion /°C from 20°C	-	11.0 x 10^{-6}	11.4 x 10^{-6}
Thermal conductivity* W/m °C	16	20	24
Specific heat J/kg °C	460	-	-

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

TENSILE STRENGTH (at room temperature)

The tensile strength values are to be considered as approximate only. All samples were taken from a bar (in the rolling direction) 25 mm diameter. Hardened in oil from 1025 ± 10 °C and tempered twice to the hardness indicated.

Hardness	50 HRC	45 HRC
Tensile strength N/mm²	1 780	1 420
Yield point Rp0.2 N/mm²	1 360	1 280

CORROSION RESISTANCE

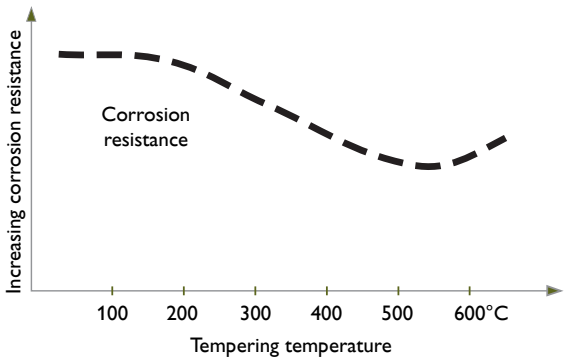
Stavax ESR is resistant to corrosive attack by water, water vapour, weak organic acids, dilute solutions of nitrates, carbonates and other salts.

A tool made from Stavax ESR will have good resistance to rusting and staining due to humid working and storage conditions and when moulding corrosive plastics under normal production conditions.

Note: Special protectants are not recommended during mould storage. Many protectants are chloride based and may attack the passive oxide film, resulting in pitting corrosion. Tools should be thoroughly cleaned and dried prior to storage.

Stavax ESR shows the best corrosion resistance when tempered at low temperature and polished to a mirror finish.

THE INFLUENCE OF TEMPERING TEMPERATURE ON CORROSION RESISTANCE



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 890 °C. Then cool in the furnace at 20 °C per hour to 850 °C, then at 10 °C per hour to 700 °C, then freely in air.

STRESS-RELIEVING

After rough machining the tool should be heated through to 650 °C, holding time 2 hours. Cool slowly to 500 °C, then freely in air.

HARDENING

Preheating temperature: 600 – 850 °C.
Austenitising temperature: 1000 – 1050 °C, but usually 1020 – 1030 °C.

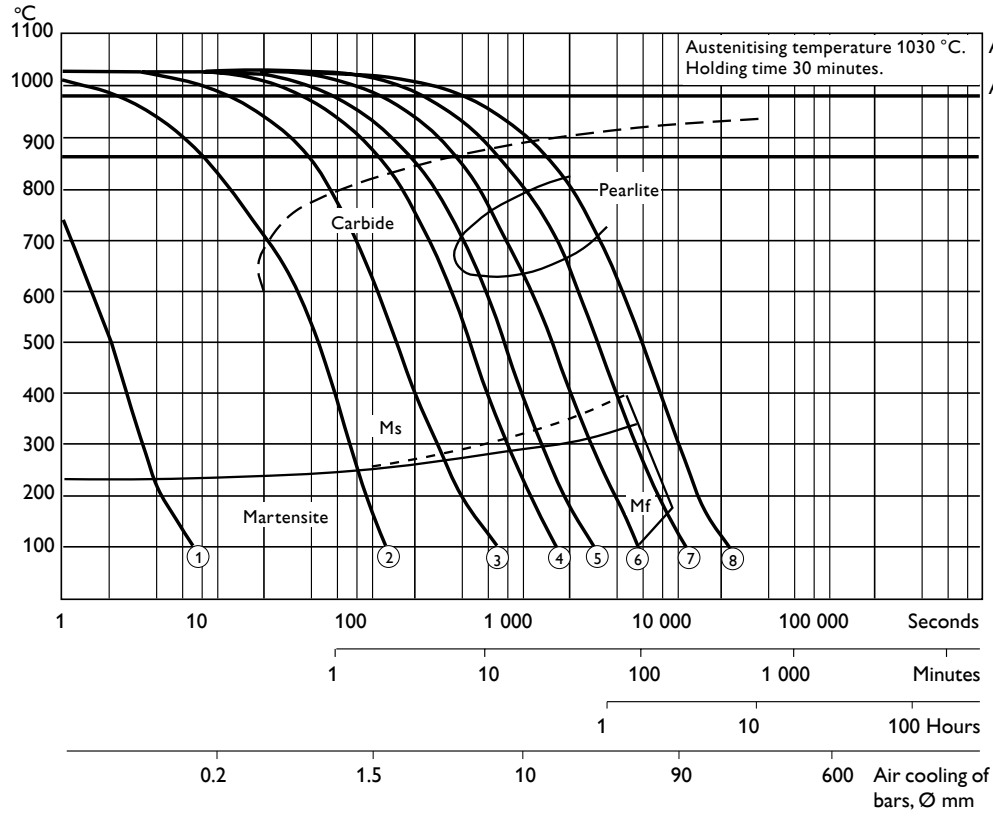
Temperature	Soaking time* minutes	Hardness before tempering
1020 °C	30	56±2 HRC
1050 °C	30	57±2 HRC

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

Protect the part against decarburisation and oxidation during hardening.

CCT-GRAPH

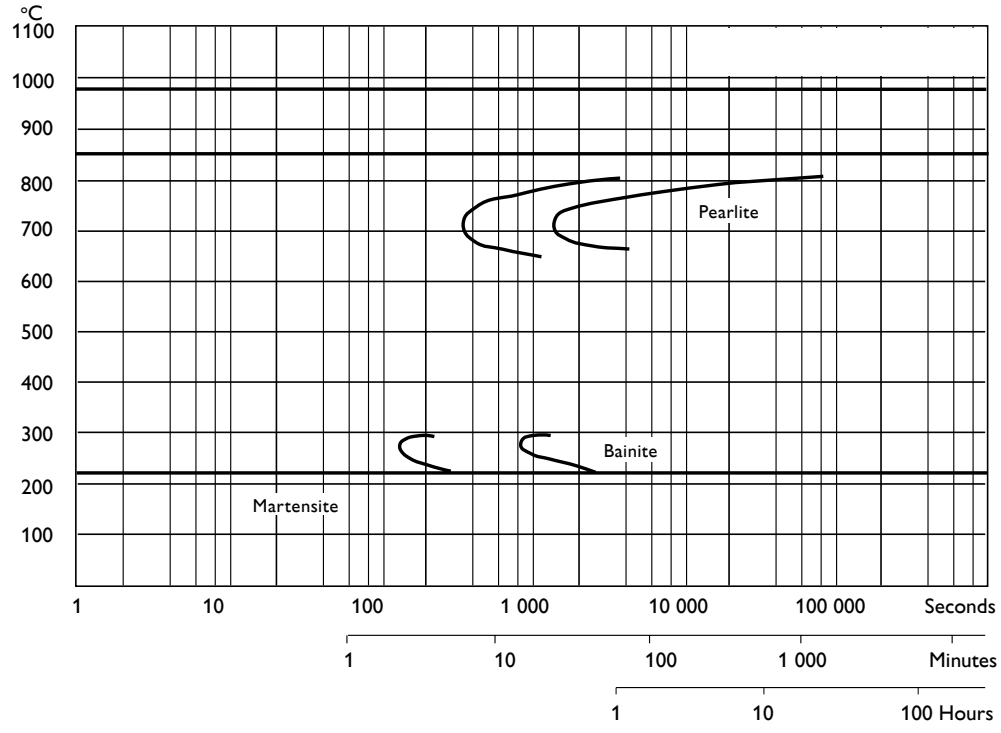
Austenitising temperature 1030 °C. Holding time 30 minutes.



Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	649	1
2	634	31
3	613	105
4	592	316
5	585	526
6	421	1 052
7	274	2 101
8	206	4 204

TTT- GRAPH

Austenitising temperature 1030 °C. Holding time 30 minutes.



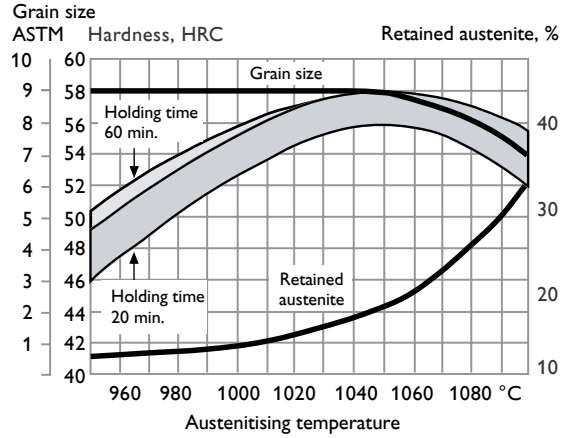
Temp. °C	Time hours	Hardness HV10
800	16.7	173
750	1.8	199
700	0.5	218
650	2.3	240
600	18.3	268
550	18.0	542
500	15.3	613
350	73.6	649
300	7.9	560
275	0.4	606
250	17.2	536

QUENCHING MEDIA

- Fluidised bed or salt bath at 250 – 550 °C, then cool in air blast
- Vacuum with sufficient positive pressure
- High speed gas/circulating atmosphere

In order to obtain optimum properties, the cooling rate should be as fast as is concomitant with acceptable distortion. When heat treating in a vacuum furnace, a 4 – 5 bar overpressure is recommended. Temper immediately when the tool reaches 50 – 70 °C.

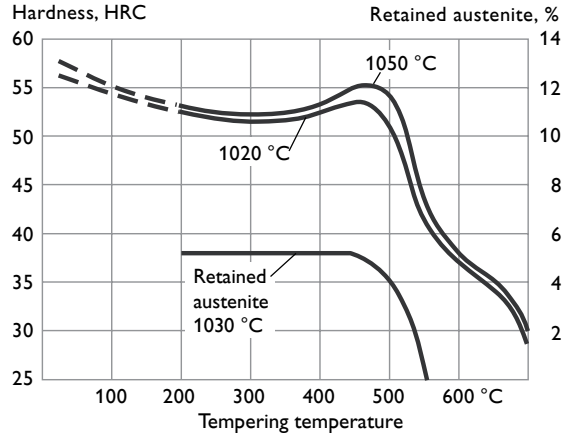
HARDNESS, GRAIN SIZE AND RETAINED AUSTENITE AS A FUNCTION OF THE AUSTENITISING TEMPERATURE



TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature.

TEMPERING GRAPH



The 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.

Lowest tempering temperature 250 °C. Holding time at temperature minimum 2 hours.

Note that:

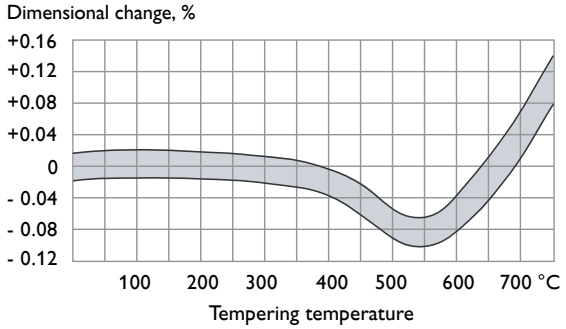
- Tempering at 250 °C is recommended for the best combination of toughness, hardness and corrosion resistance
- The curves are valid for small samples, achieved hardness depends on mould size
- A combination of high austenitising temperature and low tempering temperature < 250 °C gives a high stress level in the mould and should be avoided.

DIMENSIONAL CHANGES

The dimensional changes during hardening and tempering vary depending on temperatures, type of equipment and cooling media used during heat treatment.

The size and geometric shape of the tool is also of essential importance. Thus, the tool shall always be manufactured with enough working allowance to compensate for dimensional changes. Use 0.15% as a guideline for Stavax ESR provided that a stress relief is performed between rough and semi-finished machining as recommended.

DURING TEMPERING



DURING HARDENING

An example of dimensional changes on a plate, hardened under ideal conditions 100 x 100 x 25 mm is shown below.

Hardening from 1020°C		Width %	Length %	Thickness %
Martempered	Min.	+0.02	±0	-0.04
	Max.	-0.03	+0.03	-
Air hardened	Min.	-0.02	±0	±0
	Max.	+0.02	-0.03	-
Vacuum hardened	Min.	+0.01	±0	-0.04
	Max.	-0.02	+0.01	-

Note: Dimensional changes during hardening and tempering should be added together.

MACHINING RECOMMENDATIONS

The cutting data below, for machining material in soft annealing condition, are to be considered as guiding values which must be adapted to existing local conditions.

TURNING

Cutting data parameter	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (V_c) m/min	160 – 210	210 – 260	18 – 23
Feed (f) mm/rev	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	-

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (Vc) m/min	Feed (f) mm/rev
≤ 5	12 – 14 *	0.05 – 0.10
5 – 10	12 – 14 *	0.10 – 0.20
10 – 15	12 – 14 *	0.20 – 0.30
15 – 20	12 – 14 *	0.30 – 0.35

* For coated HSS drill v_c = 20 - 22 m/min.

CARBIDE DRILL

Cutting data parameter	Type of drill		
	Indexable insert	Solid carbide	Carbide tipped [1]
Cutting speed (V_c) m/min	210 – 230	80 – 100	70 – 80
Feed. (f) mm/rev	0.05 – 0.15 [2]	0.08 – 0.20 [3]	0.15 – 0.25 [4]

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

MILLING

FACE AND SQUARE SHOULDER FACE MILLING

Cutting data parameter	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (V_c) m/min	180 – 260	260 - 300
Feed (f) mm/tooth	0.2 – 0.4	0.1 – 0.2
Depth of cut (a_p) mm	2 – 4	0.5 - 2
Carbide designation ISO	P20 - P40 Coated carbide	P10 - P20 Coated carbide or cermet

END MILLING

Cutting data parameter	Type of end mill		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (V_c) m/min	120 – 150	170 – 230	25 - 30 [1]
Feed. (f) mm/tooth	0.01 – 0.2 [2]	0.06 – 0.2 [2]	0.01 – 0.30 [2]
Carbide designation ISO	–	P20 – P30	–

[1] For coated HSS end mill v_c = 45 – 50 m/min.
[2] Depending on radial depth of cut and cutter diameter

MACHINING RECOMMENDATIONS

The cutting data below for machining material with pre-hardened condition at approximately 310 HB are to be considered as guiding values which must be adapted to existing local conditions.

TURNING

Cutting data parameter	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (V_c) m/min	120 - 170	170 – 220	15 – 20
Feed (f) mm/rev	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	-

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (Vc) m/min	Feed (f) mm/rev
≤ 5	10 – 12 *	0.05 – 0.15
5 – 10	10 – 12 *	0.15 – 0.25
10 – 20	10 – 12 *	0.25 – 0.35
20 – 30	10 – 12 *	0.30 – 0.40
30 - 40	10 – 12 *	0.40 - 0.45

* For coated HSS drill v_c = 18 - 20 m/min.

CARBIDE DRILL

Cutting data parameter	Type of drill		
	Indexable insert	Solid carbide	Carbide tipped [1]
Cutting speed (V_c) m/min	160 – 180	60 – 80	50 – 70
Feed. (f) mm/rev	0.03 – 0.12 [2]	0.08 – 0.20 [3]	0.15 – 0.25 [4]

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

MILLING

FACE AND SQUARE SHOULDER FACE MILLING

Cutting data parameter	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (V_c) m/min	120-160	160-200
Feed (f) mm/tooth	0.2 – 0.4	0.1 – 0.2
Depth of cut (a_p) mm	2 – 4	≤2
Carbide designation ISO	P20 - P40 Coated carbide	P10 - P20 Coated carbide or cermet

END MILLING

Cutting data parameter	Type of end mill		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (V_c) m/min	80-120	90-130	15-20 [1]
Feed. (f) mm/tooth	0.006 – 0.04 [2]	0.06 – 0.12 [2]	0.01 – 0.09 [2]
Carbide designation ISO	–	P15 – P40	–

[1] For coated HSS end mill v_c = 45 – 50 m/min.
[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 "Grinding of tool steel" brochure.

Type of grinding	Wheel recommendation	
	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	A120 KV

WELDING

Good results when welding tool steel can be achieved if proper precautions are taken to elevated working temperature, joint preparation, choice of consumables and welding procedure.

For best result after polishing and photoetching use consumables.

Welding method	TIG
Working temperature	200 - 250 °C
Welding consumables	STAVAX TIG Weld
Hardness after welding	54 - 56 HRC
Heat treatment after welding: Hardened condition	Temper at 10 - 20 °C below the original tempering temperature.
Soft annealed condition	Heat through to 890 °C in protected atmosphere. Then cool in the furnace at 20 °C per hour to 850 °C, then at 10 °C per hour to 700 °C, then freely in air.

LASER WELDING

For laser welding Stavax laser weld rods are available.

PHOTO-ETCHING

Stavax ESR has a very low content of slag inclusions, making it suitable for photo-etching.

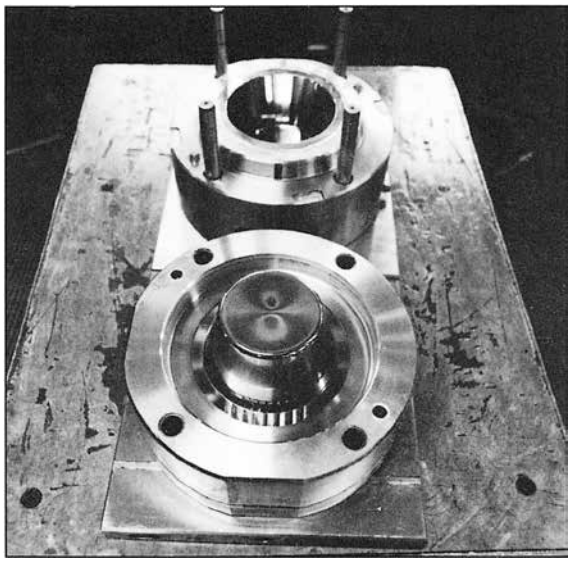
The special photo-etching process that might be necessary because of Stavax ESR's good corrosion resistance is familiar to all the leading photo-etching companies.

POLISHING

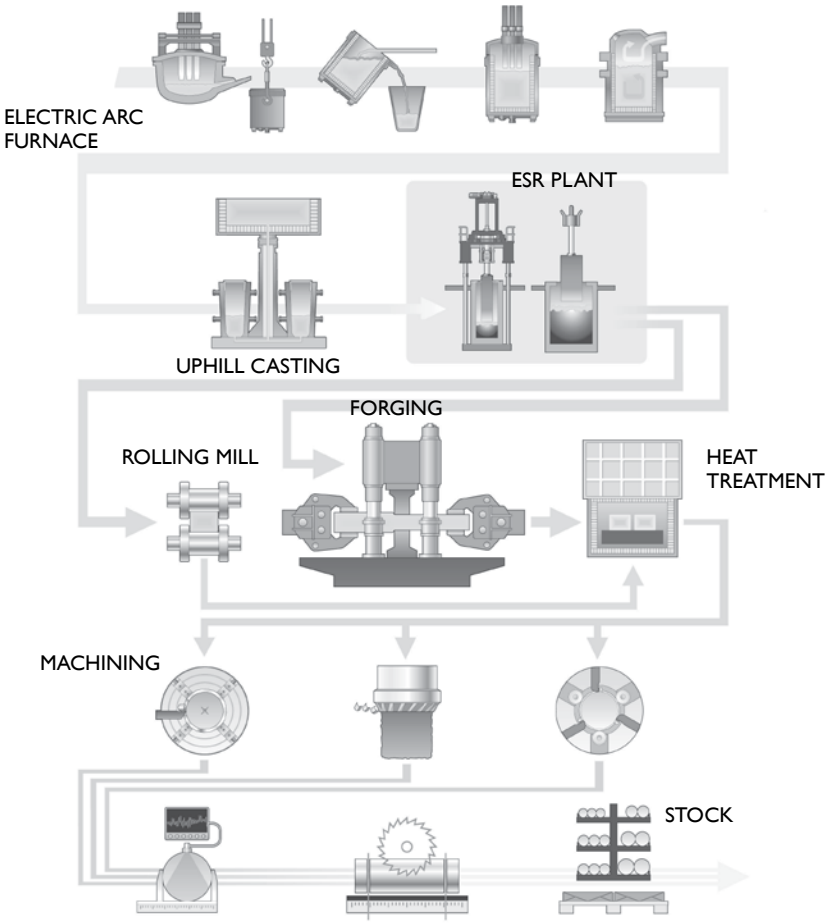
Stavax ESR has a very good polishability in the hardened and tempered condition. A slightly different technique, in comparison with other ASSAB mould steel, should be used. The main principle is to use smaller steps at the fine-grinding/polishing stages and not to start polishing on too rough a surface. It is also important to stop the polishing operation immediately the last scratch from the former grain size has been removed.

FURTHER INFORMATION

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



Mould in Stavax ESR for producing clear plastic bowls



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.

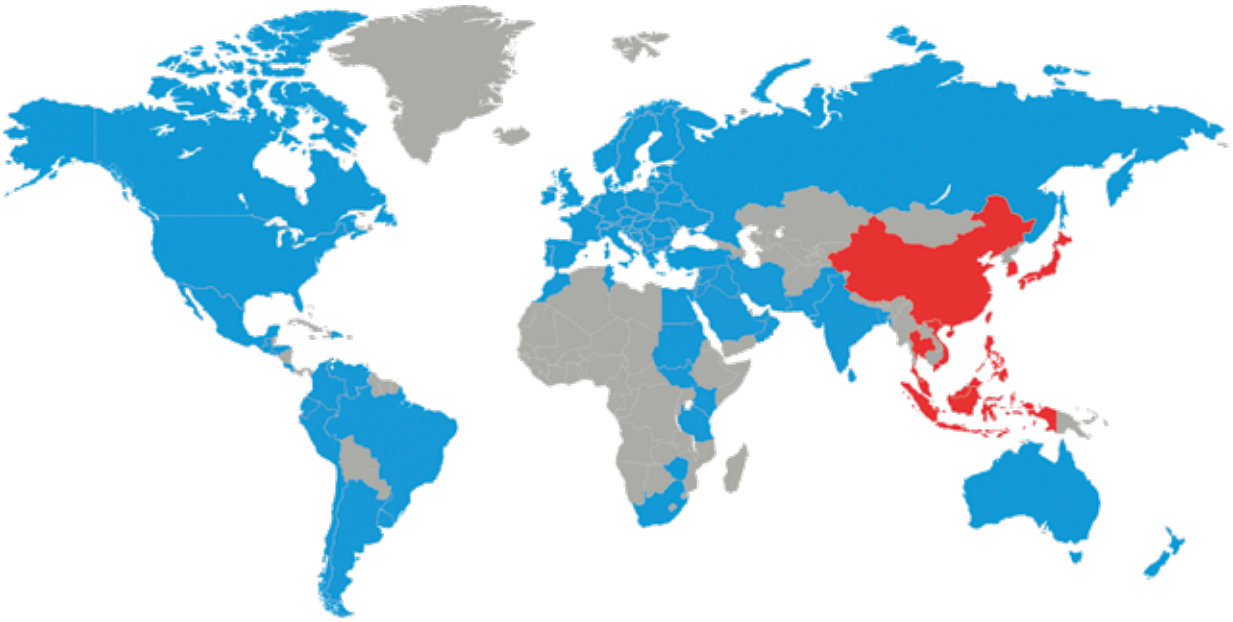
MACHINING

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.

ASSAB
SUPERIOR TOOLING SOLUTIONS
A ONE-STOP SHOP

ASSAB is unmatched as a one-stop product and service provider that offers superior tooling solutions. In addition to the supply of tool steel and other special steel, our range of comprehensive value-added services, such as machining, heat treatment and coating services, span the entire supply chain to ensure convenience, accountability and optimal usage of steel for customers. We are committed to achieving solutions for our customers, with a constant eye on time-to-market and total tooling economy.



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 most suitable treatment for each application. ASSAB not only supplies steel products with superior quality, but we also offer state-of-the-art machining, heat treatment, surface treatment services and additive manufacturing (3D printing) to enhance your tooling performance while meeting your requirements in the shortest lead time. Using a holistic approach as a one-stop solution provider, we are more than just another tool steel supplier.

In Asia Pacific, ASSAB anchors the distribution network for Uddeholm, a Swedish tool steel manufacturer with more than 350 years of experience in the tool steel industry. The two companies together service leading multinational companies (MNCs) in more than 90 countries.

For more information, please visit
www.assab.com

UDDEHOLM
a voestalpine company

ASSAB