UNIMAX

UDDEHOLM UNIMAX

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Unimax

The excellent properties offered enable Unimax to be used for many tooling applications. Reduced cycle time and longer tool life contributes to improve the overall economy. With an exceptional combination of high ductility and high hardness, Unimax is perfect when moulding plastic details and constructions that mean hard wear on the mould.

For the customers Unimax gives a lot of benefits:

- excellent for reinforced plastic details, suitable for long run production and compression moulding. The combination of high ductility and high hardness means improved durability and wear resistance
- longer tool life
- very good hardenability which results in the same good properties throughout the entire cross-section

The excellent combination of toughness and hardness also makes it a universal engineering grade.

As we say: The harder, the better!

GENERAL

Unimax is a ESR remelted chromium-molybdenum-vanadium alloyed tool steel which is characterised by:

- Excellent toughness and ductility in all directions
- Good wear resistance
- Good dimensional stability at heat treatment and in service
- Excellent through-hardening properties
- Good resistance to tempering back
- Good hot strength
- Good thermal fatigue resistance
- Excellent polishability

Typical analysis %	C 0.5	Si 0.2	Mn 0.5	Cr 5.0	Mo 2.3	V 0.5
Standard specification	None					
Delivery condition	Soft annealed to approx. 185 HB					

APPLICATIONS

Unimax is suitable for long run production moulds, moulds for reinforced plastics and compression moulding.

Unimax is a problem solver in severe cold work tooling applications such as heavy duty blanking, cold forging and thread rolling, where high chipping resistance is required.

Engineering and hot work applications requiring high hardness and toughness are also an option.

PROPERTIES

The properties below are representative of samples which have been taken from the centre of bars with dimensions 396 x 136 mm, Ø 125 mm and Ø 220 mm. Unless otherwise indicated all specimens have been hardened at 1025°C, gas quenched in a vacuum furnace and tempered twice at 525°C for two hours; yielding a working hardness of 56–58 HRC.

Physical Data

Hardened and tempered to 56–58 HRC

Temperature	20 °C	200 °C	400 °C
Density kg/m³	7 790	-	-
Modulus of elasticity MPa	213 000	192 000	180 000
Coefficient of thermal expansion /°C from 20 °C	-	11.5×10^{-6}	12.3×10^{-6}
Thermal conductivity W/m°C	-	25	28
Specific heat J/kg°C	460	-	-

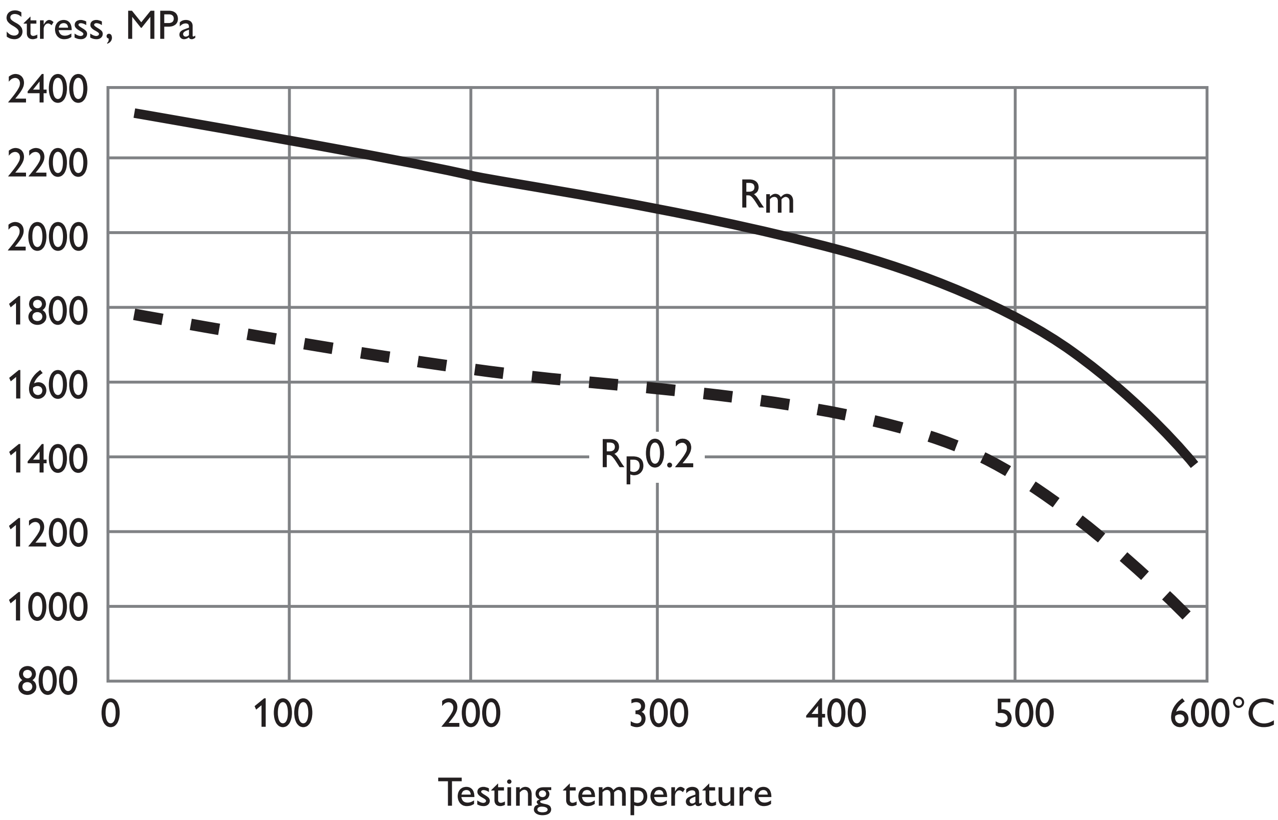
Mechanical properties

Approx. strength and ductility at room temperature at tensile testing.

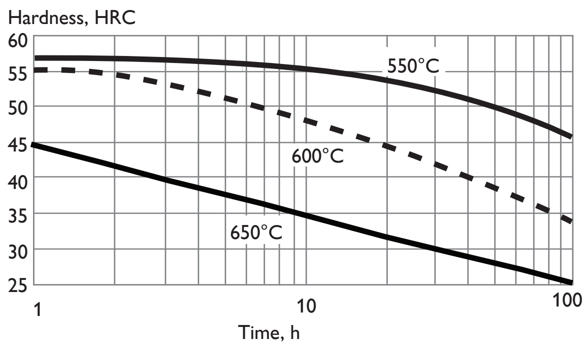
Hardness	54 HRC	56 HRC	58 HRC
Yield strength, $R_{p0.2}$ MPa	1 720	1 780	1 800
Tensile strength, R_m MPa	2 050	2 150	2 280
Elongation, A_5 %	9	8	8
Area contraction, Z %	40	32	28

Approximate Strength at Elevated Temperatures

Longitudinal direction. The specimens were hardened from 1025°C and tempered twice at 525°C to 58 HRC.

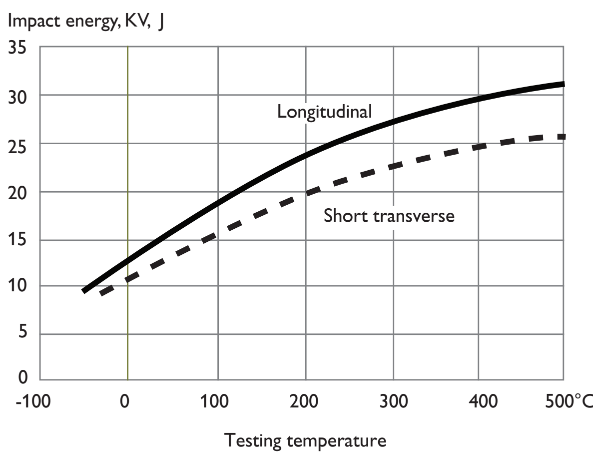


EFFECT OF TIME AT HIGH TEMPERATURES ON HARDNESS INITIAL HARDNESS 57 HRC



EFFECT OF TESTING TEMPERATURE ON IMPACT ENERGY

Charpy-V specimens, longitudinal and short transverse direction. Approximate values for specimens from Ø125 mm bar.



HEAT TREATMENT

Soft Annealing

Protect the steel and heat through to 850°C. Then cool in furnace at 10°C per hour to 600°C, then freely in air.

Stress Relieving 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: 600–650°C and 850–900°C.
Austenitising temperature: 1000–1025°C, normally 1025°C.
Holding time: 30 minutes

Temperature °C	Soaking time min	Hardness before tempering HRC
1 000	30	61

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

Protect the tool against decarburisation and oxidation during austenitising.

Quenching Media

- High speed gas/circulating atmosphere
- Vacuum furnace (high speed gas with sufficient overpressure)
- Martempering bath, salt bath or fluidised bed at 300-550°C

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

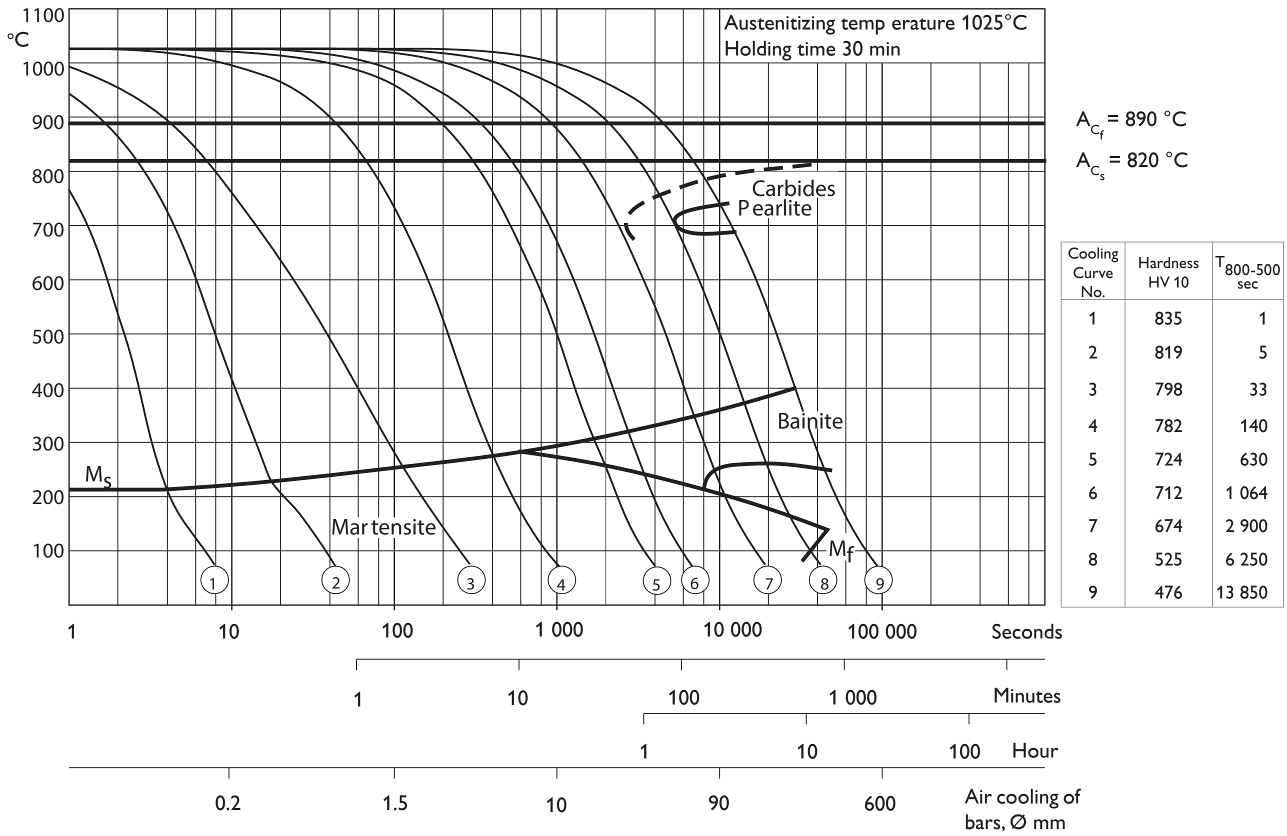
In order to obtain the optimum properties for the tool, the cooling rate should be as fast as possible with regards to acceptable distortion.

A slow quench rate will result in loss of hardness compared with the given tempering curves.

Martempering should be followed by forced air cooling if wall thickness is exceeding 50 mm.

CCT GRAPH

Austenitising temperature 1025°C. Holding time 30 minutes.



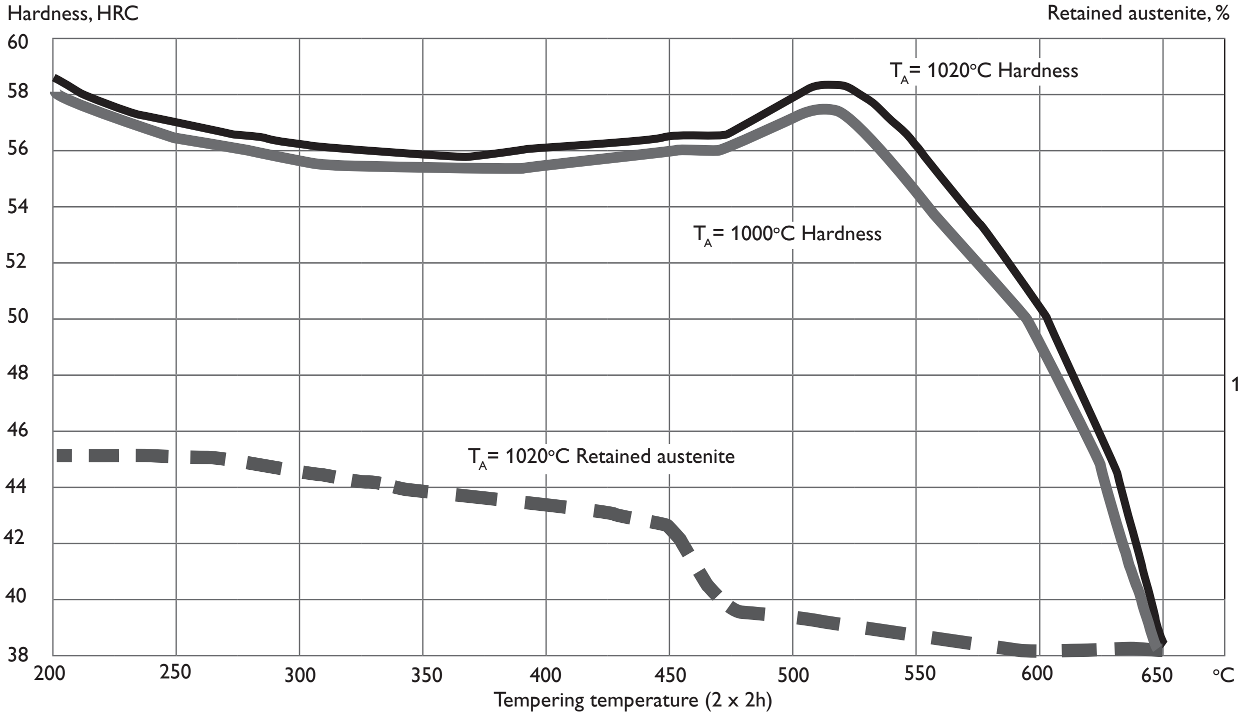
Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	835	1
2	819	5
3	798	33
4	782	140
5	724	630
6	712	1 064
7	674	2 900
8	525	6 250
9	476	13 850

TEMPERING

Choose the tempering temperature according to the hardness required by reference to the tempering graph below.

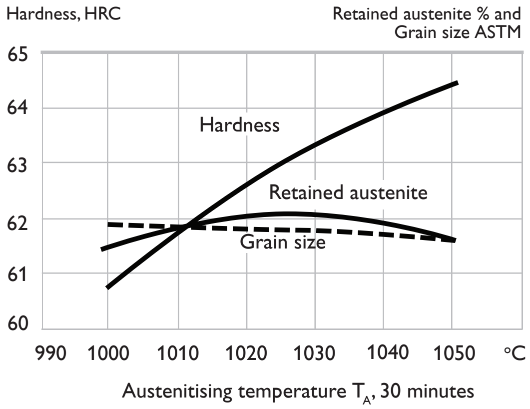
Temper at least twice with intermittent cooling to room temperature. High temperature tempering >525°C is recommended whenever possible.

TEMPERING GRAPH



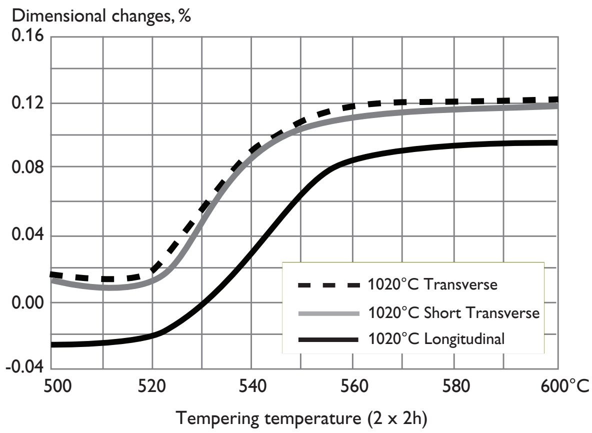
The tempering curves are obtained after heat treatment of samples with a size of 15 x 15 x 40mm, cooling in forced air. Lower hardness can be expected after heat treatment of tools and dies due to factors like actual tool size and heat treatment parameters.

HARDNESS, GRAIN SIZE AND RETAINED AUSTENITE AS FUNCTIONS OF AUSTENITISING TEMPERATURE



DIMENSIONAL CHANGES DURING HARDENING AND TEMPERING

The dimensional changes have been measured after austenitising at 1020°C/30 minutes followed by gas quenching in N_2 at a cooling rate of 1.1°C/sec. d between 800-500°C in a cold chamber vacuum furnace. Specimen size : 100 x 100 x 100 mm



SURFACE TREATMENT

Tool steel may be given a surface treatment in order to reduce friction and increase wear resistance. The most commonly used treatments are nitriding and surface coating with wear resistant layers produced via PVD or CVD.

The high hardness and toughness together with a good dimensional stability makes Unimax suitable as a substrate steel for various surface coatings.

NITRIDING AND NITROCARBURISING

Nitriding and nitrocarburising result in a hard surface layer which is very resistant to wear and galling.

The surface hardness after nitriding is approximately 1000-1200HV $_{0.2kg}$.

DEPTH OF NITRIDING

The thickness of the layer should be chosen to suit the application in question. Example of the depths and hardness that could be achieved after different kind of nitriding operations are shown in the table below.

Process	Time hr	Depth * mm	Hardness $HV_{0.2}$
Gas nitriding at 510°C	10	0.15	1180
	30	0.25	1180
Plasma nitriding at 480°C	10	0.15	1180
Nitrocarburising			
- in gas at 580°C	1.5 h	0.12	1130
- in salt bath at 580°C	1 h	0.08	1160

* Depth case = distance from surface where hardness is 50 $HV_{0.2}$ higher than matrix hardness.

PVD

Physical vapour deposition, PVD, is a method for applying wear-resistant surface coating at temperature between 200-500°C.

CVD

Chemical vapour deposition, CVD, is a method for applying wear-resistant surface coating at temperature of around 1000°C.

MACHINING RECOMMENDATIONS

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions.

Condition: Soft annealed condition ~185 HB

Turning

Cutting data parameter	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (V_c) m/min	150 – 200	200 – 250	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 - 2
Carbide designation ISO	P20 – P30	P10 Coated carbide	Coated carbide or cermet

Drilling

HIGH SPEED STEEL TWIST DRILL

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

* For coated HSS drill v_c = 35 – 40 m/min.

CARBIDE DRILL

Cutting data parameter	Type of drill		
	Indexable insert	Solid carbide	Carbide tipped[1]
Cutting speed (V_c) m/min	180 – 200	120 – 150	60 – 90
Feed. (f) mm/rev	0.03 – 0.10[2]	0.10 – 0.25[3]	0.15 – 0.25[4]

[1] Drill with internal cooling channels and brazed carbide tip
[2] Depending on drill diameter 20-40 mm
[3] Depending on drill diameter 5-20 mm
[4] Depending on drill diameter 10-20 mm

Milling

FACE AND SQUARE SHOULDER

Cutting data parameter	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (V_c) m/min	120 – 170	170 – 210
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 Coated carbide or cermet

END MILLING

Cutting data parameter	Type of milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (V_c) m/min	120 – 150	110 – 150	20 – 25 [1]
Feed. (f) mm/tooth	0.01 – 0.20 [2]	0.06 – 0.20 [2]	0.01 – 0.30 [2]
Carbide designation ISO	–	P20 – P30	–

[1] For coated HSS end mill v_c = 35 – 40 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.

WHEEL RECOMMENDATION

Type of grinding	Soft annealed condition	Hardened condition
Surface grinding straight wheel	A 46 HV	A 46 HV
Surface 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	A 120 KV

ELECTRICAL DISCHARGE MACHINING — EDM

Following the EDM process, the applicable die surfaces are covered with a resolidified layer (white layer) and a rehardened and untempered layer, both of which are very brittle and hence detrimental to die performance.

If EDM is used, the white layer must be completely removed mechanically by grinding or stoning. After finish-machining the tool should be given an additional temper at approximately 25°C below the highest previous tempering temperature.

WELDING

Welding of die components can be performed, with acceptable results, as long as the proper precautions are taken during the preparation of the joint, the filler material selection, the preheating of the die, the controlled cooling of the die and the post weld heat treatment processess. The following guidelines summarise the most important welding process parameters.

Welding method	TIG	MMA
Preheating temperature	200 - 250°C	200 - 250°C
Filler material	Unimax TIG-Weld UTP ADUR600 UTP A73G2	UTP 67S UTP 73G2
Max interpass temperature	350°C	350°C
Post weld cooling	20-40°C/h for the first two hours and then freely in air.	
Hardness after welding	54 - 60 HRC	55 - 58 HRC
Post weld heat treatment		
Hardened condition	Temper at 510°C for 2 hr.	
Soft annealed condition	Soft anneal according to the "Heat treatment recommendations".	

PHOTO ETCHING

Unimax 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

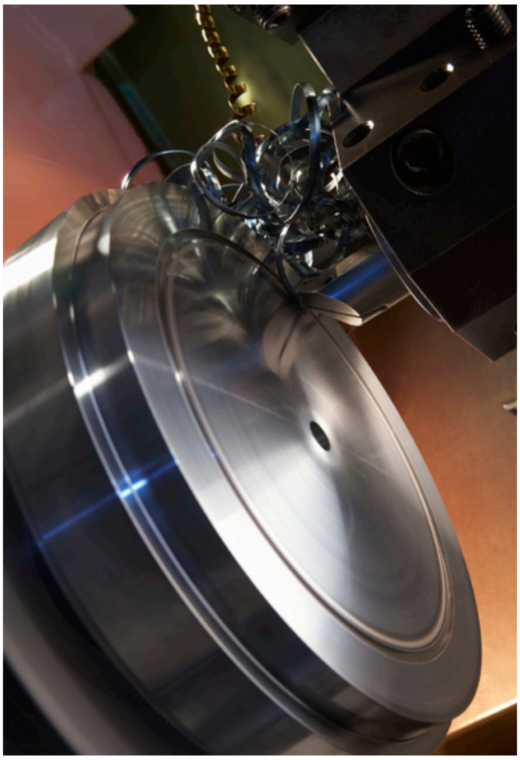
Unimax has good polishability in the hardened and tempered condition because of a very homogeneous structure. This coupled with a low level of non metallic inclusions, due to ESR process, ensures good surface finish after polishing.

Note: Each steel grade has an optimum polishing time which largely depends on hardness and polishing technique. Over-polishing can lead to a poor surface finish, "orange peel" or pitting.

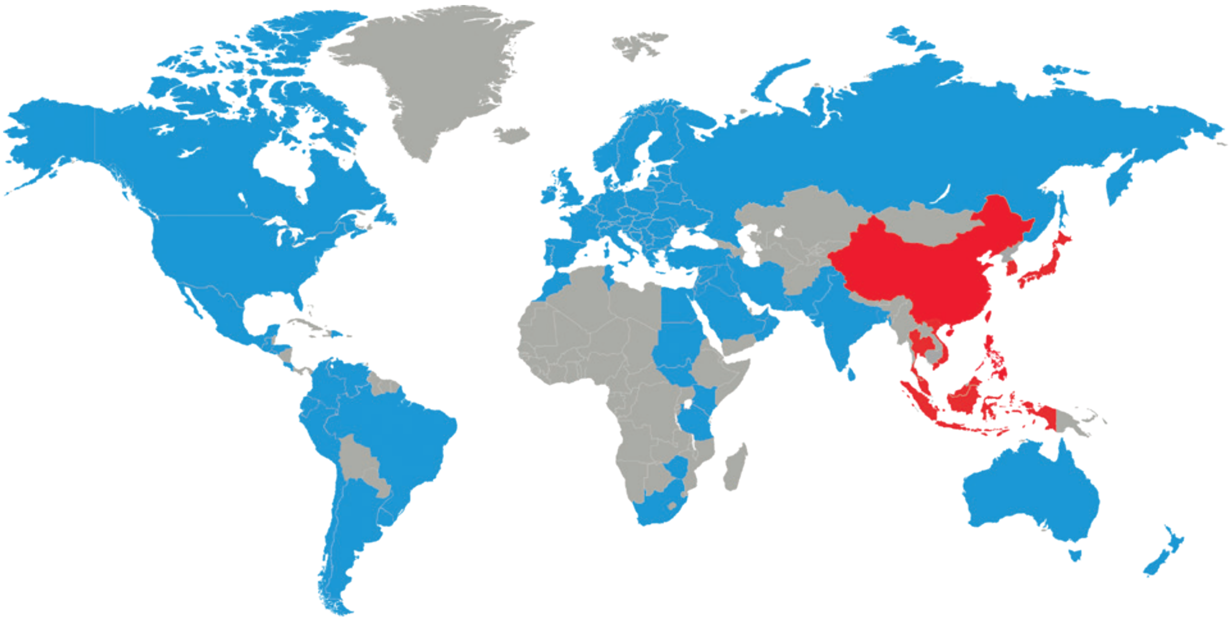
FURTHER INFORMATION

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

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 of 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. Both are integral parts of voestalpine AG, a prominent Austrian-based company listed on the Vienna Stock Exchange since 1995. Together, we establish ourselves as a key player in the steel and technology sector, with a diverse range of products and services.

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