VIKING

UDDEHOLM VIKING

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			

20220718

( ) - modified grade

Edition 20220718

GENERAL

Viking is an oil-air-vacuum hardening steel which is characterised by:

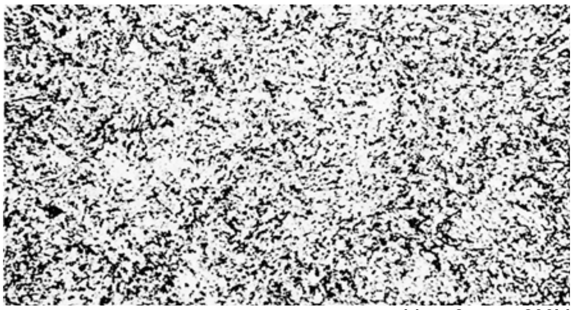
- Good dimensional stability during heat treatment
- Good machinability and grindability
- Excellent combination of toughness and wear resistance
- Normal hardness in the range 52-58 HRC
- Ideal for surface coating (CVD, PVD)

Typical analysis %	C 0.5	Si 1.0	Mn 0.5	Cr 8.0	Mo 1.5	V 0.5
Delivery condition	Soft annealed to approx. 225 HB					

STRUCTURE

The structure of Viking, hardened from 1010°C and tempered twice at 540°C, consists of carbides, tempered martensite, and approx. 1% retained austenite.

The photomicrograph below shows the typical heat treated microstructure through the cross section of a bar.



Magnification 800X

APPLICATIONS

Viking is a versatile, high alloyed tool steel characterised by the right combination of toughness and wear resistance required for heavy duty blanking and forming.

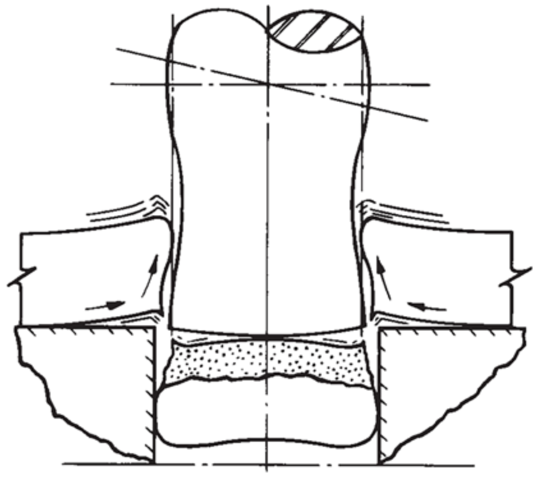
- Blanking and piercing of thick materials up to 25 mm.

Other applications:

- Fine blanking
- Shear blades
- Deep drawing
- Hot stamping
- Cold forging
- Swaging dies
- Rolls
- Cold extrusion dies with complicated geometry
- Tools for tube drawing

TOOL OPERATING CONDITIONS

The tool behaviour is influenced by a number of factors such as lubrication and cooling, rigidity of the tool set, characteristics of the working material (abrasive and adhesive wear), thickness of the working material, tool and part design, length of production runs and so on.



Exaggerated sketch of a typical punch and die in action

The chemical composition of Viking gives a hardness potential of 58 HRC with compressive strength and wear resistance accordingly. The small amount of primary carbides means a high chipping resistance and with 8% chromium follows a very good hardenability and also a fairly good resistance to corrosion.

PROPERTIES

PHYSICAL DATA

Hardened and tempered to 58 HRC. Data at room and elevated temperatures.

Temperature	20 °C	200 °C	400 °C
Density kg/m^3	7 750	7 700	7 650
Modulus of elasticity MPa	190 000	185 000	170 000
Coefficient of thermal expansion per °C from 20 °C	-	11.6 x 10^{-6}	11.3 x 10^{-6}
Thermal conductivity W/m °C	26.1	27.1	28.6
Specific heat J/kg °C	460	-	-

TENSILE STRENGTH

The tensile strength figures are to be considered as typical values only. All samples were taken in the rolling direction from a round bar 35 mm diameter. The samples have been hardened in oil from 1010 ± 10 °C and tempered twice to the hardness indicated.

	Hardness HRC		
	58	55	50
Tensile strength Rm N/mm^2	1 960	1 860	1 620
Yield point $Rp_{0.2}$ N/mm^2	1 715	1 620	1 470
Reduction of area, Z%	15	28	35
Elongation, A5%	6	7	8

COMPRESSIVE STRENGTH

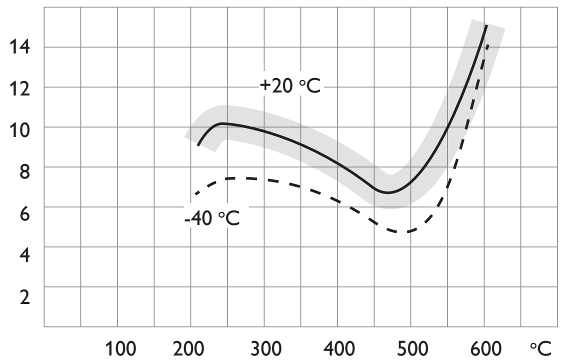
The sample have been taken out and heat treated in the same way as the samples when testing the tensile strength.

	Hardness HRC		
	58	55	50
Compressive strength, Rm, N/mm²	2 745	2 450	2 060
Compressive yield strength Rp0.2, N/mm²	2 110	2 060	1 715

IMPACT STRENGTH

Approx values. The samples have been taken out and heat treated in the same way as the samples when testing the tensile strength.

Charpy U, Joule



HEAT TREATMENT

SOFT ANNEALING

Protect the steel and heat through to 880 °C. Then cool in the furnace at 10 °C per hour to 650 °C, then freely in air.

STRESS RELIEVING

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

HARDENING

Preheating temperature: 600 – 700 °C.

Austenitising temperature: 980 – 1050 °C, but usually 1010 °C.

Temperature °C	Holding time * minutes	Hardness before tempering (approx) HRC
980	40	57
1010	30	60
1050	20	60

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

PROTECTION AGAINST DECARBURISATION

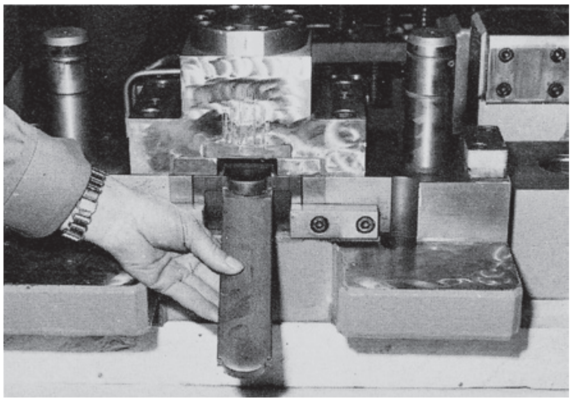
Protection against decarburisation and oxidation, while heating for hardening, is obtained by:

- heating in neutral saltbath
- packing in spent cast-iron chips, spent coke or paper
- protective atmosphere - endothermic gas
- vacuum

QUENCHING MEDIA

- Circulating air or atmosphere
- Air blast
- Martempering bath 200-550°C 1 - 120 minutes, then cool in air
- Oil

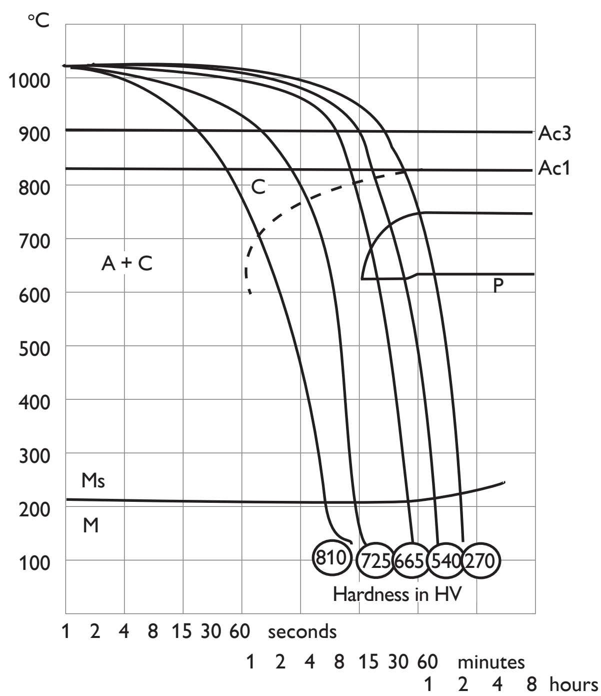
Note: Temper the tool as soon as its temperature reaches 50 – 70 °C.



Cold cropping tool made from Viking

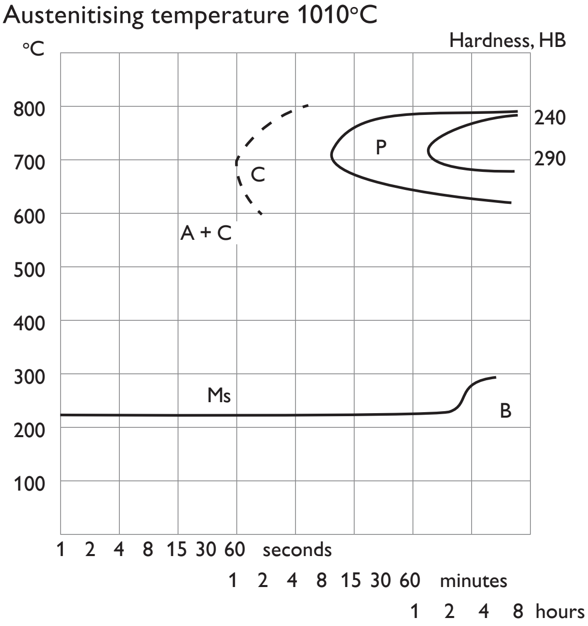
CCT GRAPH

Austenitising temperature 1010°C



TTT GRAPH

Austenitising temperature 1010°C

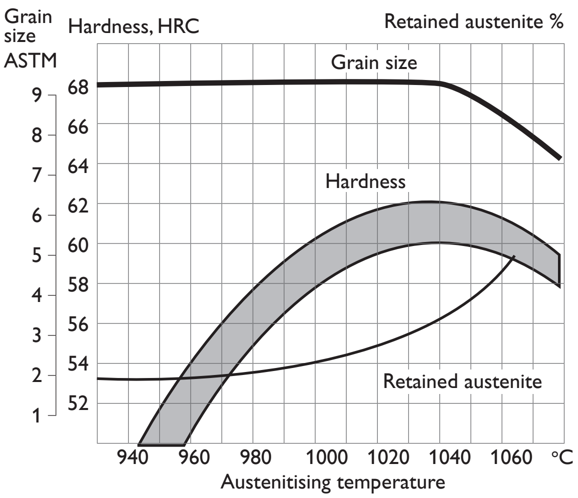


TRANSFORMATION TEMPERATURE

When heating 100°C per hour, austenite starts forming at approx. 800°C and ends at approx. 850°C.

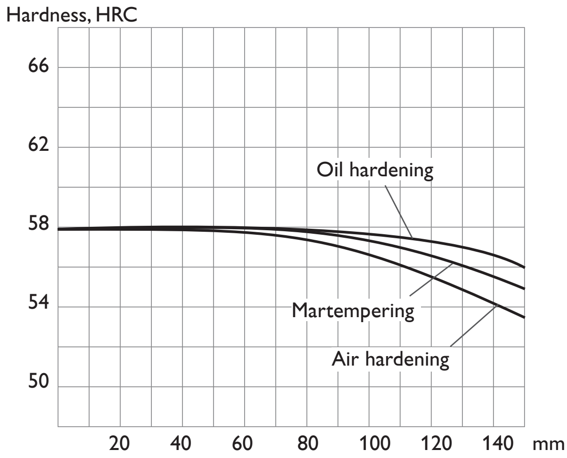
When cooling 100°C per hour, austenite starts transforming at approx 820°C and ends at approx. 750°C.

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



HARDENABILITY

Hardness as a function of section thickness. Tempering temperature 180°C.

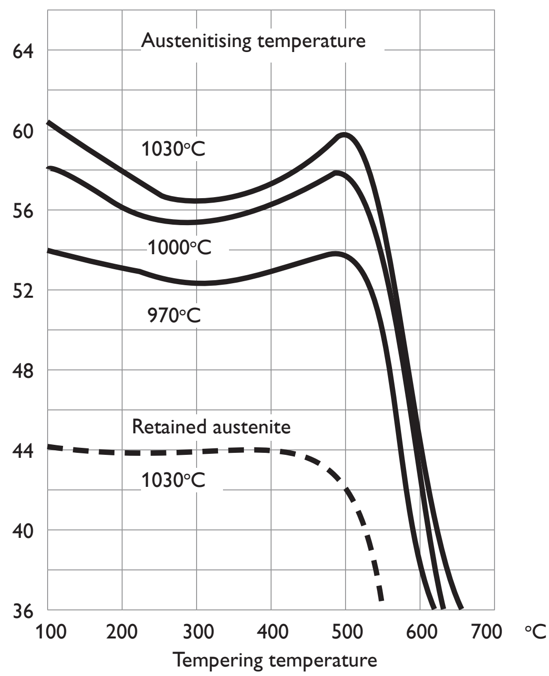


Viking hardens through in all common sizes.

TEMPERING

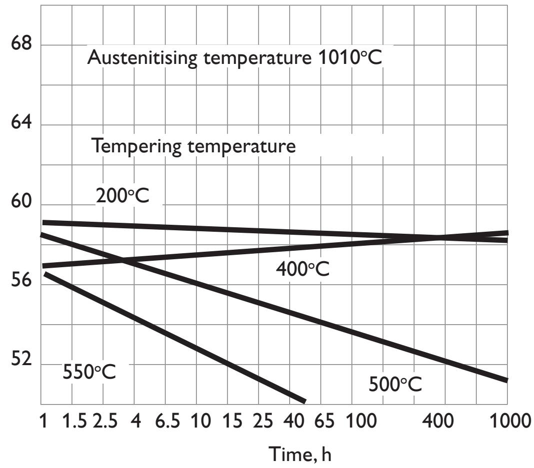
Heating to tempering temperature should be carried out slowly and uniformly. Tempering should be carried out twice. Lowest temperature 180°C. Holding time at temperature minimum 2 hours.

TEMPERING GRAPH



Above 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.

EFFECT OF TIME AT TEMPERING TEMPERATURE

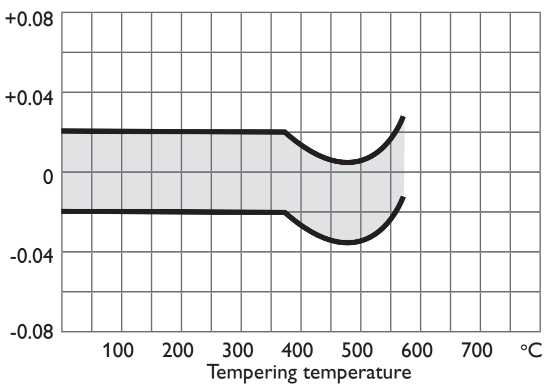


DIMENSIONAL CHANGES AFTER COOLING IN AIR

Sample plate: 100 x 100 x 25 mm

Austenitising temperature		Width %	Length %	Thickness %
970°C	Min	-0.01	-0.02	+0.04
	Max	+0.03	+0.04	+0.08
1000°C	Min	+0.02	+0.02	+0.04
	Max	+0.08	+0.09	+0.12
1030°C	Min	+0.01	+0.01	+0.04
	Max	+0.12	+0.10	+0.12

DIMENSIONAL CHANGES AFTER TEMPERING



Note: The dimensional changes in hardening and tempering should be added together.

FLAME AND INDUCTION HARDENING

Both flame and induction hardening methods can be applied to Viking.

In order to get a very uniform hardness after flame or induction hardening the steel can first be prehardened to approx . 35±2 HRC. After flame or induction hardening the steel should be tempered at least 180°C.

SURFACE TREATMENT

NITRIDING

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

The surface hardness after nitriding is approx. 1000-1200 $HV_{0.2kg}$. The thickness of the layer should be chosen to suit the application in question. For cold work applications a thickness of 10-50 µm is recommended and for hot work applications an increased case depth (up to 0.3 mm) might be appropriate.

PVD AND CVD

The good tempering resistance and dimensional stability during heat treatment means good possibilities for CVD and PVD coating of Viking, if 58 HRC is enough for the application.

Physical Vapour Deposition, PVD, is a method for applying a wear-resistant surface coating at temperatures between 200-500°C.

Chemical vapour deposition, CVD, is a method for applying a wear resistant surface coating at a 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.

TURNING

Cutting data parameters	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (v_C), m/min	160 – 210	210 – 260	20 – 25
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 cemet	–

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_C), m/min	140 – 230	230 – 270
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 cemet

END MILLING

Cutting data parameters	Type of milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_C), m/min	110 – 140	130 – 180	20 – 25 [1)]
Feed (f_z) mm/tooth	0.006–0.20 [2)]	0.06–0.20 [2)]	0.01 – 0.35 [2)]
Carbide designation ISO	–	P20 – P40 Coated carbide	–

1) For coated High Speed Steel end mill, v_C~ 40 – 45 m/min
2) Depending on the type of milling (side or slot) end cutter diameter

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (v_C) m/min	Feed (f) mm/r
≤5	15 – 17*	0.08 – 0.20
5 – 10	15 – 17*	0.20 – 0.30
10 – 15	15 – 17*	0.30 – 0.35
15 – 20	15 – 17*	0.35 – 0.40

CARBIDE DRILL

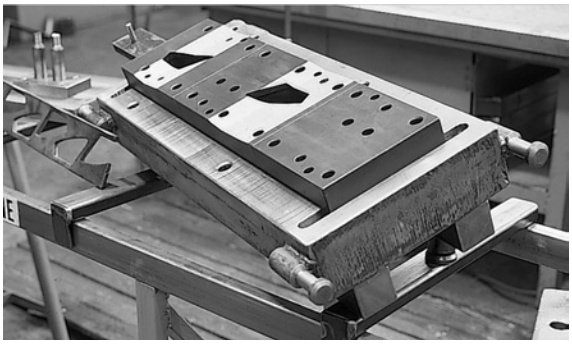
Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1)]
Cutting speed (v_C), m/min	200 – 220	110 – 140	70 – 90
Feed (f) mm/r	0.05 – 0.15 [2)]	0.10 – 0.25 [3)]	0.15 – 0.25 [4)]

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

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 KV	A 120 JV



Blanking tool set for producing a plate part

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 prcedure.

Viking can be welded. It is essential, however, to pre-heat the part concerned prior to welding to avoid cracking. An outline on how to proceed is given below:

1. Welding of soft annealed Viking
- Pre-heat to 300-400°C
- Weld at 300-400°C
- Immediately soft anneal after slowly cooling to approx. 70°C
- Harden and temper

2. Repair welding of Viking in hardened and tempered condition
- Pre-heat to the previously used tempering temperature, min 250°C, max 300°C
- Weld at this temperature. Do not weld below 200°C
- Cool in air to approx. 70°C
- Temper immediately at a temperature 10-20°C below the previous tempering temperature

Note: When welding soft annealed Viking, always use an electrode with the same analysis as the base material.

When welding Viking in the hardened condition use:

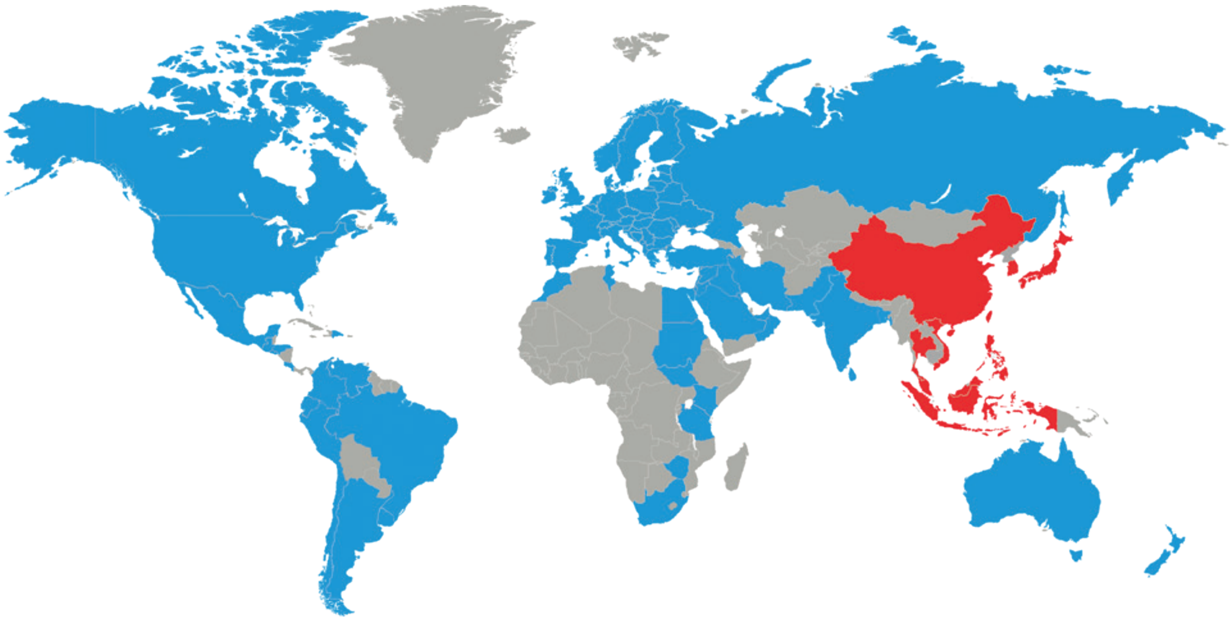
OK Selectrode 84.52, UTP 73G2 or UTP 67S for MMA-welding.

For TIG welding use UTP ADUR600, UTP A73G2 or Castolin Casto Tig 45303W.

The weld material will have approximately the same hardness as the base material.

ELECTRICAL DISCHARGE MACHINING (EDM)

If spark-erosion is performed in the hardened and tempered condition the tool should then be given an additional temper at approx. 25°C below the previous tempering temperature.



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 steel 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
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