SKOLVAR

UDDEHOLM SKOLVAR

ASSAB	UDDEHOLM a voestalpine company	REFERENCE STANDARD		
		AISI	WNr.	JIS
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			
MIRRAX 40	MIRRAX 40	(420)		
MIRRAX ESR	MIRRAX ESR	(420)		
STAVAX ESR	STAVAX ESR	(420)	(1.2083)	(SUS 420J2)
TYRAX ESR	TYRAX ESR			
VIDAR 1 ESR	VIDAR 1 ESR	H11	1.2343	SKD 6
UNIMAX	UNIMAX			
ROYALLOY	ROYALLOY	(420 F)		
POLMAX	POLMAX	(420)	(1.2083)	(SUS 420J2)
CORRAX	CORRAX			
ELMAX SUPERCLEAN	ELMAX SUPERCLEAN			
VANAX SUPERCLEAN	VANAX SUPERCLEAN			
ASSAB 2083		420	1.2083	SUS 420J2
COOLMOULD	COOLMOULD			
ASSAB 2714			1.2714	SKT 4
ASSAB 2344		H13	1.2344	SKD 61
DIEVAR	DIEVAR			
FORMVAR	FORMVAR			
VIDAR SUPERIOR	VIDAR SUPERIOR	(H11)	(1.2343)	(SKD 6)
ASSAB 8407 SUPREME	ORVAR SUPREME	H13 Premium	1.2344	SKD 61
ASSAB 8407 2M	ORVAR 2M	H13	1.2344	SKD 61
QRO 90 SUPREME	QRO 90 SUPREME			
SKOLVAR	SKOLVAR			
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			

20240223

( ) - modified grade

Edition 20240223

SKOLVAR

ASSAB offer a wide range of high-quality hot forming material for superior performance in a variety of applications. The unique forging grade Skolvar is designed to withstand extreme heat, pressure, and wear, making it ideal for the most demanding hot forming applications.

To improve the heat resistance of hot forming dies and reduce the risk for wear, manufacturers may use high-performance materials such as Skolvar. This material has excellent thermal stability and can withstand the high temperatures and load involved in the forming process.

GENERAL

Skolvar is an ESR-premium Cr-Mo-V-alloyed tool steel characterised by

- very good hot-wear resistance
- very good resistance to abrasive wear
- good ductility
- very good resistance to tempering back
- very good cleanliness
- possible to heat-treat to 50-61 HRC
- very good hardenability
- good machinability and grindability

Typical analysis %	C 0.7	Si 0.2	Mn 0.45	Cr 5.0	Mo 2.25	V 1.6
Standard specification	None					
Delivery condition	Soft annealed. Hardness ≤229 HB.					

APPLICATIONS

Skolvar is suitable for hot/press-forging and hot-stamping where hot wear is the predominant failure mechanism. Special applications in extrusion and e.g. "shot sleeves" in die-casting are other areas where Skolvar's excellent properties are favourable. The properties of Skolvar makes it also suitable for other applications such as cold work and components.

PROPERTIES

The physical and mechanical properties are representative of samples which have been taken from the centre of bars with dimension 300 x 150 mm. Unless otherwise indicated all specimens have been hardened at 1050°C gas quenched in a vacuum furnace and tempered three times at 560°C for two hours; yielding a working hardness of 56±1 HRC.

PHYSICAL DATA

Temperature	20 °C	500 °C	600 °C
Density, kg/m^3	7 760	7 630	7 600
Modulus of elasticity N/mm^2	208 000	171 000	154b000
Coefficient of thermal expansion /°C from 20°C	-	12.8 x 10^{-6}	13.2 x 10^{-6}
Thermal conductivity* W/m °C	27	29	29
Specific heat J/kg °C	478	641	737

MECHANICAL PROPERTIES

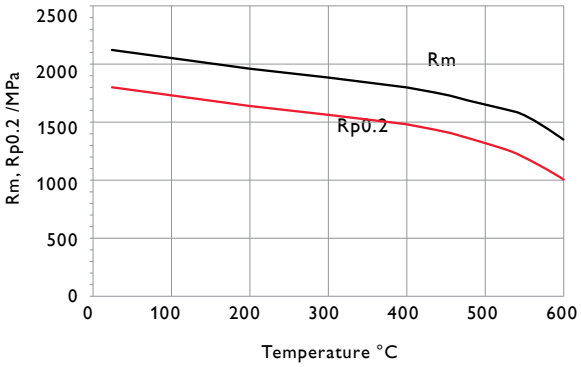
APPROXIMATE TENSILE STRENGTH AT ROOM TEMPERATURE

Hardness	51 HRC	56 HRC	59 HRC
Tensile strength, R_m MPa	1 750	2 110	2 350
Yield point Rp0.2 MPa	1 490	1 790	2 030
Elongation, A_5, %	7	4	2
Reduction of area Z, %	25	7	0

APPROXIMATE TENSILE PROPERTIES AT ELEVATED TEMPERATURE

Hardness 56±1 HRC

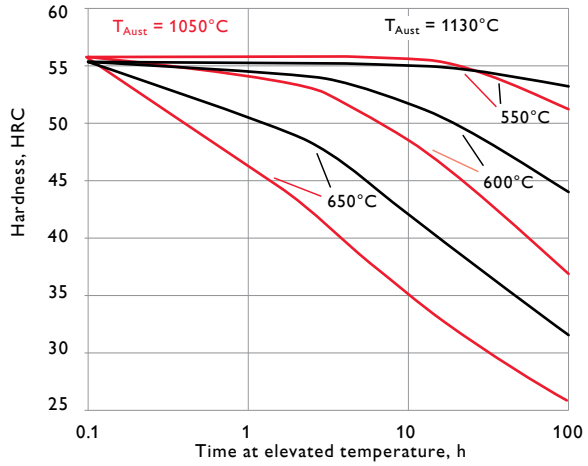
Austenitising temperature 1050°C, tempering temperature 560°C 3x2h.



EFFECT OF TIME AT HIGH TEMPERATURES ON HARDNESS

Hardness 56±1 HRC

Austenitising temperature 1050°C vs 1130 °C.



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

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.

HARDENIING

Preheating temperature: 600–650°C (1110–1200°F) and 850–900°C.

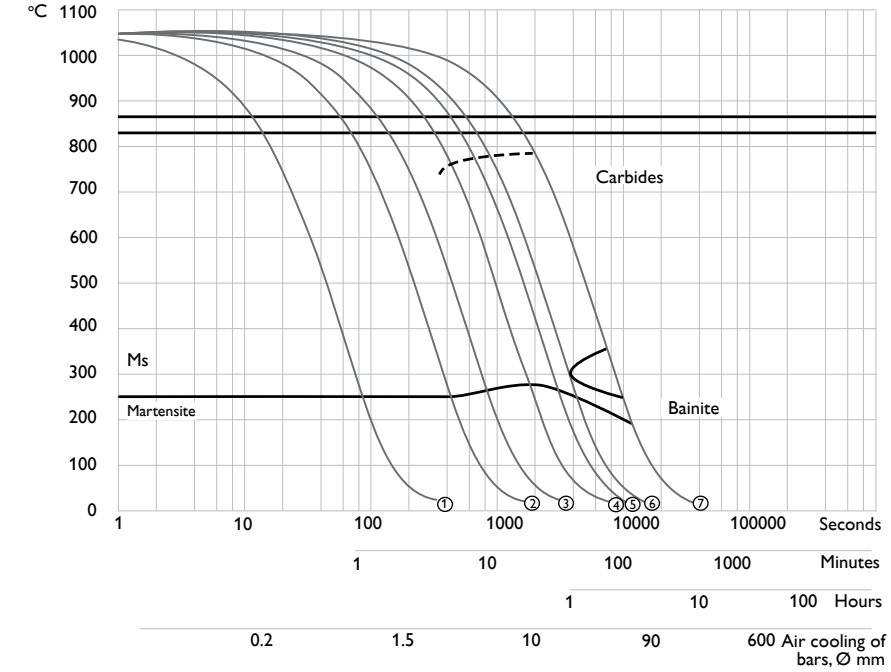
Austenitizing temperature: 1050–1150°C, normally 1050°C or 1130°C.

Holding time: 30 minutes (<1100°C) or 10 minutes (≥1100°C).

Protect the tool against decarburization and oxidation during austenitising.

CCT-GRAPH

Austenitising temperature 1050 °C. Holding time 30 minutes.



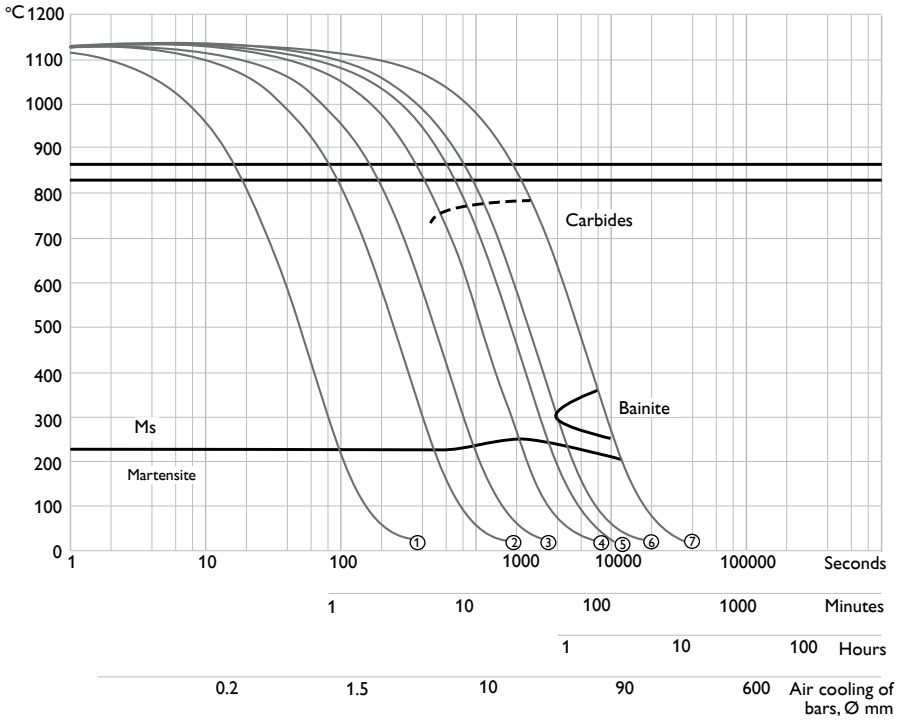
A_{C1f} = 865 °C

A_{C1s} = 830 °C

Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	782	28
2	781	140
3	755	280
4	718	630
5	711	1 030
6	726	1 390
7	606	3 205

CCT-GRAPH

Austenitising temperature 1130 °C. Holding time 30 minutes.



A_{C1f} = 865 °C

A_{C1s} = 830 °C

Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	806	28
2	812	140
3	804	280
4	800	630
5	764	1 030
6	750	1 390
7	638	3 205

QUENCHING

QUENCHING MEDIA

- High speed gas/circulating atmosphere
- Vacuum furnace (high speed gas with sufficient overpressure)

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

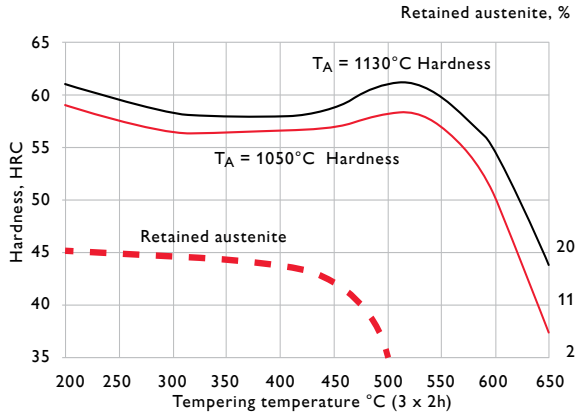
To obtain the optimum properties for the tool, the cooling rate should be as fast as possible with regards to acceptable distortion.

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

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.



DIMENSIONAL CHANGES DURING HARDENING AND TEMPERING

During hardening and tempering the tool is exposed to both thermal and transformation stresses. These stresses will result in distortion. Insufficient levels of machine stock may result in slower than recommended quench rates during heat treatment. To predict maximum levels of distortion with a proper quench, a stress relief is always recommended between rough and semifinished machining, prior to hardening. For a stress relieved Skolvar tool a minimum machining stock of 0.3% is recommended to account for acceptable levels of distortion during a heat treatment with a rapid quench.

MACHINING RECOMMENDATIONS

SOFT ANNEALED CONDITION

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 Fine turning
	Rough turning	Fine turning	
Cutting speed (v_c), m/min	130 – 180	180 – 230	15 - 20
Feed (f) mm/rev	0.2 – 0.4	0.5 – 2	0.05 -0.3
Depth of cut (a_p) mm	2 – 4	0.5 – 2	0.5 - 3
Carbide designation ISO	K20 - P20 Coated carbide	K15-P15 Coated carbide or cermet	-

DRILLING

HIGH SPEED STEEL TWIST DRILL

Drill diameter mm	Cutting speed (v_c) m/min	Feed (f) mm/r
≤ 5	12 – 16 *	0.05 – 0.15
5 – 10	12 – 16 *	0.15 – 0.20
10 – 15	12 – 16 *	0.20 – 0.25
15 – 20	12 – 16 *	0.25 – 0.35

* For coated HSS drill v_c = 22 - 24 m/min.

CARBIDE DRILL

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip [1]
Cutting speed (v_c), m/min	150 – 200	80 – 120	60 – 90
Feed (f) mm/r	0.03 – 0.10 [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

MILLING

FACE AND SQUARE SHOULDER MILLING

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c), m/min	30 – 50	50 – 70
Feed (f_z) mm/tooth	0.05 – 0.1	0.05 – 0.1
Depth of cut (a_p) mm	0.5 – 1.0	0.1 - 0.5
Carbide designation ISO	P10 – P20 Coated carbide	P10 - P20 Coated carbide or cermet

END MILLING

Cutting data parameters	Type of milling	
	Solid carbide	Carbide indexable insert
Cutting speed (v_c), m/min	60 – 80	40 – 90
Feed (f_z) mm/tooth	0.01 – 0.10 [1)]	0.05 – 0.15 [1)]
Carbide designation ISO	–	P10-20

[1)] 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 publication "Grinding of tool steel".

Type of grinding	Hardened
Face grinding straight wheel	A 46 HV
Face grinding segments	A 36 GV
Cylindrical grinding	A 60 KV
Internal grinding	A 60 IV
Profile grinding	A 120 JV

SURFACE TREATMENT

Tool steel may be given a surface treatment to reduce friction and increase wear resistance. The most used treatments are nitriding and surface coating (PVD or CVD). Skolvar is suitable as a substrate steel for various surface coatings.

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. The maximum surface hardness after nitriding is approximately 1100–1320 $HV_{0.2}$

Process	Time (hr)	Depth* (mm)	Hardness ($HV_{0.2}$)
Gas nitriding at 520°C	10	0.10	~1170
at 550°C	25	0.16	~1300
Nitrocarburising in gas at 570°C	1	0.12	~1200

* Depth of 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 temperatures between 200–500°C.

CVD

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

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 approx. 25°C below the highest previous tempering temperature.

WELDING

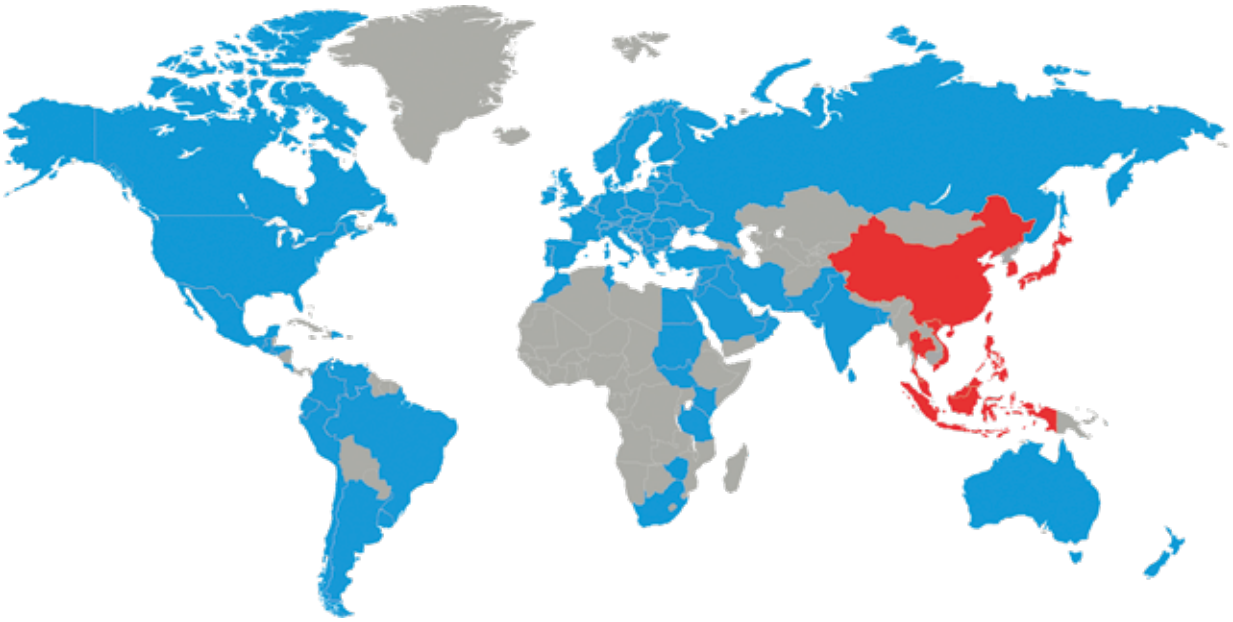
Welding of die components can be performed with acceptable results, if the proper precautions are taken during the preparation of the joint, the filler material selection, the pre-heating of the tool, the controlled cooling of the tool and the post weld heat-treatment processes.

The following guidelines summarize the most important welding process parameters.

Welding method	TIG	MMA
Preheating temperature*	330 °C ± 25 °C	330 °C ± 25 °C
Filler material	UTP A696 QRO 90TIG Caldie TIGWeld	UTP 690
Maximum interpass temperature	500 °C	500 °C
Post welding cooling	20 - 40 °C/h for the first 2 hours and then freely in air <70°C	
Hardness after welding	54 - 62 HRC	54 - 62 HRC
Heat treatment after welding		
Hardened condition	Temper 25°C for 2 hr below previous tmpering temperature.	
Soft annealed condition	Soft anneal according to the "heat treatment recommendations"	

FURTHER INFORMATION

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



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

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