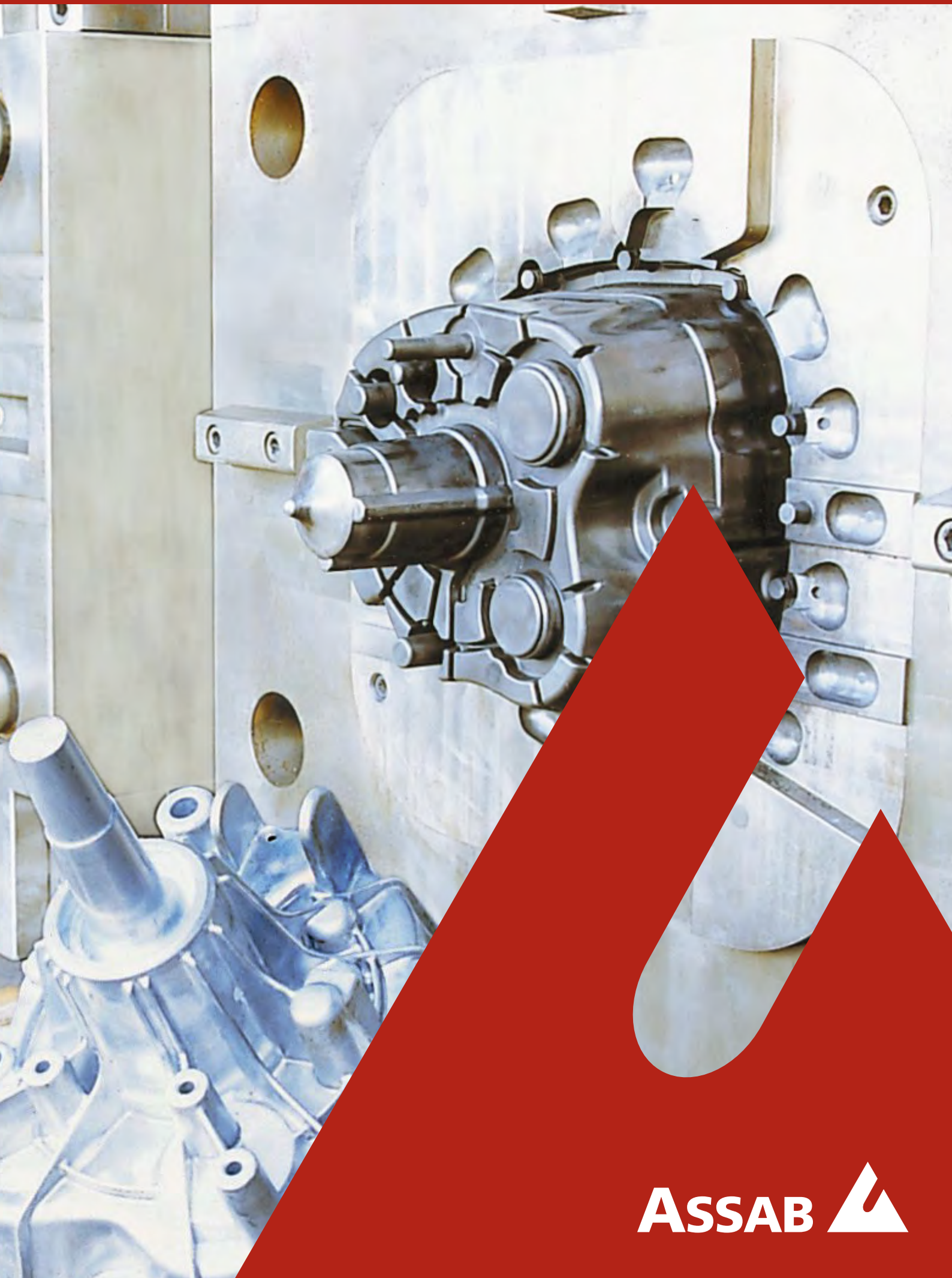
ASSAB 8407 2M

UDDEHOLM
ORVAR 2M



ASSAB

		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

ASSAB 8407 2M is a chromium-molybdenum-vanadium-alloyed steel which is characterised by:

- Good resistance to abrasion at both low and high temperatures
- High level of toughness and ductility
- Uniform and high level of machinability and polishability
- Good high-temperature strength and resistance to thermal fatigue
- Excellent through-hardening properties
- Very limited distortion during hardening

Typical analysis %	C 0.39	Si 1.0	Mn 0.4	Cr 5.3	Mo 1.3	V 0.9
Standard specification	AISI H13, WNr. 1.2344, SKD 61, EN X40CrMoV5-1					
Delivery condition	Soft annealed to approx. 185 HB					
Colour code	Orange / Violet					

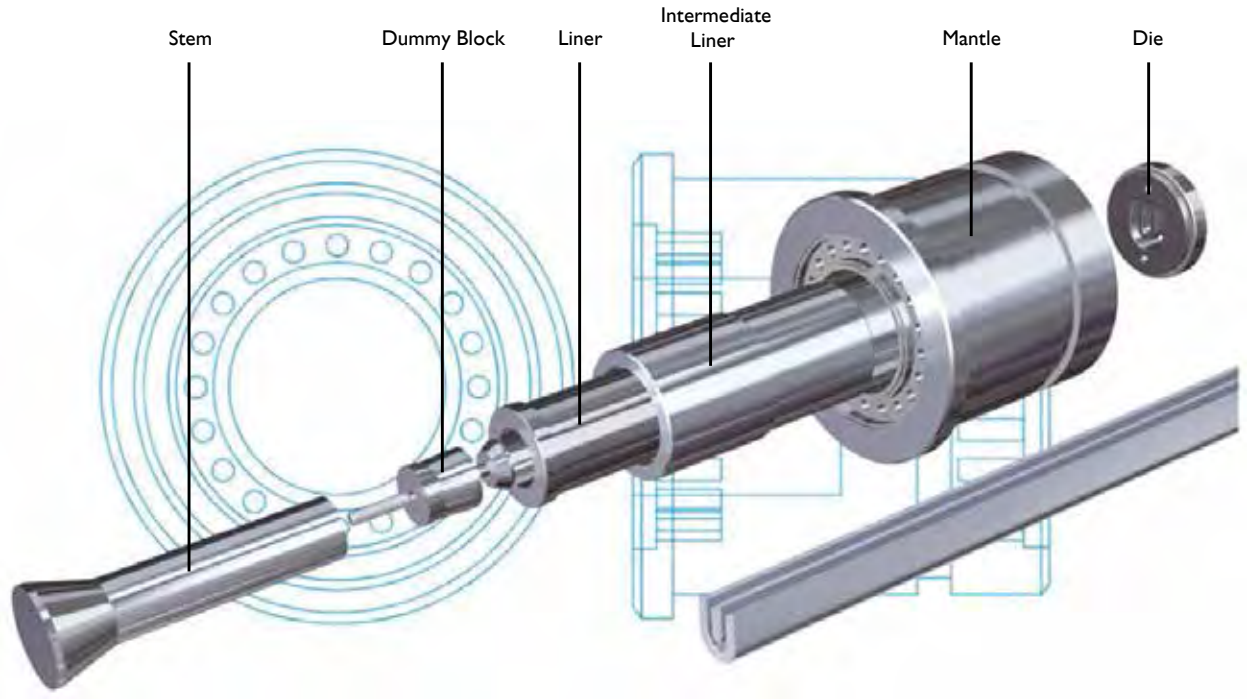
Applications

PLASTIC MOULDING

Part	Aust. and tempering temp.	HRC
Injection moulds Compression/ transfer moulds	Austenitising 1020-1030°C Tempering 250°C	50-52

EXTRUSION

Part	Aluminium, magnesium alloys, HRC	Copper alloys HRC	Stainless steels HRC
Dies	44-50	43-47	45-50
Backers, die holders, liners, dummy blocks, stems	41-50	40-48	40-48
Austenitising temperature	1020–1030°C	1040–1050°C	



Extrusion tooling components.

Aluminium extrusion profiles.

Properties

PHYSICAL DATA

Unless otherwise indicated, all specimens were hardened 30 minutes at 1025°C, quenched in air and tempered 2 + 2 h at 610°C. The hardness were 45 ± 1 HRC.

Temperature	20°C	400°C	600°C
Density kg/m^3	7800	7700	7600
Modulus of elasticity MPa	210 000	180 000	140 000
Coefficient of thermal expansion per °C from 20°C	-	12.6 x 10^{-6}	13.2 x 10^{-6}
Thermal conductivity W/m °C	25	29	30

MECHANICAL PROPERTIES

Approximate tensile strength at room temperature.

Hardness	52 HRC	45 HRC
Tensile strength, R_m	1820 MPa	1420 MPa
Yield strength, $R_p0.2$	1520 MPa	1280 MPa

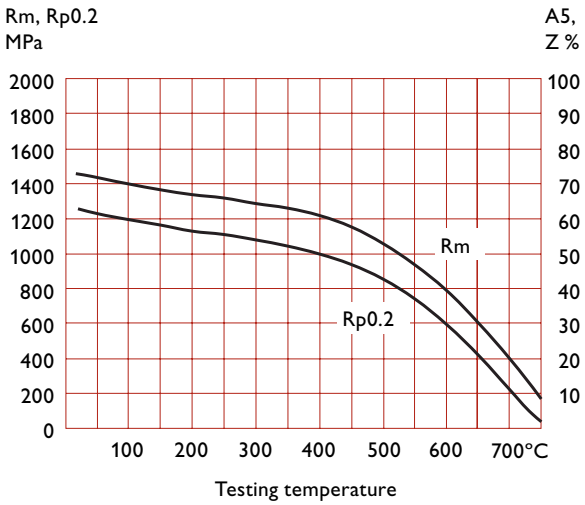
OTHER APPLICATIONS

Application	Aust. and tempering temp.	HRC
Severe cold punching, scrap shears	Austenitising 1020-1030°C Tempering 250°C	50-52
Hot Shearing	Austenitising 1020-1030°C Tempering 250°C Tempering 575-600°C	50-52 45-50
Shrink rings (e.g., for cemented carbide dies)	Austenitising 1020-1030°C Tempering 575-600°C	45-50
Wear resisting parts	Austenitising 1020-1030°C Tempering 575°C Nitriding	Core 50-52 Surface ~1000HV$_1$

For applications requiring extreme levels of toughness and ductility, e.g., die casting dies, forging dies, the premium grade H13 steel, 8407 Supreme, is recommended.

Approximate strength at elevated temperatures

Longitudinal direction.



Heat treatment

SOFT ANNEALING

Protect the steel and heat through to 850°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, holding time 2 hours. Cool slowly to 500°C, then freely in air.

HARDENING

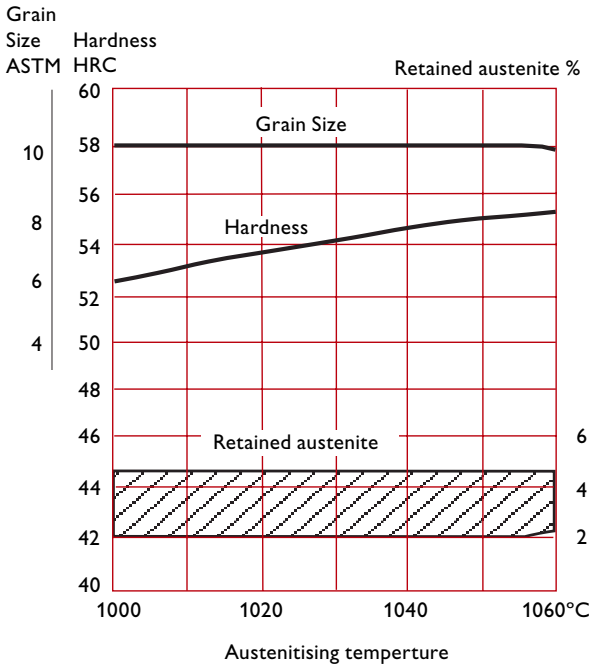
Preheating temperature: 600–850°C, normally in two preheating steps.
Austenitising temperature: 1020–1050°C, normally 1020°–1030°C.

Temperature °C	Soaking time minutes	Hardness before tempering
1025	30	53±2 HRC
1050	15	54±2 HRC

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

Protect the tool against decarburisation and oxidation during hardening.

Hardness, grain size and retained austenite as functions of austenitising temperature



QUENCHING MEDIA

- High speed gas/circulating atmosphere
- Vacuum (high speed gas with sufficient positive pressure). Interrupted quench is recommended for distortion control, or when quench cracking is a concern.
- Martempering bath or fluidised bed at 450–550°C, then cool in air
- Martempering bath or fluidised bed at approx. 180–220°C then cool in air
- Warm oil

Note 1: Temper the tool as soon as its temperature reaches 50–70°C.

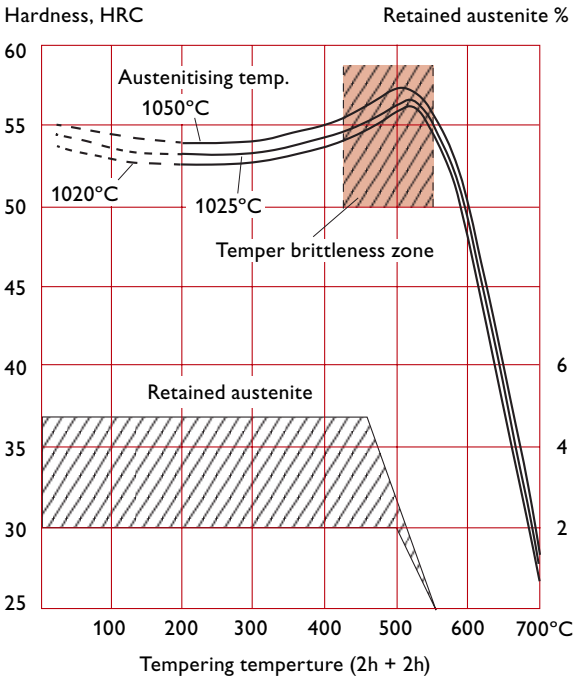
Note 2: In order to obtain the optimum properties for the tool, the cooling rate should be fast, but not at a level that gives excessive distortion or cracks.

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.

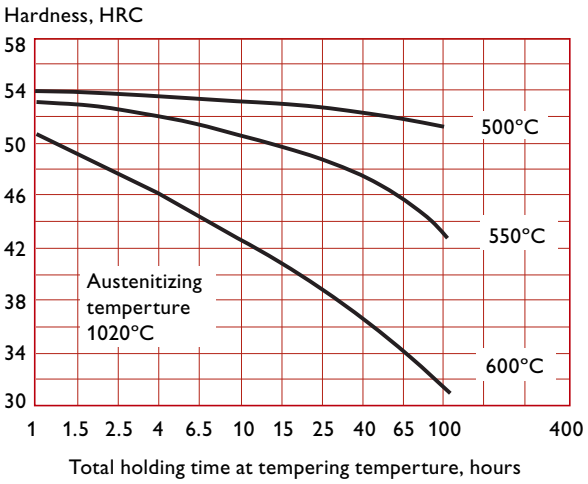
The lowest tempering temperature which should be used is 180°C. The minimum holding time at tempering temperature is 2 hours. To avoid "temper brittleness", do not temper in the range 425–550°C, see graph.

Tempering graph



Tempering within the range 425–550°C is normally not recommended due to the reduction in toughness properties.

Effect of time at tempering temperature

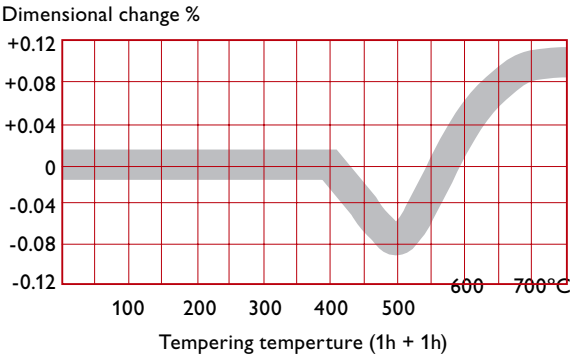


DIMENSIONAL CHANGES DURING HARDENING

Specimen size: 100 x 100 x 25 mm.

		Width %	Length %	Thickness %
Oil hardened from 1020°C	Min.	-0.08	-0.06	±0
	Max.	-0.15	-0.16	+0.03
Air hardened from 1020°C	Min.	-0.02	-0.05	±0
	Max.	+0.03	+0.02	+0.05
Vacuum hardened from 1020°C	Min.	+0.01	-0.02	+0.08
	Max.	+0.02	-0.04	+0.12

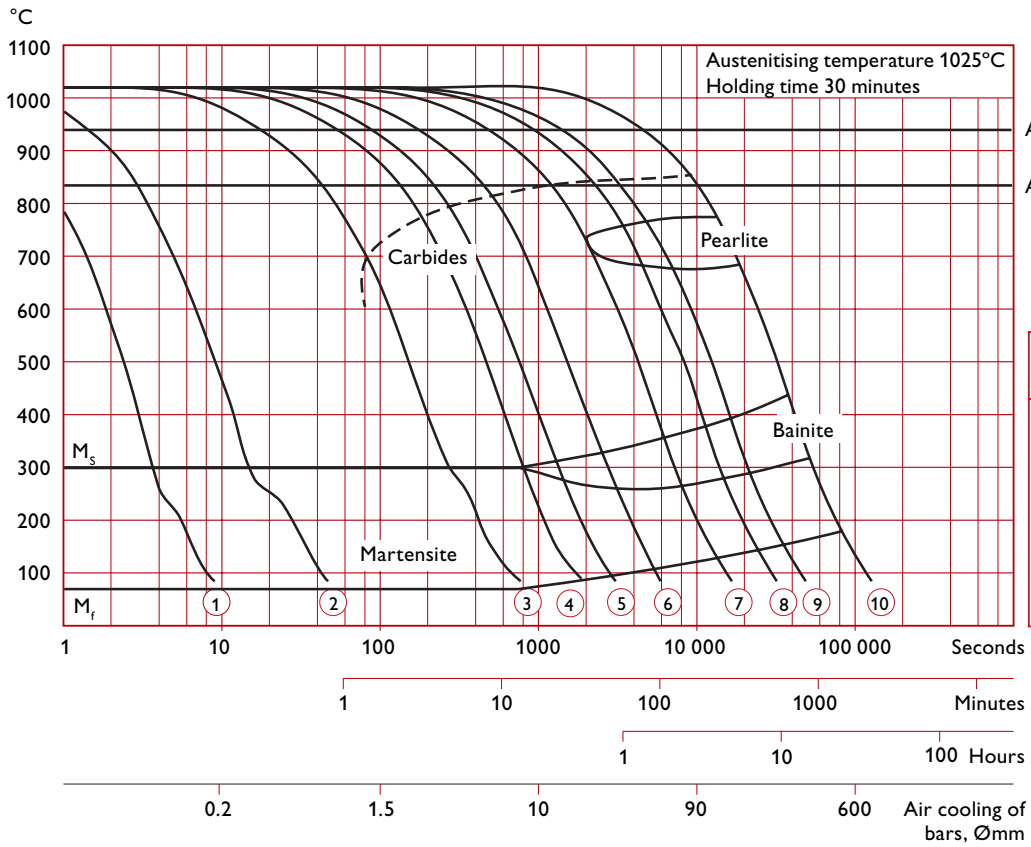
DIMENSIONAL CHANGES DURING TEMPERING



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

CCT graph

Austenitising temperature 1025°C. Holding time 30 minutes.



Cooling Curve No.	Hardness HV 10	$T_{800-500}$ (sec)
1	707	1
2	673	6
3	613	105
4	613	316
5	599	527
6	592	1054
7	560	2772
8	519	5271
9	483	7944
10	222	20768

Machining recommendations

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

Condition: Soft annealed condition ~185 HB

TURNING

Cutting data parameters	Turning with carbide		Turning with HSS†
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) m/min	200 - 250	250 - 300	25 - 30
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	16 - 18*	0.05 - 0.15
5 - 10	16 - 18*	0.15 - 0.20
10 - 15	16 - 18*	0.20 - 0.25
15 - 20	16 - 18*	0.25 - 0.35

* *For coated HSS drill, v_c ~ 28–30 m/min*

Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Brazed carbide[1]
Cutting speed (v_c) m/min	220 - 240	130 - 160	80 - 110
Feed (f) mm/r	0.03 - 0.10[2]	0.10 - 0.25[2]	0.15 - 0.25[2]

[1] *Drill with interntal cooling channels and brazed carbide tip*
[2] *Depending on drill diameter*

MILLING

Face and square shoulder milling

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) m/min	180 - 260	260 - 300
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 milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c) m/min	160 - 200	170 - 230	35 - 40[1]
Feed (f) mm/tooth	0.03 - 0.20[2]	0.08 - 0.20[2]	0.05 - 0.35[2]
Carbide designation ISO	-	P20 - P30	-

[1] *For coated HSS end mill, v_c ~ 55–60 m/min*
[2] *Depending on radial depth of cut and cutter diameter*

GRINDING

Wheel recommendation

Type of grinding	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	A 120 KV

Surface treatment

NITRIDING AND NITROCARBURISING

Nitriding and nitrocarburising result in a hard surface layer which is very resistant to wear and erosion. The nitrided layer is, however, brittle and may crack or spall when exposed to mechanical or thermal shock, the risk increasing with layer thickness. Before nitriding, the tool should be hardened and tempered at a temperature at least 25–50°C above the nitriding temperature.

Nitriding in ammonia gas at 510°C, or plasma nitriding in a 75% hydrogen/25% nitrogen mixture at 480°C, both result in a surface hardness of about 1100 $HV_{0.2}$. In general, plasma nitriding is the preferred method because of better control over nitrogen potential. Particularly, plasma nitriding can readily avoid the formation of so-called white layer, which is not recommended for hot work service. However, careful gas nitriding can give perfectly acceptable results.

ASSAB 8407 2M can also be nitrocarburised in either gas or salt bath. The surface hardness after nitrocarburising is 900–1000 $HV_{0.2}$.

Depth of nitriding

Process	Time h	Depth mm
Gas nitriding at 510°C	10 30	0.12 0.20
Plasma nitriding at 480°C	10 30	0.12 0.18
Nitrocarburising – in gas at 580°C – in salt bath at 580°C	 2.5 1	 0.11 0.06

Nitriding to case depths >0.3 mm is not recommended for hot work applications. ASSAB 8407 2M can be nitrided in the soft annealed condition. The hardness and depth of case will, however, be reduced somewhat in this case.

HARD CHROME PLATING

After plating, parts should be tempered at 180°C for 4 hours, within 4 hours of plating, to avoid the risk of hydrogen embrittlement.

Electrical discharge machining

If spark-erosion is performed in the hardened and tempered condition, the white re-cast layer should be removed mechanically by grinding or stoning. The tool should then be given an additional temper at approx. 25°C below the previous tempering temperature.

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 procedure. The following guidelines summarise the most important welding process parameters.

Welding method	TIG	MMA
Working temp.	325 - 375°C	325 - 375°C
Filler material	QRO 90 TIG-WELD DIEVAR TIG-WELD	QRO 90 WELD
Cooling rate	20 - 40°C/h for the first 2 to 3 hours and then freely in air	
Hardness after welding	50 - 55 HRC	50 - 55 HRC
Heat treatment after welding		
Hardened condition	Temper at 25°C below the original tempering temperature.	
Soft annealed condition	Soft anneal the material at 850°C in protected atmosphere. Then cool in the furnace at 10°C per hour to 650°C, then freely in air.	

Polishing

ASSAB 8407 2M exhibits good polishability in the hardened and tempered condition. Polishing after grinding can be effected using aluminium oxide or diamond paste.

TYPICAL PROCEDURE

1. Rough grinding to 180–320 grain size using a wheel or stone.
2. Fine grinding with abrasive paper or powder, down to 400–800 grain size.
3. Polish with diamond paste grade 15 (15µm grain size) using a polishing tool of soft wood or fibre.
4. Polish with diamond paste 8–6–3 (8–6–3µm grain size) using a polishing tool of soft wood or fibre.
5. When demands on surface finish are high, grade 1 (1µm grain size) diamond paste can be used for final polishing with a fibre polishing pad.

Photo-etching

ASSAB 8407 2M 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.

Further information

For further information, i.e., steel selection, heat treatment, application and availability, please contact our ASSAB office nearest to you.

Relative comparison of ASSAB hot work die steels

QUALITATIVE COMPARISON OF RESISTANCE TO DIFFERENT DIE FAILURES

ASSAB grade	Hot wear	Plastic deformation	Premature cracking	Heat checking
QRO 90 SUPREME				
UNIMAX				
DIEVAR				
ASSAB 8407 SUPREME				
ASSAB 8407 2M				
ALVAR 14				
FORMVAR				

REGIONAL HEAD OFFICE

SINGAPORE
ASSAB Pacific Pte Ltd
Tel : +65 6534 5600
Fax: +65 6534 0655
info@assab.com
www.assab.com

CHINA

Beijing
ASSAB Tooling (Beijing) Co., Ltd.
Tel : +86 10 6786 5588
Fax: +686 10 6786 2988
info.beijing@assab.com

Changchun*
ASSAB Tooling (Beijing) Co., Ltd.,
Dalian Branch
Tel : +86 431 8897 8922
Fax: +68 431 8897 8922
info.changchun@assab.com

Changzhou*
ASSAB Tooling Technology (Shanghai)
Co., Ltd. - Changzhou Branch
Dalian Branch
Tel : +86 519 8188 0008
Fax: +86 519 8510 2820
info.changzhou@assab.com

Chongqing
ASSAB Tooling Technology
(Chongqing) Co., Ltd.
Tel : +86 23 6745 5698
Fax: +86 23 6745 5699
info.chongqing@assab.com

Dalian
ASSAB Tooling (Beijing) Co., Ltd.,
Dalian Branch
Tel : +86 411 8761 8080
Fax: +86 411 8761 9595
info.dalian@assab.com

Dongguan
ASSAB Tooling (Dong Guan)
Co., Ltd.
Tel : +86 769 2289 7888
Fax: +86 769 2289 9312
info.dongguan@assab.com

Guangzhou*
ASSAB Tooling (Dong Guan)
Co., Ltd., Guangzhou Branch
Tel : +86 020 3482 8891
Fax: +86 020 3482 5329
info.guangzhou@assab.com

Hong Kong*
ASSAB Steels (HK) Ltd.
Tel : +852 2487 1991
Fax: +852 2489 0938
info.hongkong@assab.com

Changsa*
ASSAB Tooling (Dong Guan)
Co.., Ltd., Hunan Branch
Tel : +86 731 8452 3986
Fax: +86 731 8452 3986
info.changsa@assab.com

Nanchang*
ASSAB Tooling (Dong Guan)
Co.. Ltd., Jiangxi Branch
Tel : +86 769 2289 7888
Fax: +86 769 2289 9312
info.nanchang@assab.com

Ningbo
ASSAB Tooling Technology
(Ningbo) Co., Ltd.
Tel : +86 574 8680 7188
Fax: +86 574 8680 7166
info.ningbo@assab.com

Qingdao
ASSAB Tooling (Qingdao) Co., Ltd.
Tel : +86 532 8752 9999
Fax: +86 532 8752 9588
info.qingdao@assab.com

Shanghai
ASSAB Tooling Technology
(Shanghai) Co., Ltd.
Tel : +86 21 2416 9688
Fax: +86 21 5442 4244
info.shanghai@assab.com

Suzhou*
ASSAB Tooling Technology
(Shanghai) Co., Ltd. - Suzhou Branch
Tel : +86 512 6900 0161
Fax: +86 512 6252 9227
info.suzhou@assab.com

Tianjin*
ASSAB Tooling (Beijing) Co., Ltd.,
Tianjin Branch
Tel : +86 22 2370 7808
Fax: +86 22 2370 7806
info.tianjin@assab.com

Wuhan
ASSAB Tooling Technology
(Shanghai) Co., Ltd. - Wuhan Branch
Tel : +86 27 6930 0156
Fax: +86 27 6934 6326
info.wuhan@assab.com

Xiamen
ASSAB Tooling (Xiamen) Co., Ltd.
Tel : +86 592 562 4678
Fax: +86 592 568 3703
info.xiamen@assab.com

Xi'an*
ASSAB Tooling (Beijing) Co., Ltd.,
Xi'an Branch
Tel : +86 29 8525 5139
Fax: +86 29 8526 2080
info.xian@assab.com

Yantai*
ASSAB Tooling (Qingdao) Co., Ltd.
Tel : +86 535 693 4100
Fax: +86 535 693 4200
info.yantai@assab.com

INDONESIA

Jakarta - Head Office
PT. ASSAB Steels Indonesia
Tel : +62 21 461 1314
Fax: +62 21 461 1306/
+62 21 461 1309
info.jakarta@assab.com

Bandung*
PT. ASSAB Steels Indonesia
Tel : +62 22 5234 017
Fax: +62 22 5234 020
info.bandung@assab.com

Cikarang*
PT. ASSAB Steels Indonesia
Tel : +62 21 461 1314
Fax: +62 21 461 1306/
+62 21 461 1309
info.cikarang@assab.com

Medan*
PT. ASSAB Steels Indonesia
Tel : +62 61 8477 935
Fax: +62 21 8477 936
info.medan@assab.com

Semarang*
PT. ASSAB Steels Indonesia
Tel : +62 24 7071 2574/
+62 24 7658 4803
Fax: +62 24 674 7145
info.semarang@assab.com

Surabaya
PT. ASSAB Steels Indonesia
Tel : +62 31 849 9606
Fax: +62 31 843 2040
info.surabaya@assab.com

Tangerang*
PT. ASSAB Stees Indonesia
Tel : +62 21 5316 0720-1
Fax: +62 21 5316 0794
info.tangerang@assab.com

JAPAN

Tokyo - Head Office*
Bohler-Uddeholm KK
Tel : +81 3 5226 3771
Fax: +81 3 5226 6110
info@bohler-uddeholm.jp

Fukuroi*
Bohler-Uddeholm KK
Tel : +81 538 43 9240
Fax: +81 538 43 9244
info@bohler-uddeholm.jp

Nagoya*
Bohler-Uddeholm KK
Tel : +81 52 979 5081
Fax: +81 52 933 6461
info@bohler-uddeholm.jp

Osaka*
Bohler-Uddeholm KK
Tel : +81 6 6307 7621
Fax: +81 6 6307 7627
info@bohler-uddeholm.jp

KOREA

Incheon - Head Office
ASSAB Steels (Korea) Co., Ltd.
Tel : +82 32 821 4300
Fax: +82 32 821 3311
info.korea@assab.com

Busan
ASSAB Steels (Korea) Co., Ltd.
Tel : +82 51 831 3315
Fax: +82 51 831 3319
info.korea@assab.com

Daegu
ASSAB Steels (Korea) Co., Ltd.
Tel : +82 53 384 3315
Fax: +82 53 384 3317
info.korea@assab.com

MALAYSIA

Kuala Lumpur - Head Office
ASSAB Steels (Malaysia) Sdn. Bhd. (79223-X)
Tel : +60 3 6189 0022
Fax: +60 3 6189 0044/55
info.kualalumpur@assab.com

Northern Branch
ASSAB Steels (Malaysia) Sdn. Bhd. (79223-X)
Tel : +60 4 507 2020
Fax: +60 4 507 6323
info.penang@assab.com

Southern Branch
ASSAB Steels (Malaysia) Sdn. Bhd. (79223-X)
Tel : +60 7 598 0011
Fax: +60 7 599 4890
info.johor@assab.com

PHILIPPINES

ASSAB Pacific Pte Ltd -
Philippine Branch
Tel : +63 29 539 0441 to 0442
Fax: +63 49 539 1075
info.philippines@assab.com

SINGAPORE

ASSAB Steels Singapore (Pte) Ltd
Tel : +65 6862 2200
Fax: +65 6862 0162
info.singapore@assab.com

TAIWAN

Taipei - Head Office
ASSAB Steels Taiwan Co., Ltd.
Tel : +886 2 2299 2849
Fax: +886 2 2299 0147
info.taipei@assab.com

Kaoshiung
ASSAB Steels Taiwan Co., Ltd.
Tel : +886 7 624 6600
Fax: +886 7 624 0012
info.kaoshiung@assab.com

Nantou
ASSAB Steels Taiwan Co., Ltd.
Tel : +886 49 225 1702
Fax: +886 49 225 3173
info.nantou@assab.com

THAILAND

ASSAB Steels (Thailand) Ltd.
Tel : +66 2 757 5017
Fax: +66 2 385 5943
info.thailand@assab.com

VIETNAM

ASSAB Steels (Vietnam) Co. Ltd.
Tel : +84 61 8899 099
Fax: +84 61 8899 191
info.vietnam@assab.com

* Sales office

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.

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