钢铁之家

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Global Steel Grade Encyclopedia

涵盖的行业或国家与地区类别

ASTM	GJB	SAE	EU	AISI	DIN	AMS	ISO	JASO
国材料与试验协会	国家军用标准	动力机械工程师协会	前欧洲标准化	美国钢铁学会	德国工业标准	空航天材料规范	国际标准	日本汽车标准组织

EN	JB	UNS	UNI	ASME	SS	GB	JIS
欧洲标准	国机械行业标准	统一编号系统	意大利标准	美国机械工程师协会	瑞典标准	国家标准	日本工业标准

General

Vanadis 10 is a high vanadium alloyed powder metallurgical (PM) tool steel offering a unique combination of an excellent abrasive wear resistance in combination with a good chipping resistance.

Vanadis 10 is characterised by:

- Extremely high abrasive wear resistance
- High compressive strength
- Very good through-hardening properties
- Good toughness
- Very good stability during hardening
- Good resistance to tempering back
- Good surface treatment properties

Typical analysis %	C 2.9	Si 0.5	Mn 0.5	Cr 8.0	Mo 1.5	V 9.8
Standard specification	None					
Delivery condition	Soft annealed to approx. 280 - 310 HB					
Colour code	Green / Violet					

Due to the very carefully balanced alloying and the powder metallurgical manufacturing route, Vanadis 10 has a similar heat treatment procedure to the steel D2. One very big advantage with Vanadis 10 is that the dimensional stability after hardening and tempering is much better than for the conventionally produced high performance cold work steels. This also means that Vanadis 10 is a tool steel which is very suitable for CVD coating.

Applications

Vanadis 10 is especially suitable for very long run tooling where abrasive wear is the dominating problem. Its very good combination of extremely high wear resistance and good toughness also makes Vanadis 10 an interesting alternative in applications where tooling made of carbide tends to chip or crack.

TYPICAL APPLICATIONS

- Blanking and forming
- Fine blanking
- Blanking of electrical sheet
- Gasket stamping
- Deep drawing
- Cold forging
- Slitting knives (paper and foil)
- Powder pressing
- Granulator knives
- Extruder screws etc.

Properties

PHYSICAL PROPERTIES

Hardened and tempered to 62 HRC.

Temperature	20°C	200°C	400°C
Density kg/m³	7 400	–	–
Modulus of elasticity MPa	220 000	210 000	200 000
Coefficient of thermal expansion per °C from 20°C	–	10.7×10^{-6}	11.4×10^{-6}
Thermal conductivity W/m °C	–	20	22
Specific heat J/kg °C	460	–	–

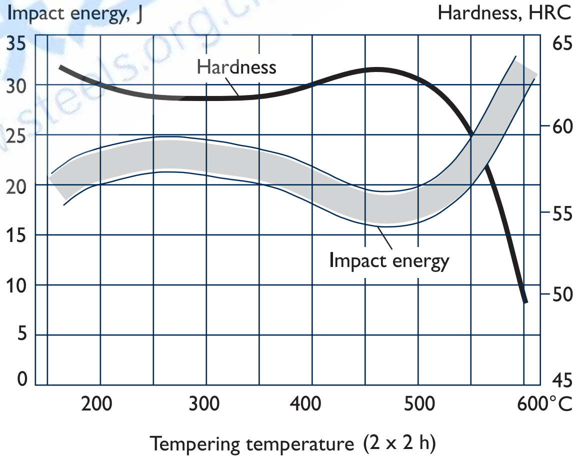
IMPACT STRENGTH

The effect of tempering temperature on unnotched impact strength at room temperature.

Specimen size: 7 x 10 x 55 mm

Specimen type: Unnotched

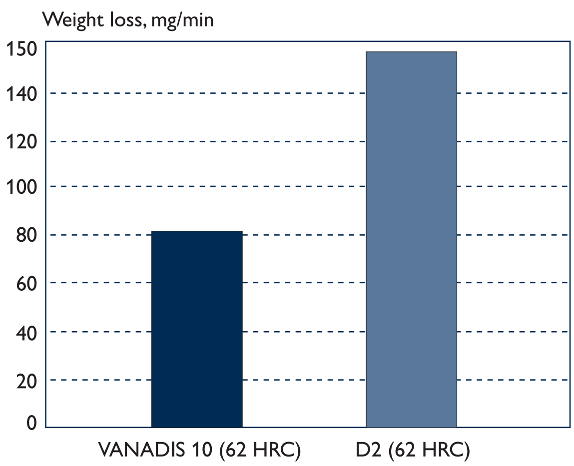
Heat treatment: Hardened at 1020°C. Quenched in air. Tempered twice.



WEAR RESISTANCE

Test method: Pin-on-disc test

Disc material: SiC



Heat treatment

SOFT ANNEALING

Protect the steel and heat through to 900°C. Cool in the furnace at 10°C per hour to 750°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 - 700°C

Austenitising temperature: 1020 - 1100°C

Holding time: 30 minutes

Holding time = Time at hardening temperature after the tool is fully heated through. A holding time of less than 30 minutes will result in loss of hardness.

Protects the parts against decarburisation and oxidation during hardening.

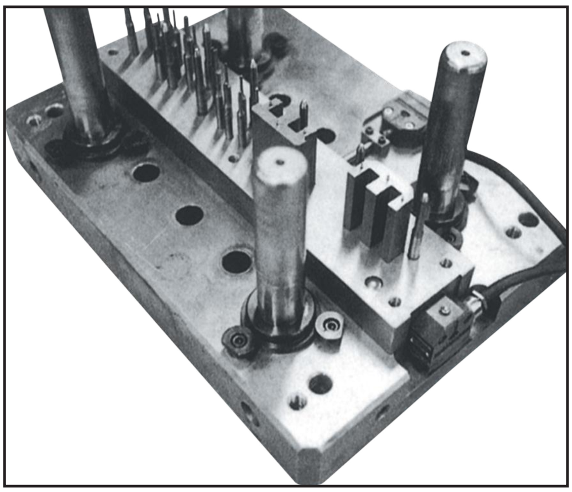
QUENCHING MEDIA

- Forced air/gas
- Vacuum furnace (gas overpressure 2 - 5 bar)
- Martempering bath or fluidised bed at 500 - 550°C
- Martempering bath or fluidised bed at 200 - 350°C whereby 350°C is preferred

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 as fast as possible while maintaining an acceptable level of distortion.

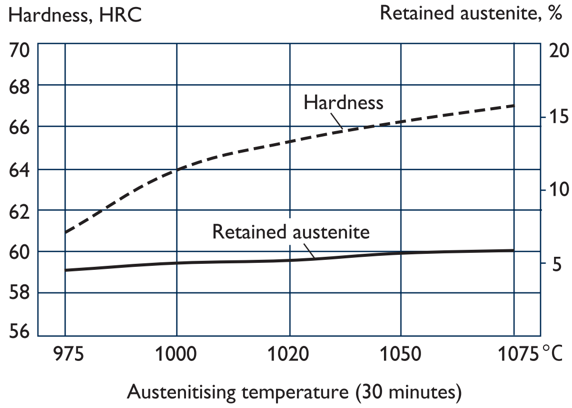
Note 3: Tools with sections >50 mm should be quenched in forced air. Quenching in still air will result in loss of hardness.



Typical application of Vanadis 10. Tool for blanking and forming electrical strip.

Hardness and retained austenite as functions of austenitising temperature

Air-cooling.

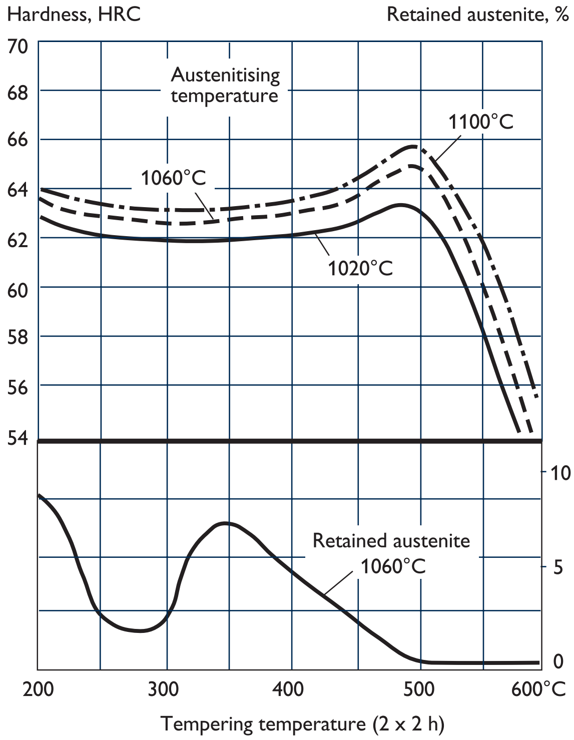


TEMPERING

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

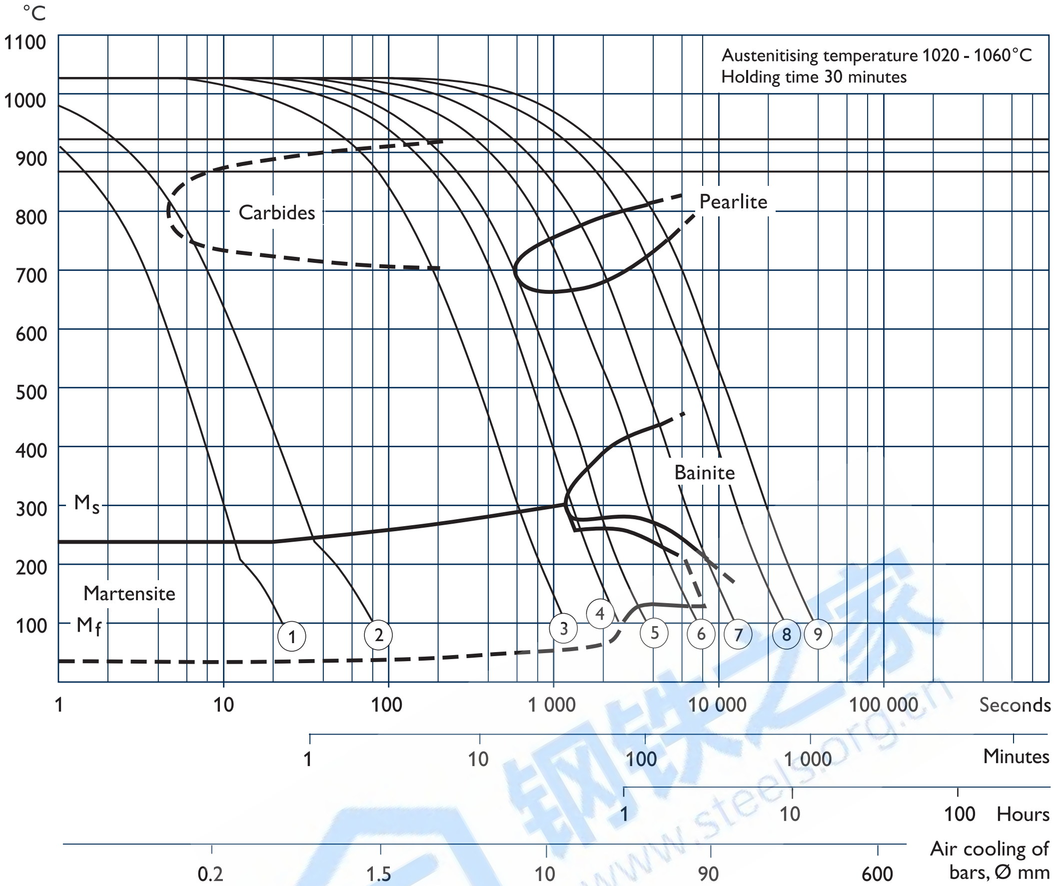
Temper at least twice with intermediate cooling to room temperature. The lowest tempering temperature which should be used is 180°C. The minimum holding time at temperature is 2 hours. At a hardening temperature of 1100°C or higher, Vanadis 10 should be tempered at minimum 525°C in order to reduce the amount of retained austenite.

Tempering graph



CCT graph

Austenitising temperature 1020 - 1060°C. Holding time 30 minutes.



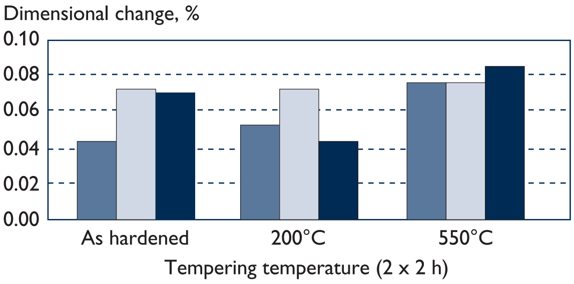
Cooling Curve No.	Hardness HV 10	$T_{800-500}$ sec
1	890	3.8
2	878	10
3	818	232
4	806	481
5	731	695
6	635	1389
7	509	2318
8	325	4633
9	311	6947

DIMENSIONAL CHANGES AFTER TEMPERING

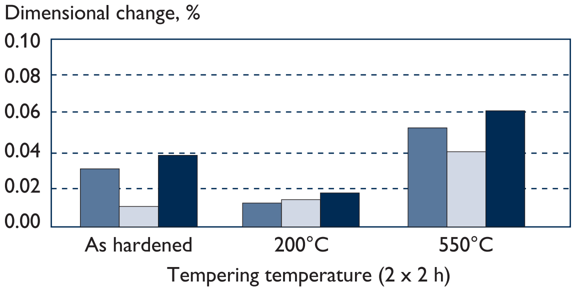
Hardening temperature

980°C 1020°C 1060°C

Specimen size: 65 x 65 x 65 mm



Specimen size: 125 x 125 x 25 mm



SUB-ZERO TREATMENT

Tools requiring maximum dimensional stability in service can be sub-zero treated as follows:

Immediately after quenching, the piece should be sub-zero treated, followed by tempering. Vanadis 10 is commonly sub-zero treated between -150°C and -196°C for 1 - 3 hours, although occasionally -40°C and lower temperatures (e.g., -80°C) are used due to constraints of the sub-zero medium and equipment available. The sub-zero treatment leads to a reduction of retained austenite content. This, in turn, will result in a hardness increase of ~1 HRC compared to non sub-zero treated tools if low temperature tempering is used.

Tools that are high temperature tempered, even without a sub-zero treatment, will have a low retained austenite content; and in most cases, a sufficient dimensional stability. However, for high demands on dimensional stability in service, it is also recommended to use a sub-zero treatment in combination with high temperature tempering.

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 280 - 310 HB

TURNING

Cutting data parameters	Turning with carbide		Turning with HSS†
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) m/min	50 - 80	80 - 100	5 - 8
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	K20* Coated carbide	K15* Coated carbide or cermet	–

† *High speed steel*
* *Use a wear-resistant Al_2O_3 coated carbide grade*

DRILLING

High speed steel twist drill

Drill diameter mm	Cutting speed (v_c) m/min	Feed (f) mm/r
≤ 5	6 - 8*	0.05 - 0.15
5 - 10	6 - 8*	0.15 - 0.20
10 - 15	6 - 8*	0.20 - 0.25
15 - 20	6 - 8*	0.25 - 0.35

* *For coated HSS drill, v_c = 12 - 14 m/min*

Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip[1]
Cutting speed (v_c) m/min	70 - 90	40 - 60	20 - 30
Feed (f) mm/r	0.05 - 0.15[2]	0.10 - 0.25[2]	0.15 - 0.25[2]

[1] *Drill with replaceable or 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	30 - 50	50 - 70
Feed (f_z) mm/tooth	0.2 - 0.4	0.1 - 0.2
Depth of cut (a_p) mm	2 - 4	≤ 2
Carbide designation ISO	K20 - P20* Coated carbide	K15 - P15* Coated carbide or cermet

* *Use a wear-resistant Al_2O_3 coated carbide grade*

End milling

Cutting data parameter	Type of end mill		
	Solid carbide	Carbide indexable insert	High speed steel[1]
Cutting speed (v_c) m/min	30 - 40	30 - 50	10 - 14
Feed (f_z) mm/tooth	0.03 - 0.20[2]	0.08 - 0.20[2]	0.05 - 0.35[2]
Carbide designation ISO	–	K15[3] Coated carbide	–

[1] *Uncoated HSS is not recommended*
[2] *Depending on radial depth of cut and cutter diameter*
[3] *Use a wear-resistant Al_2O_3 coated carbide grade*

GRINDING

Wheel recommendation

Type of grinding	Soft annealed condition	Hardened condition
Face grinding straight wheel	A 46 HV	B151 R50 B3[1] A 46 GV[2]
Face grinding segments	A 36 GV	A 46 GV
Cylindrical grinding	A 60 KV	B151 R75 B3[1] A 60 JV[2]
Internal grinding	A 60 JV	B151 R75 B3[1] A 60 IV
Profile grinding	A 100 IV	B126 R100 B6[1] A 100 JV[2]

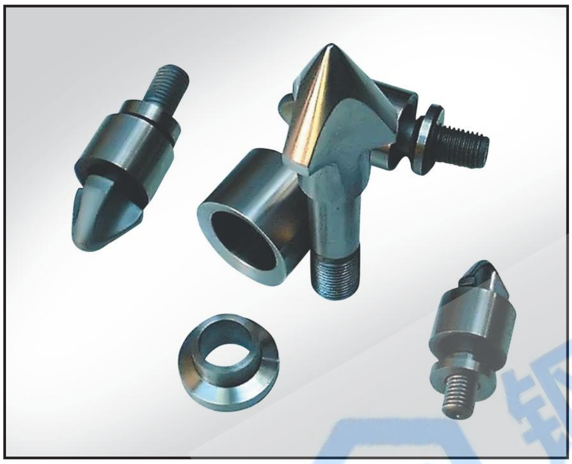
[1] *If possible, use CBN wheels for this application*
[2] *Preferably a wheel type containing sintered Al_2O_3 (seeded gel)*

Electrical discharge machining

If EDM is performed in the hardened and tempered condition, the EDM'd surface is covered with a resolidified layer (white layer) and a rehardened and untempered layer, both of which are very brittle and hence detrimental to the tool performance.

When a profile is produced by EDM, it is recommended to finish with "fine-sparking", i.e., low current, high frequency. For optimal performance, the EDM'd surface should be ground/polished to remove the white layer completely. The tool should then be retempered at approx. 25°C below the highest previous tempering temperature.

When EDM'ing larger sizes or complicated shapes, Vanadis 10 should be high temperature tempered above 500°C.



Nozzles and rings made of Vanadis 10 for extrusion screws, used for the extrusion of glass-reinforced plastic.

Surface treatment

NITRIDING

Nitriding produces a hard surface layer that increases wear resistance and reduces the tendency towards galling.

If high temperature tempered, Vanadis 10 is normally tempered at 525°C. This means that the nitriding temperature used should not exceed 500 - 525°C. Ion nitriding at a temperature below the tempering temperature used is preferred.

The surface hardness after nitriding is approximately 1250 $HV_{0.2\ kg}$. The thickness of the layer should be chosen to suit the application in question.

Further information

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

*See back cover page.

Relative comparison of ASSAB cold work tool steels

MATERIAL PROPERTIES AND RESISTANCE TO FAILURE MECHANISMS

ASSAB grade	Hardness/ Resistance to plastic deformation	Machinability	Grindability	Dimension stability	Resistance to		Fatigue cracking resistance	
					Abrasive wear	Adhesive wear	Ductility/ resistance to chipping	Toughness/ gross cracking
DF-3								
CALMAX								
CALDIE (ESR)								
XW-10								
ASSAB 88								
XW-42								
XW-5								
VANADIS 4 EXTRA								
VANADIS 10								
VANCRON 40								
ASP 23								
ASP 30								
ASP 60								
AISI M2								