VH13 | VH13SI®
Hot Work Tool Steel

VILLARES METALS
a voestalpine company

The presented information in this datasheet is only for technical guidance and represents our present state of knowledge of this product. This information shall not be considered as warranty of specific properties or fitness for a particular application of this product..

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SIMILAR STANDARDS

VH13 | VH13SI® is similar to the following grades: AISI H13, DIN X40CrMoV5-1 and W.Nr. 1.2344; BS BH13; UNS T20813; JIS SKD61; AFNOR Z40CDV5; EN X40CrMoV5-1-1. This steel is produced in accord with ASTM A681, EN ISO 4957.

GENERAL INFORMATION

VH13 | VH13SI® is a 5% Cr hot work tool steel with good combination of properties such as high toughness and hot resistance. Its alloy design makes VH13 | VH13SI® a very versatile tool steel, employed in several application in hot work tooling and plastic molds.

MAIN CHARACTERISTICS

VH13 | VH13SI® has a martensitic matrix mainly with fine vanadium primary carbides, and other secondary hardening carbides. Its processing ensures good isotropy and homogeneity of properties throughout the tool. In addition, VH13 | VH13SI® presents high resistance to thermal fatigue, good machinability, polishability and high hardenability. For higher toughness applications, consider the use of VH13ISO® (NADCA Premium version) or VH13IM® (NADCA Superior version).

CHEMICAL COMPOSITION

Typical Analysis (Weight Percent)

C	Si	Mn	P	S	Cr	Mo	V	Fe
0,38	0,5	0,4	0.03 max	0.03 max	5,00	1,30	0,90	Bal.

STANDARD PRODUCTION RANGE

Production Route	Standard	Production Range	Finishing
Rolled Products	ASTM A681	Thickness between 8 to 152 mm with width between 38.10 to 320mm Rd. 5.50-152mm	Centerless ground Peeled Turned
Forged Products		Rd. 152 – 760 mm Thickness up to 400mm with width up to 800mm	Turned Peeled Milled

*Other dimensions and conditions are available upon inquiry.

DELIVERY CONDITION

VH13 | VH13SI® is available in round, square or flat bars in annealed condition with maximum hardness of 235 HB. Can be supplied in hardened condition upon agreement.

HEAT TREATMENTS

Soft Annealing

Soft annealing should be carried out by heat part between 840 - 860 °C for two hours controlled by the core, Cool slowly at a rate that does not exceed 20°C hour to a temperature of 650°C then air cooling. Use of protective atmosphere is important to avoid surface oxidation and decarburization.

Stress Relief

Stress relief heat treatment aims to reduce the residual stress of the part and it shall be employed after machining and before hardening. It shall be applied in dies with draws and profiles, in which the machining removal has been higher than 30%, in other to minimize distortions during and after hardening.

Stress relief heat treatment consists in a slowly heating to 650°C followed by furnace cooling until 200°C. In hardened parts, the stress relief must employ a temperature 50°C lower than the last tempering temperature.

Hardening

Preheat the part to 780- 820°C in two steps, until the temperature from center to surface is equal in each step. Austenitizing temperature should be between 1000 and 1040°C holding 30min in temperature.

For better toughness performance, it is indicated 1000°C and for better heat resistance response 1040°C can be applied. The choice of ideal temperature should also consider aspects of design and finishing details of the parts.

After austenitization, quenching can be performed in different quench media as:

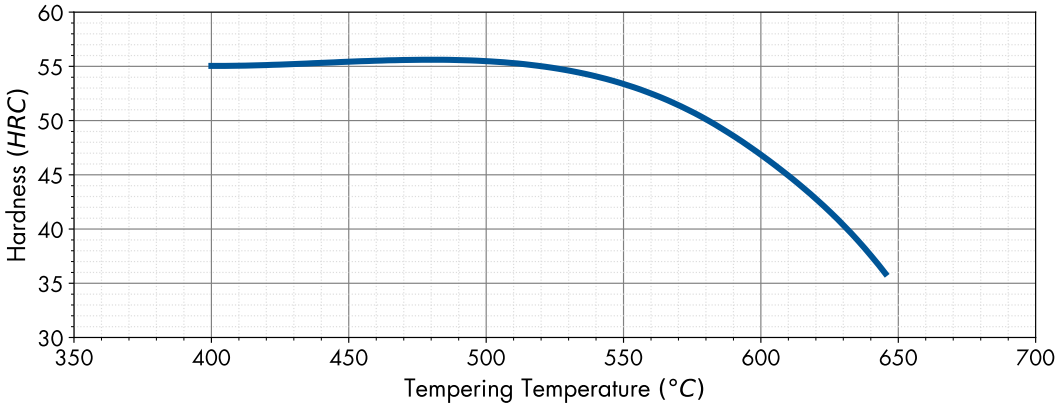
- Pressurized vacuum furnace with pressure higher than 5 bar.
- Warm oil, 40 - 70°C.
- Salt or fluidized bed between 500 - 550°C.
- Forced air cooling.

Tempering

Temper immediately after quenching, i.e. as soon as parts reaches 60°C. Double tempering, at least is recommended and after each tempering cycle, parts shall be slowly cooled to room temperature.

Tempering temperatures are generally between 550-650°C, depending upon the desired hardness. The time of each tempering cycle shall be at least 2 hours in temperature. Avoid temperature range between 450 and 540°C as it can promote an excessive loss in toughness.

For parts with thickness larger than 70 mm, the time at temperature should be calculated according to their size, being a reference for calculation about one hour for each inch of thickness.



Tempering curve of VH13 | VH13SI® after hardening at 1020°C. Tempering time: 2 hours
Curve obtained from specimens with cross section of 20 mm x 20 mm

Surface Treatments

VH13 | VH13SI® is an adequate substrate for nitriding, leading to surface hardness around 1100 HV. Nitriding temperature should be at least 50 °C lower than that of the tempering. Surface must be in an adequate condition.
PVD or CVD coatings can also be applied in VH13 | VH13SI® without losses in core hardness.

MAIN APPLICATIONS

The physical and mechanical properties of VH13 | VH13SI® make possible its use in many applications, being classified as a general-purpose hot work tool steel. Some typical applications are presented below:

- Extrusion dies for aluminum or other non-ferrous alloys.
- Forging dies and die holders for steel or other ferrous and non-ferrous alloys.
- Hot shearing blades.
- Wear resistance parts, when nitrided.
- Injection or other molds for plastic.
- Dies for die casting of aluminum or other light metals.
- For higher performance, consider use of VH13ISO® or VH13IM®.

MACHINABILITY

VH13 | VH13SI® can be conventionally machined in the annealed condition. Due to its refined structured, It presents good behavior in grinding operations. This contributes to reduce the risk to surface overheating and cracking. Select tools and speed carefully to allow a good machinability. In order to avoid distortions on the part during the hardening and tempering, a stress relief heat treatment before hardening stress relief is recommended, if more than 30% of part weight in machining operations was removed. Electro-erosion process can be employed in heat treated dies or molds. After electro-erosion machining it is recommended to remove the superficial layer thru fine grinding wheel and perform a tempering heat treatment in temperatures around 50°C lower than that of the last tempering.

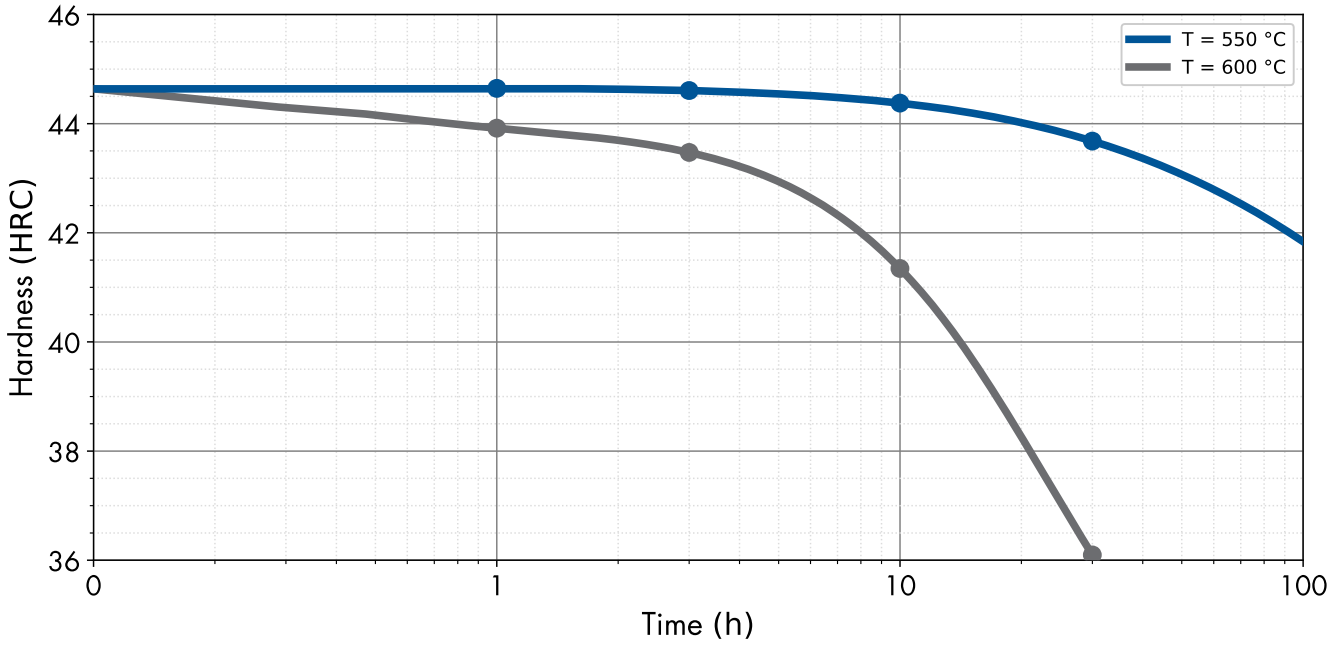
WELDING

It is not recommended to perform welding operations on VH13 | VH13SI® steel. Welding operations will produce Heat Affected Zones (HAZ), which will reduce the performance of the steel in the application. HAZ produced during arc welding operation are harder and brittle, with risk of cracking unless great care is exercised. In exceptional cases and always considering that, the welding would be a temporary solution VH13 | VH13SI® might be welded using special procedures to minimize the HAZ.
The sequence of operations for repair welding depends upon its prior heat treatment. As a general guideline, it is recommended to: (a) preheat, (b) weld with appropriate filler metal, (c) perform a stress relief heat treatment, (d) machine, (e) quench and temper if in the annealed condition or stress relief if already hardened and (f) grind to final dimensions. The qualification of a specific welding procedure for repair is the key point to obtain the desired quality. The skill and experience of the welder is also a vital factor in obtaining satisfactory results.

MECHANICAL PROPERTIES

VH13 | VH13SI® is highly resistant to softening. After 30 h at temperatures higher than 550°C,

the hardness decreases only 1,0 HRC at 550°C and 9,0 HRC at 600°C.



VH13 | VH13SI® resistance to softening.
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PHYSICAL PROPERTIES

Density:

Temperature	g/cm³	lb/in³
20°C (68°F)	7.70	0.278

Specific Heat:

Temperature 20 °C to (68°F to)		J/kg.K	Btu/lb.°F
100°C (212°F)		460	0.110

Thermal Conductivity:

Temperature	W/(m.K)	Btu.in/(h.ft².°F)
20°C (68°F)	25.0	173
350°C (662°F)	28.3	196
700°C (1292°F)	29.3	203

Thermal Expansion Coefficient:

Temperature 20 °C to (68°F to)	10^{-6}m/m.K	10^{-6}in/in.°F
100°C (212°F)	11.5	6.4
200°C (392°F)	12.0	6.7
300°C (572°F)	12.2	6.8
400°C (752°F)	12.5	6.9
500°C (932°F)	12.9	7.2
600°C (1112°F)	13.0	7.2

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ISO 17025
ISO 50001

OHSAS 18001:2007
IATF 16949:2016
AS 9100 D
NORSOK M-650
NADCAP – Heat Treating and Non Destructive Testing

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