VTMPLUS®
Hot Work Tool Steel

VILLARES METALS
a voestalpine company

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Edition 1, 01.2021

SIMILAR STANDARDS

VTMPLUS® is a selectively modified hot work tool steel produced according to ISOMAX process. This steel is an alternative to AISI H13 or 1.2367 for higher hardness.

GENERAL INFORMATION

VTMPLUS® is a hot work tool steel developed by Villares Metals, for application in high performance warm and hot forging tools.

MAIN CHARACTERISTICS

Typically, VTMPLUS® presents a martensitic matrix with a few primary carbides. Its microstructure combines higher hardness, hot wear resistance and thermal stability, keeping a good toughness level, which are characteristics that ensure the resistance to thermal fatigue and failures at high temperatures.

CHEMICAL COMPOSITION

Hot work tool steel, alloyed with chromium, molybdenum and vanadium.

C	Si	Mn	Cr	Mo	V	Fe
0.50	0.30	0.30	3,80	3,00	0,55	Bal.

STANDARD PRODUCTION RANGE

Production Route	Production Range	Finishing
Rolled Products	Thickness between 8 to 152 mm with width between 38.10 to 320mm Rd. 12.70-152.40mm	Centerless ground Peeled Turned
Forged Products	Rd. 152.40 – 570 mm Thickness up to 350mm with width up to 760mm	Turned Peeled Milled

*Other dimensions and conditions are available upon inquiry.

DELIVERY CONDITION

VTMPLUS® is usually supplied in the soft annealed condition with maximum hardness of 250 HB. This steel can also be supplied in the hardened and tempered condition.

HEAT TREATMENTS

Soft Annealing

Soft annealing should be carried out by heating between 840 and 860°C for 2 hours, followed by cooling with cooling rate between 10 and 20°C per hour until 650°C and, then, by air cooling. In this treatment, the 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 parts with draws and profiles, in which the machining removal has been higher than 30%, in other to minimize distortions after hardening.

Stress relief heat treatment consists in a slowly heating to 650°C, holding 2h in temperature and furnace cooling until 200°C and then free cooling in air. In case that this heat treatment is applied after hardening and tempering, the stress relief shall employ a temperature 50°C lower than that of the last tempering temperature.

Hardening

Preheat the part to 600- 850°C in two steps, until the temperature from center to surface is equal in each step. The austenitizing temperature should be between 1030 and 1050°C.

For better toughness performance, it is indicated 1030°C and for better heat resistance response 1050°C can be applied. The choice of the ideal temperature should also consider aspects of design and finishing details of the parts.

After austenitization, the 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 450 - 550°C.

Tempering

After quenching, the parts shall be tempered immediately after quenching, i.e. as soon as they reach 60°C. It is necessary, at least, double tempering. After each tempering, parts shall be slowly cooled to room temperature.

Tempering temperatures are generally between 540-620°C, depending upon the desired hardness. The time of each tempering cycle shall be at least 2 hours in temperature.

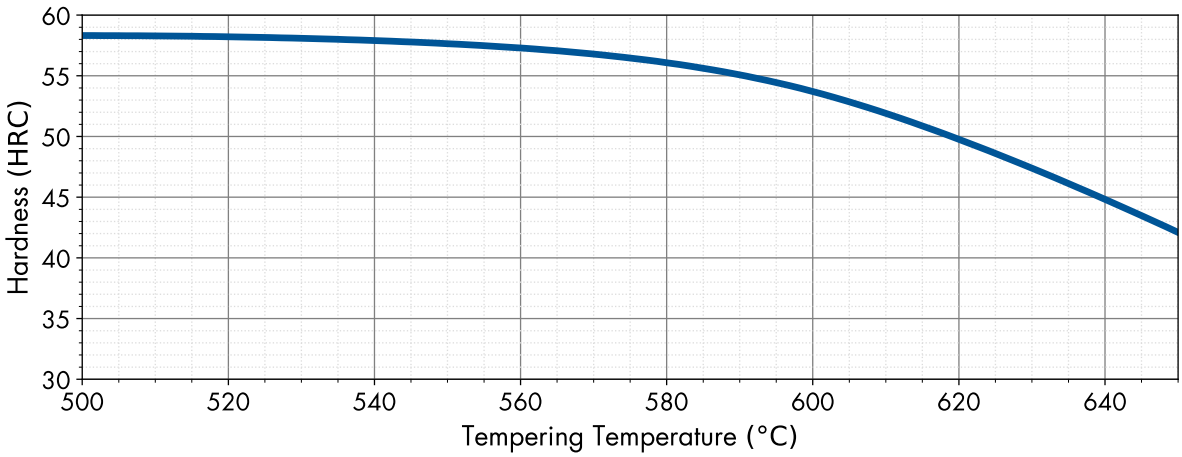
For parts with thickness larger than 70 mm, the time at temperature should be calculated according to their size, being a reference for calculation about one hour for each inch of thickness.

Surface Treatments

Nitriding or nitrocarburizing are recommended when higher levels of surface hardness or wear resistance are required.

VTMPLUS® has a good nitriding response. PVD or CVD coatings are also suitable to be applied on VTMPLUS®.

Surface treatments shall be applied after hardening and tempering, since their temperatures is at least 30°C lower than the last tempering heat treatment.



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

MAIN APPLICATIONS

The physical and mechanical properties of VTMPLUS® make possible its use in many applications. Some typical application are:

- Warm and hot forging dies and punches.
- Extrusion dies of aluminum and others non-ferrous alloys.
- Complex shaped die-casting dies and inserts.
- Hot shearing blades and toughness demand in cold work applications.

MACHINABILITY

VTMPLUS® can be conventionally machined in the annealed condition. Care need to be taken in the selection of the tool and the speed in order to allow a good machinability. In order to avoid distortions on the part during the hardening and tempering heat treatments, it is recommended to perform a stress relief heat treatment before hardening, if it was removed more than 30% of part weight in machining operations.

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 a temperature around 50°C lower than the last tempering temperature.

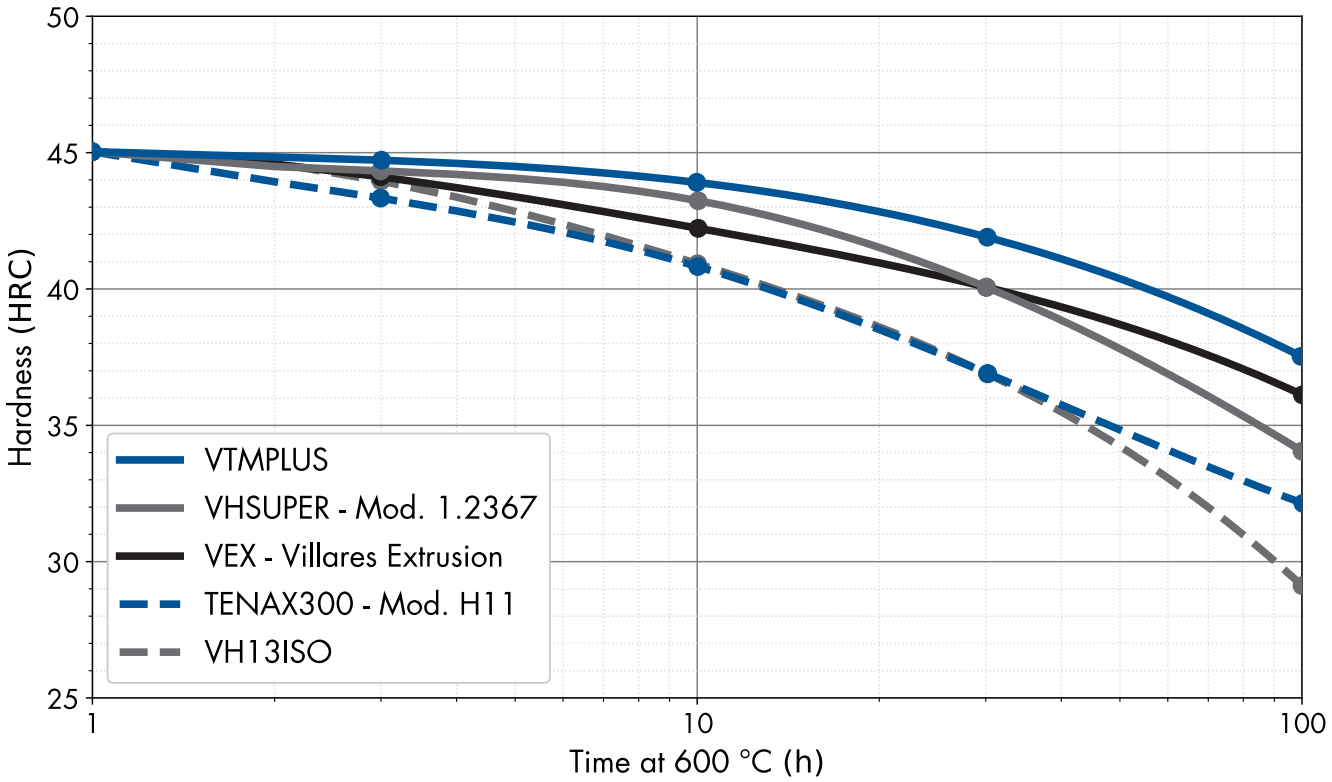
WELDING

It is not recommended to perform welding operations on VTMPLUS® 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 VTMPLUS® might be welded using special procedures to minimize the HAZ.

The sequence of operations for repair welding VTMPLUS® 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 ingredient in obtaining satisfactory results.

MECHANICAL PROPERTIES

VTMPLUS® shows higher resistance to softening at elevated temperatures in comparison with typical hot work tools steels.



VTMPLUS® resistance to softening.
Curve obtained from specimens with cross section of 20 mm x 20 mm

IMPROVEMENT OF TOOL LIFE

Before starting operation, pre-heat slowly between 200-300°C, to obtain thermal homogenization of core and surface. Periodic stress relieving during the use of tools is recommended to improve the tool life.

PHYSICAL PROPERTIES

Density:

Temperature	g/cm³	lb/in³
20°C (68°F)	7.57	0.273

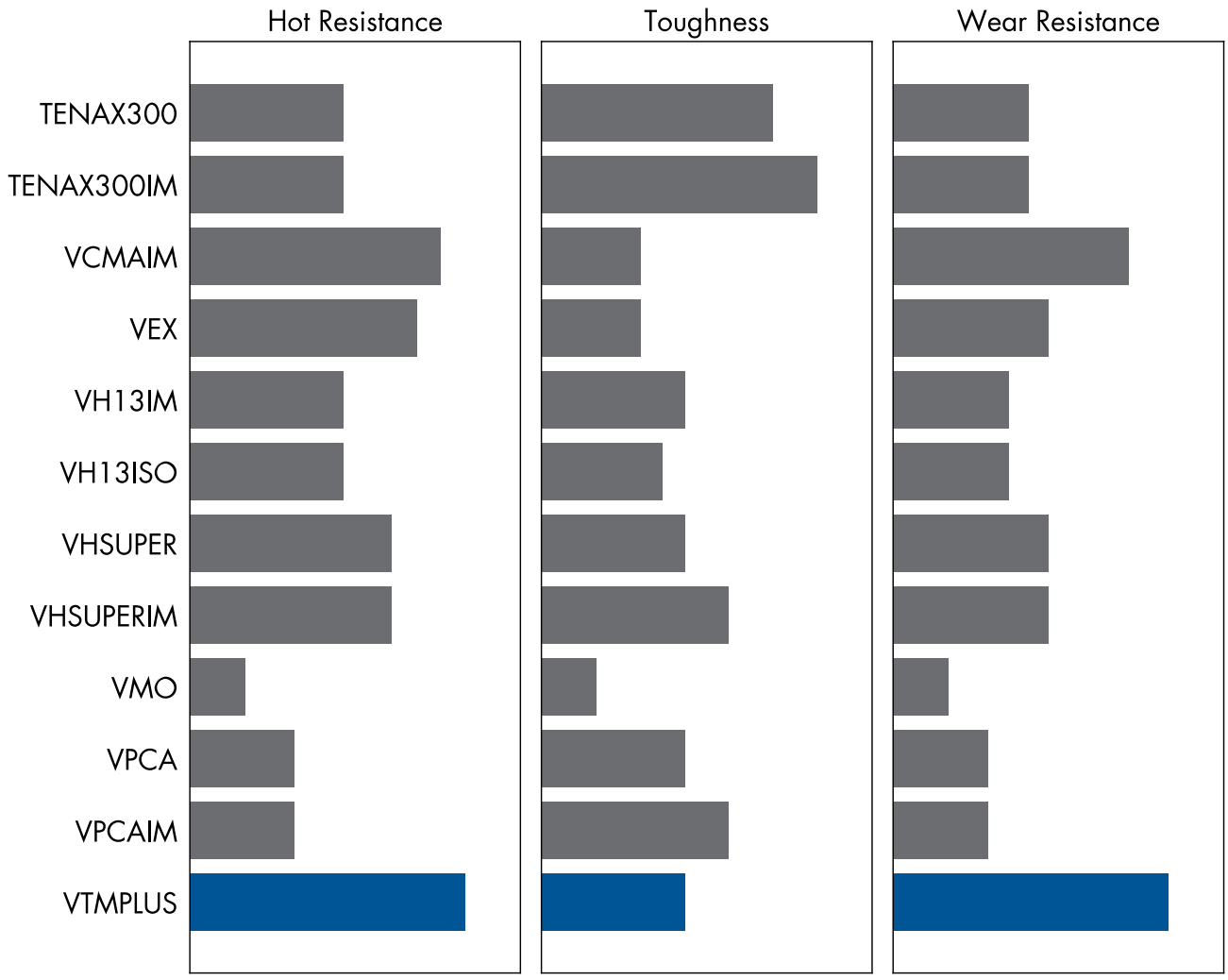
Thermal Conductivity:

Temperature	W/(m.K)	Btu.in/(h.ft².°F)
100°C (212°F)	25.4	176
200°C (392°F)	26.2	181
300°C (572°F)	27.6	191
400°C (752°F)	28.7	198
500°C (932°F)	30.0	208
600°C (1112°F)	31.9	221

Specific Heat:

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

COMPARISON BETWEEN VILLARES METALS HOT WORK STEELS



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ISO 50001

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NADCAP – Heat Treating and Non Destructive Testing

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