TENAX300®

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..

Edition 1, 01.2021

SIMILAR STANDARDS

TENAX300® is a modified AISI H11 grade with reduced Si and controlled residual elements. This steel is similar to UNS T20811, DIN X38CrMoV5-1 and W.Nr. 1.2343.

GENERAL INFORMATION

TENAX300® is a hot work tool steel with toughness considerably higher in comparison with other steels for the same application, as AISI H13 and AISI H11. TENAX300® presents higher thermal conductivity and an adequate response to nitriding and polishing.

MAIN CHARACTERISTICS

TENAX300® is a martensitic hot work steel intended to deliver high toughness associated with compatible mechanical resistance of AISI H13 and AISI H11 steels. Indicated for applications where the resistance to initiation and propagation of mechanical and thermal cracks are essential. In these situations, toughness is the most important property and determines the tool life. For higher toughness applications, consider the use of TENAX300IM® (ESR version). TENAX300IM® meets the quality required by NADCA 207 Grade E.

CHEMICAL COMPOSITION

Typical Analysis (Weight Percent)

C	Si	Mn	P	S	Cr	Mo	V	Fe
0,37	0,30	0,30	0.02 max	0.03 max	5,00	1,30	0,35	Bal.

STANDARD PRODUCTION RANGE

Production Route	Standard	Production Range	Finishing
Rolled Products	ASTM A681	Thickness between 8 and 152 mm with width between 25 and 320mm Rd. 5.50-152.40mm	Centerless ground Peeled Turned Milled
Forged Products		Rd. 152.40 – 760 mm Thickness up to 550mm with width up to 1000mm	Turned Peeled Milled

*Other dimensions and conditions are available upon inquiry.

DELIVERY CONDITION

TENAX300® is supplied in the annealed condition with a maximum hardness of 230HB. TENAX300® can be supplied in the hardened condition upon customer and supplier agreement.

Identification Colors: black, purple,  black

HEAT TREATMENTS

Soft Annealing

Soft annealing should be carried out by heat parts between 860 – 890 °C for two hours controlled by the core; cool slowly at a rate not exceeds 15°C per hour to 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. According to NADCA, stress relief is not recommended under temperatures of 560°C.

Hardening

The austenitizing temperature should be between 1010-1030°C. For better toughness performance, it is indicated 1010°C and for better heat resistance austenitize at 1030°C. The choice of the ideal temperature should also consider aspects of design and finishing details of the parts. The heating cycle shall provide preheating depending upon the geometry of the part. After austenitization, the quenching can be performed in different quench media as:

- Pressurized vacuum furnace with pressure higher than 5 bar, according to NADCA.
- Oil between 40-70°C.
- Salt bath between 500-550°C.

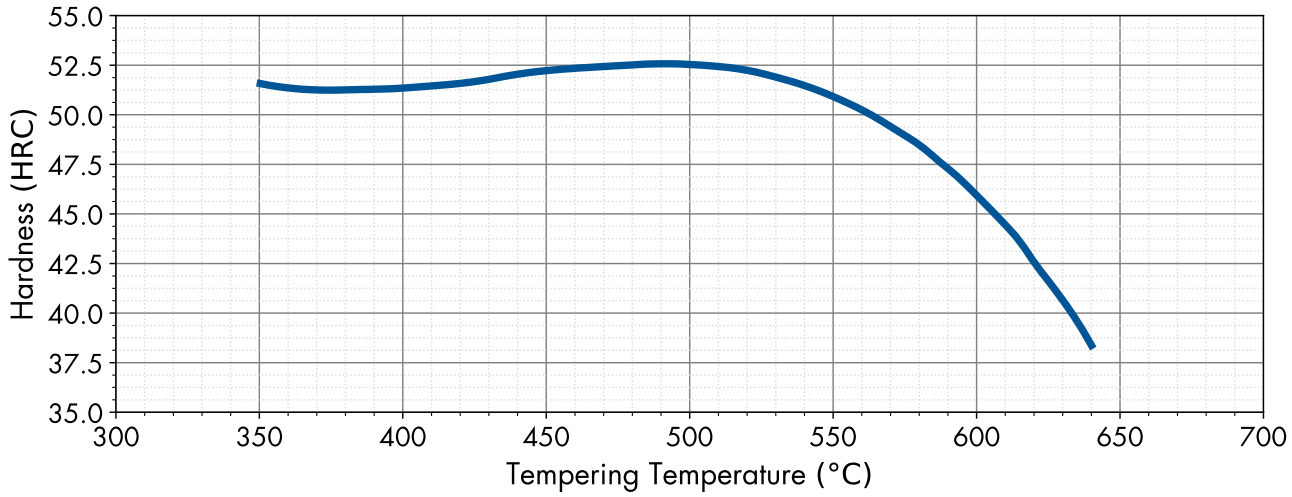
Tempering

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. 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

Surface treatments as nitriding, PVD and CVD are recommended when higher values of surface hardness and high abrasion wear resistance are required. Surface treatments shall be employed after hardening and tempering, since their temperatures is at least 50°C lower than the last tempering heat treatments.



Tempering curve of TENAX300IM® after hardening at 1020°C. Tempering time: 2 hours
Curve obtained from specimens with cross section of 20 mm x 20 mm

MAIN APPLICATIONS

TENAX300® is recommended for:

- Dies and components for die casting of aluminum alloys and other non-ferrous alloys, such as zinc, tin and lead,
- Tools for hot extrusion of Al alloys, brass and magnesium alloys, including hot-upsetting,
- Inserts, shear blades and all types of dies for hot work that involves shock,
- Injection molds for not chlorinated thermoplastic polymers, due to its high capability to polishing,
- For higher performance, consider use of TENAX300IM®.

MACHINABILITY

TENAX300® can be conventionally machined in the annealed condition. Care need to be taken in the selection of the tool and the speed 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 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. After grinding, it is recommended to perform a tempering heat treatment in temperature around 50°C lower than that of the last tempering.

WELDING

It is not recommended to perform welding operations on TENAX300® 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 TENAX300® might be welded using special procedures to minimize the HAZ.

The sequence of operations for repair welding TENAX300® 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.

IMPROVEMENT OF TOOL LIFE

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

PHYSICAL PROPERTIES

Density:

Temperature	g/cm³	lb/in³
20°C (68°F)	7.80	0.282

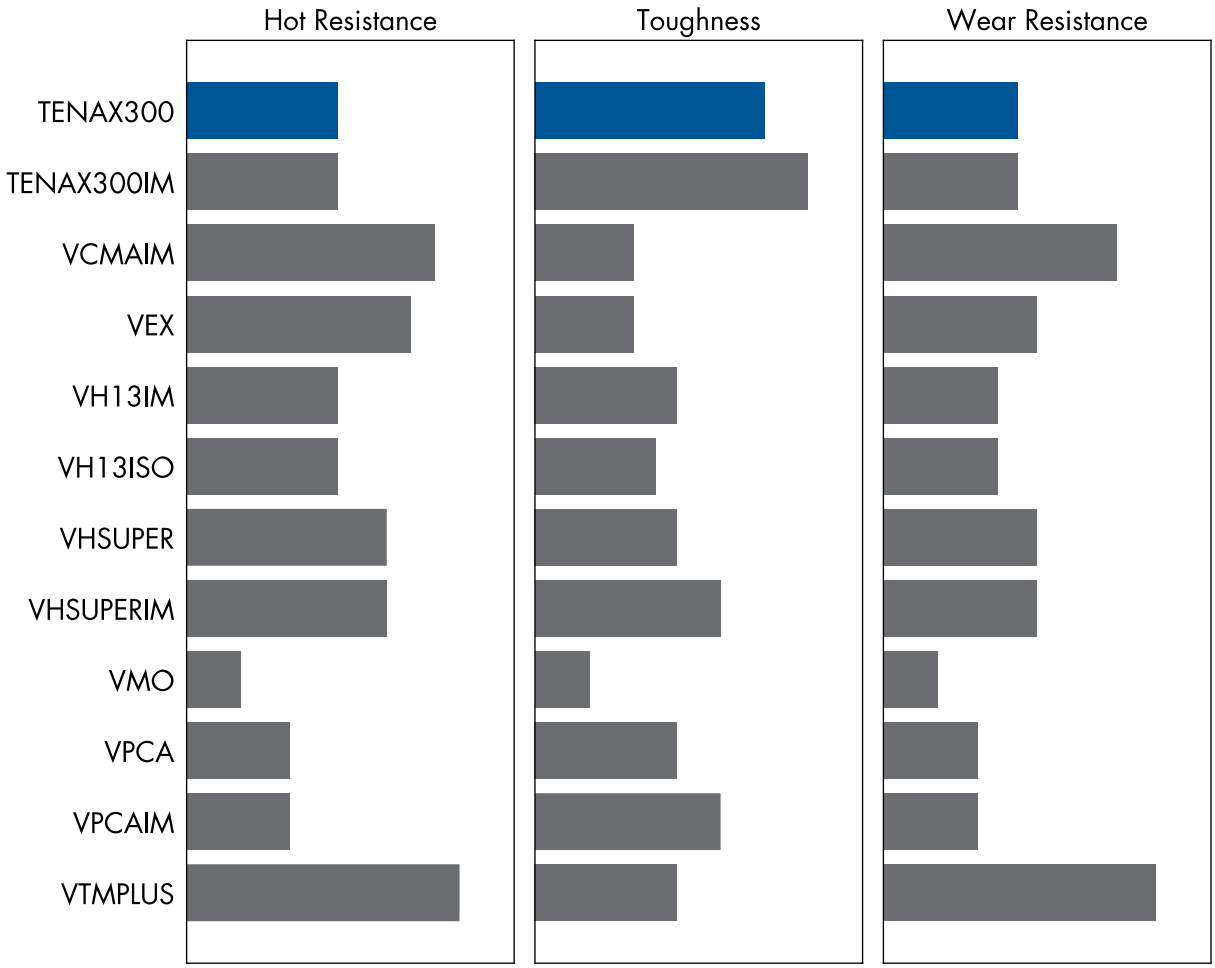
Thermal Conductivity:

Temperature	W/(m.K)	Btu.in/(h.ft².°F)
100°C (212°F)	23.0	159
350°C (662°F)	28.4	196
400°C (752°F)	33.4	231
675°C (1247°F)	30.1	208

Thermal Expansion Coefficient:

Temperature 20 °C to (68°F to)	10^{-6}m/m.K	10^{-6}in/in.°F
100°C (212°F)	10.5	5.8
200°C (392°F)	10.7	5.9
300°C (572°F)	11.0	6.1
400°C (752°F)	11.3	6.3
500°C (932°F)	11.7	6.5
600°C (1112°F)	12.1	6.7

COMPARISON BETWEEN VILLARES METALS HOT WORK STEELS



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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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