VD2®
Cold 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

VD2® corresponds to AISI D2 and it is similar to the following grades: DIN: X155CrVMo12-1 and W.Nr. 1.2379; BS BD2; JIS SDK11; AFNOR Z160CDV12; EN X160CrMoV12-1; UNS T30402. This steel is produced in accord with ASTM A681 and EN ISO 4957.

GENERAL INFORMATION

VD2® is a cold work tool steel with high-carbon, high-chromium and alloyed with molybdenum and vanadium. This steel presents high mechanical and wear resistance coupled with a high stability of hardening and tempering cycles.

MAIN CHARACTERISTICS

VD2® cold work steel presents a martensitic matrix alloyed with chromium, vanadium and molybdenum. This steel presents large amount of primary MC and M_2C carbides, which are responsible for a high abrasive wear resistance. Due to its microstructure and chemical balance, VD2® presents adequate properties for applications in cold work tooling where the abrasive wear resistance is essential for the application.

CHEMICAL COMPOSITION

Typical Analysis (Weight Percent)

C	Si	Mn	Cr	Mo	V	Fe
1,5	0,4	0,35	12,00	0,80	0,80	Bal.

STANDARD PRODUCTION RANGE

Production Route	Standard	Production Range	Finishing
Rolled Products	ASTM A681 EN ISO 4957	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 – 825 mm Thickness up to 400mm with width up to 800mm	Turned Peeled Milled

*Other dimensions and conditions are available upon inquiry.

DELIVERY CONDITION

Usually VD2® is available in round, square or flat bars in annealed condition with maximum hardness of 255 HB. This steel can also be supplied in the final heat treatment condition in accord with ASTM A681 and EN ISO 4957 standards.
Identification Color: purple, green, purple.

HEAT TREATMENTS

Soft Annealing

Soft annealing should be carried out by heating between 870 and 900°C for 1 hour for each inch of thickness, 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 500-600°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 790- 830°C in two steps, until the temperature from center to surface is equal in each step. The austenitizing temperature should be between 1000 and 1080°C. 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.
- Forced air cooling.

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 for VD2® are generally between 200 and 250°C for high hardness and between 500-600°C, for lower hardness. If the desired hardness is around 60HRC, tempering between 200 and 250°C shall be selected. 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

VD2® is an adequate substrate for nitriding. As nitriding temperature is normally higher than 500 °C, core hardness of nitrided tools is normally limited to 58 HRC. This fact can restrict nitriding application in some applications. PVD or CVD coatings are also available to be applied in VD2® if desired. The same discussion about treatment temperature and loss in core hardness is also important in this case.

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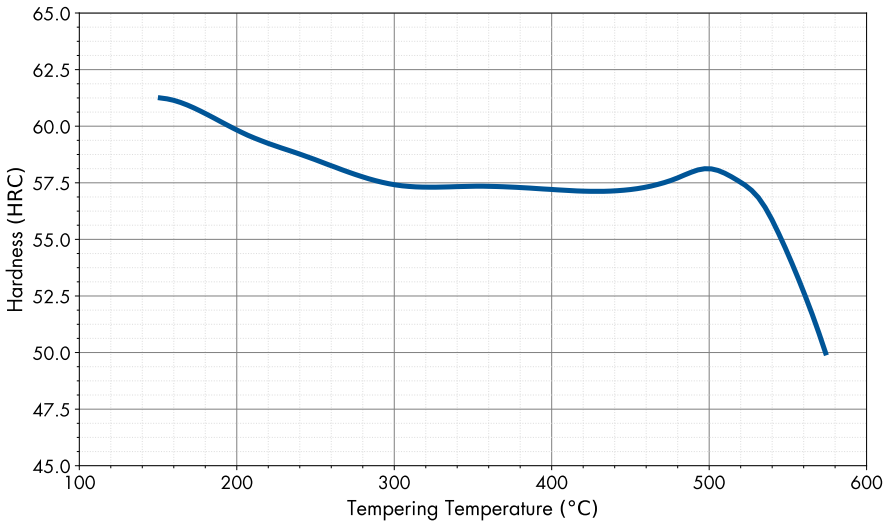


Tempering curve of VD2® after hardening at 1020°C. Tempering time: 2 hours
Curve obtained from specimens with cross section of 20 mm x 20 mm

MAIN APPLICATIONS

VD2® can be employed in several cold work tools including that where both high wear resistance and toughness are necessary. Some typical applications are:

- Blanking, piercing and coining dies
- Punches and dies used to cold form metals in stamping presses and extrusion.
- Tools for press forming dies.
- Deep drawing and thread-rolling dies.
- Blades for cold shearing flat materials, with thickness up to 13 mm (1/2 inches). Also for cold slitting up to 6.5 mm (1/4 inches),
- Cold rolling mill rolls
- Cold heading dies

MACHINABILITY

VD2® 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 during hardening and tempering. It is recommended to perform a stress relief heat treatment before hardening if more than 30% of part weight is removed during 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. 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 VD2® 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 welding is a temporary solution, VD2® might be welded using special procedures to minimize the HAZ.

The sequence of operations for repair welding VD2® 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

VD2® cold work tool steel presents a bend strength around 3000MPa with a total deflection of 2.0mm. In comparison with low alloyed cold work tool steel grades, the bend strength is lower however VD2® toughness values are higher in comparison with high speed steels.

PHYSICAL PROPERTIES

Density:

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

Specific Heat:

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

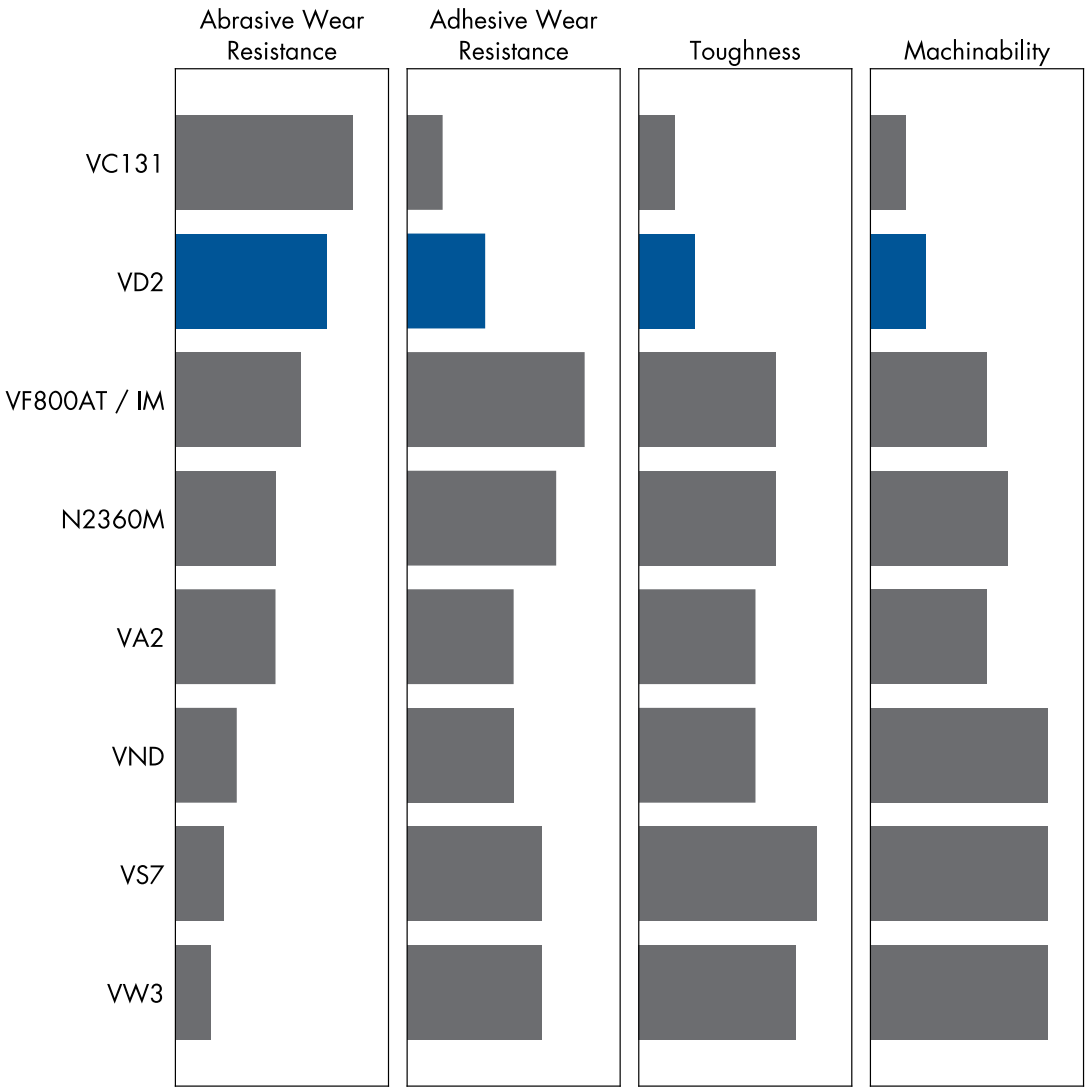
Thermal Conductivity:

Temperature	W/(m.K)	Btu.in/(h.ft².°F)
100°C (212°F)	20.9	145
315°C (599°F)	24.2	168
540°C (1004°F)	25.6	178

Thermal Expansion Coefficient:

Temperature 20 °C to (68°F to)	10^{-6}m/m.K	10^{-6}in/in.°F
100°C (212°F)	11.7	6.5
200°C (392°F)	12.0	6.7
300°C (572°F)	12.2	6.8
400°C (752°F)	12.7	7.0

COMPARISON BETWEEN VILLARES METALS COLD WORK STEEL



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AS 9100 D
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