

# HOT WORK TOOL STEELS

## Available Product Variants

Long Products

Open Die Forgings

## Product Description

BÖHLER W403 VMR is a vacuum remelted material which was developed as a problem solver for tools for where a standard solution is no longer sufficient. The steel can be assigned to the 5% chromium steels and has a very high purity due to the special manufacturing technology. In addition, the increased molybdenum content leads to improved thermal resistance as well as wear resistance, which makes BÖHLER W403 VMR an all-rounder that is often used for highly stressed dies in the die casting sector. In addition, Böhler W403 VMR has outstanding polishability. For this reason, the steel is also popular as a molding material for plastic injection molds.

## Process Melting

Airmelted + VAR

## Properties

- > Toughness & Ductility : high
- > Wear Resistance : high
- > Machinability : good
- > Hot Hardness (red hardness) : high
- > Polishability : very high
- > Thermal conductivity : very high
- > Micro-cleanliness : very high

## Applications

- > High Pressure Die-Casting
- > General Components for Mechanical Engineering
- > Press Hardening / Hot Stamping
- > Glasfibre reinforced plastics
- > Extrusion
- > Gravity / Low Pressure Die-Casting
- > Progressive Forging (Hatebur)
- > Forging (Hot / Semi-hot)
- > Injection Molding
- > Mechanical Engineering

## Technical data

Material designation		Standards	
~1.2367	SEL	#207	NADCA
~X38CrMoV5-3	EN		
C1885	NADCA		

## Chemical composition (wt. %)

C	Si	Mn	Cr	Mo	V
0.38	0.20	0.25	5.00	2.80	0.65

## Material characteristics

	High temperature strength	High temperature toughness	High temperature wear resistance	Machinability
<b>BÖHLER W403</b> <b>VMR®</b>	★★★★	★★★★	★★★★	★★★★
<b>BÖHLER W300</b> <b>ISOBLOC®</b>	★★	★★★★	★★	★★★★★
<b>BÖHLER W300</b> <b>ISODISC®</b>	★★	★★★	★★	★★★★★
<b>BÖHLER W302</b> <b>ISOBLOC®</b>	★★★	★★★★	★★★	★★★★★
<b>BÖHLER W302</b> <b>ISODISC®</b>	★★★	★★★	★★★	★★★★★
<b>BÖHLER W303</b> <b>ISODISC®</b>	★★★★	★★★	★★★★	★★★★★
<b>BÖHLER W350</b> <b>ISOBLOC®</b>	★★★	★★★★★	★★★	★★★★★
<b>BÖHLER W360</b> <b>ISOBLOC®</b>	★★★★★	★★★★	★★★★★	★★★★★
<b>BÖHLER W400</b> <b>VMR®</b>	★★	★★★★★	★★	★★★★

## Delivery condition

### Annealed

Hardness (HB)	max. 205
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## Heat treatment

### Annealing

Temperature	800 to 850 °C   1,472 to 1,562 °F	Holding time 6 to 8 hours. Slow, controlled furnace cooling at 10 to 20°C/h (50 to 68 °F/hr) to approx. 600°C (1112°F), further cooling in air.
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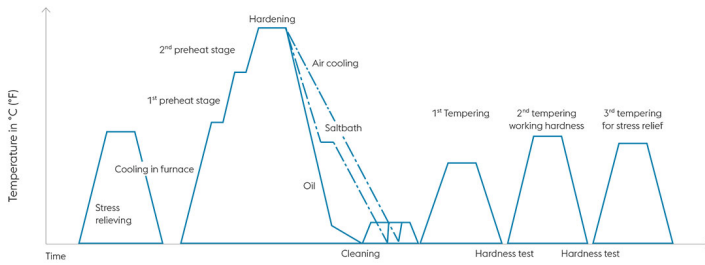
### Stress relieving

Temperature	600 to 670 °C   1,112 to 1,238 °F	For stress relief after extensive machining or for complicated tools. Holding time depending on tool size after complete heating 2 - 6 hours in neutral atmosphere. Slow furnace cooling.
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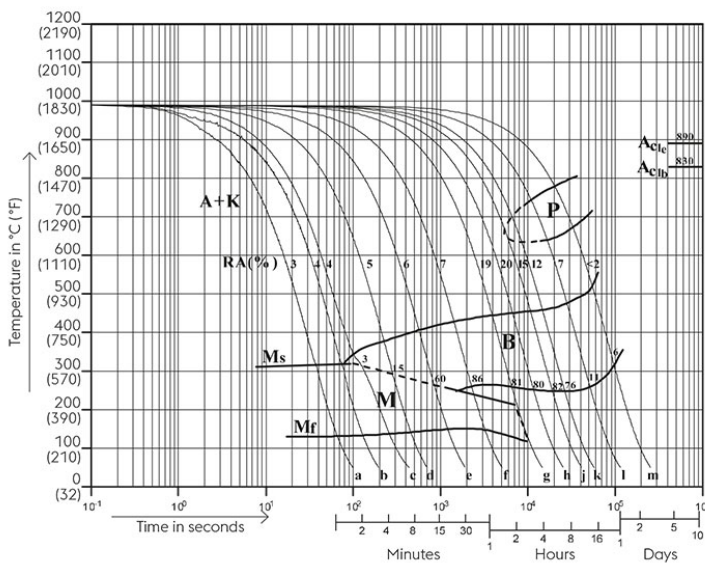
### Hardening and Tempering

Temperature	1,020 to 1,030 °C   1,868 to 1,886 °F	Holding time after temperature equalization: 15 to 30 minutes; In order to prevent coarsening of the grain, hardening must be carried out at the recommended temperature; Quenching: oil, salt bath (500 - 550°C [930 to 1020 °F]), air, inert gas in vacuum; After hardening, required tempering treatment to achieve desired working hardness (see tempering chart).
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### Heat treatment sequence



### Continuous cooling CCT curves

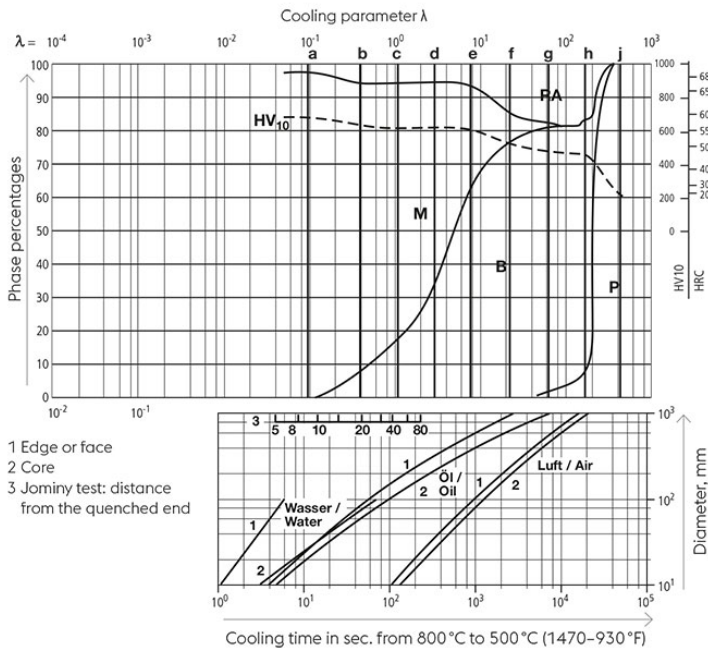


Austenitising temperature: 1025°C (1877°F)  
 Holding time: 15 minutes  
 5...100 phase percentages  
 0.5...180 cooling parameter, i.e. duration of cooling from 800 - 500°C (1472-932°F) in  $s \times 10^{-2}$

Table:  
 Sample  $\lambda$  HV10

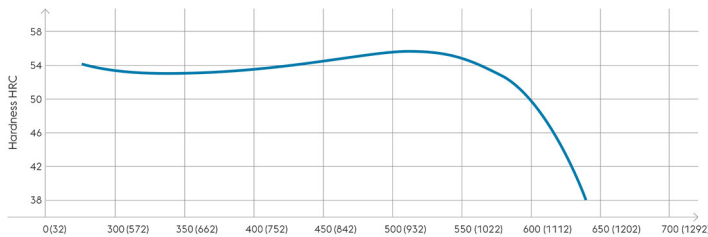
a	0,1	686
b	0,4	643
c	1,1	619
d	3	624
e	8	615
f	23	529
g	65	494
h	180	465
j	400	234

**Quantitative phase diagram**



A... Austenite  
B... Bainite  
K... Carbide  
M... Martensite  
P... Pearlite  
RA... Retained austenite

**Tempering chart**



Tempering:

Slow heating to tempering temperature immediately after hardening (time in furnace 1 hour for each 0,787 inch (20 mm) of workpiece thickness but at least 2 hours / cooling in air).

It is recommended to temper at least twice.

A third tempering cycle for the purpose of stress relieving may be advantageous.

1st tempering approx. 86°F (30°C) above maximum secondary hardness.

2nd tempering to desired working hardness. The tempering chart shows average tempered hardness values.

3rd for stress relieving at a temperature 86 to 122°F (30 to 50°C) below highest tempering temperature.

Hardening temperature: 1030°C (1886°F)  
Specimen size: square 20 mm

## Physical Properties

Temperature (°C   °F)	20   68
Density (kg/dm <sup>3</sup>   lb/in <sup>3</sup> )	7.85   0.28
Thermal conductivity (W/(m.K)   BTU/ft h °F)	29.8   17.22
Specific heat (kJ/kg K   BTU/lb °F)	0.47   0.1123
Spec. electrical resistance (Ohm.mm <sup>2</sup> /m   10 <sup>-4</sup> Ohm.inch <sup>2</sup> /ft)	-
Modulus of elasticity (10 <sup>3</sup> N/mm <sup>2</sup>   10 <sup>3</sup> ksi)	211   30.66

## Thermal Expansions between 20°C | 68°F and ...

Temperature (°C   °F)	100   212	200   392	300   572	400   752	500   932	600   1,112
Thermal expansion (10 <sup>-6</sup> m/(m.K)   10 <sup>-6</sup> inch/inch. °F)	10.63   5.9	10.83   6	12   6.7	12.92   7.2	14.13   7.9	14.34   8

For more information see <https://www.voestalpine.com/boehler-edelstahl/de/>

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