

# HOT WORK TOOL STEELS

## Application Segments

Hot Work

## Available Product Variants

Long Products

## Product Description

BÖHLER W400 VMR is a vacuum remelted material specially developed for tools with complex structures. The steel can be assigned to the 5% chromium steels and has a very high purity due to the special manufacturing technology. Because of its high degree of purity, the excellent homogeneity and the special alloying concept, BÖHLER W400 VMR is one of the hot work tool steels with the highest reachable toughness values. Therefore, this material is a problem solver in many areas when standard grades are no longer sufficient. In addition, Böhler W400 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 : very high
- > Wear Resistance : good
- > English (United Kingdom) : good
- > Hot Hardness (red hardness) : good
- > Polishability : very high
- > Thermal conductivity : very high
- > Micro-cleanliness : very high

## Applications

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

## Technical data

| Material designation |       | Standards |       |
|----------------------|-------|-----------|-------|
| 1.2340               | SEL   | #207      | NADCA |
| ~X37CrMoV5-1         | EN    |           |       |
| ~T20811              | UNS   |           |       |
| ~H11                 | AISI  |           |       |
| E1810                | NADCA |           |       |

## Chemical composition (wt. %)

| C    | Si   | Mn   | Cr   | Mo   | V    |
|------|------|------|------|------|------|
| 0.37 | 0.20 | 0.30 | 5.00 | 1.30 | 0.50 |

## Material characteristics

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

## Delivery condition

### Annealed

|               |          |
|---------------|----------|
| Hardness (HB) | max. 205 |
|---------------|----------|

## Heat treatment

### Annealing

|             |               |                                                                                                                                                 |
|-------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature | 750 to 800 °C | 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. |
|-------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------|

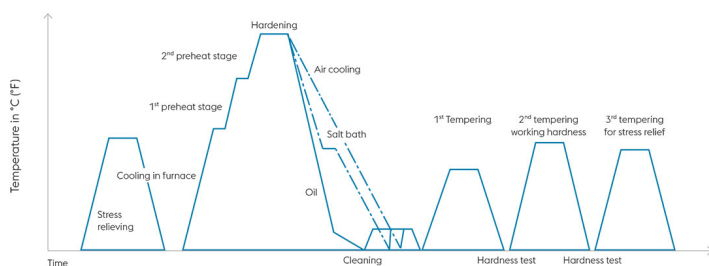
### Stress relieving

|             |               |                                                                                                                                                                                           |
|-------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature | 600 to 670 °C | 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. |
|-------------|---------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

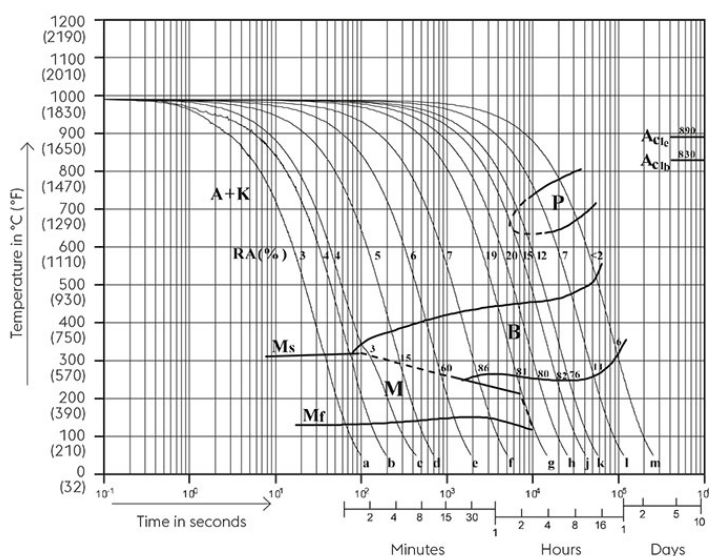
### Hardening and Tempering

|             |               |                                                                                                                                                                                                                                                                                                                                                                        |
|-------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Temperature | 980 to 990 °C | 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). |
|-------------|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## Heat treatment sequence



## Continuous cooling CCT curves

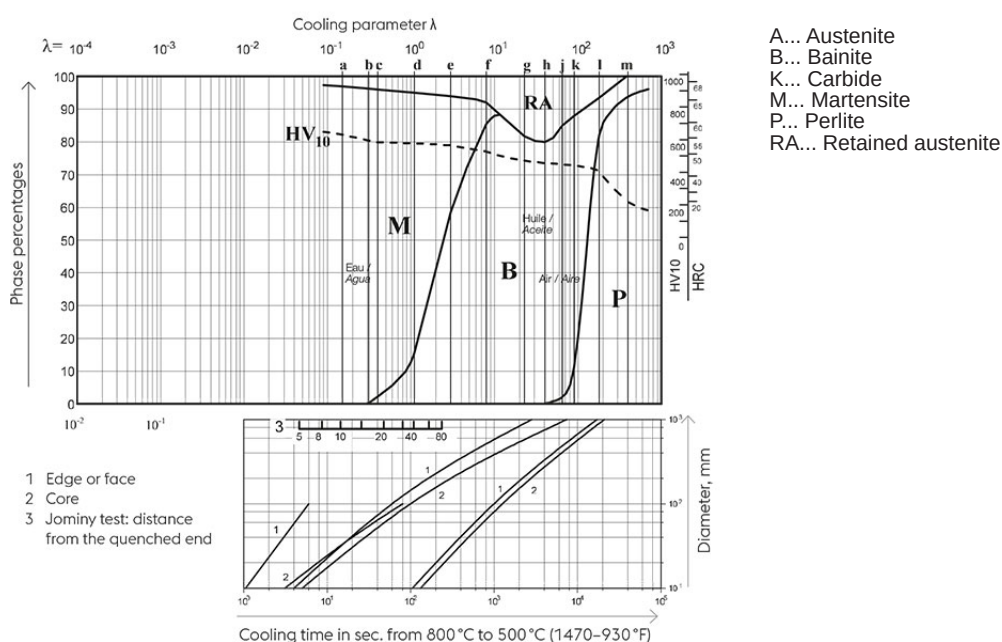


Austenitising temperature: 990°C (1814°F)  
Holding time: 15 minutes  
5...100 phase percentages  
0.15...400 cooling parameter, i.e. duration of cooling  
from 800 - 500°C (1472-932°F) in  $s \times 10^{-2}$

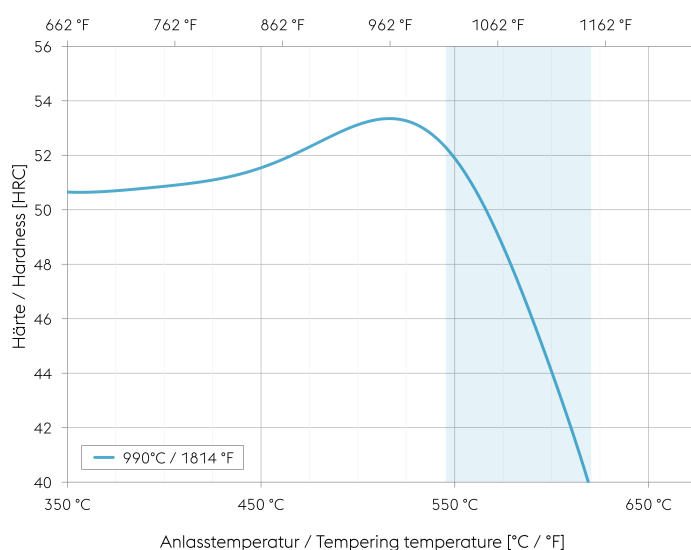
Table:

| Sample | $\lambda$ | HV10 | Sample | $\lambda$ | HV10 |
|--------|-----------|------|--------|-----------|------|
| a      | 0,15      | 647  | g      | 23        | 478  |
| b      | 0,31      | 619  | h      | 40        | 462  |
| c      | 0,40      | 590  | j      | 65        | 462  |
| d      | 1,1       | 595  | k      | 90        | 454  |
| e      | 3         | 582  | l      | 180       | 434  |
| f      | 8         | 546  | m      | 400       | 226  |

## Quantitative phase diagram



## 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.

Recommended tempering temperature range is indicated by the blue area in the chart.

Hardening temperature: 990°C (1814°F)  
Specimen size: square 20 mm

## Physical Properties

| Temperature (°C)                                           | 20   |
|------------------------------------------------------------|------|
| Density (kg/dm <sup>3</sup> )                              | 7.8  |
| Thermal conductivity (W/(m.K))                             | 31.5 |
| Specific heat (kJ/kg K)                                    | 0.46 |
| Spec. electrical resistance (Ohm.mm <sup>2</sup> /m)       | -    |
| Modulus of elasticity (10 <sup>3</sup> N/mm <sup>2</sup> ) | 211  |

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

| Temperature (°C)                             | 100 | 200  | 300  | 400  | 500 | 600  |
|----------------------------------------------|-----|------|------|------|-----|------|
| Thermal expansion (10 <sup>-6</sup> m/(m.K)) | 11  | 11.2 | 11.9 | 12.7 | 14  | 14.3 |

If other available product variants are listed in addition to long products, please note that these may differ in terms of melting process, technical data, delivery and surface condition as well as available product dimensions. For mandatory technical specifications, other requirements and dimensions, please contact our regional voestalpine BÖHLER sales companies. The data contained in this brochure is merely for general information and therefore shall not be binding on the company. We may be bound only through a contract explicitly stipulating such data as binding. Measurement data are laboratory values and can deviate from practical analyses. The manufacture of our products does not involve the use of substances detrimental to health or to the ozone layer.