YOUR PARTNER FOR
HIGH SPEED STEELS, TOOL STEELS
AND SPECIAL MATERIALS
FOR THE WORLD’S TOP PERFORMERS

METALLURGICAL KNOW-HOW SINCE 1870.

For generations worldwide customers appreciate the highest steel quality from BÖHLER.

We produce SPECIAL STEEL FOR THE WORLD’S TOP PERFORMERS and our standard is to provide the best solution every time – whether in manufacturing technology, materials development, or customer service.

With an international sales and service network we are always close to our customers – worldwide.

WELCOME TO BÖHLER.
It is impossible to imagine our modern world without special steel. This material will continue to drive success and growth in crucial branches of industry, both in direct components and in the tools used to shape them.
FOR THE WORLD’S BEST STEEL GRADES

Flow of material

Melting | Secondary metallurgy | Casting / Melting | Remelting | Powder metallurgy
Rolling and Forging

Heat Treatment

Machining

Testing

Dispatch

52 MN Press

Rotary forging machine

Cogging Mill

Multiline Rolling Mill

Turning

Grinding

Milling

Peeling

Wire forming

Precision forming

Stock

Shipment

Turning

Grinding

Milling

Peeling

Wire forming

Precision forming
What do we stand for?

We develop, produce and deliver high speed steels, tool steels and special materials worldwide, to provide our customers with customized solutions.

**MICROCLEAN**
Powder metallurgical steels

**VMR**
Special materials subjected to vacuum refining or melting during at least one stage of manufacture.

**ISOPLAST**
Plastic mould steels in ESR quality

**ISODUR**
Cold work tool steels in ESR quality

**ISORAPID**
High speed steels in ESR quality

**ISOBLOC**
Hot work tool steels in ESR quality with special heat treatment

**ISODISC**
Hot work tool steels in conventional quality with special heat treatment

**EXTRA**
Special property and/or achievement characteristics

**BÖHLER ©HT**
Bars hardened and tempered

**AMPO**
Additive Manufacturing Powder
### PRODUCT RANGE

#### Materials

**High speed steels**

**Tool steels**
- Cold work tool steels
- Hot work tool steels
- Plastic mould steels

**Special materials**
- Special constructional steels
- Stainless steels
- Creep resisting steels
- Heat resisting steels
- Valve steels
- Steels with special physical properties
- Steels for particular applications
- Ni base alloys

#### Products

**BAR STEEL rolled**
- round: 12.5 – 150 mm
- square: 15 – 150 mm
- flat: width 15 – 60 mm, thickness 5 – 41 mm

**ROLLED WIRE**
- rolled (dia.): 5.0 – 13.5 mm
- drawn (wire, bar steel): 0.6 – 13.3 mm Ø
- round (bar steel): 2.0 – 28.0 mm Ø
- peeled (wire): 4.5 – 13.0 mm Ø
- BHT (hardened and tempered) bar steel: 3.0 – 20.0 mm Ø
- flat or profiled wire: 0.5 – 40.0 mm²

**BAR STEEL forged**
- round: 101 – 1150 mm
- square: 110 – 1150 mm
- flat: width 107 mm minimum, thickness 70 mm minimum

#### BAR STEEL pre-machined
- IBO ECOMAX 12.5 – 315 mm (on request up to 900 mm)

#### BRIGHT STEEL
- BRIGHT STEEL ground and polished
- ECOBLANK peeled and polished
- ECOFINISH band ground

#### Surface finish
- Black (abrasive blasted); pickled; machined (turned, peeled, polished h12 – h9); ground – polished

#### Forgings
- Open-die forgings of a gross weight of up to 45t: unmachined, premachined, machined ready for mounting. Machining of rolled, forged and cast components on state-of-the-art machines.

#### Industries
- Automotive industry, aviation industry, turbine construction, toolmaking industry, general mechanical engineering, offshore industry, energy engineering, medical technology
COLD WORK TOOL STEELS
3 QUALITY LEVELS – 3 TECHNOLOGIES

Conventional Manufacture

Ingot casted cold work tool steel
The conventional steel quality for standard tooling applications.

ESR / PESR Manufacture

Improved service life due to:
- Least possible inclusion content
- Lower micro and macro segregation
- Good homogeneity and a higher degree of purity
- Homogeneous structure throughout the entire cross-section and bar length
- Producing larger bar dimensions at a constant carbide distribution
- Uniform size change
- Broad range of application owing to a high degree of toughness

Powder Metallurgical Manufacture

For the highest demands:
- Finest carbide distribution
- Highest metallurgical purity
- Segregation free high performance steel
- Isotropic properties
- Maximum wear resistance with a simultaneously higher toughness
- High degree of hardness
- Very good dimensional stability
- High compressive strength
- Good polishability
The reason for using quality tool materials is obvious, as the material amount of a high performance tool is often only 5% of the total value of a tool, yet it extends the lifetime of tools many times. In a word, it's a direct commercial advantage in production.
BÖHLER K340 ISODUR is a universal cold work tool steel with which you’ll be making money – and not just when blanking coins, but also when blanking, cutting, cold rolling, extruding, deep drawing, bending.

In applications where materials with good wear resistance and compressive strength coupled with excellent toughness are required, BÖHLER K340 ISODUR has proved itself to be the all-rounder among tool steels.

**Advantages compared to ledeburitic 12% Cr-steels and conventional 8% Cr-steels**
- Homogeneous structure throughout the entire cross-section and length
- Production of bars with greater diameters and a good distribution of carbides
- Uniform, solely minor dimensional changes
- High toughness providing a wider scope of application
- Increased compressive strength, a particular advantage for critical tools
- Improved machinability due to the homogeneous structure

**Reasons why BÖHLER K340 ISODUR is so cost-efficient**
- 8% Cr-steel with a modified chemical composition
- High toughness and outstanding compressive strength
- Excellent adhesive wear resistance thanks to special alloy additions
- High abrasive wear resistance
- Very good resistance to tempering
- Secondary-hardening cold work tool steel with good dimensional stability
- Outstanding EDM machinability
- Very well suited to salt-bath, gas and plasma nitriding
- Can be PVD coated well
- Well suited to vacuum hardening
- Thanks to the chemical composition and the manufacturing process, this steel has finer and more evenly distributed carbides than ledeburitic 12% Cr-steels (AISI D2) and conventional 8% Cr-steels. This gives the steel its improved toughness properties.

**Application fields**
Forming and punching tools e.g. dies and punches, cold working tools e.g. tools for deep drawing or extrusion, coining tools, bending tools, thread rolling tools, industrial knives, machine components (e.g. guide rails)
Innovation
BÖHLER's new cold work tool steel K490 MICROCLEAN closes the gap in the material demands between wear resistance and the desired toughness on a very high level.

Flexibility
A further advantage of this powder metallurgical cold work tool steel, being produced in a plant of the newest generation, lies in the good machinability and the high flexibility of its heat treatment, which allows variable heat treatment cycles without affecting the mechanical properties.

Cost-Efficiency
These excellent properties guarantee a risk-free, more flexible and faster – that is economically efficient – tool manufacture.

Versatility
BÖHLER K490 MICROCLEAN is a greatly improved and more efficient cold work tool steel compared with other commonly used PM steels such as M4 or PM23. Toughness is more than doubled with a similar wear resistance.

BÖHLER K490 MICROCLEAN's balanced properties can be made use of in a wide range of applications, making it a real PM all-rounder for cold work tool steel applications.

Blanking and punching industry
- Cutting tools (dies, punches) for normal and precision blanking
- Cutting rolls

Cold forming applications
- Extrusion tooling (cold and warm forming)
- Drawing and deep-drawing tools
- Stamping tools
- Thread rolling tools
- Cold rolls for multiple roller stands
- Cold pilger rolling mandrels
- Compression moulding dies for the ceramics and pharmaceutical industries
- Compression moulding dies for the processing of sintered parts

Industrial knives

Saves time and money
Speed is vital in component manufacture. Process time from prototype to finished tooling is drastically reduced. Tools of complicated design and high quality can be produced quickly and efficiently.

Benefits
- Shorter and cheaper production processes due to a flexible heat treatment and an excellent hard machinability
- Higher tool life due to the excellent and stable mechanical properties

Properties
- High hardness (64 HRC)
- Very good toughness
- High abrasive and adhesive wear resistance
- Excellent hard machinability
- High compressive strength
- Heat treatment together with common cold work steels (1.2379, D2) at hardening temperatures from 1030 to 1080 °C possible
- Stable mechanical properties

Samples taken from a rolled steel bar in longitudinal direction, heat treated at a cooling rate of: \( \lambda \leq 0,5 \)
Primary material size: rund / round 35 mm
Sample size: 10 x 7 x 55 mm
Heat treatment parameters for:
- BÖHLER K490 MICROCLEAN: 1080 °C, 3 x 2 h, 560 °C
- 1.2379/D2: 1070 °C, 3 x 2 h, 520 °C

Determined by the Rubber-Wheel-Dry-Sand test according to ASTM G65
Samples taken from a rolled steel bar in lateral direction, center
Primary material size: rund / round 70 mm
Sample size: 60 x 25 x 8 mm, Ra < 0,8 µm
Heat treatment parameters for:
- BÖHLER K490 MICROCLEAN: 1080 °C, 3 x 2 h, 560 °C
- 1.2379/D2: 1070 °C, 3 x 2 h, 510 °C

Samples taken from a rolled steel bar in longitudinal direction, heat treated at a cooling rate of: \( \lambda \leq 0,5 \)
Primary material size: rund / round 35 mm
Sample size: 10 x 7 x 55 mm
Heat treatment parameters for:
- BÖHLER K490 MICROCLEAN: 1080 °C, 3 x 2 h, 560 °C
- 1.2379/D2: 1070 °C, 3 x 2 h, 520 °C

Determined by the Rubber-Wheel-Dry-Sand test according to ASTM G65
Samples taken from a rolled steel bar in lateral direction, center
Primary material size: rund / round 70 mm
Sample size: 60 x 25 x 8 mm, Ra < 0,8 µm
Heat treatment parameters for:
- BÖHLER K490 MICROCLEAN: 1080 °C, 3 x 2 h, 560 °C
- 1.2379/D2: 1070 °C, 3 x 2 h, 510 °C

Properties
- High hardness (64 HRC)
- Very good toughness
- High abrasive and adhesive wear resistance
- Excellent hard machinability
- High compressive strength
- Heat treatment together with common cold work steels (1.2379, D2) at hardening temperatures from 1030 to 1080 °C possible
- Stable mechanical properties
Materials used for cutting, punching and blanking of high-strength and ultrahigh-strength sheets

Tool steels – sheet materials

- **Cast iron tools**
- **Boehler K110**
- **Boehler K340**
- **Boehler K380**
- **Boehler K400**
- **Boehler K390**
- **Boehler K490**
- **S390**

Legend:
- **ULC** Ultra low carbon steels
- **LC** Low carbon steels
- **HSIF** High strength IF steels
- **Isotrop** Isotropic steels
- **BH** Bake-hardening steels
- **HSLA** High-strength low alloyed steels
- **TRIP** Transformation induced plasticity steels
- **DP** Dual phase steels
- **PM** Partial martensitic steels
- **PHS** Presshardened steels

Fracture strain Av (%)

Tensile strength (MPa)
Evaluation of material properties in blanking and cutting applications (please note: The comparison is strongly dependent on the heat treatment conditions and applicable for the brands within this table only):

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Wear resistance abrasive</th>
<th>Wear resistance adhesive</th>
<th>Toughness</th>
<th>Compressive strength</th>
<th>Dimensional stability in heat treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOHLER K100</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K110</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K305</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K310</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K350</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K360</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K390</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K455</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K490</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K500</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER K590</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER S600</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER S290</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER S390</td>
<td>★★★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER S690</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>BOHLER W360</td>
<td>★</td>
<td>★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
</tbody>
</table>

For specific applications and selection of proper material and working hardness please refer to our technical sales staff.
HOT WORK TOOL STEELS

Tool load

Hot work tool steels applied in hot forming processes such as die casting, forging or extrusion may be damaged on multiple and complex occasions. Damages may arise by collective stress factors combining high mechanical strengths, high temperatures and temperature gradients, whereas the individual stress factors dependent on process type and processing exert variably strong effects on the material. Material hardness, material strength, toughness, ductility and thermal conductivity are vital hot work tool steel properties when it comes to damage mechanisms to be avoided or delayed.

As the leading producer of tool steels worldwide BÖHLER is focused on offering solutions for the demanding requirements on hot working tool steels.

Hot wear resistance, hot toughness, hot strength, retention of hardness, thermal shock resistance as well as thermal conductivity are characterized not only by the composition of the hot work tool steel but are metallurgical features regulated during the melting and re-melting process.

Our experience and on-going research lead to the continuous improvement of the metallurgical properties by further developments in the melting and re-melting process of hot work tool steels and their heat treatment.

3 qualities for special applications:

ISO DISC®
- Conventional hot work tool steels
- Special heat treated

ISO BLOC®
- Hot work tool steels, ESR quality
- Special heat treated

VMR®
- Hot work tool steels, VAR quality
- Special heat treated

Production routes for BÖHLER hot work tool steels

<table>
<thead>
<tr>
<th>Melting</th>
<th>Secondary Metallurgy</th>
<th>Casting</th>
<th>Remelting</th>
<th>Homogenising</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ladle Furnace</td>
<td>Ingot Casting</td>
<td>ESR</td>
<td>Forging or Rolling</td>
<td>Special Heat Treatment</td>
</tr>
<tr>
<td>Vacuum Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The quality of a tool made of hot work tool steel is defined by its mechanic-technological properties. It largely depends on the metal alloy’s chemical composition, on the tool material’s production process (electro slag remelting, vacuum remelting, forging and annealing technologies) and finally on the tool’s heat treatment.

**Heat treatment**

In order to achieve high toughness in tools, the cooling rate from the hardening temperature is of major importance. Cooling rate is primarily dependent on the tool size.

With increasing tool thickness, resulting in a reduced quenching rate, a change of microstructure occurs, leading to a significant decrease of toughness.

### Damage mechanisms

- **Thermal fatigue**
- **Crack networks**
- **Erosion**
- **Gross cracking**
- **Stress cracks**
- **Chemical attack**

### Tool steel properties

- **Hardness**
- **Strength**
- **Toughness**
- **Ductility**
- **Thermal conductivity**

### Cooling chart

- **DIN 1.2343 / H11**
- **Temperature (°C)**
  - 1100
  - 900
  - 700
  - 500
  - 300
  - 100
  - 0
- **Time (s)**
  - 0
  - 10
  - 100
  - 1000
  - 10000
  - 100000
- **Microstructure**
  - Pearlite
  - Bainite

### Toughness comparison

- **DIN 1.2343 / H11**
- **Toughness Charpy-V (J)**
  - 18
  - 16
  - 14
  - 12
  - 10
  - 8
  - 6
  - 4
  - 2
  - 0
- **44 HRc**
- **47 HRc**
- **1 Fast quenched**
- **2 Slowly quenched**

**NADCA material approval**

- **BÖHLER W300 ISOBLOC**
- **BÖHLER W302 ISOBLOC**
- **BÖHLER W350 ISOBLOC**
- **BÖHLER W400 VMR**
- **BÖHLER W403 VMR**
With the development of **W350 ISOBLOC**, BÖHLER Edelstahl allows large tool sizes for complex loads in hot forming and for effects of heat treating.

A balanced alloy composition ensuring high toughness even in large tools and an improved thermal stability opts for an optimal hardness/strength-toughness/ductility ratio (elongation after fracture and percentage reduction of area after fracture) tailor-fit to every application.

A pressurized remelting process (pressure ESR) coupled with optimized forging technology in three dimensions guarantees a high degree of homogeneity of the microstructure and the material properties. A high degree of purity can also be realized.

Hot work steel BÖHLER W350 ISOBLOC is characterized by a significantly higher level of toughness for a fast and a slow cooling from the hardening temperature compared with standard materials DIN 1.2343 and 1.2367.

The reduced cooling velocity leads to a significant decrease of toughness. If the hardness is increased, the decrease in toughness is even higher.
FORGING

The demands on forging die steels are primarily determined by the respective forging process but also by the shape and properties of the material the components are to be made of. As a result, the demands on the die steel are derived, such as:

- High thermal shock resistance
- High hot strength
- High retention of hardness
- Exceptional high hot toughness
- High hot wear resistance
- Improved thermal conductivity
- Good heat checking resistance

Drop forging

Drop forging is carried out by impacting material with a hammer or by applying a great amount of pressure with a forging press or forging machine.

When forging with a hammer the forging piece is only in contact with the die for a short period of time. Due to this, the die has to withstand lower temperatures. However, the mechanical stress is high. Thus, it is quite important for the hot work tool steel used to have very good toughness properties.

Compared with that, the contact during forging pressing occurs over a longer period of time, which then causes a higher temperature strain on the tool. Thus, in such a case hot work tool steels with a chromium-molybdenum base are used, which are singled out as having good tempering resistance, high temperature strength, hot wear resistance, and hot toughness.

Rapid forging

A fully automatic multi-stage press is forging equipment that produces even the most difficult shapes from materials hard to deform in several stages of deformation. This equipment mostly produces rotation symmetric parts. Heating the slugs, feeding, shearing and deforming take place completely automatically.

Semi hot forging

The term semi hot forging refers to a deformation process in which the workpiece is preheated to such a point that permanent strain hardening occurs under the given deformation conditions. This definition means that the material is deformed below the recrystallization temperature, yet the term is also used for temperatures occurring above this. In practice this is understood to be the deformation of steel in the temperature range of 650 to approx. 950 °C. These temperatures lie significantly below the conventional forging temperatures of 1100 – 1250 °C.

<table>
<thead>
<tr>
<th>Requirement profile</th>
<th>Drop forging with hammer</th>
<th>Drop forging with press</th>
<th>Semi hot forging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear resistance</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Retention of hardness</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>High temperature strength</td>
<td>★★★</td>
<td>★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Heat checking resistance</td>
<td>★</td>
<td>★</td>
<td>★</td>
</tr>
<tr>
<td>High temperature toughness</td>
<td>★★★★★</td>
<td>★★★★</td>
<td>★★</td>
</tr>
</tbody>
</table>
BÖHLER W360 ISOBLOC was developed as a tool steel for dies and punches in semi-hot and hot forging. It owes its excellent properties to a patented alloying concept and the electroslag remelting (ESR) process. This grade can be used for a variety of applications where hardness and toughness are required.

Properties
- High hardness (recommended in use: 52 – 57 HRc)
- Exceptional toughness
- High temper resistance
- Good thermal conductivity
- Can be cooled with water
- Homogeneous microstructure

Applications and uses
- Dies and punches in warm and hot forging
- Tooling for high speed presses
- Toughness-critical cold work applications
- Extrusion tooling, e.g. dies
- Core pins and inserts in die-casting dies
- Specific applications in the plastic processing sector

Toughness
The toughness of hot work tool steels is one of the most important properties for safety against fracture and increased resistance to heat-checking and thermal shock. High hardness is usually associated with low toughness. This is not the case for W360 ISOBLOC.

Hot hardness
Alongside the outstanding toughness, W360 ISOBLOC is distinguished by its high thermal stability. This is reflected in the high hot hardness and the stability of the material under thermal loading. These properties, combined in W360 ISOBLOC, ensure a high resistance to thermal fatigue and catastrophic failure.

At 51 HRc, BÖHLER W360 ISOBLOC has a higher hot hardness than 1.2885 and 1.2367. If the hardness of BÖHLER W360 ISOBLOC is increased to 57 HRc, then the result is a further increase in the hot hardness.

Looking at the toughness over tempering temperature (hardness), it can be seen that the toughness of BÖHLER W360 ISOBLOC is almost constant from 51 to 57 HRc.
Rod extrusion

Highly stressed extrusion tools require a high degree of metal-lurgical cleanliness, excellent homogeneity and best toughness at high working hardness. These requirements are met by selected BÖHLER hot work tool steels for the extrusion industry.

- Increased heat checking resistance
- Reduced hot wear
- Increased hot strength
- Higher working hardness
- Longer tool life

That increases the productivity, lowers the unit costs and makes the final product more competitive.

<table>
<thead>
<tr>
<th>Requirement profile</th>
<th>Mantle</th>
<th>Liner holder</th>
<th>Liner</th>
<th>Stem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wear resistance</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★</td>
</tr>
<tr>
<td>Hot hardness</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>High temperature strength</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Creep resistance</td>
<td>★★★★★★</td>
<td>★★★★</td>
<td>★★★</td>
<td>★★</td>
</tr>
<tr>
<td>Heat checking resistance</td>
<td>★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★</td>
</tr>
<tr>
<td>High temperature toughness</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
</tbody>
</table>

Evaluation of material properties

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>High temperature strength</th>
<th>High temperature toughness</th>
<th>High temperature wear resistance</th>
<th>Machinability</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOHLER W300</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W301</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W302</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W303</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W320</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W321</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W350</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W360</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W400</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W403</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>BOHLER W500</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★★</td>
</tr>
</tbody>
</table>

Maraging steels (ageing temperature about 480 °C), in this form not comparable with the heat treatable steels.

For specific applications and selection of proper material and working hardness please refer to our technical sales staff.
To meet the highest demands BÖHLER plastic mould steels are the ultimate solution to any application in the manufacture of mould and machine parts, meeting the highest expectations of users as regards shape, function, aesthetics, product quality and durability. BÖHLER steels are of a guaranteed consistent quality and developed for the most stringent future demands.

As a mould maker you certainly know of all the demands a product should meet. BÖHLER, therefore, offers you competent material consulting on the steel, its properties and the heat treatment to meet your requirements best.
BÖHLER M268 VMR is a hardened and tempered plastic mould steel with excellent cleanliness for best polishability. The hardness is constant over the entire cross-section of the steel block, even at large sizes, due to the addition of nickel.

**Applications**
Moulds for plastics processing, components for general mechanical engineering and tool manufacture where highest polishability and fatigue strength are required.

**Condition of supply**
Hardened and tempered to 350 – 400 BHN, High-hard. Generally, no heat treatment is required. If heat treatment is carried out, e.g. to obtain an increase in strength, the instructions given in this brochure should be observed.

**Mirror Polishability**
The excellent cleanliness of BÖHLER M268 VMR, achieved by the vacuum remelting technology, has a positive impact on the polishability of large moulds and complex geometries.

**Optimizing of cycle times**
The high thermal conductivity guarantees a reduction of cycle time and increases the efficiency of the production process.

---

**Further advantages of our hardened and tempered plastic mould steel BÖHLER M268 VMR:**
- Suitable for all nitriding processes to improve wear resistance
- Can be hard chromium plated. Suitable for every type of galvanic surface treatment used to optimize hardness and corrosion resistance
- Suitable for PVD coating, providing excellent adhesion conditions for the TiN-layer
- The material can be induction-hardened if necessary
- Suitable for photo-etching

**Advantages and benefits**
The economic and technological advantages of BÖHLER M268 VMR at a glance:

**Higher quality**
- Uniformly high strength and toughness, even at larger sizes
- High through hardenability
- Excellent thermal conductivity

**Efficient tool making**
- No heat treatment required
- Excellent, high polishability
- Good texturing properties
- Good electrical discharge machining properties

**Reliability**
- The material does not require heat treatment, reducing the risk of errors
- The good toughness decreases the risk of cracking during service

= Improved productivity and cost reduction
The new classic

BÖHLER M303 EXTRA is a corrosion resistant martensitic chromium steel, offering excellent toughness, corrosion and wear resistance. It is characterized by improved machinability and polishability.

And what is special about it – BÖHLER M303 EXTRA was developed for improved homogeneity ensuring excellent usage properties. And the outcome is – compared to 1.2316 – the prevention of delta ferrite in the matrix.

This material is also offered by BÖHLER in the "High-Hard"-version, with a significantly better wear resistance.

Comparisons made with 1.2316 show that BÖHLER M303 EXTRA has a more regular and improved toughness over the block zones thus ensuring a better fracture resistance and avoiding unexpected downtimes.

In the case of 1.2316, the hard carbide phases being imbedded in the soft delta ferrite zone, are causing an irregular polish. In contrast BÖHLER M303 EXTRA shows regular polish.
A product is only as good as the surface finish of the tool in which the product is formed. Particularly in the field of mirrored finishes no mistakes are condoned. Irregularities on the surface are immediately visible. Until now it has been particularly time-consuming and costly for toolmakers to produce inserts with a mirrored finish. That effort was coupled with the fact that the finished results were less than satisfactory.

**Advantage of BÖHLER M333 ISOPLAST at a glance:**
- Optimum polishability for mirror finish
- Improved thermal conductivity
- Exceptional toughness and hardness
- Very good corrosion resistance

Mean values of the findings of several Austrian and German companies regarding time and quality after mechanical and hand-polishing of 6 samples of each material.
BÖHLER M390 MICROCLEAN is a martensitic chromium steel produced with powder metallurgy. Due to its alloying concept this steel offers extremely high wear resistance and high corrosion resistance – the perfect combination for best application properties.

- Extremely high wear resistance
- High corrosion resistance
- Excellent grindability
- High mirrorfinish polishability
- High toughness
- Minimum dimensional changes
- Better resistance to vibrations and mechanical shocks

**Benefit**

- Long and consistant tool life
- Reproducibility of production processes
- High precision components

**Enable**

- Increased productivity
- Reduced unit costs

**Field of applications**

- Mould inserts for the production of CDs and DVDs
- Moulds for the processing of chemically aggressive plastics containing highly abrasive fillers
- Moulds for the processing of duroplasts
- Moulds for the production of chips for the electronics industry
- Screws for injection moulding machines
- Non return valves
- Linings for injection moulding cylinders
<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Wear resistance</th>
<th>Toughness</th>
<th>Polishability</th>
<th>Machinability in as-supplied condition</th>
<th>Through-hardenability</th>
<th>Grindability</th>
<th>Supplied condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOHLER M200</td>
<td>★★★</td>
<td>★</td>
<td>★</td>
<td>★★★★</td>
<td>★</td>
<td>★</td>
<td>V 290 – 330 HB</td>
</tr>
<tr>
<td>BOHLER M238</td>
<td>★★★</td>
<td>★★★★★</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★★★★★</td>
<td>V 290 – 330 HB</td>
</tr>
<tr>
<td>BOHLER M268 VMR</td>
<td>★★★★★</td>
<td>★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★</td>
<td>★★★★★</td>
<td>V approx. 40 HRC (HIGH HARD)</td>
</tr>
<tr>
<td>BOHLER M261 EXTRA</td>
<td>★★★★★</td>
<td>★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★</td>
<td>★★★★★</td>
<td>V approx. 40 HRC (HIGH HARD)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Corrosion resistance</th>
<th>Wear resistance</th>
<th>Toughness</th>
<th>Polishability</th>
<th>Machinability in as-supplied condition</th>
<th>Supplied condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat treated, corrosion resistant steels *</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>V approx. 1000 N/mm²</td>
</tr>
<tr>
<td>BOHLER M303 EXTRA</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>V approx. 40 HRC</td>
</tr>
<tr>
<td>BOHLER M303 EXTRA</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>V approx. 1000 N/mm²</td>
</tr>
<tr>
<td>BOHLER M315 EXTRA</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>V approx. 1000 N/mm²</td>
</tr>
<tr>
<td>BOHLER M320 EXTRA</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>V approx. 1500 N/mm²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Corrosion resistance</th>
<th>Wear resistance</th>
<th>Toughness</th>
<th>Polishability</th>
<th>Machinability in as-supplied condition</th>
<th>Supplied condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardenable, corrosion resistant steels *</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>W max. 225 HB</td>
</tr>
<tr>
<td>BOHLER M335 ISO PLAST</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>W max. 220 HB</td>
</tr>
<tr>
<td>BOHLER M340 ISO PLAST</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>W max. 260 HB</td>
</tr>
<tr>
<td>BOHLER M390 MICROCLEAN</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>W max. 260 HB</td>
</tr>
<tr>
<td>BOHLER N685</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
<td>W max. 265 HB</td>
</tr>
</tbody>
</table>

Evaluation of material properties in plastic moulding applications (Please note: The comparison is applicable for the brands of each group only): For particular requirements in terms of corrosion resistance, wear resistance or dimensional stability please consult our technical sales staff.

W Soft annealed
V Hardened and tempered to obtain good mechanical properties
LA Solution annealed and precipitation hardened
*
The profiles given are characteristic of each group of steels.
3rd generation high speed steels and tool steels made from uniquely fine, pure powder produced in the world’s most modern PM plant at BÖHLER Edelstahl in Kapfenberg, Austria.

- High homogeneity
- Improved toughness
- High fatigue resistance
- Optimal reliability
- Uniquely consistent properties

High purity, homogeneous alloyed powders, with appropriate particle size and distribution are subjected to a high pressure, high temperature process to obtain a homogeneous, segregation-free tool steel with virtually isotropic properties.

Production routes for BÖHLER MICROCLEAN
<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Chemical composition in %</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Si</td>
</tr>
<tr>
<td>S290</td>
<td>2.00</td>
<td>0.50</td>
</tr>
<tr>
<td>S390</td>
<td>1.64</td>
<td>0.45</td>
</tr>
<tr>
<td>S590</td>
<td>1.29</td>
<td>0.60</td>
</tr>
<tr>
<td>S690</td>
<td>1.35</td>
<td>0.60</td>
</tr>
<tr>
<td>S790</td>
<td>1.29</td>
<td>0.60</td>
</tr>
<tr>
<td>K390</td>
<td>2.47</td>
<td>0.55</td>
</tr>
<tr>
<td>K490</td>
<td>1.40</td>
<td>–</td>
</tr>
<tr>
<td>K890</td>
<td>0.85</td>
<td>0.55</td>
</tr>
<tr>
<td>M390</td>
<td>1.91</td>
<td>0.60</td>
</tr>
</tbody>
</table>
BOHLER has improved the production process for powder metallurgy high speed steels and tool steels. MICROCLEAN materials of the 3rd generation with improved performance features are produced in Kapfenberg on the most modern unit worldwide. An extensive assortment of cold work, plastic mould and high speed steels provides our customers with a definitive competitive advantage.

**BOHLER MICROCLEAN** have the following advantages:

- Extremely high wear resistance
- Excellent corrosion resistance
- Optimum grindability
- Easily polishable to a high mirror finish
- High toughness
- Only minor isotropic dimensional changes
- Repeatable production processes
- Better resistance to vibrations
- More resistance to mechanical shocks

 ENABLE

- High precision components
- Long tool life
- Consistant tool life

ENSURING

- Increased productivity
- Reduced unit costs

Requirements in the machining industry

The efficiency of a machining tool depends on the wear resistance, red hardness, toughness and compressive strength of the tool material.
Requirements in the cold forming industry

The service life of a cold work tool depends on the wear resistance, toughness and compressive strength of the tool material.

Requirements in the plastic processing industry

The major factors which influence the tool performance in the plastics processing industry are wear resistance, corrosion resistance, toughness and polishability.

BOHLER S290 MICROCLEAN is a tough alternative to hard metals.

BOHLER S390 MICROCLEAN

BOHLER S690 MICROCLEAN

12 % ledeburitic Cr-steels

Toughness

BOHLER K390 MICROCLEAN

BOHLER K490 MICROCLEAN

BOHLER K890 MICROCLEAN

K490

K390

K890

aggressive plastics

abrasive plastics

Corrosion resistance

12-18% corrosion resistance chromium steels

12 % chromium steels
BÖHLER – THE DRIVING FORCE IN THE AUTOMOTIVE INDUSTRY FOR HIGH PERFORMANCE TOOLING
## HIGH SPEED STEELS

Comparison of the major high speed steel properties
(This comparison does not take into account the various stress conditions imposed on the tool in different kinds of application. Comparisons also depend very much on the heat treatment conditions. Our technical sales staff will be glad to assist you in any questions concerning the application and heat treatment of our steels.)

### BOHLER grade

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Red hardness</th>
<th>Wear resistance</th>
<th>Toughness</th>
<th>Grindability</th>
<th>Compressive strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>S500</td>
<td>★★★★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S600</td>
<td>★★★★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S705</td>
<td>★★★★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S800</td>
<td>★★★★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S900</td>
<td>★★★★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S290</td>
<td>★★★★★</td>
<td>★★★★</td>
<td>★★</td>
<td>★★★★★</td>
<td>★★★★★</td>
</tr>
<tr>
<td>S390</td>
<td>★★★★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S490</td>
<td>★★</td>
<td>★★★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S590</td>
<td>★★</td>
<td>★★★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>S690</td>
<td>★★</td>
<td>★★★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
</tbody>
</table>

### BOHLER grade

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Chemical composition in %</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>Si</td>
</tr>
<tr>
<td>S500</td>
<td>1.10</td>
<td>0.50</td>
</tr>
<tr>
<td>S600</td>
<td>0.90</td>
<td>max. 0.45</td>
</tr>
<tr>
<td>S705</td>
<td>0.92</td>
<td>0.40</td>
</tr>
<tr>
<td>S800</td>
<td>2.00</td>
<td>0.50</td>
</tr>
<tr>
<td>S900</td>
<td>1.64</td>
<td>0.45</td>
</tr>
<tr>
<td>S290</td>
<td>1.29</td>
<td>0.60</td>
</tr>
<tr>
<td>S390</td>
<td>1.35</td>
<td>0.60</td>
</tr>
<tr>
<td>S490</td>
<td>1.29</td>
<td>0.60</td>
</tr>
<tr>
<td>S590</td>
<td>1.29</td>
<td>0.60</td>
</tr>
<tr>
<td>S690</td>
<td>1.29</td>
<td>0.60</td>
</tr>
<tr>
<td>S790</td>
<td>1.29</td>
<td>0.60</td>
</tr>
</tbody>
</table>

### BOHLER grade

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Hardness after annealing</th>
<th>Hardening temperature</th>
<th>Quenchant</th>
<th>Obtainable hardness after tempering</th>
</tr>
</thead>
<tbody>
<tr>
<td>S500</td>
<td>max. 280 HRW</td>
<td>1160 – 1180 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>67 – 69 HRc</td>
</tr>
<tr>
<td>S600</td>
<td>max. 280 HRW</td>
<td>1190 – 1230 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>64 – 66 HRc</td>
</tr>
<tr>
<td>S705</td>
<td>max. 280 HRW</td>
<td>1190 – 1230 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>64 – 66 HRc</td>
</tr>
<tr>
<td>S800</td>
<td>max. 350 HRW</td>
<td>1150 – 1210 °C</td>
<td>Salt bath, Gas</td>
<td>66 – 70 HRc</td>
</tr>
<tr>
<td>S900</td>
<td>max. 300 HRW</td>
<td>1150 – 1230 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>65 – 69 HRc</td>
</tr>
<tr>
<td>S290</td>
<td>max. 300 HRW</td>
<td>1075 – 1180 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>65 – 67 HRc</td>
</tr>
<tr>
<td>S390</td>
<td>max. 280 HRW</td>
<td>1150 – 1200 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>64 – 66 HRc</td>
</tr>
<tr>
<td>S490</td>
<td>max. 280 HRW</td>
<td>1105 – 1180 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>64 – 66 HRc</td>
</tr>
<tr>
<td>S590</td>
<td>max. 280 HRW</td>
<td>1050 – 1180 °C</td>
<td>Oil, Ar, Salt bath (500 – 550 °C), Gas</td>
<td>64 – 66 HRc</td>
</tr>
</tbody>
</table>
# COLD WORK TOOL STEELS

## BOHLER grade

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Chemical composition in %</th>
<th>Standards DIN / EN</th>
<th>Standards AISI</th>
</tr>
</thead>
<tbody>
<tr>
<td>K100</td>
<td>C</td>
<td>Si</td>
<td>Mn</td>
</tr>
<tr>
<td>2.00</td>
<td>0.25</td>
<td>0.35</td>
<td>11.50</td>
</tr>
<tr>
<td>K105</td>
<td>1.60</td>
<td>0.33</td>
<td>0.30</td>
</tr>
<tr>
<td>K107</td>
<td>2.10</td>
<td>0.25</td>
<td>0.38</td>
</tr>
<tr>
<td>K110</td>
<td>1.55</td>
<td>0.30</td>
<td>0.38</td>
</tr>
<tr>
<td>K215</td>
<td>0.63</td>
<td>1.05</td>
<td>1.05</td>
</tr>
<tr>
<td>K340</td>
<td>1.10</td>
<td>0.90</td>
<td>0.40</td>
</tr>
<tr>
<td>K353</td>
<td>0.82</td>
<td>0.70</td>
<td>0.40</td>
</tr>
<tr>
<td>K360</td>
<td>1.25</td>
<td>0.90</td>
<td>0.35</td>
</tr>
<tr>
<td>K390</td>
<td>2.47</td>
<td>0.55</td>
<td>0.40</td>
</tr>
<tr>
<td>K450</td>
<td>0.95</td>
<td>0.25</td>
<td>1.10</td>
</tr>
<tr>
<td>K460</td>
<td>1.40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>K480</td>
<td>0.85</td>
<td>0.55</td>
<td>0.40</td>
</tr>
</tbody>
</table>

## COLD WORK TOOL STEELS

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Hardness after annealing</th>
<th>Hardening temperature</th>
<th>Quenchant</th>
<th>Obtainable hardness</th>
<th>Average Rockwell C hardness after tempering at °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>K100</td>
<td>max. 248 HB</td>
<td>940 – 970 °C</td>
<td>Oil, Air, Gas, Salt bath (220 – 250 °C / 500 – 550 °C)</td>
<td>57 – 62 HRC</td>
<td>64</td>
</tr>
<tr>
<td>K105</td>
<td>max. 250 HB</td>
<td>980 – 1010 °C</td>
<td>Oil, Air, Gas, Salt bath (950 – 980 °C)</td>
<td>63 – 65 HRC</td>
<td>64</td>
</tr>
<tr>
<td>K107</td>
<td>max. 250 HB</td>
<td>950 – 980 °C</td>
<td>Oil, Air, Gas, Salt bath (950 – 980 °C)</td>
<td>64 – 66 HRC</td>
<td>65</td>
</tr>
<tr>
<td>K110</td>
<td>max. 250 HB</td>
<td>1020 – 1040 °C</td>
<td>Oil, Air, Gas, Salt bath (220 – 250 °C / 500 – 550 °C)</td>
<td>58 – 61 HRC</td>
<td>63</td>
</tr>
<tr>
<td>K215</td>
<td>max. 235 HB</td>
<td>830 – 860 °C</td>
<td>Oil</td>
<td>59 – 62 HRC</td>
<td>61</td>
</tr>
<tr>
<td>K340</td>
<td>max. 235 HB</td>
<td>1040 – 1080 °C</td>
<td>Oil, Air, Gas, Salt bath</td>
<td>57 – 63 HRC</td>
<td>see tempering chart</td>
</tr>
<tr>
<td>K353</td>
<td>max. 240 HB</td>
<td>1030 – 1060 °C</td>
<td>Oil, Air, Gas, Salt bath</td>
<td>55 – 61 HRC</td>
<td>see tempering chart</td>
</tr>
<tr>
<td>K360</td>
<td>max. 250 HB</td>
<td>1040 – 1080 °C</td>
<td>Oil, Air, Gas, Salt bath</td>
<td>57 – 63 HRC</td>
<td>see tempering chart</td>
</tr>
<tr>
<td>K390</td>
<td>max. 280 HB</td>
<td>1030 – 1180 °C</td>
<td>Oil, Gas</td>
<td>58 – 64 HRC</td>
<td>see tempering chart</td>
</tr>
<tr>
<td>K455</td>
<td>max. 225 HB</td>
<td>870 – 900 °C</td>
<td>Oil</td>
<td>53 – 59 HRC</td>
<td>60</td>
</tr>
<tr>
<td>K460</td>
<td>max. 230 HB</td>
<td>780 – 820 °C</td>
<td>Oil, Salt bath (200 – 250 °C)</td>
<td>63 – 65 HRC</td>
<td>64</td>
</tr>
<tr>
<td>K490</td>
<td>max. 280 HB</td>
<td>1030 – 1180 °C</td>
<td>Oil, Gas</td>
<td>58 – 64 HRC</td>
<td>see tempering chart</td>
</tr>
<tr>
<td>K890</td>
<td>max. 280 HB</td>
<td>1030 – 1180 °C</td>
<td>Oil, Gas</td>
<td>58 – 64 HRC</td>
<td>see tempering chart</td>
</tr>
</tbody>
</table>
# HOT WORK TOOL STEELS

## BOHLER grade Chemical composition in % Standards

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Chemical composition</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>W300</td>
<td>C 0.38, Si 0.40, Mn 0.40, Cr 5.00, Mo 1.30, Ni 0.40, V 0.40, W 0.40</td>
<td>DIN/EN 1.2343, X37CrMoV5-1, H11</td>
</tr>
<tr>
<td>W302</td>
<td>C 0.39, Si 0.40, Mn 0.40, Cr 5.20, Mo 1.30, Ni 0.95, V 0.55</td>
<td>DIN/EN 1.2344, X40CrMoV5-1, H13</td>
</tr>
<tr>
<td>W303</td>
<td>C 0.38, Si 0.40, Mn 0.40, Cr 5.00, Mo 2.80, Ni 0.55</td>
<td>DIN/EN 1.2367, X38CrMoV5-3, H11</td>
</tr>
<tr>
<td>W320</td>
<td>C 0.31, Si 0.30, Mn 0.35, Cr 2.90, Mo 2.70, Ni 0.50</td>
<td>DIN/EN 1.2368, 30CrMoV12-28, H10</td>
</tr>
<tr>
<td>W350</td>
<td>C 0.38, Si 0.21, Mn 0.50, Cr 4.95, Mo 1.75, Ni 0.04, V 0.53</td>
<td>Patent</td>
</tr>
<tr>
<td>W360</td>
<td>C 0.50, Si 0.20, Mn 0.25, Cr 4.50, Mo 3.00, Ni 0.60</td>
<td>Patent</td>
</tr>
<tr>
<td>W400</td>
<td>C 0.38, Si 0.20, Mn 0.30, Cr 5.00, Mo 1.30, Ni 0.50</td>
<td>Patent</td>
</tr>
<tr>
<td>W403</td>
<td>C 0.38, Si 0.20, Mn 0.25, Cr 5.00, Mo 2.80, Ni 0.65</td>
<td>Patent</td>
</tr>
</tbody>
</table>

## BOHLER grade Hardness after annealing

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>Hardness after annealing</th>
<th>Hardening temperature</th>
<th>Quenchant</th>
<th>Obtainable hardness</th>
<th>Average Rockwell C hardness at tempering at °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>W300</td>
<td>max. 206 HB</td>
<td>1000 – 1040 °C</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>52 – 56 HRc</td>
<td>53 54 52 48 38 30</td>
</tr>
<tr>
<td>W302</td>
<td>max. 206 HB</td>
<td>1020 – 1080 °C</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>52 – 56 HRc</td>
<td>54 55 54 50 40 32</td>
</tr>
<tr>
<td>W303</td>
<td>max. 206 HB</td>
<td>1030 – 1080 °C</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>52 – 56 HRc</td>
<td>52 54 53 50 44 36</td>
</tr>
<tr>
<td>W320</td>
<td>max. 206 HB</td>
<td>1010 – 1050 °C</td>
<td>Oil, Salt bath, (500 – 550 °C), Gas</td>
<td>52 – 56 HRc</td>
<td>50 51 52 50 45 36</td>
</tr>
<tr>
<td>W350</td>
<td>max. 240 HB</td>
<td>1020 °C (1010 °C)</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>52 – 54 HRc</td>
<td>52 54 52 50 44 36</td>
</tr>
<tr>
<td>W360</td>
<td>max. 206 HB</td>
<td>approx. 1050 °C</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>57 – 58 HRc</td>
<td>see tempering chart</td>
</tr>
<tr>
<td>W400</td>
<td>max. 206 HB</td>
<td>980 – 990 °C</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>52 – 54 HRc</td>
<td>53 54 52 48 38 30</td>
</tr>
<tr>
<td>W403</td>
<td>max. 206 HB</td>
<td>1020 – 1030 °C</td>
<td>Oil, Salt bath (500 – 550 °C), Gas</td>
<td>52 – 54 HRc</td>
<td>52 54 53 50 44 35</td>
</tr>
</tbody>
</table>

* for big dies
## PLASTIC MOULD STEELS

<table>
<thead>
<tr>
<th>BOHLER grade</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>V</th>
<th>W</th>
<th>Co</th>
<th>Others</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOHLER M238</td>
<td>0.38</td>
<td>0.30</td>
<td>1.45</td>
<td>1.96</td>
<td>0.20</td>
<td>1.05</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1.2738</td>
</tr>
<tr>
<td>BOHLER M261</td>
<td>0.13</td>
<td>0.30</td>
<td>1.95</td>
<td>0.35</td>
<td>–</td>
<td>3.50</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>~ P20</td>
</tr>
<tr>
<td>BOHLER M265</td>
<td>0.38</td>
<td>0.30</td>
<td>1.50</td>
<td>2.00</td>
<td>0.20</td>
<td>1.10</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>~ 1.2738</td>
</tr>
<tr>
<td>BOHLER M300</td>
<td>0.28</td>
<td>0.25</td>
<td>0.65</td>
<td>14.50</td>
<td>0.95</td>
<td>0.86</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+N</td>
<td>~ 1.2316</td>
</tr>
<tr>
<td>BOHLER M310</td>
<td>0.38</td>
<td>0.70</td>
<td>0.43</td>
<td>14.25</td>
<td>–</td>
<td>0.20</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>~ 1.2083</td>
<td></td>
</tr>
<tr>
<td>BOHLER M315</td>
<td>0.05</td>
<td>0.30</td>
<td>0.95</td>
<td>12.60</td>
<td>–</td>
<td>0.45</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>+N</td>
<td>~ 220</td>
</tr>
<tr>
<td>BOHLER M333</td>
<td>0.28</td>
<td>0.30</td>
<td>0.30</td>
<td>13.50</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>Patent</td>
<td>~ 220</td>
</tr>
<tr>
<td>BOHLER M340</td>
<td>0.54</td>
<td>0.45</td>
<td>0.40</td>
<td>17.25</td>
<td>1.10</td>
<td>–</td>
<td>0.10</td>
<td>–</td>
<td>–</td>
<td>+N</td>
<td>~ 220</td>
</tr>
<tr>
<td>BOHLER M390</td>
<td>1.91</td>
<td>0.60</td>
<td>0.30</td>
<td>20.00</td>
<td>1.00</td>
<td>–</td>
<td>4.00</td>
<td>0.60</td>
<td>–</td>
<td>Patent</td>
<td>~ 220</td>
</tr>
</tbody>
</table>

### BOHLER grade

<table>
<thead>
<tr>
<th>Hardness after annealing</th>
<th>Hardening temp. Quenchant</th>
<th>Supplied condition N/mm²</th>
<th>Average surface hardness after hardening Rockwell C</th>
<th>Normal assembly condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOHLER M238</td>
<td>–</td>
<td>840 – 860 °C Oil</td>
<td>approx. 1000</td>
<td>hardened and tempered</td>
</tr>
<tr>
<td>BOHLER M261</td>
<td>approx. 30 HRC solution annealed</td>
<td>560 – 580 °C Air</td>
<td>–</td>
<td>approx. 40</td>
</tr>
<tr>
<td>BOHLER M265</td>
<td>–</td>
<td>840 – 880 °C Oil</td>
<td>approx. 1200</td>
<td>hardened and tempered</td>
</tr>
<tr>
<td>BOHLER M300</td>
<td>–</td>
<td>1000 – 1020 °C / Oil, Gas, Salt bath (400 – 450 °C)</td>
<td>900 - 1120</td>
<td>hardened and tempered</td>
</tr>
<tr>
<td>BOHLER M310</td>
<td>max. 200 HBW</td>
<td>1000 – 1050 °C Gas, Salt bath, Oil</td>
<td>–</td>
<td>hardened and tempered</td>
</tr>
<tr>
<td>BOHLER M315</td>
<td>–</td>
<td>max. 220 HBW</td>
<td>980 – 1030 °C Oil, Gas</td>
<td>48 – 52</td>
</tr>
<tr>
<td>BOHLER M340</td>
<td>–</td>
<td>max. 280 HBW</td>
<td>980 – 1000 °C Oil, Gas</td>
<td>53 – 58</td>
</tr>
<tr>
<td>BOHLER M390</td>
<td>max. 280 HBW</td>
<td>1120 – 1180 °C Oil, Gas, Salt bath</td>
<td>–</td>
<td>58 – 60</td>
</tr>
</tbody>
</table>

1) for certain applications sub zero treatment is recommended for dimensional stability

---

35
TEMPERING CHARTS

Tempering chart BÖHLER K390 MICROCLEAN
- Recommended tempering area
- 1180 °C, 1110 °C, 1070 °C, 1030 °C

Tempering chart BÖHLER K490 MICROCLEAN
- Recommended tempering area
- 1030 °C, 1050 °C, 1080 °C

Tempering chart BÖHLER K890 MICROCLEAN
- Recommended tempering area
- 1180 °C, 1150 °C, 1100 °C, 1070 °C, 1030 °C

Tempering chart BÖHLER K340 ISODUR
- Recommended tempering area
- 1040 °C, 1060 °C

Tempering chart BÖHLER K360 ISODUR
- 1080 °C, 1060 °C, 1040 °C, 1070 °C
- Vacuum/N₂ (5 bar) 3 x 2 h

Tempering chart BÖHLER K353
- 1030 °C

Sample size: round 35 x 15 mm

Hardened in vacuum furnace: N₂ cooling, 5 bar
One of the remarkable features of BÖHLER K490 MICROCLEAN is its flexibility in heat treatment:

- We recommend the same hardening temperatures as with widely used cold work tool steels (e.g. 1.2379/D2)
- Very stable mechanical properties, regardless of the hardening temperature (1030 – 1080 °C)
HIGH FLYING MATERIALS
Materials for the aircraft industry

Faster, lighter, further

-- are terms of our times which must be taken literally, especially in the aerospace industry. This demands the work of the best. Fulfilling these requirements demands everything of materials. BÖHLER provides the materials that aerospace engineers need -- in the grade and dimension they want.

Expertise in all material matters

Main system approvals
AS9100, ISO9001
- GE AE S1000
- PWA 300
- Rolls Royce SABRE
- Snecma
- MTU
- ITP
- Agusta (acc. AQM-002)
- Airbus Germany (acc. QVA-V06-02-00)
- Airbus UK Ltd. (acc. AUK/SA/001-3)
- BAE Systems (operations) Ltd.
- BAE Systems Regional Aircraft (RALOA/00503/3)
- Böhlen Schmiedetechnik
- Boeing (D1-4426)
- Bombardier Aerospace (Code 1013)
- Hawker Beechcraft Corp. (Code QCOO Rev.F)
- Korean Air
- Messier Dowty (SAFRAN Group)
- NHBB
- Westland Helicopters
- SKF Aeroengines France (SNFA)
- GKN Aerospace
- Goodrich Aerostructures

Main Laboratory Approvals
- NADCAP Chemical, Mechanical, Corrosion Testing, Metallography and Hardness, Heat treatment
- GE Aero Engines S400
- Pratt & Whitney LCS/MCS MCL F17
- Snecma Moteurs FAL n°310 acc. PRO 0430
- Rolls Royce MSR 9951
- Airbus France MM 049
- Boeing D1-4426

Main NDT Approvals
- NADCAP AMS-STD 2154
- GE Aero Engines P3TF34
- Pratt & Whitney SIM 14, SIS 45
- Snecma Moteurs DMC 0022
- Rolls Royce RRP58002
- Airbus UK APB 6-5232
- Boeing D1-4426
Innovation is the power for high performance

As an energy production company you demand the highest standards from our steels. That makes us partners in performance. The high-end field in particular is where we can show our advantage in technology at its best; where we can put forward our metallurgical know-how and highlight our 120 years of experience. It is precisely these demands that inspire us to carry on research and constantly improve the properties of our steels.

Your interests and our will to continuous development, has made us the clear-cut number one in the world of melting and remelting technology. We are well aware that this market position is not something we should ever take for granted. It is a daily reminder for the best minds working under the best production conditions in revolutionary production facilities to go beyond the confines of what is feasible.

Meeting the energy of the society in which we live is a challenge we face up to on a daily basis. Economically and ecologically. It’s a challenge we would like to take up with you at our side.

The best test results

The BÖHLER testing laboratory has been accredited by the performance review institute ISO 17025 and NADCAP to conduct tests for the zero tolerance field of aviation as well. This means that all of the mechanical-technological and metallographical tests carried out not only meet the simulated demands of reality but exceed them beyond expectations!
<table>
<thead>
<tr>
<th>Ni-base alloys</th>
<th>Special steels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alloy 80A</td>
<td>17-4 PH</td>
</tr>
<tr>
<td>Alloy 263</td>
<td>422</td>
</tr>
<tr>
<td>Alloy 617</td>
<td>X20CrMoV12-1</td>
</tr>
<tr>
<td>Alloy 625</td>
<td>Jethete</td>
</tr>
<tr>
<td>Alloy 718</td>
<td>403 CB+</td>
</tr>
<tr>
<td>Alloy X750</td>
<td>X20Cr13</td>
</tr>
<tr>
<td>Alloy 901</td>
<td>403/410</td>
</tr>
<tr>
<td>Böhler L080A</td>
<td></td>
</tr>
<tr>
<td>Böhler L263</td>
<td></td>
</tr>
<tr>
<td>Böhler L617</td>
<td></td>
</tr>
<tr>
<td>Böhler L625</td>
<td></td>
</tr>
<tr>
<td>Böhler L718</td>
<td></td>
</tr>
<tr>
<td>Böhler L750</td>
<td></td>
</tr>
<tr>
<td>Böhler L901</td>
<td></td>
</tr>
<tr>
<td>Böhler T700</td>
<td></td>
</tr>
<tr>
<td>Böhler T504</td>
<td></td>
</tr>
<tr>
<td>Böhler T550</td>
<td></td>
</tr>
<tr>
<td>Böhler T552</td>
<td></td>
</tr>
<tr>
<td>Böhler T600SB</td>
<td></td>
</tr>
<tr>
<td>Böhler T651</td>
<td></td>
</tr>
<tr>
<td>Böhler T655SC</td>
<td></td>
</tr>
</tbody>
</table>
Quality knows no compromises

More efficient, safer – These are concepts to which great significance is assigned particularly when it comes to the production of energy. Covering daily energy needs while simultaneously practicing environmental conservation is a challenge for engineers and their materials alike.

For generations BÖHLER has been facing up to this challenge by developing and producing materials of the highest metallurgical purity for use in extreme environments. The material properties there are as varied as the manufacturing possibilities at BÖHLER. As one of the few producers of steel we at BÖHLER have all of the melting and remelting facilities (ESR, PESR, VAR) here at our disposal.

Expertise in all material matters

Main Quality System approvals
- ISO 9001
- EN 9100

Main Laboratory Approvals
- bmwwf, EN ISO/IEC 17025
- PRI Performance Review Institute (NADCAP)

Main Material Approvals:
- NORSOK M-650, Teknologisk Institut Certification AS
- Statoil Hydro, rolled and forged bars in ASTM A276 grade, Norsok Standard M-650
- Lloyds Register, Steelmaking and bars, Forgings in carbon, carbon-manganese and alloy steel
- PRI (NADCAP), AC7114, AC7114/3
- TÜV-Süd, AD2000 Instruction W0/TRD100/HP0, Pressure equipment directive 97/23/EG
### Ni-Superalloys
- BOHLER L625
- BOHLER L718
- BOHLER L626

### Super-Duplex
- BOHLER A911SA
- BOHLER A913

### Austenitics
- BOHLER P511
- BOHLER T200

### Heat treatable
- BOHLER N400
- BOHLER N404
BÖHLER Edelstahl has expanded the portfolio and offers three powders for additive manufacturing with the brand BÖHLER AMPO. Our customer benefit from:

**PRODUCT RANGE**
Atomization of BÖHLER standard brands (theoretical selection from 250 steel brands). Customization of alloys with small scale production plant and metallurgical expertise.

**STATE OF THE ART TECHNOLOGY**
Vacuum induction melting and atomization under inert gas ensure the highest product quality. Powder is produced on latest atomization techniques and tested in-house.

**HIGHEST PRODUCT QUALITY**
Depending on the steel grade and customer requirements, raw materials molten under vacuum or remolten can be used. This ensures the highest quality standards and minimizes undesired impurities.

**PARTICLE SIZE DISTRIBUTION**
Depending on the requirements of the AM process used, we can provide the appropriate particle fraction in a range from 15–150 μm.

**TEST LABORATORY / ANALYSES**
BÖHLER Edelstahl’s modern in-house laboratories provide our production facilities with vital information and product parameters for process control and product certification in accordance with test standards and customer specifications.

**RECYCLING**
We support our customers in powder recycling to contribute to greater efficiency.

**GLOBAL SALES NETWORK**
Optimal availability through storage at the central warehouse in Kapfenberg and in sales warehouses worldwide as needed. Short delivery times combined with high delivery reliability.
THE NEXT GENERATION OF COMPONENT MANUFACTURING
We offer powders with the right properties for every application and printing technology. In our **own development and test center in Düsseldorf** – the voestalpine Additive Manufacturing Center – we produce test objects with 3D printing in order to acquire experience and explore new application areas for additive manufacturing of components.

<table>
<thead>
<tr>
<th>AMPO Grade</th>
<th>15–45 [µm] (e.g. laser powder bed fusion)</th>
<th>45–150 [µm] (e.g. direct laser deposition)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flowability* [s]</td>
<td>Flowability* [s]</td>
</tr>
<tr>
<td></td>
<td>Apparent density* [g/cm³]</td>
<td>Apparent density* [g/cm³]</td>
</tr>
<tr>
<td><strong>BÖHLER</strong></td>
<td>&lt;18</td>
<td>&lt;21.5</td>
</tr>
<tr>
<td><strong>AMPO</strong></td>
<td>3.96</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>L718</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BÖHLER</strong></td>
<td>&lt;19</td>
<td>&lt;21.5</td>
</tr>
<tr>
<td><strong>AMPO</strong></td>
<td>3.96</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>N700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BÖHLER</strong></td>
<td>&lt;18</td>
<td>&lt;22.0</td>
</tr>
<tr>
<td><strong>AMPO</strong></td>
<td>3.90</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>W722</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Measurement of particle size distribution is based on ISO 13322-2 (Dynamic image analysis methods); Flowability and apparent density are based on DIN EN ISO 4490 resp. DIN EN ISO 3923-1.

Your contact for further information:
info-powder@bohler-edelstahl.at
exportsales@bohler-international.com
**Additive Manufacturing Powder**

**Order quantity**
- 10 kg minimum

**Particle size distribution**
- 15 to 150 μm

---

### BÖHLER L718
DIN 2.4068 (capable to meet the chemistry of API and AMS)

Chemical Composition [wt. %]

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Ni</th>
<th>Cr</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Si</th>
<th>Mo</th>
<th>Fe</th>
<th>Cu</th>
<th>Co</th>
<th>Al</th>
<th>Nb</th>
<th>Ti</th>
</tr>
</thead>
<tbody>
<tr>
<td>min</td>
<td>0.02</td>
<td>50</td>
<td>17</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.8</td>
<td>remainder</td>
<td>-</td>
<td>-</td>
<td>0.3</td>
<td>4.7</td>
<td>0.65</td>
</tr>
<tr>
<td>max</td>
<td>0.08</td>
<td>55</td>
<td>21</td>
<td>0.35</td>
<td>0.015</td>
<td>0.015</td>
<td>0.35</td>
<td>3.3</td>
<td>remainder</td>
<td>0.3</td>
<td>1</td>
<td>0.7</td>
<td>5.5</td>
<td>1.15</td>
</tr>
</tbody>
</table>

---

### BÖHLER N700
DIN 1.4542 / 17-4PH (capable to meet chemistry of AMS)

Chemical Composition [wt. %]

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Ni</th>
<th>Cr</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Si</th>
<th>Mo</th>
<th>Cu</th>
<th>Nb</th>
</tr>
</thead>
<tbody>
<tr>
<td>min</td>
<td>-</td>
<td>3</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>5xC</td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>0.07</td>
<td>5</td>
<td>17</td>
<td>1.5</td>
<td>0.04</td>
<td>0.015</td>
<td>0.7</td>
<td>0.6</td>
<td>5</td>
<td>0.45</td>
</tr>
</tbody>
</table>

---

### BÖHLER W722
DIN 1.2709 / ~ MS1 / Marage 300

Chemical Composition [wt. %]

<table>
<thead>
<tr>
<th>Element</th>
<th>C</th>
<th>Si</th>
<th>Mn</th>
<th>P</th>
<th>S</th>
<th>Cr</th>
<th>Mo</th>
<th>Ni</th>
<th>Ti</th>
<th>Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>min</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>max</td>
<td>0.03</td>
<td>0.1</td>
<td>0.15</td>
<td>0.01</td>
<td>0.01</td>
<td>0.25</td>
<td>5.2</td>
<td>19</td>
<td>12</td>
<td>10.0</td>
</tr>
</tbody>
</table>

---

Order quantity: 10 kg minimum

Particle size distribution: 15 to 150 μm
Your partner:

BÖHLER International GmbH
DC Tower, Donau-City-Straße 7
1220 Vienna, Austria
Phone: +43-50304 30-23100
Fax: +43-50304 70-23308
E-Mail: exportsales@bohler-international.com
www.bohler-international.com

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.