

**K110**



**BÖHLER K110**

冷作工具钢  
COLD WORK TOOL STEEL



钢材主要性能对照表

Qualitative comparison of the major steel properties

| Marke / Grade<br>BÖHLER    | 抗磨粒磨损<br>Wear resistance<br>abrasive   | 抗粘着磨损<br>Wear resistance<br>adhesive | 韧性<br>Toughness | 抗压强度<br>Compressive strength | 热处理尺寸 稳定性<br>Dimensional stability<br>during heat treatment |
|----------------------------|--|--------------------------------------|-----------------|------------------------------|---|
| BÖHLER K100                | ***  | **                                   | *               | **                           | **  |
| BÖHLER K105                | **   | **                                   | *               | **                           | **  |
| BÖHLER K107                | ***  | **                                   | *               | **                           | **  |
| BÖHLER K110                | ***  | **                                   | *               | **                           | **  |
| BÖHLER K245                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K305                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K306                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K329                | **   | *                                    | *****           | *                            | *   |
| BÖHLER K340<br>ISODUR®     | ***  | *****                                | ***             | *****                        | ***   |
| BÖHLER K353                | ***  | ***                                  | *****           | **                           | **  |
| BÖHLER K360<br>ISODUR®     | *****  | *****                                | **              | *****                        | ***   |
| BÖHLER K390<br>MICROCLEAN® | *****  | *****                                | *****           | *****                        | *****   |
| BÖHLER K455                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K460                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K600                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K605                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K720                | *  | *                                    | *****           | *                            | *   |
| BÖHLER K890<br>MICROCLEAN® | ***  | ***                                  | *****           | *****                        | *****   |
| BÖHLER K700                | 奥氏体高锰钢在冲击及压应力的情况下产生加工硬化，进而保证其相关性能，因此不适用此表比较。<br>Austenitic manganese steel maintaining its characteristic properties by work hardening under impact and compressive stresses.<br>Therefore it is not comparable with the hardenable steels in this form. |                                      |                 |                              |   |

此表旨在协助钢材的选用，并未考虑各种不同用途所承受的应力条件。

This table is intended to facilitate the steel choice. It does not, however, take into account the various stress conditions imposed by the different types of application.

性能比较受热处理工艺影响深远。

Comparison is strongly dependent on the heat treatment conditions.

我们专业的技术顾问很乐意回答，您在钢材使用和加工方面的相关问题。

Our technical consultancy staff will be glad to assist you in any questions concerning the use and processing of steels.

## 性能

尺寸稳定，高碳，高铬钢(12%)。  
特别适合气淬。  
良好的韧性。

## 用途

高负荷切削工具（凹模与冲头），下料和冲孔工具，木工工具，剪切薄板的剪切刀，搓丝模具，拉深与冷挤压模具，陶瓷与制药产业的粉末压实，冷轧辊（工作辊）的复合滚轧承辊，测量仪器，要求高耐磨耗的小型塑胶模具。

## Properties

Dimensionally stable, high carbon, high-chromium (12%) steel.  
Particularly suitable for air hardening.  
Good toughness.

## Application

High-duty cutting tools (dies and punches), blanking and punching tools, woodworking tools, shear blades for cutting light-gauge material, thread rolling tools, tools for drawing, deep drawing and cold extrusion, pressing tools for the ceramics and pharmaceutical industries, cold rolls (working rolls) for multiple-roll stands, measuring instruments and gauges, small moulds for the plastics industry where excellent wear resistance is required.

### 化学成份 (平均值) / Chemical composition (average %)

| C    | Si   | Mn   | Cr    | Mo   | V    |
|------|------|------|-------|------|------|
| 1,55 | 0,30 | 0,30 | 11,30 | 0,75 | 0,75 |

### 标准

**DIN / EN**  
< 1.2379 >  
X153CrMoV12

**AISI**  
D2

**JIS**  
~ SKD11

**GOST**  
~ Ch12F1

### Standards

## 热成型

### 锻造

1050°C~850°C

随炉或保温材料中缓慢冷却

## Hot forming

### Forging:

1050 to 850°C

Slow cooling in furnace or thermoinsulating material.

## 热处理

### 退火

800°C~850°C

以10~20°C/小时随炉慢冷到600°C

然后空冷

退火后硬度：**最高250HB**

## Heat treatment

### Annealing:

800 to 850°C

Slow controlled cooling in furnace at a rate of 10 to 20°C/hr down to approx. 600°C, further cooling in air.

Hardness after annealing:

**max. 250 HB.**

### 应力消除

650~700°C

随炉慢冷，意在消除大量加工或复杂形状加工所产生的应力。

完全热透后，中性气体中保温1~2小时。

### Stress relieving:

650 to 700°C

Slow cooling in furnace.

Intended to relieve stresses set up by extensive machining, or in complex shapes.

After through heating, hold in neutral atmosphere for 1 to 2 hours.

### 淬火

1020~1040°C

复杂形状 / 空气冷却，

简单形状 / 气冷，油冷，

盐浴 (220~250°C或500~550°C)或

气体冷却。

热透后保温15~30分钟。

可获得硬度：58~61HRC。

### Hardening:

1020 to 1040°C

Complex shapes / air,

simple shapes / air blast, oil,

salt bath from (220 to 250°C or 500 to 550°C) or gas.

Holding time after temperature equalization:

15 to 30 minutes.

Obtainable hardness: 58 - 61 HRC.



## 回火

淬火后立即回火，缓慢加热至回火温度，保温时间：工件厚度每20mm保温1小时，至少2小时。然后空冷，回火后平均硬度值请参考回火曲线图。某些情况下我们建议降低回火温度，增加保温时间。

对于硬度保持性要求较高的应用，建议进行氮化处理（见下图）。

## Tempering:

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

For average hardness figures to be obtained please refer to the tempering chart.

For certain cases we recommend to reduce tempering temperature and increase holding time.

For certain applications requiring improved retention of hardness, a nitriding treatment is recommended (see below).

## 回火曲线图

淬火温度

—— 1030°C

----- 1070°C

工件尺寸：方形20x20mm

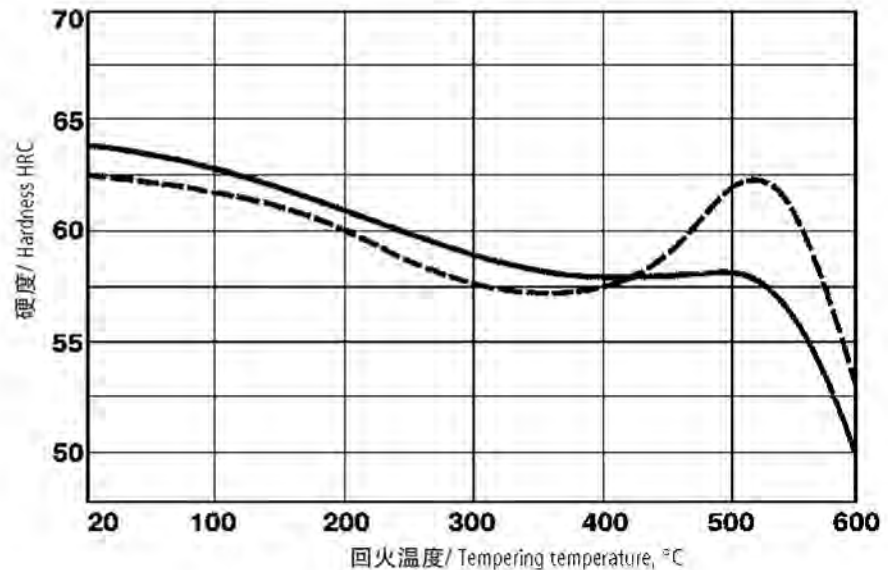
## Tempering chart:

Hardening temperature:

—— 1030°C

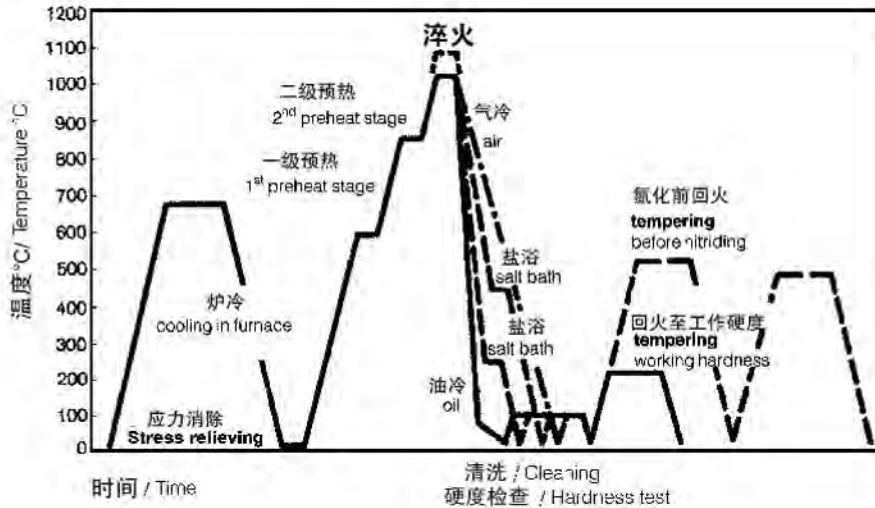
----- 1070°C

Specimen size: square 20 mm



## 热处理程序

## Heat treatment sequence



## 表面处理

### 氮化:

通过这样处理可以使基体材料的最小硬度达到大约60HRC。如果要求最高的尺寸稳定性，回火温度至少应与随后的氮化温度一样。氮化处理后，建议在300°C消除应力。如果要进行盐浴氮化，我们建议提高淬火温度（1060°C-1080°C），然后回火二次。第一次520°C第二次比第一次回火温度低30-50°C然后盐浴氮化，扩散渗氮，在570°C进行，保温时间：30分钟，以便达到0.03mm的氮化层深度。

### 补焊

工具钢焊接一般有产生裂纹的倾向。必须进行焊接时，应征求并遵循焊丝生产厂商的建议与指导。

## Surface treatment

### Nitriding:

From this treatment a minimum hardness of the base material of approx. 60 HRC will result. If maximum dimensional stability is required, the tempering temperature should be at least equal to the subsequent nitriding temperature. After nitriding, stress relieving at about 300°C is recommended. If salt bath nitriding is to be effected, we recommend elevated hardening temperature (1060-1080°C) with subsequent tempering in two cycles. 1<sup>st</sup> at 520°C. 2<sup>nd</sup> at 30-50°C below 1st tempering temperature. Then bath nitriding, e.g. Tufftride process, is carried out at 570°C; holding time: 30 minutes for a depth of nitration of about 0.03 mm.

### Repair welding

There is a general tendency for tool steels to develop cracks after welding. If welding cannot be avoided, the instructions of the appropriate welding electrode manufacturer should be sought and followed.



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## 连续冷却CCT曲线

Continuous cooling  
CCT curves

奥氏体化温度: 1080°C

保温时间: 30分钟

- 维氏硬度
- 2...100 相含量百分比
- 0.40...59.8 冷却参数, 即从800°C连续冷却到500°C所需的时间, 单位为秒 $\times 10^{-2}$
- 2...1K/min. 在800°C-500°C范围内的冷却速度, 单位为K/分钟
- Ms'-Ms 马氏体相变温度区间
- KgM 马氏体晶界

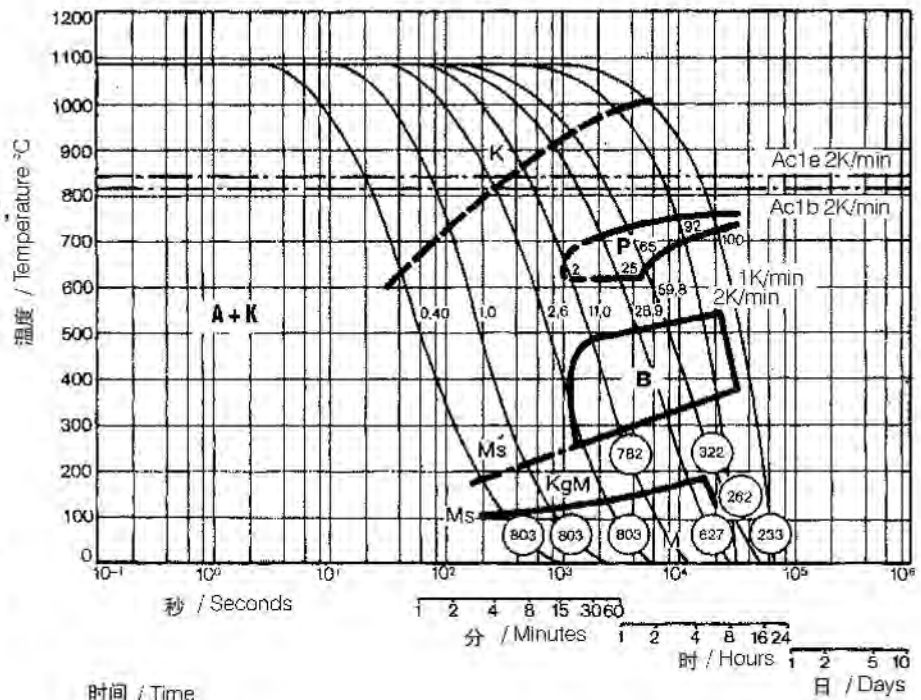
Austenitising temperature: 1080°C

Holding time: 30 minutes

- Vickers hardness
- 2...100 phase percentages
- 0.40...59.8 cooling parameter, i.e. duration of cooling from 800°C to 500°C in  $s \times 10^{-2}$
- 2...1K/min cooling rate in K/min in the 800°C to 500°C range
- Ms'-Ms
- Range of grain boundary martensite formation
- KgM.....Grain boundary martensite

化学成份 (平均值) / Chemical composition (average %)

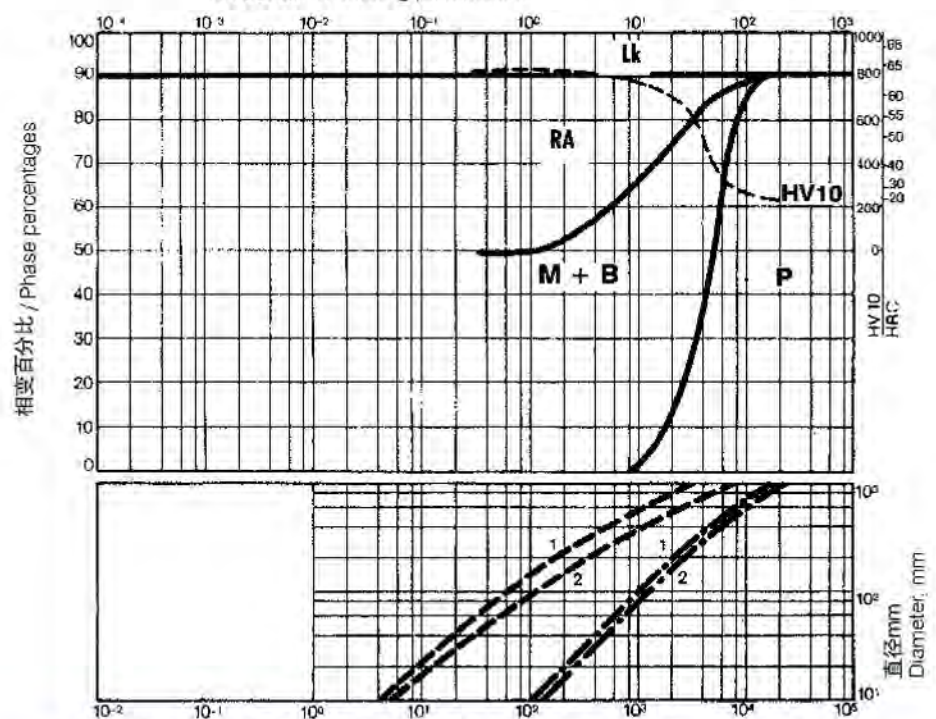
| C    | Si   | Mn   | P     | S     | Cr    | Mo   | Ni   | V    | W    |
|------|------|------|-------|-------|-------|------|------|------|------|
| 1,51 | 0,32 | 0,27 | 0,019 | 0,016 | 11,60 | 0,63 | 0,20 | 0,91 | 0,02 |



## 定量相图

## Quantitative phase diagram

冷却参数  $\lambda$  / Cooling parameter  $\lambda$



从800°C冷却到500°C所需时间, 单位为秒。 / Cooling time in sec. from 800°C to 500°C



## 连续冷却CCT曲线

Continuous cooling  
CCT curves

奥氏体化温度: 1020°C

保温时间: 30分钟

- 维氏硬度
- 1...100 相含量百分比
- 0.38...18 冷却参数, 即从800°C连续冷却到500°C所需的时间, 单位为秒 $\times 10^{-2}$
- 5...2K/min. 在800°C-500°C范围内的冷却速度, 单位为K/分钟
- Ms'-Ms 马氏体相变温度区间
- KgM 马氏体晶界

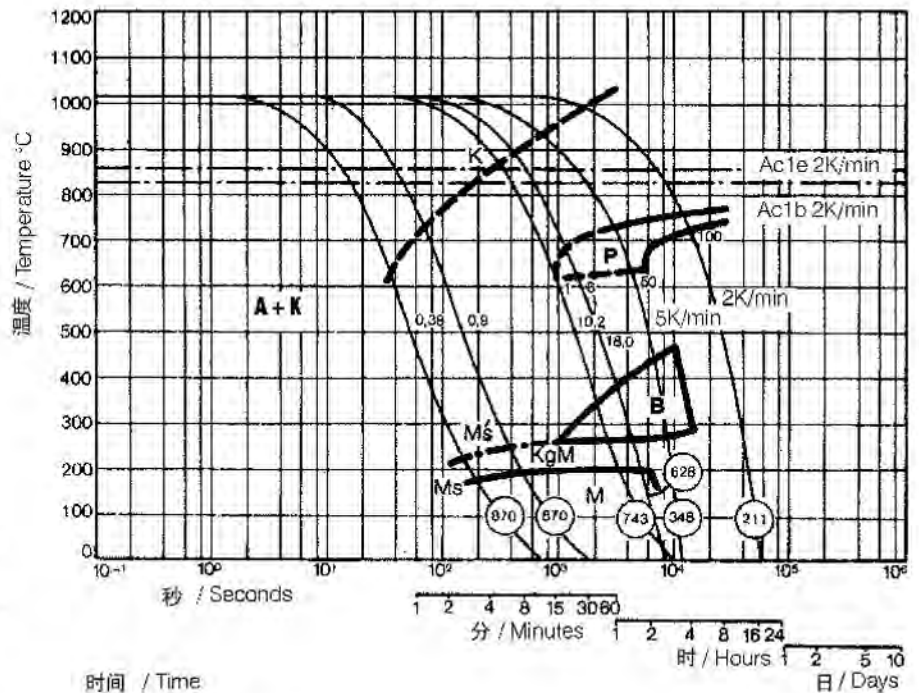
Austenitising temperature: 1020°C

Holding time: 30 minutes

- Vickers hardness
- 1... 100 phase percentages
- 0.38... 18 cooling parameter, i.e. duration of cooling from 800°C to 500°C in  $s \times 10^{-2}$
- 5... 2K/min cooling rate in K/min in the 800°C to 500°C range
- Ms'-Ms
- Range of grain boundary martensite formation
- KgM.....Grain boundary martensite

## Chemische Zusammensetzung (Anhaltswerte in %) / Chemical composition (average %)

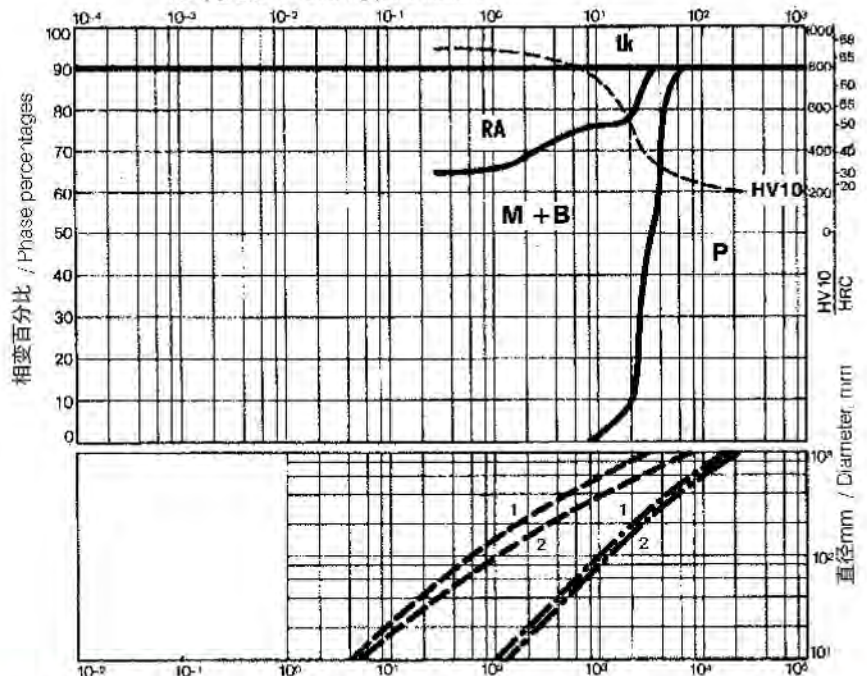
| C    | Si   | Mn   | P     | S     | Cr    | Mo   | Ni   | V    | W    |
|------|------|------|-------|-------|-------|------|------|------|------|
| 1,52 | 0,34 | 0,27 | 0,020 | 0,013 | 11,37 | 0,75 | 0,19 | 0,88 | 0,19 |



## 定量相图

## Quantitative phase diagram

冷却参数  $\lambda$  / Cooling parameter  $\lambda$



- Lk ... 莱氏体 / Ledeburite carbide
- RA ... 残留奥氏体 / Residual austenite
- A ... 奥氏体 / Austenite
- B ... 贝氏体 / Bainite
- P ... 珠光体 / Pearlite
- K ... 碳化物 / Carbide
- M ... 马氏体 / Martensite

- - - 油冷 / Oil cooling
- · - 气冷 / Air cooling
- 1..... 边缘或表面 / Edge or face
- 2..... 心部 / Core

从800°C冷却到500°C所需时间, 单位为秒。 / Cooling time in sec. from 800°C to 500°C

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## 等温度变态TTT曲线图 / Isothermal TTT curves

奥氏体化温度: 1020°C

保温时间: 30分钟

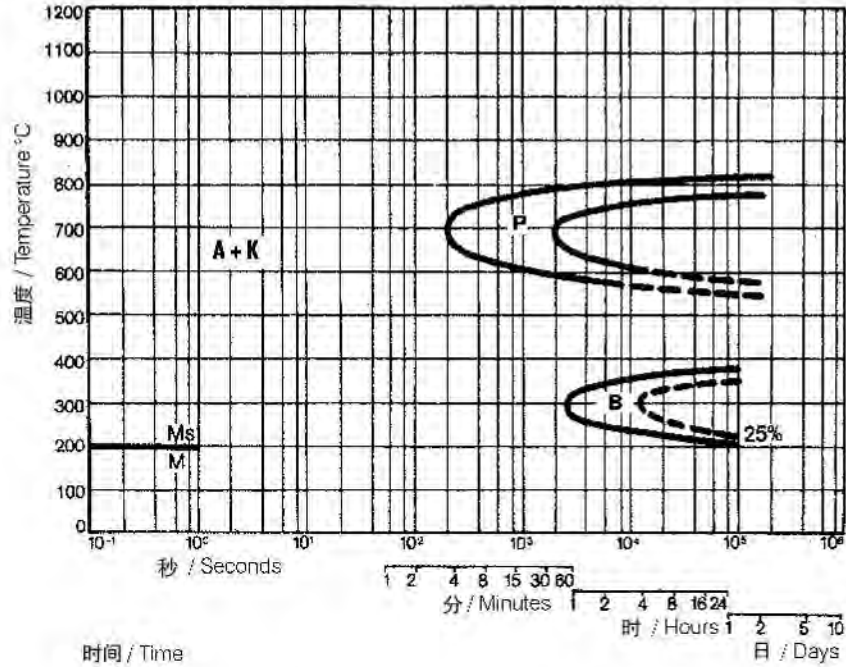
Austenitising temperature: 1020°C

Holding time: 30 minutes

- A ..... 奥氏体 / Austenite
- B ..... 贝氏体 / Bainite
- P ..... 珠光体 / Pearlite
- K ..... 碳化物 / Carbide
- M ..... 马氏体 / Martensite

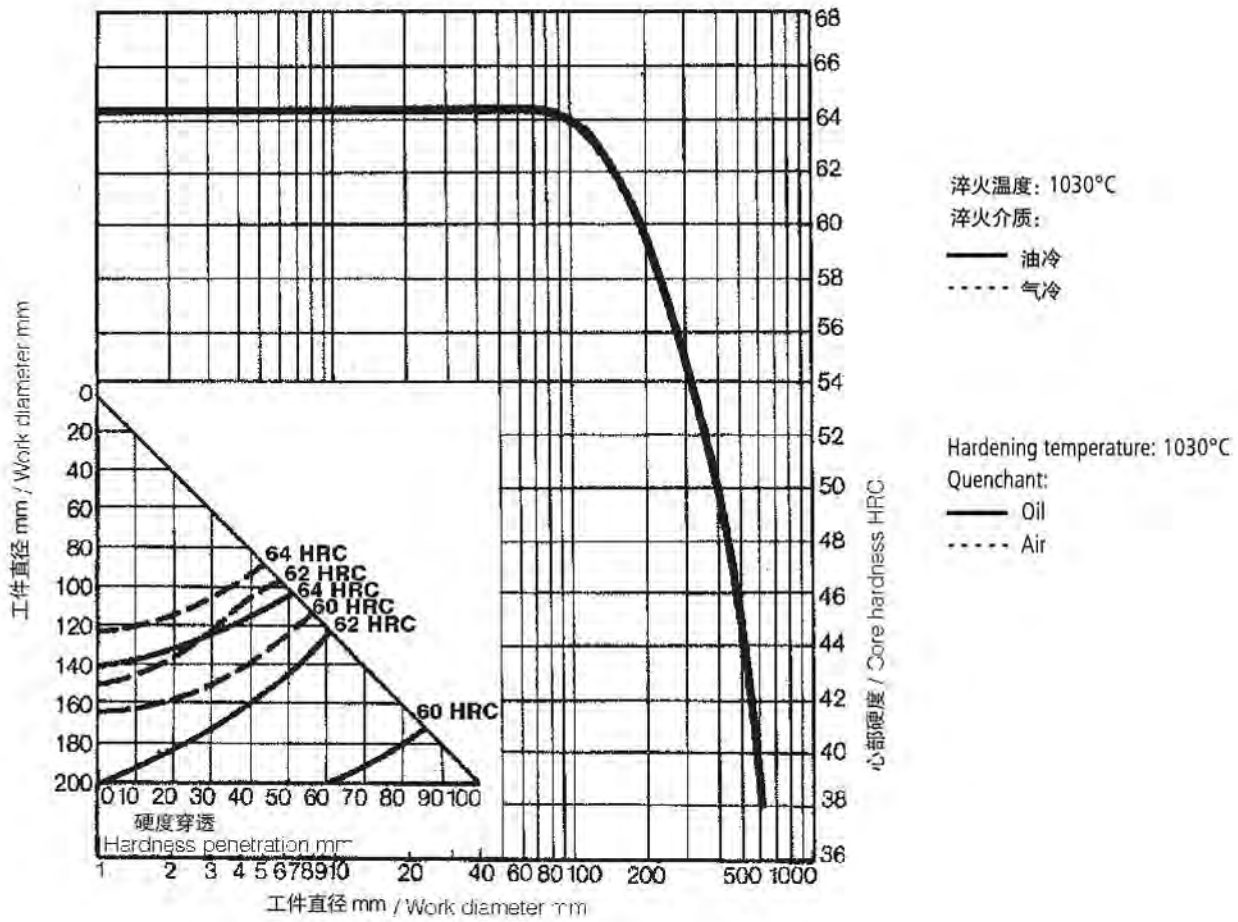
化学成份 (平均值) / Chemical composition (average %)

| C    | Si   | Mn   | P     | S     | Cr    | Mo   | Ni   | V    | W    |
|------|------|------|-------|-------|-------|------|------|------|------|
| 1,52 | 0,34 | 0,27 | 0,020 | 0,013 | 11,37 | 0,75 | 0,19 | 0,88 | 0,19 |



## 有效直径对心部硬度及淬透性的影响

Influence of work diameter on core hardness and hardness penetration





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## 机加工建议

退火状态: 平均值

### 用硬质合金车削

|                     |             |                  |             |             |
|---------------------|-------------|------------------|-------------|-------------|
| 切削深度                | 0,5 bis 1   | 1 bis 4          | 4 bis 8     | über 8      |
| 进给 mm/rev.          | 0,1 bis 0,3 | 0,2 bis 0,4      | 0,3 bis 0,6 | 0,5 bis 1,5 |
| BOEHLERIT 牌号        | SB10,SB20   | SB10, SB20, EB10 | SB30, EB20  | SB30, SB40  |
| ISO 牌号              | P10,P20     | P10, P20, M10    | P30, M20    | P30, P40    |
| <b>切削速度 米/分</b>     |             |                  |             |             |
| 可换式硬质合金刀片加工15分钟     | 210 bis 150 | 160 bis 110      | 110 bis 80  | 70 bis 45   |
| 钎焊硬质合金刀具加工30分钟      | 150 bis 110 | 135 bis 85       | 90 bis 60   | 70 bis 35   |
| 表面镀层可换式刀片加工15分钟     |             |                  |             |             |
| BOEHLERIT ROYAL 121 | bis 210     | bis 180          | bis 130     | bis 80      |
| BOEHLERIT ROYAL 131 | bis 140     | bis 140          | bis 100     | bis 60      |
| 钎焊硬质合金刀具切削角度        |             |                  |             |             |
| 前角                  | 6 bis 12    | 6 bis 12°        | 6 bis 12°   | 6 bis 12°   |
| 后角                  | 6 bis 8     | 6 bis 8          | 6 bis 8     | 6 bis 8     |
| 倾角                  | 0°          | -4°              | -4°         | -4°         |

### 用高速钢车削

|                 |                       |           |           |
|-----------------|-----------------------|-----------|-----------|
| 切削深度            | 0,5                   | 3         | 6         |
| 进给 mm/rev.      | 0,1                   | 0,4       | 0,8       |
| Bohler 牌号 DW 规范 | S700 / DIN 510-4-3-10 |           |           |
| <b>切削速度 米/分</b> |                       |           |           |
| 加工60分钟          | 30 bis 20             | 20 bis 15 | 18 bis 10 |
| 前角              | 14°                   | 14°       | 14°       |
| 后角              | 8°                    | 8°        | 8°        |
| 倾角              | -4°                   | -4°       | -4°       |

### 用硬质合金铣削

|                               |             |             |
|-------------------------------|-------------|-------------|
| 进给 mm/rev.                    | bis 0,2     | 0,2 bis 0,4 |
| <b>切削速度 米/分</b>               |             |             |
| BOEHLERIT SBF / ISO P25       | 150 bis 100 | 110 bis 60  |
| BOEHLERIT SB40 / ISO P40      | 100 bis 60  | 70 bis 40   |
| BOEHLERIT ROYAL 131 / ISO P35 | 130 bis 85  | 130 bis 85  |

### 用硬质合金钻孔

|                    |               |               |               |
|--------------------|---------------|---------------|---------------|
| 钻头直径 mm            | 3 bis 8       | 8 bis 20      | 20 bis 40     |
| 进给 mm/rev.         | 0,02 bis 0,05 | 0,05 bis 0,12 | 0,12 bis 0,18 |
| BOEHLERIT / ISO 牌号 | HB10/K10      | HB10/K10      | HB10/K10      |
| <b>切削速度 米/分</b>    |               |               |               |
|                    | 50 bis 35     | 50 bis 35     | 50 bis 35     |
| 顶角                 | 115 bis 120°  | 115 bis 120°  | 115 bis 120°  |
| 后角                 | 5°            | 5°            | 5°            |



## Recommendation for machining

(Condition annealed, average values)

| Turning with carbide tipped tools   |                           |                            |                            |                            |
|---|---------------------------|----------------------------|----------------------------|----------------------------|
| depth of cut mm   | 0.5 to 1                  | 1 to 4                     | 4 to 8                     | over 8                     |
| feed, mm/rev.   | 0.1 to 0.3                | 0.2 to 0.4                 | 0.3 to 0.6                 | 0.5 to 1.5                 |
| BOEHLERIT grade   | SB10, SB20                | SB10, SB20, EB10           | SB30, EB20                 | SB30, SB40                 |
| ISO grade   | P10, P20                  | P10, P20, M10              | P30, M20                   | P30, P40                   |
| <b>cutting speed, m/min</b>   |                           |                            |                            |                            |
| indexable carbide inserts<br>edge life 15 min   | 210 to 150                | 160 to 110                 | 110 to 80                  | 70 to 45                   |
| brazed carbide tipped tools<br>edge life 30 min   | 150 to 110                | 135 to 85                  | 90 to 60                   | 70 to 35                   |
| hardfaced indexable carbide inserts<br>edge life 15 min<br>BOEHLERIT ROYAL 121<br>BOEHLERIT ROYAL 131   | to 210<br>to 140          | to 180<br>to 140           | to 130<br>to 100           | to 80<br>to 60             |
| cutting angles for brazed carbide tipped tools<br>rake angle<br>clearance angle<br>angle of inclination | 6 to 12°<br>6 to 8°<br>0° | 6 to 12°<br>6 to 8°<br>-4° | 6 to 12°<br>6 to 8°<br>-4° | 6 to 12°<br>6 to 8°<br>-4° |

| Turning with HSS tools      |                       |          |          |
|-----------------------------|-----------------------|----------|----------|
| depth of cut, mm            | 0.5                   | 3        | 6        |
| feed, mm/rev.               | 0.1                   | 0.4      | 0.8      |
| HSS-grade BOEHLER/DIN       | S700 / DIN S10-4-3-10 |          |          |
| <b>cutting speed, m/min</b> |                       |          |          |
| edge life 60 min            | 30 to 20              | 20 to 15 | 18 to 10 |
| rake angle                  | 14°                   | 14°      | 14°      |
| clearance angle             | 8°                    | 8°       | 8°       |
| angle of inclination        | -4°                   | -4°      | -4°      |

| Milling with carbide tipped cutters |            |            |
|-------------------------------------|------------|------------|
| feed, mm/tooth                      | to 0.2     | 0.2 to 0.4 |
| <b>cutting speed, m/min</b>         |            |            |
| BOEHLERIT SBF/ ISO P25              | 150 to 100 | 110 to 60  |
| BOEHLERIT SB40/ ISO P40             | 100 to 60  | 70 to 40   |
| BOEHLERIT ROYAL 131 / ISO P35       | 130 to 85  | 130 to 85  |

| Drilling with carbide tipped tools |              |              |              |
|------------------------------------|--------------|--------------|--------------|
| drill diameter, mm                 | 3 to 8       | 8 to 20      | 20 to 40     |
| feed, mm/rev.                      | 0.02 to 0.05 | 0.05 to 0.12 | 0.12 to 0.18 |
| BOEHLERIT / ISO-grade              | HB10/K10     | HB10/K10     | HB10/K10     |
| <b>cutting speed, m/min</b>        |              |              |              |
|                                    | 50 to 35     | 50 to 35     | 50 to 35     |
| top angle                          | 115 to 120°  | 115 to 120°  | 115 to 120°  |
| clearance angle                    | 5°           | 5°           | 5°           |

## 物理性能 <sup>1)</sup>

## Physical properties <sup>1)</sup>

密度

Density at .....20°C .....7,67 .....kg/dm<sup>3</sup>

热传导系数

Thermal conductivity at .....20°C .....23,9 .....W/(m.K)

比热

Specific heat at .....20°C .....470 .....J/(kg.K)

电阻率

Electrical resistivity at .....20°C .....0,65 .....Ohm.mm<sup>2</sup>/m

弹性模量

Modulus of elasticity at .....20°C .....200 x 10<sup>3</sup> ...N/mm<sup>2</sup>

| 热膨胀系数 20°C 与 ...°C, 10 <sup>-6</sup> m/(m.K)<br>Thermal expansion between 20°C and ...°C, 10 <sup>-6</sup> m/(m.K) at |       |       |       |       |       |       |
|---|-------|-------|-------|-------|-------|-------|
| 100°C   | 200°C | 300°C | 400°C | 500°C | 600°C | 700°C |
| 11,0  | 11,4  | 11,9  | 12,2  | 12,7  | 12,8  | 12,1  |

1) 测量值

1) measured values

本产品说明书没有专门提及有关用途和加工手段的数据图表，用户可在个别咨询时提出要求。

As regards applications and processing steps that are not expressly mentioned in this product description/data sheet, the customer shall in each individual case be required to consult us.



您的伙伴:

Your partner:

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