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Global Steel Grade Encyclopedia

涵盖的行业或国家与地区类别

ASTM INTERNATIONAL 美材料与试验协会
GJB 国家军用标准
SAE INTERNATIONAL 动力机械工程师协会
EU 前欧洲标准化
AISI 美国钢铁学会
DIN 德国工业标准
AMS 国空航天材料规范
ISO 国际标准
JASO 日本汽车标准组织
EN 欧洲标准
JB 国机械行业标准
UNS 统一编号系统
UNI 意大利标准
ASME 美国机械工程师协会
SS 瑞典标准
GB 国家标准
JIS 日本工业标准

WARMARBEITSSTAHL
HOT WORK TOOL STEEL

W360

ISOBLOC®

热作工具钢

HOT WORK TOOL STEEL

热作工具钢
HOT WORK TOOL STEEL

W360 ISOBLOC®

BOHLER W360 ISOBLOC 是百禄研发的用于温锻、热锻模具之凹模，冲头模具钢材。同时，W360 ISOBLOC 被广泛应用于有高硬度及高韧性双重要求的工具钢。

BÖHLER W360 ISOBLOC was developed as a tool steel for dies and punches in warm and hot forging. The steel can be used for a variety of applications where hardness and toughness are required.

性能特点：

- 高硬度（推荐使用硬度：52–57HRc）
- 极高韧性
- 优良的抗回火软化性能
- 良好的热传导性能
- 可用水冷
- 各向同性的微观组织

Properties

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

用途：

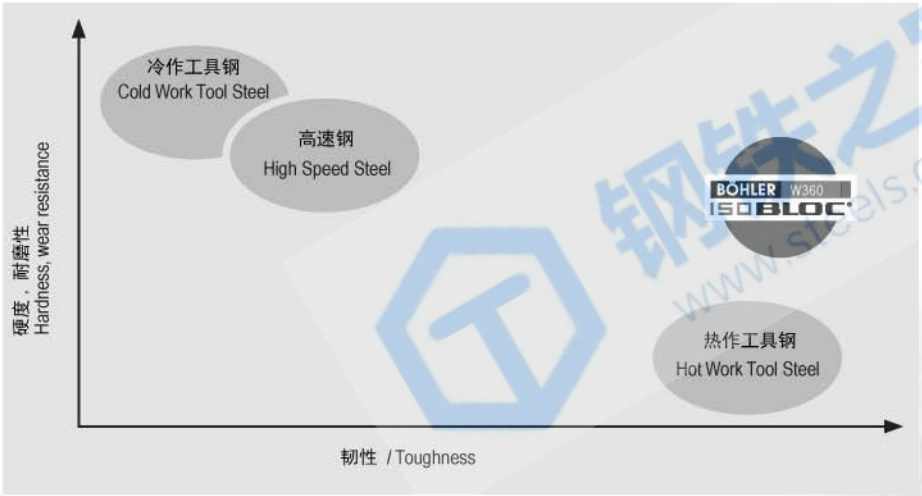
- 温锻、热锻模具的凹模与冲头
- 高速冲压模具
- 韧性要求极其苛刻的冷作应用场合
- 挤出模具
- 压铸模具型芯镶件
- 塑料成型工具中的材料应用

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

高硬度热作工具钢
HOT WORK TOOL STEEL WITH HIGH HARDNESS

产品定位 / Product placement



百禄 W360 ISOBLOC 是根据市场需求开发生产的，即具备与高速钢相当的高硬度，又具备热作钢的高韧性的模具钢，从而明显提升模具寿命

BÖHLER W360 ISOBLOC has been developed to meet the requirements of the market and has the combined advantages of the high hardness of a high speed steel with the very good toughness of a hot work tool steel. These are characteristics which can significantly increase the life-time of your tool.

电渣重熔保证了冶金高纯净度及最佳材料性能

Electroslag remelting ensures a high metallurgical cleanliness and therefore best material properties

热作工具钢
HOT WORK TOOL STEEL

W360 ISOBLOC®

百禄独特的优秀产品特性源于专利合金成风和电熔过程，以专利的合金化概念及电渣重熔冶炼保证了 W360 ISBLOC 最佳的材料性能。

BÖHLER W360 ISOBLOC owes its excellent properties to a patented alloying concept and the electroslag remelting process.

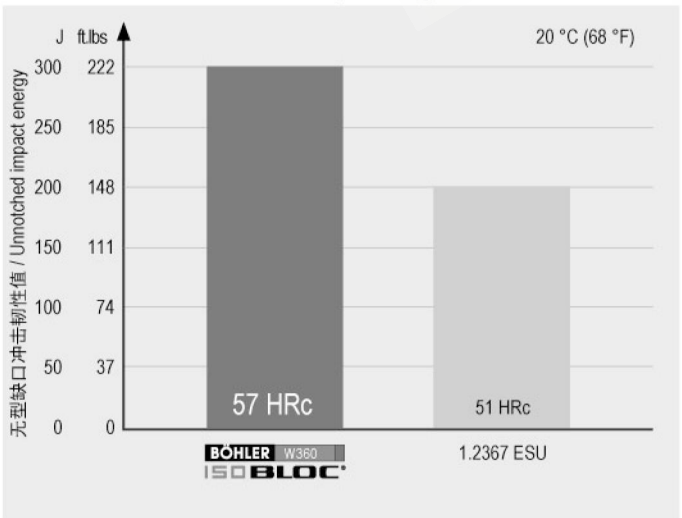
韧性

热作钢的韧性是保证不开裂，增强抗龟裂和热冲击的重要特性之一高硬度往往对应是低韧性，但 W360 是例外

Toughness

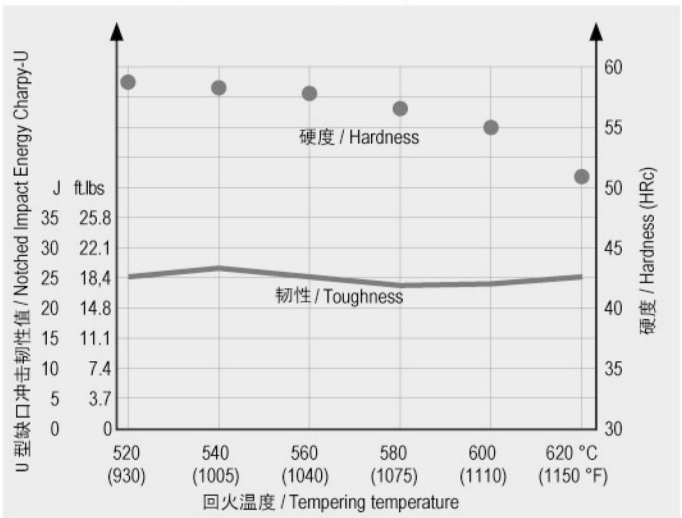
The toughness of hot work tool steels is one of the most important properties for safety against fracture and increased resistance to heat-checking and thermal shock. High hardness is usually associated with low toughness. This is not the case for W360 ISOBLOC.

无型缺口冲击韧性值 / Unnotched impact energy



W360 ISOBLOC 与 1.2367ESR 相比在更高硬度的情况下，反而具备更高的韧性。
BÖHLER W360 ISOBLOC has a significantly higher toughness than 1.2367 ESU – at a higher hardness.

500 °C 的韧性 / Toughness at 500 °C (930 °F)



参照不同回火温度所对应的韧性值，我们可以看，W360 ISOBLOC 在硬度 HRC51-57 范围内韧性基本一致。
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.

对照数据
THE COMPARISON SPEAKS FOR ITSELF

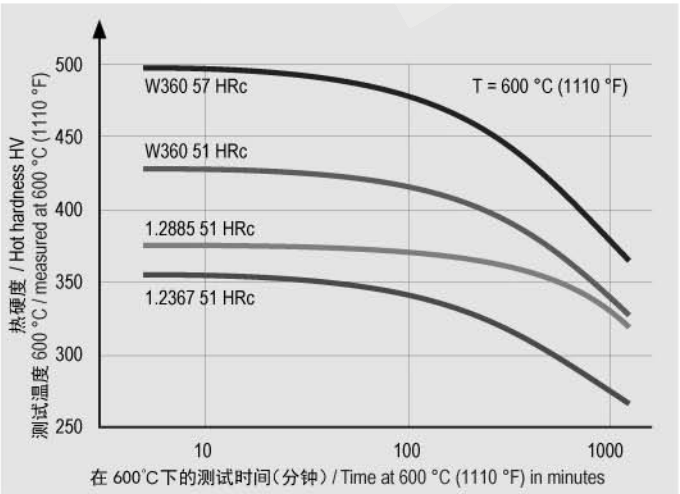
韧性

除了杰出的韧性 ,W360 ISOBLOC 还具有非常好的热稳定性，这表现于热载荷下，W360 具备极高的热硬度及材料稳定性。这些特性保证了 W360 具有很高的抗热疲劳及突变失效的能力。

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.

热硬度 / Hot hardness



在 52HRC 硬度下，百禄 W360ISOBLOC 的热度比 1.2885 和 1.2367 高；当硬度提高到 57HRC, 这时 W360 的热硬度有了一个更显著的提高。

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.

热作工具钢
HOT WORK TOOL STEEL

W360 ISOBLOC®

从实验室到客户

在研发过程中，百禄视模具成本的最优化为最核心的考虑问题。

百禄 W360 的各项数据与事实一览：

From laboratory to customer

BÖHLER recognises cost effectiveness of tooling as a central concern during the development process.

The facts and figures of **BÖHLER W360 ISOBLOC** at a glance.

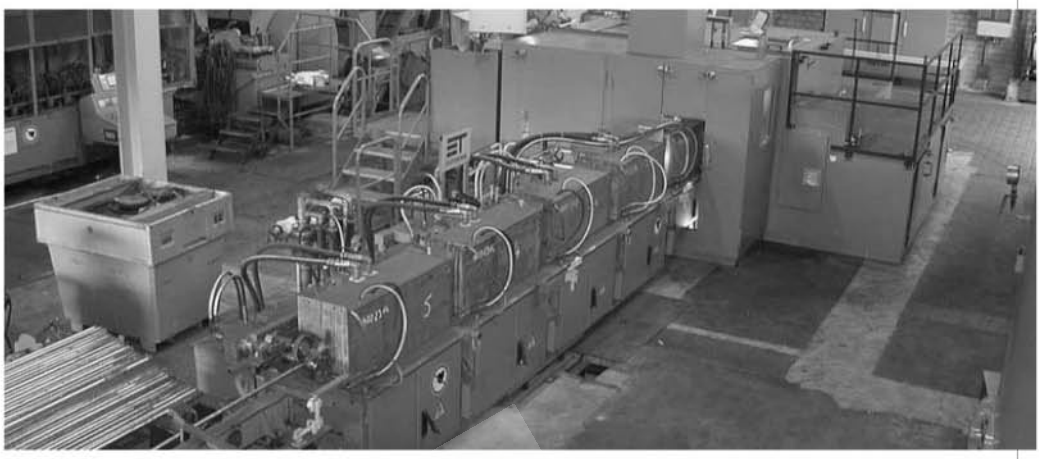
合金成份 (%) / Chemical composition (%)					
C	Si	Mn	Cr	Mo	V
0,50	0,20	0,25	4,50	3,00	0,55

物理性能 / Physical properties	
状况：淬火 + 回火 / Condition: hardened and tempered	
20 °C 密度 / Density at 20 °C 68 °F 密度	7,6 kg/dm³ 0.274 lbs/in³
20 °C 电阻率 / Electrical resistivity at 20 °C 68 °F 电阻率	0,59 Ohm.mm²/m 0.98 x 10⁻³ Ohm circular-mil per ft

热传导率 Thermal conductivity at					
100 °C	200 °C	300 °C	400 °C	500 °C	
31,5	32,3	32,6	32,5	31,9	in W/(m.K)
210 °F	390 °F	570 °F	750 °F	930 °F	
18.2	18.7	18.8	18.8	18.4	Btu / in/ft² h °F

热膨胀系数（20 °C） Thermal expansion between 20 °C (68 °F) and ... °C (°F)						
100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C
11,1	11,5	11,9	12,3	12,8	13,2	13,6 10⁻⁶ m/(m.K)
210 °F	390 °F	570 °F	750 °F	930 °F	1110 °F	1290 °F
6.2	6.4	6.6	6.8	7.1	7.3	7.6 10⁻⁶ in/in°F

数字，数据，事实
NUMBERS, DATA, FACTS

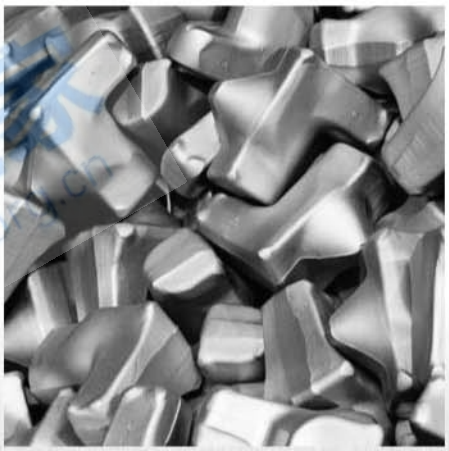


供货状态：

• 退火，最高 205HB

Supplied condition

• Annealed, 205 HB max.



热处理：

Heat treatment

退火

• 750-800 °C(1380-1470 °F), 保持时间 6-8 小时。

• 随炉慢冷，以每小时 10-20 °C 的速度冷却至 600 °C 左右，随后空冷。

Annealing

• 750 bis 800 °C (1380 to 1470 °F), Holding time 6 to 8 hours

• Slow, controlled cooling in furnace at a rate of 10 to 20 °C/h (50 to 68 °F/h) down to approx. 600 °C (1110 °F), further cooling in air.

消除应力

• 650-700 °C(1200-1290 °F)

• 在热透后，在保护氛围中保温 1 到 2 小时

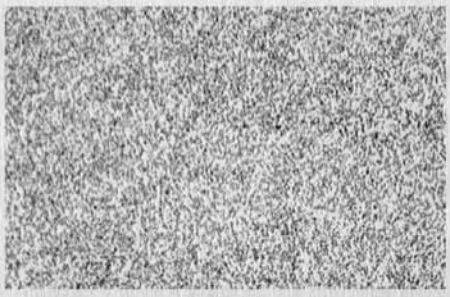
• 随炉慢冷

Stress relieving

• 650 bis 700 °C (1200 to 1290 °F)

• After through-heating, soak for 1 to 2 hours in a neutral atmosphere.

• Cool slowly in furnace.



淬火

• 1050°C(1200-1290 °F)/ 油冷，盐浴 500-550 °C(930 to 1020 °F), 气冷，真空气淬。

• 热透后保温 15-30 分钟。

Hardening

• 1050 °C (1920 °F)/oil, salt bath 500 bis 550 °C (930 to 1020 °F), air, vacuum furnace with gas quenching

• Holding time after through-heating: 15 to 30 minutes

回火

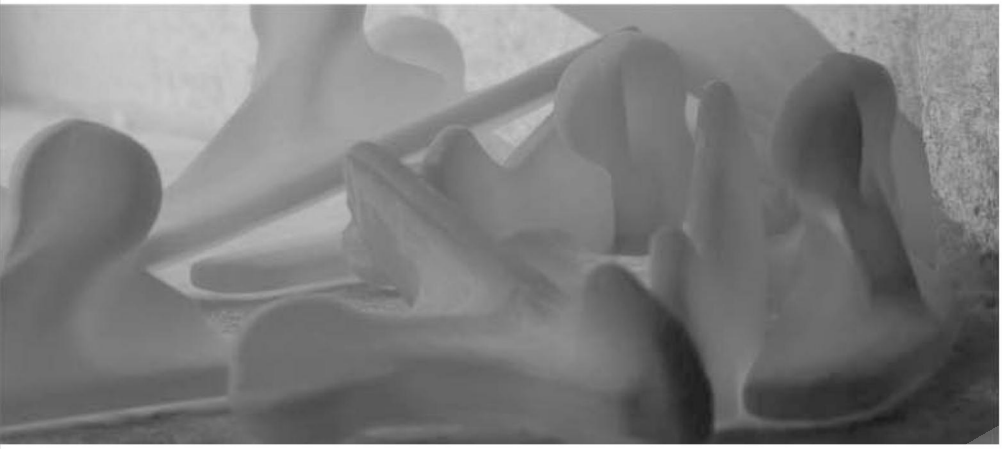
在淬火后缓慢加热到回火温度。回火保持时间：工件厚度方向每 20mm 一小时，至少 2 小时，我们建议至少回火 3 次。

Tempering

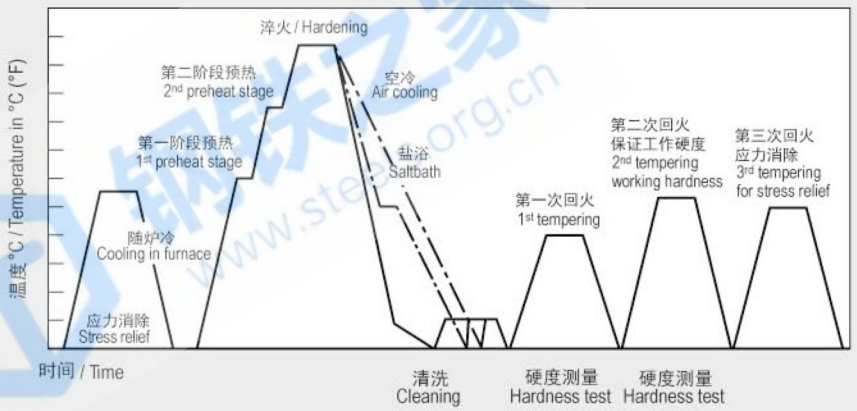
Slowly heat to tempering temperature immediately after hardening. Time in furnace: 1 hour for every 20 mm of workpiece thickness but at least 2 hours. Cool in air. We recommend that the steel be tempered at least 3 times.

热作工具钢
HOT WORK TOOL STEEL

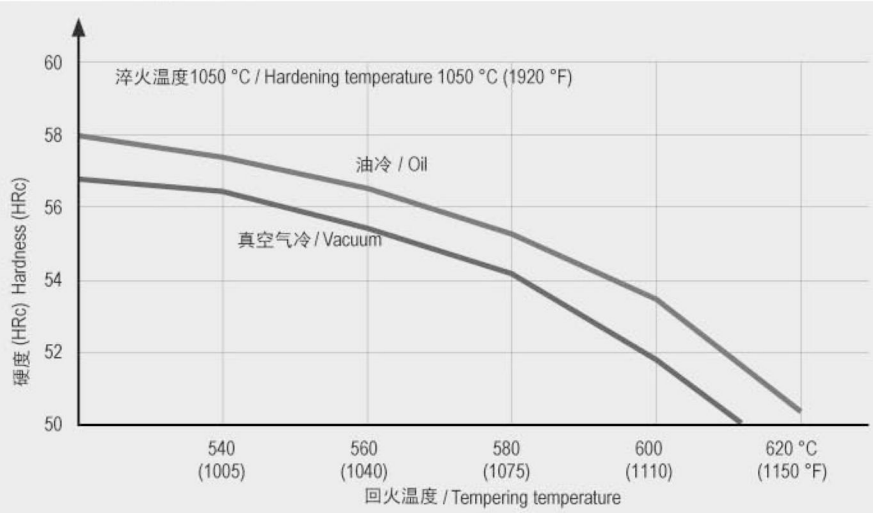
W360 ISOBLOC®



热处理工艺 / Heat treatment sequence



回火曲线图 / Tempering chart



连续冷却 CCT 曲线
Continuous cooling CCT curves

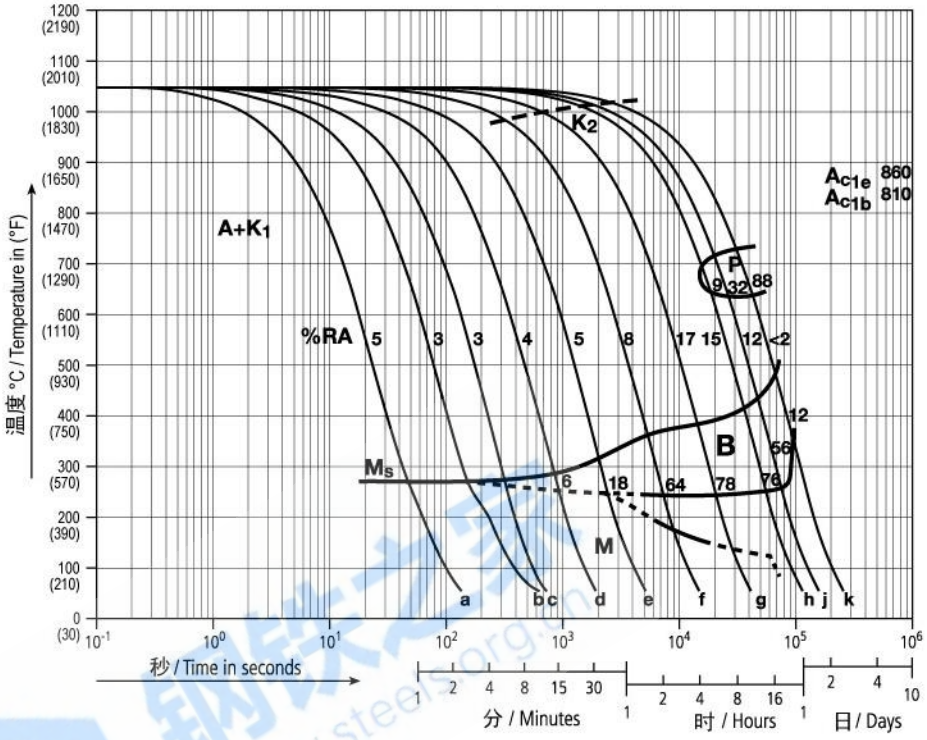
奥氏体化温度 :1050°C
保持时间 :30Minuten

5...100　相含量百分比
0,15...400　冷却参数，即以 800°C 连续冷却到 500°C 所需时间，单位 = 秒 x10^{-2}

Austenitizing temperature: 1050 °C (1920 °F)
Holding time: 30 minutes

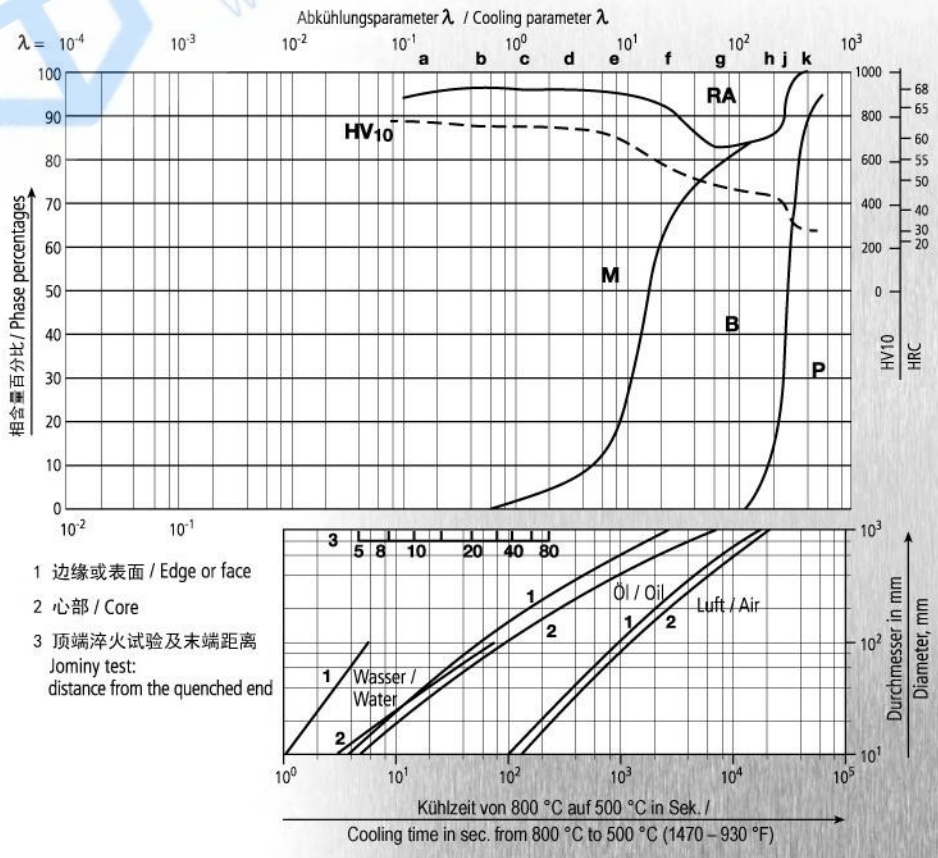
5 ... 100　phase percentages in %
0,15 ... 400　cooling parameter, i.e. duration of cooling from 800 – 500 °C (1470 – 930 °F) in s x 10^{-2}

样本 / Sample	λ	HV_{10}
a	0,15	785
b	0,5	760
c	1,1	762
d	3	754
e	8	724
f	23	582
g	65	498
h	180	453
j	250	415
k	400	294



定量相图
Quantitative phase diagram

$K_{1,2}$	碳化物 / Carbide
RA	残留奥氏体 / Retained austenite
A	奥氏体 / Austenite
M	马氏体 / Martensite
P	珠光体 / Pearlite
B	贝氏体 / Bainite



机加工建议
MACHINING RECOMMENDATIONS

状态：退火态，数据仅供参考

硬质合金刀具车削加工				
切削深度mm	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)	over 8 (over .31)
进给mm/u	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.6 (.012 – .024)	0.5 – 1.5 (.020 – .060)
BOEHLERIT grade	SB10, SB20	SB10, SB20, EB10	SB30, EB20	SB30, SB40
ISO grade	P10, P20	P10, P20, M10	P30, M20	P30, P40
	切削速度(m/min)**(f.p.m)**			
换挡硬质合金刀具 持续操作时间:15分钟	310 – 200 (1015 – 655)	220 – 130 (720 – 425)	180 – 100 (590 – 330)	120 – 50 (395 – 165)
钎焊硬质合金刀具 持续操作时间:30分钟	260 – 150 (850 – 490)	210 – 100 (690 – 330)	130 – 85 (425 – 280)	90 – 50 (295 – 165)
表面强化换挡硬质合金刀具 持续操作时间:15分钟 BOEHLERIT ROYAL 121 BOEHLERIT ROYAL 131	 最大 (980) 最大 (790)	 最大 270 (885) 最大 175 (575)	 最大 195 (640) 最大 135 (445)	 最大 125 (410) 最大 70 (230)
适合于钎焊硬质合金刀具的切削角度 后角 前角 倾角	 6° – 8° 12° 0°	 6° – 8° 12° -4°	 6° – 8° 12° -4°	 6° – 8° 12° -4°

高速钢刀具车削加工					
切削深度mm	0.5 (.02)	3 (.12)	6 (.24)	10 (.40)	over 10 (.40)
进给mm/u	0.1 (.004)	0.5 (.020)	1.0 (.040)	1.5 (.060)	over 1.5 (.060)
HSS-grade BÖHLER/DIN	S700 / DIN S10-4-3-10				
持续操作时间:60分钟	45 – 30 (150 – 100)	30 – 22 (100 – 70)	22 – 18 (70 – 60)	18 – 12 (60 – 40)	16 – 8 (50 – 25)
后角	14°	14°	14°	14°	14°
前角	8°	8°	8°	8°	8°
倾角	0°	0°	-4°	-4°	-4°

镶嵌硬质合金铣刀铣削加工				
进给mm/齿	最大 0.2 (.008)	0.2 – 0.4 (.008 – .016)		
	切削速度(m/min)**(f.p.m)**			
BOEHLERIT SBF/ISO P25	150 – 100 (490 – 330)	110 – 60 (360 – 195)		
BOEHLERIT SB40/ISO P40	100 – 60 (330 – 195)	70 – 40 (230 – 130)		
BOEHLERIT ROYAL 131/ISO P35	130 – 85 (425 – 280)			

切削速度(m/min)**(f.p.m)**

硬质合金刀具钻孔加工				
钻头直径 mm	3 – 8 (.12 – .31)	8 – 20 (.31 – .80)	20 – 40 (.80 – 1.6)	
进给 mm/rev.	0.02 – 0.05 (.001 – .002)	0.05 – 0.12 (.002 – .005)	0.12 – 0.18 (.005 – .007)	
BOEHLER/ISO牌号	HB10 / K10	HB10 / K10	HB10 / K10	
顶角	切削速度(m/min)**(f.p.m)**			
后角	50 – 35 (165 – 115)	50 – 35 (165 – 115)	50 – 35 (165 – 115)	
	115° – 120°	115° – 120°	115° – 120°	
	5°	5°	5°	

机加工建议
MACHINING RECOMMENDATIONS

Condition: annealed. Figures given are guidelines only.

Turning with sintered carbide				
Depth of cut mm (inches)	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)	over 8 (over .31)
Feed mm / rev. (inches/rev.)	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.6 (.012 – .024)	0.5 – 1.5 (.020 – .060)
BOEHLERIT grade	SB10, SB20	SB10, SB20, EB10	SB30, EB20	SB30, SB40
ISO grade	P10, P20	P10, P20, M10	P30, M20	P30, P40
	Cutting speed v_c m/min (f.p.m)			
Indexable inserts Tool life: 15 min.	310 – 200 (1015 – 655)	220 – 130 (720 – 425)	180 – 100 (590 – 330)	120 – 50 (395 – 165)
Brazed carbide tools Tool life: 30 min.	260 – 150 (850 – 490)	210 – 100 (690 – 330)	130 – 85 (425 – 280)	90 – 50 (295 – 165)
Coated indexable inserts Tool life: 15 min.				
BOEHLERIT ROYAL 121	up to 300 (980)	up to 270 (885)	up to 195 (640)	up to 125 (410)
BOEHLERIT ROYAL 131	up to 240 (790)	up to 175 (575)	up to 135 (445)	up to 70 (230)
Tool angles for brazed carbide tools				
Clearance angle	6° – 8°	6° – 8°	6° – 8°	6° – 8°
Rake angle	12°	12°	12°	12°
Inclination angle	0°	-4°	-4°	-4°

Turning with high speed steel					
Depth of cut mm (inches)	0.5 (.02)	3 (.12)	6 (.24)	10 (.40)	over 10 (.40)
Feed mm / rev. (inches/rev.)	0.1 (.004)	0.5 (.020)	1.0 (.040)	1.5 (.060)	over 1.5 (.060)
HSS-grade BÖHLER/DIN	S700 / DIN S10-4-3-10				
	Cutting speed v_c m/min (f.p.m)				
Tool life: 60 min.	45 – 30 (150 – 100)	30 – 22 (100 – 70)	22 – 18 (70 – 60)	18 – 12 (60 – 40)	16 – 8 (50 – 25)
Rake angle	14°	14°	14°	14°	14°
Clearance angle	8°	8°	8°	8°	8°
Inclination angle	0°	0°	-4°	-4°	-4°

Milling with inserted tooth cutter				
Feed mm/tooth (inches/tooth)	up to 0.2 (.008)	0.2 – 0.4 (.008 – .016)		
	Cutting speed v_c m/min (f.p.m)			
BOEHLERIT SBF / ISO P25	150 – 100 (490 – 330)	110 – 60 (360 – 195)		
BOEHLERIT SB40 / ISO P40	100 – 60 (330 – 195)	70 – 40 (230 – 130)		
BOEHLERIT ROYAL 131 / ISO P35	130 – 85 (425 – 280)			

Drilling with inserted carbide				
Drill diameter mm (inches)	3 – 8 (.12 – .31)	8 – 20 (.31 – .80)	20 – 40 (.80 – 1.6)	
Feed mm / rev. (inches/rev.)	0.02 – 0.05 (.001 – .002)	0.05 – 0.12 (.002 – .005)	0.12 – 0.18 (.005 – .007)	
BOEHLERIT/ISO grade	HB10 / K10	HB10 / K10	HB10 / K10	
	Cutting speed v_c m/min (f.p.m)			
	50 – 35 (165 – 115)	50 – 35 (165 – 115)	50 – 35 (165 – 115)	
Point angle	115° – 120°	115° – 120°	115° – 120°	
Clearance angle	5°	5°	5°	