



PLASTIC  
MOULD STEEL

# PLASTIC MOULD STEEL M303 塑膠模具鋼

**BOHLER M303**  
**EXTRA**

**BOHLER M303**  
**EXTRA**  
**HIGH HARD**



# 均質性 帶來最好的性能

## BEST PROPERTIES BY MEANS OF HOMOGENEITY

### 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 significant better wear resistance.

#### 奠定新的經典

**BÖHLER M303 EXTRA** 為麻田散鐵系列含鉻不銹鋼材，擁有出色的韌性、抗腐蝕性及耐磨耗性。此鋼種也針對加工性及拋光性進行改善。

另外**BÖHLER M303 EXTRA**最大的特色在於-該鋼種是為了改善均質性，進而確保傑出性能而研發的。獲得的成果-與傳統1.2316鋼種相比，此鋼種大幅度的防止基底中的 $\delta$ 肥粒鐵殘留。

百樂鋼廠也同時提供M303高硬度的出廠熱處理，能夠顯著的提升鋼材的耐磨耗性

#### Chemical composition (average %) 合金成分 (平均%)

C	Si	Mn	Cr	Ni	Mo	N	Additions
0.27	0.30	0.65	14.50	0.85	1.00	+	others

DIN-Standard: ~1.2316



## FIELD OF APPLICATIONS 應用範圍

Moulds for chemically aggressive plastics, e.g.:

- » Moulds for household appliances
- » Extrusion tools
- » Moulds for fittings

處理化學侵蝕性塑膠之模具，如：

- » 家庭用品之模具
- » 擠型模具
- » 接頭模具

**Homogeneous structure over the entire steel block – helps to avoid bad surprises during manufacturing and use of tools!**

整塊鋼材組織均為均質化結構—有助於避免在模具的製造和使用過程中出現意外情況。



DIN-Number 1.2316

Martensitic structure with delta ferrite content  
含有δ肥粒鐵芝麻田散鐵組織

**BÖHLER M303 EXTRA**

回火硬化至  
Hardened and tempered:  
290 –330 HB

**BÖHLER M303 EXTRA**  
**HIGH HARD**

回火硬化至  
Hardened and tempered:  
350 –390 HB

Hence, particular mechanical technological properties are the result.

組織均質化能夠優化特定的機械性能



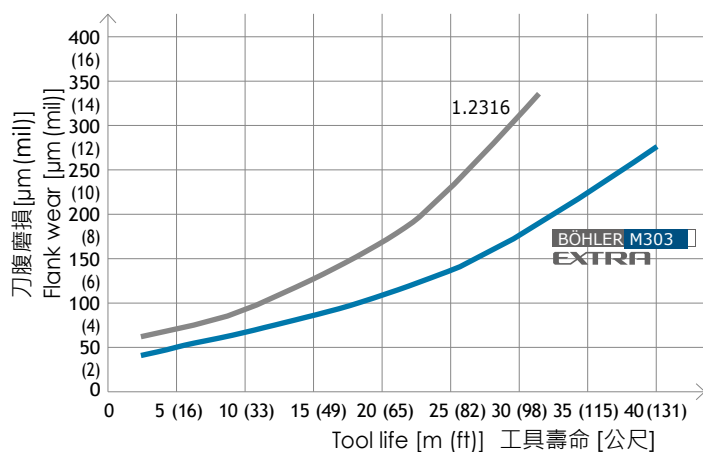
BÖHLER M303 EXTRA

Homogeneous structure  
均質化組織

# 有效率之加工性 為使用者帶來的益處

## BENEFITS FROM MORE EFFICIENT MACHINABILITY

Milling 銑削

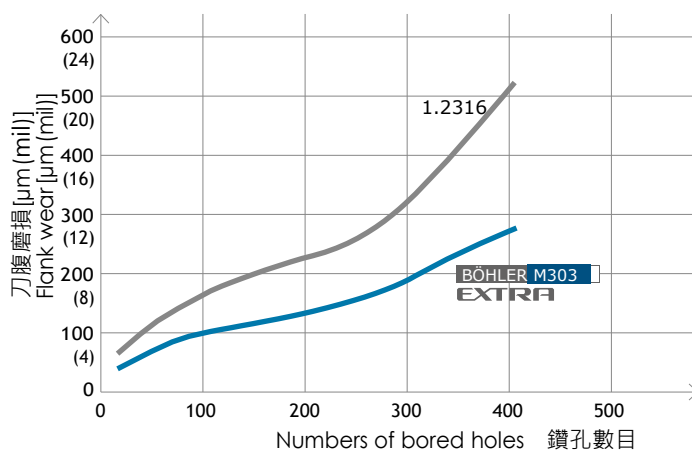


Machining parameter for milling:  
 Cutting speed:  $v_c = 200$  m/min (655 f.p.m)  
 Feed/tooth:  $f_z = 0.3$  mm (0.012 inch)  
 Milling cutter diameter:  $D = 15$  mm (0.60 inch)  
 Number of teeth:  $z = 1$   
 Depth of cut:  $a_p = 0.4$  mm (0.016 inch)  
 Cutting width:  $a_e = 8$  mm (0.32 inch)

銑削的加工參數:

切削速度:  $v_c = 200$  公尺/分鐘 (655 f.p.m)  
 每齒進給:  $f_z = 0.3$  公厘  
 銑刀直徑:  $D = 15$  公厘  
 銑刀齒數:  $z = 1$   
 加工深度:  $a_p = 0.4$  公厘  
 加工寬度:  $a_e = 8$  公厘

Drilling 鑽孔

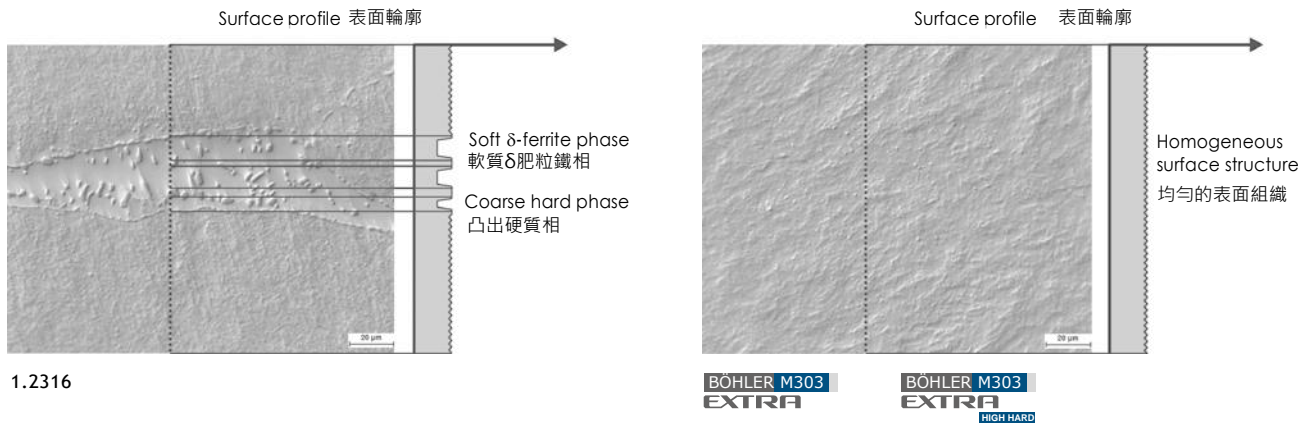


Machining parameters for drilling:  
 Cutting speed:  $v_c = 60$  m/min (197 f.p.m)  
 Tooth feed/rev.:  $f_d = 0.15$  mm (0.006 inch)  
 Diameter: 6.8 mm (0.27 inch)

鑽孔的加工參數:

加工速度:  $v_c = 60$  公尺/分鐘 (197 f.p.m)  
 每齒進給:  $f_d = 0.15$  公厘  
 直徑: 6.8 公厘

## Surface comparison 表面比較



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 **BOHLER M303 EXTRA** shows regular polish.

1.2316 中的軟質 $\delta$ 肥粒鐵區域內含硬質碳化物，會造成拋光表面的不規則。而百樂鋼M303 EXTRA均勻的表面組織會產生一致的拋光表面。

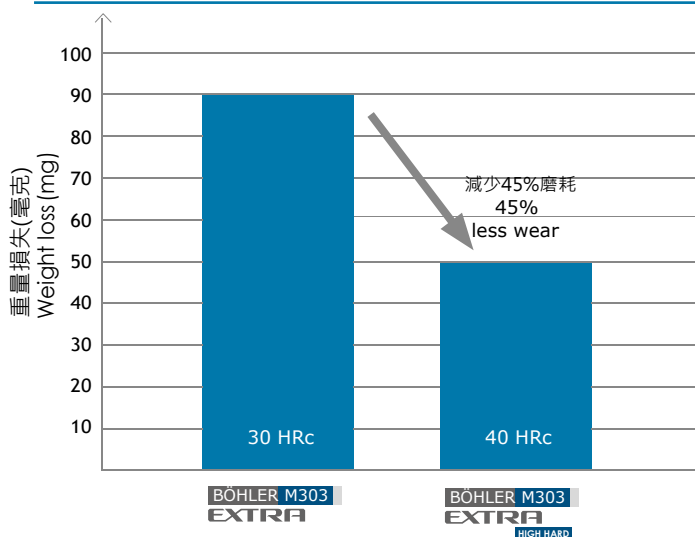
## Physical properties 物理性質

	20	100	200	300	400	500	600	°C
	68	210	390	570	750	930	1110	°F
<b>Specific heat capacity</b> 比熱容量	460 0.110	484 0.116	529 0.126	564 0.135	615 0.147	694 0.166	795 0.190	J/kg.K Btu/lb. °F
<b>Thermal expansion between 20 °C (68 °F) and ... °C</b> 20°C與各目標溫度間之熱膨脹係數	- -	10.5 5.83	10.8 6.00	11.1 6.20	11.4 6.33	11.7 6.50	12.1 6.72	10 <sup>-6</sup> m/m.K 10 <sup>-6</sup> in/in. °F
<b>Density</b> 密度	7.7 0.278	7.7 0.278	7.7 0.278	7.7 0.278	7.6 0.274	7.6 0.274	7.6 0.274	kg/dm <sup>3</sup> lbs/in <sup>3</sup>
<b>Modulus of elasticity</b> 彈性係數	218 31.6	214 31.0	207 30.0	200 29.0	191 27.7	181 26.3	168 24.4	10 <sup>3</sup> MPa 10 <sup>3</sup> ksi
<b>Thermal conductivity</b> 熱傳導係數	22.8 13.2	23.5 13.6	24.8 14.3	25.1 14.5	25.7 14.9	26.7 15.4	25.9 15.0	W/m.K Btu/ft h. °F

# 最佳應用性能 BEST USAGE PROPERTIES



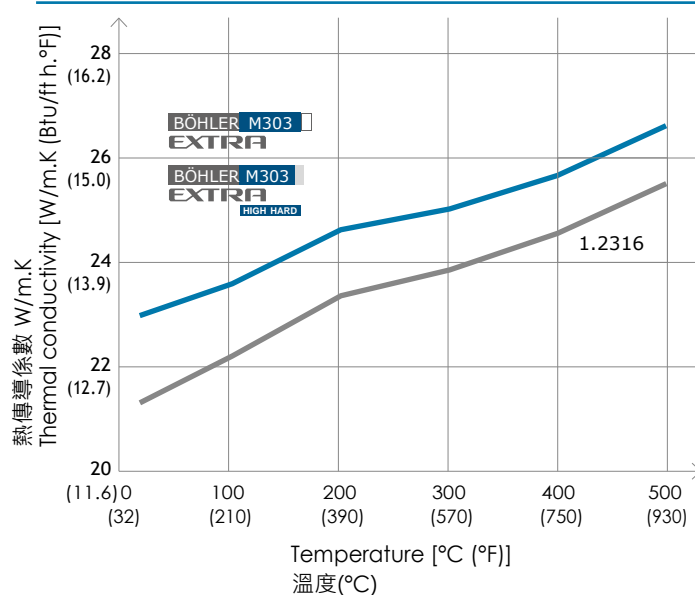
Wear resistance 耐磨耗性

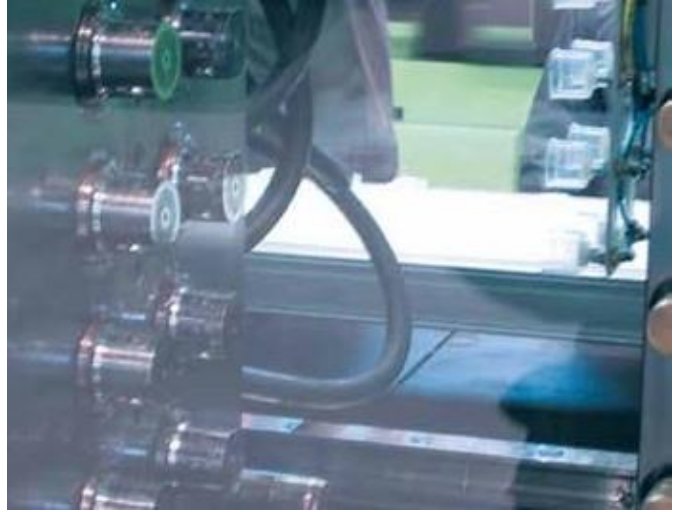


Plastics processing: injection moulding  
Processed plastic: ULTRAMIDA3WG10 (BASF) with content of fibre glass of 50 wt.%

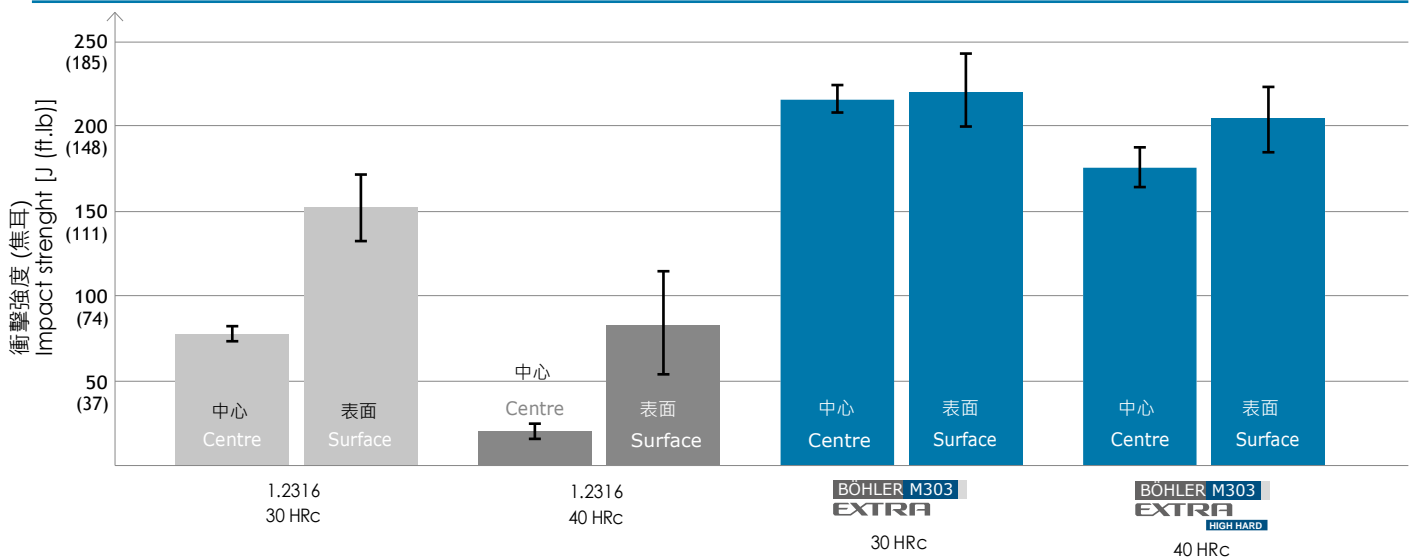
塑膠加工應用: 塑膠射出模具  
加工之塑料: BASF 之 ULTRAMIDA3WG10含 50%玻纖

Thermal conductivity 熱傳導係數





Toughness (unnotched) 韌性 (無缺口測試)



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.

與1.2316相比，百樂M303 EXTRA整體材料(含中心及表面)之韌性有顯著提升並較為一致，得以確保M303 EXTRA較優異之抗斷裂性能並避免意外的停機時間。

# 優異的抗腐蝕性

## EXCELLENT CORROSION PROPERTIES

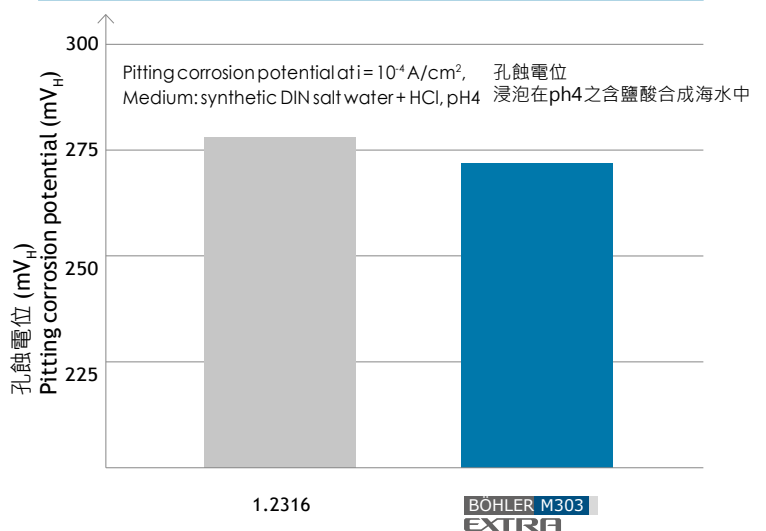
### PITTING CORROSION RESISTANCE

Current density potential graphs for both materials 1.2316 and **BÖHLER M303 EXTRA** were recorded. For both steels the corrosion resistance can be compared with each other in the testing medium used here (synthetic DIN seawater + HCl, pH4).

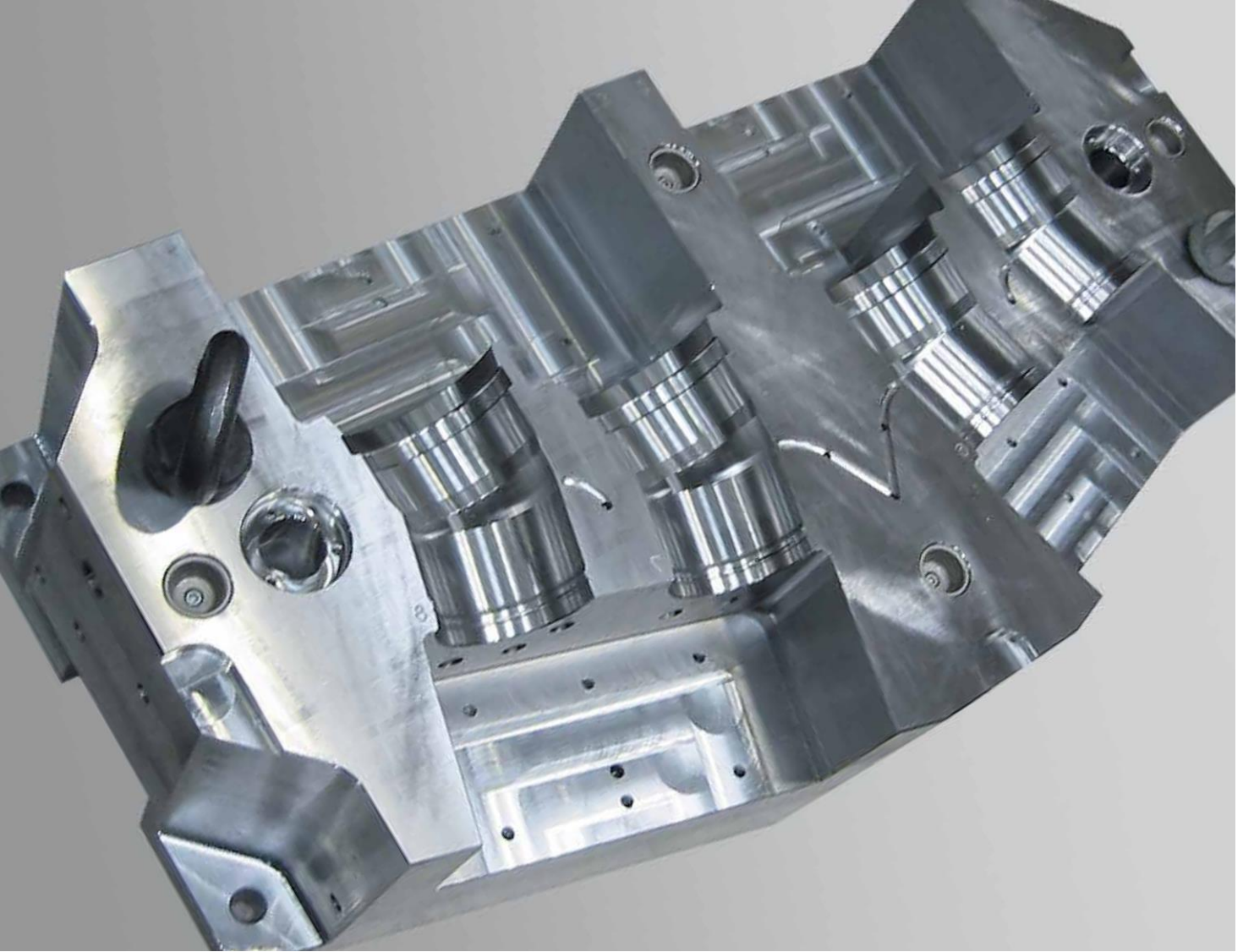
#### 抵抗孔蝕之性能

右表為1.2316以及百樂鋼之M303 EXTRA電流密度電位之記錄，而兩者的抗腐蝕性相似(測試方式為浸泡在pH4之含鹽酸合成海水中)

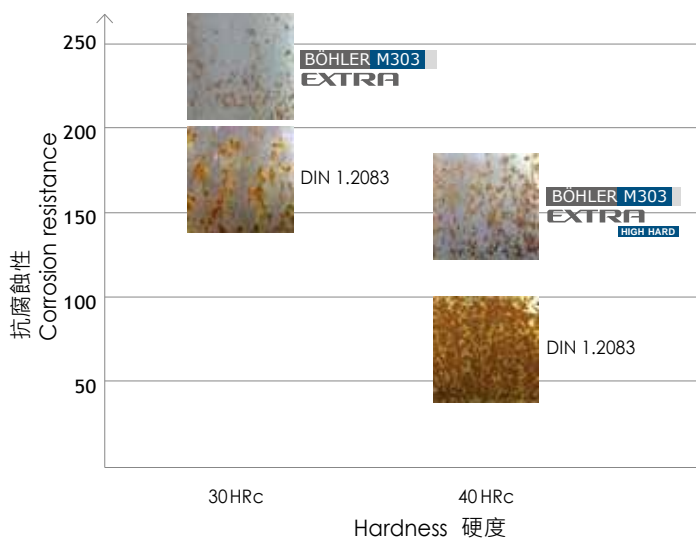
#### Corrosion resistance 抗腐蝕性







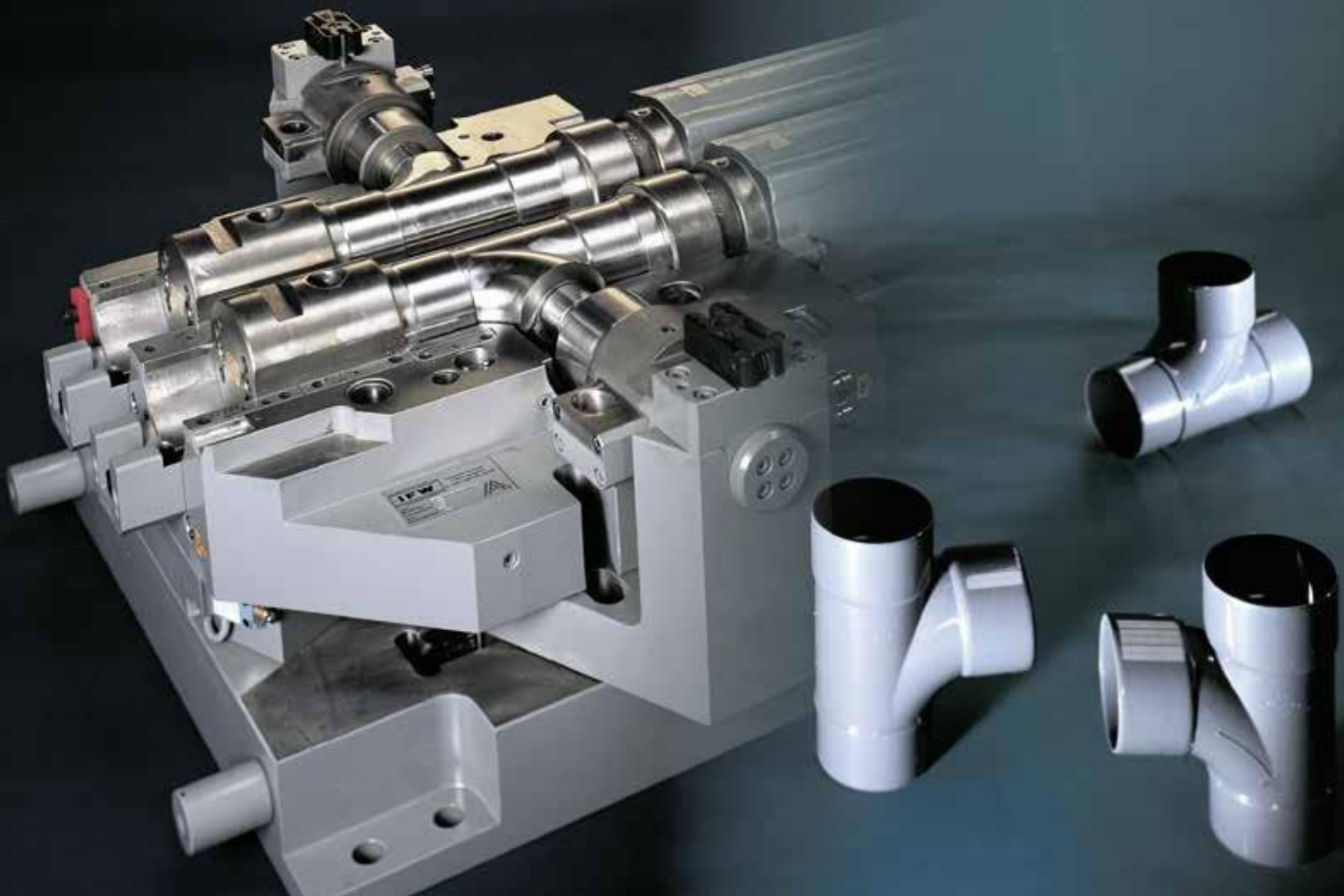
### Corrosion resistance 抗腐蝕性



Salt spray test acc. DIN 50021  
按照DIN 50021規範執行之鹽霧試驗

At the salt spray test BÖHLER M303 EXTRA exhibits a lower corrosive attack compared to 1.2083 in the same equivalent hardness level.

使用鹽霧試驗測試鋼材抗腐蝕性，與相同硬度等級的1.2083相比，百樂M303 EXTRA受到腐蝕之影響程度較低。



Since BÖHLER M303 EXTRA is supplied in the hardened and tempered condition (290 – 330 HB, 350 – 390 HB), no heat treatment is generally required.

#### Stress relieving after machining in the pre-hardened condition

- » max. 400 °C (750 °F)
- » After through-heating, soak for minimum 2 hours in a neutral atmosphere.
- » Slow cooling in furnace with 20 °C/hr (68 °F/hr) down to 200 °C (390 °F), then in air.

In case a higher hardness is required, following procedure is recommended:

#### Annealing

- » 700 to 725 °C (1290 – 1340 °F)
- » Annealing time minimum 25 hours after through-heating
- » Slow, controlled cooling in furnace at a rate of 10 to 20 °C/hr (50 – 68 °F/hr) down to approx. 500 °C (930 °F), further cooling in air.
- » Hardness after annealing: max. 250 HB

#### Stress relieving after machining in the annealed condition

- » approx. 650 °C (1200 °F)
- » After through-heating, soak for 1 – 2 hours in a neutral atmosphere.
- » Slow cooling in furnace with 20 °C/hr (68 °F/hr) down to 300 °C (570 °F), then in air.

#### Hardening

- » 1000 to 1020 °C (1830 – 1870 °F)/oil, N<sub>2</sub>, salt bath (400 to 450 °C [750 – 840 °F])
- » After through-heating, hold for 15 to 30 minutes
- » Obtainable hardness: 51 to 53 HRC

#### Tempering

- » Slow heating to tempering temperature immediately after hardening
- » Time in furnace 1 hour for each 20 mm (0.79 inch) of workpiece thickness, but at least 2 hours
- » We recommend the tempering at least twice. A third tempering for stress relieving 30 – 50 °C (85 – 120 °F) below tempering temperature is of advantage.
- » For information on the average hardness figures obtained after tempering please refer to the tempering chart.

百樂M303 EXTRA是以預硬(290 – 330 HB)方式提供，因此通常不需要另外進行熱處理

#### 預硬條件下加工後，進行之應力消除

- » 溫度最高 400°C
- » 透熱後，在中性氣體中放置至少兩小時
- » 在爐中以20°C/hr 之速度緩慢冷卻至 200°C，再進行空冷

#### 如果需要更高的硬度，建議執行以下處理:

##### 退火

- » 退火溫度應介於700 至 725 °C
- » 透熱後，應進行至少25小時之退火
- » 在爐中控制以20°C/hr 之速度緩慢冷卻至 500 °C，再進行空冷
- » 退火後硬度250 HB

#### 退火及機加工後之應力消除

- » 溫度約650 °C
- » 透熱後，在中性氣體中放置約一至兩小時
- » 在爐中以20°C/hr 之速度緩慢冷卻至 300 °C，再進行空冷

#### 硬化

- » 1000 至 1020 °C /油淬，氮氣淬，鹽浴(400 至 450 °C)
- » 透熱後，持溫15-30分鐘
- » 可達硬度: 51 至 53 HRC

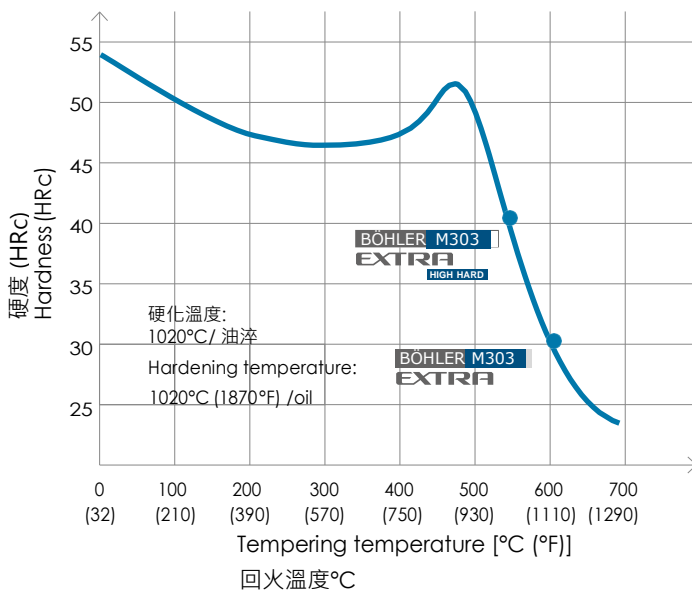
#### 回火

- » 硬化後立即緩慢加熱至回火溫度
- » 爐中持溫時間計算方法: 每20mm厚度加一小時，但至少需回火兩小時
- » 建議至少回火兩次，也可再進行第三次作為應力消除的回火增加優勢，溫度為回火溫度降低30–50 °C
- » 回火後可達硬度之資訊請參閱回火硬度溫度關係曲線圖

## 熱處理建議

# HEAT TREATMENT RECOMMENDATIONS

Tempering chart 回火硬度溫度關係曲線圖



# 熱處理建議

## HEAT TREATMENT RECOMMENDATIONS

### Continuous cooling CCT curves 持續冷卻CCT曲線圖

Austenitizing temperature: 1020°C (1870°F)

Holding time: 30 minutes

沃斯田鐵化溫度: 1020 °C

持溫時間: 30分鐘

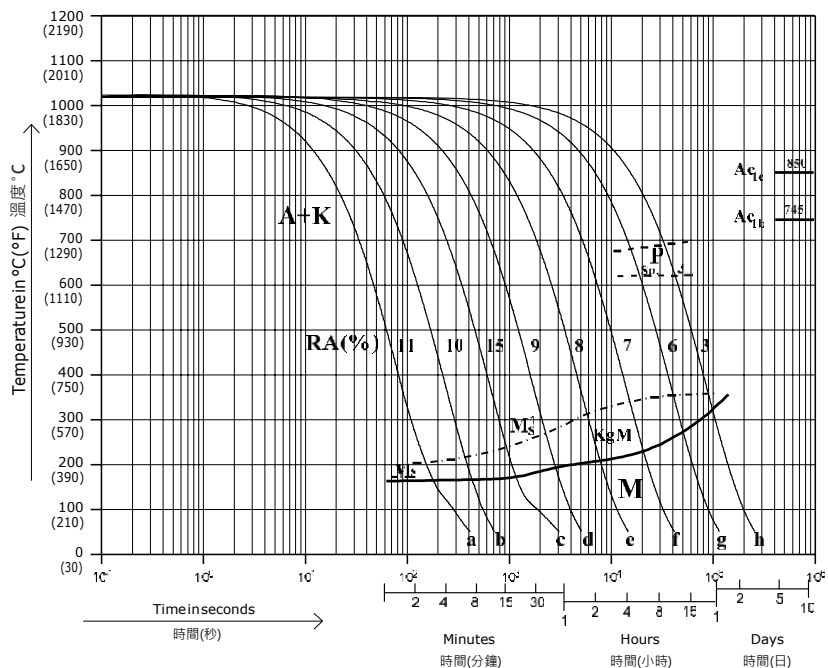
0,4...400 cooling parameter, i.e. duration of cooling from 800–500°C (1470–930 °F) in  $s \times 10^{-2}$

冷卻參數 · 例如800 – 500 °C 之冷卻時間，以  $s \times 10^{-2}$  為單位 (s=秒)

KgM Grain boundary martensite  
晶界麻田散鐵

Ms–Ms' Formation of grain boundary martensite  
晶界麻田散鐵之生成

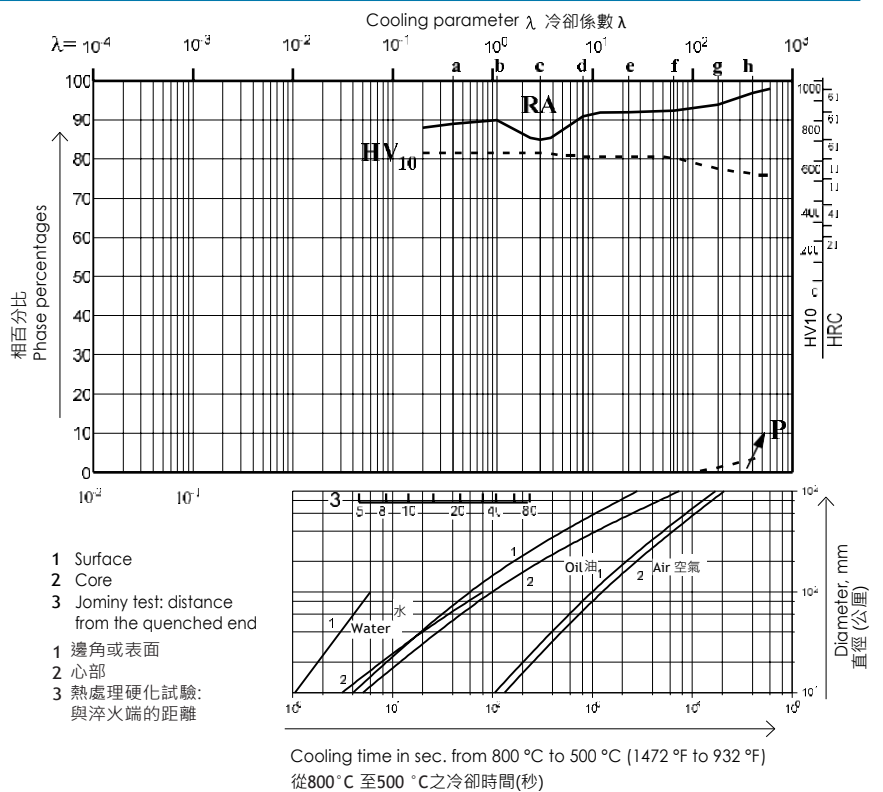
Sample 樣本	$\lambda$	HV10
a	0.40	628
b	1.10	631
c	3.00	633
d	8.00	606
e	23.00	610
f	65.00	604
g	90.00	551
h	180.00	525





**Quantitative phase diagram 定量相圖**

- RA Retained austenite 殘留沃斯田鐵
- A Austenite 沃斯田鐵
- M Martensite 麻田散鐵
- P Pearlite 波來鐵
- K Carbide 碳化物



# MACHINING 加工建議

## RECOMMENDATIONS

### Turning with sintered carbide 碳化鎢切削

Depth of cut mm (inch) 切削深度 公厘	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)
Feed mm/rev. (inch/rev.) 進給量 公厘/轉速	0.1 – 0.2 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.6 (.012 – .024)
BOEHLERIT-grade BOEHLERIT 牌號	SB10, SB20, EB10	SB10, EB20, EB20	SB30, EB20, HB10
ISO grade ISO 牌號	P10, P20, M10	P10, M10, M20	P30, M20, K10
Cutting speed $v_c$ (m/min.) (f.p.m) 切削速度 $v_c$ (公尺/分鐘)			
Indexable inserts tool life: 15 min 捨棄式刀片 工具壽命15分鐘	260 – 200 (850 – 655)	200 – 150 (655 – 490)	150 – 110 (490 – 360)
Brazed carbide tools tool life: 30 min. 硬鎢工具 工具壽命15分鐘	210 – 170 (690 – 560)	170 – 130 (560 – 425)	140 – 90 (460 – 295)
Coated indexable inserts 鍍膜捨棄式刀片			
BOEHLERIT ROYAL 121	up to 240 (270)	up to 210 (690)	up to 160 (525)
BOEHLERIT ROYAL 131	up to 210(690)	up to 160 (525)	up to 140 (460)
Tool angles for brazed carbide tools 硬鎢工具角度			
Rake angle 法前角	12° – 15°	12° – 15°	12° – 15°
Clearance angle 法後角	6° – 8°	6° – 8°	6° – 8°
Inclination angle 斜角	0°	0°	-4°

### Turning with high speed steel 高速鋼切削

Depth of cut mm (inch) 切削深度 公厘	0.5 (.02)	3 (.12)	6 (.24)
Feed mm/rev. (inch/rev.)	0.1 (.004)	0.5 (.02)	1 (.04)
HSS-grade BÖHLER/DIN BOEHLERIT 高速鋼牌號	S700 / DIN S10-4-3-10		
Cutting speed $v_c$ (m/min.) (f.p.m) 切削速度 $v_c$ (公尺/分鐘)			
Tool life: 60 min. 工具壽命: 60分鐘	55 – 45 (180 – 150)	45 – 35 (150 – 115)	35 – 25 (115 – 80)
Rake angle 法前角	14° – 18°	14° – 18°	14° – 18°
Clearance angle 法後角	8° – 10°	8° – 10°	8° – 10°
Inclination angle 斜角	0°	0°	0°

### Milling with inserted tooth cutter 碳化鎢插入式銑刀銑削

Feed mm/tooth (inch/tooth) 進給量 公厘/轉速	up to 0.2 (.008)	0.2 – 0.3 (.008 – .012)
Cutting speed $v_c$ (m/min.) (f.p.m) 切削速度 $v_c$ (公尺/分鐘)		
BOEHLERIT SBF/ISO P25	160 – 100 (525 – 330)	110 – 60 (360 – 195)
BOEHLERIT SB40/ISO P40	100 – 60 (330 – 195)	70 – 40 (230 – 130)
BOEHLERIT ROYAL 131/ISO P35	140 – 110 (460 – 360)	140 – 110 (460 – 360)

### Drilling with sintered carbide 碳化鎢鑽孔

Drill diameter mm (inch) 孔徑 公厘	3 – 8 (.12 – .31)	8 – 20 (.31 – .80)	20 – 40 (.80 – 1.6)
Feed mm/rev. (inch/rev.) 進給量 公厘/轉速	0.02 – 0.05 (.001 – .002)	0.05 – 0.12 (.002 – .005)	0.12 – 0.18 (.005 – .007)
BOEHLERIT/ISO grade 牌號	HB10 / K10		
Cutting speed $v_c$ (m/min.) (f.p.m) 加工速度 公尺/分鐘			
Point angle 尖角	115° – 120°	115° – 120°	115° – 120°
Inclination angle 法後角	5°	5°	5°

Condition: H & T 290 – 330 HB  
 Figures are guidelines only.

條件: 預硬至 290 – 330 HB  
 以上數字均為參考值



## Machinability: comparative study

### 加工性: 比較研究

BÖHLER M303  
EXTRA

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#### CUTTING 切削

Feed rate $v_f$ (mm/min.) 進給速度 $v_f$ (公厘/分鐘)	4.50	3.00
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	23.00	20.00

#### ROUGH MACHINING 粗加工

Tool 工具	Depo NTV-M40	
Feed $f_z$ (mm/tooth) 進給 $f_z$ (公厘/每齒)	0.40	0.30
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	180.00	180.00

#### FINE MACHINING 精加工

Tool 工具	Franken-Emuge 1966A.008	
Feed $f_z$ (mm/tooth) 進給 $f_z$ (公厘/每齒)	0.09	0.09
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	200.00	180.00

#### DRILLING 5 X D 鑽孔 深度為五倍直徑

Tool 工具	Titex VHM Bohrer A3388TFT-6.8	
Feed $f$ (mm/U) 進給 $f$ (公厘/U)	0.15	0.15
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	77.00	77.00

#### DEEP-HOLE DRILLING 30 X D 鑽深孔 深度為三十倍直徑

Tool 工具	Hammond GM08000 A0320 EFHM (Gun drill)	
Feed $f$ (mm/U) 進給 $f$ (公厘/U)	0.02	0.02
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	36.00	36.00
Tool 工具	Mitsubishi MSL 0700-L30C VP15TF (Twist drill)	
Feed $f$ (mm/U) 進給 $f$ (公厘/U)	0.11	0.16
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	50.00	65.00

#### TAPPING M8 攻牙

Tool 工具	Franken-Emuge B04537010080	
Feed $f$ (mm/U) 進給 $f$ (公厘/U)	1.25	1.25
Cutting speed $v_c$ (m/min.) 切削速度 $v_c$ (公尺/分鐘)	11.00	5.00

BÖHLER M303 EXTRA: Condition: H & T 290 – 330 HB  
 BÖHLER M303 EXTRA HIGH HARD: Condition: H & T 350 – 390 HB  
 Figures are guidelines only.

BÖHLER M303 EXTRA: 條件: 預硬至 290 – 330 HB  
 BÖHLER M303 EXTRA HIGH HARD: 條件: 預硬至 350 – 390 HB  
 以上數字均為參考值

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