BÖHLER

EDRO

PLASTIC
MOULD STEEL

PLASTIC MOULD STEEL

BÖHLER M303 EXTRA

BÖHLER M303 EXTRA HIGH HARD

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.

Chemical composition (average %)

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

Moulds for chemically agressive plastics, e.g.:

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

BÖHLER M303 EXTRA — Hardened and tempered: 290 – 330 HB

BÖHLER M303 EXTRA HIGH HARD — Hardened and tempered: 350 – 390 HB

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

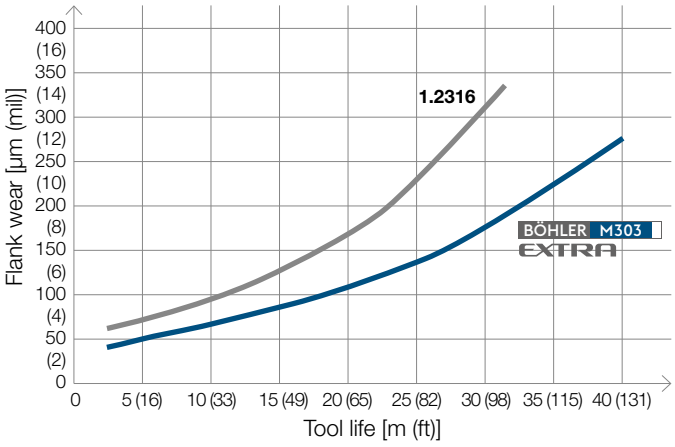
Hence, particular mechanical technological properties are the result.

DIN-Number 1.2316
Martensitic structure with delta ferrite content

BÖHLER M303 EXTRA
Homogeneous structure

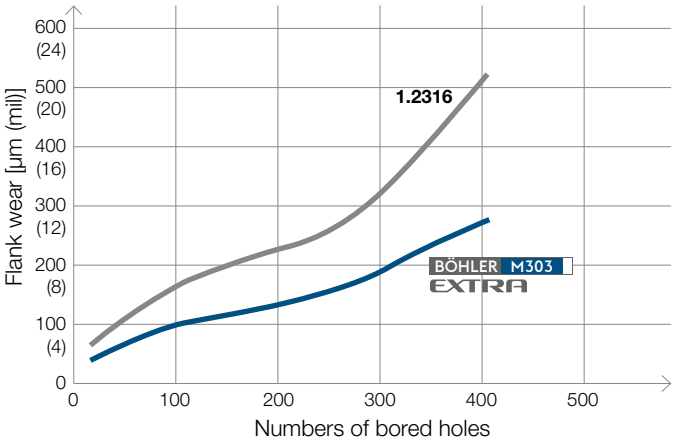
BENEFITS FROM MORE EFFICIENT MACHINABILITY

Milling



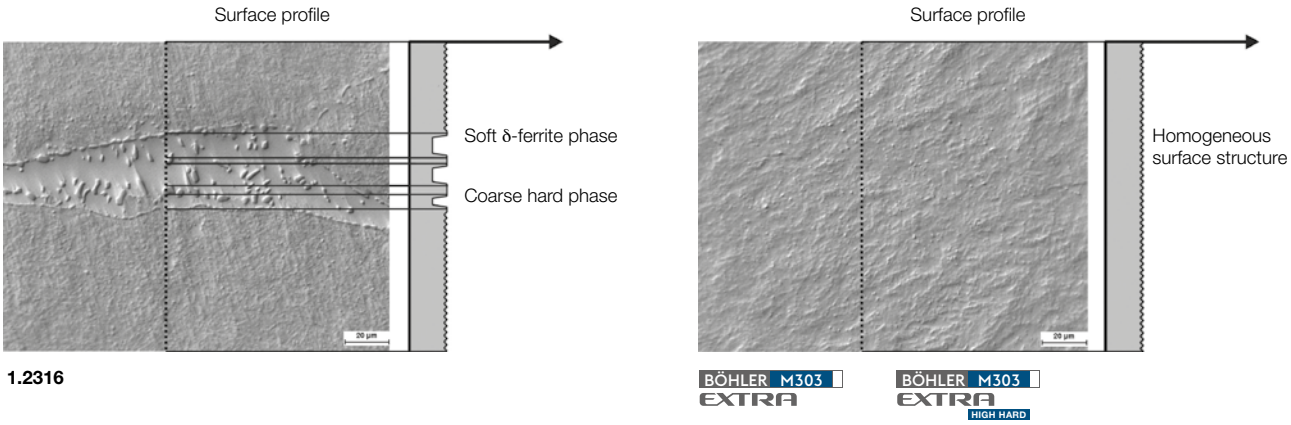
Machining parameter for milling:
Cutting speed: v_c = 200 m/min (655 f.p.m)
Feed/tooth: f_z = 0.3 mm (0.012 inch)
Milling cutter diameter: D = 15 mm (0.60 inch)
Number of teeth: z = 1
Depth of cut: a_p = 0.4 mm (0.016 inch)
Cutting width: a_e = 8 mm (0.32 inch)

Drilling



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

Surface comparison



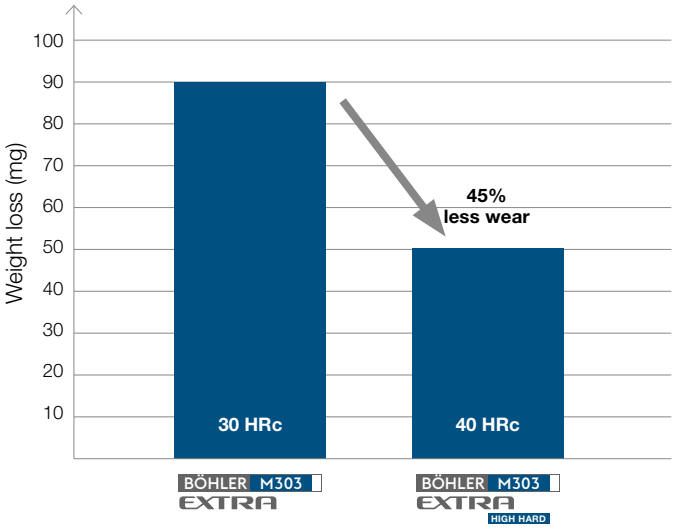
In the case of 1.2316, the hard carbide phases being imbedded in the soft delta ferrite zone, are causing an irregular polish. In contrast **BÖHLER M303 EXTRA** shows regular polish.

Physical properties

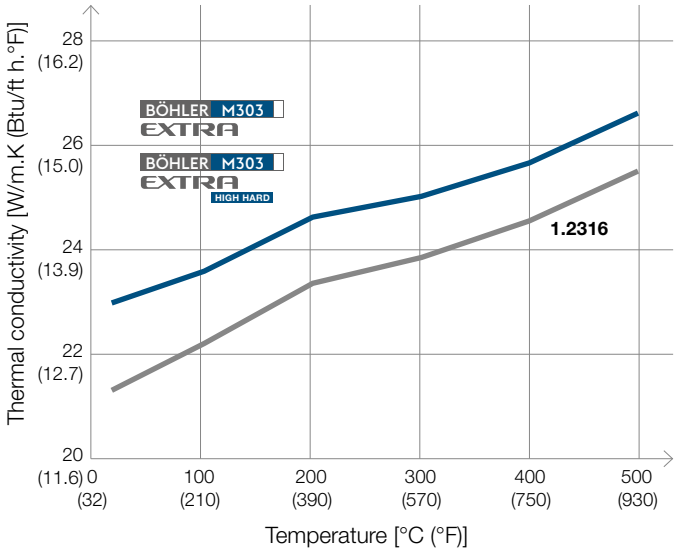
	20 **68**	**100** **210**	**200** **390**	**300** **570**	**400** **750**	**500** **930**	**600** **1110**	**°C** **°F**
Specific heat capacity	460 0.110	484 0.116	529 0.126	564 0.135	615 0.147	694 0.166	795 0.190	J/kg.K Btu/lb.°F
Thermal expansion between 20 °C (68 °F) and ... °C	– –	10.5 5.83	10.8 6.00	11.1 6.20	11.4 6.33	11.7 6.50	12.1 6.72	10^{-6}m/m.K 10^{-6}in/in.°F
Density	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^3 lbs/in^3
Modulus of elasticity	218 31.6	214 31.0	207 30.0	200 29.0	191 27.7	181 26.3	168 24.4	10^3 MPa 10^3 ksi
Thermal conductivity	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

BEST USAGE PROPERTIES

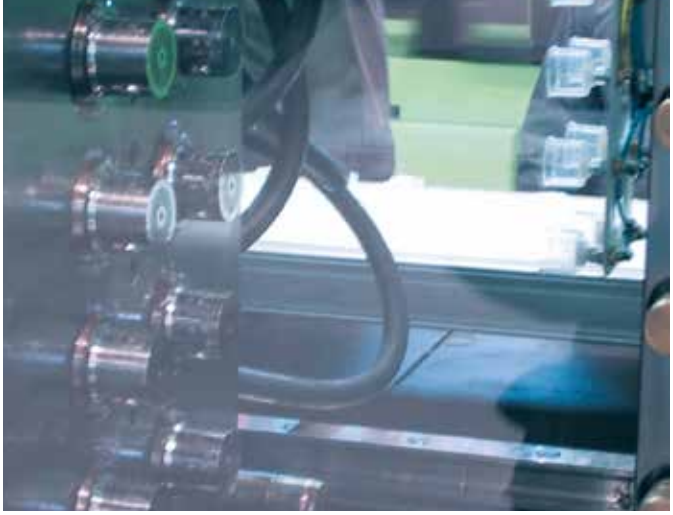
Wear resistance



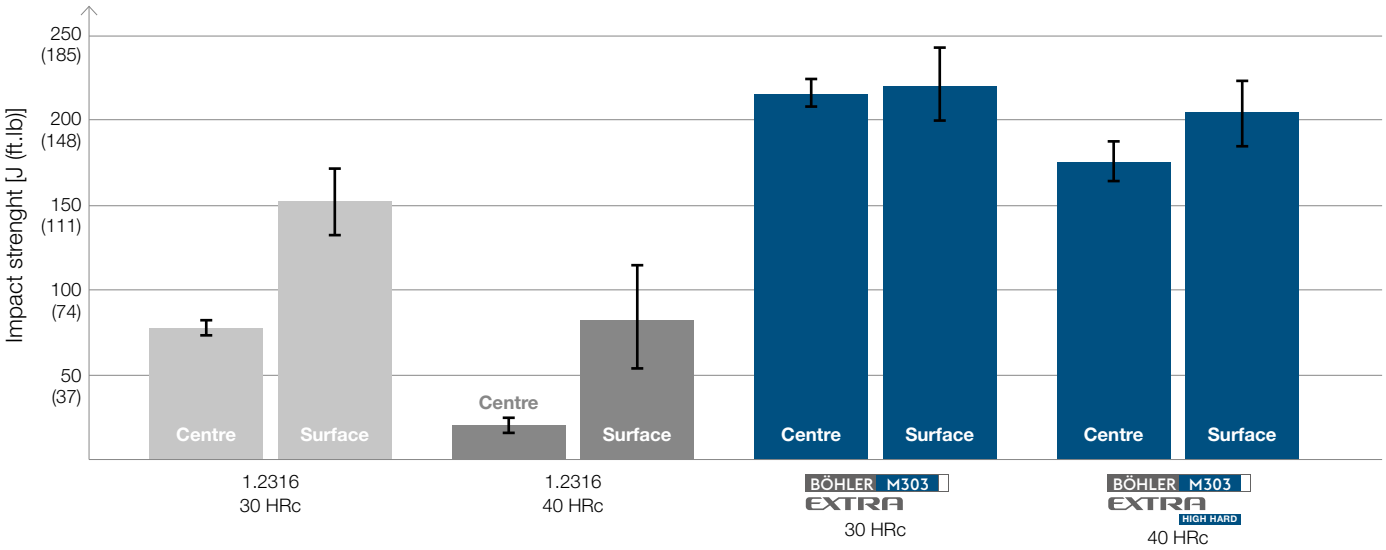
Thermal conductivity



Plastics processing: injection moulding
Processed plastic: ULTRAMID A3WG10 (BASF) with content of fibre glass of 50 wt.%



Toughness (unnotched)



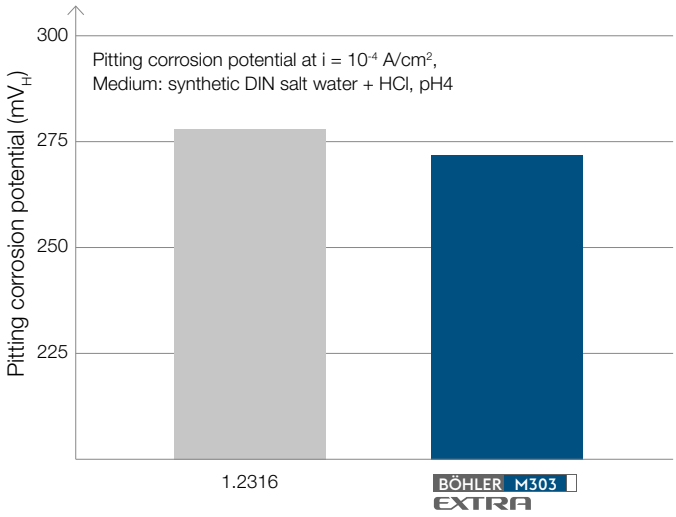
Comparisons made with 1.2316 show that **BÖHLER M303 EXTRA** has a more regular and improved toughness over the block zones thus ensuring a better fracture resistance and avoiding unexpected downtimes.

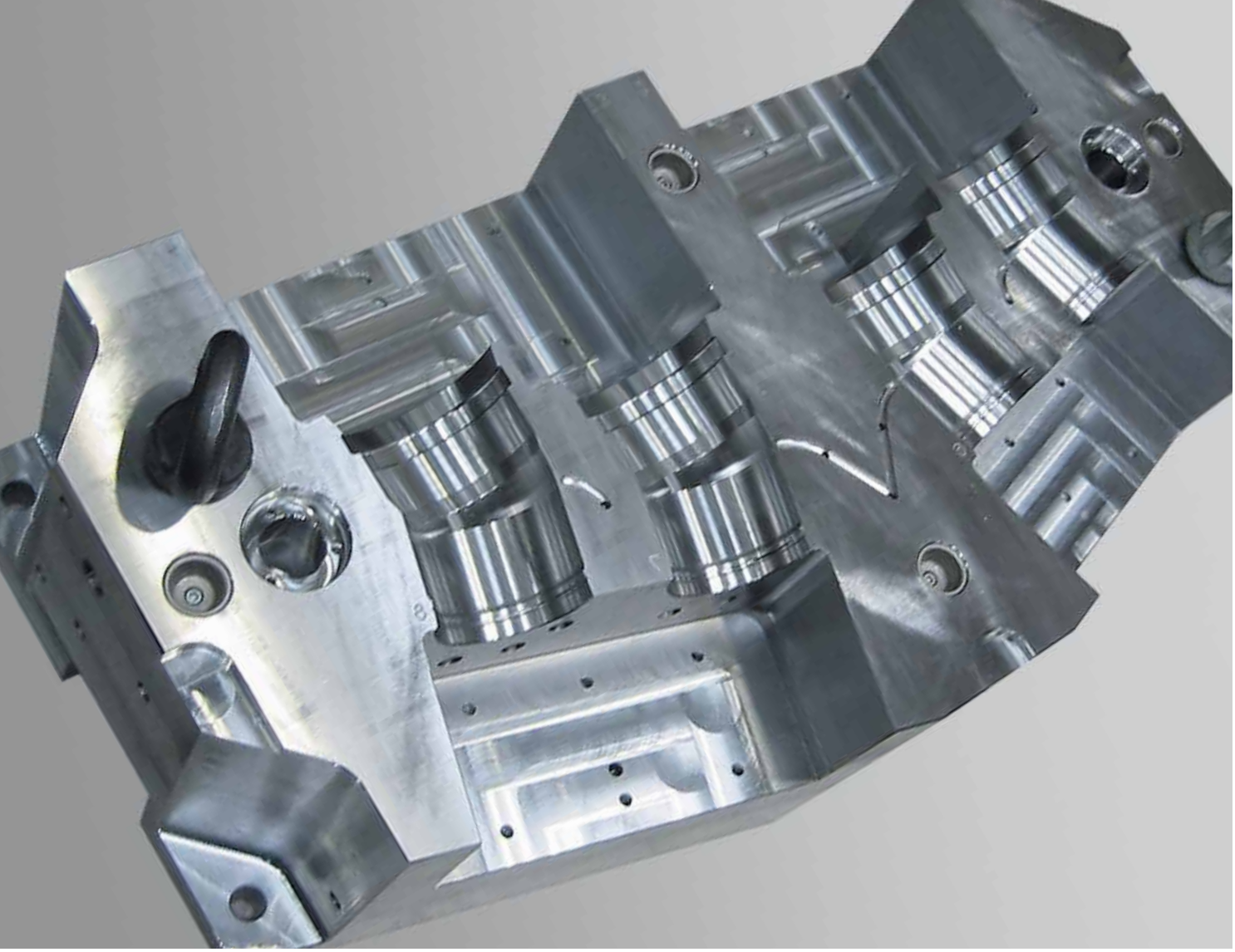
EXCELLENT CORROSION PROPERTIES

PITTING CORROSION RESISTANCE

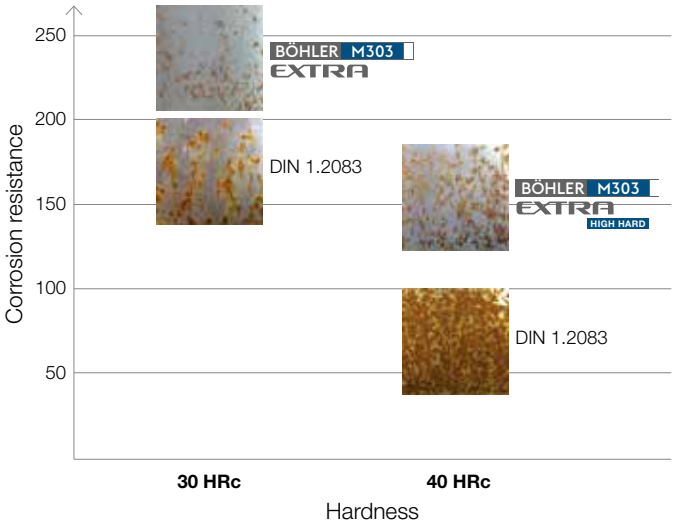
Current density potential graphs for both materials 1.2316 and **BÖHLER M303 EXTRA** were recorded. For both steels the corrosion resistance can be compared with each other in the testing medium used here (synthetic DIN seawater + HCl, ph4).

Corrosion resistance





Corrosion resistance



Salt spray test acc. DIN 50021

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

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

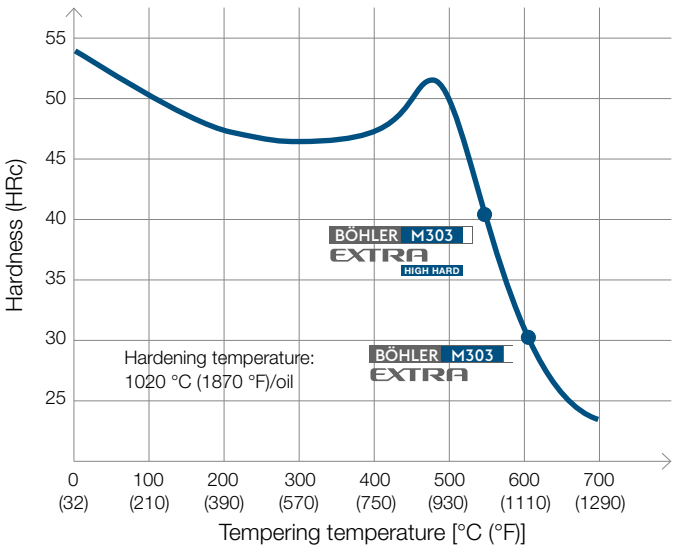
» 1000 to 1020 °C (1830 – 1870 °F)/oil, N_2, salt bath (400 to 450 °C [750 – 840 °F])
» After through-heating, hold for 15 to 30 minutes
» Obtainable hardness: 51 to 53 HRC

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.

HEAT TREATMENT RECOMMENDATIONS

Tempering chart

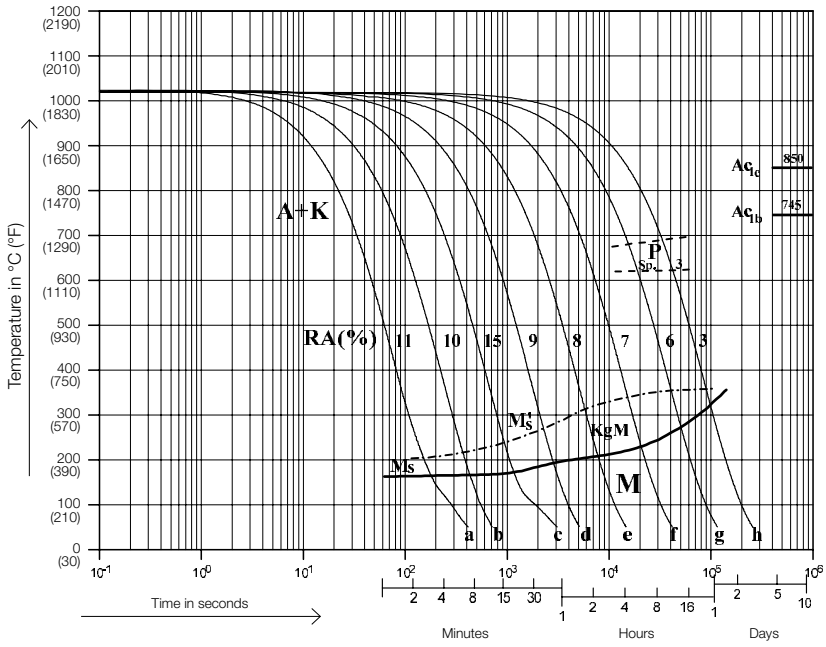


HEAT TREATMENT RECOMMENDATIONS

Continuous cooling CCT curves

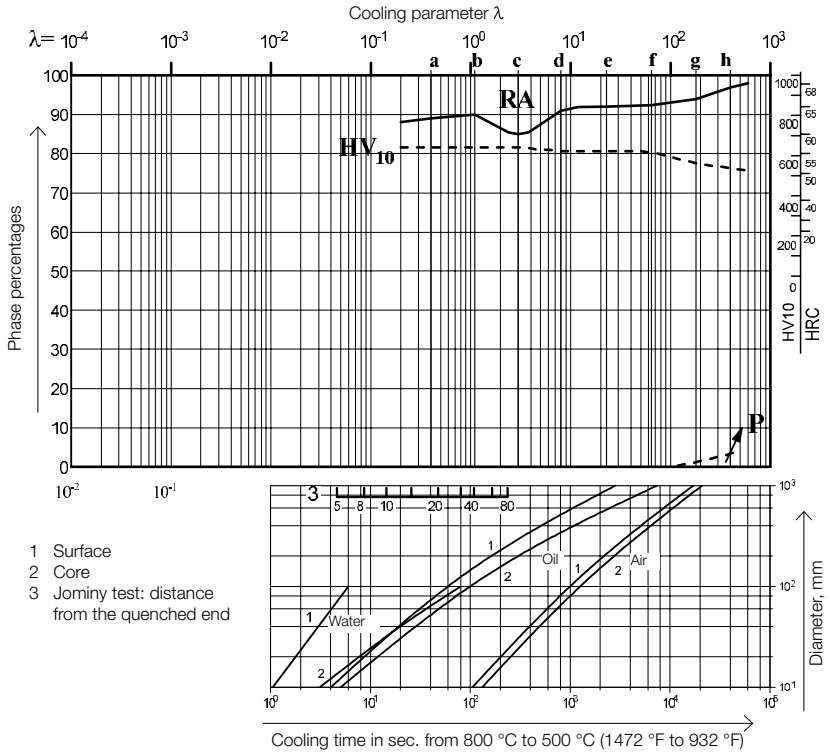
Austenitizing temperature: 1020 °C (1870 °F)
Holding time: 30 minutes
0,4 … 400 cooling parameter, i.e. duration of cooling from 800 – 500° C (1470 – 930 °F) in s x 10^{-2}
KgM Grain boundary martensite
Ms – Ms‘ Formation of grain boundary martensite

Sample	λ	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

RA Retained austenite
A Austenite
M Martensite
P Perlite
K Carbide



MACHINING RECOMMENDATIONS

Turning with sintered carbide

Depth of cut mm (inch)	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)	4 – 8 (.16 – .31)
Feed mm/rev. (inch/rev.)	0.1 – 0.2 (.004 – .012)	0.2 – 0.4 (.008 – .016)	0.3 – 0.6 (.012 – .024)
BOEHLERIT-grade	SB10, SB20, EB10	SB10, EB20, EB20	SB30, EB20, HB10
ISO grade	P10, P20, M10	P10, M10, M20	P30, M20, K10
Cutting speed v_c (m/min.) (f.p.m)			
Indexable inserts tool life: 15 min.	260 – 200 (850 – 655)	200 – 150 (655 – 490)	150 – 110 (490 – 360)
Brazed carbide tools tool life: 30 min.	210 – 170 (690 – 560)	170 – 130 (560 – 425)	140 – 90 (460 – 295)
Coated indexable inserts			
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			
Rake angle	12° – 15°	12° – 15°	12° – 15°
Clearance angle	6° – 8°	6° – 8°	6° – 8°
Inclination angle	0°	0°	-4°

Turning with high speed steel

Depth of cut mm (inch)	0.5 (.02)	3 (.12)	6 (.24)
Feed mm/rev. (inch/rev.)	0.1 (.004)	0.5 (.02)	1 (.04)
HSS-grade BÖHLER/DIN	S700 / DIN S10-4-3-10		
Cutting speed v_c (m/min.) (f.p.m)			
Tool life: 60 min.	55 – 45 (180 – 150)	45 – 35 (150 – 115)	35 – 25 (115 – 80)
Rake angle	14° – 18°	14° – 18°	14° – 18°
Clearance angle	8° – 10°	8° – 10°	8° – 10°
Inclination angle	0°	0°	0°

Milling with inserted tooth cutter

Feed mm/tooth (inch/tooth)	up to 0.2 (.008)	0.2 – 0.3 (.008 – .012)
Cutting speed v_c (m/min.) (f.p.m)		
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

Drill diameter mm (inch)	3 – 8 (.12 – .31)	8 – 20 (.31 – .80)	20 – 40 (.80 – 1.6)
Feed mm/rev. (inch/rev.)	0.02 – 0.05 (.001 – .002)	0.05 – 0.12 (.002 – .005)	0.12 – 0.18 (.005 – .007)
BOEHLERIT/ISO grade	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°
Inclination angle	5°	5°	5°

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

Machinability: comparitive study

	BÖHLER M303 EXTRA	BÖHLER M303 EXTRA HIGH HARD
CUTTING		
Feed rate v_f (mm/min.)	4.50	3.00
Cutting speed v_c (m/min.)	23.00	20.00
ROUGH MACHINING		
Tool	Depo NTV-M40	
Feed f_z (mm/tooth)	0.40	0.30
Cutting speed v_c (m/min.)	180.00	180.00
FINE MACHINING		
Tool	Franken-Emuge 1966A.008	
Feed f_z (mm/tooth)	0.09	0.09
Cutting speed v_c (m/min.)	200.00	180.00
DRILLING 5 X D		
Tool	Titex VHM Bohrer A3388TFT-6.8	
Feed f (mm/U)	0.15	0.15
Cutting speed v_c (m/min.)	77.00	77.00
DEEP-HOLE DRILLING 30 X D		
Tool	Hammond GM08000 A0320 EFHM (Gun drill)	
Feed f (mm/U)	0.02	0.02
Cutting speed v_c (m/min.)	36.00	36.00
Tool	Mitsubishi MSL 0700-L30C VP15TF (Twist drill)	
Feed f (mm/U)	0.11	0.16
Cutting speed v_c (m/min.)	50.00	65.00
TAPPING M8		
Tool	Franken-Emuge B04537010080	
Feed f (mm/U)	1.25	1.25
Cutting speed v_c (m/min.)	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.

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