



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 aggressive plastics, e.g.:

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

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



DIN-Number 1.2316
Martensitic structure with delta ferrite content

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EXTRA

Hardened and tempered:
290 – 330 HB

BÖHLER M303
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HIGH HARD

Hardened and tempered:
350 – 390 HB

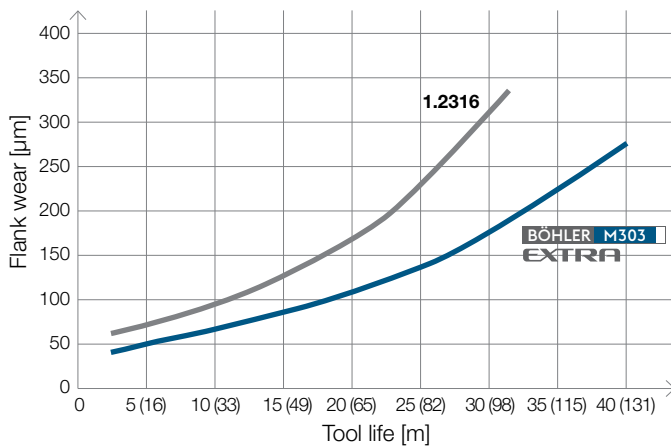
Hence, particular mechanical technological properties are the result.



BÖHLER M303 EXTRA
Homogeneous structure

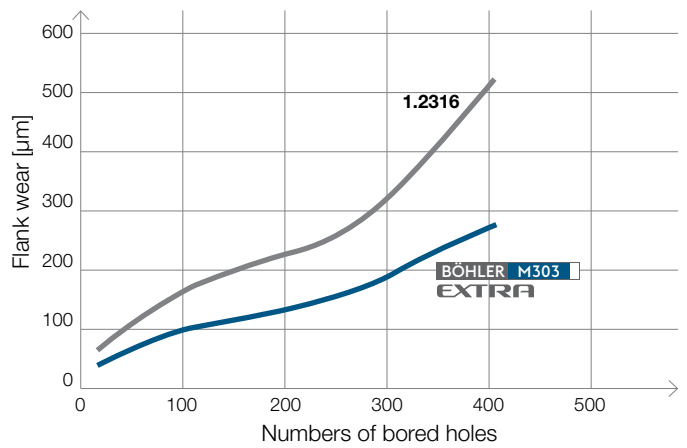
BENEFITS FROM MORE EFFICIENT MACHINABILITY

Milling



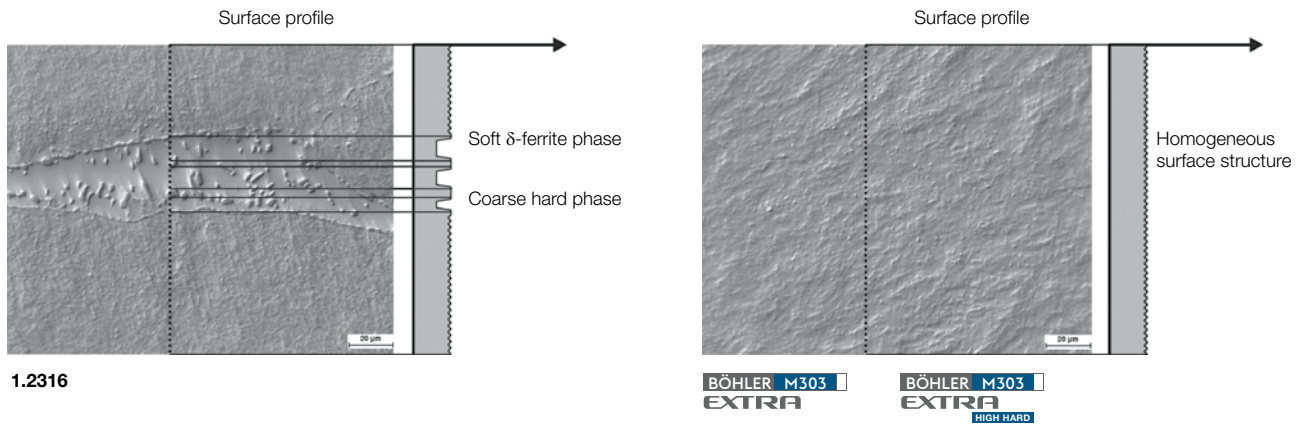
Machining parameter for milling:
 Cutting speed: $v_c = 200$ m/min
 Feed/tooth: $f_z = 0.3$ mm
 Milling cutter diameter: $D = 15$ mm
 Number of teeth: $z = 1$
 Depth of cut: $a_p = 0.4$ mm
 Cutting width: $a_e = 8$ mm

Drilling



Machining parameters for drilling:
 Cutting speed: $v_c = 60$ m/min
 Tooth feed/rev.: $f_u = 0.15$ mm
 Diameter: 6.8 mm

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.

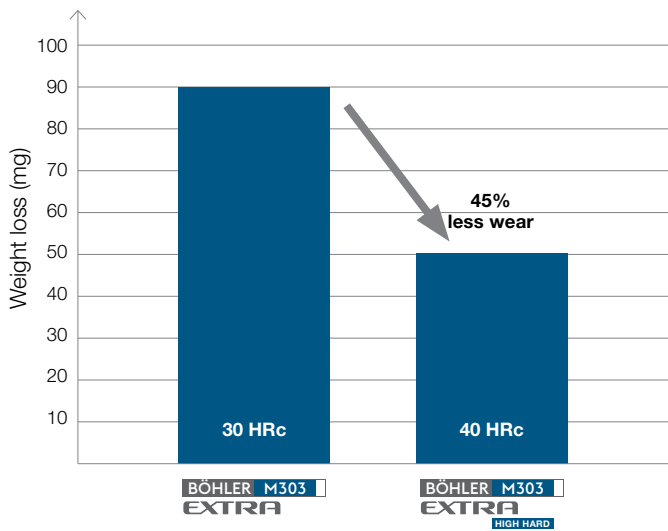
Physical properties

| | 20 68 | 100 210 | 200 390 | 300 570 | 400 750 | 500 930 | 600 1110 | °C °F |
|---|----------|------------|------------|------------|------------|------------|-------------|------------------------|
| Specific heat capacity | 460 | 484 | 529 | 564 | 615 | 694 | 795 | J/kg.K |
| Thermal expansion between 20 °C and ... °C | – – | 10.5 | 10.8 | 11.1 | 11.4 | 11.7 | 12.1 | 10 ⁻⁶ m/m.K |
| Density | 7.7 | 7.7 | 7.7 | 7.7 | 7.6 | 7.6 | 7.6 | kg/dm ³ |
| Modulus of elasticity | 218 | 214 | 207 | 200 | 191 | 181 | 168 | 10 ³ MPa |
| Thermal conductivity | 22.8 | 23.5 | 24.8 | 25.1 | 25.7 | 26.7 | 25.9 | W/m.K |

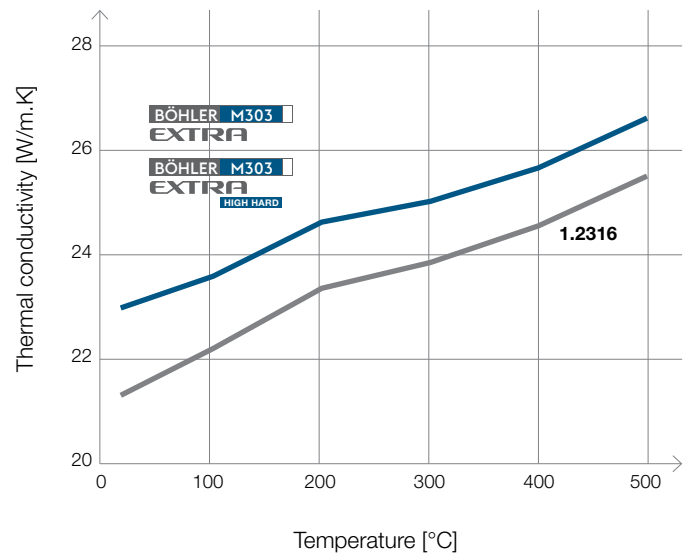
BEST USAGE PROPERTIES



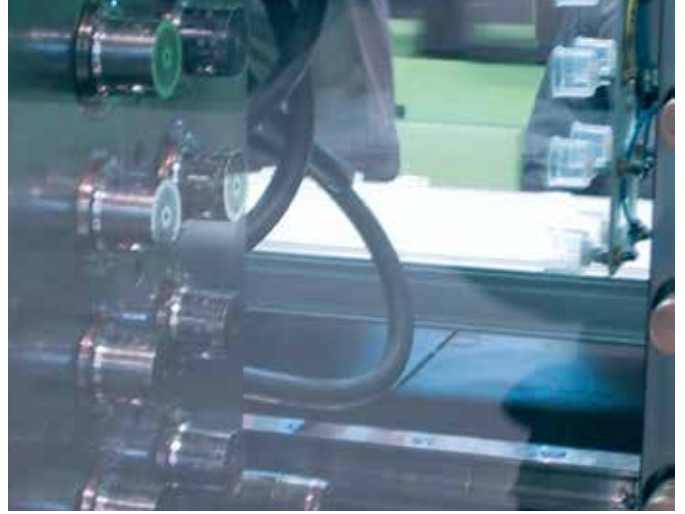
Wear resistance



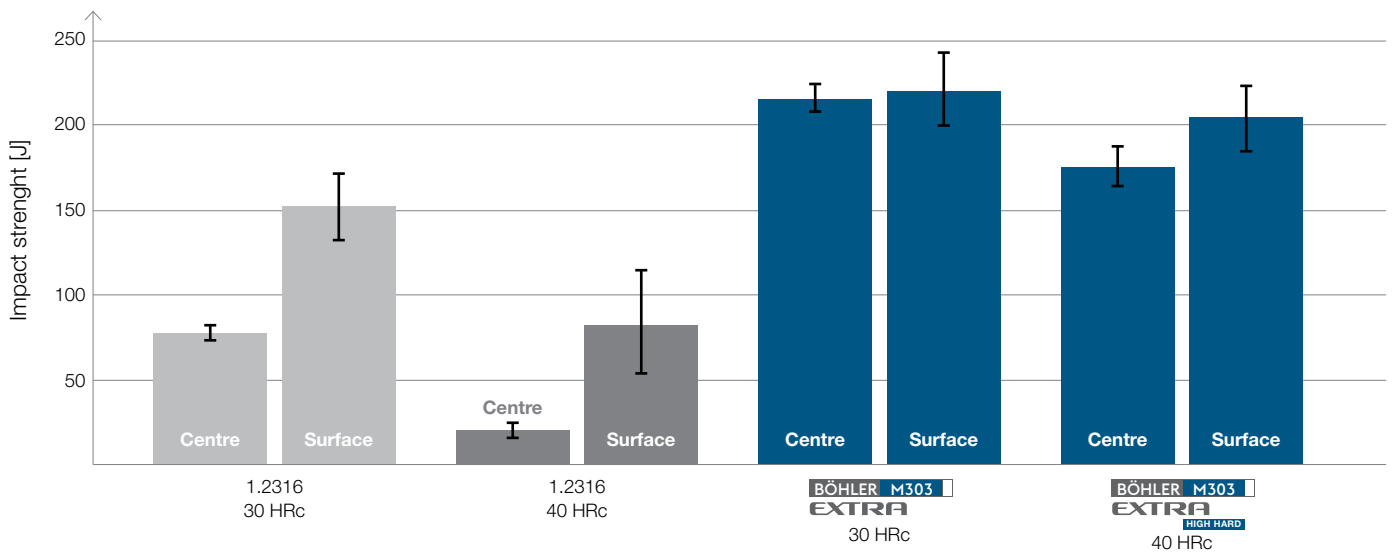
Thermal conductivity



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



Toughness (unnotched)



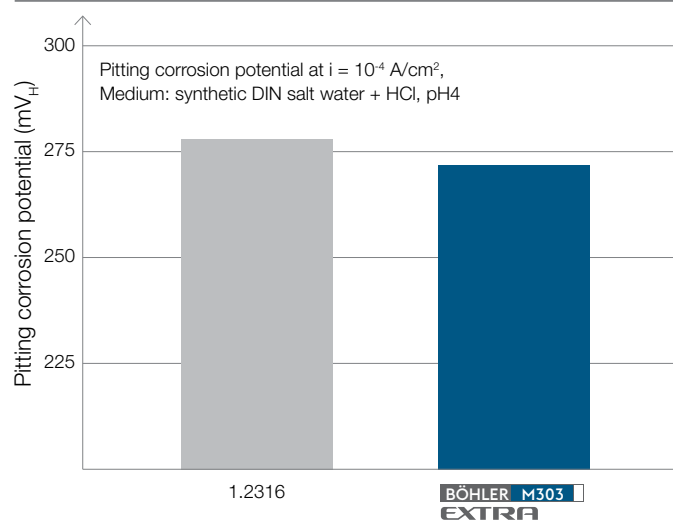
Comparisons made with 1.2316 show that **BÖHLER M303 EXTRA** has a more regular and improved toughness over the block zones thus ensuring a better fracture resistance and avoiding unexpected downtimes.

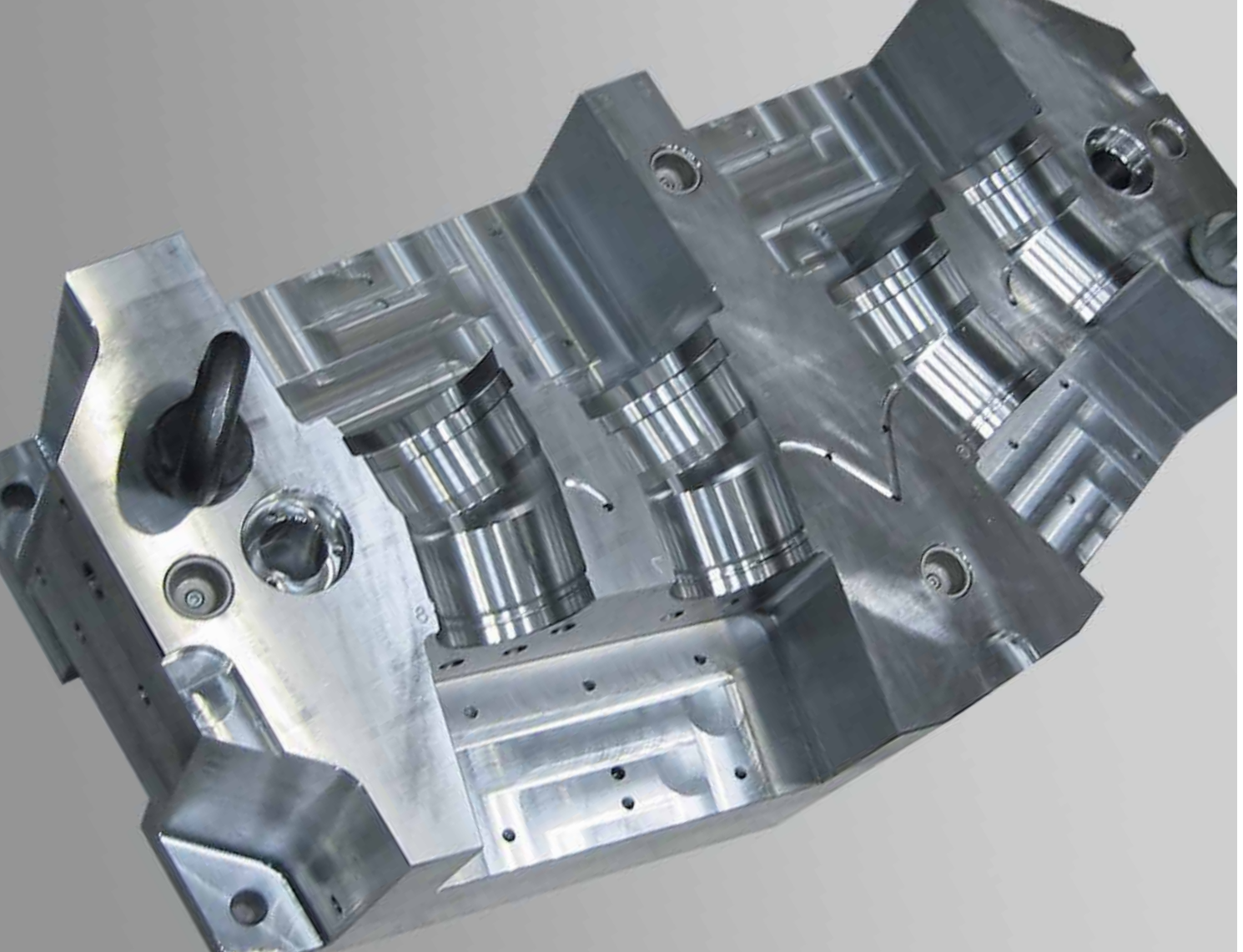
EXCELLENT CORROSION PROPERTIES

PITTING CORROSION RESISTANCE

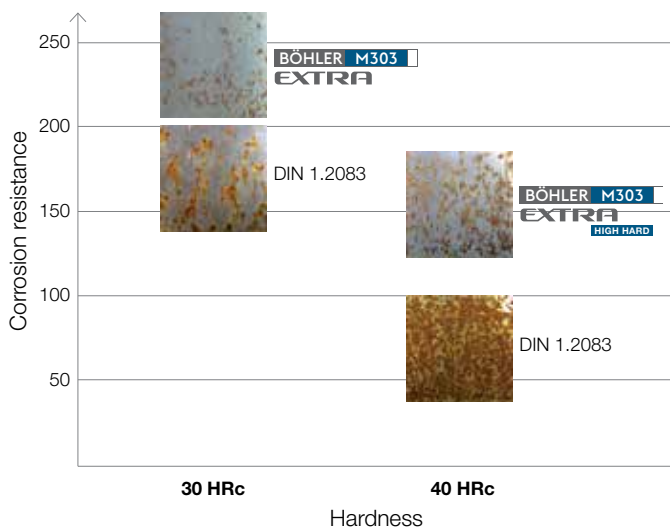
Current density potential graphs for both materials 1.2316 and **BÖHLER M303 EXTRA** were recorded. For both steels the corrosion resistance can be compared with each other in the testing medium used here (synthetic DIN seawater + HCl, pH4).

Corrosion resistance





Corrosion resistance



Salt spray test acc. DIN 50021

At the salt spray test **BOHLER 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
- » After through-heating, soak for minimum 2 hours in a neutral atmosphere.
- » Slow cooling in furnace with 20 °C/hr down to 200 °C, then in air.

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

Annealing

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

Stress relieving after machining in the annealed condition

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

Hardening

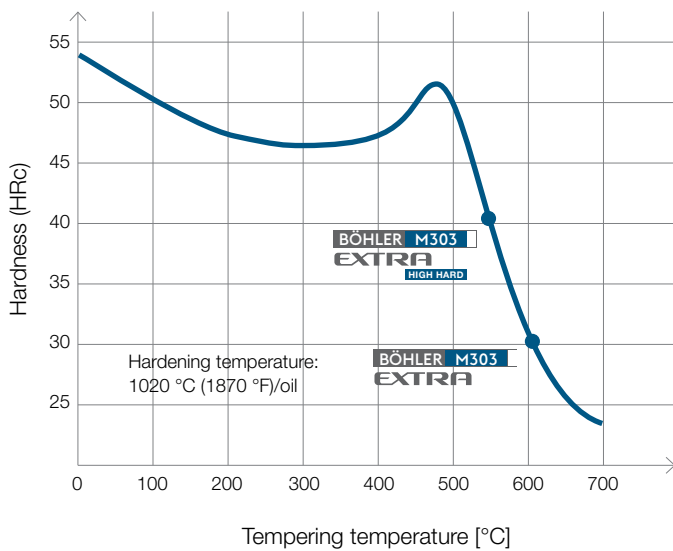
- » 1000 to 1020 °C/oil, N₂, salt bath (400 to 450 °C)
- » After through-heating, hold for 15 to 30 minutes
- » Obtainable hardness: 51 to 53 HRC

Tempering

- » Slow heating to tempering temperature immediately after hardening
- » Time in furnace 1 hour for each 20 mm of workpiece thickness, but at least 2 hours
- » We recommend the tempering at least twice. A third tempering for stress relieving 30 – 50 °C 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



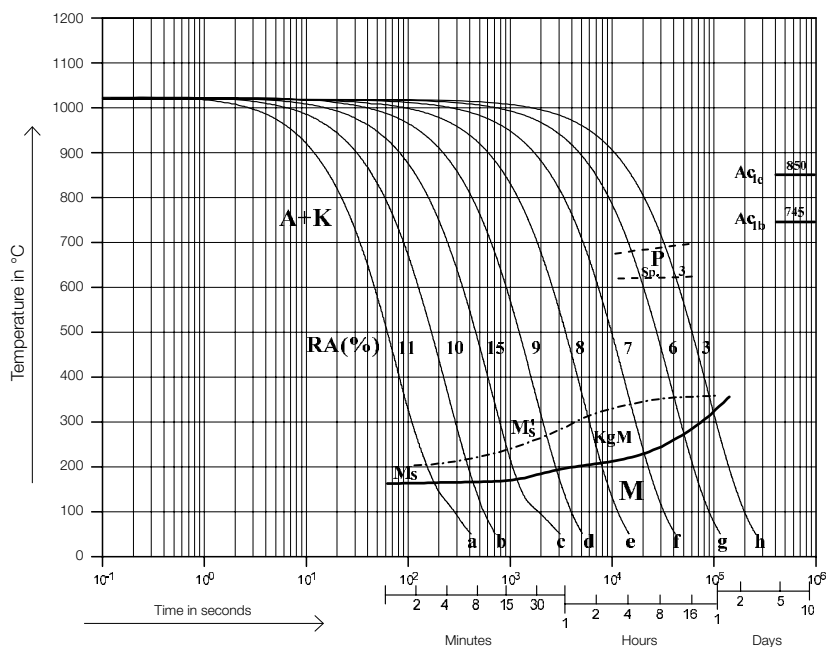
HEAT TREATMENT RECOMMENDATIONS

Continuous cooling CCT curves

Austenitizing temperature: 1020 °C
 Holding time: 30 minutes
 0.4 ... 400 cooling parameter, i.e. duration of cooling from 800 – 500° C in $s \times 10^{-2}$

KgM Grain boundary martensite
 Ms – Ms' Formation of grain boundary martensite

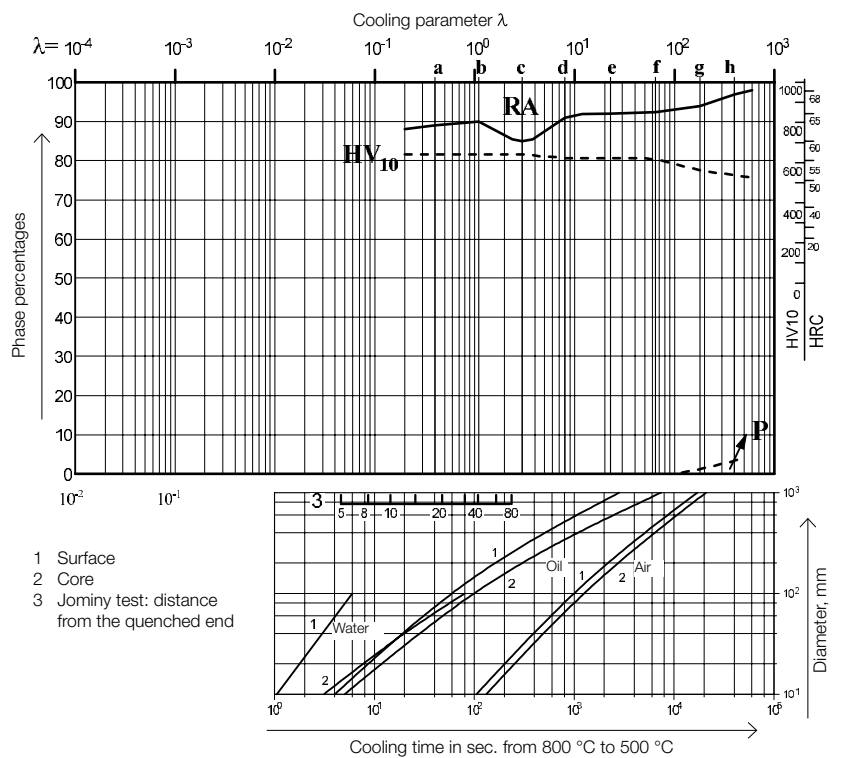
| Sample | λ | HV10 |
|--------|-----------|------|
| a | 0.40 | 628 |
| b | 1.10 | 631 |
| c | 3.00 | 633 |
| d | 8.00 | 606 |
| e | 23.00 | 610 |
| f | 65.00 | 604 |
| g | 90.00 | 551 |
| h | 180.00 | 525 |





Quantitative phase diagram

- RA Retained austenite
- A Austenite
- M Martensite
- P Perlite
- K Carbide



MACHINING RECOMMENDATIONS

Turning with sintered carbide

| | | | |
|---|------------------|------------------|------------------|
| Depth of cut mm | 0.5 – 1 | 1 – 4 | 4 – 8 |
| Feed mm/rev. | 0.1 – 0.2 | 0.2 – 0.4 | 0.3 – 0.6 |
| 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.) | | | |
| Indexable inserts tool life: 15 min. | 260 – 200 | 200 – 150 | 150 – 110 |
| Brazed carbide tools tool life: 30 min. | 210 – 170 | 170 – 130 | 140 – 90 |
| Coated indexable inserts | | | |
| BOEHLERIT ROYAL 121 | up to 240 | up to 210 | up to 160 |
| BOEHLERIT ROYAL 131 | up to 210 | up to 160 | up to 140 |
| 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 | 0.5 | 3 | 6 |
| Feed mm/rev. | 0.1 | 0.5 | 1 |
| HSS-grade BÖHLER/DIN | S700 / DIN S10-4-3-10 | | |
| Cutting speed v_c (m/min.) | | | |
| Tool life: 60 min. | 55 – 45 | 45 – 35 | 35 – 25 |
| 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 | up to 0.2 | 0.2 – 0.3 |
| Cutting speed v_c (m/min.) | | |
| BOEHLERIT SBF/ISO P25 | 160 – 100 | 110 – 60 |
| BOEHLERIT SB40/ISO P40 | 100 – 60 | 70 – 40 |
| BOEHLERIT ROYAL 131/ISO P35 | 140 – 110 | 140 – 110 |

Drilling with sintered carbide

| | | | |
|------------------------------|-------------|-------------|-------------|
| Drill diameter mm | 3 – 8 | 8 – 20 | 20 – 40 |
| Feed mm/rev. | 0.02 – 0.05 | 0.05 – 0.12 | 0.12 – 0.18 |
| BOEHLERIT/ISO grade | HB10 / K10 | | |
| Cutting speed v_c (m/min.) | 50 – 35 | 50 – 35 | 50 – 35 |
| Point angle | 115° – 120° | 115° – 120° | 115° – 120° |
| Inclination angle | 5° | 5° | 5° |

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



Machinability: comparative study

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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.

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. The manufacture of our products does not involve the use of substances detrimental to health or to the ozone layer.



SPECIAL STEELS FOR THE WORLD'S TOP PERFORMERS

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