BÖHLER

COLD WORK
TOOL STEEL

COLD WORK TOOL STEEL

BÖHLER K890
MICROCLEAN®

voestalpine BÖHLER Edelstahl GmbH & Co KG
www.voestalpine.com/bohler-edelstahl

voestalpine
ONE STEP AHEAD.

HIGHLY DUCTILE

A HIGHLY DUCTILE COLD WORK TOOL STEEL

A powder metallurgy cold work tool steel with an outstanding capacity for plastic yield and a high fatigue strength.

The property profile

» high strength
» highest ductility
» highest fatigue strength
» good compressive strength
» good wear resistance
» good thermal stability

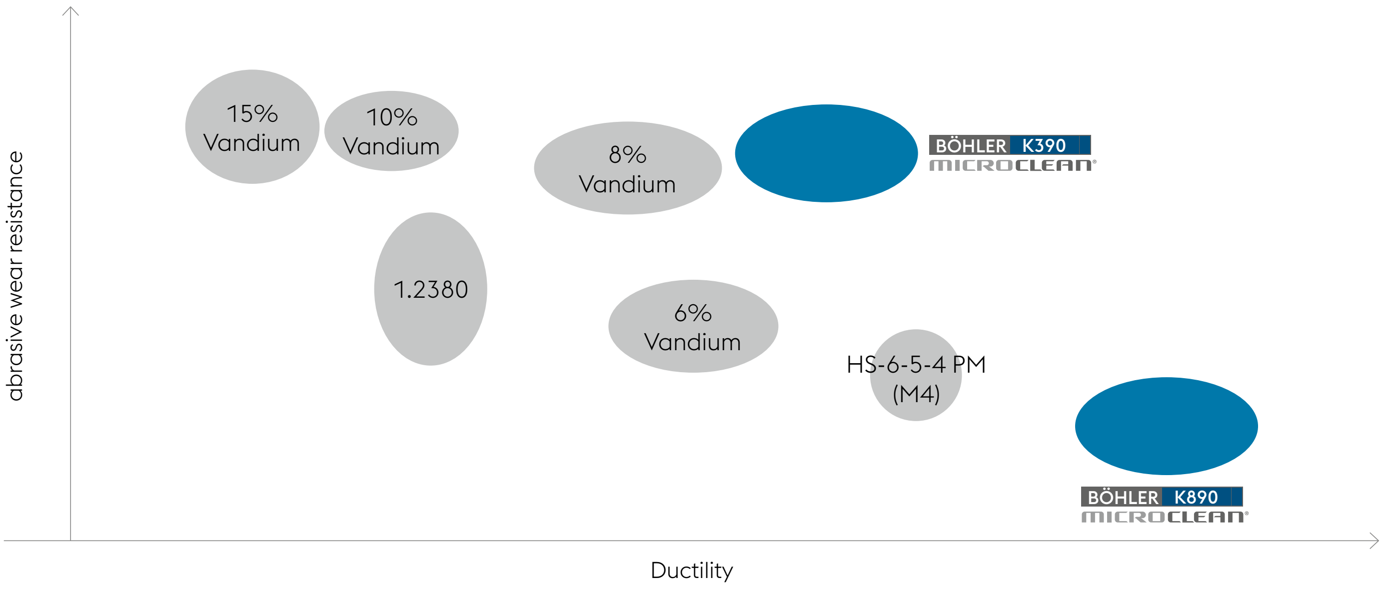
Areas of use

BÖHLER K890 MICROCLEAN is particularly suitable for tooling which requires a high edge stability and therefore a high capacity for plastic yield and a high fatigue strength.

Examples

» cutting and blanking
» fine cutting
» cold forming
» cold massive forming
» powder compaction
» warm forging at lower temperatures

Product placement



Chemical composition (average %)

C	Si	Mn	Cr	Mo	V	W	Co
0.85	0.55	0.40	4.35	2.80	2.10	2.55	4.50

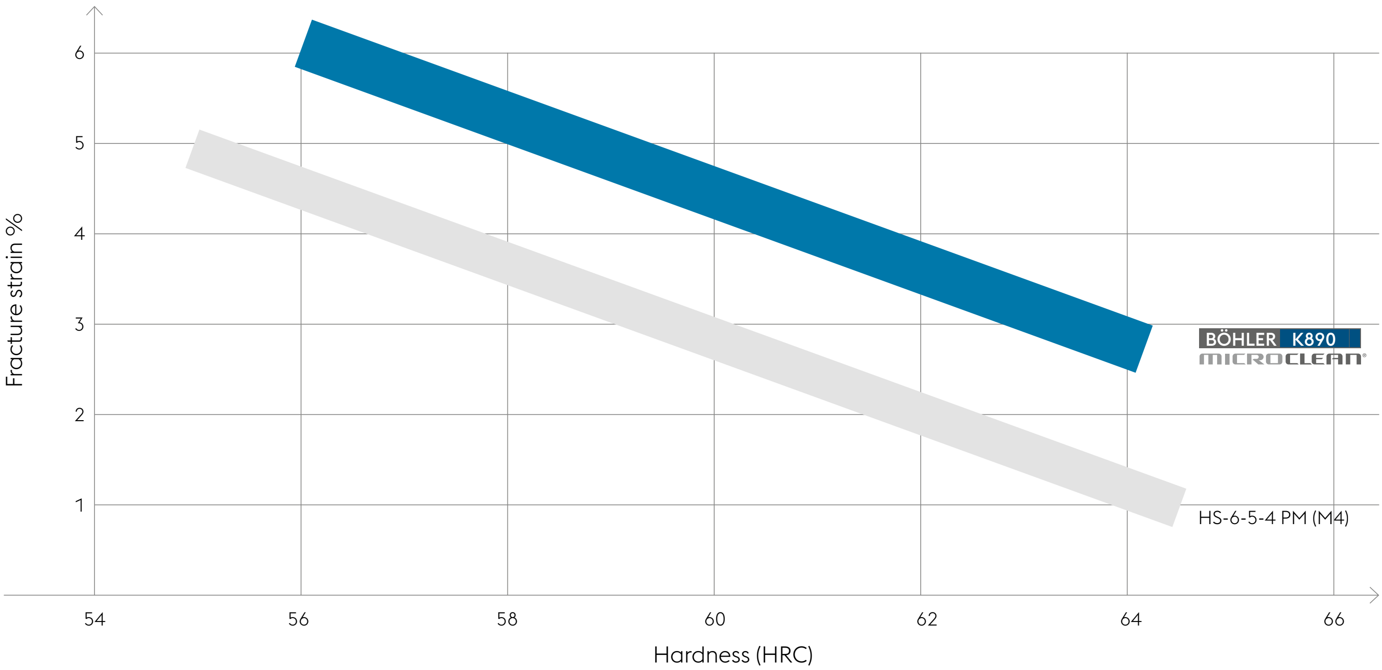
Brittle material
(brittle fracture)

BÖHLER K890 MICROCLEAN

In general, ductility is understood to be the capa- city of a material to yield; the ability to deform plastically before fracture. The material fails when the fracture strain of the material is exceeded. Fracture strain is a characteristic material property used to quantify ductility. This means that a mate- rial with a high fracture strain has a better safety against fracture.

The most important test used to characterise the strength and ductility of a tool steel is the uniaxial tensile test. Since none of the standard test piece geometries is suitable for use with high-strength tool steels, BÖHLER has developed a suitable test piece in cooperation with the Materials Center Leoben Forschung GmbH. The results of tensile tests carried out using the test piece specially designed for high-strength tool steels are summarised in the following diagram.

Higher capacity for plastic yield



Values obtained from uniaxial tensile tests using test pieces developed specifically for high-strength tool materials at the Materials Center Leoben Forschung GmbH.

BEST DUCTILITY FOR OPTIMAL PROPERTIES

BÖHLER K890 MICROCLEAN stands out from, i.e., HS-6-5-4 PM (M4) tool steel with the same strength due to its much higher strain at fracture. For tools under extremely high plastic loading, **BÖHLER K890 MICROCLEAN** offers a higher safety against fracture and therefore a longer tool life.

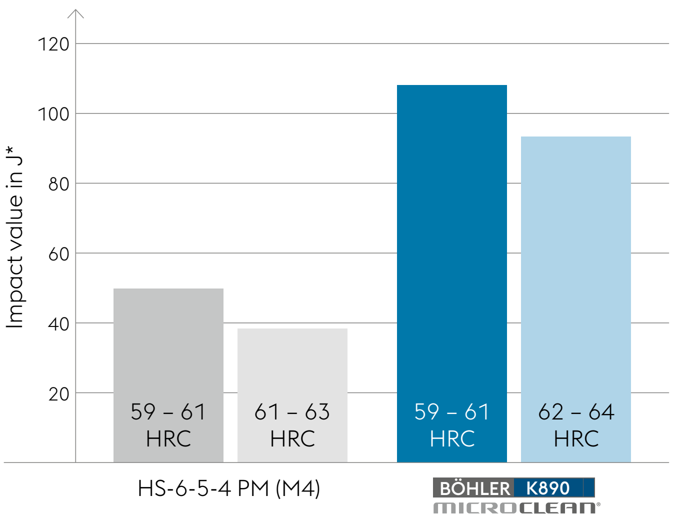
Physical properties at 20°C (68°F)

Condition: hardened and tempered		
Modulus of elasticity at	20 °C 68 °F	217.6 GPa 31.6 x 10^3 psi
Density at	20 °C 68 °F	7.85 kg/dm^3 0.284 lbs/in^3
Electrical resistivity at	20 °C 68 °F	0.50 Ohm.mm^2/m 301 Ohm circular-mil per ft
Specific heat capacity at	20 °C 68 °F	450 J/(kg.K) 0.107 Btu/lb °F
Thermal conductivity at	20 °C 68 °F	22.5 W/(m.K) 13.0 Btu/ft h °F

Thermal expansion between 20 °C (68 °F) and ... °C (°F)

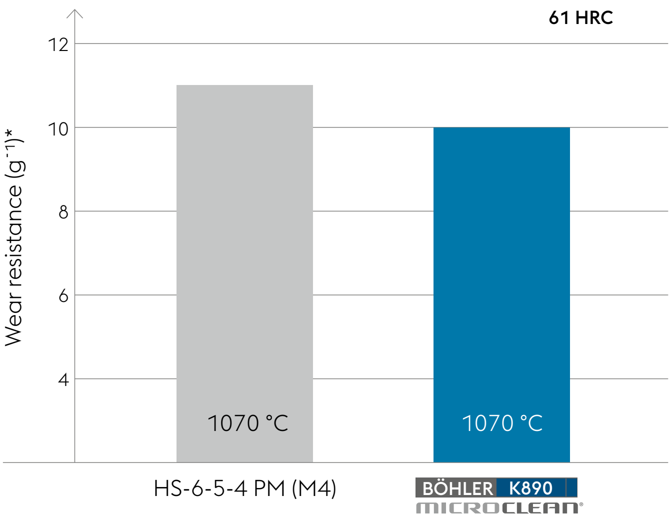
100 °C	200 °C	300 °C	400 °C	500 °C	600 °C	700 °C	
10.5	11.0	11.3	11.7	12.1	12.4	12.9	10^{-6} m/(m.K)
210 °F	**390 °F**	**570 °F**	**750 °F**	**930 °F**	**1110 °F**	**1290 °F**	
5.83	6.11	6.28	6.50	6.72	6.89	7.16	10^{-6} in/in °F

Impact tests unnotched



* Samples taken from rolled bars in longitudinal direction, heat treated with a cooling rate of λ ≤ 0,5.

Wear resistance



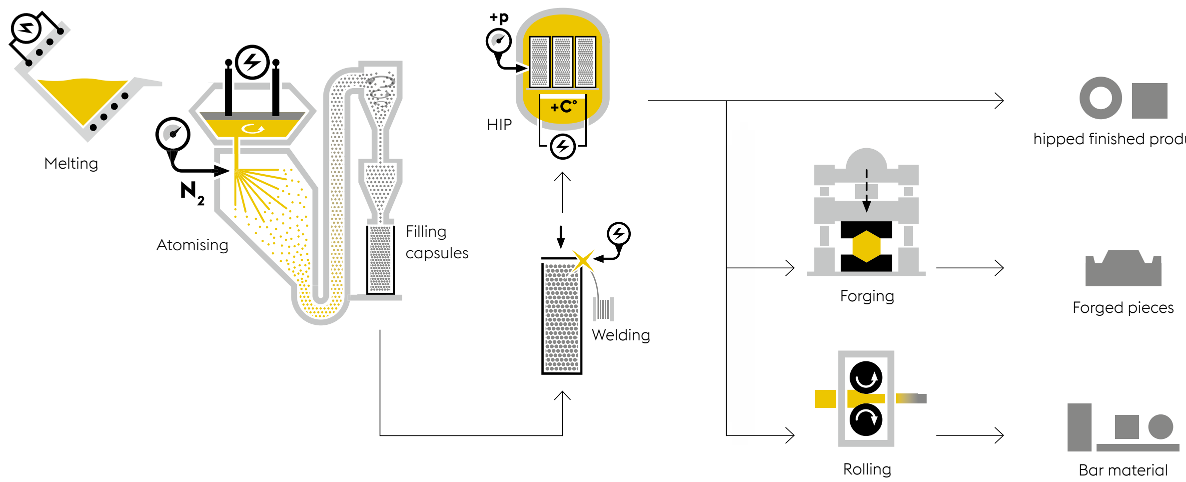
* determined in laboratory tests using SiC grinding paper

THE ADVANTAGES OF MICROCLEAN MATERIALS

THE WORLD'S MOST MODERN PM STEEL PRODUCTION PLANT.

BÖHLER developes and produces high-performance PM-high speed steels and -tool steels, which increase the life of the tool by several hundred percent. We consider this to be a technological leap of BÖHLER's own making: 3rd generation PM materials. These materials, known by the name MICROCLEAN, offer even further improvements in wear resistance, compressive strength, toughness, fatigue strength and polishability.

Flow chart



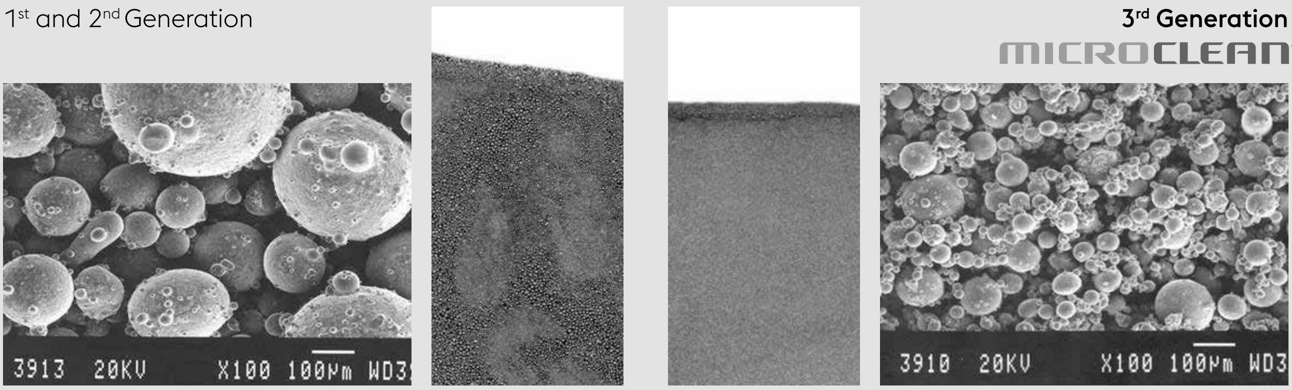
POWDER COMPACTION

High purity, homogeneous alloyed powders, with appropriate particle size and distribution are sub- jected to a high pressure, high temperature process to obtain a homogeneous, segregation-free tool steel with virtually isotropic properties.
Following this, the desired final dimension is achieved by hot forming.

COMPARISON OF PARTICLE SIZE

1st and 2nd Generation

3rd Generation
MICROCLEAN®



The manufacturing of a fine powder with higher cleanliness is a prerequisite in achieving the aforementioned improvements in material properties.

INSTRUCTIONS FOR HEAT TREATMENT

Recommendations

» For highest ductility:
1030 °C / 3 x 2 h 560 °C (1885 °F / 3 x 2 h 1040 °F)

» For a combination of high strength and high ductility:
1100 °C / 3 x 2 h 540 °C (2010 °F / 3 x 2 h 1005 °F)

» For highest strength / compressive strength:
1180 °C / 3 x 2 h 540 ° (2155 °F / 3 x 2 h 1005 °F)

Annealing

» Hardness after annealing: max. 280 HB

Stress relieving

» 650 to 700 °C (1200 to 1290 °F)

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

» Cool slowly in furnace

Hardening

» 1030 to 1180 °C (1885 to 2155 °F) /oil, N_2

» Following temperature equalisation:
20 – 30 minutes for a hardening temperature of
1030 – 1100 °C (1885 – 2010 °F)
6 minutes for a hardening temperature of
1150 – 1180 °C (2100 – 2155 °F)

Tempering

» Slowly heat to tempering temperature immediately after hardening

» Time in furnace: 1 hour for every 20 mm (0.79 inch) of workpiece thickness but at least 2 hours.

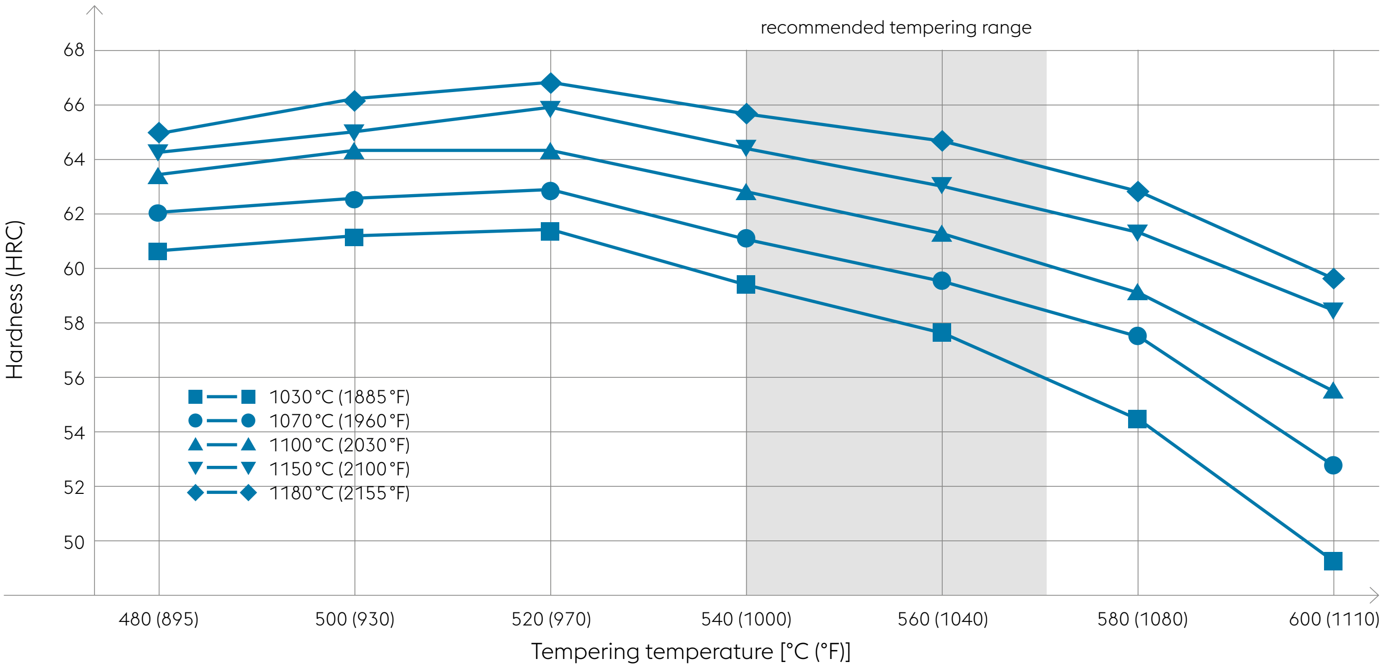
» Cool in air

» We recommend that the steel be tempered at least 3 times

» Obtainable hardness: 58 – 64 HRC

» Erzielbare Härte: 58 – 64 HRC

Tempering chart

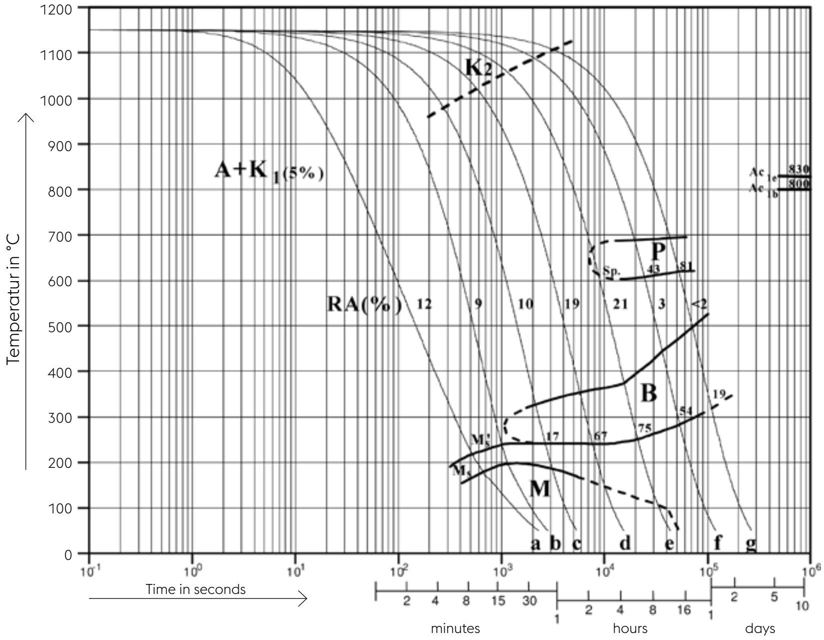


hardened in vacuum furnace: N_2 cooling, 5 bar

Continuous cooling CCT curves

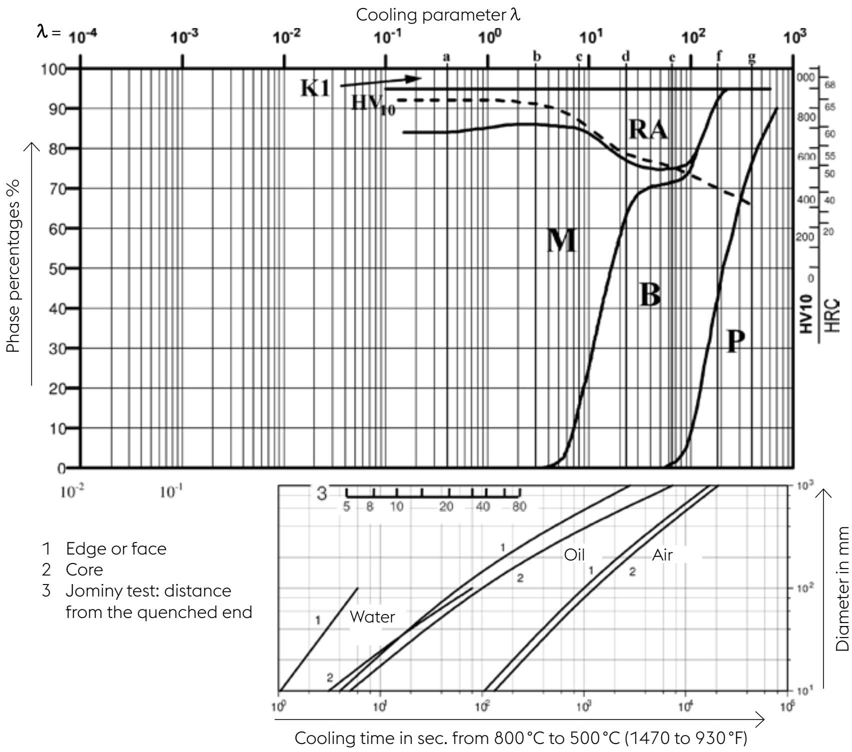
Austenitizing temperature: 1150 °C (2100 °F)
Holding time: 30 minutes
0.4 ... 180 cooling parameter, i.e. duration of cooling 600 from 800 – 500 °C (1470–930 °F) in s x 10^{-2}

Sample	λ	HV_{10}
a	0.40	841
b	3.00	824
c	8.00	755
d	23.00	585
e	65.00	515
f	180.00	412
g	400.00	329



Quantitative phase diagram

K1 carbides which are not dissolved during austenitization 5%)
K2 start of carbide precipitation during quenching from austenitizing temperature
RA Retained austenite
A Austenite
M Martensite
P Perlite
B Bainite



MACHINING RECOMMENDATIONS

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)
ISO grade	HC-K10, HC-P15, HC-P25	HC-K10, HC-P25, HC-M35	HW-P30, HC-M35	HW-P40
Cutting speed v_c m/min (f.p.m)				
BOEHLERIT LC 215 B / ISO P15	140 – 180 (460 – 590)	100 – 150 (330 – 490)	80 – 130 (260 – 425)	60 – 90 (195 – 295)
BOEHLERIT LC 620 H / ISP K15	140 – 180 (460 – 590)	100 – 150 (330 – 490)	80 – 130 (260 – 425)	60 – 90 (195 – 295)
BOEHLERIT LC 225 C / ISO P25	120 – 150 (395 – 490)	85 – 130 (280 – 425)	70 – 100 (230 – 330)	50 – 80 (165 – 260)
BOEHLERIT LC 235 C / ISO P35	110 – 140 (360 – 460)	80 – 120 (260 – 395)	60 – 90 (195 – 295)	40 – 70 (135 – 230)

Condition: annealed; average values

Turning with CBN – Cubic boron nitride

Schnitttiefe mm	0.5 – 1 (.02 – .04)	1 – 4 (.04 – .16)
Feed mm / rev. (inches / rev.)	0.1 – 0.3 (.004 – .012)	0.2 – 0.4 (.008 – .016)
Cutting speed v_c m/min (f.p.m)		
BOEHLERIT BN 022	80 – 120 (260 – 395)	60 – 100 (195 – 330)

Condition: hardened and tempered ≥ 60 HRC; average values

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 LC 610 T / ISO K10	160 – 220 (525 – 720)	120 – 180 (395 – 590)
BOEHLERIT LC 225 T / ISO P25	120 – 160 (395 – 525)	90 – 150 (295 – 490)
BOEHLERIT LC 230 F / ISO P30	110 – 180 (360 – 590)	70 – 150 (230 – 490)

Condition: annealed; average values

Milling with CBN – Cubic boron nitride

Feed mm/tooth (inches/tooth)	up to 0.2 (.008)
Cutting speed v_c m/min (f.p.m)	
BOEHLERIT BN 022	50 – 120 (165 – 395)

Condition: hardened and tempered ≥ 60 HRC; average values

Drilling with sintered carbide

Drill diameter mm (inhes)	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 – 0.1 (.002 – .004)	0.1 – 0.15 (.004 – .005)
BOEHLERIT LC 610 S / ISO HC-K10			
Cutting speed v_c m/min (f.p.m)	30 – 50 (100 – 165)	30 – 50 (100 – 165)	30 – 50 (100 – 165)
Point angle	115° – 120°	115° – 120°	115° – 120°
Clearance angle	5°	5°	5°

Condition: hardened and tempered ≥ 60 HRC; average value

voestalpine BÖHLER Edelstahl GmbH & Co KG
Mariazeller Straße 25
8605 Kapfenberg, Austria
T. +43/50304/20-7181
F. +43/50304/20-7576
E. info@bohler-edelstahl.at
www.voestalpine.com/bohler-edelstahl

voestalpine
ONE STEP AHEAD.

K890EN – 10.2020