BÖHLER

COLD WORK TOOL STEEL

POWDER METALLURGY

COLD WORK TOOL STEEL

BÖHLER K490 MICROCLEAN®

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

voestalpine
ONE STEP AHEAD.

THE ALL-ROUNDER

INNOVATION

BÖHLER's new cold work tool steel K490 MICROCLEAN closes the gap in the material demands between wear resistance and the desired high toughness.

Flexibility

A further advantage of this powder metallurgical cold work tool steel, being produced in a plant of the newest generation, lies in the good machinability and the high flexibility of its heat treatment, which allows variable heat treatment cycles without affecting the mechanical properties.

Cost-efficiency

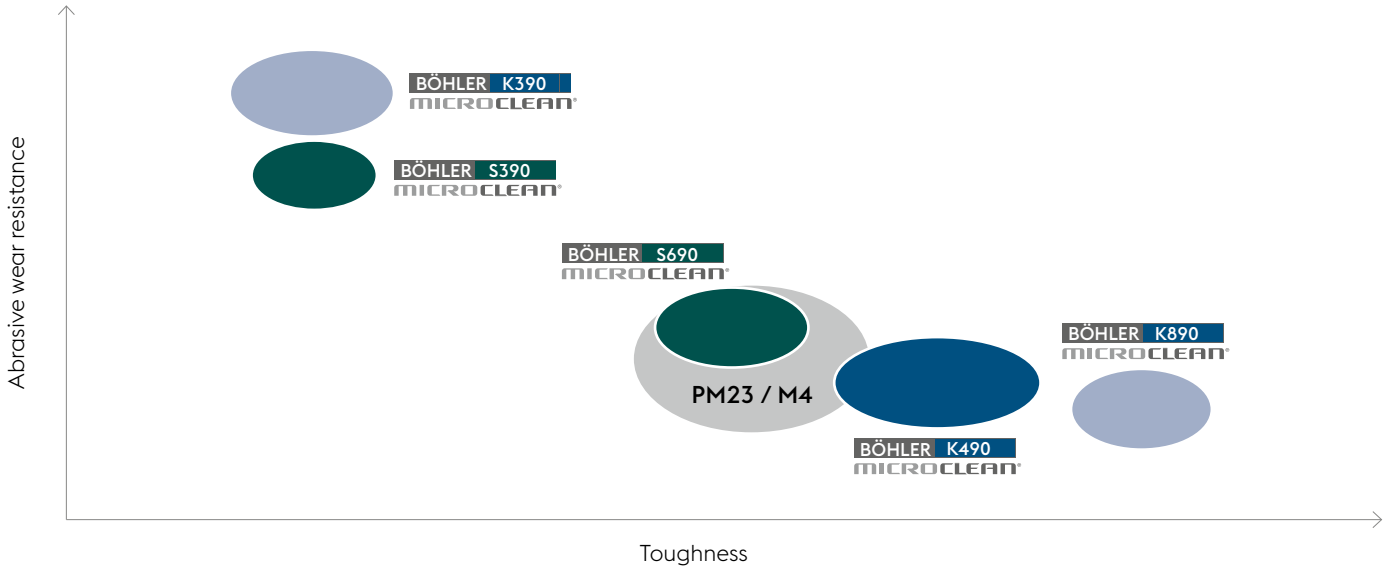
These excellent properties guarantee tool manufacturing that is risk-free, more flexible, faster and more economical.

Versatility

BÖHLER's K490 MICROCLEAN is a greatly improved and more efficient cold work tool steel compared with other commonly used PM steels such as M4 or PM23. **Toughness is more than doubled with a similar wear resistance.**

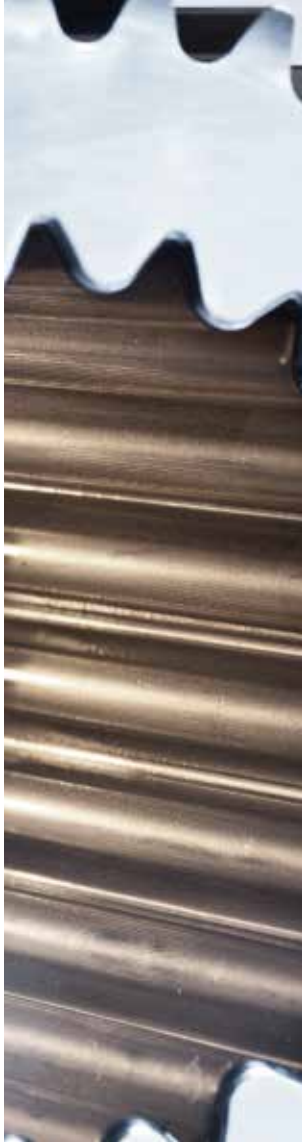
IN SHORT:
SIMPLE, FAST,
VERSATILE EQUALS
PROFITABLE, EFFICIENT,
PRODUCTIVE.

Product portfolio



Chemical composition (average %)

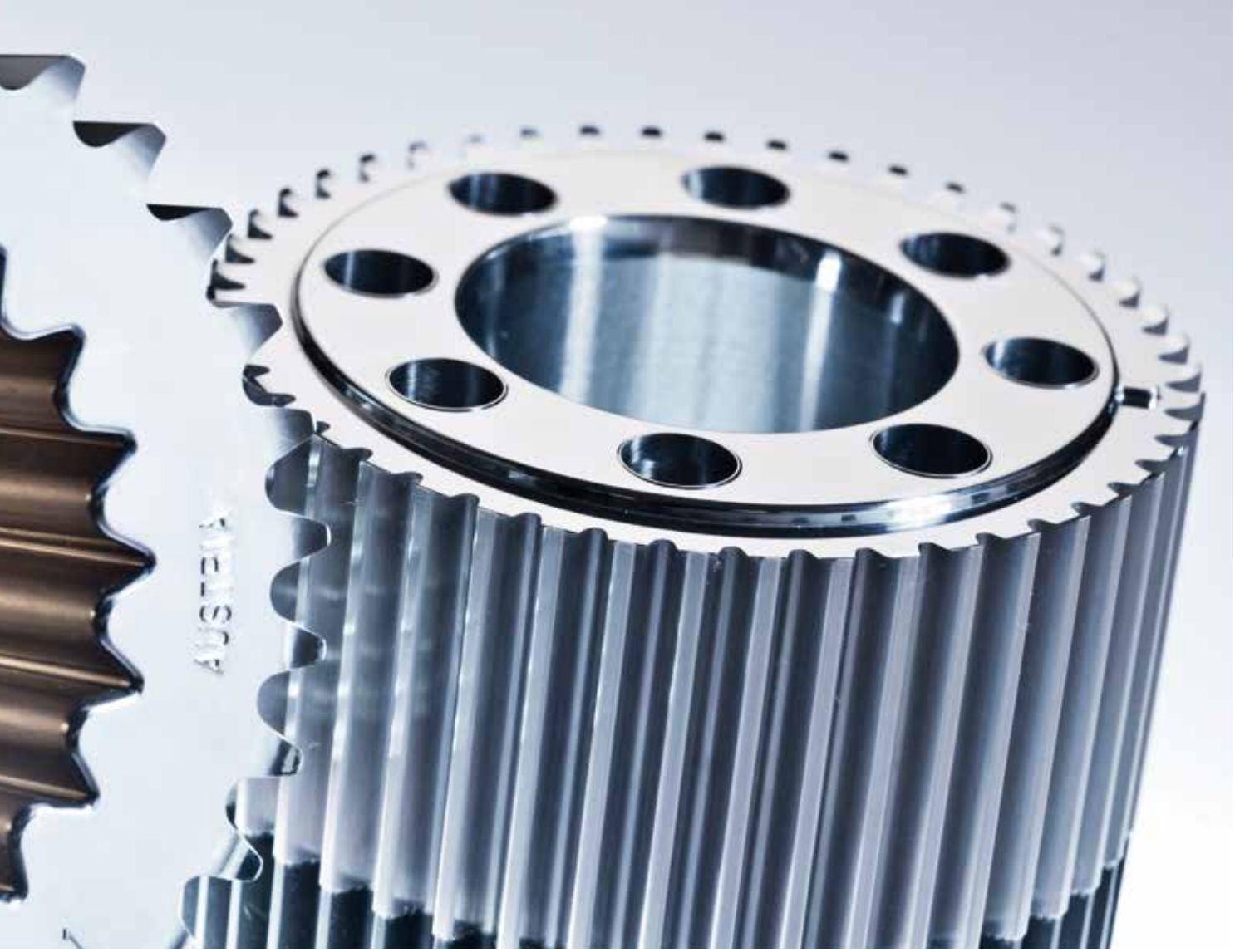
C	Cr	Mo	V	W	others
1.40	6.40	1.50	3.70	3.50	+Nb



THE BEST IS THE SUM OF OUTSTANDING PROPERTIES

PROPERTIES

- High hardness (up to 64 HRC)
- Very good toughness
- High abrasive and adhesive wear resistance
- Excellent hard machinability
- High compressive strength
- Heat treatment together with common cold work tool steels (1.2379, D2) at hardening temperatures from 1030 to 1080 °C (1885 – 1980 °F) possible
- Stable mechanical properties



BENEFITS

BÖHLER K490 MICROCLEAN for the tool maker

» Shorter and cheaper production processes due to flexible heat treatment and excellent hard machinability.

BÖHLER K490 MICROCLEAN for the tool user

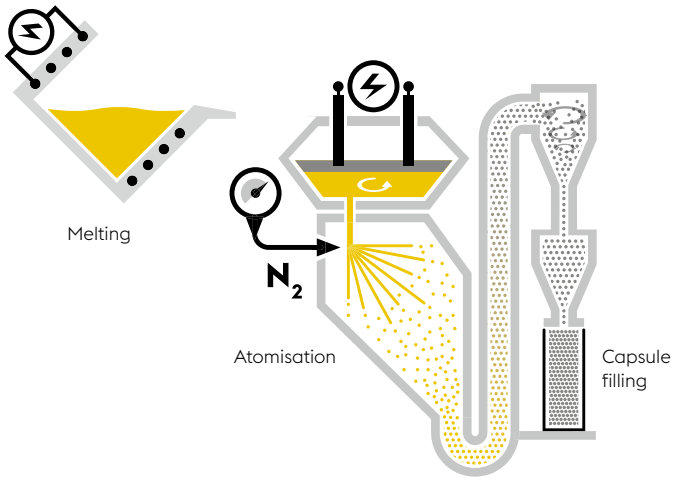
» Increased tool life due to the excellent and stable mechanical properties – **resulting in a reduction in unit costs.**

PROGRESS BASED ON SUPERIOR TECHNOLOGY

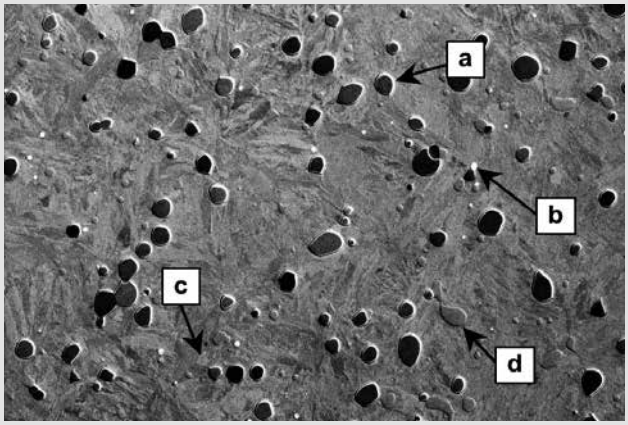
THE WORLD'S MOST MODERN PM STEEL PRODUCTION PLANT.

voestalpine BÖHLER develops and produces high-performance PM-high speed steels and tool steels, which increase tool life time cycles several times over. We consider this to be a technological leap forward from BÖHLER: 3rd generation PM materials.

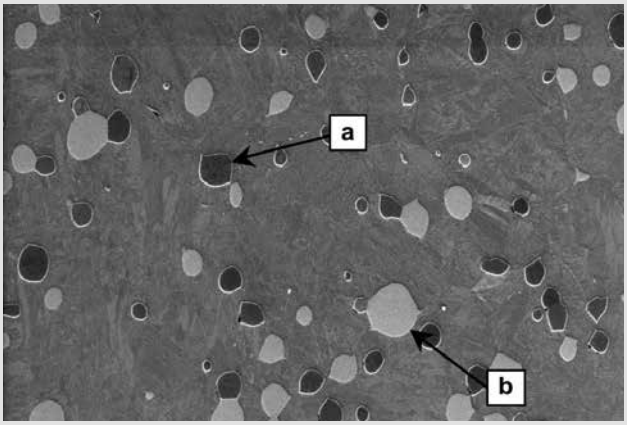
BÖHLER K490 MICROCLEAN owes its superior properties above all to the powder-metallurgical production process and the newly developed alloy which has a very fine and regularly distributed carbide microstructure with different carbide types. This new development made by BÖHLER results in **an improved toughness, an increased adhesive wear resistance and in stable mechanical properties.**



Microstructure comparison of BÖHLER K490 MICROCLEAN with a PM23.



BÖHLER K490 MICROCLEAN



PM23 type

a = MC-type b = M_6C-type c = M_7C_3-type d = $M_{23}C_6$-type

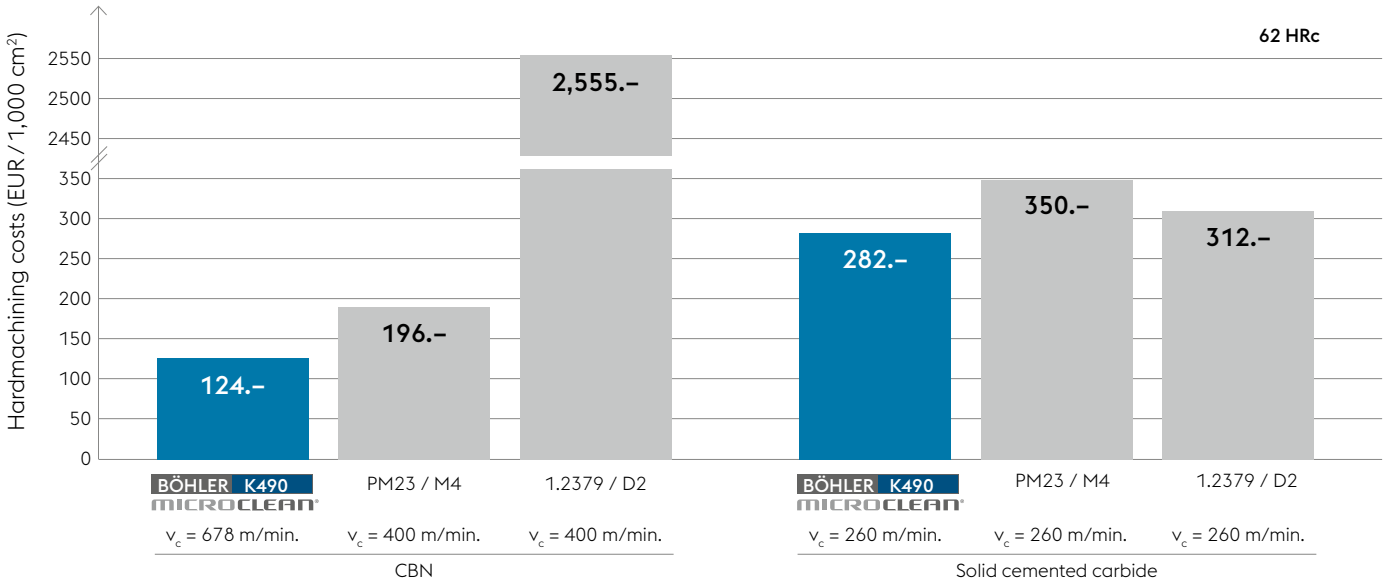
TESTED FOR THE HIGHEST REQUIREMENTS

The following diagram shows the results of **BÖHLER K490 MICROCLEAN's** machinability in a hardened and tempered condition by using tools with changing plates made of solid cemented carbide and cubic Bornitride CBN.

The advantages of these CBN tools lie in their higher tool life and in higher cutting speeds in tool usage. CBN cutting materials, however, are more expensive than solid cemented carbide. The advantages and disadvantages were nevertheless taken into account in the evaluation of costs.

BÖHLER K490 MICROCLEAN is, all in all, the **more cost-effective solution** when compared to other powder metallurgical and conventional ledeburitic 12% Cr steels.

Cost comparison final machining



Tested under real conditions in the machining laboratory. Company: Profactor
CBN – Cutting plate: BN081 CBN
VHM – Solid cemented carbide cutting plate: LC610Z VHM

THE BEST ONES ARE THE VERSATILE ONES

BÖHLER K490 MICROCLEAN's balanced properties can be made use of in a wide range of applications, making it a real PM all-rounder for cold work tool steel applications.

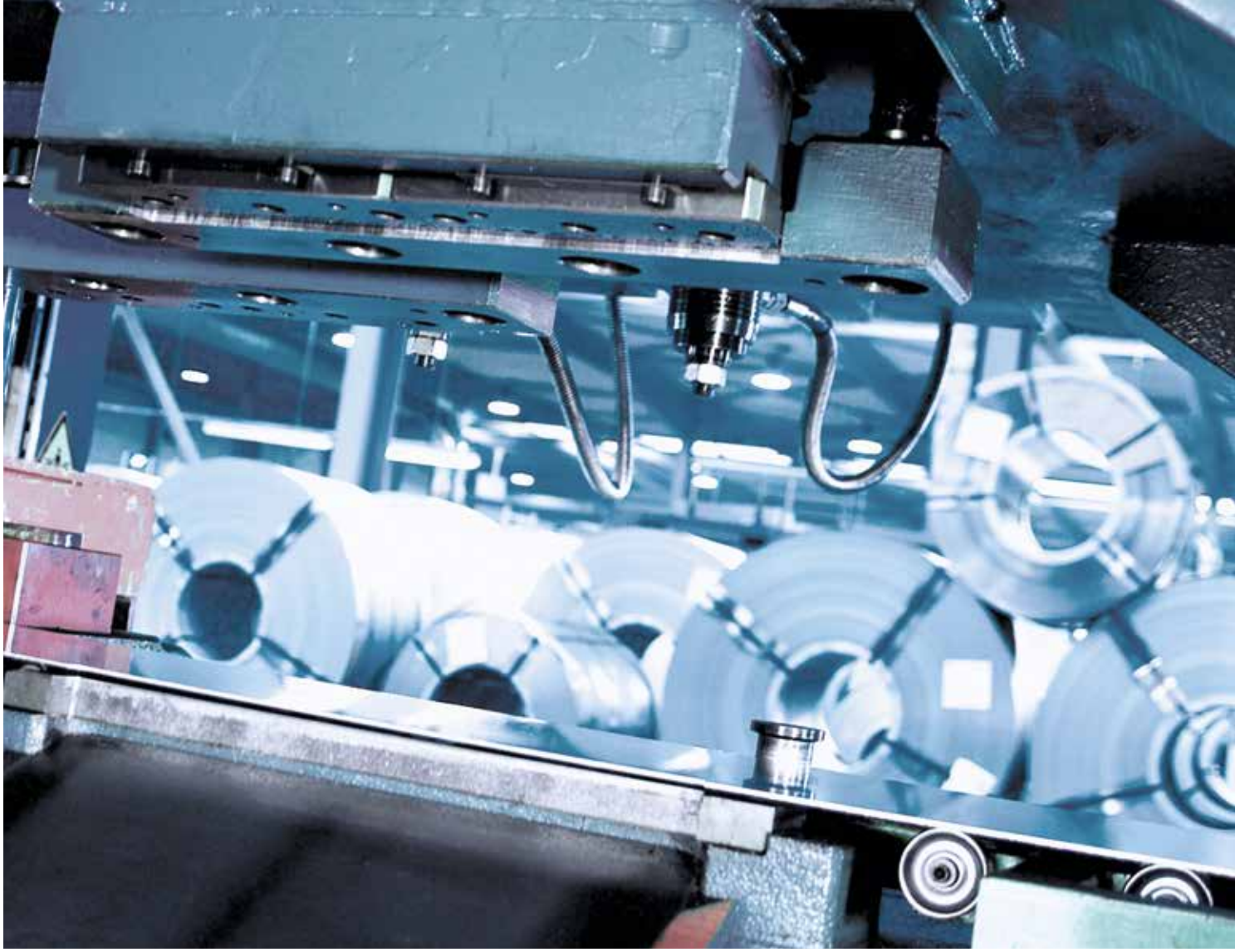
Blanking and punching industry

» Cutting tools (dies, punches) for normal and precision blanking
» Cutting rolls

Cold forming applications

» Extrusion tooling (cold and warm forming)
» Drawing and deep-drawing tools
» Stamping tools
» Thread rolling tools
» Cold rolls for multiple roller stands
» Cold pilger rolling mandrels
» Compression moulding dies for the ceramics and pharmaceutical industries
» Compression moulding dies for the processing of sintered parts

» **Industrial knives**
» **Plastics processing industry**



Physical properties at 20°C (68°F)

Condition: hardened and tempered		
Modulus of elasticity at	20 °C 68 °F	223 GPa 32.3 x 10^3 ksi
Density at	20 °C 68 °F	7.79 kg/dm^3 0.281 lbs/in^3
Electrical resistivity at	20 °C 68 °F	0.55 Ohm.mm^2/m 331 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	19.6 W/(m.K) 11.3 Btu/ft h °F

* Source: Materials Center Leoben Forschung GmbH, ÖGI

Coefficient of thermal expansion between 20 °C (68 °F) and ....°C (°F)

100 °C	**200 °C**	**300 °C**	**400 °C**	**500 °C**	**600 °C**	**700 °C**	
10.6	11.1	11.6	11.9	12.3	12.6	12.8	10^{-6} m/(m.K)
210 °F	**390 °F**	**570 °F**	**750 °F**	**930 °F**	**1110 °F**	**1290 °F**	
5.89	6.17	6.44	6.61	6.83	7.00	7.11	10^{-6} in/in°F

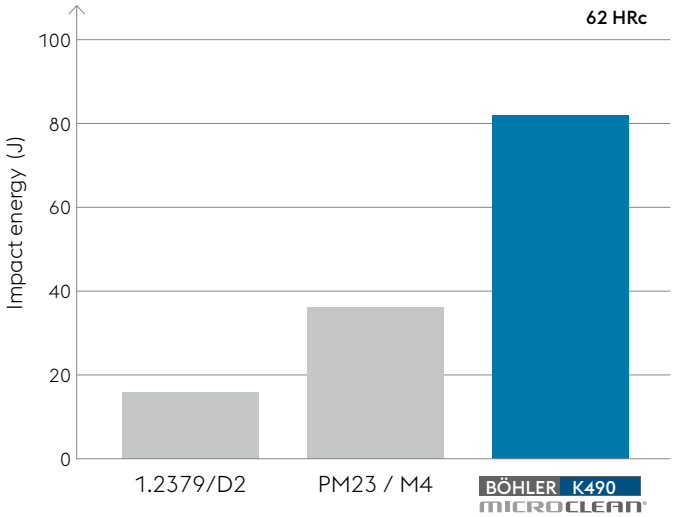
The customer will be required to **consult with us** on an individual basis regarding applications and processing steps that are not expressly mentioned in this product description/data sheet.

Compared with commonly used PM alloys in cold work tool steel applications, **BÖHLER K490 MICROCLEAN** excels with its consistent **wear resistance coupled with a more than doubled toughness**. In addition, the higher deformability provides increased security against unforeseeable breakage.

All of these properties result in a longer tool life.

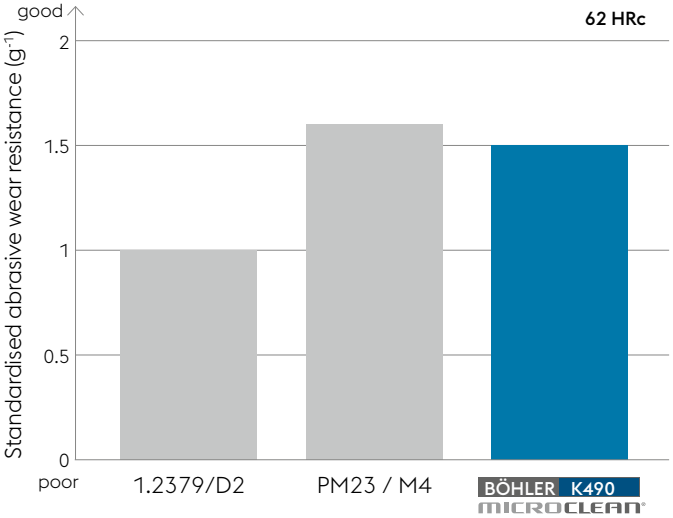
THE BEST UNITE EVEN SEEMINGLY OBVIOUS CONTRADICTIONS

Impact energy (unnotched)



Samples taken from a rolled steel bar in longitudinal direction,
heat treated at a cooling rate of: $\lambda \leq 0.5$
Primary material size: round 35 mm
Sample size: 10 x 7 x 55 mm
Heat treatment parameters for:
BÖHLER K490 MICROCLEAN: 1080 °C (1980 °F), 3 x 2 h, 560 °C (1040 °F)
PM23: 1100 °C (2012 °F), 3 x 2 h, 570 °C (1058 °F)
1.2379/D2: 1070 °C (1958 °F), 3 x 2 h, 520 °C (968 °F)

Abrasive wear resistance



Determined by the rubber disc dry sand test according to ASTM G65
Samples taken from a rolled steel bar in lateral direction, center
Primary material size: round 70 mm
Sample size: 60 x 25 x 8 mm, Ra < 0.8 µm
Heat treatment parameters for:
BÖHLER K490 MICROCLEAN: 1080 °C (1980 °F), 3 x 2 h, 560 °C (1040 °F)
PM23: 1130 °C (2066 °F), 3 x 2 h, 590 °C (1094 °F)
1.2379/D2: 1070 °C (1958 °F), 3 x 2 h, 510 °C (968 °F)

HEAT TREATMENT RECOMMENDATIONS

Delivery condition
» soft annealed max. 280 HB

Stress relieving
» 650 bis 700 °C (1200 – 1290 °F)
» After through-heating, soak for 1 to 2 hours in a neutral atmosphere.
» Slow cooling in furnace

Hardening
» 1030 bis 1080 °C (1885 – 1980 °F)/oil, N_2
» Following temperature equalisation: 20 – 30 minutes for a hardening temperature of 1030 – 1080 °C (1885 – 1980 °F)
» For additional hardening temperatures please consult us.

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

Surface treatment
» Suitable for salt bath, gas and plasma nitriding and for any conventionally used PVD coatings

Repair welding
There is a general risk of cracking during welding as is the case with tool steels. Should there be a need for welding we ask you to follow the guidelines of your manufacturer of weld consumables.

For further information please ask for our ”Welding in Tool Making“ leaflet.


Genkinger
HUBTEX

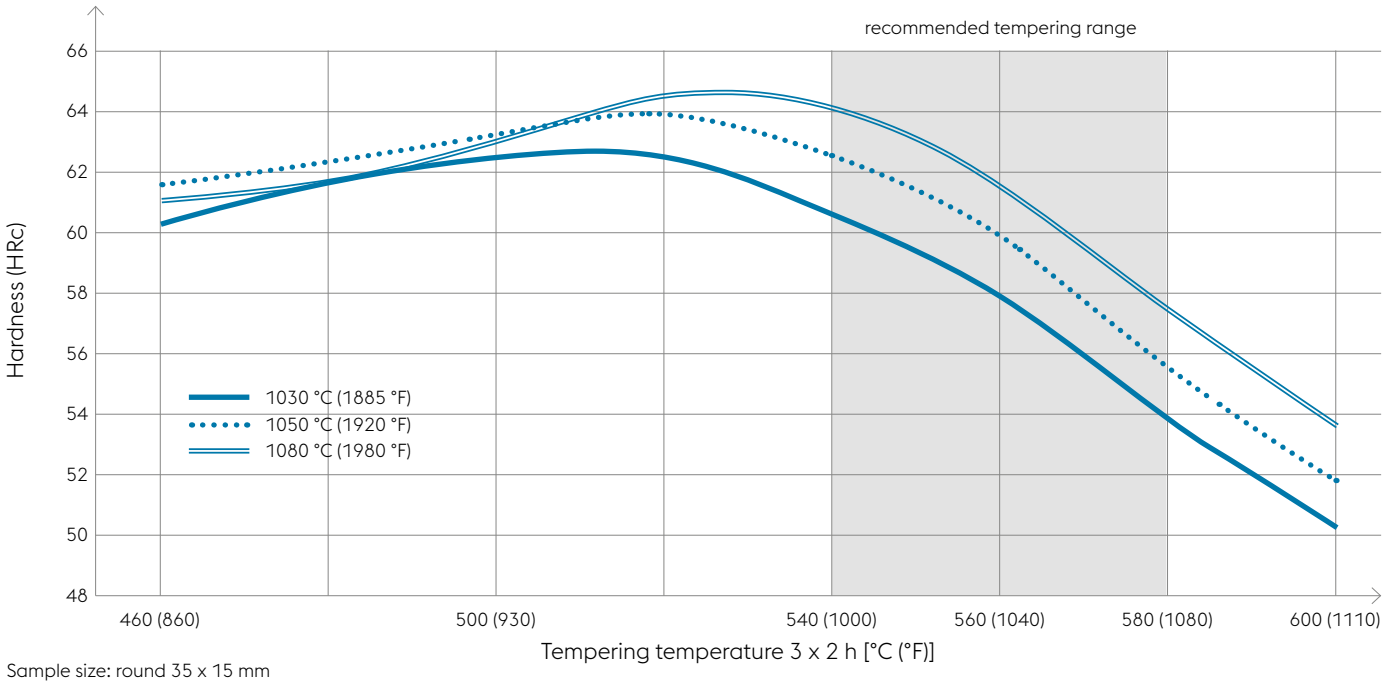
HEAT TREATMENT RECOMMENDATIONS

One of the remarkable features of **BÖHLER K490 MICROCLEAN** is its flexibility in heat treatment:

» We recommend the same hardening temperatures as with widely used cold work tool steels (e.g. 1.2379/D2)

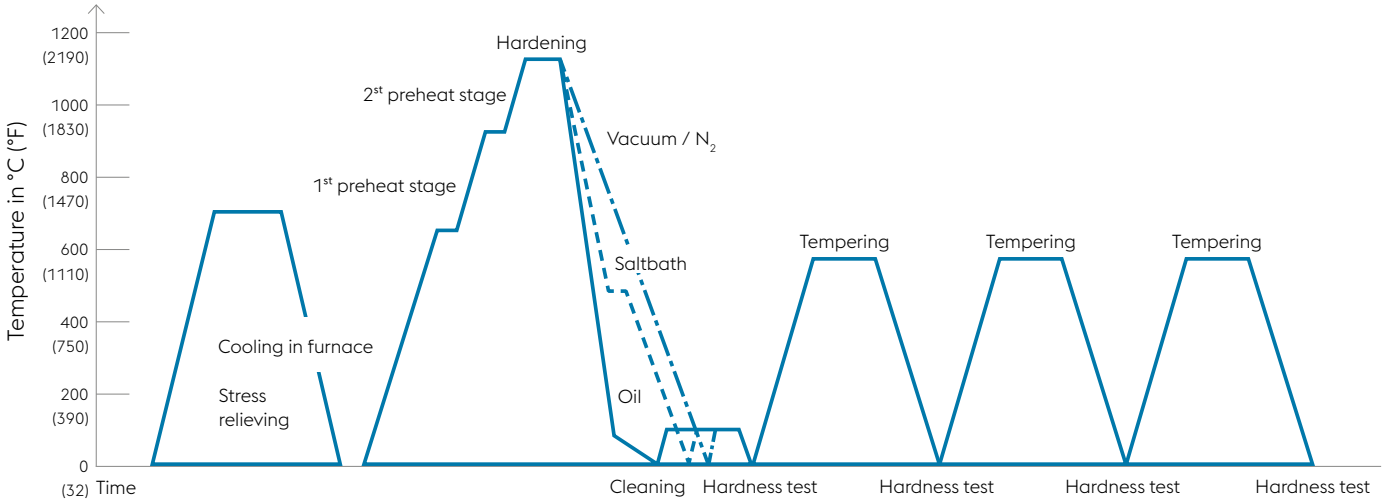
» Very stable mechanical properties, regardless of the hardening temperature (1030 – 1080 °C [1885 – 1980 °F])

Tempering chart



Sample size: round 35 x 15 mm

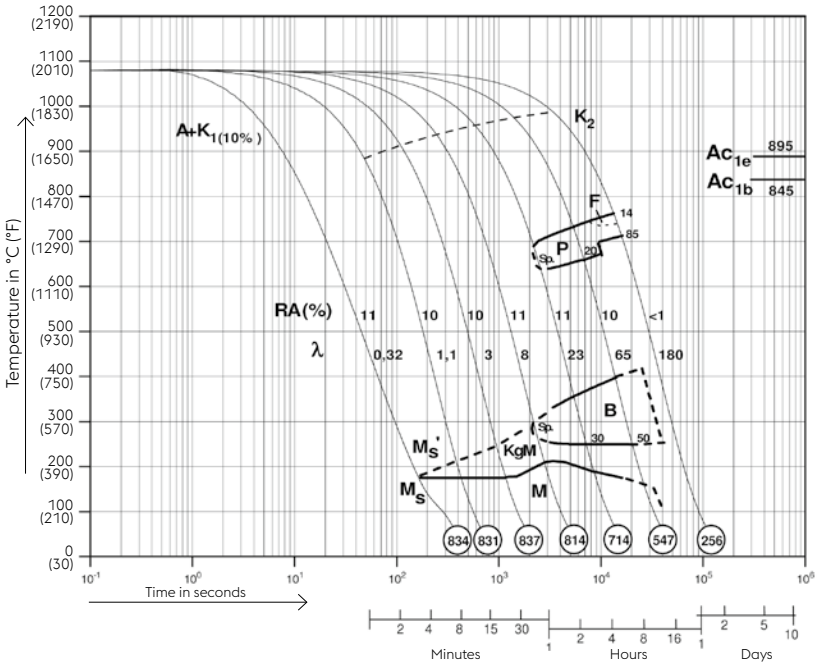
Heat treatment sequence



Continuous cooling CCT curves

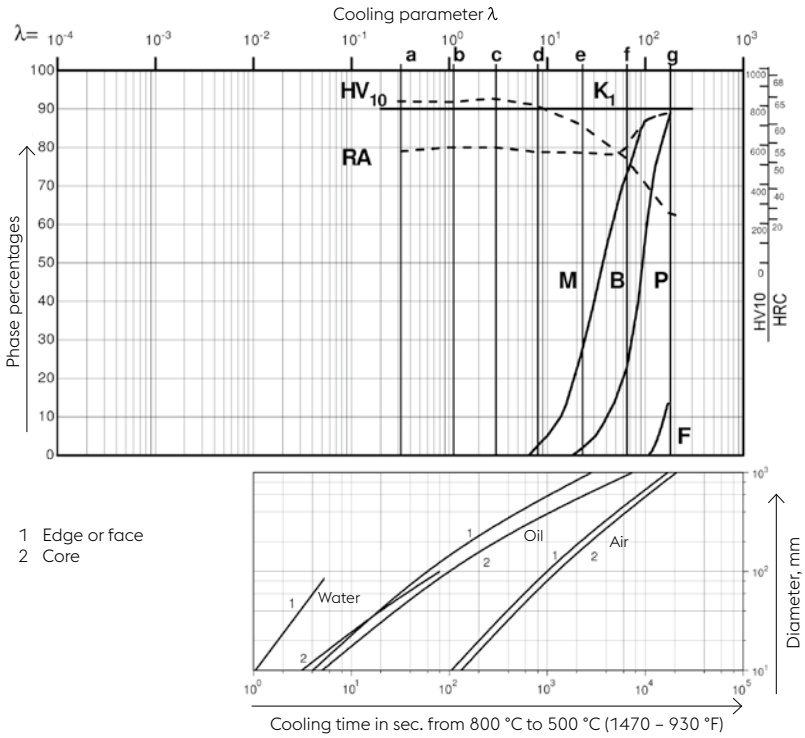
Austenitizing temperature: 1080 °C (1980 °F)
Holding time: 30 minutes
0.32 ... 180 cooling parameter λ, i.e. duration of cooling from 800 – 500° C (1470 – 930 °F) in s x 10^{-2}

Probe	λ	HV_{10}
a	0.32	834
b	1.10	831
c	3.00	837
d	8.00	814
e	23.00	714
f	65.00	547
g	180.00	256



Quantitative phase diagram

K1 carbides which are not dissolved during austenitization (10%)
K2 start of carbide precipitation during quenching from austenitizing temperature
LK Ledeburitic carbides
RA Retained austenite
A Austenite
M Martensite
P Perlite
B Bainite
F Ferrite



MACHINING GUIDELINES

Turning with cemented carbide in annealed condition

Type of machining	ROUGH MACHINING	NORMAL MACHINING	FINAL MACHINING
Depth of cut mm (inches)	2 – 5 (.08 – .2)	1 – 3 (.04 – .12)	0.2 – 0.3 (.008 – .012)
Feed mm/rev. (inches/rev.)	0.3 – 0.8 (.012 – .032)	0.2 – 0.4 (.008 – .016)	0.15 – 0.25 (.006 – .01)
BOEHLERIT carbide grade	LC 215K	LC 215H, LC 610H	LCM 205
ISO carbide grade	P15	P15, K10	
Cutting speed v_c m/min (f.p.m)	80 – 120 (260 – 390)	150 – 220 (490 – 740)	100 – 170 (330 – 560)

Machining in hardened and tempered condition (58 – 64 HRc)

ROUGH MACHINING	CBN	VHM
Cutting speed v_c m/min (f.p.m)	300 (985)	220 (740)
Feed mm/tooth (inches/tooth)	0.17 (.0068)	0.17 (.0068)
FINAL MACHINING	**CBN**	**VHM**
Cutting speed v_c m/min (f.p.m)	678 (2270)	260 (850)
Feed mm/tooth (inches/tooth)	0.2 (.008)	0.2 (.008)

Cutting plate: BN081 CBN
Cutting plate: LC610Z VHM

Grinding

Condition	External grinding	Internal grinding		Centerless	Flat grinding	Profile- / deep grinding
soft annealed	57A80 H8V300W	54A80 H15VPMF904W	Surface Plunging	54A80 J7V904W 54A120 J7V904W	54A60 H15VPMF904W	54A80 H15VPMF904W
hardened and tempered < 62HRc	93N80 H8V601W	93A80 H13VP601	Surface Plunging	93A80 J7V601W 93A120 J7V601W	64A60 H15VP300W	93A80 F15VPH601W 54A80 F15VPH904W
hardened and tempered > 62HRc	32B91 P5V600C100 ev. 93A80 H8V601W	32B91 P8CV600C100	Surface Plunging	32B126 P8CV600C100 32B126 N5CV800C100	93A60 F15VPH601W 32B126 Q15CVPMF600C75	93A80 F15VPH601W

Quality of discs:
93N... Nanowin, suitable for soft alloys
93A... Blend of sintered corundum + white corundum
54A... White corundum, with a re-crystalline bonding system
57A... Pink corundum, grain is somewhat tougher than 54A
64A... Monocrystal corundum – pink corundum blend
32B... Cubic Bornitrite (CBN)

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