BÖHLER

PLASTIC
MOULD STEEL

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BÖHLER M333
ISOPLAST®

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

voestalpine
ONE STEP AHEAD.

WITH
MIRROR FINISH GUARANTEE

Quality standards and design requirements for products made in series production are steadily increasing. Toolmakers are being challenged to put ideas of product designers into practice. Besides elaborately and costly photo-etched structures, high-gloss surface is an essential feature in product design.

Whether a high-gloss surface meets all optical requirements strongly depends on the tool's features and qualities. Impurities in tool steel inexorably appear in the final product. High-gloss surfaces can only be achieved with high-purity metallurgical tool steels.

BÖHLER'S M333 ISOPLAST plastic mould steel has been developed to fulfill just this requirement and offers tool makers straight-forward manufacture of high-gloss surfaces at low costs.

ADVANTAGES AT A GLANCE

- » Optimum polishability for mirror finish
- » Improved thermal conductivity
- » Exceptional toughness
- » Very good corrosion resistance

SPECIAL REMELTING TECHNOLOGY MAKES IT POSSIBLE

This technology allows remelting in a closed vessel in a nitrogen and/or argon atmosphere, which excludes oxygen. Thus an increase in degree of oxide purity level is achieved and, as a result, improved corrosion resistance, polishability, photo etching and spark eroding of the steel is realized.

This collection of positive attributes guarantees cost savings by considerably reducing polishing efforts to a mirror finish, guaranteeing longer mould life, (thus ensuring reduced need for new tools, reducing maintenance and repair time, and providing security against fracture) and increasing productivity by shortening cycle times.

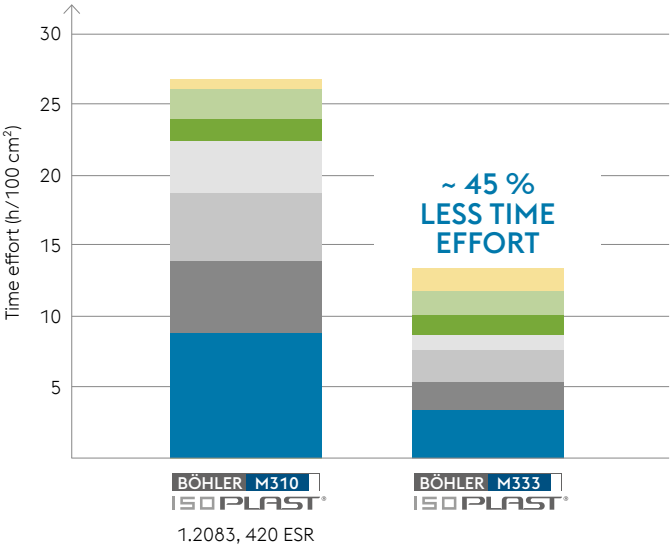
THE RECIPE WITH A "MIRROR FINISH GUARANTEE".

Chemical composition (average %)

C	Si	Mn	Cr	others
0.24	0.20	0.35	13.25	+N, Mo, V, Ni

POLISHING

Quick high-grade polish in no time at all (tests from the lab and practice)



The following comparison illustrates exemplarily the **time effort reaching a mirror-polished surface** with Ra = 0.04 µm starting from a pre-ground surface.
For further details please ask for our "Polishing" leaflet.

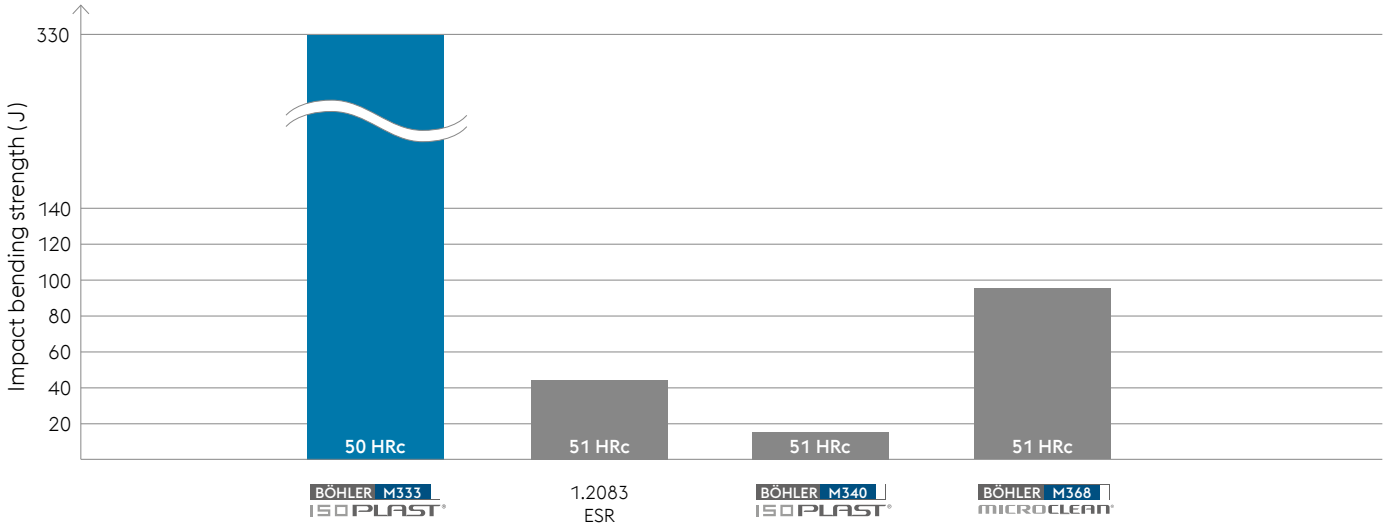
Polishing steps

K400	K600	25 µm	14 µm	9 µm	6 µm	3 µm

coarse → fine

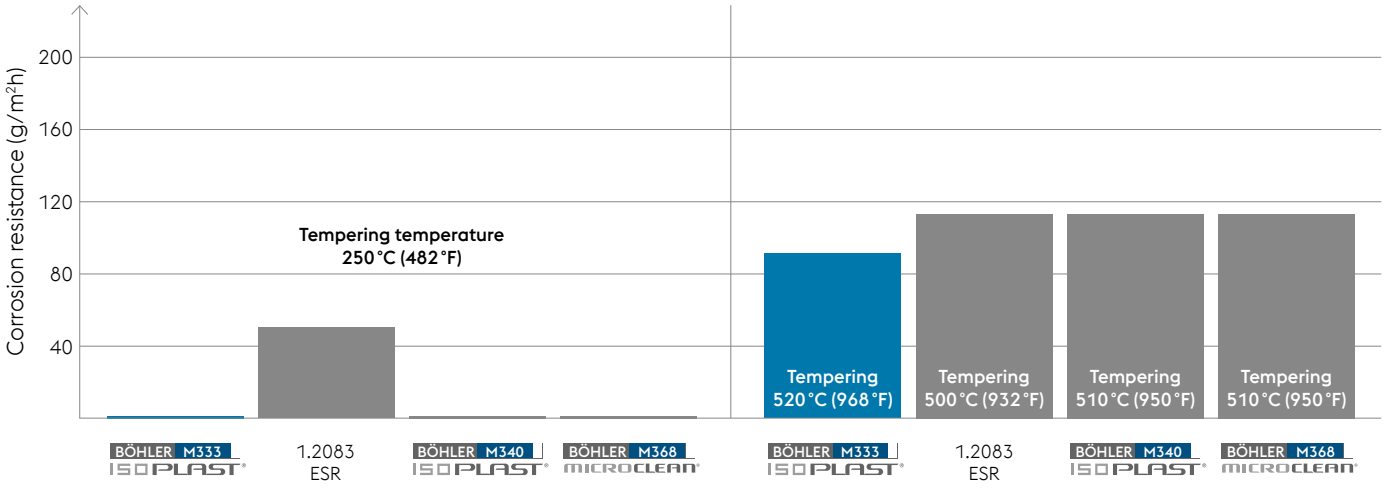
EXTRAORDINARY PROPERTIES

Toughness



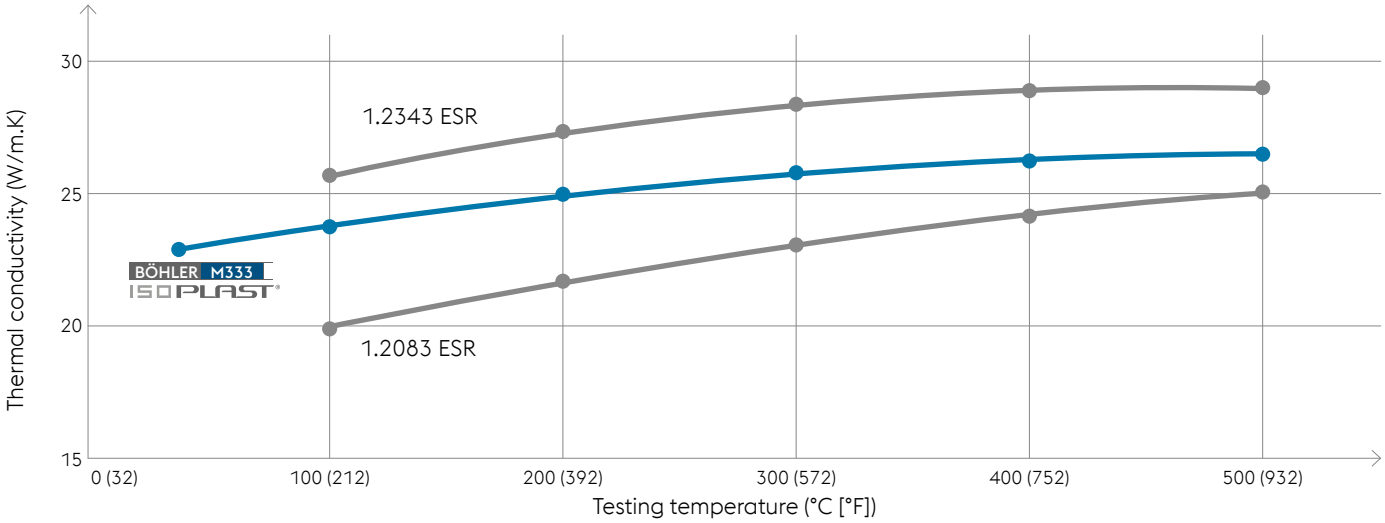
Samples from motherblock 403 x 303 mm, high tempered
Sample size: 10 x 7 x 55 mm (unnotched)

Corrosion resistance (weight loss – test according DIN 50905-2)



For highest corrosion resistance use lower tempering temperatures.
Heat treatment without subzerocooling.
Weight loss test: measured after 24 h with 20 % boiling acetic acid

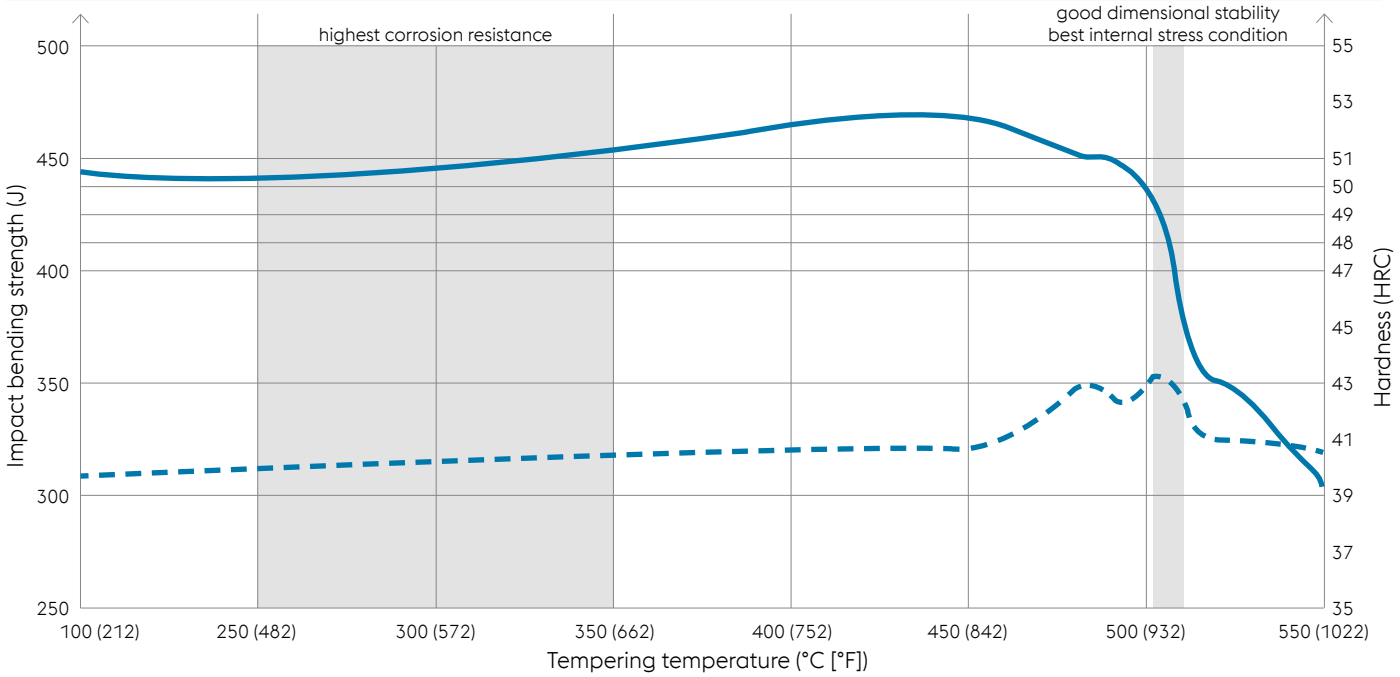
Shorter cycle time and higher productivity due to improved thermal conductivity. Your tool stays "cool".



Source: Materials Center Leoben Forschung GmbH, ÖGI

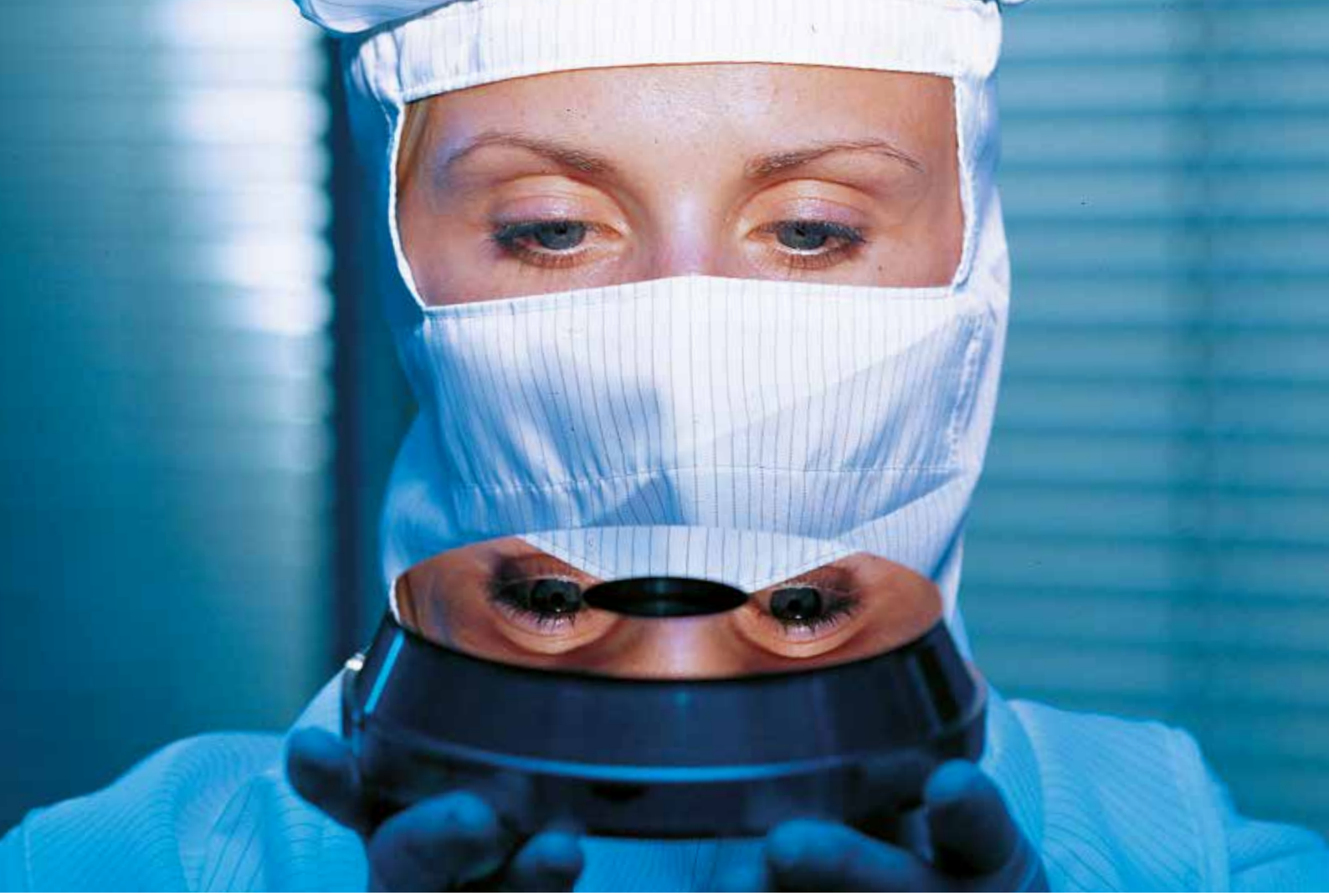
HEAT TREATMENT

Tempering chart (Vacuum heat treatment without subzero treatment)

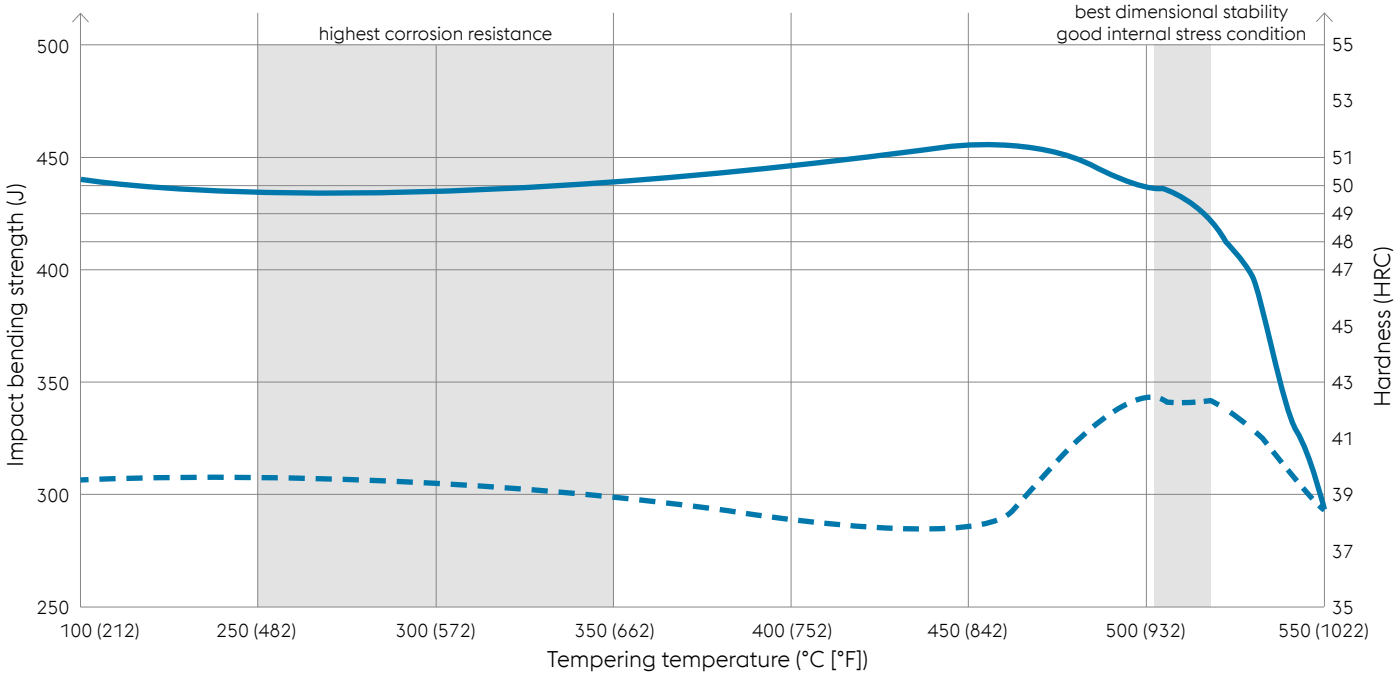


Impact bending strength 980 °C (1796 °F) without subzero treatment

Hardness 980 °C (1796 °F) without subzero treatment



Tempering chart (Vacuum heat treatment with subzero treatment)



Impact bending strength 980 °C (1796 °F) with subzero treatment

Hardness 980 °C (1796 °F) with subzero treatment

HEAT TREATMENT RECOMMENDATIONS

RIGHT HEAT TREATMENT MEANS OPTIMUM RESULTS

Delivery condition
» soft annealed max. 220 HB

Stress relieving
» approx. 650 °C (1202 °F)
» following temperature equalisation, hold at temperature for 1 – 2 hours in a neutral atmosphere
» slow furnace cooling

Hardening
» 980 °C (1796 °F), quick quenching as possible
» Holding time: 15 – 30 minutes after temperature equalisation.

Tempering
» Tempering should be done directly following hardening.
» 3 times tempering is recommended.
» Holding time in furnace 1 hour per 20 mm material thickness, at least 2 hours in any case.

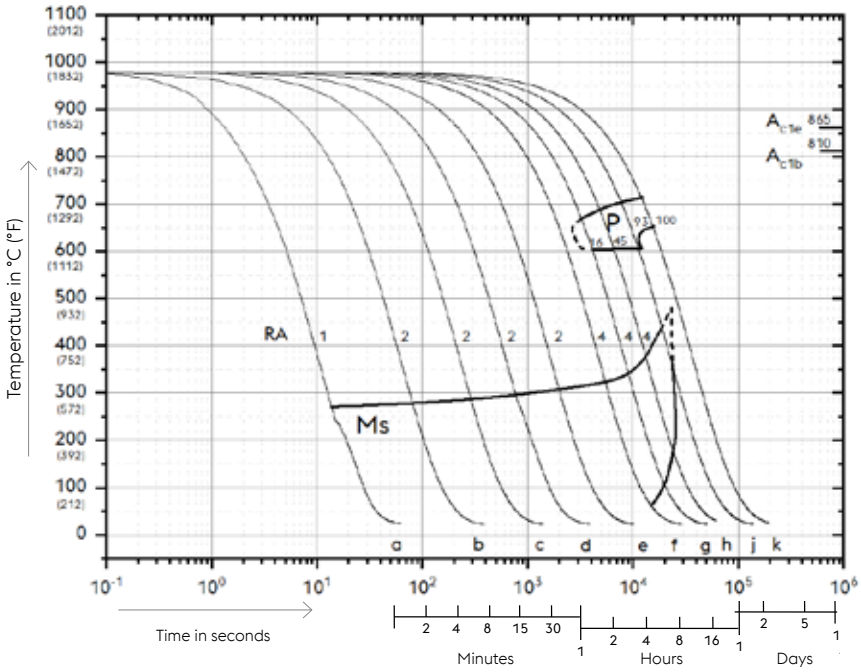
Maximal goal hardness
» 48 – 50 HRC


Genkinger
HUBTEX

Continuous cooling transformation (CCT) diagram

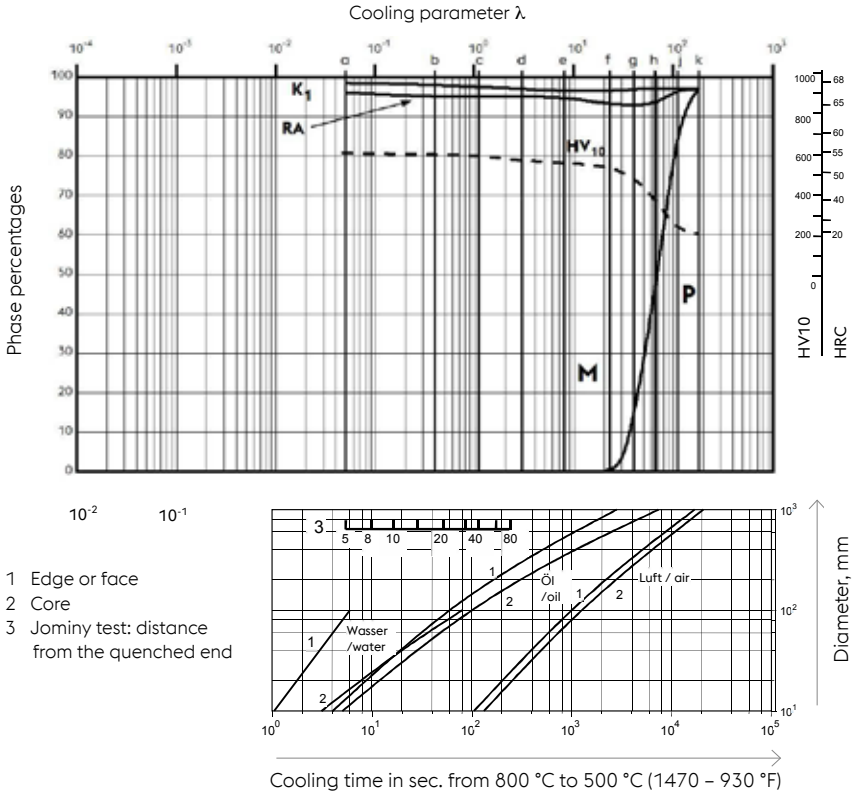
Austenitizing temperature: 980 °C (1796 °F)
Holding time: 15 minutes
2 ... 100 phase in %
0.05 ... 180 cooling parameter,
i.e. duration of cooling from
800 – 500° C (1470 – 930 °F)
in s x 10^{-2}

Probe	λ	HV_{10}
a	0.05	610
b	0.40	601
c	1.10	600
d	3.00	570
e	8.00	561
f	23.00	543
g	40.00	498
h	65.00	397
j	110.00	224
k	180.00	199



Quantitative phase diagram

K1	carbides which are not dissolved during austenitization
A	Austenite
M	Martensite
P	Perlite



MACHINING RECOMMENDATIONS

Turning

Depth of cut mm (inches)	8 – 4 (.31 – .16)	4 –1 (.16 – .04)	1 – 0.5 (.04 – .02)
Feed mm / rev. (inches / rev.)	0.8 – 0.4 (.032 – .016)	0.4 – 0.25 (.016 – .01)	0.25 – 0.1 (.01 – .004)
Cutting speed v_c m/min (f.p.m)			
BOEHLERIT LC 225 C / ISO HC-P25	110 – 150 (360 – 490)	150 – 200 (490 – 660)	190 – 300 (625 – 985)
BOEHLERIT LC 235 / ISO HC-P53	90 – 130 (295 – 425)	130 – 180 (425 – 590)	170 – 280 (395 – 920)

Heat treatment condition: soft annealed / mill finish

Milling

Feed mm/tooth (inches/tooth)	0.5 – 0.36 (.02 – .014)	0.35 – 0.16 (.014 – .006)	0.15 – 0.08 (.006 – .003)
Cutting speed v_c m/min (f.p.m)			
BOEHLERIT LW 225 / ISO HW-P25	60 – 100 (195 – 330)	70 – 110 (230 – 360)	80 – 120 (260 – 395)
BOEHLERIT LC 225 M / ISO HC-P25	80 – 120 (260 – 395)	100 – 150 (330 – 490)	140 – 190 (460 – 625)
BOEHLERIT LC 230 F / ISO HC-P30	70 – 100 (230 – 330)	80 – 130 (260 – 425)	120 – 170 (395 – 560)

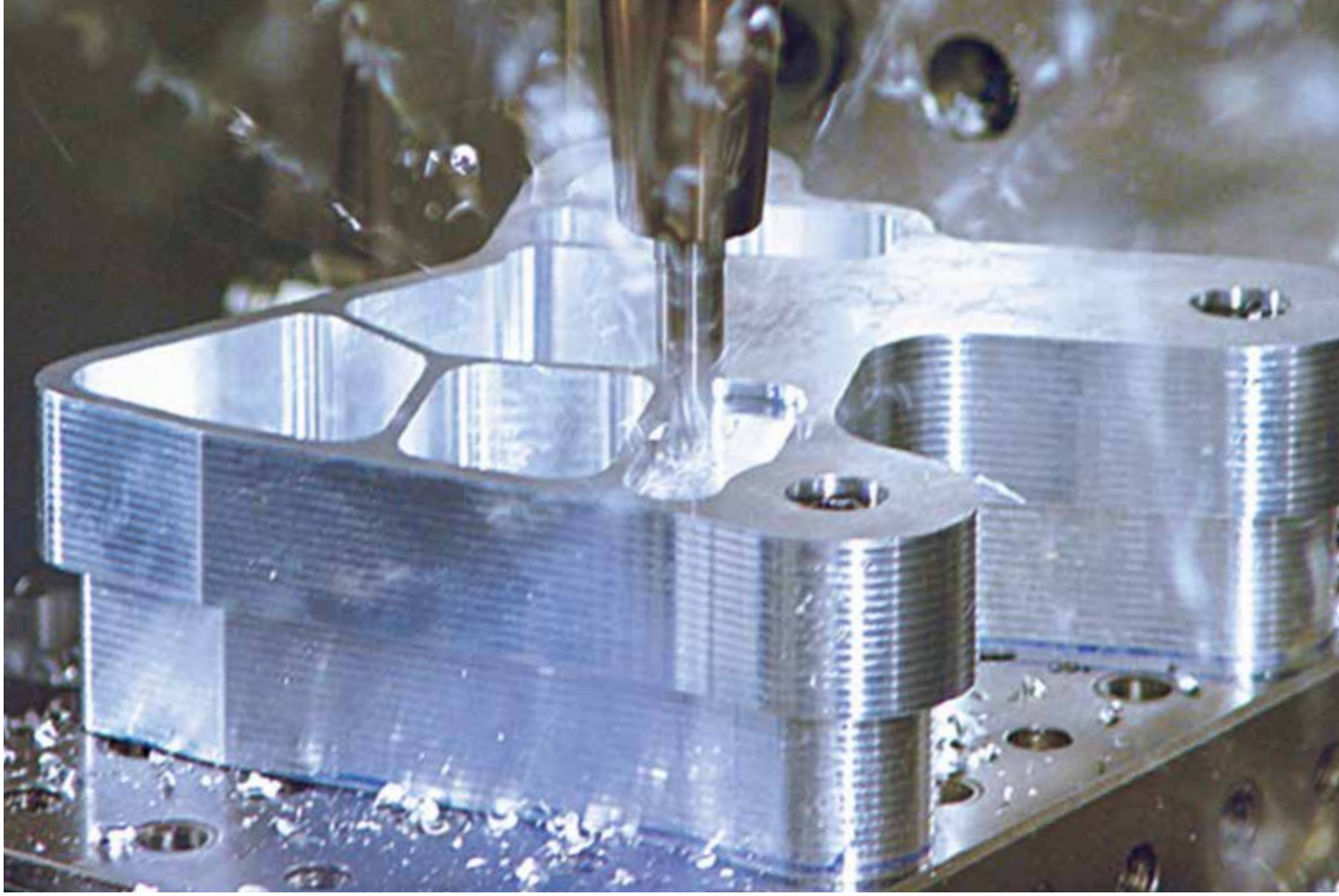
Cutting material recommendations for dry machining, standard values for indexable insert tools.
If using carbide tooling a lower feed should be used.

Drilling

Drill diameter mm (inches)	3 – 20 (.12 – .80)	20 – 54 (.80 – 2.13)
	Carbide tooling	Indexable inserts
Feed mm / rev. (inches / rev.)	0.15 – 0.25 (.006 – .01)	0.05 – 0.20 (.002 – .008)
Cutting speed v_c m/min (f.p.m)		
Fette LC 640S / ISO HC-K40	50 – 100 (165 – 330)	50 – 100 (165 – 330)
BOEHLERIT R 331 / ISO HC-P30	150 – 200 (490 – 660)	150 – 200 (490 – 660)
BOEHLERIT SB 40 / ISO HW-P40	100 – 140 (330 – 460)	100 – 140 (330 – 460)

Repair welding

There is a general tendency for tool steels to develop cracks after welding.
If welding cannot be avoided, the instructions of the appropriate welding electrode manufacturer should be followed or check BÖHLER welding leaflet.



NUMBERS, FACTS AND DATA

Physical properties

Density at	20 °C 68 °F	7.70 kg/dm³ 0.278 lbs/in³
Specific heat capacity at	20 °C 68 °F	460 J/(kg.K) 0.110 Btu/(lb °F)
Magnetic properties existing		

Source: Materials Center Leoben Forschung GmbH, ÖGI

Thermal conductivity

20 °C	**100 °C**	**200 °C**	**300 °C**	**400 °C**	**500 °C**	
22.9	23.9	25.1	25.8	26.4	27.0	W/(m.K)
68 °F	**210 °F**	**390 °F**	**570 °F**	**750 °F**	**930 °F**	
13.23	13.81	14.50	14.90	15.25	15.60	Btu/(ft h °F)

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

100 °C	**200 °C**	**300 °C**	**400 °C**	**500 °C**	
10.50	11.00	11.00	11.50	12.00	10^{-6} m/(m.K)
210 °F	**390 °F**	**570 °F**	**750 °F**	**930 °F**	
5.83	6.11	6.11	6.39	6.67	10^{-6} in/(in °F)

Modulus of elasticity

20 °C	**100 °C**	**200 °C**	**300 °C**	**400 °C**	**500 °C**	
216	212	205	198	190	180	GPa
68 °F	**210 °F**	**390 °F**	**570 °F**	**750 °F**	**930 °F**	
31.3	30.7	29.7	28.7	27.6	26.1	10^3 KSI

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