

HIGH SPEED STEELS

Application Segments

[Cutting Tools](#)
[Automotive](#)

Available Product Variants

[Long Products*](#)
[Plates](#)

* Presented data refer exclusively to long products. Please observe the detailed explanations at the end of the data sheet (pdf).

Product Description

BÖHLER S390 MICROCLEAN – "The decathlete"

This grade is our PM steel with many positive usage properties. For twist drills, taps, mills, broaches, or cold-work applications, BÖHLER S390 MICROCLEAN is always a high performer.

Process Melting

[Powder metallurgy](#)

Properties

- > Toughness & Ductility : high
- > Wear Resistance : high
- > Compressive strength : very high
- > Edge Stability : very high
- > Grindability : high
- > Hot Hardness (red hardness) : very high

Applications

- | | | |
|---|--|--|
| <ul style="list-style-type: none"> > Broaches and Reamers > Fine Blanking, Stamping, Blanking > Rolling > Twist Drills and Taps > Machine knife (for producers) > Mineral Processing > Pumps > Packaging industry | <ul style="list-style-type: none"> > Cold Forming / Coining > Gear Cutting, Shaving and Shaping Tools > Industrial Knives > Wear parts > Packaging > Wear Applications > Camshafts | <ul style="list-style-type: none"> > End Mills > Powder Pressing > Special Cutting Tools > Pill punching dies > Drilling > Injection Components > Roll Forming |
|---|--|--|

Chemical composition (wt. %)

C	Cr	Mo	V	W	Co
1.64	4.80	2.00	4.80	10.40	8.00

Material characteristics

	Compressive strength	Grindability	Red hardness	Toughness	Wear resistance	Edge Stability
BÖHLER S390 MICROCLEAN	★★★★	★★★	★★★★	★★★★	★★★★	★★★★
BÖHLER S290 MICROCLEAN	★★★★★	★	★★★★	★★	★★★★★	★★★★
BÖHLER S393 MICROCLEAN	★★★★	★★★	★★★★	★★★★	★★★★	★★★★
BÖHLER S590 MICROCLEAN	★★★★	★★★	★★★★	★★★	★★★	★★★
BÖHLER S690 MICROCLEAN	★★★	★★★	★★	★★★★★	★★★	★★
BÖHLER S790 MICROCLEAN	★★★	★★★	★★	★★★★	★★	★★★
BÖHLER S793 MICROCLEAN	★★★	★★★	★★★★	★★★	★★★	★★★

Delivery condition

Annealed	
Hardness (HB)	max. 320 drawn execution max. 320 HB
Tensile Strength (MPa)	max. 1,080

Hardened and Tempered	
Hardness (HRC)	64 to 68

Heat treatment

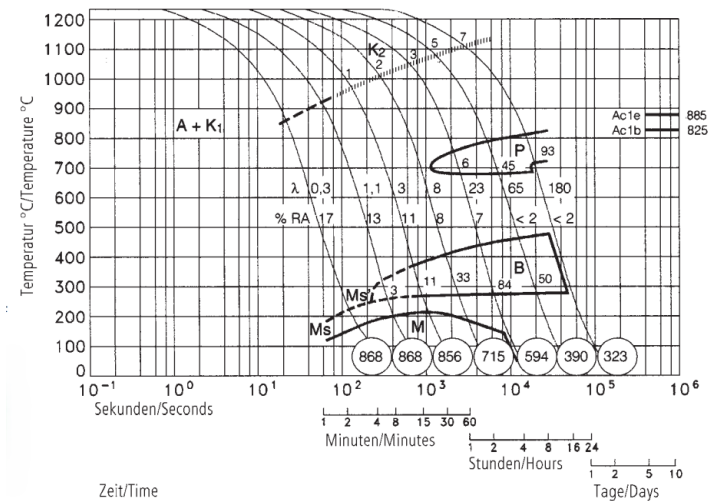
Annealing		
Temperature	770 to 840 °C	4 h controlled slow cooling in furnace (10 to 20°C/h / (50 to 68°F/h) to 740°C/2h (1364°F/2 h) cooling in furnace,

Stress relieving		
Temperature	600 to 650 °C	Slow cooling in furnace. To relieve stresses set up by extensive machining or in tools of intricate shape. After through heating, hold in neutral atmosphere for 1 to 2 hours.

Hardening and Tempering		
Temperature	1,100 to 1,230 °C	Salt bath, vacuum Preheating: 1st stage ~ 500 °C (930 °F), 2nd stage ~ 850 °C (1560 °F), 3rd stage ~1050 °C (1920 °F) Austenitising: 1100 - 1230 °C (2012 °F - 2246 °F), holding time after complete heating 80 seconds, maximum 150 seconds, to avoid material damage due to overheating. Quenching: oil, warm bath (500 - 550 °C (930 °F - 1020 °F)), gas
Temperature	550 to 570 °C	Slow heating to tempering temperature immediately after austenitising. Holding time in the furnace at least 2 hours Slow cooling to room temperature between each tempering step 3 tempering cycles recommended Hardness see tempering chart

Continuous cooling CCT curves

Austenitising temperature: 1230°C Austenitising temperature: 1230°C (2246°F)
 Haltedauer: 180 Sekunden Holding time: 180 seconds



Austenitising temperature: 1230 °C (2246 °F)

Holding time: 180 seconds

○ Vickers hardness

3...93 phase percentages

0.30...180 cooling parameter λ, i.e. duration of cooling from 800 to 500 °C (1472 to 932 °F) in s x 10⁻²

A... Austenite

K... Carbide

P... Pearlite

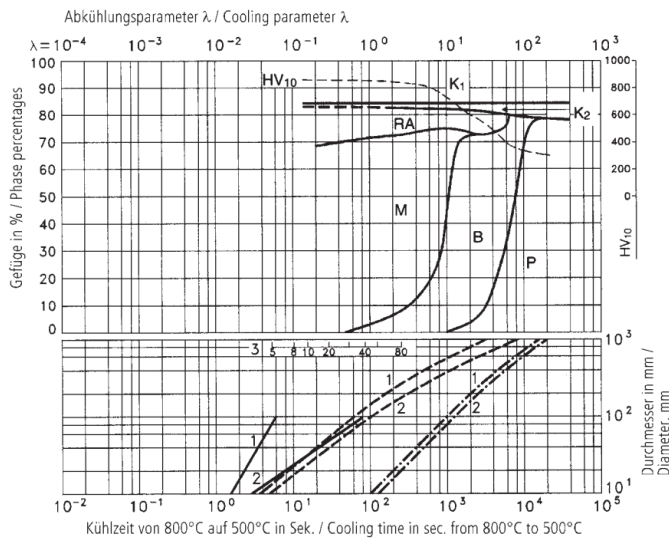
B... Bainite

M... Martensite

Ms... Martensite starting temperature

Quantitative phase diagram

Austenitising temperature: 1230°C Austenitising temperature: 1230°C (2246°F)
 Haltedauer: 180 Sekunden Holding time: 180 seconds



A....Austenite

B....Bainite

K....Carbide

P....Pearlite

M....Martensite

RA...Retained Austenite

1....Edge or Face

2....Core

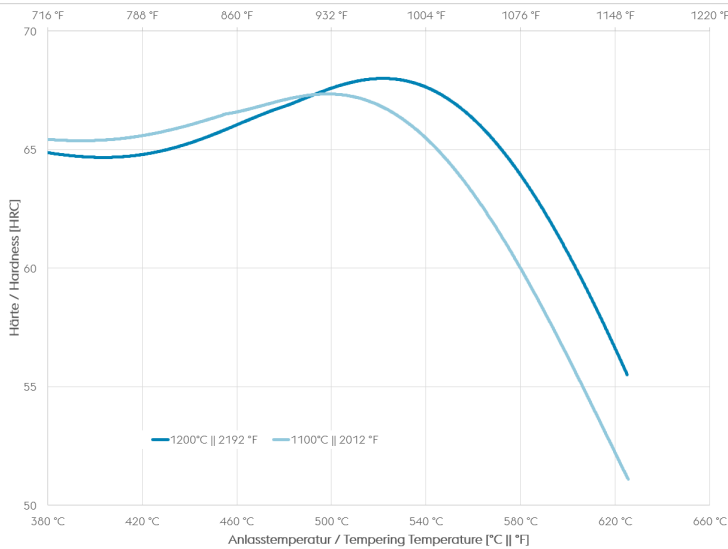
3....Jominy test: distance from quenched end

— watercooling

-- oilcooling

- - - aircooling

Tempering Chart



Holdingtime 3x2 hours
 Specimensize: square 25mm
 Austenitising in vacuum

Physical Properties

Temperature (°C)	20
Density (kg/dm ³)	8.1
Thermal conductivity (W/(m.K))	17
Specific heat (kJ/kg K)	0.42
Spec. electrical resistance (Ohm.mm ² /m)	0.61
Modulus of elasticity (10 ³ N/mm ²)	231

Thermal Expansions between 20°C | 68°F and ...

Temperature (°C)	100	200	300	400	500	600	700
Thermal expansion (10 ⁻⁶ m/(m.K))	10	10.5	10.8	11.2	11.3	11.4	11.6

If other available product variants are listed in addition to long products, please note that these may differ in terms of melting process, technical data, delivery and surface condition as well as available product dimensions. For mandatory technical specifications, other requirements and dimensions, please contact our regional voestalpine BÖHLER sales companies. 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. Measurement data are laboratory values and can deviate from practical analyses. The manufacture of our products does not involve the use of substances detrimental to health or to the ozone layer.

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