

BÖHLER UDDEHOLM

MATERIALIZING VISIONS

Bohler-Uddeholm P20 Modified

General

Bohler-Uddeholm P20 Modified is a Cr-Mo-alloyed steel which is supplied in the hardened and tempered condition. P20 Modified offers the following benefits:

- No hardening risks
- No hardening costs
- Time saving, e.g. no waiting for heat treatment
- Lower tool cost (e.g. no distortion to rectify)
- Modifications easily carried out
- Can be subsequently nitrided to increase surface wear resistance or locally flame hardened to reduce surface damage

P20 Modified is manufactured to consistently high quality standards, providing a steel with the following characteristics:

- Good polishing and texturing properties
- Good machinability
- Uniform hardness

Heavier sections are supplied premachined which offers the following advantages compared with unmachined material:

- Saving of weight
- Non-decarburized surface
- Exact nominal size (plus tolerance)
- Less machining
- Absence of scale minimizes machine and tool wear

Standard specification	AISI P20 modified
Delivery condition	Hardened and tempered to 285–340 HB*
Color code	Yellow/green

* Custom forged blocks can be supplied to specified hardness levels upon request.

This grade has been manufactured to our internal specifications, and audited to meet our guidelines.

Applications

- For large injection and compression molds
- Extrusion dies for thermoplastics
- Blow molds
- High strength holders, plates and bolsters
- Forming tools, press-brake dies (possibly flame hardened or nitrided)
- Aluminum die casting prototype dies
- Zinc die casting dies
- Long run die shoes
- Structural components, shafts

Properties

PHYSICAL DATA

Hardened and tempered to 310 HRC.

Temperature	68°F (20°C)	390°F (200°C)
Density lbs/in ³ kg/m ³	0.282 7,800	0.280 7,750
Modulus of elasticity psi N/mm ²	29.7 x 10 ⁶ 250,000	29.0 x 10 ⁶ 200,000
Coefficient of thermal expansion per °F from 68°F per °C from 20°C	– –	7.0 x 10 ⁻⁶ 12.7 x 10 ⁻⁶
Thermal conductivity Btu in/(ft ² h°F) W/m °C	202 29.0	205 29.5
Specific heat Btu/lb °F J/kg °C	0.11 460	– –

MECHANICAL PROPERTIES

Tensile strength

Approximate values. Hardness 300 HB

Testing temperature	68°F (20°C)	390°F (200°C)
Tensile strength R _m psi N/mm ²	147,900 1020	134,850 930
Yield strength R _{p0.2} psi N/mm ²	130,500 900	116,000 800
Compressive yield strength R _{c0.2} psi N/mm ²	123,250-145,000 850-1000	

Heat treatment

P20 Modified is intended for use in the hardened and tempered condition, i.e. the delivered condition. When, however, the steel is to be heat treated to a higher hardness or case hardened, the following instructions may be helpful.

SOFT ANNEALING

Protect the steel and heat through to 1330°F (720°C). Then cool in the furnace at 20°F (10°C) per hour to 1110°F (600°C), then freely in air.

STRESS RELIEVING

After rough machining the tool should be heated through to 1020°F (550°C), holding time 2 hours. Cool slowly to room temperature.

HARDENING

Note: The steel should be soft annealed before hardening. Preheating temperature: 930–1110°F (500–600°C). Austenitizing temperature: 1620°F (880°C). The steel should be heated through to the austenitizing temperature and held at temperature for 30 minutes. Protect the tool against decarburization and oxidation during the hardening process.

QUENCHING MEDIA

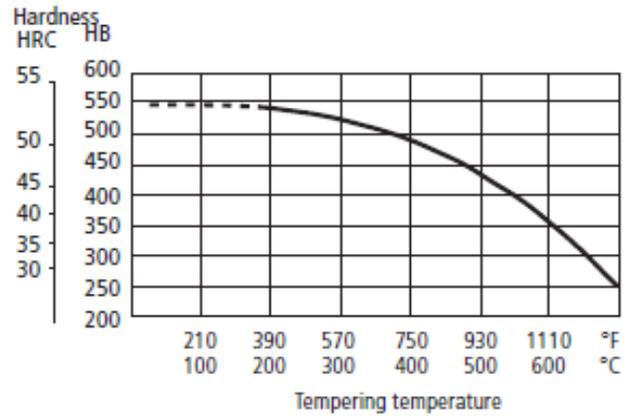
- High speed gas/circulating atmosphere. (Only suitable for small dimensions)
- Oil (Warm oil 150-175°F (65-80°C))
- Martempering bath 570°F (300°C), max. 4 minutes, then air cool

Note: Temper immediately when tool reaches 120–160°F (50–70°C).

TEMPERING GRAPH

Choose the tempering temperature according to the hardness required by reference to the tempering graph. Temper twice with intermediate cooling to room temperature. Lowest tempering temperature 360°F (180°C) for small inserts, but preferred minimum is 480°F (250°C), unless material is to be nitride or nitrocarburized later. Holding time at temperature minimum 2 hours.

The diagram is valid for small samples 0.6 x 0.6 x 1.6 inch. (15 x 15 x 40 mm) austenitized 30 min. at 1620°F (880°C), quenched in air and tempered 2 + 2 hours.



FLAME AND INDUCTION HARDENING

P20 Modified can be flame or induction hardened to a hardness of approx. 50 HRC. Cooling in air is preferable.

NITRIDING AND NITROCARBURIZING

Nitriding gives a hard surface which is very resistant to wear and erosion. A nitrided surface also increases the corrosion resistance.

For best result the following steps should be followed:

1. Rough machining
2. Stress tempering at 1020°F (550°C)
3. Grinding
4. Nitriding

Following surface hardness and nitriding depths will be achieved after nitriding.

	Nitriding temperature		Nitriding time	Surface Hardness	Depth of case, approx.	
	°F	°C			hours	HV
Gas-nitriding	980	525	20	650	0.012	0.30
	980	525	30	650	0.014	0.35
Ion-nitriding	900	480	24	700	0.012	0.30
	900	480	48	700	0.016	0.40
Nitro-carburizing	1,060	570	2	700	0.004	0.10

Machining

The cutting data below, valid for Bohler-Uddeholm P20 in soft annealed condition, are to be considered as guiding values which must be adapted to existing local conditions.

TURNING

Cutting data parameters	Turning with carbide		Turning with high speed steel
	Rough turning	Fine turning	Fine turning
Cutting speed (v_c) f.p.m. m/min	394-558 120-170	558-722 170-220	49-66 15-20
Feed (f) i.p.r. mm/r	0.008-0.016 0.2-0.4	0.002-0.008 0.05-0.2	0.002-0.012 0.05-0.3
Depth of cut (a_p) inch mm	0.08-0.16 2-4	0.02-0.08 0.5-2	0.02-0.08 0.5-2
Carbide designation US ISO	C6 P20-P30 Coated carbide	C7 P10 Coated carbide or cermet	– –

MILLING

Face and square shoulder milling

Cutting data parameters	Milling with carbide	
	Rough milling	Fine milling
Cutting speed (v_c) f.p.m. m/min	265-492 80-150	492-623 150-190
Feed (f_z) inch/tooth mm/tooth	0.008-0.016 0.2-0.4	0.004-0.008 0.1-0.2
Depth of cut (a_p) inch mm	0.08-0.16 2-4	-0.08 -2
Carbide designation US ISO	C6-C5 P20-P40 Coated carbide	C7-C6 P10-P20 Coated carbide or cermet

End milling

Cutting data parameters	Type of milling		
	Solid carbide	Carbide indexable insert	High speed steel
Cutting speed (v_c) f.p.m. m/min	230-361 70-110	262-394 80-120	49-66 ¹⁾ 15-20 ¹⁾
Feed (f_z) inch/tooth mm/tooth	0.001-0.008 ²⁾ 0.03-0.20 ²⁾	0.003-0.008 ²⁾ 0.08-0.20 ²⁾	0.002-0.014 ²⁾ 0.05-0.35 ²⁾
Carbide designation US ISO	– –	C6-C5 P20-P40	– –

1)For coated HSS end mill v_c 115-131 f.p.m. (35-40 m/min.)

2)Depending on radial depth of cut and cutter diameter.

DRILLING

High speed steel twist drill

Drill diameter		Cutting speed (v_c)		Feed (f)	
inch	mm	f.p.m.	m/min	i.p.r.	mm/r
-3/16	-5	46-52	14-16*	0.003-0.008	0.08-0.15
3/16-3/8	5-10	46-52	14-16*	0.006-0.010	0.15-0.25
3/8-5/8	10-15	46-52	14-16*	0.010-0.012	0.25-0.30
5/8-3/4	15-20	46-52	14-16*	0.012-0.014	0.30-0.35

*)For coated HSS drill $v_c=79-85$ f.p.m. (24-26 m/min.)

Carbide drill

Cutting data parameters	Type of drill		
	Indexable insert	Solid carbide	Carbide tip ¹⁾
Cutting speed (v_c) f.p.m. m/min	600-656 180-200	394-492 120-150	197-262 60-80
Feed (f) i.p.r. mm/r	0.002-0.01 ²⁾ 0.05-0.25 ²⁾	0.004-0.01 ³⁾ 0.10-0.25 ³⁾	0.006-0.01 ⁴⁾ 0.15-0.25 ⁴⁾

1) Drill with replaceable or brazed carbide tip

2) Feed rate for drill diameter 0.8"–1.6" (20–40 mm)

3) Feed rate for drill diameter 0.2"–0.8" (5–20 mm)

4) Feed rate for drill diameter 0.4"–0.8" (10–20 mm)

GRINDING

A general grinding wheel recommendation is given below

Type of grinding	Wheel recommendation
Face grinding straight wheel	A 46 HV
Face grinding segments	A 24 GV
Cylindrical grinding	A 60LV
Internal grinding	A 46 JV
Profile grinding	A 100 KV

Electrical-discharge machining–EDM

If spark-erosion, EDM, is performed in the as-delivered condition, the tool should then be given a temper at approx. 1020°F (550°C). If the steel has been rehardened, the additional tempering temperature should be 50°F (25°C) below the lowest tempering temperature used.

Welding

Good results when welding tool steel can be achieved if proper precautions are taken during welding (elevated working temperature, joint preparation, choice of consumables and welding procedure). If the tool is to be polished or textured, it is necessary to work with an electrode type of matching composition.

Welding method	TIG	MMA (SMAW)
Working temp.	390-480°F (200-250°C)	390-480°F (200-250°C)
Consumables	P20 Grade IMPAX TIG-WELD	P20 Grade IMPAX WELD
Hardness after welding	320-350 HB	320-350 HB

Hard – chromium - plating

After hard chrome-plating, the tool should be tempered for approx. 4 hours at 350°F (180°C), within 4 hours of plating in order to avoid hydrogen embrittlement.

Texturing

P20 Modified is particularly suitable for texturing by the photo-etching process. Its very low sulfur content ensures accurate and consistent pattern reproduction. For heavy sections an extra tempering at 1020°F (550°C) before texturing is recommended.

Polishing

P20 Modified has good polishability in the hardened and tempered condition. After grinding, polishing is undertaken with aluminum oxide or diamond paste.

Note: Each steel grade has an optimum polishing time which largely depends on hardness and polishing technique. Overpolishing can lead to a poor surface finish (e.g. an “orange peel” effect).

BOHLER-UDDEHOLM CORPORATION

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