

Premium P20 Modified

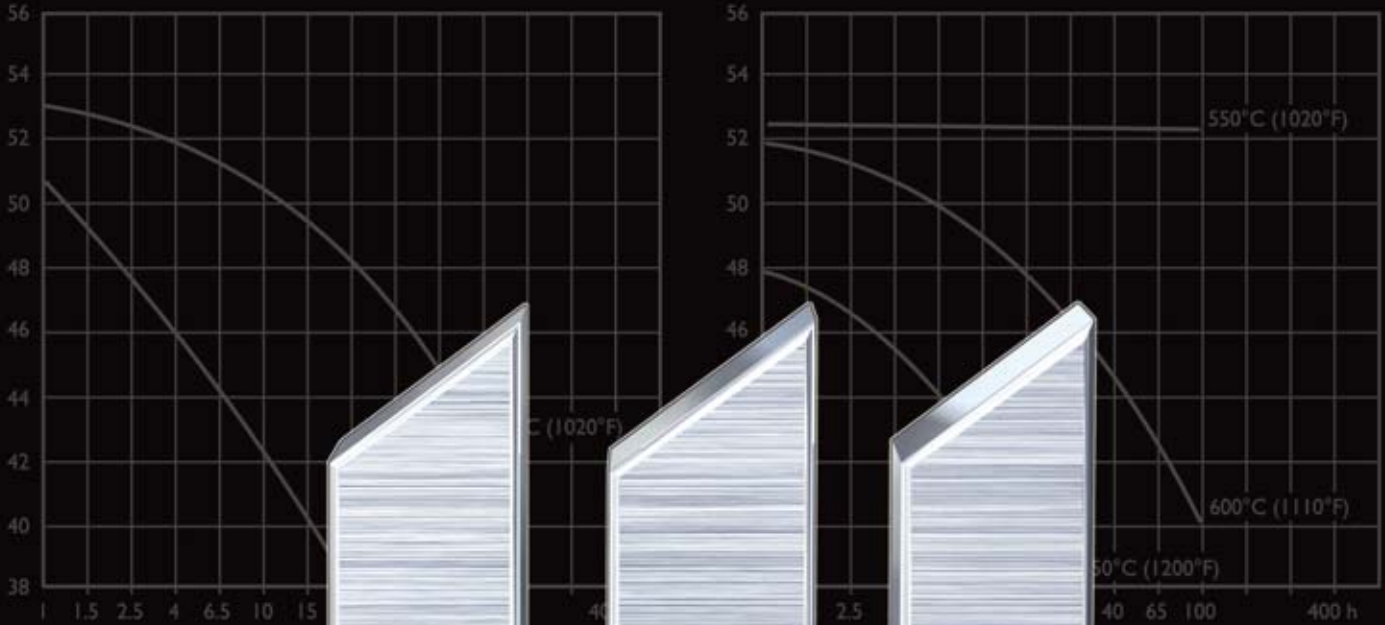
Prehardened mold steel

COLD WORK

PLASTIC MOULDING

HOT WORK

HIGH PERFORMANCE STEEL



Typical analysis %	C 2,05	Cr 5	Mn 0,8	Cr 4,5	W 0,2
Standard specification	AISI D6, ()			D3 (W.Nr. 1.2796)	
Delivery condition	Soft annealed			to approx. 200 HB	
Colour code	Red			our co	

Temperature	20°C (68°F)	200°C (390°F)	400°C (750°F)
Density kg/m ³ lbs/m ³	7 770 0,281	7 700 0,277	7 650 0,275
Modulus of elasticity N/mm ² psi	194 000 28,1 × 10 ⁴	188 000 27,3 × 10 ⁴	173 000 25,1 × 10 ⁴
Coefficient of thermal expansion per °C from 20°C per °F from 68°F	to 100°C 11,7 × 10 ⁻⁶ to 212°F 6,5 × 10 ⁻⁶	to 200°C 12 × 10 ⁻⁶ to 400°F 6,7 × 10 ⁻⁶	to 400°C 13,0 × 10 ⁻⁶ to 750°F 7,3 × 10 ⁻⁶
Thermal conductivity W/m °C Btu in (ft ² h°F)	-	27 187	32 221
Specific heat K/kg °C Btu/lbs °F	455 0,109	525 0,126	608 0,145
Thermal conductivity W/m °C Btu in (ft ² h°F)	-	20,5 142	21,5 149
Specific heat K/kg °C Btu/lbs °F	-	460 0,110	-

This information is based on our present state of knowledge and is intended to provide general notes on our products and their uses. It should not therefore be construed as a warranty of specific properties of the products described or a warranty for fitness for a particular purpose.

General

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, giving 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 spec.	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 by customers.



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 HB.

Temperature	68°F (20°C)	390°F (200°C)
Density, lbs/in ³ kg/m ³	0.282 7,800	0.280 7,750
Coefficient of thermal expansion per °F from 68°F per °C from 20°	– –	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
Modulus of elasticity psi N/mm ²	29.7 x 10 ⁶ 205,000	29.0 x 10 ⁶ 200,000
Specific heat capacity Btu/lb °F J/kg °C	0.110 460	– –

MECHANICAL PROPERTIES

Tensile strength

Approximate values. Hardness 300 HB.

Testing temperature	68°F (20°C)
Tensile strength R _m psi N/mm ²	138,000–160,000 950–1,100
Yield strength R _{p0.2} psi N/mm ²	≥101,000 ≥700
Elongation, A	≥12

Heat treatment

P20 Modified is intended for use in the hardened and tempered condition, i.e. the delivery 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 50°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 fully 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

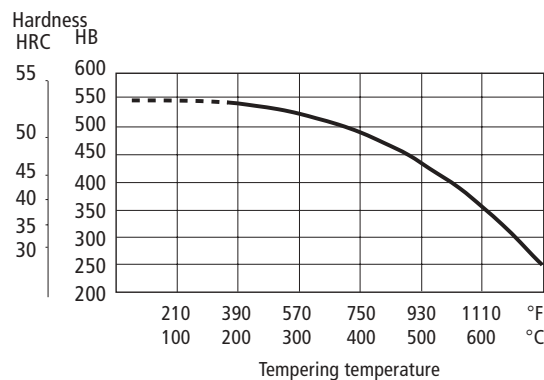
- High speed gas/circulating atmosphere. (Only suitable for small dimensions)
- Oil
- Martempering bath 570°F (300°C), max. 4 minutes, then air

Note: Temper immediately 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). 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. Further information can be obtained from the Uddeholm Technical Services Report “Flame hardening of Impax Supreme”.

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.

	Temperature		Time h	Surface hardness (HV)	Depth of case approx	
	°F	°C			in	mm
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
Nitrocarburizing	1060	570	2	700	0.004	0.10

Machining recommendations

The cutting data below are to be considered as guiding values which must be adapted to existing local conditions. More information can be found in our "Cutting data recommendations".

TURNING

Cutting data parameters	Turning with carbide		Turning with high speed steel Fine turning
	Rough 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	0,02–0,12 0,5–3
Carbide designation, US ISO	C6 P20–P30 Coated carbide	C7 P10 Coated carbide or Cermet	– –

MILLING

Face and square shoulder face 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	Milling cutter		
	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*	0,003–0,006	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	Brazed carbide 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 ²⁾ 0,10–0,25 ²⁾	0,006–0,01 ²⁾ 0,15–0,25 ²⁾

¹⁾ Drill with internal cooling channels and brazed carbide tip

²⁾ Depending on drill diameter

GRINDING

A general grinding wheel recommendation is given below. More information can be found in the Uddeholm brochure "Grinding of Tool Steel".

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

Electrical-discharge machining

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

Further information can be obtained from the Uddeholm brochure "EDM of tool steel".

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	P20 Grade
Hardness after welding	320–350 HB	320–350 HB

Further information is given in the Uddeholm brochure "Welding of Tool Steel".



Large mold to produce laundry-baskets. Suitable grade for this molding tool is Premium P20 Modified.

Hard-chromium-plating

After hardchrome-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). Further information is given in the Uddeholm publication "Polishing of mold steel".

Further information

Contact your Bohler-Uddeholm office for further information on the selection, heat treatment, application and availability of Bohler-Uddeholm tool steels.

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