EDRO #3

Prehardened Mold Quality P20

color code: orange

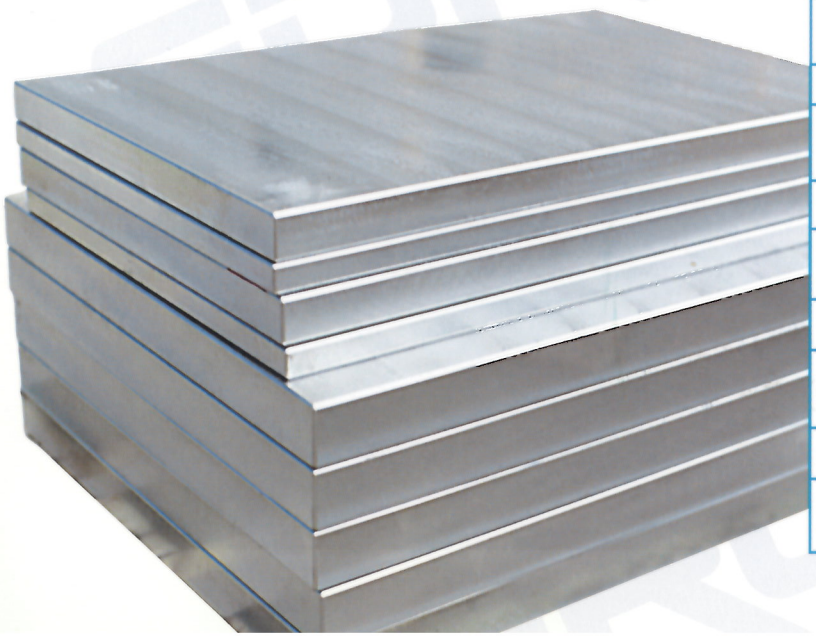
General

EDRO #3™ is a vacuum-degassed, ladle refined, Cr-Ni-Mo-alloyed steel which is supplied in the hardened and tempered condition, offering 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; only one polishing sequence)
- Modifications easily carried out
- Can be subsequently nitrided to increase surface wear resistance or locally flame-hardened to reduce surface damage.

EDRO #3™ is manufactured to consistently high quality standards with a very low inclusion content, giving a steel with the following characteristics:

- Excellent polishing and photo-etching properties
- Good machinability
- High purity and good homogeneity
- Uniform hardness in all dimensions



Applications

- Injection molds for thermo-plastics
- Extrusion dies for thermo-plastics
- Blow molds
- Forming tools, press-brake dies
- (possibly flamehardened or nitrided)
- Structural components, shafts

Approximate Analysis %	C 0.31	Si 0.40	Mn 0.75	Cr 1.2	Ni 0.8	Mo 0.41	S 0.008
Specification	AISI P20 Improved (W.-Nr. 1.2710)						
Delivery condition	Hardened and tempered to 277–332 HB						
Color code	Orange						

PROPERTIES

PHYSICAL DATA

Hardened and tempered to 310 HB. Data at room and elevated temperatures.

Temperature	68°F (20°C)	390°F (200°C)	750°F (400°C)
Density lbs/in^3 kg/m^3	0.282 7800	0.280 7750	0.277 7700
Coefficient of thermal expansion			
per °F from 68° per °C from 20°	— —	7.0 x 10^{-6} 12.7 x 10^{-6}	7.5 x 10^{-6} 13.6 x 10^{-6}
Thermal conductivity			
Btu in/ft^{2}h°F J/m s °C	202 29.0	205 29.5	216 31.0
Modulus of elasticity			
psi N/mm^2	29.7 x 10^6 205 000	29.0 x 10^6 200 000	26.8 x 10^6 185 000
Specific heat			
Btu /lb°F J/kg °C	0.110 460	— —	— —

Mechanical properties

TENSILE STRENGTH

Approx. values. Samples were taken from a round bar 1" (25 mm) diameter. Hardness: 310 HB.

Testing temperature	68°F (20°C)	390°F (200°C)	750°F (400°C)
Tensile Strength psi N/mm^2	146,000 1010	138000 950	115000 790
Yield Strength psi N/mm^2	116,000 800	109000 750	91000 630
Reduction of Area	60%	63%	65%
Elongation in 2"	20%	22%	25%

IMPACT STRENGTH

Approx. values. Samples taken from a round bar 1" (25 mm). Hardness: 310 HB.

Testing temperature	68°F (20°C)	390°F (200°C)	750°F (400°C)
Joules	50	55	65
Ft-lbs.	37	41	48

Heat Treatment

EDRO #3™ is intended for use in the hardened and tempered condition, i.e. the delivery condition.

When 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 1300°F (700°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 930F (500°C), then freely in air.

Hardening

The steel should be fully soft annealed before hardening.
Pre-heating temperature:
930–1110°F (500–600°C).
Austenitizing temperature:
1560°F (850°C).
The steel should be heated through to the austenitizing temperature and held at temperature for 30 minutes.

Protection against decarburization

Protect the tool against decarburization and oxidation during the hardening process.

Quenching media

- Oil
- Martempering bath 570°F (300°C), max. 4 minutes, then air.

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

TEMPERING

Temperature °F	Temperature °C	Holding time hours	Hardness
355	180	2	52 HRC
390	200	2	52 HRC
570	300	2	49 HRC
750	400	2	47 HRC
930	500	2	45 HRC
1110	600	2	39 HRC
1200	650	2	36 HRC

Surface Hardening

EDRO #3™ can be flame or induction hardened to a hardness of approximately 50 HRC. Cooling in air is preferable. Smaller pieces may require forced cooling. hardening should be immediately followed by tempering.

Case Hardening

Before case hardening is carried out, the steel should be soft annealed.

Carburizing

Temperature 1560–1720°F (850–940°C). Time and temperature are to be adjusted depending on the depth of case required. A mild carburizer should be used.

Normalizing

If the carburizing temperature has been above 1610°F (880°C) and the carburizing time more than 2 hours, normalizing should be performed in order to regain the fine-grained structure.

Hardening

Hardening is performed as previously described. The following surface hardnesses are normally obtained after tempering.

Tempering temperature °F	°C	Holding time hours	Hardness HRC
355	180	2	60
390	200	2	59
570	300	2	55

Note: if the carburizing temperature has been less than 1610°F (880°C) or in cases where a fine grained structure with good mechanical properties is not of paramount importance, direct hardening may be carried out. After carburizing, the tool is furnace-cooled to 1490°F (830°C), and when the tool has reached this temperature, quench in oil, then temper.

Nitriding

Nitriding gives a hard surface which is very resistant to wear and erosion. A nitrided surface also increases the corrosion resistance. The surface hardness after nitriding at a temperature of 980°F (525°C) in ammonia gas will be approx. 650 HV.

Nitriding temperature °F	°C	Nitriding time hours	Depth of case approx. in.	mm
980	525	20	0.012	0.30
980	525	30	0.014	0.35
980	525	60	0.020	0.50

Tufftriding (Tenifer process)

Tufftriding at 1025°F (570°C) will give a surface hardness of approx. 700 HV. After 2 hours treatment, the hard layer will be approx. 0.0004 in., (0.01 mm.)

Hard-chromium-plating

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

Machining

MILLING		
Carbide tools and high speed steel tools	Rough milling	Finish milling
Depth of cut (t) in. mm	min. 0.08 min. 2	max. 0.08 max. 2
Feed (s) in./tooth mm/tooth	min. 0.008 min. 0.2	max. 0.008 max. 0.2
	Carbide tools	
ISO machining group Cutting speed (v) f.p.m. m/min	P30–P40 180–280 55–85	P10–P20 230–330 75–95
	High speed steel tools	
Cutting speed (v) f.p.m. m/min	30–70 10–20	50–100 15–30

DRILLING

Diam-eter in./mm	Depth of Hole 2 x D	6 x D rpm/feed (rev./mm/in.)	8 x D	10 x D
0.157/4	1430 / .003 .08	1435 / .003 .06	1090 / .002 .05	990 / .002 .04
0.315/8	900 / .006 .14	750 / .004 .11	680 / .003 .08	620 / .003 .07
0.630/16	475 / .010 .25	395 / .009 .19	365 / .006 .15	330 / .005 .012
0.984/25	310 / .012 .29	260 / .009 .22	235 / .007 .17	215 / .006 .15

Chip removal is recommended when depth of hole is 4 x D. Flush cooling should be used.

Electrical-discharge Machining

(EDM, "spark machining")

If spark-erosion is performed in the hardened and tempered condition, the tool should then be given an additional temper at 930°F (500°C).

Welding

Welding of tool steel should generally be avoided, due to the risk of cracking. Where repair welding is necessary, however, it is essential to pre-heat the part concerned prior to welding. Immediately after the welding operation:

1. Stress-relieve material that has been welded in the soft annealed state.
2. Temper material twice that has been welded in the hardened and tempered condition.

Grinding

Correct grinding technique will avoid grinding cracks and improve tool life. Tools that have been tempered at low temperatures are especially sensitive during grinding. Only properly dressed, soft, open-grained grinding wheels should be used. Restrict the peripheral speed and use plenty of coolant. More detailed instructions can be obtained from the grinding wheel manufacturer.

Polishing

EDRO #3™ has excellent polishability in the hardened and tempered condition. After grinding, polishing is undertaken with aluminum oxide or diamond paste.

Typical procedure:

1. Grind to .002 in. (0.05 mm) from finished size.
2. Polish with diamond paste grade 45, to obtain a dull, even surface.
3. Polish with diamond paste grade 15.
4. Polish with diamond paste grade 3, or grade 1 for particularly high demands on surface finish.

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

Photo-etching

EDRO #3™ is particularly suitable for texturing by the photo-etching process. Its very low sulphur content ensures extremely accurate and consistent pattern reproduction.

Edro will be pleased to provide additional information on our full line of quality mold steels, machining capabilities, and special mold bases.

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