钢铁之家

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Global Steel Grade Encyclopedia

涵盖的行业或国家与地区类别

ASTM	GJB	SAE	EU	AISI	DIN	AMS	ISO	JASO
国材料与试验协会	国家军用标准	动力机械工程师协会	前欧洲标准化	美国钢铁学会	德国工业标准	空航天材料规范	国际标准	日本汽车标准组织
EN	JB	UNS	UNI	ASME	SS	GB	JIS	
欧洲标准	国机械行业标准	统一编号系统	意大利标准	美国机械工程师协会	瑞典标准	国家标准	日本工业标准	

DATA SHEET

FX-XTRA®

~AISI N/A - ~W.Nr. 1.2714 Mod

HOT WORK TOOL STEEL

TYPICAL APPLICATIONS

- Hammer Dies & Rams
- Press Dies and Coining Dies
- Sow Blocks and Knockout Pins
- Punches and Inserts
- Headers and Insert Die Holders
- Gear Applications

GENERAL:

Delivery Condition:

Hardened and tempered

Hardness Range:

Finkl Std.	BHN	HRC
XH	495-534	51-54
H	444-477	47-50
T1	401-429	43-46
T2	352-388	38-42
T3	311-341	33-37
T4	277-302	29-32
Annealed	229 approx	20 approx.

FX-XTRA®, also known as **FX®**, is a Ni-Cr-Mo steel offered in a wide range of heat treated conditions for versatile service in the forging industry.

The most popular, **FX®** Temper 2 (38-42 HRC) is a remarkably strong die steel with balanced wear and fracture toughness characteristics.

The more ductile, **FX®** Temper 3 (33-37 HRC) is for die blocks, rams, shafts, die holders, v-guides, sow blocks and other general industrial uses favoring fracture toughness over abrasion demands.

Higher hardness **FX®** Temper 1 (43-46 HRC) or Temper H (47-50 HRC) is for applications where higher die temperatures and cavity pressures, or wear-prone components demand more abrasion resistance.

Typical Chemical Analysis* - % weight

C	Mn	Si	Ni	Cr	Mo	V
0.50	0.85	0.25	0.90	1.15	0.50	0.07

*Covered under one or more of the following U.S. Patents: 5,496,516; 5,827,376; 6,398,885

FX-XTRA® is quenched in water. Best properties in steel are produced with the highest achievable quench severity.

FX-XTRA® is characterized by:

- Good Temper Resistance
- High Toughness
- Good Wear Resistance
- Through-hardenability up to 20" thick. For larger dies, we recommend grade DURODI® or hardening and tempering after contour roughing in the annealed condition.

Machinability

Machinability at all hardness levels is enhanced through patented micro-alloying additions, but where maximum machinability is desired, a fully annealed condition (approximately 229 HB) is available.

Note: Provided technical data and information in this data sheet are typical values. Normal variations in chemistry, size and conditions of heat treatment may cause deviations from these values. We suggest that information be verified at time of enquiry or order. For additional data or metallurgical assistance, please contact us.

DATA SHEET

HOT WORK TOOL STEEL

FX-XTRA®

FX® TENSILE PROPERTIES

1" Laboratory Test Bars, Longitudinal Capability Testing

Tested Block Hardness Category	Test Temperature		Tensile Strength		Yield Strength		Elongation in 2"	Reduction Area .505"
	°F	°C	ksi	MPa	ksi	MPa	%	%
Temper H 444-477 BHN	80	27	218	1503	202	1393	12.5	41
	300	149	207	1428	178	1228	12.0	39
	600	316	196	1352	160	1103	15.0	38
	800	427	165	1138	142	979	16.0	55
Temper 1 401-429 BHN	80	27	205	1414	187	1290	12.7	34
	300	149	196	1352	166	1145	12.5	35
	600	316	183	1262	150	1034	13.0	36
	800	427	156	1076	133	917	15.2	55
	900	482	137	945	123	848	17.0	61
	1000	538	109	752	95	655	24.0	66
Temper 2 352-388 BHN	80	27	174	1200	146	1007	15.5	50
	300	149	157	1083	128	883	15.8	48
	600	316	147	1014	119	821	17.2	47
	700	371	144	993	113	779	16.5	56
	800	427	130	897	105	724	18.2	64
	900	482	113	779	97	669	20.5	71
	1000	538	94	648	78	538	23.8	78
	1100	593	52	359	39	269	22.8	64
Temper 3 311-341 BHN	80	27	151	1041	130	897	18.2	50
	300	149	140	966	112	772	17.5	49
	400	204	136	938	102	703	19.0	48
	500	260	136	938	103	710	22.0	43
	600	316	134	924	95	655	21.8	49
	700	371	121	834	89	614	22.0	55
	800	427	108	745	82	566	24.2	63
	900	482	93	641	78	538	28.0	75
	1000	538	75	517	67	462	36.8	84
	1100	593	55	379	46	317	54.0	86

Mechanical Properties for Commercial-Sized Die Blocks

Mechanical properties developed from laboratory-sized test bars, as in the above table, are useful for comparing properties to other grades of steel from similar-sized test bars. Full-sized blocks, however, experience a "mass-effect" during the quenching process that reduces the effectiveness of the quench. The extent of the hardness and strength loss is determined by the cross-section size and test depth below the quench surface. Properties of full-sized blocks should be viewed with this factor taken into account.

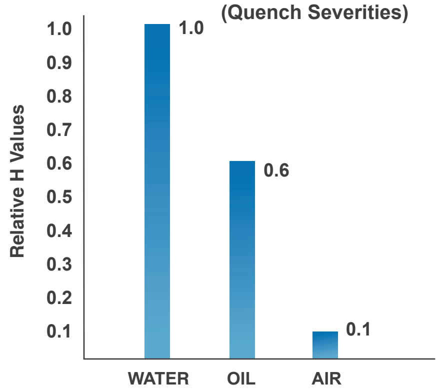
The Water Quench Advantage

Quench Severity

Employing a *Cold Water Quench* rather than a less effective oil or polymer quench achieves the highest possible H-value (Heat extraction rate during the quench) and the best possible microstructure and hardness throughout a cross-section.

Relative H-Values

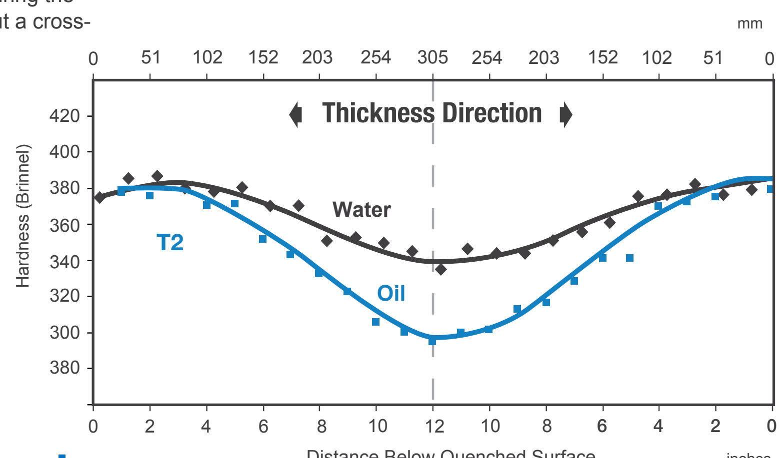
(Quench Severities)



Hardness Profile Comparison

Water versus Oil Quench

24" x 48" (610 x 1220 mm) Quenched Cross-Sections



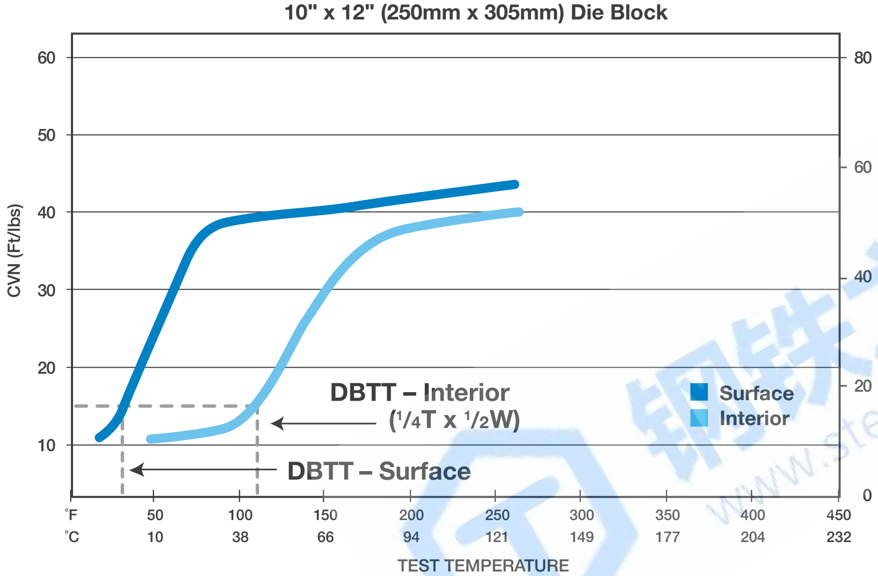
DATA SHEET

HOT WORK TOOL STEEL
FX-XTRA®

Impact Toughness—Ductile-Brittle Transition Temperature (DBTT)

The DBTT is common to all die steels, and is the temperature where the fracture characteristics transition from a brittle, crack-prone condition to a more ductile, crack-resistant condition. The DBTT is influenced by the chemistry, hardness and microstructure of the steel. Therefore, the DBTT may differ between surface and interior locations of die blocks. Heating beyond the DBTT offers a rapid improvement to impact toughness until the "Upper Energy Shelf" is reached.

FX® Temper 2
10" x 12" (250mm x 305mm) Die Block



Die Preheating

The DBTT for a die block is influenced by the hardness and microstructure. For this reason, the minimum recommended die preheating temperatures change with block thickness and hardness according to the provided table.

Selective Shank Tempering

For high hardness die blocks (T1, TH, TXH) selective tempering is available to reduce hardness only on the shank side by approximately one Finkl "Temper Range", or about four Rockwell points. The modified shank hardness gradually transitions to the base hardness at approximately three-inches below the shank surface. This option improves machinability and fracture toughness in the critical shank area.

Recommended FX® Die Steel Minimum Preheating Temperatures ˚F

Die Block (Thickness)

Increased Wear Resistance / Increased Fracture Sensitivity ↑	DIE HARDNESS	inches / mm: 5 / 127	10 / 254	15 / 381	20 / 508
	XH	300	350	NA	NA
	H	250	300	350	350
	1	200	250	300	300
	2	70	150	200	200
	3	70	70	200	200
	4	70	70	70	200

Conversion:

˚F	70	150	200	250	300	350
˚C	20	65	95	120	150	175

Physical Properties

Test Temperature	20˚C/68˚F	200˚C/390˚F	400˚C/750˚F
Density	7800 Kg/m³	7750	7700
	0.282 lbs/in³	0.280	0.277
Coefficient of Thermal Expansion	11.9x10⁻⁶ cm/cm/˚C	12.7x10⁻⁶	13.6x10⁻⁶
	6.6x10⁻⁶ in/in/˚F	7.0x10⁻⁶	7.5x10⁻⁶
Thermal Conductivity	29.0 J/m²/m/s/˚C	29.5	31.0
	202 BTU/ft²/in/hr/˚F	205	216
Modulus of Elasticity	205x10³ N/mm²	200x10³	185x10³
	29.7x10⁶ lbs/in²	29.0x10⁶	26.8x10⁶
Specific Heat	460 J/Kg ˚C	492	538
	0.110 BTU/lb ˚F	0.118	0.129
Poisson's Ratio	0.3	0.3	0.3

DATA SHEET

HOT WORK TOOL STEEL
FX-XTRA®

Heat Treating FX-XTRA®

Sub-Critical Anneal
Softening may be achieved through *Sub-Critical Annealing* by holding at 1220˚F (660˚C) for an extended period, typically 1.5 hrs/inches (1.5 hrs/25 mm). Expected hardness is approximately 248 BHN maximum.

Full Anneal
Softening with additional refinement to the microstructure may be achieved through a Full Anneal:

– Heat to 1440/1460˚F (780/800˚C) and Hold 1/2 hr./inch (25mm)
– Drop to 1220˚F (660 ˚C) and Hold 4 hrs.
– Furnace Cool to 800˚F (425˚C)
– Air Cool to ambient temperature

Expected hardness is approximately 229 BHN

Tempering
Lower hardness may be achieved by heating above the tempering temperature used to establish the existing hardness of the die block. Nominal tempering temperatures employed to establish the standard hardness ranges are:

Tempering Table

Nominal Tempering Temperatures for Water-Quenched Forgings

Temperature	Finkl Std.	BHN	HRC
450˚F (232˚C)	XH	495-534	51-54
880˚F (471˚C)	H	444-477	47-50
1020˚F (549˚C)	T1	401-429	43-46
1120˚F (604˚C)	T2	352-388	38-42
1180˚F (638˚C)	T3	311-341	33-37
1220˚F (660˚C)	T4	277-30	29-32

Welding
Your selection of welding rod should be discussed with a welding rod supplier. Beyond the choice of welding rod, there are many variables affecting the success of a weld. One common cause of failure is an embrittled Heat Affected Zone (HAZ). To minimize the risk of this type of failure, a preheating and post-heating procedure should be employed:

– Preheat: 800ȩF (425ȩC)
– Maintain minimum of 400ȩF (200ȩC) during welding
– Post-heat/Stress Relieving: To avoid softening of the base hardness, heat to a temperature that is 50 ȩF (30 ȩC) below the tempering temperature used to establish the base hardness (see Tempering Table above).

Hardening
Increasing the hardness requires heating to an austenitizing temperature followed by a quenching operation. Some oxidation/decarburization will occur on the block surface unless heating is performed in a vacuum or protective atmosphere furnace. Quenching is a high stress operation introducing a risk of cracking, particularly for a machined block with contours, sharp edges, drilled holes or thin-web features. For such product, employing a quenchant with a lower quench-severity rating will lower the risk of cracking.

– Heat to 1550/1600˚F (840/870˚C) and Hold 1/2 hr./ inch (25mm)
– Drop to 1450˚F (790 ˚C) and Hold 2 hrs.
– Quench (Oil, Polymer or Molten salt bath)
– Immediately temper according to the Tempering Table to the left.