钢铁之家
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全球钢号百科!

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

WF-XTRA®

AISI N/A - W.Nr. N/A - ~35CrMoV11-10

HOT WORK TOOL STEEL

TYPICAL APPLICATIONS

- Hammer Dies
- Press Dies
- Insert Dies
- Punches
- Extrusion Dies
- Headers
- Casting Dies

GENERAL:

Delivery Condition:

Hardened and tempered

Hardness Range:

Finkl Std.	BHN	HRC
H	444-477	47-50
T1	401-429	43-46
T2	352-388	38-42
T3	311-341	33-37
Annealed	229 approx	20 approx.

WF-XTRA® also known as **WF®**, is a special NiCrMoV steel offered in a wide range of heat treated conditions for versatile service in the forging industry.

WF-XTRA® is designed for strengthening from higher alloy content. This allows standard die hardness to be achieved with a lower Carbon level for improved fracture toughness and greater heat-checking resistance.

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.

Typical Chemical Analysis* - % weight

C	Mn	Si	Ni	Cr	Mo	V
0.37	0.65	0.45	0.80	2.50	1.00	0.10

*Covered under one or more of the following U.S. Patents: 5,110,379; 5,180,444; 5,827,376; 6,398,885

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

WF-XTRA® is characterized by :

- Great Fracture Toughness
- Improved Heat-Checking Resistance
- High Wear resistance
- Good Temper Resistance

Wear Resistance

Increased levels of strong carbide-forming alloys Chromium, Molybdenum and Vanadium provide a higher concentration of hard carbide particles for enhanced wear resistance.

Temper Resistance

Higher levels of Chromium, Molybdenum and Vanadium precipitate carbides at elevated temperatures to help counteract the loss of surface hardness normally experienced from contact with hot forging stock.

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

WF-XTRA®

WF® 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	235	1621	210	1448	11.5	39
	300	149	225	1552	199	1372	12.5	39
	600	316	210	1448	186	1283	12.0	35
	800	427	185	1276	160	1103	16.0	42
	1000	538	140	966	125	862	18.5	59
Temper 1 401-429 BHN	80	27	210	1448	188	1297	12.5	35
	300	149	200	1379	176	1214	13.0	35
	600	316	188	1297	163	1124	13.5	37
	800	427	160	1103	135	931	15.8	47
	900	482	145	1000	125	862	18.0	62
	1000	538	117	807	97	669	23.5	65
Temper 2 352-388 BHN	80	27	180	1241	156	1076	13.5	41
	300	149	174	1200	148	1021	13.5	46
	600	316	163	1124	136	938	13.0	38
	700	371	157	1083	130	897	14.5	49
	800	427	147	1014	122	841	18.0	62
	900	482	139	959	115	793	20.0	71
	1000	538	118	814	100	690	22.0	76
	1100	593	92	634	74	510	25.5	79

Mechanical Properties for Commercial-Sized Die Blocks

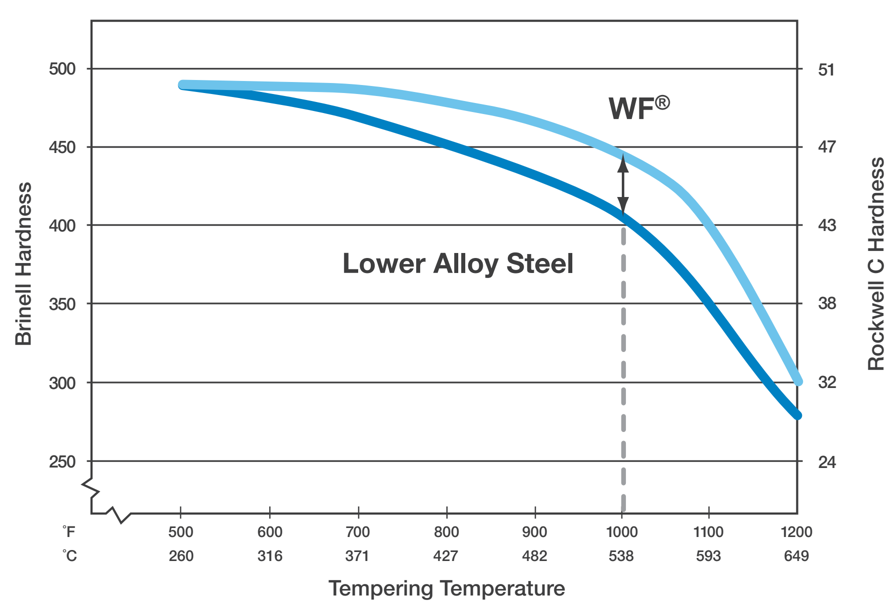
Mechanical properties developed from laboratory-sized test bars, as in the above table, are useful for comparing properties to other grades of steel from similar-sized test bars. Full-sized blocks, however, experience a "mass-effect" during the quenching process that reduces the effectiveness of the 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.

Temper Resistance

Repetitive exposure of a die to hot forging stock can lower the surface hardness in a die impression through a cumulative tempering effect. Such hardness loss accelerates wear and reduces die life.

The alloy composition of WF® provides improved temper resistance for better hardness retention and extended die life.

TEMPERING CURVE COMPARISON

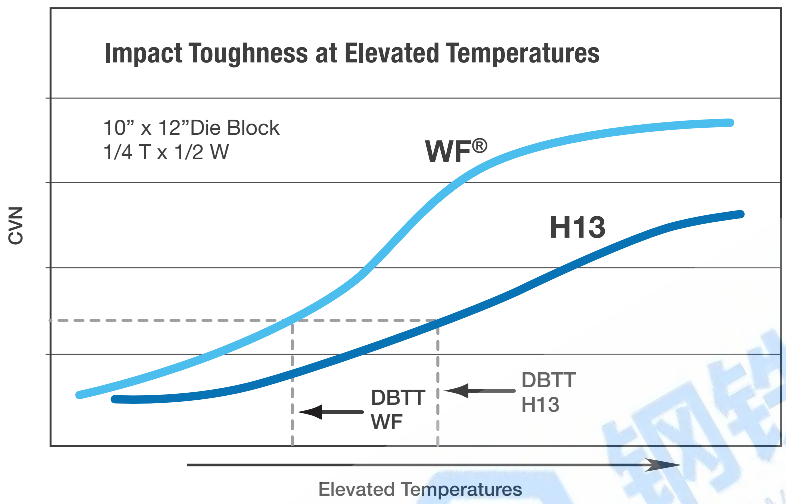


DATA SHEET

HOT WORK TOOL STEEL
WF-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.



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.

Recommended Minimum WF® Die Preheating Temperatures (˚F)

Die Block Thickness

Increased Wear Resistance / Increased Fracture Sensitivity

DIE HARDNESS				
inches	5	10	15	20
mm	127	254	381	508
H	325	375	425	425
T1	275	325	375	375
T2	145	225	275	275
T3	145	145	275	275

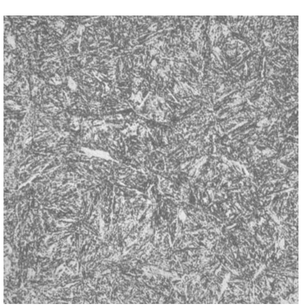
Conversion:

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

Microstructure

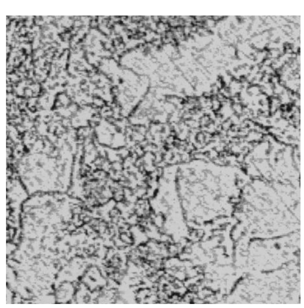
WF-XTRA® avoids formation of Crack-Prone, Grain-Boundary Carbide Networks

The balanced chemistry of WF-XTRA offers enhanced heat and wear resistance without the tendency to form embrittling, grain-boundary carbide networks characteristic of H13.



500X, 5% Nital

WF-XTRA® typical water quenched microstructure is characterized by uniform carbide distribution that promotes good fracture toughness



500X, 5% Nital

H13 typical gas quenched microstructure at interior of large cross-section contains brittle, crack-prone carbide networks

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	11.9×10^{-6} cm/cm/˚C	12.7×10^{-6}	13.6×10^{-6}
	6.6×10^{-6} in/in/˚F	7.0×10^{-6}	7.5×10^{-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	205×10^3 N/mm²	200×10^3	185×10^3
	29.7×10^6 lbs/in²	29.0×10^6	26.8×10^6
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
WF-XTRA®

Heat Treating WF-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
500°F (260°C)	XH	495-534	51-54
900°F (482°C)	H	444-477	47-50
1040°F (560°C)	T1	401-429	43-46
1140°F (615°C)	T2	352-388	38-42
1200°F (684°C)	T3	311-341	33-37
1230°F (666°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: 800ęF (425ęC)
Maintain minimum of 400ęF (200ęC) during welding
Post-heat/Stress Relieving: To avoid softening of the base hardness, heat to a temperature that is 50 ęF (30 ęC) 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.