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

DATA SHEET

DU® - *DURODI*®

~AISI L6 - W.Nr. 1.2714mod - ~55NiCrMoV7

HOT WORK TOOL STEEL

TYPICAL APPLICATIONS

- Press Dies
- Hammer Dies & Inserts
- Punches
- Herf Machine Dies & Punches
- Dies & Inserts for stainless, high temperature alloys and non-ferrous forgings
- Reducer Rolls

GENERAL:

Delivery Condition:

Hardened and tempered

Hardness Range:

Finkl Std.	HB	HRC
TXH	495-534	51-54
TH	444-477	47-50
T1	401-429	43-46
T2	352-388	38-42
Annealed	255 approx.	25 approx.

DURODI® is specially designed to provide maximum abrasion and heat resistance over a full range of service temperature normally encountered in forging applications.

Aluminum and Titanium Forging

Appropriate for hammer forging of aluminum where strain rates and the formation of abrasive aluminum oxides exert strong wear forces on the die.

Warm Ferrous Forging

Forging steel at lower temperatures offers improved dimensional precision and improved heating efficiency, but subjects the dies to increased cavity pressures and strong abrasion forces. Water-quenched **DURODI®** offers excellent performance under these conditions through a balanced combination of enhanced wear resistance and good impact toughness.

Typical Chemical Analysis - % weight

C	Mn	Si	Ni	Cr	Mo	V
0.55	0.65	0.50	1.65	1.00	0.80	0.07

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

DURODI® is characterized by :

- Improved High Temperature Yield Strength over standard grades
- Improved Temper Resistance
- High Through-Hardenability up to 40 inches
- High Toughness
- Excellent Thermal Shock 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 255 HB) is available.

Counterblow Hammers

Large counterblow hammer dies are subjected to incredibly high impact forces and flow stresses. The combination of water quenching and the deep hardening capacity of DURODI® provide the microstructure and hardness needed for large counterblow hammer dies.

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.

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DU® 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	231	1593	198	1365	13.2	38.0
	300	149	224	1544	187	1289	13.2	36.1
	600	316	211	1455	166	1145	18.8	59.6
	800	427	182	1255	154	1062	18.8	64.9
	900	482	164	1131	142	979	20.0	67.2
Temper 1 401-429 BHN	80	27	197	1358	172	1186	15.0	40.2
	300	149	190	1310	160	1103	14.0	38.8
	700	371	168	1158	135	931	19.2	64.1
	800	427	157	1082	127	876	19.5	68.3
	1000	538	118	814	99	683	24.0	77.8
Temper 2 352-388 BHN	80	27	173	1193	151	1041	16.6	45.7
	300	149	166	1145	139	958	14.2	41.5
	600	316	160	1103	121	834	20.0	58.6
	800	427	135	931	108	745	22.2	71.1
	900	482	116	800	97	669	23.8	77.5
	1000	538	102	703	89	614	28.0	83.2

Mechanical Properties for Commercial-Sized Die Blocks

Longitudinal mechanical properties developed from laboratory-sized test bars, as in the above table, are useful for comparing properties to other grades of steel taken from similar-sized test bars. *Full-sized blocks, however, experience a "mass-effect"* during quenching that reduces the effectiveness of the quench. This results in a lower as-quenched hardness, and affects the microstructure and tempering response. The specific affect on commercial-sized blocks depends upon actual cross-section size and test location with respect to the quench surface. Test orientation with respect to grain flow of the steel affects ductility and toughness values. Comparing properties between different grades, or even the same grade, of steel taken from commercial-sized blocks should be considered with these factors taken into account.

Die Preheating

Heating beyond the recommended minimum preheating temperature by 200˚ to 300˚F (95˚ to 150˚C) will achieve the full toughness ("Upper Shelf" energy) capability of the die steel.

Recommended DURODI® Die Steel Minimum Preheating Temperatures ˚F

		Die Block (Thickness)			
	inches / mm	5 / 127	10 / 254	15 / 381	20 / 508
Increased Wear Resistance ↑ Increased Fracture Sensitivity	XH	300	350	400	400
	H	250	300	350	400
	T1	200	250	250	300
	T2	150	150	200	250
	T3	150	150	200	200

DIE HARDNESS

Conversion:

˚F	150	200	250	300	350	400
˚C	65	95	120	150	175	204

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Heat Treating DURODI®

Tempering according to the temperatures in the following table is employed with water-quenching to establish the standard hardness ranges. For a given hardness, lower temperatures may be used for Stress Relieving with minimal effect on the base hardness.

Tempering Table

Nominal Tempering Temperatures for Water-Quenched Forgings

Temperature	Finkl Std.	HB	HRC
900˚F (482˚C)	XH	495-534	51-54
1020˚F (482˚C)	H	444-477	47-50
1080˚F (582˚C)	T1	401-429	43-46
1120˚F (604˚C)	T2	352-388	38-42
1150˚F (621˚C)	T3	311-341	33-37
1180˚F (638˚C)	T4	277-302	29-32

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/inch (1.5 hrs/25 mm). Expected hardness is approximately 255 HB maximum.

Full Anneal

Softening with additional refinement to the micro-structure may be achieved through a Full Anneal:

- Heat to 1460/1480˚F (793/804˚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 HB

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 1680/1700˚F (916/927˚C) and Hold 1/2 hr./inch (25mm)
- Drop to 1470˚F (800 ˚C) and Hold 2 hrs.
- Quench (Oil or Polymer)
- Immediately temper according to the Tempering Table to the left. Lower severity quenchants may require a downward adjustment to tempering temperature.

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

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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**

METALLURGICAL SERVICE

The Metallurgical Laboratory provides standard mechanical properties testing for *Tensile Testing* (ASTM A 370), *Impact Testing* (ASTM E 23), *Hardness Testing* (ASTM E10, E18, A956), *Macroetch Testing* (ASTM E 381), and other metallurgical testing with certification of results where requested.

Metallurgical facilities are made available to customers through your sales representative to assist in analysis of technical issues that may arise during processing or performance of Finkl forgings. Reports and consultation are offered as a service to customers with the aim of improving product performance.