



Aluminum Alloy Characteristics ALUMINUM PRODUCTS NON-HEAT TREATABLE GRADES

ALUMINUM PRODUCTS NON-HEAT TREATABLE GRADES														
GRADE & NOMINAL COMPOSITION	ALLOY DESCRIPTION	APPLICATIONS	TEMPER	TYPICAL PROPERTIES				CORROSION RESISTANCE*	FORM-ABILITY*	MACHIN-ABILITY*	WELDABILITY			
				TENSILE STRENGTH KSI	YIELD STRENGTH KSI	% ELONGATION					GAS	INERT ARC	RESISTANCE	
						SHEET	ROD							
5052 2.5% Mg. .25% Cr.	High strength, good workability and toughness. Good salt water corrosion resistance and other marine applications Anodic-coating bright and clear.	Truck parts, fencings, bus bodies, kitchen cabinets, marine applications, home appliances, chemical drums, boat hulls.	0	28	13	25	30	1	1	4	1	1	2	
			H32	33	28	12	18	1	2	3	1	1	1	
			H34	38	31	10	14	1	2	3	1	1	1	1
			H36	40	35	8	10	1	3	3	1	1	1	1
H38	42	37	7	8	1	3	3	1	1	1	1			
5086 4.0% Mg. .25% Cr.	Good formability, combined with excellent welding characteristics and corrosion resistance	cranes, boats, military applications high welding strength characteristics pressure vessels	H112	38	17	22	-	1	1	4	3	1	2	
			H32	39	19	14	-	1	2	3	3	1	1	
			H34	42	30	10	-	1	2	4	3	1	1	
				47	37	12	-	2	2	3	3	1	1	

* 1 - Superior
* 4 - Poor

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						SHEET	ROD						
2024 4.5% Cu. .6% Mn. 1.5%Mg.	Strength exceeding 2017. Arc and gas welding 2024 not generally recommended	Aircraft alloy, hinges, scientific instruments, ortho-pedic equipment, most cold headed fasteners.	0	27	11	20	22	3	2	2	4	3	3
			T3	70	50	18	-	3	3	3	4	3	2
			T4	68	47	20	-	3	3	2	4	3	2
6061 1.0%Mg. .25% Cu. &Cr. .6% Si	Combines relatively high-strength, good workability and corrosion; widely available in most forms, structurals.	Chemical equipment, fire ladders, truck and bus bodies, scaffolding mine skips, furniture, marine equipment, molding, transmission towers, awnings.	0	18	8	25	30	1	1	2	1	1	2
			T4	34	21	22	25	1	3	3	1	1	1
			T451	45	40	12	17	1	3	3	1	1	1
7075 5.6% Zn. 2.5% Mg. 1.6% Cu. .3% Cr.	Very high strength. Used for highly stressed structural parts.	Aircraft	T0	33	15	17	16	2	2	4	4	4	2
			T6	83	13	11	11	3	4	2	4	4	2
			T651										

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Aluminum Temper Designations

TEMPER DESIGNATION SYSTEM

The temper designation follows the alloy designation and is separated from it by a hyphen. The basic temper designations and subdivisions are as follows:

1-0 Annealed, recrystallized (wrought products only): Applies to (he softest temper of wrought products.

2-H Strain-hardened (wrought products only): Applies to products which have their strength increased by strain-hardening with or without supplementary thermal treatments to produce

Subdivisions of H Temper: Strain-Hardened

The -H is always followed by two or more digits. The first digit indicated the specific combination of basic operations, as follows:

H-1 Strain-hardened only: Applies to products which are strain-hardened to obtain the desired mechanical properties without supplementary thermal treatment. The number following this designation indicates the degree of stain-hardening.

H-2 Strain-hardened and then partially annealed: Applies to products which are stain-hardened more than the desired final amount and then reduced in strength to the desired level by partial annealing, for alloys that age-soften at room temperature, the -H2 tempers have approximately the same ultimate strength as the corresponding -H3 tempers. For other alloys, the -H2 tempers have approximately the same ultimate strength as the corresponding -H1 tempers and slightly higher elongations. The number following this designation indicted the degree of stain-hardening remaining after the product has been partially annealed.

H-3 Strain-hardened and then stabilized: Applies to products which are strain-hardened and then stabilized by a low temperature heating to slightly lower their strength and increase ductility. This designation applies only to the magnesium-containing alloys which, unless stabilized, gradually age-soften at room temperature. The number following this designation indicates the degree of strain-hardening remaining after the product has been strain-hardened a specific amount and then stabilized.

The second digit indicates stain hardening to the following degrees:

2 = 1/4 hard, 4 = 1/2 hard, 6 = 3/4 hard,
8 = full hard, 9 = extra hard

The third digit when used, indicates a variation of two-digit temper. It is used when the degree of control of temper or the mechanical properties are different from but close to those for the two-digit H temper designation to which it is added or when some other characteristic is significantly affected.

3-T Thermally treated

Subdivisions of T Temper: Thermally Treated

Numerals 3 through 7 following the T indicate specific sequences of basic treatments, as follows:

T3 Solution heat-treated and then cold worked. Applies to products which are cold worked to improve strength, or in which the effect of cold work in flattening or straightening is recognized in mechanical property limits.

T4 Solution heat-treated and naturally aged to a substantially stable condition. Applies to products which are not cold worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

T5 Cooled from an elevated temperature shaping process and then artificially aged. Applies to products which are cooled from an elevated temperature.

T6 Solution heat-treated and then artificially aged. Applies to products which are not cold worked after solution heat-treatment, or in which the effect of cold work in flattening or straightening may not be recognized in mechanical property limits.

T7 Solution heat-treated and then stabilized. Applies to products which are stabilized to carry them beyond the point of maximum strength to provide control of some special characteristics.

Additional Digits for T Tempers

The following specific additional digits have been assigned for stress-relieved tempers of wrought products.

Txx51 Stress relieved by stretching. Applies to the following products when stretched the indicated amounts after solution heat-treatment or cooling from an elevated temperature shaping process.

Txx52 Stress-relieved by compressing. Applies to products which are stress-relieved by compressing after solution heat-treatment, or cooling from an elevated temperature shaping process to produce a permanent set of 1 to 5 percent.

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Comparative Physical Properties & Machinability

RANDOM PHYSICAL PROPERTIES BASED ON 1" ROUND

(FOR COMPARISON ONLY)

STAINLESS					
	TENSILE	YIELD	ELONG	RED. OF AREA	BHN
302-304	89,800	43,100	61	77	165
303 S	90,000	41,500	56	61	177
316	94,800	66,000	45	72.5	200
416	95,800	77,200	21	56.3	203
CARBON STEELS					
	TENSILE	YIELD	ELONG	RED. OF AREA	BHN
C-1018	78,000	68,000	22	50	165
C-12L14	78,000	68,000	15	45	165
C-1144 (Stressproof)	110,000	100,000	12	28	230
C-1045	110,000	85,000	19	32	223
ALLOY STEEL					
	TENSILE	YIELD	ELONG	RED. OF AREA	BHN
HR-4140 Ann	89,000	62,000	26	58	187
HR-4140 H.T.	125,000	100,000	16	45	302
HR-4340 Ann	101,000	69,000	21	45	207

**MACHINABILITY RATINGS
(FOR COMPARISON ONLY)**

STAINLESS ALLOY					
GRADE	APPROXIMATE SURF. FT. PER MIN.	% RELATIVE SPEED BASED ON C-1215 as 100%	GRADE	APPROXIMATE SURF. FT. PER MIN.	% RELATIVE SPEED BASED ON C-1215 as 100%
303	150	75	E-4130	120	72
304	70	40	E-4140	110	66
316	60	36	E-4340	95	57
416 Ann	150	75		CARBON	
440C	65	40	GRADE	APPROXIMATE SURF. FT. PER MIN.	% RELATIVE SPEED BASED ON C-1215 as 100%
15-5 PH	75	45	C-1018	130	78
17-4 PH	75	45	C-1045	95	57
			C-1144	125	76
			C-12L14	325	198

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Steel Pipe Weights and Sizes

DIMENSIONS AND WEIGHTS OF SEAMLESS AND WELDED PIPE

PIPE SCHEDULES							
PIPE SIZE	O.D. in inches	Sch. 10 WALL THICKNESS	Sch.10 WEIGHT PER FOOT IN LBS	Sch. 40 WALL THICKNESS	Sch.40 WEIGHT PER FOOT IN LBS	Sch. 80 WALL THICKNESS	Sch.80 WEIGHT PER FOOT IN LBS
1/2	.840	.083	.6710	.109	.8510	.147	1.088
3/4	1.050	.083	.8572	.113	1.131	.154	1.474
1	1.315	.109	1.404	.133	1.679	.179	2.172
1 1/4	1.660	.109	1.806	.140	2.273	.191	2.997
1 1/2	1.900	.109	2.085	.145	2.718	.200	3.631
2	2.375	.109	2.638	.154	3.653	.219	5.043
2 1/2	2.875	.120	3.531	.203	5.793	.276	7.661
3	3.500	.120	4.332	.216	7.576	.300	10.25
3 1/2	4.000	.120	4.973	.226	9.109	.318	12.51
4	4.500	.120	5.613	.237	10.79	.337	14.98
5	5.563	.134	7.770	.258	14.62	.375	20.78
6	6.625	.134	9.289	.280	18.97	.432	28.57
8	8.625	.148	13.40	.322	28.55	.500	43.39
10	10.750	.165	18.65	.365	40.48	.594	64.43

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Steel Weights and Formulas

STEEL WEIGHT – SHEET

DIA. INCHES	PER INCH	PER FOOT	12FT BAR	DIA. INCHES	PER INCH	PER FOOT	12FT BAR	DIA. INCHES	PER INCH	PER FOOT	12FT BAR
1/16	.001	.010	.12	29/32	.183	2.193	26.32	1/4	2.36	28.21	338.5
5/64	.001	.016	.19	15/16	.196	2.347	28.16	5/16	2.45	29.30	351.6
3/32	.002	.023	.28	31/32	.209	2.506	30.07	3/8	2.54	30.42	365.0
7/64	.003	.032	.38	1	.22	2.670	32.04	7/16	2.64	31.55	378.6
1/8	.004	.042	.50	1/64	.23	2.750	33.00	1/2	2.73	32.71	392.5
.130		.0451	.54	1/16	.25	3.014	36.17	5/8	2.93	35.09	421.1
9/64	.004	.053	.64	3/32	.27	3.194	38.33	11/16	3.03	36.31	435.7
5/32	.005	.065	.78	1/8	.28	3.379	38.33	3/4	3.14	37.55	450.6
11/64	.007	.079	.95	9/64	.29	3.470	41.64	7/8	3.35	40.10	481.2
3/16	.008	.094	1.13	5/32	.30	3.570	42.84	15/16	3.45	41.40	496.8
13/64	.009	.110	1.32	3/16	.31	3.766	45.19	4	3.56	42.73	512.6
7/32	.011	.128	1.54	1/4	.35	4.173	50.08	1/8	3.79	45.43	545.2
15/64	.012	.147	1.76	17/64	.36	4.276	51.31	1/4	4.02	48.23	578.7
¼	.014	.167	2.00	9/32	.37	4.384	52.60	3/8	4.26	51.11	613.3
17/64	.016	.188	2.256	5/16	.38	4.600	55.20	7/16	4.39	52.58	630.9
9/32	.018	.211	2.53	3/8	.42	5.049	60.59	1/2	4.51	54.07	648.9
19/64	.019	.235	2.82	13/32	.44	5.279	63.35	5/8	4.76	57.12	685.4
5/16	.022	.261	3.13	7/16	.46	5.518	66.22	3/4	5.03	60.25	723.0
21/64	.024	.287	3.44	1/2	.50	6.008	72.10	7/8	5.29	63.45	761.5
11/32	.026	.316	3.79	17/32	.52	6.261	75.13	15/16	5.42	65.10	781.2
23/64	.029	.345	4.14	9/16	.54	6.520	78.24	5	5.56	66.75	801.1
3/8	.031	.376	4.51	5/8	.59	7.051	84.61	1/8	5.84	70.13	841.6
25/64	.034	.407	4.88	11/16	.64	7.604	91.25	1/4	6.13	73.60	883.2
13/32	.037	.441	5.29	3/4	.68	8.178	98.14	3/8	6.43	77.15	925.7
27/64	.039	.475	5.70	13/16	.73	8.773	105.30	7/16	6.60	78.95	947.4
7/16	.043	.511	6.13	7/8	.78	9.388	112.70	1/2	6.73	80.77	969.2
29/64	.048	.546	6.576	15/16	.84	10.02	120.20	5/8	7.04	84.48	1013.8
15/32	.049	.587	7.04	2	.89	10.68	128.2	3/4	7.36	88.29	1059.0
31/64	.052	.626	7.51	1/16	.95	11.36	136.3	15/16	7.84	94.14	1130.0
½	.056	.668	8.02	1/8	1.01	12.06	144.7	6	8.01	96.12	1153.5
33/64	.059	.710	8.52	3/16	1.07	12.78	153.4	1/8	8.35	100.2	1202.4

DIA. INCHES	PER INCH	PER FOOT	12FT BAR	DIA. INCHES	PER INCH	PER FOOT	12FT BAR	DIA. INCHES	PER INCH	PER FOOT	12FT BAR
17/32	.063	.754	9.05	1/4	1.13	13.52	162.2	1/4	8.71	104.3	1252.
9/16	.070	.845	10.14	5/16	1.19	14.28	171.4	1/2	9.40	112.8	1353.8
37/64	.074	.892	10.70	3/8	1.26	15.06	180.7	3/4	10.14	121.7	1460.
19/32	.078	.941	11.29	7/16	1.33	15.87	190.4	7	10.90	130.8	1570.8
5/8	.087	1.043	12.52	1/2	1.39	16.69	200.3	1/4	11.70	140.4	1684.1
41/64	.092	1.096	13.15	9/16	1.46	17.53	210.4	1/2	12.52	150.2	1802.2
21/32	.096	1.150	13.80	5/8	1.54	18.40	220.8	3/4	13.36	160.4	1924.4
11/16	.105	1.262	15.14	11/16	1.61	19.29	231.5	8	14.24	170.9	2050.6
23/32	.115	1.379	16.55	3/4	1.69	20.20	242.4	1/4	15.14	181.7	2180.7
3/4	.125	1.502	18.02	13/16	1.76	21.12	253.4	1/2	16.08	192.9	2315.0
49/64	.131	1.565	18.78	7/8	1.84	22.07	264.8	3/4	17.04	204.5	2453.1
25/32	.136	1.630	19.56	15/16	1.92	23.04	276.5	9	18.02	216.3	2595.2
13/16	.147	1.763	21.16	3	2.01	24.03	288.4	1/4	19.04	228.5	2741.4
27/32	.158	1.901	22.81	1/16	2.09	25.05	300.6	1/2	20.08	241.0	2891.6
7/8	.170	2.044	24.53	1/8	2.18	26.08	312.9	3/4	21.15	253.8	3045.8
57/64	.177	2.118	25.42	3/16	2.27	27.13	325.6	10	22.25	287.0	3204.0

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Steel Weights and Gauges

STEEL WEIGHT - SHEET

NOMINAL GAUGE	THICKNESS (INCHES)	MILLIMETERS	LBS. PER SQ. FOOT
8	.1644	4.1757	6.9
10	.1405	3.5687	5.6
11	.1196	3.0378	5.0
12	.1046	2.6568	4.3
13	.0897	2.2784	3.7
14	.0747	1.8974	3.0
15	.0673	1.7094	2.8
16	.0598	1.5189	2.5
17	.0538	1.3665	2.2
18	.0478	1.2141	2.0
19	.0418	1.0617	1.7
20	.0359	.9119	1.5
21	.0329	.8357	1.3
22	.0299	.7595	1.2
23	.0269	.7595	1.1
24	.0239	.6071	1.0
25	.0209	.5309	0.9
26	.0179	.4547	0.73
27	.0164	.4166	0.67
28	.0149	.3785	0.61

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Tool Steel Alloys

BASIC GROUPS OF TOOL STEELS

		AISI TYPE	DESCRIPTION
WATER HARDENING	CARBON	W1	All of the water-hardening grades can be furnished with 1.00/1.10 pet carbon for general tool die applications; with .70/.90 pet carbon for shock applications; with .90/1.00 pet carbon for cold-heading applications; or with 1.10/1.30 pet carbon for maximum abrasion resistance.
	OIL HARDENING	01 06	A versatile safe-hardening steel for general purpose tools and dies. Has good edge holding ability at high hardness levels. This grade has the highest machinability rating of any tool steel. It is good for general purpose applications particularly those requiring resistance to sliding wear rather than maintaining a cutting edge.
COLD WORK	AIR HARDENING	A2	An extremely safe-hardening steel with low distortion and high abrasion resistance.
		A6	A low-alloy air-hardening steel. The low austenitizing temperature offers safe, economical heat treatment.
		D2	A high-carbon, high-chromium grade for maximum service and minimum dimensional change in heat treatment.
SHOCK RESISTING		S7	A general purpose cold work grade with high shock resistance and strength. Air-hardening reduces quenching hazards, and offers good resistance to distortion during heat treatment. Also used for injection and compression molding of plastics.
HOT WORK		H13	Chrome-moly-high vanadium. For die-casting dies and extrusion tooling.
HIGH SPEED		M2 T1	This is the most widely used type of high speed steel. A tungsten-base, high speed steel. T-1 can be used where modern heat treatment equipment is not available. It is often used for roughing cuts.
PLASTIC MOLD		420	A machined-cavity mold steel for injection or compression operations subject to corrosive media.
		P20	A prehardened (Brinell 300) medium alloy machined-cavity mold steel. Expressly for deep cavities in large cross sections.

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