

TAPPING SPEED GUIDE

Proper tapping speeds are very important in obtaining efficient tapping results. There are many factors which affect proper tapping speeds, some of which are listed below and to the right.

MATERIAL FACTORS:

- Thermo-conductivity of the material and wall thickness as it affects heat dispersion
- Variations in carbon content of steel
- Hard spots in material
- Depth of hole to be tapped
- Percentage of full thread to be tapped

TAP FACTORS:

- Major diameters, pitch and lead
- Style of tap
- Width of lands
- Amount of hook or rake
- Length of chamfer
- Bottoming taps normally require slower speeds than plug chamfered taps

TAPPING SPEED GUIDE			
Materials			Speed Feet/ Minute
HSSE-V3 BLUE RING			
Low carbon	1018, 1010, 1035	Normalized	20-50
Medium carbon	1045, 1050, 1065	Normalized	20-40
Aluminum	Unalloyed, cast	–	30-80
Brass/bronze	–	–	30-80
Copper	–	–	25-60
Cast iron	–	As cast	20-40
HSSE-V3			
Stainless steel	200 Series,	Annealed	20-35
	300 Series, 17-4, 15-5	Annealed	20-35
	AM286	Annealed	15-25
	400 Series	Annealed	20-35
Tool steels	01, A-2, D-2, H-13, P-20	Annealed	15-25
Medium carbon	1030, 1035, 1038, 1040, 1045, 1050	Normalized	20-40
Alloyed high carbon	1065, 1070, 1080, 1090, 1095, 1561, 1572	Normalized	20-30
High strength	4140, 4340	Normalized	20-30
Titanium	Commercially pure	Annealed	15-30
Aluminum	Cast, wrought	–	30-90
P-HSS			
Stainless steel	17-4PH, 15-5, 17-7PH, AM350	Hardened	12-20
Tool steels	01, A-2, D-2, H-13, P-20,	Hardened	10-20
High strength	4140, 4340, 50100	Hardened	15-20
Nickel alloys	Inconel, Hastaloy, Waspaloy, Astraloy, Rene, Monel	Annealed and Hardened	5-20
Titanium	6 AL 4	Annealed/ hardened	8-15
ALUMINUM			
Aluminum			25-60
Die cast aluminum			30-80
ROLL FORM			
Steels	Sheet, low/medium carbon/stainless steels	Hardened	20-50
Aluminum/copper	Pure/low alloyed		30-60
Aluminum cast, copper alloys	Die cast, zinc die cast, brass, bronze		30-80

Proper tapping speeds are determined best by experiment. In the table below, speeds shown should be used as a guide only, and the suggested surface feet per minute adjusted upward or downward until the best results are obtained.

CONVERSION CHART																
Surface Feet Per Minute	20	25	30	40	50	60	70	80	90	100	110	120	130	140	150	
tap size rpm																
0	1273	1592	1910	2546	3183	3820	4456	5093	5730	6366	7003	7639	8276	8913	9549	
1	1047	1308	1570	2093	2617	3140	3663	4186	4710	5233	5756	6279	6808	7326	7849	
2	888	1110	1333	1777	2221	2665	3109	3554	3999	4442	4886	5330	5774	6218	6662	
3	772	964	1157	1543	1929	2315	2701	3086	3472	3858	4244	4629	5015	5401	5787	
4	682	853	1023	1364	1705	2046	2387	2728	3069	3411	3751	4092	4434	4775	5116	
5	611	764	917	1222	1528	1833	2139	2445	2750	3056	3361	3667	3973	4278	4584	
6	553	691	829	1106	1382	1658	1934	2211	2487	2764	3040	3316	3592	3869	4145	
8	466	583	699	932	1165	1387	1631	1864	2097	2330	2563	2796	3029	3262	3495	
10	402	502	603	804	1005	1208	1406	1607	1808	2009	2210	2411	2612	2813	3014	
12	354	442	531	707	884	1061	1238	1415	1592	1769	1945	2122	2300	2476	2653	
1/4	306	382	458	611	764	917	1070	1222	1375	1528	1681	1833	1986	2139	2292	
5/16	245	306	367	489	611	733	856	978	1100	1222	1345	1467	1589	1711	1833	
3/8	204	255	306	407	509	611	713	815	917	1019	1120	1222	1324	1426	1528	
7/16	175	219	262	349	437	524	611	698	786	872	960	1048	1135	1222	1310	
1/2	153	191	229	306	382	458	535	611	688	764	840	917	993	1070	1146	
9/16	137	172	206	275	344	412	481	550	619	687	756	825	893	963	1031	
5/8	122	153	183	244	306	367	428	489	550	611	672	733	794	856	917	
3/4	102	128	153	203	255	306	357	407	458	509	560	611	662	713	764	
7/8	87	109	131	175	218	262	306	350	392	437	480	524	568	611	655	
1	76	96	115	153	191	230	268	306	344	382	420	458	497	535	573	

MECHANICAL FACTORS:

- Type of tapping machine and holder; speeds for small diameter taps are often governed by the limitations of the machine
- Condition of tapping machine and spindle
- Type of fixture; vertical or horizontal tapping (faster speeds for vertical tapping)
- Method of feeding the tap
- Cutting fluid used and method of application
- The optimum speed for tapping is the highest speed that conditions permit, consistent with economic tool life

ANSI TAP DIMENSIONS

Mach. Screw Size No.	Nominal Fractional Diameter inches	Nominal Metric Diameter millimeters	Tap Dimensions – inches				
			Overall Length	Thread Length	Square Length	Shank Diameter	Size of Square
0	1/16	M1.6	1-5/8	5/16	3/16	.141	.110
1		M1.8	1-11/16	3/8	3/16	.141	.110
2		M2, M2.2	1-3/4	7/16	3/16	.141	.110
3	3/32	M2.5	1-13/16	1/2	3/16	.141	.110
4			1-7/8	9/16	3/16	.141	.110
5	1/8	M3, M3.15	1-15/16	5/8	3/16	.141	.110
6		M3.5	2	11/16	3/16	.141	.110
8	5/32	M4	2-1/8	3/4	1/4	.168	.131
10	3/16	M4.5, M5	2-3/8	7/8	1/4	.194	.152
12	7/32		2-3/8	15/16	9/32	.220	.165
14	1/4	M6, M6.3	2-1/2	1	5/16	.255	.191
	5/16	M7, M8	2-23/32	1-1/8	3/8	.318	.238
	3/8	M10	2-15/16	1-1/4	7/16	.381	.286
	7/16		3-5/32	1-7/16	13/32	.323	.242
	1/2	M12, M12.5	3-3/8	1-21/32	7/16	.367	.275
	9/16	M14	3-19/32	1-21/32	1/2	.429	.322
	5/8	M16	3-13/16	1-13/16	9/16	.480	.360
	11/16	M18	4-1/32	1-13/16	5/8	.542	.406
	3/4		4-1/4	2	11/16	.590	.442
	13/16	M20	4-15/32	2	11/16	.652	.489
	7/8	M22	4-11/16	2-7/32	3/4	.697	.523
	15/16	M24	4-29/32	2-7/32	3/4	.760	.570
	1	M25	5-1/8	2-1/2	13/16	.800	.600
	1-1/16	M27	5-1/8	2-1/2	7/8	.895	.672
	1-1/8		5-7/16	2-9/16	7/8	.896	.672
	1-3/16	M30	5-7/16	2-9/16	1	1.021	.766
	1-1/4		5-3/4	2-9/16	1	1.021	.766
	1-5/16	M33	5-3/4	2-9/16	1-1/16	1.108	.831
	1-3/8		6-1/16	3	1-1/16	1.108	.831
	1-7/16	M36	6-1/16	3	1-1/8	1.233	.925
	1-1/2		6-3/8	3	1-1/8	1.233	.925
	1-5/8	M39	6-11/16	3-3/16	1-1/8	1.305	.979
	1-3/4	M42	7	3-3/16	1-1/4	1.430	1.072
	1-7/8		7-5/16	3-9/16	1-1/4	1.519	1.139
	2	M48	7-5/8	3-9/16	1-3/8	1.644	1.233

Nominal Size Inches	NPT Dimensions – inches				
	Overall Length	Thread Length	Square Length	Shank Diameter	Size of Square
1/16	2-1/8	11/16	3/8	.3125	.234
1/8	2-1/8	3/4	3/8	.3125	.234
1/8	2-1/8	3/4	3/8	.4375	.328
1/4	2-7/16	1-1/16	7/16	.5625	.421
3/8	2-9/16	1-1/16	1/2	.7000	.531
1/2	3-1/8	1-3/8	5/8	.6875	.515
3/4	3-1/4	1-3/8	11/16	.9063	.679
1	3-3/4	1-3/4	13/16	1.1250	.843
1-1/4	4	1-3/4	15/16	1.3125	.984
1-1/2	4-1/4	1-3/4	1	1.5000	1.125
2	4-1/2	1-3/4	1-1/8	1.8750	1.406

To minimize tapping problems and lengthen tool life, use the largest drill possible to produce a minor diameter that will result in the lowest percentage of full thread consistent with adequate strength. A minor diameter that provides a 55% to 65% thread is sufficient for most requirements, but in some cases a higher percentage of thread may be necessary to conform with the minor diameter limits of the thread class specified.

TAP DRILL SIZES

Drills generally cut holes larger than their diameters. In the table to the right, the probable percentages of full thread were determined by the average amount oversize the various drills are expected to cut.

■ SUGGESTED PIPE TAP DRILL SIZES		
Tap Size	Pipe Taper	Tap Drill Size Straight [†]
1/16	D	-
1/8	R	S
1/4	7/16	29/64
3/8	37/64	19/32
1/2	23/32	47/64
3/4	59/64	15/16
1	1-5/32	1-3/16
1-1/4	1-1/2	1-33/64
1-1/2	1-47/64	1-3/4
2	2-7/32	2-7/32
2-1/2	2-5/8	-
3	3-1/4	-

* Sizes given permit direct tapping without reaming the hole, but only give a full thread for the first two or three threads

† For Dryseal Straight Pipe Threads suggested drill sizes are as shown, except; 1/4" pipe, use .444 drill size

TAP/DRILL SELECTION						
Tap	Tap Drill	Decimal Equiv. of Tap Drill	Theo. Oversize Mean	Probable Oversize Mean	Probable Hole Size	% of Threads
0-80	56	.0465	83	.0015	.0480	74
	3/64	.0469	81	.0015	.0484	71
1-64	54	.0550	89	.0015	.0565	81
	53	.0595	67	.0015	.0610	59
1-72	53	.0595	75	.0015	.0610	67
	1/16	.0625	58	.0015	.0640	50
5-56	51	.0670	82	.0017	.0687	74
	50	.0700	69	.0017	.0717	62
	49	.0730	56	.0017	.0747	49
2-64	50	.0700	79	.0017	.0717	70
	49	.0730	64	.0017	.0747	56
3-48	48	.0760	85	.0019	.0779	78
	5/64	.0781	77	.0019	.0800	70
	47	.0785	76	.0019	.0801	69
	46	.0810	67	.0019	.0829	60
	45	.0820	61	.0019	.0839	56
3-56	46	.0810	78	.0019	.0829	69
	45	.0820	73	.0019	.0839	65
	44	.0860	56	.0020	.0880	47
4-40	44	.0860	80	.0020	.0880	74
	43	.0890	71	.0020	.0910	65
	42	.0935	57	.0020	.0955	51
	3/32	.0938	56	.0020	.0958	50
4-48	42	.0935	68	.0020	.0955	61
	3/32	.0938	68	.0020	.0958	60
	41	.0960	59	.0020	.0980	52
5-40	40	.0980	83	.0023	.1003	76
	39	.0995	79	.0023	.1018	71
	38	.1015	72	.0023	.1038	65
	37	.1040	65	.0023	.1063	58
5-44	38	.1015	79	.0023	.1038	72
	37	.1040	71	.0023	.1063	63
	36	.1065	63	.0023	.1088	55
6-32	37	.1040	84	.0023	.1063	78
	36	.1065	78	.0023	.1088	72
	7/64	.1094	70	.0026	.1120	64
6-40	35	.1100	69	.0026	.1126	63
	34	.1110	67	.0026	.1136	60
	33	.1130	62	.0026	.1156	55
	34	.1110	83	.0026	.1136	75
8-32	33	.1130	77	.0026	.1156	69
	32	.1160	68	.0026	.1186	60
	29	.1360	69	.0029	.1389	62
8-36	28	.1405	58	.0029	.1434	51
	29	.1360	78	.0029	.1389	70
	28	.1405	68	.0029	.1434	57
	9/64	.1406	68	.0029	.1435	57
10-24	27	.1440	85	.0032	.1472	79
	26	.1470	79	.0032	.1502	74
	25	.1495	75	.0032	.1527	69
	24	.1520	70	.0032	.1552	64
	23	.1540	67	.0032	.1572	61
	5/32	.1563	62	.0032	.1595	56
10-32	22	.1570	61	.0032	.1602	55
	5/32	.1563	83	.0032	.1595	75
	22	.1570	81	.0032	.1602	73
	21	.1590	76	.0032	.1622	64
	20	.1610	71	.0032	.1642	64
12-24	19	.1660	59	.0032	.1692	51
	11/64	.1719	82	.0035	.1754	75
	17	.1730	79	.0035	.1765	73
	16	.1770	72	.0035	.1805	66
	15	.1800	67	.0035	.1835	60
12-28	14	.1820	63	.0035	.1855	56
	16	.1770	84	.0035	.1805	77
	15	.1800	78	.0035	.1835	70
	14	.1820	73	.0038	.1835	66
	13	.1850	67	.0035	.1885	59
	3/16	.1875	61	.0035	.1970	54

TAP/DRILL CHART-INCH

Formula: Percentage of Full Thread

$$\text{Threads Per Inch} \times \frac{\text{Major Dia. of Tap} = \text{Drill Dia.}}{.01299}$$

= Percentage of Full Thread

Example: Determine percentage of full thread for 2" - 12N Tap, using 1.9219" Drill.

$$2.0000 - 1.9219 = .0781 \div .01299 = 6.012$$

$$\text{Threads Per Inch} = \underline{x 12}$$

Theoretical Percentage of Full Threads = 72.144

Formula: Tap Drill Size

$$\frac{\text{Major Dia. of Tap} - (.1299 \times \text{Percent of Full Thread})}{\text{Number of threads Per inch}}$$

= Drill Size

Example: Determine drill size for 2" - 12N Tap, 70% Full Thread.

Basic Major Diameter of Tap = 2.0000"

$$.01299 \times 70 = .9093 \div 12 = .0758"$$

$$\text{Theoretical Drill Size} = 1.9242"$$

Nearest Standard Drill Size 1 59/64 = 1.9219"

	*Deep Hole Tapping	Average Commercial	Thin Sheet Stock or Stamping
FREE CUTTING MATERIAL			
Aluminum			
Brass			
Bronze			
Cast Iron	60%-70%	65%-70%	75%-85%
Copper			
Mild Steel			
Tool Steel			
FREE CUTTING MATERIAL			
Cast Steel			
Drop Forging			
Monel Metal	55%-65%	65%-70%	
Nickel Steel			
Stainless Steel			

TAP/DRILL SELECTION						
Tap	Tap Drill	Decimal Equiv. of Tap Drill	Theo. Oversize Mean	Probable Oversize Mean	Probable Hole Size	% of Threads
1/4-20	9	.1960	83	.0038	.1998	77
	8	.1990	79	.0039	.2028	73
	7	.2010	75	.0038	.2048	70
	13/64	.2031	72	.0038	.2068	66
	6	.2040	71	.0038	.2078	65
1/4-28	5	.2055	69	.0038	.2093	63
	4	.2090	63	.0038	.2128	57
	3	.2130	80	.0038	.2168	72
	7/32	.2188	67	.0038	.2226	59
5/16-18	2	.2210	63	.0038	.2248	55
	F	.2570	77	.0038	.2608	72
	G	.2610	71	.0041	.2651	66
5/16-24	17/64	.2656	65	.0041	.2697	59
	H	.2660	64	.0041	.2701	59
	H	.2660	86	.0041	.2701	78
3/8-16	I	.2720	75	.0041	.2761	67
	J	.2770	66	.0041	.2811	58
	5/16	.3125	77	.0044	.3169	72
3/8-24	O	.3160	73	.0044	.3204	68
	P	.3230	64	.0044	.3274	59
	21/64	.3281	87	.0044	.3325	79
7/16-14	Q	.3320	79	.0044	.3364	71
	R	.3390	67	.0044	.3434	58
	T	.3580	86	.0046	.3626	81
	23/64	.3594	84	.0046	.3640	79
7/16-20	U	.3680	75	.0046	.3726	70
	3/8	.3750	67	.0046	.3796	62
	V	.3770	65	.0046	.3816	61
	W	.3860	79	.0046	.3906	72
1/2-13	25/64	.3906	72	.0046	.3952	65
	X	.3970	62	.0046	.4016	55
	27/64	.4219	78	.0047	.4266	73
1/2-20	7/16	.4375	63	.0047	.4422	58
	29/64	.4531	72	.0047	.4578	65
9/16-12	15/32	.4688	87	.0048	.4736	82
	31/64	.4844	72	.0048	.4892	68
9/16-18	1/2	.5000	87	.0048	.5048	80
	33/64	.5156	65	.0048	.5204	58
5/8-11	17/32	.5313	79	.0049	.5362	75
	35/64	.5469	66	.0049	.5618	62
5/8-18	9/16	.5628	87	.0049	.5674	80
	37/64	.5781	65	.0049	.5831	58
3/4-10	41/64	.6406	84	.0050	.6456	80
	21/32	.6563	72	.0050	.6613	68
3/4-16	11/16	.6875	77	.0050	.6925	71
	49/64	.7656	76	.0052	.7708	72
7/8-9	25/32	.7812	65	.0052	.7864	61
	51/64	.7969	84	.0052	.8021	79
7/8-14	13/16	.8125	67	.0052	.8177	62
	55/64	.8594	87	.0059	.8653	83
1-8	7/8	.8750	77	.0059	.8809	73
	57/64	.8906	67	.0059	.8965	64
1-12	29/32	.9063	58	.0059	.9122	54
	59/64	.9219	87	.0060	.9279	81
1-14	15/16	.9375	58	.0060	.9435	52
	59/64	.9219	84	.0060	.9279	78
1-1/8-7	15/16	.9375	67	.0060	.9435	61
	31/21	.9688	84	.0062	.9750	81
1-1/8-12	63/64	.9844	76	.0067	.9911	72
	1	1.0000	67	.0070	1.0070	64
1-1/4-7	1-1/64	1.0156	59	.0070	1.0226	55
	1-1/32	1.0313	87	.0071	1.0384	80
1-1/4-12	1-3/64	1.0469	72	.0072	1.0541	66
	1-3/32	1.0938				
1-1/8-6	1-7/64	1.1094				
	1-1/8	1.1250				
	1-5/32	1.1563				
1-3/8-6	1-11/64	1.1719				
	1-3/16	1.1875				
	1-13/64	1.2031				
	1-7/32	1.2188				
1-3/8-12	1-15/64	1.2344				
	1-9/32	1.2813				
1-1/2-6	1-19/64	1.2969				
	1-5/16	1.3125				
	1-21/64	1.3281				
1-1/2-12	1-11/32	1.3438				
	1-23/64	1.3594				
	1-13/32	1.4063				
	1-27/64	1.4219				

Reaming Recommended

METRIC TAP DRILL SIZES

(drill sizes based on approximate 72%-77% Full Thread)

Tap Size	Pitch Form	Tap Drill Size	Alt. Tap Drill	Tap Size	Pitch Form	Tap Drill Size	Alt. Tap Drill
I.S.O. METRIC COARSE				I.S.O. METRIC FINE			
1.6	0.35mm	1.25mm	3/64	3	0.35mm	2.65mm	37
1.7	0.35mm	1.35mm	55	4	0.35mm	3.65mm	27
1.8	0.35mm	1.45mm	54	4	0.50mm	3.50mm	29
2	0.40mm	1.60mm	1/16	4.5	0.45mm	4.06mm	21
2.2	0.45mm	1.75mm	50	5	0.50mm	4.50mm	16
2.3	0.40mm	1.90mm	49	5	0.70mm	4.30mm	18
2.5	0.45mm	2.05mm	46	5	0.75mm	4.25mm	18
2.6	0.45mm	2.15mm	44	5.5	0.50mm	5.00mm	9
3	0.5mm	2.50mm	40	6	0.50mm	5.50mm	7/32
3.5	0.60mm	2.90mm	33	6	0.75mm	5.25mm	5
4	0.70mm	3.30mm	30	7	0.75mm	6.25mm	D
4.5	0.75mm	3.70mm	27	8	0.50mm	7.50mm	M
5	0.80mm	4.20mm	19	8	1.00mm	7.00mm	J
5.5	0.90mm	4.60mm	15	9	0.50mm	8.50mm	Q
6	1.00mm	5.00mm	9	9	1.00mm	8.00mm	O
7	1.00mm	6.00mm	15/64	10	0.50mm	9.50mm	3/8
8	1.25mm	6.80mm	H	10	0.75mm	9.25mm	U
9	1.25mm	7.80mm	5/16	10	1.00mm	9.00mm	T
10	1.50mm	8.50mm	Q	10	1.25mm	8.75mm	11/32
11	1.50mm	9.50mm	3/8	11	1.00mm	10.00mm	X
12	1.75mm	10.20mm	Y	12	1.00mm	11.00mm	7/16
14	2.00mm	12.00mm	15/32	12	1.25mm	10.75mm	27/64
16	2.00mm	14.00mm	35/64	12	1.50mm	10.50mm	Z
18	2.50mm	15.50mm	39/64	13	1.50mm	11.50mm	29/64
20	2.50mm	17.50mm	11/16	13	1.75mm	11.25mm	7/16
22	2.50mm	19.50mm	49/64	14	1.25mm	12.75mm	1/2
24	3.00mm	21.00mm	53/64	14	1.50mm	12.50mm	31/64
27	3.00mm	24.00mm	61/64	15	1.50mm	13.50mm	17/32
30	3.50mm	26.50mm	1-3/64	16	1.00mm	15.00mm	19/32
33	3.50mm	29.50mm	1-5/32	16	1.25mm	14.75mm	37/64
36	4.00mm	32.00mm	1-1/4	16	1.50mm	14.50mm	9/16
39	4.00mm	35.00mm	1-3/8	18	1.00mm	17.00mm	43/64
				18	1.25mm	16.75mm	21/32
				18	1.50mm	16.50mm	41/64
				18	2.00mm	16.00mm	5/8
				20	1.00mm	19.00mm	3/4
				20	1.50mm	18.50mm	47/64
				20	2.00mm	18.00mm	45/64
				22	1.0mm	21.00mm	53/64
				22	1.50mm	20.50mm	13/16
				22	2.00mm	20.00mm	25/32
				24	1.00mm	23.00mm	29/32
				24	1.50mm	22.50mm	7/8
				24	2.00mm	22.00mm	55/64
				24	2.50mm	21.50mm	27/32