

Drill Application Questions

- 1). What is the material being drilled?
 - Try to get the grade and what it machines like? For Example:
 - Low Carbon Steel
 - Stainless Steel
 - Inconel, Hastelloy, Titanium
 - Cast Iron
 - Aluminum
 - Use **HSS** for Soft GP Applications
 - Use **Cobalt** for Tough Applications
 - Use **Solid Carbide** for High Production CNC Applications
- 2). How hard is the material?
 - Rockwell C or Brinnell Hardness
- 3). What is required hole diameter?
 - Using shorter drill length gives more accurate holes and better wear life of drill
- 4). How deep is hole being drilled?
 - Anything over 3-4 diameters of the drill will require special geometry or pecking of the tool will be required
 - Parabolic Fluting
 - Coolant Holes
- 5). What type of machine will drill be used in? For Example:
 - Hand drilling
 - Drill Press
 - Milling Machine
 - CNC Machine
- 6). Will material be rigidly clamped down?
- 7). Will coolant or lubricant is being used and how applied?
 - Paint Brush - poor
 - Squirt Can - better
 - Coolant Line from machine - good if pointed in proper direction
- 8). What speeds and feeds is drill being run at now?
 - See tech section of each catalog for SFM and Feeds



End Mill Application Questions

- 1). What is the material being milled?
 - Try to get the grade and what it machines like; for example:
 - Soft Material
 - Tough Material
 - HSS Tools
 - Cobalt Tools
 - Need High Production - Solid Carbide Tools
 - Use **Solid Carbide** for High Production
- 2). How hard is the material being milled?
 - Rockwell C or Brinnell Hardness
- 3). What type of cut will End Mill be used to produce?
 - Will material be slot or pocket cuts - if so use 2 or 3 flute tool
 - Peripheral cuts - if so use 3 or 4 flute tool
 - Profile cuts - if so use radius or ball nose tool
- 4). What diameter tool is required?
- 5). What shank size is required?
 - Shank size must match the size of the End Mill holder
- 6). What length of cut is required?
 - This indicates the greatest depth the End Mill is capable of cutting
- 7). What overall length is required?
- 8). What type of machine will be used?
 - Manual milling machine - CNC machine



Taps Application Questions

- 1). What is the material being tapped?
 - Try to get the grade or what it machines like
- 2). How hard is the material being tapped?
 - Rockwell C or Brinnell Hardness
- 3). Is this a thru hole or a blind hole?
 - Hand or spiral point taps for thru holes
 - Spiral flute or forming taps for blind holes
- 4). What class of fit is required for the part thread?
 - 1b - Loose Fit - Bolts and Nuts
 - 2b - Medium Fit - Fasteners on machines, etc.
 - 3b - Tight Fit - Airplane Wings
- 5). What H-Limit is required on Tap, if any?
 - H-3 is most common and appropriate for many 2b fit
 - Most MRO do not require H-Limit, so Cle-Line maintenance taps are appropriate for maintenance applications
- 6). What chamfer is required on the tap?
 - Taper 7-10 threads
 - Plug 3-5 threads
 - Bottoming 1-2 threads
 - Special requirements - any other chamfer length
 - The closer the tap must produce **full** threads near the bottom of the hole, the **shorter** the chamfer must be
 - The **shorter** the chamfer length, the harder the tap must work and the **lower** the **tap life** will be
- 7). What surface treatment or thin film coating is required?
 - Surface treatments - do not add size to the tool
 - Bright or untreated
 - Nitride
 - Black oxide
 - Thin film coating - do add size to the tool
 - TiN - TiAlN - Other
 - TiCN - CrN
 - All surface treatment will help increase tap life, but only bright finish taps can be coated with a thin film



TAP/DRILL RECOMMENDATIONS

Note: Drill size recommendations are for approximately 70-75% thread height. Drills produce a hole slightly larger than their nominal size. Size obtained will depend on drill style, machine, drilling conditions, fixturing and coating selected.

MACHINE SCREW, FRACTIONAL, AND METRIC SIZES

Tap Size & Pitch		Cutting Taps		Forming Taps		Tap Size & Pitch		Cutting Taps		Forming Taps	
inch	metric	drill size	decimal inch	drill size	decimal inch	inch	metric	drill size	decimal inch	drill size	decimal inch
0-80		3/64	.0469	54	.0550	5/8-11		17/32	.5312	14,75	.5807
	M1,6 x 0,35	1,25	.0492	1,45	.0571	5/8-18		37/64	.5781	15,25	.6004
	M1,8 x 0,35	1,45	.0571	1,65	.0650		M16 x 2	14,0	.5512	19/32	.5938
1-64		53	.0595	51	.0670		M16 x 1,5	14,5	.5709	15,25	.6004
1-72		53	.0595	51	.0670		M18 x 2,5	15,5	.6102	39/64	.6094
	M2 x 0,4	1,6	.0630	1,8	.0709		M18 x 1,5	16,5	.6496	17,25	.6791
2-56		50	.0700	5/64	.0781	3/4-10		21/32	.6562	45/64	.7031
2-64		50	.0700	47	.0785	3/4-16		11/16	.6875	23/32	.7188
	M2,2 x 0,45	1,75	.0689	2,0	.0787		M20 x 2,5	17,5	.6890		
	M2,5 x 0,45	2,05	.0807	2,3	.0906		M20 x 1,5	18,5	.7283		
3-48		47	.0785	43	.0890		M22 x 2,5	19,5	.7677		
3-56		46	.0810	2,3	.0906		M22 x 1,5	20,5	.8071		
4-40		43	.0890	38	.1015	7/8-9		49/64	.7656		
4-48		42	.0935	2,6	.1024	7/8-14		13/16	.8125		
	M3 x 0,5	2,5	.0984	7/64	.1094		M24 x 3	21,0	.8268		
5-40		38	.1015	33	.1130		M24 x 2	22,0	.8661		
5-44		37	.1040	2,9	.1142	1-8		7/8	.8750		
	M3,5 x 0,6	2,9	.1142	3,2	.1260	1-12		59/64	.9219		
6-32		36	.1065	1/8	.1250		M27 x 3	24,0	.9449		
6-40		33	.1130	3,25	.1280		M27 x 2	25,0	.9843		
	M4 x 0,7	3,3	.1299	3,7	.1457	1-1/8-7		63/64	.9844		
8-32		29	.1360	25	.1495	1-1/8-12		13/64	1.0469		
8-36		29	.1360	24	.1520		M30 x 3,5	26,5	1.0433		
	M4,5 x 0,75	3,7	.1457	4,1	.1614		M30 x 2	28,0	1.1024		
10-24		26	.1470	11/64	.1719	1-1/4-7		17/64	1.1094		
10-32		21	.1590	16	.1770	1-1/4-12		11/64	1.1719		
	M5 x 0,8	4,2	.1654	14	.1820		M33 x 3,5	29,5	1.1614		
12-24		16	.1770	8	.1990		M33 x 2	31,0	1.2205		
12-28		15	.1800	7	.2010	1-3/8-6		17/32	1.2188		
	M6 x 1	5,0	.1969	7/32	.2188	1-3/8-12		19/64	1.2969		
1/4-20		7	.2010	1	.2280		M36 x 4	32,0	1.2598		
1/4-28		3	.2130	15/64	.2340		M36 x 3	33,0	1.2992		
	M7 x 1	6,0	.2362	F	.2570	1-1/2-6		11/32	1.3438		
5/16-18		F	.2570	L	.2900	1-1/2-12		127/64	1.4219		
5/16-24		I	.2720	M	.2950		M39 x 4	35,0	1.3780		
	M8 x 1,25	6,7	.2638	7,4	.2913		M39 x 3	36,0	1.4173		
	M8 x 1	7,0	.2756	19/64	.2969						
3/8-16		5/16	.3125	S	.3480						
3/8-24		Q	.3320	T	.3580						
	M10 x 1,5	8,5	.3346	U	.3680						
	M10 x 1,25	8,7	.3425	9,4	.3701						
7/16-14		U	.3680	Y	.4040						
7/16-20		25/64	.3906	Z	.4130						
	M12 x 1,75	10,2	.4016	11,2	.4409						
	M12 x 1,25	10,8	.4252	11,5	.4528						
1/2-13		27/64	.4219	15/32	.4688						
1/2-20		29/64	.4531	12,25	.4823						
	M14 x 2	12,0	.4724	33/64	.5156						
9/16-12		31/64	.4844	17/32	.5312						
9/16-18		33/64	.5156	13,5	.5315						

FORMING TAPS NOT AVAILABLE IN THESE SIZES



PIPE TAPS — NPT, NPTF, NPSM, NPSC, NPSF SIZES

Nominal Tap Size & Pitch	NPT & NPTF		NPSM	NPSC	NPSF
	w/ reamer	w/reamer			
1/16 - 27	C (.242)	A (.234)	—	1/4	D (.246)
1/8 - 27	Q (.332)	21/64	T (.358)	Q	R (.339)
1/4 - 18	7/16	27/64	15/32	7/16	7/16
3/8 - 18	9/16	9/16	.603*	37/64	37/64
1/2 - 14	45/64	11/16	19,0mm	23/32	.705*
3/4 - 14	29/32	57/64	61/64	59/64	59/64
1 - 11 1/2	19/64	1 1/8	1 13/64	15/32	1 5/32
1 1/4 - 11 1/2	131/64	1 15/32	1.546*	1 1/2	—
1 1/2 - 11 1/2	123/32	1 45/64	1 25/32	1 47/64	—
2 - 11 1/2	2 3/16	2 11/64	2 1/4	2 1/4	—

METRIC - GREEN

FRACTIONAL - RED

WIRE GAGE - PURPLE

LETTER SIZE - BLUE

*special



DECIMAL EQUIVALENTS



DRILL SIZE	DECIMAL INCHES	DRILL SIZE	DECIMAL INCHES	DRILL SIZE	DECIMAL INCHES	DRILL SIZE	DECIMAL INCHES	DRILL SIZE	DECIMAL INCHES	DRILL SIZE	DECIMAL INCHES
0,3mm	.0118	54	.0550	3,1mm	.1220	5,5mm	.2165	8,5mm	.3346	9/16	.5625
0,32mm	.0126	1,4mm	.0551	1/8	.1250	7/32	.2188	8,6mm	.3386	14,5mm	.5709
80	.0135	1,45mm	.0571	3,2mm	.1260	5,6mm	.2205	R	.3390	37/64	.5781
0,35mm	.0138	1,5mm	.0591	30	.1285	2	.2210	8,7mm	.3425	14,75mm	.5807
79	.0145	53	.0595	3,3mm	.1299	5,7mm	.2244	11/32	.3438	15,0mm	.5906
0,38mm	.0150	1,55mm	.0610	3,4mm	.1339	1	.2280	8,8mm	.3465	19/32	.5938
1/64	.0156	1/16	.0625	29	.1360	5,8mm	.2283	S	.3480	15,25mm	.6004
0,4mm	.0157	1,6mm	.0630	3,5mm	.1378	5,9mm	.2323	8,9mm	.3504	39/64	.6094
78	.0160	52	.0635	28	.1405	A	.2340	9,0mm	.3543	15,5mm	.6102
0,42mm	.0165	1,65mm	.0650	9/64	.1406	15/64	.2344	T	.3580	15,75mm	.6201
0,45mm	.0177	1,7mm	.0669	3,6mm	.1417	6,0mm	.2362	9,1mm	.3583	5/8	.6250
77	.0180	51	.0670	27	.1440	B	.2380	23/64	.3594	16,0mm	.6299
0,48mm	.0189	1,75mm	.0689	3,7mm	.1457	6,1mm	.2402	9,2mm	.3622	16,25mm	.6398
0,5mm	.0197	50	.0700	26	.1470	C	.2420	9,3mm	.3661	41/64	.6406
76	.0200	1,8mm	.0709	25	.1495	6,2mm	.2441	U	.3680	16,5mm	.6496
75	.0210	1,85mm	.0728	3,8mm	.1496	D	.2460	9,4mm	.3701	21/32	.6562
0,55mm	.0217	49	.0730	24	.1520	6,3mm	.2480	9,5mm	.3740	16,75mm	.6594
74	.0225	1,9mm	.0748	3,9mm	.1535	1/4, E	.2500	3/8	.3750	17,0mm	.6693
0,6mm	.0236	48	.0760	23	.1540	6,4mm	.2520	V	.3770	43/64	.6719
73	.0240	1,95mm	.0768	5/32	.1562	6,5mm	.2559	9,6mm	.3780	17,25mm	.6791
0,62mm	.0244	5/64	.0781	22	.1570	F	.2570	9,7mm	.3819	11/16	.6875
72	.0250	47	.0785	4,0mm	.1575	6,6mm	.2598	9,8mm	.3858	17,5mm	.6890
0,65mm	.0256	2,0mm	.0787	21	.1590	G	.2610	W	.3860	45/64	.7031
71	.0260	2,05mm	.0807	20	.1610	6,7mm	.2638	9,9mm	.3898	18,0mm	.7087
0,7mm	.0276	46	.0810	4,1mm	.1614	17/64	.2656	25/64	.3906	23/32	.7188
70	.0280	45	.0820	4,2mm	.1654	H	.2660	10,0mm	.3937	18,5mm	.7283
69	.0292	2,1mm	.0827	19	.1660	6,8mm	.2677	X	.3970	47/64	.7344
0,75mm	.0295	2,15mm	.0846	4,3mm	.1693	6,9mm	.2717	10,2mm	.4016	19,0mm	.7480
68	.0310	44	.0860	18	.1695	I	.2720	Y	.4040	3/4	.7500
1/32	.0312	2,2mm	.0866	11/64	.1719	7,0mm	.2756	13/32	.4062	49/64	.7656
0,8mm	.0315	2,25mm	.0886	17	.1730	J	.2770	Z	.4130	19,5mm	.7677
67	.0320	43	.0890	4,4mm	.1732	7,1mm	.2795	10,5mm	.4134	25/32	.7812
66	.0330	2,3mm	.0906	16	.1770	K	.2810	27/64	.4219	20,0mm	.7874
0,85mm	.0335	2,35mm	.0925	4,5mm	.1772	9/32	.2812	10,8mm	.4252	51/64	.7969
65	.0350	42	.0935	15	.1800	7,2mm	.2835	11,0mm	.4331	20,5mm	.8071
0,9mm	.0354	3/32	.0938	4,6mm	.1811	7,3mm	.2874	7/16	.4375	13/16	.8125
64	.0360	2,4mm	.0945	14	.1820	L	.2900	11,2mm	.4409	21,0mm	.8268
63	.0370	41	.0960	4,7mm	.1850	7,4mm	.2913	11,5mm	.4528	53/64	.8281
0,95mm	.0374	2,45mm	.0965	3/16	.1875	M	.2950	29/64	.4531	27/32	.8438
62	.0380	40	.0980	4,8mm	.1890	7,5mm	.2953	11,8mm	.4646	21,5mm	.8465
61	.0390	2,5mm	.0984	11	.1910	19/64	.2969	15/32	.4688	55/64	.8594
1,0mm	.0394	39	.0995	4,9mm	.1929	7,6mm	.2992	12,0mm	.4724	22,0mm	.8661
60	.0400	38	.1015	10	.1935	N	.3020	12,2mm	.4803	7/8	.8750
59	.0410	2,6mm	.1024	9	.1960	7,7mm	.3031	31/64	.4844	22,5mm	.8858
1,05mm	.0413	37	.1040	5,0mm	.1969	7,8mm	.3071	12,5mm	.4921	57/64	.8906
58	.0420	2,7mm	.1063	8	.1990	7,9mm	.3110	1/2	.5000	23,0mm	.9055
57	.0430	36	.1065	5,1mm	.2008	5/16	.3125	12,8mm	.5039	29/32	.9062
1,1mm	.0433	7/64	.1094	7	.2010	8,0mm	.3150	13,0mm	.5118	59/64	.9219
1,15mm	.0453	35	.1100	13/64	.2031	O	.3160	33/64	.5156	23,5mm	.9252
56	.0465	2,8mm	.1102	6	.2040	8,1mm	.3189	13,2mm	.5197	15/16	.9375
3/64	.0469	34	.1110	5,2mm	.2047	8,2mm	.3228	17/32	.5312	24,0mm	.9449
1,2mm	.0472	33	.1130	5	.2055	P	.3230	13,5mm	.5315	61/64	.9531
1,25mm	.0492	2,9mm	.1142	5,3mm	.2087	8,3mm	.3268	13,8mm	.5433	24,5mm	.9646
1,3mm	.0512	32	.1160	4	.2090	21/64	.3281	35/64	.5469	31/32	.9688
55	.0520	3,0mm	.1181	5,4mm	.2126	8,4mm	.3307	14,0mm	.5512	25,0mm	.9843
1,35mm	.0531	31	.1200	3	.2130	Q	.3320	14,25mm	.5610	63/64	.9844





METRIC - GREEN

FRACTIONAL - RED

WIRE GAGE - PURPLE

LETTER SIZE - BLUE

1" 1.0000

BRAND	MARKET	PRODUCTS	APPLICATIONS	USAGES	COMPETITORS	PRICE POINT	PRODUCT LEVEL
	Maintenance (MRO), STAFDA, DIY	Drills, Taps, Dies, Burs	Light Spindle, Hand Held (Drilling & Tapping) Applications	Mild Steels, Aluminum, Wood	Morse, PTD, Norseman, Triumph, Drillco, Champion, FMT	Lowest Cost GFI Line, Competitive Bid Products	"GOOD"
	Industrial (some MRO)	Drills, Reamers, Countersinks	Fixed Spindle (Controlled Machining Parameters)	Steel, Stainless, Aluminum, Cast Iron, Some Hard Metals	PTD, Morse, YG-1, Viking, Guhring	Mid-Cost GFI Line, Very Competitively Priced Against the Competition	"BETTER"
	Industrial (some MRO)	Taps, Special Taps	Fixed Spindle (Controlled Machining Parameters), Close Tolerance Machining	Steel, Stainless, Aluminum, Cast Iron, Some Hard Metals	Greenfield Tap and Die (GTD), OSG, YMW	Low to Mid-Cost GFI Line, Very Competitively Priced Against the Competition	"GOOD" to "BETTER"
	Industrial	Drills, Taps, End Mills (Carbide, High Speed & Cobalt Steels) Reamers, (Performance Products)	Fixed Spindle (Controlled Machining Parameters), Close Tolerance Machining	Steel, Stainless, Aluminum, Cast Iron, Titanium, Nickel Based	PTD, Morse, YG-1, Guhring, OSG, Greenfield Tap and Die (GTD)	Highest-Priced GFI Line, Competitively Priced Against Some of Our Competitors	"BEST"

Drills Technical Information

Recommended Surface Feet per Minute (SFM) and Coolant by Material Application

Ferrous Materials

Materials	Brinell Hardness	Geometry	SFM
Low Carbon Steel	85-125	general-purpose	80-95
Medium Carbon Steel	125-175	general-purpose	70-85
High Carbon Steel	175-225	heavy-duty	45-65
Steels Alloyed	Under 200	general-purpose	60-90
Steel Drop Forgings Heat Treated	330-370		30-40
Grey Cast Iron Soft	125	general-purpose	140-150
Grey Cast Iron Medium	120-200	heavy-duty	50-80
Grey Cast Iron Hard	Up to 350	heavy-duty	25-40
Titanium Alloys (Ti)-75A	300-440	cobalt	50-60
Ti-150A, RS-120	300-440	cobalt	40-50
Ti-140A, RC 130B	300-440	cobalt	30-40
Ti-6AL -4V	300-440	cobalt	20-30
300 Series Stainless	120-200	cobalt	20-40
400 Series Stainless	200-300	cobalt	40-70
Martensitic 416, 420, F416 Plus K, 400F, 4165SE, 440F	135-185	cobalt	40-50
Precipitation Hardening	325-375	cobalt	30
Stainless Steel, Cast	400-450	cobalt	20
Heat Resisting Steels	175-225	cobalt	10-25
Nimonic Alloys	200-300	cobalt	10-20
Manganese 12-14% min	125-220	heavy-duty	10-12
Spring Steels	402	cobalt	15-30
Armor Plate	200-250	cobalt	40

Non-Ferrous Materials

*bright only

Materials	Brinell Hardness	Geometry	SFM
Aluminum Pure	140-350	fast spiral*	130-200
Aluminum Alloys	140-330	fast spiral*	150-300
Aluminum Leaded	40-100	fast spiral*	200-325
Aluminum Silicon Alloy Die Cast	40-100	fast spiral*	25-50
Brass	190-210	slow spiral*	200-250
Bronze	150-200	slow spiral*	200-250
Copper - Nickel & Copper Tin Alloy	65-100	general-purpose*	140-200
Copper - Aluminum Alloys	30-100	general-purpose*	120-200
Magnesium Alloys - Wrought	50-90	general-purpose*	140-330
Magnesium Alloys - Cast	50-90	general-purpose*	140-365
Nickel Alloys - Wrought and Cast	80-170	general-purpose	70
Nickel Alloys - Monel	115-240	general-purpose	55
Nickel Alloys - Beryllium Nickel	200-250	general-purpose	12
Zinc Alloy	112-126	general-purpose	200-250

*bright only

Drill Feeds

Diameter Range (inches)	Normal Feeds IPR (inches per revolution)	Heavy Feed IPR (inches per revolution)
1/16 through 1/8	.001 - .002	.002 - .004
over 1/8 through 1/4	.002 - .004	.004 - .008
over 1/4 through 1/2	.004 - .008	.008 - .016
over 1/2 through 1	.008 - .016	.016 - .024
over 1	.016 - .024	.024 - .032

End Mills - Operating Parameters

Speed and Feed Data in Selected Materials – Regular HSS and Cobalt HSS End Mills

Material	Heat-Resistant Cobalt Base Alloys, High Tensile Steels (50-55C)		Heat-Resistant Austenitic Alloys, High Tensile Steels (46-50C)		Heat-Resistant Nickel Base Alloys, High Strength Stainless Steels, High Strength Titanium Alloys		High Strength Stainless Steels, High Tensile Steels (40-46C) Medium Strength Titanium Alloys		Heat-Resistant Ferritic Base Alloys, Medium Strength Stainless Steels, Unalloyed Titanium Tool Steels (30-40C)	
End Mill Style	Cobalt HSS HSS 2 or more flute		Cobalt HSS HSS 2 or more flute		Cobalt HSS HSS 2 or more flute		Cobalt HSS HSS 2 or more flute		HSS 2 or more flute	
Speed (all diameters)	5-10 SFM		10-15 SFM		15-20 SFM		20-40 SFM		40-60 SFM	
Mill Diameter	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth
1/16	*	*	*	*	*	*	1222-2444	.0002-.0005	2444-3667	.0002-.0005
3/32	*	*	*	*	611-815	.0002-.0005	815-1629	.0002-.0005	1629-2750	.0002-.0005
1/8	*	*	*	*	456-611	.0002-.0005	611-1222	.0002-.0005	1222-1833	.0002-.0005
3/16	*	*	204-306	.0002-.0005	306-407	.0002-.0005	407-815	.0002-.0005	815-1222	.0002-.0005
1/4	76-153	.0002-.0010	153-230	.0002-.0010	229-306	.0002-.0010	306-611	.0002-.0010	611-917	.0002-.0010
5/16	61-122	.0002-.0010	122-183	.0002-.0010	183-244	.0002-.0010	244-489	.0002-.0010	489-733	.0002-.0010
3/8	51-102	.0002-.0010	102-153	.0002-.0010	153-203	.0002-.0010	203-407	.0005-.0020	407-611	.0005-.0020
7/16	44-88	.0005-.0010	88-132	.0005-.0010	131-175	.0005-.0020	175-349	.0005-.0020	349-524	.0005-.0020
1/2	38-76	.0005-.0010	76-115	.0005-.0010	115-153	.0005-.0020	153-306	.0005-.0030	306-458	.0010-.0030
9/16	34-68	.0005-.0020	68-104	.0005-.0020	104-136	.0005-.0020	136-272	.0005-.0030	272-412	.0010-.0030
3/8	31-61	.0005-.0020	61-92	.0005-.0020	92-122	.0005-.0020	122-244	.0010-.0040	244-367	.0010-.0040
11/16	28-56	.0005-.0020	56-84	.0005-.0020	84-111	.0005-.0020	111-222	.0010-.0040	222-337	.0010-.0040
3/4	26-51	.0005-.0020	51-76	.0005-.0020	76-102	.0010-.0040	102-203	.0010-.0040	203-306	.0010-.0040
13/16	24-47	.0010-.0030	47-71	.0010-.0030	71-94	.0010-.0040	94-189	.0010-.0040	189-284	.0010-.0040
7/8	22-44	.0010-.0030	44-65	.0010-.0030	65-87	.0010-.0040	87-175	.0010-.0040	175-262	.0020-.0060
15/16	20-40	.0010-.0030	40-62	.0010-.0030	62-81	.0010-.0040	81-163	.0010-.0040	163-246	.0020-.0060
1	19-38	.0010-.0030	38-58	.0010-.0030	58-76	.0010-.0040	76-153	.0020-.0060	153-229	.0020-.0060
1-1/8	34	.0015-.0040	34-51	.0015-.0040	51-68	.0015-.0050	68-136	.0020-.0060	136-204	.0020-.0060
1-1/4	31	.0015-.0040	31-46	.0015-.0040	46-61	.0015-.0050	61-122	.0020-.0060	122-183	.0020-.0060
1-3/8	28	.0015-.0040	28-42	.0015-.0040	42-55	.0015-.0050	55-111	.0020-.0060	111-167	.0030 +
1-1/2	26	.0015-.0040	26-38	.0015-.0040	38-51	.0020 +	51-102	.0030 +	102-153	.0030 +
1-5/8	24	.0020 +	35	.0020 +	35-47	.0020 +	47-94	.0030 +	94-141	.0030 +
1-3/4	22	.0020 +	32	.0020 +	32-43	.0020 +	43-87	.0030 +	87-131	.0030 +
1-7/8	20	.0020 +	30	.0020 +	30-40	.0030 +	40-81	.0030 +	81-122	.0030 +
2	19	.0020 +	29	.0030 +	29-38	.0030 +	38-76	.0030 +	76-115	.0030 +
2-1/8	18	.0030 +	28	.0030 +	36	.0030 +	36-72	.0030 +	72-108	.0030 +
2-1/4	17	.0030 +	26	.0030 +	34	.0030 +	34-68	.0030 +	68-102	.0030 +
2-3/8	16	.0030 +	25	.0030 +	32	.0030 +	32-64	.0030 +	64-97	.0030 +
2-1/2	15	.0030 +	23	.0030 +	30	.0030 +	30-61	.0030 +	61-92	.0030 +
2-5/8	15	.0030 +	22	.0030 +	29	.0030 +	29-58	.0030 +	58-88	.0030 +
2-3/4	14	.0030 +	21	.0030 +	28	.0030 +	28-56	.0030 +	56-83	.0030 +
2-7/8	14	.0030 +	20	.0030 +	27	.0030 +	27-53	.0030 +	53-80	.0030 +
3	13	.0030 +	19	.0030 +	26	.0030 +	26-51	.0030 +	51-76	.0030 +

End Mills - Operating Parameters

Speed and Feed Data in Selected Materials – Regular HSS and Cobalt HSS End Mills

Material	Machine Steel		Cast Iron		Brass and Bronze		Aluminum	
	Hard Brass & Bronze Electrolytic Copper Mild Steel Formings		Mild Steel Half-Hard Brass and Bronze		Alloyed Aluminum Abrasive Plastics		Plastics Wood	
End Mill Style	HSS 2 or more flutes		HSS surface treatment helpful in cast iron 2 or more flutes		High Helix HSS 1 to 6 flutes		High Helix HSS 1 to 6 flutes	
Speed (all diameters)	60-80 SFM		80-100 SFM		100-200 SFM		200-600 SFM	
Mill Diameter	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth	Speed RPM	Feed Chip Load per Tooth
1/16	3667-4888	.0002-.0005	4888-6111	.0002-.0005	6111-12222	.0002-.0005	12222 +	.0002-.0005
3/32	2750-3259	.0002-.0005	3259-4073	.0002-.0005	4073-8146	.0002-.0005	8146 +	.0002-.0005
1/8	1833-2440	.0002-.0010	2440-3056	.0002-.0010	3056-6112	.0002-.0010	6112 +	.0002-.0010
3/16	1222-1625	.0002-.0010	1625-2037	.0002-.0010	2037-4074	.0002-.0010	4074-12222	.0002-.0010
1/4	917-1222	.0005-.0020	1222-1528	.0005-.0020	1528-3056	.0005-.0020	3056-9168	.0005-.0020
5/16	733-978	.0005-.0020	978-1222	.0005-.0020	1222-2444	.0005-.0020	2444-7332	.0005-.0020
3/8	611-815	.0010-.0030	815-1019	.0010-.0030	1019-2038	.0005-.0030	2038-6114	.0005-.0020
7/16	524-698	.0010-.0030	698-873	.0010-.0030	873-1746	.0005-.0030	1746-5238	.0005-.0020
1/2	458-611	.0010-.0030	611-764	.0010-.0030	764-1528	.0005-.0030	1528-4584	.0005-.0020
9/16	412-543	.0010-.0040	543-678	.0010-.0040	678-1356	.0005-.0040	1356-4071	.0005-.0030
3/8	367-489	.0010-.0040	489-611	.0010-.0040	611-1222	.0005-.0040	1222-3666	.0005-.0030
11/16	337-444	.0010-.0040	444-555	.0010-.0040	555-1110	.0005-.0040	1110-3330	.0005-.0030
3/4	306-407	.0010-.0040	407-509	.0020-.0060	509-1018	.0010-.0060	1018-3054	.0010-.0040
13/16	284-379	.0020-.0060	379-469	.0020-.0060	469-938	.0010-.0060	938-2814	.0010-.0040
7/8	262-349	.0020-.0060	349-436	.0020-.0060	436-872	.0010-.0060	872-2616	.0010-.0040
15/16	246-326	.0020-.0060	326-407	.0020-.0060	407-814	.0010-.0060	814-2442	.0010-.0040
1	229-306	.0020-.0060	306-382	.0020-.0060	382-764	.0020 +	764-2292	.0020 +
1-1/8	204-272	.0020-.0060	272-340	.0030 +	340-680	.0020 +	680-2040	.0020 +
1-1/4	183-244	.0030 +	244-306	.0030 +	306-612	.0020 +	612-1836	.0020 +
1-3/8	167-222	.0030 +	222-278	.0030 +	278-556	.0020 +	556-1668	.0020 +
1-1/2	153-204	.0030 +	204-255	.0030 +	255-510	.0030 +	510-1530	.0020 +
1-5/8	141-188	.0030 +	188-235	.0030 +	235-470	.0030 +	470-1410	.0020 +
1-3/4	131-175	.0030 +	175-218	.0030 +	218-436	.0030 +	436-1308	.0020 +
1-7/8	122-163	.0030 +	163-204	.0030 +	201-408	.0030 +	408-1224	.0030 +
2	115-153	.0030 +	153-191	.0030 +	191-382	.0030 +	382-1146	.0030 +
2-1/8	108-144	.0030 +	144-179	.0030 +	179-358	.0030 +	358-1074	.0030 +
2-1/4	102-136	.0030 +	136-170	.0030 +	170-340	.0030 +	340-1020	.0030 +
2-3/8	97-128	.0030 +	128-161	.0030 +	161-322	.0030 +	322-966	.0030 +
2-1/2	92-122	.0030 +	122-153	.0030 +	153-306	.0030 +	306-918	.0030 +
2-5/8	88-116	.0030 +	116-145	.0030 +	145-290	.0030 +	290-870	.0030 +
2-3/4	83-111	.0030 +	111-139	.0030 +	139-278	.0030 +	278-834	.0030 +
2-7/8	80-106	.0030 +	106-132	.0030 +	132-264	.0030 +	264-792	.0030 +
3	76-102	.0030 +	102-127	.0030 +	127-254	.0030 +	254-762	.0030 +

Reamers - Speeds and Feeds

Ferrous Materials

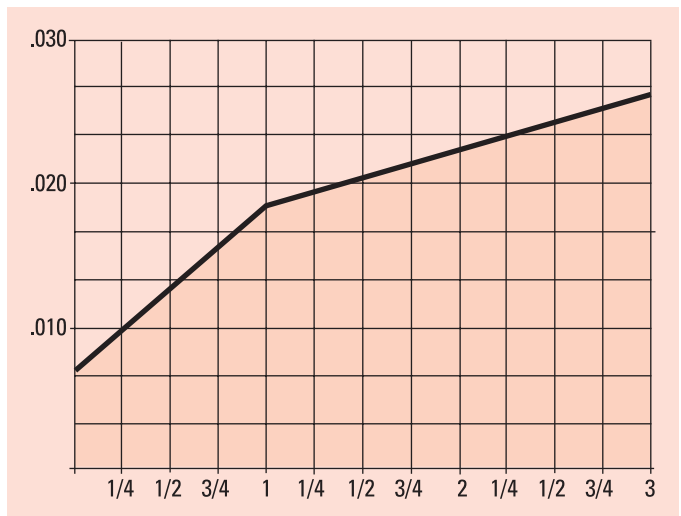
Material	Speed (sfm)	Feed (ipr) for Diameter (inches)						
		<1/16	> 1/16 - 1/8	>1/8 - 1/4	> 1/4 - 1/2	> 1/2 - 1	> 1	
Steel	under 200 BHN	55-80	.0005-.003	.002-.006	.004-.010	.006-.015	.010-.030	.020-.050
	200-300 BHN	30-55	.005-.002	.002-.004	.004-.006	.006-.010	.010-.020	.020-.040
	300-400 BHN	20-30	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020
	400-500 BHN	10-20	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020
	500 BHN +	—	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020
Cast Iron	Soft (Ferritic)	50-100	.001-.003	.003-.006	.006-.010	.010-.015	.015-.030	.030-.050
	Medium (Pearlitic)	25-50	.0002-.002	.001-.004	.002-.006	.004-.010	.006-.020	.010-.040
	Hard (Martensitic or Acicular)	15-25	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020
Stainless Steel	Free Machining & 400 Ann	40-60	.0005-.002	.002-.004	.004-.006	.006-.010	.010-.020	.020-.040
Steel	300 Series	20-30	.0005-.002	.002-.004	.004-.006	.006-.010	.010-.020	.020-.040
	PH and HT 400Series	15-25	.0002-.002	.001-.004	.002-.006	.004-.010	.006-.020	.010-.040
High-Temp Alloys	Nickel-base	10-20	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020
	Cobalt-base	10-15	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020
Titanium	Pure	35-50	.0005-.002	.002-.004	.004-.006	.006-.010	.010-.020	.020-.040
	Alloys	10-20	.0002-.002	.001-.004	.002-.006	.004-.010	.006-.020	.010-.04

Non-Ferrous Materials

Material	Speed (sfm)	Feed (ipr) for Diameter (inches)						
		<1/16	> 1/16 - 1/8	>1/8 - 1/4	> 1/4 - 1/2	> 1/2 - 1	> 1	
Aluminum	150-300	.0005-.003	.002-.006	.004-.010	.006-.015	.010-.030	.020-.050	
Brass/ Bronze	Free Machining	125-200	.0005-.002	.002-.004	.004-.006	.006-.010	.010-.020	.020-.040
	Tough	75-125	.0005-.002	.002-.004	.004-.006	.006-.010	.010-.020	.020-.040
Copper/ Hard Bronze	50-75	.0002-.001	.001-.002	.002-.004	.004-.006	.006-.010	.010-.020	
Magnesium	200-400	.005-.003	.002-.006	.004-.010	.006-.015	.010-.030	.020-.050	

Reamer Stock Removal

Stock removal is dependent on material, feed, and finish required. The stock removal chart below illustrates starting points for various diameters when using machine and chucking reamers. See reamer speed chart on pages 127-128.



Suggested Speeds for Uncoated and Coated Taps

Work Material	Speed-feet-per-minute	
	Uncoated Tap	Coated Tap
Alloy Steels:		
125-225 Bhn	30-60	60-120
225-325 Bhn	20-45	40-90
325-425 Bhn	10-35	20-70
Aluminum Alloys	75-150	150-300
Carbon Steels, 225 Bhn or less:		
low carbon (.10-.25C)	50-75	100-150
medium carbon (.30-.55C)	40-65	80-130
high carbon (.60-.95C)	30-55	90-110
Cast Iron		
ductile, annealed	40-60	80-120
ductile, as cast	20-45	40-90
gray (class 20, 25)	40-80	80-160
gray (class 30-50)	25-50	50-100
malleable, 200 Bhn or less	30-60	60-120
Copper Alloys	40-100	80-200
Graphites & Carbons	5-10	10-20
High-Temperature Alloys:		
cobalt base (Haynes alloys)	3-8	5-16
iron base (Incoloy, A-286)	7-15	15-30
nickel base (Hastelloy, Inconel)	4-10	8-20
Magnesium	100-150	150-200
Plastics	25-50	50-100
Stainless Steels	15-35	30-70
Titanium:		
pure	25-55	50-110
alloys (Ti-6Al-4V)	10-25	20-50
Tool Steels:		
200-275 Bhn	15-30	30-60
300-350 Bhn	10-25	20-50
40-50 Rc	5-15	10-30
Zinc Alloys	100-150	150-250

**Success of coated taps in non-ferrous materials depends on the machining conditions used.*

Tapping Formulae

Inch Sizes

$$\begin{aligned} \text{SFM} &= (\text{RPM} \times \text{tool diameter}) / 3.82 \\ &\text{or } 0.26 \times \text{RPM} \times \text{tool diameter} \\ \text{RPM} &= (3.82 \times \text{SFM}) / \text{tool diameter} \\ \text{IPM} &= \text{RPM} / \text{TPI}^* \\ &\text{or } *P \times \text{RPM} \end{aligned}$$

Metric Sizes

$$\begin{aligned} \text{S m/m} &= (\text{p} \times \text{tool diameter} \times \text{RPM}) / 1000 \\ \text{RPM} &= (\text{m/m} \times 1000) / \text{p} \times \text{tool diameter} \\ \text{mm/m} &= \text{mm P} \times \text{RPM} \end{aligned}$$

SFM = Surface Feet per Minute

IPM = Inches Per Minute

S m/m = Surface Meters per Minute

mm/m = Millimeters per Minute

RPM = Revolutions Per Minute

TPI = Threads Per Inch

p = 3.1416

P = Pitch (1/ No of Threads Per Inch)