INSERT GRADE SELECTION

INSERT GRADE SELECTION

COATED CARBIDE INSERTS		
IAN5	General purpose & heavy duty milling grade with excellent wear resistance for machining at low speeds & interrupted cuts	Low speed cutting for carbon steel or alloyed steel & higher speeds for cast iron
R5	Premium milling grade recommended for heavy roughing	Machining unalloyed & alloyed steels Preferably used for P20 - P40 applications
HN	Premium multi-purpose high speed machining grade	Machining high strength aerospace alloys, high nickel base materials, cast iron, & stainless
TA	Ultra fine submicron grade for general purpose milling	Machining titanium but can be used to machine high-temp. alloys & hard steels (up to <54 HRc)
TI-8	Premium milling grade for general purpose milling	Machining aluminum, kirksite, & remboard
TI-8J	Premium milling grade for general purpose milling (Uncoated carbide with J-Polish)	Machining aluminum, kirksite, & remboard
CERMET INSERTS		
TI-300	Cermet milling grade for high speed finishing	High speed machining semi-finishing & finishing for unalloyed & alloyed steels, cast iron, & harden steels ("RC" 50/60)

RECOMMENDED CUTTING GRADES

MATERIAL	INSERT GRADE
▲ **Unalloyed**	IAN5, R5, & TI-300
△ **Alloyed**	
△ **Stainless Steels**	HN, TA
△ **PH Stainless**	
▲ **Cast Irons**	IAN5, HN, TA, & TI-300
▲ **Aluminum & Alloys**	TI-8 & TI-8J
▲ **High Temp. Alloys**	HN & TA
▲ **Harden Steels**	HN, TA, & TI-300

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RECOMMENDED CUTTING CONDITIONS

RECOMMENDED CUTTING CONDITIONS FOR: COATED INSERTS

ISO	MATERIAL	MATERIAL STRENGTH	CARBIDE						CERMET
			COATED					UNCOATED	
			IAN5	R5	HN	TA	TI-8	TI-8 (J-Polished)	TI-300
SURFACE SPEED FEET PER MINUTE		*SURFACE SPEED FEET PER MINUTE*					* SURFACE SPEED FEET PER MINUTE*		
P	UNALLOYED STEELS	< 180 HBN	795 - 340	795 - 340	920 - 420	920 - 420	-	-	1140 - 770
		< 180 HBN	700 - 300	700 - 300	830 - 370	830 - 370	-	-	1010 - 670
	ALLOYED STEELS	210-280 HBN	650 - 300	650 - 300	790 - 320	790 - 320	-	-	890 - 590
		280-360 HBN	550 - 200	550 - 200	630 - 260	630 - 260	-	-	680 - 450
		360-415 HBN	325 - 130	325 - 130	360 - 160	360 - 160	-	-	430 - 290
M	STAINLESS STEELS	AUSTENIC + FERRITIC	-	-	920 - 420	920 - 420	710 - 390	-	1010 - 670
		MARTENSITIC	-	-	830 - 370	830 - 370	640 - 360	-	910 - 620
	PH STAINLESS	REFRACTORY P.H.	-	-	380 - 180	380 - 180	300 - 160	-	-
K	CAST IRONS	GREY GG-FT	840 - 360	840 - 360	970 - 470	970 - 470			1200 - 820
		SPHEROIDAL-DUCTILE GGG-FGS	655 - 280	655 - 280	780 - 370	780 - 370	-	-	940 - 630
		MALLEABLE GTS-MN/MP	595 - 255	595 - 255	710 - 340	710 - 340		-	860 - 570
N	ALUMINUM & ALLOYS	< 16% SILICON	-	-	-	-	3290 - 1300	3290 - 1300	-
		> 16% SILICON	-	-	-	-	1560 - 800	1560 - 800	-
S	HIGH TEMPERATURE ALLOYS	IRON BASED	-	-	300 - 130	300 - 130	250 - 130	-	-
		COBALT BASED	-	-	170 - 80	170 - 80	140 - 80	-	-
		NICKEL BASED	-	-	190 - 80	190 - 80	150 - 80	-	-
		TITANIUM BASED	-	-	220 - 90	220 - 90	170 - 90	-	-
H	HARD STEELS	48 - 52 HRC	300 - 130	300 - 130	200 -450	200 -450	-	-	200 - 360
		52 - 56 HRC	285 - 120	285 - 120	170 - 320	170 - 320	-	-	170 - 320
		56 - 58 HRC	265 - 115	265 - 115	70 - 130	70 - 130	-	-	70 - 130
		46 - 50 HRC	235 - 100	235 - 100	235 - 100	235 - 100	-	-	235 - 100
SURFACE SPEED FEET PER MINUTE		*SURFACE SPEED FEET PER MINUTE*					*SURFACE SPEED FEET PER MINUTE*		

Surface Speed Feet Per Minute

Surface Speed = $\frac{3.142 \times \text{Cutter Dia.} \times \text{R.P.M}}{12}$

R.P.M = $\frac{\text{Surface Speed} \times 12}{(\text{Cutter Dia.} \times 3.142)}$

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RECOMMENDED CUTTING CONDITIONS

CUTTING CONDITIONS FOR ARF INSERTS

ARF INSERT

AVAILABLE INSERTS
ARF-375
ARF-500
ARF-750
ARF-100
ARF-125

Note: Reduce Feeds & Speeds For Extended Tooling Lengths & Reduce RPM's If Chattering Occurs.
(Increasing & Decreasing Depth of Cut Depends On Tooling, Insert Geometry, Insert Coating, & Cutting Material)

GENERAL CUTTING DATA

MATERIAL	CUTTING SPEED (FT/MIN)		TOOL DIAMETER								MAX D.O.C. FINISH
			0.250"	0.3125"	0.375"	0.500"	0.625"	0.750"	1.000"	1.250"	
GRAY CAST IRON (HB 200 - 250)	1,000	R.P.M	8,000	8,000	8,000	7,500	6,100	5,100	3,850	2,052	0.012
		INCH/MIN	256	272	288	285	244	204	154	122	
NODULAR CAST IRON (HB 180 - 250)	900	R.P.M	8,000	8,000	8,000	6,900	5,500	4,600	3,450	2,750	0.012
		INCH/MIN	256	272	317	362	220	184	138	110	
CARBON STEEL (HRc - 55)	750	R.P.M	8,000	8,000	7,650	5,570	4,600	3,850	2,850	2,300	0.012
		INCH/MIN	256	272	275	219	184	154	114	92	
LOW ALLOY STEEL (HRc - 55)	600	R.P.M	8,000	7,350	6,100	4,600	3,700	3,050	2,300	1,850	0.012
		INCH/MIN	256	250	220	175	148	122	92	74	
TOOL & DIE STEEL (HRc - 45)	750	R.P.M	8,000	8,000	7,650	5,750	4,600	3,850	2,850	2,300	0.012
		INCH/MIN	128	136	138	109	92	77	57	46	
HARDENED DIE STEEL (HRc 50 - 60)	600	R.P.M	8,000	7,350	6,150	4,600	3,700	3,050	2,300	1,850	0.008
		INCH/MIN	128	125	111	87	74	61	46	37	
STAINLESS STEEL (HRc - 45)	400	R.P.M	6,150	4,900	4,100	3,050	2,450	2,050	1,550	1,250	0.012
		INCH/MIN	98	83	74	58	49	41	31	25	
INCONEL, TITANIUM (HRc - 45)	150	R.P.M	2,293	1,834	1,529	1,146	917	764	573	459	0.006
		INCH/MIN	9.2	7.8	6.9	5.4	4.6	3.8	2.9	2.3	
ALUMINUM ALLOY (HB 30 - 100)	1,000	R.P.M	8,000	8,000	8,000	7,650	6,150	5,100	3,850	3,050	0.012
		INCH/MIN	256	272	288	291	246	204	154	122	

HIGH SPEED MACHINING CUTTING DATA

MATERIAL	CUTTING SPEED (FT/MIN)		TOOL DIAMETER								MAX D.O.C. FINISH
			0.250"	0.3125"	0.375"	0.500"	0.625"	0.750"	1.000"	1.250"	
GRAY CAST IRON (HB 200 - 250)	1,000	R.P.M	20,000	20,000	20,000	15,000	12,500	10,000	7,500	6,000	0.012
		INCH/MIN	800	800	800	600	500	400	300	240	
NODULAR CAST IRON (HB 180 - 250)	900	R.P.M	20,000	20,000	18,000	13,500	11,000	9,000	7,000	5,500	0.012
		INCH/MIN	800	800	720	540	440	360	280	220	
CARBON STEEL (HRc - 55)	750	R.P.M	20,000	18,000	15,000	11,500	9,000	7,500	5,500	4,500	0.012
		INCH/MIN	800	720	600	460	360	300	220	180	
LOW ALLOY STEEL (HRc - 55)	600	R.P.M	18,000	15,000	12,000	9,000	7,500	6,000	4,500	3,600	0.012
		INCH/MIN	720	600	480	360	300	240	180	144	
TOOL & DIE STEEL (HRc - 45)	750	R.P.M	20,000	18,000	15,000	11,500	9,000	7,500	5,500	4,500	0.012
		INCH/MIN	400	360	300	230	180	150	110	90	
HARDENED DIE STEEL (HRc 50 - 60)	600	R.P.M	18,000	15,000	12,000	9,000	7,500	6,000	4,500	3,600	0.008
		INCH/MIN	360	300	240	180	150	120	90	72	
STAINLESS STEEL (HRc - 45)	400	R.P.M	11,500	9,000	7,500	5,500	4,500	3,800	2,800	2,300	0.012
		INCH/MIN	230	180	150	110	90	76	56	46	
INCONEL, TITANIUM (HRc - 45)	150	R.P.M	2,300	1,800	1,500	1,150	900	750	550	450	0.006
		INCH/MIN	11.5	9.00	7.50	5.75	4.50	3.75	2.75	2.25	
ALUMINUM ALLOY (HB 30 - 100)	1,000	R.P.M	20,000	20,000	20,000	20,000	18,000	15,000	11,500	9,000	0.012
		INCH/MIN	800	800	800	800	720	6000	460	360	

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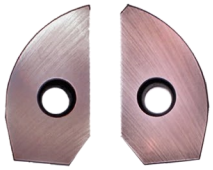
RECOMMENDED CUTTING CONDITIONS

CUTTING CONDITIONS FOR BI INSERTS



BI-750 BI-751

AVAILABLE INSERTS	AVAILABLE INSERTS
BI-750-IAN5	BI-751-IAN5
BI-100-IAN5	BI-101-IAN5
BI-125-IAN5	BI-125-IAN5
BI-200-IAN5	BI-201-IAN5

Note: IBC cutters take two different insert types
Example: IBC-75BI-2 cutter will need a BI-750 & BI-751 insert

Note: Reduce Feeds & Speeds For Extended Tooling Lengths & Reduce RPM's If Chattering Occurs.
(Increasing & Decreasing Depth of Cut Depends On Tooling, Insert Geometry, Insert Coating, & Cutting Material)

MATERIAL		CUTTING DIAMETER				
		0.750"	1.000"	1.250"	1.500"	2.000"
GRAY CAST IRON (HB 160 - 200)	SFM	450 - 550	500 - 630	520 - 690	510 - 720	520 - 730
	RPM	2,300 - 3,100	1,900 - 2,600	1,800 - 2,300	1,300 - 2,000	1,000 - 1,500
	INCH/MIN	33 - 46	32 - 45	30 - 43	27 - 40	22 - 33
	INCH/REV	0.012 - 0.016	0.014 - 0.022	0.016 - 0.024	0.016 - 0.026	0.016 - 0.028
GRAY CAST IRON (HB 200 - 240)	SFM	450 - 550	500 - 630	520 - 690	510 - 720	520 - 730
	RPM	2,300 - 3,100	1,900 - 2,600	1,800 - 2,300	1,300 - 2,000	1,000 - 1,500
	INCH/MIN	30 - 42	30 - 42	27 - 40	25 - 35	20 - 29
	INCH/REV	0.011 - 0.016	0.013 - 0.020	0.014 - 0.022	0.014 - 0.022	0.014 - 0.024
NODULAR CAST IRON (HB 140 - 190)	SFM	450 - 550	500 - 630	520 - 690	510 - 720	520 - 730
	RPM	2,300 - 3,100	1,900 - 2,400	1,800 - 2,300	1,300 - 2,000	1,000 - 1,500
	INCH/MIN	32 - 44	30 - 42	29 - 41	25 - 38	22 - 33
	INCH/REV	0.012 - 0.017	0.014 - 0.020	0.016 - 0.022	0.016 - 0.024	0.016 - 0.028
NODULAR CAST IRON (HB 190 - 240)	SFM	410 - 510	450 - 580	460 - 660	470 - 660	470 - 680
	RPM	2,100 - 2,900	1,700 - 2,400	1,350 - 1,900	1,200 - 1,850	900 - 1,400
	INCH/MIN	26 - 38	26 - 38	25 - 37	21 - 32	18 - 28
	INCH/REV	0.010 - 0.015	0.012 - 0.020	0.014 - 0.022	0.014 - 0.022	0.014 - 0.024
CAST STEEL (HB 180 - 220)	SFM	410 - 510	450 - 580	460 - 660	470 - 660	470 - 680
	RPM	2,100 - 2,900	1,700 - 2,400	1,400 - 2,200	1,200 - 1,850	900 - 1,400
	INCH/MIN	23 - 38	23 - 33	20 - 32	16 - 27	13 - 21
	INCH/REV	0.009 - 0.016	0.011 - 0.017	0.012 - 0.018	0.012 - 0.018	0.012 - 0.020
TOOL & DIE STEEL (HB 180 - 225)	SFM	390 - 490	420 - 550	450 - 600	470 - 680	470 - 680
	RPM	2,000 - 2,800	1,600 - 2,300	1,400 - 2,000	1,000 - 1,500	900 - 1,300
	INCH/MIN	18 - 30	17 - 28	16 - 26	14 - 19	12 - 19
	INCH/REV	0.008 - 0.013	0.009 - 0.015	0.010 - 0.016	0.010 - 0.016	0.010 - 0.018
LOW ALLOY STEEL (HB 180 - 280)	SFM	490 - 590	520 - 650	560 - 720	550 - 750	630 - 780
	RPM	2,500 - 3,300	2,000 - 2,700	1,700 - 2,400	1,400 - 2,000	1,200 - 1,600
	INCH/MIN	26 - 38	26 - 38	25 - 35	20 - 30	17 - 26
	INCH/REV	0.009 - 0.014	0.011 - 0.017	0.012 - 0.018	0.012 - 0.018	0.012 - 0.020
STAINLESS STEEL (HB 130 - 190)	SFM	310 - 410	340 - 480	360 - 540	350 - 540	370 - 580
	RPM	1,600 - 2,400	1,300 - 2,000	1,100 - 1,800	900 - 1,500	700 - 1,200
	INCH/MIN	15 - 26	14 - 25	13 - 23	12 - 20	9 - 17
	INCH/REV	0.008 - 0.013	0.009 - 0.015	0.010 - 0.016	0.010 - 0.016	0.010 - 0.018

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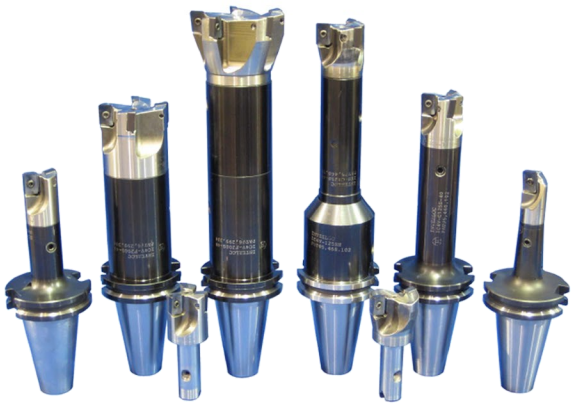
RECOMMENDED CUTTING CONDITIONS

CUTTING CONDITIONS FOR APCT, CDEW, RPG, & RPGW INSERTS



Note: Reduce Feeds & Speeds For Extended Tooling Lengths & Reduce RPM's If Chattering Occurs.

(Increasing & Decreasing Depth of Cut Depends On Tooling, Insert Geometry, Insert Coating, & Cutting Material)

MATERIAL	SURFACE FEET/MIN (SFM)			INCHES PER TOOTH (IPT)	
	ROUGHING	SEMI-FINISHING	FINISHING	APCT & CDEW	RPG & RPGW
▲ Unalloyed	600 - 700	730 - 850	730 - 980	0.003 - 0.015	0.006 - 0.015
△ Alloyed	230 - 360	330 - 630	330 - 630	0.003 - 0.015	0.006 - 0.015
△ Stainless Steels	400 - 450	600 - 750	600 - 750	0.003 - 0.012	0.004 - 0.012
△ PH Stainless	190 - 220	270 - 320	270 - 320	0.003 - 0.010	0.003 - 0.010
▲ Cast Irons	460 - 910	600 - 980	660 - 1140	0.003 - 0.015	0.006 - 0.015
▲ Aluminum & Alloys	910 - 1470	1320 - 2460	2300 - 3280	0.003 - 0.025	0.005 - 0.030
▲ High Temp. Alloys	90 - 130	120 - 160	150 - 190	0.003 - 0.008	0.003 - 0.008
▲ Hard Steels (52 - 56 HRc)	-	170 - 320	170 - 320	0.003 - 0.008	0.003 - 0.008

ADDITIONAL CUTTING DATA FOR LONGER TOOLS							
REACH/DIA.	< 4	4.10 - 4.50	4.60 - 5.30	5.40 - 5.70	5.80 - 6.20	6.30 - 6.80	6.90 +
RPM %	100	90	80	80	75	70	65
FEED %	100	90	90	80	75	70	65
NOTE: The above percentages should be applied, according to tool radio							

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RECOMMENDED CUTTING CONDITIONS

FEEDS & SPEED FOR: MILLING CUTTERHEADS (USING CARBIDE INSERTS)

General Feeds & Speeds For: APCT Cutters CDEW Cutters, Plunge Cutters, & Button Cutters

Increasing & Decreasing Dept of Cut Depends On Tooling, Insert Geometry, Insert Coating, & Cutting Material

NOTE: Reduce Feeds & Speeds For Extended Tooling Lengths & Reduce RPM's If Chattering Occurs

MATERIAL REFERENCE DATA			STARTING RPM FOR MILLING DIAMETERS												
MATERIALS	SFPM	CHIPLOAD IPT	1/2	5/8	3/4	1"	1 1/4	1 1/2	1 3/4	2"	2 1/2	3"	4"	5"	6"
Die Steel 50 - 60 Rc	80	0.003	600	500	400	300	250	200	175	150	125	100	75	60	50
Tool Steel 42 - 50 Rc	200	0.004	1500	1200	1000	800	600	500	430	375	300	250	190	150	125
Die Steel 32 -42 RC	220	0.004	1600	1350	1100	850	670	550	480	420	330	280	210	170	140
Tool Steel (Annealed)	300	0.01	2300	1900	1500	1200	900	750	650	575	450	380	300	230	190
Mold Die Steel (28 - 32 Rc)	400	0.01	3000	2400	2000	1500	1200	1000	850	750	600	500	375	300	250
4340 (Annealed)	450	0.008	3400	2700	2300	1700	1400	1150	1000	850	700	580	430	350	300
Steel (Medium Carbon)	400	0.006	3000	2400	2000	1500	1200	1000	850	750	600	500	375	300	250
Steel (Low Carbon)	850	0.008	6500	5200	4300	3200	2500	2100	1800	1600	1300	1100	800	650	550
Cast Iron (Hard)	200	0.006	1500	1200	1000	800	600	500	430	400	300	250	200	150	125
Cast Iron (Soft)	400	0.01	3000	2400	2000	1500	1200	1000	850	750	600	500	375	300	250
Malleable Iron	400	0.01	3000	2400	2000	1500	1200	1000	850	750	600	500	375	300	250
Cast Steel	500	0.008	3800	3000	2500	1900	1500	1300	1100	950	750	650	475	375	300
Steel (Low Alloy -High Carbon)	400	0.005	3000	2400	2000	1500	1200	1000	850	750	600	500	375	300	250
Chrome Nickel Alloys	300	0.005	2300	1900	1500	1200	900	750	650	575	450	380	300	230	190

USE NEGATIVE-POSITIVE INSERTS FOR:															
MATERIALS	SFPM	CHIPLOAD IPT	1/2	5/8	3/4	1"	1 1/4	1 1/2	1 3/4	2"	2 1/2	3"	4"	5"	6"
Stainless Steel 400 Series	500	0.010	3800	3000	2500	1900	1500	1300	1100	950	750	650	475	380	300
Stainless Steel 300 Series	800	0.010	6100	4900	4000	3000	2400	2000	1750	1500	1200	1000	750	600	500

GRADE CHART						
CARBIDE CLASS	C-1	C-2	C-3	C-5	C-6	C-7
METAL REMOVAL APPLICATIONS	Roughing	General Purpose	Semi-Roughing	Roughing & General Purpose	Semi-Finishing	Light Finishing

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RECOMMENDED CUTTING CONDITIONS

FEEDS & SPEED DATA USING CARBIDE INSERTS WHEN CUTTING: 4130 OR P-20 (4130 MODIFIED)

General Feeds & Speeds For: APCT Cutters CDEW Cutters, Plunge Cutters, & Button Cutters
Increasing & Decreasing Dept of Cut Depends On Tooling, Insert Geometry, Insert Coating, & Cutting Material
NOTE: Reduce Feeds & Speeds For Extended Tooling Lengths & Reduce RPM's If Chattering Occurs

	STEP 1					STEP 2	STEP 3								STEP 4
CUTTING DIA (INCHES)	NUMBER OF FLUTES	MIN. RPM	STARTING DEPTH			GRADUALLY INCREASE FEED RATE TO	5 HP	7.5 HP	10 HP	15 HP	20 HP	25 HP	30 HP	40 HP	GRADUALLY INCREASE RPM
			5 - 7.5 HP	10 - 15 HP	20 - 40 HP		GRADUALLY INCREASE DEPTH TO:								
1/2	2	3000	7"/MIN	0.050	0.100	14"/MIN	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	-
5/8	2	2400	7"/MIN	0.050	0.100	14"/MIN	0.200	0.200	0.200	0.200	0.200	0.200	0.200	0.200	-
3/4	2	2000	7"/MIN	0.050	0.100	14"/MIN	0.200	0.200	0.250	0.250	0.300	0.300	0.300	0.300	-
1"	2	1500	14"/MIN	0.050	0.100	24"/MIN	0.200	0.200	0.250	0.250	0.300	0.300	0.300	0.300	-
1 1/4	2	1200	14"/MIN	0.100	0.125	24"/MIN	0.200	0.300	0.400	0.450	0.450	0.450	0.450	0.450	1500
1 1/2	2	1000	14"/MIN	0.100	0.125	24"/MIN	0.170	0.250	0.330	0.450	0.450	0.450	0.450	0.450	1250
1 3/4	3	850	14"/MIN	0.100	0.125	24"/MIN	0.150	0.210	0.300	0.375	0.375	0.375	0.375	0.375	1100
2"	3	750	14"/MIN	0.100	0.125	24"/MIN	0.125	0.190	0.250	0.300	0.350	0.400	0.400	0.400	1000
2 1/2	3	600	14"/MIN	0.100	0.125	24"/MIN	-	0.150	0.200	0.300	0.350	0.350	0.400	0.400	800
3"	4	500	14"/MIN	0.080	0.100	24"/MIN	-	0.125	0.170	0.250	0.300	0.300	0.350	0.350	650
4"	5	375	14"/MIN	0.075	0.125	24"/MIN	-	-	-	0.180	0.250	0.300	0.300	0.350	500
5"	8	300	14"/MIN	0.060	0.100	24"/MIN	-	-	-	0.150	0.200	0.250	0.300	0.400	380
6"	8	250	14"/MIN	0.050	0.080	24"/MIN	-	-	-	-	0.160	0.200	0.250	0.300	300

METAL REMOVAL FORMULAS

FORMULA TO ESTABLISH FEED RATE
RPM x CHIPLOAD (IPT) x NUMBER OF FLUTES = FEED RATE

FORMULA TO ESTABLISH RPM	FORMULA TO CALCULATE SFPM
$\frac{\text{SFPM x 3.82}}{\text{DIA. Of CUTTER}} = \text{RPM}$	DIA. X 0.262 x RPM = SFPM

METAL REMOVAL RATE

Metal removal rate is the rate at which material is removed from an finished part. It usually measured in cubic inches per minute. The following formula can be used to calculate metal removal rate.

Depth of Cut	x	Width of Cut or Radial Depth	x	Table Feed Rate	=	Cubic Inches Per Minute

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RECOMMENDED CUTTING CONDITIONS

General Feeds & Speeds For: Uncertain Coated Carbide & Uncoated Carbide

MATERIAL	HIGH SPEED STEEL	COBALT TOOL STEEL	UNCOATED CARBIDE	COATED CARBIDE
NON-FERROUS MATERIAL				
ALUMINUM ALLOY	600+ FT./MIN.	-	1200+ FT./MIN.	650+ FT./MIN
MAGNESIUM ALLOYS	600+ FT./MIN.	-	1000+ FT./MIN.	
BRASS	300+ FT./MIN	-	800+ FT./MIN.	
BRONZE	80 - 100 FT./MIN.	-	250 - 300 FT./MIN.	
TITANIUM (DOUBLE STRATING FEED RATES)				
COMMERCIALLY PURE	115 - 140 FT./MIN.	-	275 - 325 FT./MIN	650+ FT./MIN
ALPHA & ALPHA-BETA ALLOYS		30 - 50 FT./MIN	200 - 225 FT./MIN	
FERRROUS MATERIAL				
STEELS				
FREE MACHINING CARBON STEEL	130 - 180 FT./MIN.	-	450 - 500 FT./MIN.	750 - 900 FT./MIN.
LOW CARBON STEEL	120 - 170 FT./MIN.	-	400 - 450 FT./MIN.	600 - 650 FT./MIN.
MEDIUM CARBON STEEL	100 - 120 FT./MIN.	-	375 - 425 FT./MIN.	550 - 600 FT./MIN.
ALLOY STEEL	100 - 120 FT./MIN.	-	375 - 425 FT./MIN.	550 - 600 FT./MIN.
ALLOY & MEDIUM CARBON HEATED TREATED (Rc 26 - 32)	75 - 100 FT./MIN.	-	250 -300 FT./MIN.	450 - 500 FT./MIN.
ALLOY & MEDIUM CARBON HEATED TREATED (Rc 36 - 40)	-	50 - 60 FT./MIN.	180 - 200 FT./MIN.	225 - 275 FT./MIN.
ALLOY & MEDIUM CARBON HEATED TREATED (Rc 40 - 48)	-	40 - 50 FT./MIN.	150 - 180 FT./MIN.	220 - 250 FT./MIN.
ALLOY & MEDIUM CARBON HEATED TREATED (Rc 48+)	-	20 - 30 FT./MIN.	100 - 120 FT./MIN.	-
TOOL STEEL (WROUGHT)	40 - 60 FT./MIN.	-	180 - 200 FT./MIN.	350 FT./MIN.
STAINLESS STEAL				
FREE MACHINING	80 - 110 FT./MIN.	-	100 - 140 FT./MIN.	140+ FT./MIN.
STAINLESS (300 SERIES)	50 - 70 FT./MIN.	-	80 - 100 FT./MIN.	100+ FT./MIN.
17-4PH ANNEALLED	50 - 80 FT./MIN.	-	150 - 190 FT./MIN.	190+ FT./MIN.
17-4PH 200,00 PSI	30 - 50 FT./MIN.	-	100 - 140 FT./MIN.	140+ FT./MIN.
HIGH TEMPERATURE ALLOYS				
HASTELOY X., INCONEL	15 - 20 FT./MIN.	-	45 - 55 FT./MIN.	-
INCONEL X	-	20 - 25 FT./MIN.	-	-
MONEL NICKEL ALLOY	-	20 - 25 FT./MIN.	-	-
CAST IRON				
MALLEABLE IRON	100 - 140 FT./MIN.	-	400 - 450 FT./MIN.	540 - 700 FT./MIN.
GRAY CAST IRON	65 - 110 FT./MIN.	-	220 - 300 FT./MIN.	340 - 450 FT./MIN.
DUCTILE IRON	80 - 125 FT./MIN	-	300 - 350 FT./MIN.	460 - 550 FT./MIN.

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RECOMMENDED CUTTING CONDITIONS

FORMULAS	
Surface Feet Per Minute	SFM = .262 x RPM x D
Revolutions Per Minute	RPM = 3.82 x SFM ÷ D
Inch Per Revolution	IPR = IPM ÷ RPM
Inch Per Minute (Feed Rate)	IPM = IPT x NT x RPM
Feed Per Tooth (Chip Load)	FPT = IPM ÷ (NT x RPM)
Metal Removal Rate	MRR = DOC x WOC x IPM = Cubic Inches/Min
Horse Power At Cutter	HPc = MRR ÷ K
Horse Power At Motor	HPm = HPC ÷ E

VARIABLES
DOC = Axial Dept of Cut
WOC = Radial Width of Cut
E = Spindle Efficiency (Varies 75% to 90%)
K = A power factor that represents the number of cubic inches of metal per minute that can be removed by one horsepower
NT = Number of effective teeth or inserts in a cutter
D = Cutter Diameter

"K" FACTORS		
WORK MATERIAL	**Hardness BHN**	**"K" Factor**
Steel, Wrought & Cast Iron (Plain Carbon, Alloy Steels, & Tool Steels)	85 - 200	1.64
	201 - 253	1.58
	254 - 288	1.28
	287 - 327	1.10
	328 - 371	0.88
	372 - 481	0.69
	492 - 550	0.59
	561 - 515	0.54
Precipitation, Hardening Stainless Steels	150 -450	1.27 - .42
Cast Irons (Grey, Ductile & Malleable)	150 -175	2.27
	110 -190	2.00
	176 -200	1.89
	201 - 250	1.52
	251 - 300	1.27
	301 -320	1.19
Stainless Steels Wrought & Cast (Ferritic, Austenitic, & Martensitic	135 - 275	1.54 - .76
	288 - 421	.75 - .50
Titanium	250 - 375	1.33 - .87
High-Temperature Alloys Nickel, & Cobalt Based	200 - 380	.83 - .48
Iron Base	180 - 320	.91 - .53
Nickel Alloys	80 - 360	.91 - .53
Aluminum Alloys	30 - 150 (500 kg)	6.25 - 3.33
Magnesium Alloys	40 - 90 (500 kg)	10.0 - 6.67
Copper	150	3.33
Copper Alloys	100 - 150	3.33
	151 - 240	2

Specific Cutting Resistance As Per Work Piece Material

WORK PIECE		5 HP	10 HP	20 HP	30 HP	40 HP	50 HP
STEEL	**Soft**	32	75	163	295	425	570
	Medium	26	55	127	212	310	425
	Hard	18	41	93	163	228	310
CAST IRON	**Soft**	52	116	260	455	670	880
	Medium	32	75	163	295	425	570
	Hard	26	55	127	212	310	425
BRASS BRONZE	**Soft**	77	163	390	670	980	1280
	Medium	54	118	275	490	700	910
	Hard	26	55	127	245	325	425
ALUMINUM		90	195	440	780	1110	1500

Chip Volume As Per Horse Power cm³/min

MATERIAL	Tensile Strength & Hardness	Specific Cutting Resistance ks(kg/mm²)				
		0.004 (IPT)	0.008 (IPT)	0.012 (IPT)	0.016 (IPT)	0.024 (IPT)
Soft Steel	52	220	195	182	170	158
Medium Steel	62	198	180	173	160	157
Hard Steel	72	252	220	204	185	174
Tool Steel	67	198	180	173	170	160
Tool Steel	77	203	180	175	170	158
Chrome Manganese Steel	77	230	200	188	175	166
Chrome Manganese Steel	63	275	230	206	180	178
Chrome Molybdenum Steel	73	254	225	214	200	180
Chrome Molybdenum Steel	60	218	200	186	180	167
Nickel Chrome Molybdenum Steel	94	200	180	168	160	150
Nickel Chrome Molybdenum Steel	HB352	210	190	176	170	153
Cast Steel	52	280	250	232	220	204
Hard Cast Iron	HBC46	300	270	250	240	220
Cast Iron	36	218	200	175	160	147
Gray Cast Iron	HB200	175	140	124	105	97
Brass	50	115	95	80	70	63
Aluminum Alloy (Al-Mg)	16	58	48	40	35	32
Aluminum Alloy (Al-Si)	20	70	60	52	45	39

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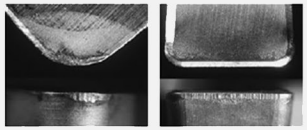
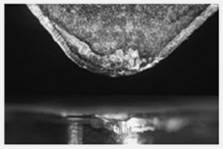
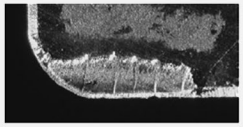
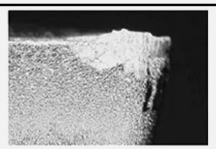
TROUBLE SHOOTING: INSERT WEAR

PROBLEM		CAUSE	SOLUTION
	**Flank Wear:**	• Cutting Speed Too High • Incorrect Grade Or Coating • Poor Wear Resistance • Feed Rate Too Low	• Reduce Cutting Speed • Select a more sufficient Wear Resistance grade or coating • Increase Feed Rate • Decrease RPM
	**Insert Chipping**	• Cutting Speed Is To Low • Incorrect Grade Or Coating • Feed Rate Too High	• Increase Cutting Speed • Decrease Feed Rate • Decrease DOC • Use Large Hone Or T-Land Insert • Select A More Tougher Grade Or Coating
	**Thermal Cracks**	• Poor Chip flow • Incorrect Grade Or Coating • Feed Rate too High • Cutting Speed Too High	• Reduce Cutting speed • Reduce Feed per Tooth • Select a more sufficient Wear Resistance grade or coating • Depending on application: Use plenty of coolant or shut coolant off
	**Built-Up Edge**	• Low Cutting Speeds • Feed Rate To Low • Negative Cutting Geometry • Incorrect Coating	• Increase Cutting Speed • Increase Feed Rate • Select A More Tougher Grade Or Coating • Use Coolant
	Poor Surface Finish	• Feed Rate Too High • Wrong Insert Position • Improper Tool Holding • Cutter Length Out Too Far	• Reduce Feed • Change Insert Position • Check Reduce Tool Length • Use More Rigid Tooling
	Vibrations	• Wrong Cutting Data • Bad Stability	• Reduce Cutting Speed • Increase Feed • Decrease DOC • Reduce Tooling Length • Use More Rigid Tooling

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