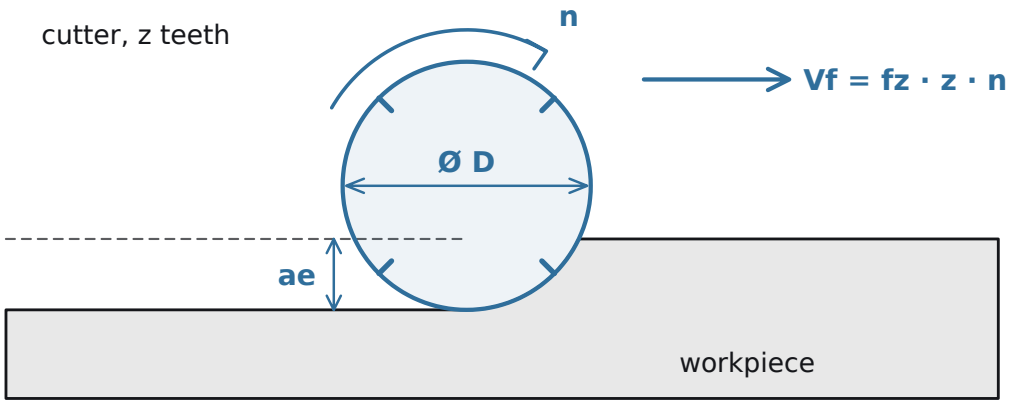
PRINTABLE REFERENCE CHART

Speeds and feeds: formulas, examples and RPM chart

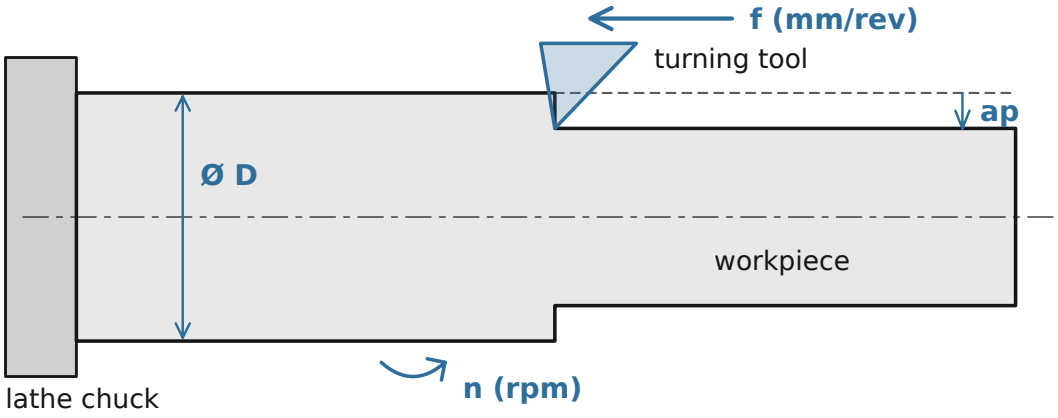
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1. Cutting speed and feed formulas



Quantity	Metric	Inch
Spindle speed	n = 1,000·Vc / (π·D) (rpm; Vc in m/min, D in mm)	RPM = 12·SFM / (π·D) ≈ 3.82·SFM / D (D in inches)
Cutting speed	Vc = π·D·n / 1000	SFM = π·D·RPM / 12
Feed rate, milling	Vf = fz·z·n (mm/min; fz in mm/tooth)	IPM = IPT·z·RPM (in/min)
Feed rate, turning and drilling	Vf = f·n (f in mm/rev)	IPM = IPR·RPM
Removal rate, milling	Q = ap·ae·Vf / 1,000 (cm³/min)	Q = ap·ae·IPM (in³/min)
Removal rate, turning	Q = Vc·ap·f (cm³/min)	Q = 12·SFM·ap·IPR (in³/min)
Removal rate, drilling	Q = π·D²/4 · Vf / 1,000 (cm³/min)	Q = π·D²/4 · IPM (in³/min)
Cutting time	t = L / Vf (min; L in mm)	t = L / IPM
Cutting power	Pc = Q·kc / 60,000 (kW; Q in cm³/min, kc in N/mm²)	—

D is the tool diameter in milling and drilling, and the workpiece diameter at the cut in turning. kc is the material's specific cutting force (in N/mm², given by tool manufacturers by material and chip thickness); the power obtained is that consumed at the cutting edge: the spindle must deliver more, including machine efficiency. 1 m/min = 3.281 surface feet per minute (SFM); 1 inch = 25.4 mm.



3. Worked examples

Case	Calculation	Result
Milling: Ø 10 end mill, 4 flutes, Vc = 100 m/min	n = 1,000 × 100 / (π × 10)	**3,183 rpm**
Feed at 0.05 mm/tooth	Vf = 0.05 × 4 × 3,183	**637 mm/min**
Removal rate, ap = 5, ae = 2 mm; time over 200 mm	Q = 5 × 2 × 637 / 1,000; t = 200 / 637	**6.37 cm³/min; 18.8 s**
Turning: Ø 50, Vc = 150 m/min, f = 0.2 mm/rev, ap = 2 mm	n = 150,000 / (π × 50); Vf = 0.2 × n; Q = 150 × 2 × 0.2	**955 rpm; 191 mm/min; 60 cm³/min**
Same turning, with an entered kc of 2,000 N/mm²	Pc = 60 × 2,000 / 60,000	**2.0 kW at the edge**
Drilling: Ø 8.5 drill, Vc = 25 m/min, f = 0.15 mm/rev	n = 25,000 / (π × 8.5); Vf = 0.15 × n	**936 rpm; 140 mm/min**
Inch: 1/2 in end mill, 4 flutes, 300 SFM, 0.002 IPT	RPM = 12 × 300 / (π × 0.5); IPM = 0.002 × 4 × RPM	**2,292 rpm; 18.3 in/min**

The kc of 2,000 N/mm² is only a value entered for the example: use the one the tool manufacturer gives for your material. The 300 SFM of the inch example equal 91.4 m/min.

4. RPM chart (rev/min)

Spindle speed n = 1,000·Vc / (π·D), rounded to the nearest rpm, for tool or workpiece diameters from 3 to 100 mm and cutting speeds from 20 to 300 m/min.

D (mm) \ Vc (m/min)	20	30	50	80	100	150	200	300
3	2,122	3,183	5,305	8,488	10,610	15,915	21,221	31,831
6	1,061	1,592	2,653	4,244	5,305	7,958	10,610	15,915
8	796	1,194	1,989	3,183	3,979	5,968	7,958	11,937
10	637	955	1,592	2,546	3,183	4,775	6,366	9,549
12	531	796	1,326	2,122	2,653	3,979	5,305	7,958
16	398	597	995	1,592	1,989	2,984	3,979	5,968
20	318	477	796	1,273	1,592	2,387	3,183	4,775
25	255	382	637	1,019	1,273	1,910	2,546	3,820
32	199	298	497	796	995	1,492	1,989	2,984
40	159	239	398	637	796	1,194	1,592	2,387
50	127	191	318	509	637	955	1,273	1,910
63	101	152	253	404	505	758	1,011	1,516
80	80	119	199	318	398	597	796	1,194
100	64	95	159	255	318	477	637	955

Speed is proportional to Vc and inversely proportional to D: for 40 m/min, double the 20 column; for Ø 5, double the Ø 10 row. A speed above the spindle maximum means lowering Vc, not changing the formula.

6. Speeds and feeds in Excel

One row per tool, in mm and m/min: D in A2, Vc in B2, z in C2, fz in D2, ap in E2, ae in F2, L in G2 (values of the milling example: 10, 100, 4, 0.05, 5, 2, 200).

Result	Excel or LibreOffice	Value
H2: spindle speed (rpm)	`=1000*B2/(PI()*A2)`	3,183.1

Result	Excel or LibreOffice	Value
I2: feed rate (mm/min)	`=D2*C2*H2`	636.6
J2: removal rate (cm³/min)	`=E2*F2*I2/1000`	6.37
K2: cutting time (s)	`=G2/I2*60`	18.8
Inch speed (RPM), D in inches, Vc in SFM	`=12*B2/(PI()*A2)`	2,291.8 (0.5 in, 300 SFM)

In turning and drilling, replace I2 with `=D2*H2` (D2 then being the feed per revolution f); in turning, the removal rate is `=B2*E2*D2`; in drilling, `=PI()*A2^2/4*I2/1000`. Cutting power in kW is `=J2*kc/60000`, kc in N/mm². In French-language Excel, PI keeps its name, with semicolons as separators. Formulas checked in LibreOffice Calc on the examples in section 3.

Reference values taken from the article https://www.baouch.fr/en/blog/vitesse-de-coupe-avance-calcul/, which explains the assumptions, formulas and edge cases. For critical use, check the current standard or the manufacturer's documentation. Free to print and share with credit to the source.