

# Cutting Speed 101

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THE BASICS OF CALCULATING RPMS

PRINCIPLES OF MACHINING



# Cutting Speed and RPMs

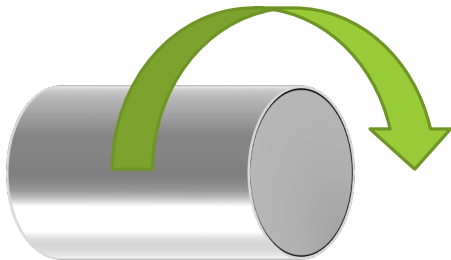
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When using a drill press, lathe, or milling machine the rotational speed of the cutting tool or workpiece is an important component that affects safety, cutting tool lifespan, and workpiece quality.

The machine tools set this speed in revolutions per minute, or RPMs.

The cutting speeds provided in the Machinery Handbook and other references are peripheral speeds. This is the rate at which the outer edge of the cutting tool or workpiece travels, measured in feet per minute.

Converting from the cutting speeds to RPMs requires that you take the diameter of the drill bit, cutting tool, or workpiece into account.



# Calculating RPM

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For calculating RPM from the cutting speeds (FPM) for a drill press, milling machine, or lathe, the equation commonly used is:

$$RPM = \frac{\textit{Cutting Speed} \times 4}{\textit{Diameter}}$$

For a drill press, the diameter is the diameter of the drill.

For a milling machine, the diameter is the diameter of your cutting tool.

For a lathe, the diameter is the diameter of your workpiece.

# Calculating RPM - Explanation

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To calculate RPM from the surface feet per minute (FPM) cutting speed, the full formula is:

$$RPM = \frac{\textit{Cutting Speed}}{\textit{Diameter} \times \pi}$$

Now, the cutting speed and diameter need to be in the same units, so if your cutting speed is in feet per minute, and the diameter of the cutting tool or workpiece is measured in inches, you will need to convert this. To convert feet per minute to inches per minute, you would multiply by 12.

$$RPM = \frac{\textit{Cutting Speed} \times 12}{\textit{Diameter} \times \pi}$$

# Calculating RPM - Explanation

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$$RPM = \frac{Cutting\ Speed \times 12}{Diameter \times \pi}$$

RPM is usually a rough value, as the machine tools do not have the precision to set very specific speeds. Therefore, it is customary in calculating speeds to approximate  $\pi$  as 3. When you do this, you can simplify the equation:

$$RPM = \frac{Cutting\ Speed \times 4}{Diameter}$$

# Calculating RPM - Metric

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You may be in a situation where you are using metric measurements. The cutting speed is provided in Meters per minute, and the diameter of the cutting tool or workpiece is measured in millimeters.

The RPM formula remains the same:

$$RPM = \frac{\textit{Cutting Speed}}{\textit{Diameter} \times \pi}$$

Estimating  $\pi$  as 3, and converting the cutting speed into millimeters per minute would give:

$$RPM = \frac{\textit{Cutting Speed} \times 1000}{\textit{Diameter} \times 3} = \frac{\textit{Cutting Speed} \times 333}{\textit{Diameter}}$$

# Speed Adjustments

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The calculated cutting speed is a starting point. The final speed used will depend on:

- Condition of the machine
- Type of cutting tools used
- Depth of cut
- Desired surface quality

When in doubt, start slower and speed up

# Example – Drill Press

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What speed should you use for a ½” diameter HSS drill when drilling aluminum? The recommended cutting speed is 200-300 fpm.

$$\begin{aligned} \text{RPM} &= \frac{\text{Cutting Speed} \times 4}{\text{Diameter}} \\ &= \frac{250 \times 4}{0.5} \\ &= \frac{1000}{0.5} \\ &= \mathbf{2000 \text{ RPM}} \end{aligned}$$

Note – We used 250 as the cutting speed as it is the midpoint of the recommended range. Depending on the workpiece and the condition of the drill press, you may opt to use the higher or lower speed.



# Example - Lathe

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What spindle speed should you use for an initial roughing cut on brass with a 3" diameter? The recommended cutting speed is 160 fpm.

$$\text{RPM} = \frac{\text{Cutting Speed} \times 4}{\text{Diameter}}$$

$$= \frac{160 \times 4}{3}$$

$$= \frac{640}{3}$$

$$= \mathbf{213 \text{ RPM}}$$

# Example – Milling Machine

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What is the cutting speed for a 6” diameter HSS side cutter, when milling freecutting steel? The recommended cutting speed is 150 – 250 fpm.

$$\text{RPM} = \frac{\text{Cutting Speed} \times 4}{\text{Diameter}}$$

$$= \frac{200 \times 4}{6}$$

$$= \frac{800}{6}$$

$$= \mathbf{133.33 \text{ RPM}}$$

Note – We used 200 as the cutting speed as it is the midpoint of the recommended range.

Depending on the desired finish, depth of the cut, or condition of the machine, you may opt to use the higher or lower values.



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