Typical Machining Spindle Speeds & Feeds Rates

Milling, turning & some drilling operations use spindle rotation when removing excessive material from a piece of stock material. The rotational movement may be that of the cutting tool (milling) or the part itself (lathes). In both cases, the operations of the machine spindle and the working feed rate of the cutting tool need to be strictly controlled by the numerical control program. These 'CNC' machines require instructions which relate to the selection of a suitable speed of the machine spindle and a cutting feed rate for each application.

Feed rate is the closest programming companion to the spindle speed. While the spindle function controls the spindle rotation & direction, feed rate controls how fast the tool will move, usually to remove excessive material (stock). Whenever a cutting motion is applied, a feed rate must be specified.

It is difficult to determine precise data for any metal – cutting operation without knowledge of the practicalities involved. The type of factors which must be taken into account would include the condition of the machine, the power available, rigidity of tooling and work, volume of material to be removed, the surface finish required and the type of coolant used.

The speeds given are for average metal cutting conditions and could be increased for light finishing cuts or reduced for heavier roughing cuts.

Surface Cutting Speeds

Surface Cutting Speeds (meters/minute)				
	Part Material			
Tool Material	Mild Steel	Cast Iron	Alum. Alloy	Brass
Cemented Carbide	170	100	250	180
High Speed Steel	28	18	120	75

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Spindle Speeds

The surface cutting speed relates to the machine spindle speed as follows:

Spindle Speeds for Lathes or Turning Centres

$$\text{Spindle Speed (rev/min)} = \frac{1000 \times \text{Cutting Speed (m/min)}}{\pi \times \text{Work Diameter (mm)}}$$

Spindle Speeds for Milling Machines or Machining Centres

$$\text{Spindle Speed (rev/min)} = \frac{1000 \times \text{Cutting Speed (m/min)}}{\pi \times \text{Tool Diameter (mm)}}$$

Machining Feed Rates

Feed Rates for Lathes and Turning Centres

Cemented Carbides are the materials of choice when selecting tools for turning operations.

Typical Feed Rates for Turning (mm/rev)			
Mild Steel	Cast Iron	Aluminium Alloy	Brass
0.25	0.25	0.3	0.3

To determine the feed rate in mm/min:

$$\text{Feed Rate (mm/min)} = \text{Feed Rate (mm/rev)} \times \text{Spindle Speed (rev/min)}$$

Feed Rates for Milling Machines and Machining Centres

Manufactures of milling cutters state recommended feed rates in mm/rev, mm/min or mm/tooth. For general use, feed rates quoted in mm/tooth are most suitable.

Typical Feed Rates for Milling (mm/tooth)				
	High Speed Steel Cutters		Cemented Carbide Cutters	
Work Material	Face Mills	End Mills & Slot Drills	Face Mills	End Mills & Slot Drills*
Mild Steel	0.25	0.15	0.30	0.18
Cast Iron	0.30	0.18	0.50	0.21
Alum. Alloy	0.40	0.17	0.60	0.25
Brass	0.35	0.15	0.40	0.19
* As with high-speed steel slot drills, the design of some cemented carbide milling				

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cutters allow for both plunge and side cutting.

This data can be used to determine the feed rate in mm/rev.

Feed Rate (mm/rev) = Feed Rate (mm/tooth) x Number of teeth

From this,

Feed Rate (mm/min) = Feed Rate (mm/rev) x Spindle Speed (rev/min)

Feed Rates for Drilling

High speed steel drills are used extensively for producing holes. The geometry of high speed drill bits cause them to be relatively fragile and therefore liable to break. As can be seen in the table below, the feed rate used for drill bits is related to the drill size.

Typical Feed Rates for High-Speed Steel Drills										
Drill Size (mm)	2	4	6	8	10	12	14	16	18	20
Feed Rate (mm/rev)	0.05	0.10	0.12	0.15	0.18	0.21	0.24	0.26	0.28	0.30

Feed Rate (mm/min) = Feed Rate (mm/rev) x Spindle Speed (rev/min)

Feed Rate & Spindle Speed Override

On the majority of control systems there are facilities which enable the operator to manually change both the feed rate and the spindle speed. This is very useful in the initial setting up of the machine and also when some of the earlier considerations are taken into account, e.g., a poor surface finish.

Changes made manually do not affect the basic program but any changes made should be recorded so that permanent change can be made if necessary.

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