Main motion in machining

Machining is any process in which a cutting tool is used to remove small chips of material from the workpiece (the workpiece is often called the "work"). To perform the operation, relative motion is required between the tool and the work. This relative motion is achieved in most machining operation by means of a primary motion, called "Cutting speed" i.e. Cutting speed (also called surface speed or simply speed) is the speed difference (relative velocity) between the cutting tool and the surface of the workpiece. Generally the simple defined of cutting speed (VC); it is the travel of a point on the cutting edge relative to the surface of cutting in unit time in the processes of the primary cutting motion.

It is expressed in units of distance are advanced along the workpiece surface per unit of time or defined as the rate that the material moves past the cutting edge of the tool, irrespective of the machining operation used and a secondary motion called "feed", Feed rate (also often as a solid compound, feed rate, or called simply feed) is the relative velocity at which the cutter or cutting tool is advanced along or inside the workpiece. The shape of the tool and its penetration into the work surface, combined with these motions, produce the desired shape of the resulting work surface.

Cutting conditions; Relative motion is required between the tool and work to perform a machining operation. The primary motion is accomplished at a certain cutting speed, is as the speed at which the metal is removed by the tool from the work piece. In other words, it is the peripheral speed of the work past the cutting tool. It is usually expressed in meters per minute. In addition, the tool must be moved across the work. This is a much slower motion is defined as the distance which the tool advances for each revolution of the work, is usually expressed in (mm/rev) called the feed. The remaining dimension of the cut is the penetration of the cutting tool below the original work surface, called the depth of cut; is defined as the depth of penetration of the tool into the work piece during machining. In other words, it is the perpendicular distance measured from the machined surface to the non-machined surface of the work piece. It is usually expressed in millimetres.

The speed, feed, and depth of cut are called the cutting conditions. Speed and feed are the most important accomplishing considerations to achieve the best results from
cutting tools. Improper speed and feed often cause low production, poor quality, and damage to the tool. Speed that is too high or feed that is too light can lead to rapid wear and dulling of the cutter, reducing tool life.

The some lows of cutting process can be used such as the following;

The formula of material removal rate of lathe machine

\[ R_{MR} = vfd \]

Since;

\[ R_{MR} \] – the material removal rate \((mm^3/s)\)

\(v\) – the cutting speed \((m/s)\)

\(f\) – the feed \((mm/rev)\)

\(d\) – the depth of cut \((mm)\)

For milling machine: \(R = w.d.F_m\)

w- width of workpiece

d- depth of cut

\(F_m\) - feed

\(F_m = f_z.z.n\)

z- number of teeth

n- revolution per minute \((r.p.m)\)

And the formula of cutting speed (velocity) ;
\[ V_c = \frac{\pi \cdot D \cdot N}{1000} \text{ m/min} \]

Since;

\( V_c \)-cutting velocity (m/minute)

D-diameter of cutter or workpiece or drill (mm)

N-number of revolution of spindle or cutter per minute

And the formula of cut depth (\( t \));

\[ t = \frac{D_1 - D_2}{2} \text{ mm} \]

Since;

D1-diameter before machining (depth of cut),

D2-diameter after machining

And the formula of feed (\( F \));

\[ F_m = f \cdot N \text{ (feed in mm per minute)} \]

Since;

f- feed in mm per revolutions or stroke

N-number of revolutions of spindle or strokes per minute

Also the feed of milling machine;

\[ F = f \cdot z \]

Since;

f- feed per tooth of cutter

z- teeth number of cutter
Or

\[ F = f \cdot T \cdot N \]

\( f \)-feed per tooth (mm)

\( T \) or \( z \)-number of teeth

\( N \)-R.P.M

Machining time formula (\( T \));

\[ T = \left( \frac{L}{F_m} \right) \cdot i \text{ (minute)} \]

Since;

\( i \)-Times number of cutting

\( L \)-length of machining surface (mm)

For lathe machine \( L = l + c \) (c; clearance)

For drilling machine \( L = l + h + s \)

\( S \); over travel of drill

\( l \)=thickness of workpiece (mm)

\( h = 0.3 \cdot D \)

For milling machine \( L = l + 2A \)

\( A = \sqrt{t(d-t)} \), \( t \) is depth of cutting and \( d \) is diameter of cutter