Important Milling Operation Formulas PDF

Formulas
Examples
with Units

List of 18
Important Milling Operation Formulas

1) Face and Vertical Milling Formulas

1.1) Diameter of Tool given Proportion of Edge Engagement for Face Milling Formula

Evaluate Formula

Formula

$$D_{cut} = \frac{a_e}{\sin\left(Q \cdot \pi\right)}$$

Example with Units

$$54.676\,\text{mm} = \frac{52\,\text{mm}}{\sin\left(0.4 \cdot 3.1416\right)}$$

1.2) Feed Speed in Vertical Milling given Maximum Chip Thickness Formula

Evaluate Formula

Formula

$$V_{fm} = C_v \cdot N_t \cdot v_{rot}$$

Example with Units

$$0.704\,\text{mm/s} = 0.004\,\text{mm} \cdot 16 \cdot 11\,\text{Hz}$$

1.3) Machining Time for Milling Operation Formula

Evaluate Formula

Formula

$$t_m = \frac{L + L_v}{V_{fm}}$$

Example with Units

$$480.1517\,\text{s} = \frac{400\,\text{mm} + 27.335\,\text{mm}}{0.89\,\text{mm/s}}$$

1.4) Machining Time for Shaping Operation Formula

Evaluate Formula

Formula

$$t_m = \frac{b_w}{f_r \cdot n_{rs}}$$

Example with Units

$$487.9121\,\text{s} = \frac{444\,\text{mm}}{0.70\,\text{mm/rev} \cdot 1.3\,\text{Hz}}$$

1.5) Maximum Chip Thickness in Vertical Milling Formula

Evaluate Formula

Formula

$$C_v = \frac{V_{fm}}{N_t \cdot v_{rot}}$$

Example with Units

$$0.0051\,\text{mm} = \frac{0.89\,\text{mm/s}}{16 \cdot 11\,\text{Hz}}$$

1.6) Minimum Length of Approach required in Face Milling Formula

Evaluate Formula

Formula

$$L_v = \frac{D_{cut}}{2}$$

Example with Units

$$27.335\,\text{mm} = \frac{54.67\,\text{mm}}{2}$$

1.7) Proportion of Cutting Edge Engagement for Face Milling Formula

Evaluate Formula

Formula

$$Q = a\frac{\sin\left(\frac{a_e}{D_{cut}}\right)}{\pi}$$

Example with Units

$$0.4001 = a\frac{\sin\left(\frac{52\,\text{mm}}{54.67\,\text{mm}}\right)}{3.1416}$$

1.8) Work Engagement given Proportion of Edge Engagement for Face Milling Formula

Evaluate Formula

Formula

$$a_e = \sin\left(Q \cdot \pi\right) \cdot D_{cut}$$

Example with Units

$$51.9943\,\text{mm} = \sin\left(0.4 \cdot 3.1416\right) \cdot 54.67\,\text{mm}$$

2) Slab and Slide Milling Formulas

2.1) Depth of Cut in Slab Milling using Tool Engagement Angle Formula

Evaluate Formula

Formula

$$d_{cut} = \left(1 - \cos\left(\theta\right)\right) \cdot \frac{D_{cut}}{2}$$

Example with Units

$$4.9435\,\text{mm} = \left(1 - \cos\left(35°\right)\right) \cdot \frac{54.67\,\text{mm}}{2}$$

2.2) Diameter of Tool given Proportion of Edge Engagement for Slab and Side Milling Formula

Evaluate Formula

Formula

$$D_{cut} = 2 \cdot \frac{a_e}{\sin\left(\left(Q - 0.25\right) \cdot 2 \cdot \pi\right) + 1}$$

Example with Units

$$57.4898\,\text{mm} = 2 \cdot \frac{52\,\text{mm}}{\sin\left(\left(0.4 - 0.25\right) \cdot 2 \cdot 3.1416\right) + 1}$$

2.3) Feed in Slab Milling given Feed Speed Formula

Evaluate Formula

Formula

$$f_r = \frac{V_{fm}}{n_{rs}}$$

Example with Units

$$0.6846\,\text{mm/rev} = \frac{0.89\,\text{mm/s}}{1.3\,\text{Hz}}$$

2.4) Feed Speed of Workpiece in Slab Milling Formula

Evaluate Formula

Formula

$$V_{fm} = f_r \cdot n_{rs}$$

Example with Units

$$0.91\,\text{mm/s} = 0.70\,\text{mm/rev} \cdot 1.3\,\text{Hz}$$

2.5) Maximum Chip Thickness obtained in Slab Milling using Depth of Cut Formula

Evaluate Formula

Formula

$$C_{max} = 2 \cdot V_{fm} \cdot \frac{\sqrt{\frac{d_{cut}}{D_{cut}}}}{N_t \cdot v_{rot}}$$

Example with Units

$$0.003\,\text{mm} = 2 \cdot 0.89\,\text{mm/s} \cdot \frac{\sqrt{\frac{4.75\,\text{mm}}{54.67\,\text{mm}}}}{16 \cdot 11\,\text{Hz}}$$

2.6) Maximum Chip Thickness obtained in Slab Milling using Tool Engagement Angle Formula

Evaluate Formula

Formula

$$C_{max} = V_{fm} \cdot \frac{\sin(\theta)}{N_t \cdot v_{rot}}$$

Example with Units

$$0.0029\,\text{mm} = 0.89\,\text{mm/s} \cdot \frac{\sin(35°)}{16 \cdot 11\,\text{Hz}}$$

2.7) Minimum Length of Approach required in Slab Milling Formula

Evaluate Formula

Formula

$$A = \sqrt{d_{cut} \cdot (D_{cut} - d_{cut})}$$

Example with Units

$$15.3987\,\text{mm} = \sqrt{4.75\,\text{mm} \cdot (54.67\,\text{mm} - 4.75\,\text{mm})}$$

2.8) Proportion of Cutting Edge Engagement for Slab and Side Milling Formula

Evaluate Formula

Formula

$$Q = 0.25 + \left(a \frac{\sin\left(\left(2 \cdot \frac{a_e}{D_{cut}}\right) - 1\right)}{2 \cdot \pi} \right)$$

Example with Units

$$0.4291 = 0.25 + \left(a \frac{\sin\left(\left(2 \cdot \frac{52\,\text{mm}}{54.67\,\text{mm}}\right) - 1\right)}{2 \cdot 3.1416} \right)$$

2.9) Tool Engagement Angle in Slab Milling using Depth of Cut Formula

Evaluate Formula

Formula

$$\theta = a\cos\left(1 - \left(2 \cdot \frac{d_{cut}}{D_{cut}}\right)\right)$$

Example with Units

$$34.2866° = a\cos\left(1 - \left(2 \cdot \frac{4.75\,\text{mm}}{54.67\,\text{mm}}\right)\right)$$

2.10) Work Engagement given Proportion of Edge Engagement for Slab and Side Milling Formula

Evaluate Formula

Formula

$$a_e = \left(\sin\left((Q - 0.25) \cdot 2 \cdot \pi\right) + 1\right) \cdot \frac{D_{cut}}{2}$$

Example with Units

$$49.4495\,\text{mm} = \left(\sin\left((0.4 - 0.25) \cdot 2 \cdot 3.1416\right) + 1\right) \cdot \frac{54.67\,\text{mm}}{2}$$

Variables used in list of Milling Operation Formulas above

- **A** Length of Approach in Slab Milling *(Millimeter)*
- a_e Work Engagement *(Millimeter)*
- b_w Width of Workpiece *(Millimeter)*
- C_{max} Max Chip Thickness in Slab Milling *(Millimeter)*
- C_v Max Chip Thickness in Vertical Milling *(Millimeter)*
- d_{cut} Depth of Cut in Milling *(Millimeter)*
- D_{cut} Diameter of a Cutting Tool *(Millimeter)*
- f_r Feed Rate in Milling *(Millimeter Per Revolution)*
- **L** Length of Workpiece *(Millimeter)*
- L_v Length of Approach in Vertical Milling *(Millimeter)*
- n_{rs} Reciprocating Strokes Frequency *(Hertz)*
- N_t Number of Teeth on Cutting Tool
- **Q** Time Proportion of Cutting Edge Engagement
- t_m Machining Time *(Second)*
- V_{fm} Feed Speed in Milling *(Millimeter per Second)*
- v_{rot} Rotational Frequency in Milling *(Hertz)*
- **θ** Tool Engagement Angle in Milling *(Degree)*

Constants, Functions, Measurements used in list of Milling Operation Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **acos**, acos(Number) *The inverse cosine function, is the inverse function of the cosine function. It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.*
- Functions: **asin**, asin(Number) *The inverse sine function, is a trigonometric function that takes a ratio of two sides of a right triangle and outputs the angle opposite the side with the given ratio.*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- Functions: **sin**, sin(Angle) *Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- Measurement: **Length** in Millimeter (mm) *Length Unit Conversion*
- Measurement: **Time** in Second (s) *Time Unit Conversion*
- Measurement: **Speed** in Millimeter per Second (mm/s) *Speed Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*
- Measurement: **Frequency** in Hertz (Hz) *Frequency Unit Conversion*
- Measurement: **Feed** in Millimeter Per Revolution (mm/rev) *Feed Unit Conversion*

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