Important Thrust and Power Requirements Formulas PDF

Formulas
Examples
with Units

List of 19
Important Thrust and Power Requirements Formulas

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1) Minimum Thrust of aircraft required Formula

Formula

$$T = P_{dynamic} \cdot S \cdot \left(C_{D,0} + C_{D,i} \right)$$

Example with Units

$$99.2\,\text{N} = 10\,\text{Pa} \cdot 8\,\text{m}^2 \cdot \left(0.31 + 0.93 \right)$$

2) Minimum Thrust required for given Lift Coefficient Formula

Formula

$$T = P_{dynamic} \cdot A \cdot \left(C_{D,0} + \left(\frac{C_L^2}{\pi \cdot e \cdot AR} \right) \right)$$

Example with Units

$$99.7603\,\text{N} = 10\,\text{Pa} \cdot 20\,\text{m}^2 \cdot \left(0.31 + \left(\frac{1.1^2}{3.1416 \cdot 0.51 \cdot 4} \right) \right)$$

3) Minimum Thrust required for given weight Formula

Formula

$$T = \left(P_{dynamic} \cdot A \cdot C_{D,0} \right) + \left(\frac{W_{body}^2}{P_{dynamic} \cdot A \cdot \pi \cdot e \cdot AR} \right)$$

Example with Units

$$100.1043\,\text{N} = \left(10\,\text{Pa} \cdot 20\,\text{m}^2 \cdot 0.31 \right) + \left(\frac{221\,\text{N}^2}{10\,\text{Pa} \cdot 20\,\text{m}^2 \cdot 3.1416 \cdot 0.51 \cdot 4} \right)$$

4) Power required for given aerodynamic coefficients Formula

Formula

$$P = W_{body} \cdot V_\infty \cdot \frac{C_D}{C_L}$$

Example with Units

$$3013.6364\,\text{W} = 221\,\text{N} \cdot 30\,\text{m/s} \cdot \frac{0.5}{1.1}$$

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5) Power required for given required thrust of aircraft Formula ↪

Formula

$$P = V_\infty \cdot T$$

Example with Units

$$3000\,\text{W} = 30\,\text{m/s} \cdot 100\,\text{N}$$

6) Power required for given total drag force Formula ↪

Formula

$$P = F_D \cdot V_\infty$$

Example with Units

$$2999.7\,\text{W} = 99.99\,\text{N} \cdot 30\,\text{m/s}$$

7) Thrust Angle for Unaccelerated Level Flight for given Drag Formula ↪

Formula

$$\sigma_T = a\cos\left(\frac{F_D}{T}\right)$$

Example with Units

$$0.0141\,\text{rad} = a\cos\left(\frac{99.99\,\text{N}}{100\,\text{N}}\right)$$

8) Thrust Angle for Unaccelerated Level Flight for given Lift Formula ↪

Formula

$$\sigma_T = a\sin\left(\frac{W_{body} - F_L}{T}\right)$$

Example with Units

$$0.01\,\text{rad} = a\sin\left(\frac{221\,\text{N} - 220\,\text{N}}{100\,\text{N}}\right)$$

9) Thrust for given coefficients of lift and drag Formula ↪

Formula

$$T = C_D \cdot \frac{W_{body}}{C_L}$$

Example with Units

$$100.4545\,\text{N} = 0.5 \cdot \frac{221\,\text{N}}{1.1}$$

10) Thrust for Level and Unaccelerated Flight Formula ↪

Formula

$$T = \frac{F_D}{\cos\left(\sigma_T\right)}$$

Example with Units

$$99.995\,\text{N} = \frac{99.99\,\text{N}}{\cos\left(0.01\,\text{rad}\right)}$$

11) Thrust of aircraft required for given Lift-to-drag ratio Formula ↪

Formula

$$T = \frac{W_{body}}{LD}$$

Example with Units

$$100\,\text{N} = \frac{221\,\text{N}}{2.21}$$

12) Thrust of Aircraft required for given required Power Formula ↪

Formula

$$T = \frac{P}{V_\infty}$$

Example with Units

$$100\,\text{N} = \frac{3000\,\text{W}}{30\,\text{m/s}}$$

13) Thrust of Aircraft required for Level, Unaccelerated Flight Formula 📲

Formula

$$T = P_{dynamic} \cdot A \cdot C_D$$

Example with Units

$$100_{\,N} = 10_{\,Pa} \cdot 20_{\,m^2} \cdot 0.5$$

14) Thrust-to-weight ratio Formula 📲

Formula

$$TW = \frac{C_D}{C_L}$$

Example

$$0.4545 = \frac{0.5}{1.1}$$

15) Weight of Aircraft for given Coefficients of Lift and Drag Formula 📲

Formula

$$W_{body} = C_L \cdot \frac{T}{C_D}$$

Example with Units

$$220_{\,N} = 1.1 \cdot \frac{100_{\,N}}{0.5}$$

16) Weight of Aircraft for given Lift-to-Drag Ratio Formula 📲

Formula

$$W_{body} = T \cdot LD$$

Example with Units

$$221_{\,N} = 100_{\,N} \cdot 2.21$$

17) Weight of aircraft for given required power Formula 📲

Formula

$$W_{body} = P \cdot \frac{C_L}{V_\infty \cdot C_D}$$

Example with Units

$$220_{\,N} = 3000_{\,w} \cdot \frac{1.1}{30_{\,m/s} \cdot 0.5}$$

18) Weight of Aircraft for Level, Unaccelerated Flight at Negligible Thrust Angle Formula 📲

Formula

$$W_{body} = P_{dynamic} \cdot A \cdot C_L$$

Example with Units

$$220_{\,N} = 10_{\,Pa} \cdot 20_{\,m^2} \cdot 1.1$$

19) Weight of Aircraft in Level, Unaccelerated Flight Formula 📲

Formula

$$W_{body} = F_L + \left(T \cdot \sin \left(\sigma_T \right) \right)$$

Example with Units

$$221_{\,N} = 220_{\,N} + \left(100_{\,N} \cdot \sin \left(0.01_{\,rad} \right) \right)$$

Variables used in list of Thrust and Power Requirements Formulas above

- **A** Area *(Square Meter)*
- **AR** Aspect Ratio of a Wing
- **C_D** Drag Coefficient
- **$C_{D,0}$** Zero Lift Drag Coefficient
- **$C_{D,i}$** Coefficient Of Drag Due to Lift
- **C_L** Lift Coefficient
- **e** Oswald Efficiency Factor
- **F_D** Drag Force *(Newton)*
- **F_L** Lift Force *(Newton)*
- **LD** Lift-to-Drag Ratio
- **P** Power *(Watt)*
- **$P_{dynamic}$** Dynamic Pressure *(Pascal)*
- **S** Reference Area *(Square Meter)*
- **T** Thrust *(Newton)*
- **TW** Thrust-to-Weight Ratio
- **V_∞** Freestream Velocity *(Meter per Second)*
- **W_{body}** Weight of Body *(Newton)*
- **σ_T** Thrust Angle *(Radian)*

Constants, Functions, Measurements used in list of Thrust and Power Requirements 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.*
- Measurement: **Area** in Square Meter (m²) *Area Unit Conversion* ↱
- Measurement: **Pressure** in Pascal (Pa) *Pressure Unit Conversion* ↱
- Measurement: **Speed** in Meter per Second (m/s) *Speed Unit Conversion* ↱
- Measurement: **Power** in Watt (W) *Power Unit Conversion* ↱
- Measurement: **Force** in Newton (N) *Force Unit Conversion* ↱
- Measurement: **Angle** in Radian (rad) *Angle Unit Conversion* ↱

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