Important Lift and Drag Requirements Formulas PDF

Formulas
Examples
with Units

List of 19
Important Lift and Drag Requirements Formulas

1) Coefficient of Drag due to Lift for Minimum Power required Formula

Evaluate Formula

Formula

$$C_{D,i} = 3 \cdot C_{D,0}$$

Example

$$0.93 = 3 \cdot 0.31$$

2) Coefficient of Drag for given Thrust and Weight Formula

Evaluate Formula

Formula

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

Example with Units

$$0.4977 = \frac{100\,\text{N} \cdot 1.1}{221\,\text{N}}$$

3) Coefficient of Drag for given Thrust-to-Weight Ratio Formula

Evaluate Formula

Formula

$$C_D = C_L \cdot TW$$

Example

$$0.495 = 1.1 \cdot 0.45$$

4) Coefficient of Lift for given thrust and weight Formula

Evaluate Formula

Formula

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

Example with Units

$$1.105 = 221\,\text{N} \cdot \frac{0.5}{100\,\text{N}}$$

5) Coefficient of Lift for given Thrust-to-Weight Ratio Formula

Evaluate Formula

Formula

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

Example

$$1.1111 = \frac{0.5}{0.45}$$

6) Drag for Level and Unaccelerated Flight Formula

Evaluate Formula

Formula

$$F_D = T \cdot \cos\left(\sigma_T\right)$$

Example with Units

$$99.995\,\text{N} = 100\,\text{N} \cdot \cos\left(0.01\,\text{rad}\right)$$

7) Drag for Level and Unaccelerated Flight at Negligible Thrust Angle Formula

Evaluate Formula

Formula

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

Example with Units

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

8) Freestream Velocity given required Power Formula

Evaluate Formula

Formula

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

Example with Units

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

9) Freestream Velocity given Total Drag Force Formula

Evaluate Formula

Formula

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

Example with Units

$$30.003\,\text{m/s} = \frac{3000\,\text{W}}{99.99\,\text{N}}$$

10) Lift Coefficient given Minimum required Thrust Formula

Evaluate Formula

Formula

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

Example with Units

$$1.1035 = \sqrt{3.1416 \cdot 0.51 \cdot 4 \cdot \left(\left(\frac{100\,\text{N}}{10\,\text{Pa} \cdot 20\,\text{m}^2}\right) - 0.31\right)}$$

11) Lift for Level and Unaccelerated Flight at Negligible Thrust Angle Formula

Evaluate Formula

Formula

$$F_L = P_{dynamic} \cdot A \cdot C_L$$

Example with Units

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

12) Lift for Unaccelerated Flight Formula

Evaluate Formula

Formula

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

Example with Units

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

13) Lift-Induced Drag Coefficient given required Thrust Formula

Evaluate Formula

Formula

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

Example with Units

$$0.94 = \left(\frac{100\,\text{N}}{10\,\text{Pa} \cdot 8\,\text{m}^2}\right) - 0.31$$

14) Lift-to-Drag Ratio given required Thrust of Aircraft Formula

Evaluate Formula

Formula

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

Example with Units

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

15) Total Drag Force given required Power Formula

Evaluate Formula

Formula

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

Example with Units

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

16) Zero-lift drag coefficient at minimum required thrust Formula

Evaluate Formula

Formula

$$C_{D0,min} = \frac{C_L^2}{\pi \cdot e \cdot AR}$$

Example

$$0.1888 = \frac{1.1^2}{3.1416 \cdot 0.51 \cdot 4}$$

17) Zero-Lift Drag Coefficient for given Lift Coefficient Formula

Evaluate Formula

Formula

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

Example with Units

$$0.3112 = \left(\frac{100\,\text{N}}{10\,\text{Pa} \cdot 20\,\text{m}^2}\right) - \left(\frac{1.1^2}{3.1416 \cdot 0.51 \cdot 4}\right)$$

18) Zero-Lift Drag Coefficient for Minimum Power required Formula

Evaluate Formula

Formula

$$C_{D,0} = \frac{C_{D,i}}{3}$$

Example

$$0.31 = \frac{0.93}{3}$$

19) Zero-Lift Drag Coefficient given required Thrust Formula

Evaluate Formula

Formula

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

Example with Units

$$0.32 = \left(\frac{100\,\text{N}}{10\,\text{Pa} \cdot 8\,\text{m}^2}\right) - 0.93$$

Variables used in list of Lift and Drag 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
- $C_{D0,min}$ Zero-Lift Drag Coefficient at Minimum Thrust
- 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 Lift and Drag Requirements Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- 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: **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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