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Aerodynamic Design Formulas

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List of 13 Aerodynamic Design Formulas

Aerodynamic Design

1) Aerofoil Thickness for 4 Digit Series

Open Calculator

fx
$$y_t = \frac{t \cdot \left(0.2969 \cdot x^{0.5} - 0.1260 \cdot x - 0.3516 \cdot x^2 + 0.2843 \cdot x^3 - 0.1015 \cdot x^4\right)}{0.2}$$

ex
$$0.066175\text{m} = \frac{0.15\text{m} \cdot \left(0.2969 \cdot (0.5)^{0.5} - 0.1260 \cdot 0.5 - 0.3516 \cdot (0.5)^2 + 0.2843 \cdot (0.5)^3 - 0.1015 \cdot (0.5)^4\right)}{0.2}$$

2) Aspect Ratio of Wing

Open Calculator

fx
$$AR_w = \frac{b_W^2}{S_{wet}}$$

ex
$$23.04035 = \frac{(15.3\text{m})^2}{10.16\text{m}^2}$$

3) Equivalent Parasite Drag Area

Open Calculator

fx
$$A = \Phi_f \cdot \mu_f \cdot S_{wet}$$

ex
$$10.96548\text{m}^2 = 1.499 \cdot 0.72 \cdot 10.16\text{m}^2$$

4) Form Factor given Flat Plate Area

Open Calculator

fx
$$\Phi_f = \frac{A}{\mu_f \cdot S_{wet}}$$

ex
$$1.499617 = \frac{10.97\text{m}^2}{0.72 \cdot 10.16\text{m}^2}$$

5) Gross Weight given Drag

Open Calculator

fx
$$W_0 = F_D \cdot \left(\frac{C_L}{C_D}\right)$$

ex
$$58.66667\text{kg} = 80\text{N} \cdot \left(\frac{1.1}{1.5}\right)$$

6) Skin Friction Coefficient given Flat Plate Area

Open Calculator

$$\mu_f = \frac{A}{\Phi_f \cdot S_{wet}}$$

$$0.720296 = \frac{10.97\text{m}^2}{1.499 \cdot 10.16\text{m}^2}$$

7) Span given Aspect Ratio

Open Calculator

$$b_W = \sqrt{AR_w \cdot S_{wet}}$$

$$15.29988\text{m} = \sqrt{23.04 \cdot 10.16\text{m}^2}$$

8) Span given Induced Drag

Open Calculator

$$b_W = \frac{F_L}{\sqrt{\pi \cdot D_i \cdot q}}$$

$$15.0786\text{m} = \frac{110\text{N}}{\sqrt{\pi \cdot 8.47\text{N} \cdot 2\text{Pa}}}$$

9) Taper Ratio of Airfoil

Open Calculator

$$\Lambda = \frac{C_{tip}}{C_{root}}$$

$$0.428571 = \frac{3\text{m}}{7\text{m}}$$

10) Thrust-to-Weight Ratio given Minimum Coefficient of Drag

Open Calculator

$$TW = \left(\frac{C_{Dmin}}{W_S} + k \cdot \left(\frac{n}{q}\right)^2 \cdot W_S\right) \cdot q$$

$$0.641 = \left(\frac{1.3}{5\text{Pa}} + 0.04 \cdot \left(\frac{1.10}{2\text{Pa}}\right)^2 \cdot 5\text{Pa}\right) \cdot 2\text{Pa}$$

11) Tip Speed Ratio with Blade Number

Open Calculator

$$\lambda = \frac{4 \cdot \pi}{N}$$

$$1.142397 = \frac{4 \cdot \pi}{11}$$

12) Wetted Area given Aspect Ratio

Open Calculator

fx $$S_{wet} = \frac{b_W^2}{AR_w}$$

ex $$10.16016\text{m}^2 = \frac{(15.3\text{m})^2}{23.04}$$

13) Wetted Area given Flat Plate Area

Open Calculator

fx $$S_{wet} = \frac{A}{\Phi_f \cdot \mu_f}$$

ex $$10.16418\text{m}^2 = \frac{10.97\text{m}^2}{1.499 \cdot 0.72}$$

Variables Used

- **A** Flat Plate Area *(Square Meter)*
- **AR_w** Aspect Ratio in Lateral Plane
- **b_W** Lateral Plane Span *(Meter)*
- **C_D** Drag Coefficient
- **C_{Dmin}** Minimum Drag Coefficient
- **C_L** Lift Coefficient
- **C_{root}** Root Chord Length *(Meter)*
- **C_{tip}** Tip Chord Length *(Meter)*
- **D_i** Induced Drag *(Newton)*
- **F_D** Drag Force *(Newton)*
- **F_L** Lift Force *(Newton)*
- **k** Lift Induced Drag Constant
- **n** Load Factor
- **N** Number of Blades
- **q** Dynamic Pressure *(Pascal)*
- **S_{wet}** Aircraft Wetted Area *(Square Meter)*
- **t** Maximum Thickness *(Meter)*
- **TW** Thrust-to-Weight Ratio
- **W_0** Gross Weight *(Kilogram)*
- **W_S** Wing Loading *(Pascal)*
- **x** Position along the Chord
- **y_t** Half Thickness *(Meter)*
- **λ** Tip Speed Ratio
- **Λ** Taper Ratio
- **μ_f** Skin Friction Coefficient
- **Φ_f** Form Factor Drag

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **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 Meter (m)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion

Check other formula lists

- **Aerodynamic Design Formulas**

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