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Propeller-Driven Airplane Formulas

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List of 22 Propeller-Driven Airplane Formulas

Propeller-Driven Airplane

1) Cruise Weight Fraction for Prop-Driven Aircraft

Open Calculator

fx $$\mathrm{FW_{cruise\ prop}} = \exp\left(\frac{\mathrm{R_{prop}}\cdot(-1)\cdot \mathrm{c}}{\mathrm{LDmax_{ratio}}\cdot\eta}\right)$$

ex $$0.777777 = \exp\left(\frac{7126.017\mathrm{m}\cdot(-1)\cdot 0.6\mathrm{kg/h/W}}{5.081527\cdot 0.93}\right)$$

2) Endurance of Propeller-Driven Airplane

Open Calculator

fx $$\mathrm{E_{prop}} = \frac{\eta}{\mathrm{c}}\cdot\frac{\mathrm{C_L^{1.5}}}{\mathrm{C_D}}\cdot\sqrt{2\cdot\rho_\infty\cdot\mathrm{S}}\cdot\left(\left(\frac{1}{\mathrm{W_1}}\right)^{\frac{1}{2}}-\left(\frac{1}{\mathrm{W_0}}\right)^{\frac{1}{2}}\right)$$

ex $$454.2055\mathrm{s} = \frac{0.93}{0.6\mathrm{kg/h/W}}\cdot\frac{(5)^{1.5}}{2}\cdot\sqrt{2\cdot 1.225\mathrm{kg/m^3}\cdot 5.11\mathrm{m^2}}\cdot\left(\left(\frac{1}{3000\mathrm{kg}}\right)^{\frac{1}{2}}-\left(\frac{1}{5000\mathrm{kg}}\right)^{\frac{1}{2}}\right)$$

3) Lift to Drag for Maximum Endurance given Preliminary Endurance for Prop-Driven Aircraft

Open Calculator

fx $$\mathrm{LDEmax_{ratio\ prop}} = \frac{\mathrm{E}\cdot\mathrm{V_{Emax}}\cdot\mathrm{c}}{\eta\cdot\ln\left(\frac{\mathrm{W_{L,beg}}}{\mathrm{W_{L,end}}}\right)}$$

ex $$85.04913 = \frac{452.0581\mathrm{s}\cdot 15.6\mathrm{m/s}\cdot 0.6\mathrm{kg/h/W}}{0.93\cdot\ln\left(\frac{400\mathrm{kg}}{394.1\mathrm{kg}}\right)}$$

4) Lift to Drag Ratio for Maximum Endurance given Max Lift to Drag Ratio for Prop-Driven Aircraft

Open Calculator

fx $$\mathrm{LDEmax_{ratio}} = 0.866\cdot\mathrm{LDmax_{ratio}}$$

ex $$4.400602 = 0.866\cdot 5.081527$$

5) Lift-to-Drag ratio for given Range of Propeller-Driven Airplane

Open Calculator

fx $$LD = c \cdot \frac{R_{prop}}{\eta \cdot \ln\left(\frac{W_0}{W_1}\right)}$$

ex $$2.5 = 0.6\text{kg/h/W} \cdot \frac{7126.017\text{m}}{0.93 \cdot \ln\left(\frac{5000\text{kg}}{3000\text{kg}}\right)}$$

6) Maximum Lift to Drag Ratio given Lift to Drag Ratio for Max Endurance of Prop-Driven Aircraft

Open Calculator

fx $$LDmax_{ratio} = \frac{LDEmax_{ratio}}{0.866}$$

ex $$5.080831 = \frac{4.40}{0.866}$$

7) Maximum Lift to Drag Ratio given Range for Prop-Driven Aircraft

Open Calculator

fx $$LDmax_{ratio} = \frac{R_{prop} \cdot c}{\eta \cdot \ln\left(\frac{W_i}{W_f}\right)}$$

ex $$5.081539 = \frac{7126.017\text{m} \cdot 0.6\text{kg/h/W}}{0.93 \cdot \ln\left(\frac{450\text{kg}}{350\text{kg}}\right)}$$

8) Power Available for Reciprocating Engine-Propeller Combination

Open Calculator

fx $$P_A = \eta \cdot BP$$

ex $$20.6553\text{W} = 0.93 \cdot 22.21\text{W}$$

9) Propeller Efficiency for given Endurance of Propeller-Driven Airplane

Open Calculator

fx $$\eta = \frac{E}{\left(\frac{1}{c}\right) \cdot \left(\frac{C_L^{1.5}}{C_D}\right) \cdot \left(\sqrt{2 \cdot \rho_\infty \cdot S}\right) \cdot \left(\left(\left(\frac{1}{W_1}\right)^{\frac{1}{2}}\right) - \left(\left(\frac{1}{W_0}\right)^{\frac{1}{2}}\right)\right)}$$

ex $$0.925603 = \frac{452.0581\text{s}}{\left(\frac{1}{0.6\text{kg/h/W}}\right) \cdot \left(\frac{(5)^{1.5}}{2}\right) \cdot \left(\sqrt{2 \cdot 1.225\text{kg/m}^3 \cdot 5.11\text{m}^2}\right) \cdot \left(\left(\left(\frac{1}{3000\text{kg}}\right)^{\frac{1}{2}}\right) - \left(\left(\frac{1}{5000\text{kg}}\right)^{\frac{1}{2}}\right)\right)}$$

10) Propeller Efficiency for given Range and Lift-to-Drag Ratio of Propeller-Driven Airplane

Open Calculator

$$\eta = R_{prop} \cdot \frac{c}{LD \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)}$$

$$0.93 = 7126.017\text{m} \cdot \frac{0.6\text{kg/h/W}}{2.50 \cdot \left(\ln\left(\frac{5000\text{kg}}{3000\text{kg}}\right)\right)}$$

11) Propeller Efficiency for given Range of Propeller-Driven Airplane

Open Calculator

$$\eta = R_{prop} \cdot c \cdot \frac{C_D}{C_L \cdot \ln\left(\frac{W_0}{W_1}\right)}$$

$$0.93 = 7126.017\text{m} \cdot 0.6\text{kg/h/W} \cdot \frac{2}{5 \cdot \ln\left(\frac{5000\text{kg}}{3000\text{kg}}\right)}$$

12) Propeller Efficiency for Reciprocating Engine-Propeller Combination

Open Calculator

$$\eta = \frac{P_A}{BP}$$

$$0.930032 = \frac{20.656\text{W}}{22.21\text{W}}$$

13) Propeller Efficiency given Preliminary Endurance for Prop-Driven Aircraft

Open Calculator

$$\eta = \frac{E_p \cdot V_{Emax} \cdot c}{LDEmax_{ratio} \cdot \ln\left(\frac{W_{L,beg}}{W_{L,end}}\right)}$$

$$0.930511 = \frac{23.4\text{s} \cdot 15.6\text{m/s} \cdot 0.6\text{kg/h/W}}{4.40 \cdot \ln\left(\frac{400\text{kg}}{394.1\text{kg}}\right)}$$

14) Propeller Efficiency given Range for Prop-Driven Aircraft

Open Calculator

$$\eta = \frac{R_{prop} \cdot c}{LDmax_{ratio} \cdot \ln\left(\frac{W_i}{W_f}\right)}$$

$$0.930002 = \frac{7126.017\text{m} \cdot 0.6\text{kg/h/W}}{5.081527 \cdot \ln\left(\frac{450\text{kg}}{350\text{kg}}\right)}$$

15) Range of Propeller-Driven Airplane

Open Calculator

$$\mathrm{R_{prop}} = \left(\frac{\eta}{c}\right) \cdot \left(\frac{C_L}{C_D}\right) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

$$7126.017\mathrm{m} = \left(\frac{0.93}{0.6\mathrm{kg/h/W}}\right) \cdot \left(\frac{5}{2}\right) \cdot \left(\ln\left(\frac{5000\mathrm{kg}}{3000\mathrm{kg}}\right)\right)$$

16) Range of Propeller-Driven Airplane for given lift-to-drag ratio

Open Calculator

$$\mathrm{R_{prop}} = \left(\frac{\eta}{c}\right) \cdot (LD) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

$$7126.017\mathrm{m} = \left(\frac{0.93}{0.6\mathrm{kg/h/W}}\right) \cdot (2.50) \cdot \left(\ln\left(\frac{5000\mathrm{kg}}{3000\mathrm{kg}}\right)\right)$$

17) Shaft Brake Power for Reciprocating Engine-Propeller Combination

Open Calculator

$$BP = \frac{P_A}{\eta}$$

$$22.21075\mathrm{W} = \frac{20.656\mathrm{W}}{0.93}$$

18) Specific Fuel Consumption for given Endurance of Propeller-Driven Airplane

Open Calculator

$$c = \frac{\eta}{E} \cdot \frac{C_L^{1.5}}{C_D} \cdot \sqrt{2 \cdot \rho_\infty \cdot S} \cdot \left(\left(\frac{1}{W_1}\right)^{\frac{1}{2}} - \left(\frac{1}{W_0}\right)^{\frac{1}{2}}\right)$$

$$0.60285\mathrm{kg/h/W} = \frac{0.93}{452.0581\mathrm{s}} \cdot \frac{(5)^{1.5}}{2} \cdot \sqrt{2 \cdot 1.225\mathrm{kg/m^3} \cdot 5.11\mathrm{m^2}} \cdot \left(\left(\frac{1}{3000\mathrm{kg}}\right)^{\frac{1}{2}} - \left(\frac{1}{5000\mathrm{kg}}\right)^{\frac{1}{2}}\right)$$

19) Specific Fuel Consumption for given Range and Lift-to-Drag Ratio of Propeller-Driven Airplane

Open Calculator

$$c = \left(\frac{\eta}{\mathrm{R_{prop}}}\right) \cdot (LD) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

$$0.6\mathrm{kg/h/W} = \left(\frac{0.93}{7126.017\mathrm{m}}\right) \cdot (2.50) \cdot \left(\ln\left(\frac{5000\mathrm{kg}}{3000\mathrm{kg}}\right)\right)$$

20) Specific Fuel Consumption for given Range of Propeller-Driven Airplane

Open Calculator

$$c = \left(\frac{\eta}{R_{prop}}\right) \cdot \left(\frac{C_L}{C_D}\right) \cdot \left(\ln\left(\frac{W_0}{W_1}\right)\right)$$

$$0.6\text{kg/h/W} = \left(\frac{0.93}{7126.017\text{m}}\right) \cdot \left(\frac{5}{2}\right) \cdot \left(\ln\left(\frac{5000\text{kg}}{3000\text{kg}}\right)\right)$$

21) Specific Fuel Consumption given Preliminary Endurance for Prop-Driven Aircraft

Open Calculator

$$c = \frac{LDEmax_{\text{ratio prop}} \cdot \eta \cdot \ln\left(\frac{W_{L,beg}}{W_{L,end}}\right)}{E \cdot V_{Emax}}$$

$$0.6\text{kg/h/W} = \frac{85.04913 \cdot 0.93 \cdot \ln\left(\frac{400\text{kg}}{394.1\text{kg}}\right)}{452.0581\text{s} \cdot 15.6\text{m/s}}$$

22) Specific Fuel Consumption given Range for Prop-Driven Aircraft

Open Calculator

$$c = \frac{\eta \cdot LDmax_{\text{ratio}} \cdot \ln\left(\frac{W_i}{W_f}\right)}{R_{prop}}$$

$$0.599999\text{kg/h/W} = \frac{0.93 \cdot 5.081527 \cdot \ln\left(\frac{450\text{kg}}{350\text{kg}}\right)}{7126.017\text{m}}$$

Variables Used

- **BP** Brake Power *(Watt)*
- **c** Specific Fuel Consumption *(Kilogram per Hour per Watt)*
- C_D Drag Coefficient
- C_L Lift Coefficient
- **E** Endurance of Aircraft *(Second)*
- E_p Preliminary Endurance of Aircraft *(Second)*
- E_{prop} Endurance of Propeller Aircraft *(Second)*
- $FW_{cruise\ prop}$ Cruise Weight Fraction Propeller Aircraft
- **LD** Lift-to-Drag Ratio
- $LDEmax_{ratio\ prop}$ Lift to Drag Ratio at Maximum Endurance Prop
- $LDEmax_{ratio}$ Lift to Drag Ratio at Maximum Endurance
- $LDmax_{ratio}$ Maximum Lift-to-Drag Ratio
- P_A Available Power *(Watt)*
- R_{prop} Range of Propeller Aircraft *(Meter)*
- **S** Reference Area *(Square Meter)*
- V_{Emax} Velocity for Maximum Endurance *(Meter per Second)*
- W_0 Gross Weight *(Kilogram)*
- W_1 Weight without Fuel *(Kilogram)*
- W_f Weight at End of Cruise Phase *(Kilogram)*
- W_i Weight at Start of Cruise Phase *(Kilogram)*
- $W_{L,beg}$ Weight at Start of Loiter Phase *(Kilogram)*
- $W_{L,end}$ Weight at End of Loiter Phase *(Kilogram)*
- η Propeller Efficiency
- ρ_∞ Freestream Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Function: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Function: **ln**, ln(Number)
  The natural logarithm, also known as the logarithm to the base e, is the inverse function of the natural exponential function.
- 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: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion
- Measurement: **Specific Fuel Consumption** in Kilogram per Hour per Watt (kg/h/W)
  Specific Fuel Consumption Unit Conversion

Check other formula lists

- **Jet Airplane Formulas**
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