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Important Formulas of Engine Dynamics

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List of 21 Important Formulas of Engine Dynamics

Important Formulas of Engine Dynamics

1) Beale Number

Open Calculator

fx $$B_n = \frac{HP}{P \cdot SV_p \cdot f_e}$$

ex $$0.101892 = \frac{160\text{hp}}{56\text{N/m}^2 \cdot 205\text{m}^3 \cdot 102\text{Hz}}$$

2) Brake Power given Mean Effective Pressure

Open Calculator

fx $$BP = (P_{mb} \cdot L \cdot A \cdot (N))$$

ex $$0.55292\text{kW} = (5000\text{Pa} \cdot 8.8\text{cm} \cdot 30\text{cm}^2 \cdot (4000\text{rev/min}))$$

3) Brake Power given Mechanical Efficiency

Open Calculator

fx $$BP = \left(\frac{\eta_m}{100}\right) \cdot IP$$

ex $$0.54\text{kW} = \left(\frac{60}{100}\right) \cdot 0.9\text{kW}$$

4) Brake specific fuel consumption

Open Calculator

$$\text{BSFC} = \frac{\dot{m}_f}{\text{BP}}$$

$$0.005891\text{kg/h/W} = \frac{0.00090\text{kg/s}}{0.55\text{kW}}$$

5) Brake Thermal Efficiency given Brake Power

Open Calculator

$$\eta_b = \left(\frac{\text{BP}}{m_f \cdot \text{CV}}\right) \cdot 100$$

$$0.245536 = \left(\frac{0.55\text{kW}}{0.14\text{kg/s} \cdot 1600\text{kJ/kg}}\right) \cdot 100$$

6) Engine displacement given number of cylinders

Open Calculator

$$E_d = r \cdot r \cdot L \cdot 0.7854 \cdot N_c$$

$$3981.036\text{cm}^3 = 12\text{cm} \cdot 12\text{cm} \cdot 8.8\text{cm} \cdot 0.7854 \cdot 4$$

7) Engine rpm

Open Calculator

$$\omega_e = \frac{\text{MPH} \cdot i_g \cdot 336}{D}$$

$$288758.6\text{rev/min} = \frac{60\text{mi/h} \cdot 2.55 \cdot 336}{76\text{cm}}$$

8) Equivalence ratio

Open Calculator

fx $$\Phi = \frac{R_a}{R_f}$$

ex $$1.22449 = \frac{18}{14.7}$$

9) Friction Power

Open Calculator

fx $$FP = IP - BP$$

ex $$0.35\text{kW} = 0.9\text{kW} - 0.55\text{kW}$$

10) Indicated Power given Mechanical Efficiency

Open Calculator

fx $$IP = \frac{BP}{\frac{\eta_m}{100}}$$

ex $$0.916667\text{kW} = \frac{0.55\text{kW}}{\frac{60}{100}}$$

11) Indicated specific fuel consumption

Open Calculator

fx $$ISFC = \frac{\dot{m}_f}{IP}$$

ex $$0.0036\text{kg/h/W} = \frac{0.00090\text{kg/s}}{0.9\text{kW}}$$

12) Indicated Thermal Efficiency given Indicated Power

Open Calculator

$$IDE = \left(\frac{IP}{m_f \cdot CV} \right) \cdot 100$$

$$0.401786 = \left(\frac{0.9kW}{0.14kg/s \cdot 1600kJ/kg} \right) \cdot 100$$

13) Inlet-Valve Mach Index

Open Calculator

$$Z = \left(\left(\frac{D_c}{D_i} \right)^2 \right) \cdot \left(\frac{s_p}{q_f \cdot a} \right)$$

$$3318.962 = \left(\left(\frac{85cm}{2cm} \right)^2 \right) \cdot \left(\frac{73.72m/s}{11.80 \cdot 340cm/s} \right)$$

14) Kinetic Energy Stored in Flywheel of IC Engine

Open Calculator

$$E = \frac{J \cdot \left(\omega^2 \right)}{2}$$

$$10J = \frac{0.2kg \cdot m^2 \cdot \left((10rad/s)^2 \right)}{2}$$

15) Mean piston speed

Open Calculator

$$s_p = 2 \cdot L \cdot N$$

$$73.72271m/s = 2 \cdot 8.8cm \cdot 4000rev/min$$

16) Mechanical Efficiency of IC engine

Open Calculator

fx $$\eta_m = \left(\frac{BP}{IP}\right) \cdot 100$$

ex $$61.11111 = \left(\frac{0.55kW}{0.9kW}\right) \cdot 100$$

17) Rate of cooling of engine

Open Calculator

fx $$R_c = k \cdot (T - T_a)$$

ex $$147/min = 0.035 \cdot (360K - 290K)$$

18) Relative Efficiency

Open Calculator

fx $$\eta_r = \left(\frac{IDE}{\eta_a}\right) \cdot 100$$

ex $$8.4 = \left(\frac{0.42}{5}\right) \cdot 100$$

19) Specific Power Output

Open Calculator

fx $$P_s = \frac{BP}{A}$$

ex $$183.3333kW = \frac{0.55kW}{30cm^2}$$

20) Swept Volume

Open Calculator

fx $$V_s = \left(\left(\left(\frac{\pi}{4}\right) \cdot D_{ic}^2\right) \cdot L\right)$$

ex $$442.3362\text{cm}^3 = \left(\left(\left(\frac{\pi}{4}\right) \cdot (8\text{cm})^2\right) \cdot 8.8\text{cm}\right)$$

21) Time taken for engine to cool

Open Calculator

fx $$t = \frac{T - T_f}{R_c}$$

ex $$0.37415\text{min} = \frac{360\text{K} - 305\text{K}}{147/\text{min}}$$

Variables Used

- **a** Sonic Velocity *(Centimeter per Second)*
- **A** Area of Cross Section *(Square Centimeter)*
- B_n Beale Number
- **BP** Brake Power *(Kilowatt)*
- **BSFC** Brake Specific Fuel Consumption *(Kilogram per Hour per Watt)*
- **CV** Calorific Value of Fuel *(Kilojoule per Kilogram)*
- **D** Tire Diameter *(Centimeter)*
- D_c Cylinder Diameter *(Centimeter)*
- D_i Inlet Valve Diameter *(Centimeter)*
- D_{ic} Inner Diameter of Cylinder *(Centimeter)*
- **E** Kinetic Energy Stored in the Flywheel *(Joule)*
- E_d Engine Displacement *(Cubic Centimeter)*
- f_e Engine Frequency *(Hertz)*
- **FP** Friction Power *(Kilowatt)*
- **HP** Engine Power *(Horsepower)*
- i_g Gear Ratio of Transmission
- **IDE** Indicated Thermal Efficiency
- **IP** Indicated Power *(Kilowatt)*
- **ISFC** Indicated Specific Fuel Consumption *(Kilogram per Hour per Watt)*
- **J** Flywheel Moment of Inertia *(Kilogram Square Meter)*
- **k** Constant for Cooling Rate
- **L** Stroke Length *(Centimeter)*
- m_f Mass of Fuel Supplied per Second *(Kilogram per Second)*

- $\dot{m}_f$ Fuel Consumption in IC engine *(Kilogram per Second)*
- **MPH** Speed of Vehicle *(Mile per Hour)*
- **N** Engine Speed *(Revolution per Minute)*
- N_c Number of Cylinders
- **P** Average Gas Pressure *(Newton per Square Meter)*
- P_{mb} Brake Mean Effective Pressure *(Pascal)*
- P_s Specific Power Output *(Kilowatt)*
- q_f Flow Coefficient
- **r** Engine Bore *(Centimeter)*
- R_a Actual Air Fuel Ratio
- R_c Rate of Cooling *(1 Per Minute)*
- R_f Stoichiometric Air Fuel Ratio
- s_p Mean Piston Speed *(Meter per Second)*
- SV_p Piston Swept Volume *(Cubic Meter)*
- **t** Time Required to Cool Engine *(Minute)*
- **T** Engine Temperature *(Kelvin)*
- T_a Engine Surrounding Temperature *(Kelvin)*
- T_f Final Engine Temperature *(Kelvin)*
- V_s Swept Volume *(Cubic Centimeter)*
- **Z** Mach Index
- η_a Air Standard Efficiency
- η_b Brake Thermal Efficiency
- η_m Mechanical Efficiency
- η_r Relative Efficiency

- Φ Equivalence Ratio
- ω Flywheel Angular Velocity *(Radian per Second)*
- ω_e Engine RPM *(Revolution per Minute)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Measurement: **Length** in Centimeter (cm)
  Length Unit Conversion
- Measurement: **Time** in Minute (min)
  Time Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3), Cubic Centimeter (cm^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Centimeter (cm^2)
  Area Unit Conversion
- Measurement: **Pressure** in Newton per Square Meter (N/m^2), Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Mile per Hour (mi/h), Meter per Second (m/s), Centimeter per Second (cm/s)
  Speed Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Horsepower (hp), Kilowatt (kW)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Second (kg/s)
  Mass Flow Rate Unit Conversion

- Measurement: **Angular Velocity** in Revolution per Minute (rev/min), Radian per Second (rad/s)
  Angular Velocity Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion
- Measurement: **Specific Energy** in Kilojoule per Kilogram (kJ/kg)
  Specific Energy Unit Conversion
- Measurement: **Specific Fuel Consumption** in Kilogram per Hour per Watt (kg/h/W)
  Specific Fuel Consumption Unit Conversion
- Measurement: **Time Inverse** in 1 Per Minute (1/min)
  Time Inverse Unit Conversion

Check other formula lists

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