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Fuel Injection in IC Engine Formulas

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List of 16 Fuel Injection in IC Engine Formulas

Fuel Injection in IC Engine

1) Actual Fuel Velocity of Injection Considering Orifice Flow Coefficient

Open Calculator

fx $$V_f = C_f \cdot \sqrt{\frac{2 \cdot (P_1 - P2) \cdot 100000}{\rho_f}}$$

ex $$138.0537\text{m/s} = 0.9 \cdot \sqrt{\frac{2 \cdot (140\text{Pa} - 40\text{Pa}) \cdot 100000}{850\text{kg/m}^3}}$$

2) Area of all Orifices of Fuel Injectors

Open Calculator

fx $$A = \frac{\pi}{4} \cdot d_o^2 \cdot n_o$$

ex $$42.4115\text{m}^2 = \frac{\pi}{4} \cdot (3\text{m})^2 \cdot 6$$

3) Compression Ratio given Clearance and Swept Volume

Open Calculator

fx $$r = 1 + \left(\frac{V_s}{V_c}\right)$$

ex $$1.01178 = 1 + \left(\frac{1178\text{cm}^3}{0.10\text{m}^3}\right)$$

4) Energy Content per Unit Cylinder Volume of Mixture Formed in Cylinder of Diesel Engine

Open Calculator

fx $$H_{de} = \frac{\rho \cdot LHV_f}{\lambda \cdot R_{af}}$$

ex $$0.586395 MJ/m^3 = \frac{1.293 kg/m^3 \cdot 10 MJ/m^3}{1.5 \cdot 14.7}$$

5) Energy Content Per Unit Cylinder Volume of Mixture Formed Prior to Induction into Cylinder

Open Calculator

fx $$H_p = \frac{\rho_{mix} \cdot LHV_f}{\lambda \cdot R_{af} + 1}$$

ex $$347.0716 MJ/m^3 = \frac{800 kg/m^3 \cdot 10 MJ/m^3}{1.5 \cdot 14.7 + 1}$$

6) Engine Capacity

Open Calculator

fx $$EC = V_s \cdot N_c$$

ex $$4712 cm^3 = 1178 cm^3 \cdot 4$$

7) Fuel Consumption Per Cycle

Open Calculator

fx $$FC_c = \frac{FC}{60 \cdot N_m}$$

ex $$0.044444 kg = \frac{400 kg/s}{60 \cdot 150}$$

8) Fuel Consumption per Cylinder

Open Calculator

fx $$FC = \frac{FC_h}{n_o}$$

ex $$0.000417\text{kg/s} = \frac{9\text{kg/h}}{6}$$

9) Fuel Consumption Per Hour in Diesel Engine

Open Calculator

fx $$FC_h = BSFC \cdot BP$$

ex $$8.99505\text{kg/h} = 0.405\text{kg/h/W} \cdot 22.21\text{W}$$

10) Fuel Jet Velocity

Open Calculator

fx $$V_{fj} = C_d \cdot \sqrt{\left(\frac{2 \cdot (p_{in} - p_{cy})}{\rho_f}\right)}$$

ex $$123.9924\text{m/s} = 0.66 \cdot \sqrt{\left(\frac{2 \cdot (200\text{Bar} - 50\text{Bar})}{850\text{kg/m}^3}\right)}$$

11) Fuel Velocity at Time of Release into Engine Cylinder

Open Calculator

fx $$V_2 = \sqrt{2 \cdot v_f \cdot (P_1 - P2)}$$

ex $$15.36229\text{m/s} = \sqrt{2 \cdot 1.18\text{m}^3\text{/kg} \cdot (140\text{Pa} - 40\text{Pa})}$$

12) Mass of air taken in each cylinder

Open Calculator

$$m_a = \frac{P_a \cdot (V_c + V_d)}{[R] \cdot T_i}$$

$$294.2446\text{kg} = \frac{1.5\text{e}5\text{Pa} \cdot (0.10\text{m}^3 + 5.005\text{m}^3)}{[R] \cdot 313\text{K}}$$

13) Number of Fuel Injections Per Minute for Four Stroke Engine

Open Calculator

$$N_i = \frac{\omega_e}{2}$$

$$15119.36 = \frac{288758.6\text{rev/min}}{2}$$

14) Total Time Taken for Fuel Injection in One Cycle

Open Calculator

$$T_f = \frac{\theta}{360} \cdot \frac{60}{\omega_e}$$

$$2.9\text{E}\hat{}\text{-6s} = \frac{30^\circ}{360} \cdot \frac{60}{288758.6\text{rev/min}}$$

15) Volume of Fuel Injected Per Cycle

Open Calculator

$$V_{fc} = \frac{FC_c}{S_g}$$

$$0.051765\text{m}^3 = \frac{0.044\text{kg}}{0.85}$$

16) Volume of Fuel Injected Per Second in Diesel Engine

Open Calculator

fx $$Q_f = A \cdot V_f \cdot T_f \cdot \frac{N_i}{60}$$

ex $$4.22341\text{m}^3 = 42\text{m}^2 \cdot 138\text{m/s} \cdot 0.000167\text{s} \cdot \frac{261.8}{60}$$

Variables Used

- **A** Area of All Orifices of Fuel Injectors *(Square Meter)*
- **BP** Brake Power *(Watt)*
- **BSFC** Brake Specific Fuel Consumption *(Kilogram per Hour per Watt)*
- C_d Coefficient of Discharge
- C_f Flow Coefficient of Orifice
- d_o Diameter of Fuel Orifice *(Meter)*
- **EC** Engine Capacity *(Cubic Centimeter)*
- **FC** Fuel Consumption per Cylinder *(Kilogram per Second)*
- FC_c Fuel Consumption per Cycle *(Kilogram)*
- FC_h Fuel Consumption per Hour *(Kilogram per Hour)*
- H_{de} Energy Content per Unit Cylinder in Diesel Engine *(Megajoule per Cubic Meter)*
- H_p Energy Content per Unit Cylinder *(Megajoule per Cubic Meter)*
- LHV_f Lower Heating Value of Fuel *(Megajoule per Cubic Meter)*
- m_a Mass of Air Taken in Each Cylinder *(Kilogram)*
- N_c Number of Cylinders
- N_i Number of Injections per Minute
- N_m Number of Cycles per Minute
- n_o Number of Orifices
- P_1 Injection Pressure *(Pascal)*
- P_a Intake Air Pressure *(Pascal)*

- p_{cy} Pressure of charge inside the cylinder *(Bar)*
- p_{in} Fuel Injection Pressure *(Bar)*
- **P2** Pressure in Cylinder during Fuel Injection *(Pascal)*
- Q_f Volume of Fuel Injected per Second *(Cubic Meter)*
- **r** Compression Ratio
- R_{af} Stoichiometric Air Fuel Ratio
- S_g Specific Gravity of Fuel
- T_f Total Time Taken for Fuel Injection *(Second)*
- T_i Intake Air Temperature *(Kelvin)*
- V_2 Fuel Velocity at Tip of Nozzle *(Meter per Second)*
- V_c Clearance Volume *(Cubic Meter)*
- V_d Displaced Volume *(Cubic Meter)*
- v_f Specific Volume of Fuel *(Cubic Meter per Kilogram)*
- V_f Actual Fuel Velocity of Injection *(Meter per Second)*
- V_{fc} Volume of Fuel Injected per Cycle *(Cubic Meter)*
- V_{fj} Fuel Jet Velocity *(Meter per Second)*
- V_s Swept volume *(Cubic Centimeter)*
- θ Time of Fuel Injection in Crank Angle *(Degree)*
- λ Relative Air Fuel Ratio
- ρ Density of Air *(Kilogram per Cubic Meter)*
- ρ_f Density of Fuel *(Kilogram per Cubic Meter)*
- ρ_{mix} Density of Mixture *(Kilogram per Cubic Meter)*
- ω_e Engine RPM *(Revolution per Minute)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[R]**, 8.31446261815324
  Universal gas 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: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Volume** in Cubic Centimeter (cm^3), Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Pressure** in Pascal (Pa), Bar (Bar)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion

- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Second (kg/s), Kilogram per Hour (kg/h)
  Mass Flow Rate Unit Conversion
- Measurement: **Angular Velocity** in Revolution per Minute (rev/min)
  Angular Velocity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Specific Volume** in Cubic Meter per Kilogram (m³/kg)
  Specific Volume Unit Conversion
- Measurement: **Energy Density** in Megajoule per Cubic Meter (MJ/m³)
  Energy 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

- **Air Standard Cycles Formulas**
- **Fuel Injection in IC Engine Formulas**

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