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Fuel Injection in IC Engine Formulas

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List of 12 Fuel Injection in IC Engine Formulas

Fuel Injection in IC Engine

1) Actual Fuel Velocity of Injection Considering Orifice Flow Coefficient

[Open Calculator !\[\]\(339a16584d5da0f0a3ca4e9ec17bf6a1_img.jpg\)](#)

$$fx \quad V_f = C_f \cdot \sqrt{\frac{2 \cdot (P_1 - P_2) \cdot 100000}{\rho_f}}$$

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

2) Area of all Orifices of Fuel Injectors

[Open Calculator !\[\]\(6059a5aa8b4ca7bb793408023d6c6e42_img.jpg\)](#)

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

$$ex \quad 3E^{-6}\text{m}^2 = \frac{\pi}{4} \cdot (8E^{-4}\text{m})^2 \cdot 6$$

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

[Open Calculator !\[\]\(e3275251d0893157c3584e20c81dc3ba_img.jpg\)](#)

$$fx \quad H_{di} = \frac{\rho \cdot LHV_f}{\lambda \cdot AFR_{stoich}}$$

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



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

$$\text{fx } H_{\text{port}} = \frac{\rho_{\text{mix}} \cdot \text{LHV}_f}{\lambda \cdot \text{AFR}_{\text{stoich}} + 1}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

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

5) Fuel Consumption Per Cycle

$$\text{fx } f_{\text{cycle}} = \frac{f_{\text{cyl}}}{60 \cdot n_{\text{cycles}}}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$\text{ex } 1.2\text{E}^{-8}\text{kg} = \frac{4\text{kg/h}}{60 \cdot 1500}$$

6) Fuel Consumption per Cylinder

$$\text{fx } f_{\text{cyl}} = \frac{f_{\text{h}}}{n_o}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$\text{ex } 4.166667\text{kg/h} = \frac{25\text{kg/h}}{6}$$

7) Fuel Consumption Per Hour in Diesel Engine

$$\text{fx } f_{\text{h}} = \text{BSFC} \cdot \text{BP}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

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




8) Fuel Velocity at Time of Release into Engine Cylinder 

$$fx \quad V_2 = \sqrt{2 \cdot v_f \cdot (P_1 - P_2)}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)


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

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

$$fx \quad N_i = \frac{E_{\text{rpm}}}{2}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)


$$ex \quad 261.7994 = 5000 \text{ r/min} \cdot \frac{1}{2}$$

10) Total Time Taken for Fuel Injection in One Cycle 

$$fx \quad T_f = \frac{\theta}{360} \cdot \frac{60}{E_{\text{rpm}}}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 0.000167 \text{ s} = \frac{30^\circ}{360} \cdot \frac{60}{5000 \text{ r/min}}$$

11) Volume of Fuel Injected Per Cycle 

$$fx \quad V_{\text{cycle}} = \frac{f_{\text{cycle}}}{S_g}$$

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 4.7 \times 10^{-5} \text{ m}^3 = \frac{4 \times 10^{-5} \text{ kg}}{0.85}$$



12) Volume of Fuel Injected Per Second in Diesel Engine [Open Calculator](#) 

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

$$\text{ex } 1.8E^{-7}m^3 = 3.14E^{-8}m^2 \cdot 138m/s \cdot 0.0033s \cdot \frac{750}{60}$$



Variables Used












- **A** Area of All Orifices of Fuel Injectors (*Square Meter*)
- **AFR_{stoich}** Stoichiometric Air Fuel Ratio
- **BP** Brake Power (*Watt*)
- **BSFC** Brake Specific Fuel Consumption (*Kilogram per Hour per Watt*)
- **C_f** Flow Coefficient of Orifice
- **d_o** Diameter of Fuel Orifice (*Meter*)
- **E_{rpm}** Engine RPM (*Revolution per Minute*)
- **fc_{cycle}** Fuel Consumption per Cycle (*Kilogram*)
- **fc_{cyl}** Fuel Consumption per Cylinder (*Kilogram per Hour*)
- **fc_h** Fuel Consumption per Hour (*Kilogram per Hour*)
- **H_{di}** Energy Content per Unit Cylinder in Diesel Engine (*Megajoule per Cubic Meter*)
- **H_{port}** Energy Content per Unit Cylinder (*Megajoule per Cubic Meter*)
- **LHV_f** Lower Heating Value of Fuel (*Megajoule per Cubic Meter*)
- **n_{cycles}** Number of Cycles per Minute
- **N_i** Number of Injections per Minute
- **n_o** Number of Orifices
- **P₁** Injection Pressure in pascals (*Pascal*)
- **P₂** Pressure in Cylinder during Fuel Injection (*Pascal*)
- **Q_f** Volume of Fuel Injected per Second (*Cubic Meter*)
- **Sg** Specific Gravity of Fuel







- T_f Total Time Taken for Fuel Injection (Second)
- V_{cycle} Volume of Fuel Injected per Cycle (Cubic Meter)
- v_f Specific Volume of Fuel (Cubic Meter per Kilogram)
- V_f Actual Fuel Velocity of Injection (Meter per Second)
- V_2 Fuel Velocity at Tip of Nozzle (Meter per Second)
- 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)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **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:** **Volume** in Cubic Meter (m³)
Volume Unit Conversion 
- **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:** **Angle** in Degree (°)
Angle Unit Conversion 
- **Measurement:** **Mass Flow Rate** in Kilogram per Hour (kg/h)
Mass Flow Rate Unit Conversion 
- **Measurement:** **Angular Velocity** in Revolution per Minute (r/min)
Angular Velocity Unit Conversion 



- **Measurement: Density** in Kilogram per Cubic Meter (kg/m^3)
Density Unit Conversion 
- **Measurement: Specific Volume** in Cubic Meter per Kilogram (m^3/kg)
Specific Volume Unit Conversion 
- **Measurement: Energy Density** in Megajoule per Cubic Meter (MJ/m^3)
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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