

Important Fuel Injection in IC Engine Formulas PDF



Formulas Examples with Units

List of 16 Important Fuel Injection in IC Engine Formulas

1) Actual Fuel Velocity of Injection Considering Orifice Flow Coefficient Formula

Formula

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

Evaluate Formula 

Example with Units

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

2) Area of all Orifices of Fuel Injectors Formula

Formula

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

Example with Units

$$42.4115 \text{ m}^2 = \frac{3.1416}{4} \cdot 3 \text{ m}^2 \cdot 6$$

Evaluate Formula 

3) Compression Ratio given Clearance and Swept Volume Formula

Formula

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

Example with Units

$$1.0118 = 1 + \left(\frac{1178 \text{ cm}^3}{0.10 \text{ m}^3} \right)$$

Evaluate Formula 

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

Formula

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

Example with Units

$$0.5864 \text{ MJ/m}^3 = \frac{1.293 \text{ kg/m}^3 \cdot 10 \text{ MJ/m}^3}{1.5 \cdot 14.7}$$

Evaluate Formula 

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

Formula

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

Example with Units

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

Evaluate Formula 



6) Engine Capacity Formula ↺

Formula

$$EC = V_s \cdot N_c$$

Example with Units

$$4712 \text{ cm}^3 = 1178 \text{ cm}^3 \cdot 4$$

Evaluate Formula ↺

7) Fuel Consumption Per Cycle Formula ↺

Formula

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

Example with Units

$$0.0444 \text{ kg} = \frac{400 \text{ kg/s}}{60 \cdot 150}$$

Evaluate Formula ↺

8) Fuel Consumption per Cylinder Formula ↺

Formula

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

Example with Units

$$0.0004 \text{ kg/s} = \frac{9 \text{ kg/h}}{6}$$

Evaluate Formula ↺

9) Fuel Consumption Per Hour in Diesel Engine Formula ↺

Formula

$$FC_h = BSFC \cdot BP$$

Example with Units

$$8.995 \text{ kg/h} = 0.405 \text{ kg/h/W} \cdot 22.21 \text{ W}$$

Evaluate Formula ↺

10) Fuel Jet Velocity Formula ↺

Formula

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

Example with Units

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

Evaluate Formula ↺

11) Fuel Velocity at Time of Release into Engine Cylinder Formula ↺

Formula

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

Example with Units

$$15.3623 \text{ m/s} = \sqrt{2 \cdot 1.18 \text{ m}^3/\text{kg} \cdot (140 \text{ Pa} - 40 \text{ Pa})}$$

Evaluate Formula ↺

12) Mass of air taken in each cylinder Formula ↺

Formula

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

Example with Units

$$294.2446 \text{ kg} = \frac{1.5e5 \text{ Pa} \cdot (0.10 \text{ m}^3 + 5.005 \text{ m}^3)}{8.3145 \cdot 313 \text{ K}}$$

Evaluate Formula ↺



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

Formula

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

Example with Units

$$15119.3649 = \frac{288758.6 \text{ rev/min}}{2}$$

Evaluate Formula 

14) Total Time Taken for Fuel Injection in One Cycle Formula

Formula

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

Example with Units

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

Evaluate Formula 

15) Volume of Fuel Injected Per Cycle Formula

Formula

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

Example with Units

$$0.0518\text{ m}^3 = \frac{0.044\text{ kg}}{0.85}$$

Evaluate Formula 

16) Volume of Fuel Injected Per Second in Diesel Engine Formula

Formula

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

Example with Units

$$4.2234\text{ m}^3 = 42\text{ m}^2 \cdot 138\text{ m/s} \cdot 0.000167\text{ s} \cdot \frac{261.8}{60}$$

Evaluate Formula 



Variables used in list of Fuel Injection in IC Engine Formulas above

- **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
- **P₁** 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

Constants, Functions, Measurements used in list of Fuel Injection in IC Engine Formulas above

- **constant(s):** pi, 3.14159265358979323846264338327950288
Archimedes' constant
- **constant(s):** [R], 8.31446261815324
Universal gas constant
- **Functions:** 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 (cm³), Cubic Meter (m³)
Volume Unit Conversion 
- **Measurement: Area** in Square Meter (m²)
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)



- **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)

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 



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