Air-Standard Cycles Formulas

List of 18 Air-Standard Cycles Formulas

Air-Standard Cycles

1) Actual Air Fuel Ratio

Open Calculator

fx $$R_a = \frac{m_a}{m_f}$$

ex $$15.9936 = \frac{23.9904\text{kg}}{1.5\text{kg}}$$

2) Air Standard Efficiency for Diesel Engines

Open Calculator

fx $$\eta_d = 100 \cdot \left(1 - \frac{1}{r^{\gamma-1}} \cdot \frac{r_c^{\gamma} - 1}{\gamma \cdot (r_c - 1)}\right)$$

ex $$64.9039 = 100 \cdot \left(1 - \frac{1}{(20)^{1.4-1}} \cdot \frac{(1.95)^{1.4} - 1}{1.4 \cdot (1.95 - 1)}\right)$$

3) Air Standard Efficiency for Petrol engines

Open Calculator

fx $$\eta_o = 100 \cdot \left(1 - \frac{1}{r^{\gamma-1}}\right)$$

ex $$69.82912 = 100 \cdot \left(1 - \frac{1}{(20)^{1.4-1}}\right)$$

4) Air Standard Efficiency given Relative Efficiency

Open Calculator

fx $$\eta = \frac{\eta_i}{\eta_r}$$

ex $$0.506024 = \frac{42}{83}$$

5) Mean Effective Pressure in Diesel Cycle

Open Calculator

fx $$P_D = P_1 \cdot \frac{\gamma \cdot r^{\gamma} \cdot (r_c - 1) - r \cdot \left(r_c^{\gamma} - 1\right)}{(\gamma - 1) \cdot (r - 1)}$$

ex $$828.2159\text{kPa} = 110\text{kPa} \cdot \frac{1.4 \cdot (20)^{1.4} \cdot (1.95 - 1) - 20 \cdot \left((1.95)^{1.4} - 1\right)}{(1.4 - 1) \cdot (20 - 1)}$$

6) Mean Effective Pressure in Dual Cycle

Open Calculator

fx $$P_d = P_1 \cdot \frac{r^{\gamma} \cdot ((R_p - 1) + \gamma \cdot R_p \cdot (r_c - 1)) - r \cdot \left(R_p \cdot r_c^{\gamma} - 1\right)}{(\gamma - 1) \cdot (r - 1)}$$

ex $$4348.961\text{kPa} = 110\text{kPa} \cdot \frac{(20)^{1.4} \cdot ((3.35 - 1) + 1.4 \cdot 3.35 \cdot (1.95 - 1)) - 20 \cdot \left(3.35 \cdot (1.95)^{1.4} - 1\right)}{(1.4 - 1) \cdot (20 - 1)}$$

7) Mean Effective Pressure in Otto Cycle

Open Calculator

fx $$P_O = P_1 \cdot r \cdot \left(\frac{\left(r^{\gamma-1} - 1\right) \cdot (r_p - 1)}{(r - 1) \cdot (\gamma - 1)}\right)$$

ex $$1567.738\text{kPa} = 110\text{kPa} \cdot 20 \cdot \left(\frac{\left((20)^{1.4-1} - 1\right) \cdot (3.34 - 1)}{(20 - 1) \cdot (1.4 - 1)}\right)$$

8) Relative Air-Fuel Ratio

Open Calculator

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

ex $$1.088 = \frac{15.9936}{14.7}$$

9) Thermal Efficiency of Atkinson Cycle

Open Calculator

fx $$\eta_a = 100 \cdot \left(1 - \gamma \cdot \left(\frac{e - r}{e^{\gamma} - r^{\gamma}}\right)\right)$$

ex $$62.24168 = 100 \cdot \left(1 - 1.4 \cdot \left(\frac{4 - 20}{(4)^{1.4} - (20)^{1.4}}\right)\right)$$

10) Thermal Efficiency of Diesel Cycle

Open Calculator

fx $$\eta_{th} = 1 - \frac{1}{r^{\gamma-1}} \cdot \frac{r_c^{\gamma} - 1}{\gamma \cdot (r_c - 1)}$$

ex $$0.649039 = 1 - \frac{1}{(20)^{1.4-1}} \cdot \frac{(1.95)^{1.4} - 1}{1.4 \cdot (1.95 - 1)}$$

11) Thermal Efficiency of Dual Cycle

Open Calculator

fx $$\varepsilon_d = 100 \cdot \left(1 - \frac{1}{r^{\gamma-1}} \cdot \left(\frac{R_p \cdot r_c^{\gamma} - 1}{R_p - 1 + R_p \cdot \gamma \cdot (r_c - 1)}\right)\right)$$

ex $$66.60463 = 100 \cdot \left(1 - \frac{1}{(20)^{1.4-1}} \cdot \left(\frac{3.35 \cdot (1.95)^{1.4} - 1}{3.35 - 1 + 3.35 \cdot 1.4 \cdot (1.95 - 1)}\right)\right)$$

12) Thermal Efficiency of Ericsson Cycle

Open Calculator

fx $$\eta_e = \frac{T_H - T_L}{T_H}$$

ex $$0.52 = \frac{250K - 120K}{250K}$$

13) Thermal Efficiency of Lenoir Cycle

Open Calculator

fx $$\eta_l = 100 \cdot \left(1 - \gamma \cdot \left(\frac{r_p^{\frac{1}{\gamma}} - 1}{r_p - 1}\right)\right)$$

ex $$18.24421 = 100 \cdot \left(1 - 1.4 \cdot \left(\frac{(3.34)^{\frac{1}{1.4}} - 1}{3.34 - 1}\right)\right)$$

14) Thermal Efficiency of Otto Cycle

Open Calculator

fx $$\varepsilon_o = 1 - \frac{1}{r^{\gamma-1}}$$

ex $$0.698291 = 1 - \frac{1}{(20)^{1.4-1}}$$

15) Thermal Efficiency of Stirling Cycle given Heat Exchanger Effectiveness

Open Calculator

fx $$\eta_s = 100 \cdot \left(\frac{[R] \cdot \ln(r) \cdot (T_f - T_i)}{[R] \cdot T_f \cdot \ln(r) + C_v \cdot (1 - \varepsilon) \cdot (T_f - T_i)} \right)$$

ex $$19.88537 = 100 \cdot \left(\frac{[R] \cdot \ln(20) \cdot (423\text{K} - 283\text{K})}{[R] \cdot 423\text{K} \cdot \ln(20) + 100\text{J/K*mol} \cdot (1 - 0.5) \cdot (423\text{K} - 283\text{K})} \right)$$

16) Work Output for Diesel Cycle

Open Calculator

fx $$W_d = P_1 \cdot V_1 \cdot \frac{r^{\gamma-1} \cdot \left(\gamma \cdot (r_c - 1) - r^{1-\gamma} \cdot \left(r_c^{\gamma} - 1\right)\right)}{\gamma - 1}$$

ex $$511.4233\text{KJ} = 110\text{kPa} \cdot 0.65\text{m}^3 \cdot \frac{(20)^{1.4-1} \cdot \left(1.4 \cdot (1.95 - 1) - (20)^{1-1.4} \cdot \left((1.95)^{1.4} - 1\right)\right)}{1.4 - 1}$$

17) Work Output for Dual Cycle

Open Calculator

fx $$W_D = P_1 \cdot V_1 \cdot \frac{r^{\gamma-1} \cdot (\gamma \cdot r_p \cdot (r_c - 1) + (r_p - 1)) - \left(r_p \cdot r_c^{\gamma} - 1\right)}{\gamma - 1}$$

ex $$2676.232\text{KJ} = 110\text{kPa} \cdot 0.65\text{m}^3 \cdot \frac{(20)^{1.4-1} \cdot (1.4 \cdot 3.34 \cdot (1.95 - 1) + (3.34 - 1)) - \left(3.34 \cdot (1.95)^{1.4} - 1\right)}{1.4 - 1}$$

18) Work Output for Otto Cycle

Open Calculator

fx $$W_o = P_1 \cdot V_1 \cdot \frac{(r_p - 1) \cdot \left(r^{\gamma-1} - 1\right)}{\gamma - 1}$$

ex $$968.0783\text{KJ} = 110\text{kPa} \cdot 0.65\text{m}^3 \cdot \frac{(3.34 - 1) \cdot \left((20)^{1.4-1} - 1\right)}{1.4 - 1}$$

Variables Used

- **C_v** Molar Specific Heat Capacity at Constant Volume *(Joule Per Kelvin Per Mole)*
- **e** Expansion Ratio
- **m_a** Mass of Air *(Kilogram)*
- **m_f** Mass of Fuel *(Kilogram)*
- **P_1** Pressure at Start of Isentropic Compression *(Kilopascal)*
- **P_d** Mean Effective Pressure of Dual Cycle *(Kilopascal)*
- **P_D** Mean Effective Pressure of Diesel Cycle *(Kilopascal)*
- **P_O** Mean Effective Pressure of Otto Cycle *(Kilopascal)*
- **r** Compression Ratio
- **R_a** Actual Air Fuel Ratio
- **r_c** Cut-off Ratio
- **R_i** Stoichiometric Air Fuel Ratio
- **r_p** Pressure Ratio
- **R_p** Pressure Ratio in Dual Cycle
- **T_f** Final Temperature *(Kelvin)*
- **T_H** Higher Temperature *(Kelvin)*
- **T_i** Initial Temperature *(Kelvin)*
- **T_L** Lower Temperature *(Kelvin)*
- **V_1** Volume at Start of Isentropic Compression *(Cubic Meter)*
- **W_d** Work Output of Diesel Cycle *(Kilojoule)*
- **W_D** Work Output of Dual Cycle *(Kilojoule)*
- **W_o** Work Output of Otto Cycle *(Kilojoule)*
- **γ** Heat Capacity Ratio
- **ε** Effectiveness of Heat Exchanger
- **ε_d** Thermal Efficiency of Dual Cycle
- **ε_o** Thermal Efficiency of Otto Cycle
- **η** Efficiency
- **η_a** Thermal Efficiency of Atkinson Cycle
- **η_d** Efficiency of Diesel Cycle
- **η_e** Thermal Efficiency of Ericsson Cycle
- **η_i** Indicated Thermal Efficiency

- η_l Thermal Efficiency of Lenoir Cycle
- η_o Efficiency of Otto Cycle
- η_r Relative Efficiency
- η_s Thermal Efficiency of Stirling Cycle
- η_{th} Thermal Efficiency of Diesel Cycle
- Φ Relative Air Fuel Ratio

Constants, Functions, Measurements used

- Constant: **[R]**, 8.31446261815324
  Universal gas constant
- 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.
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Pressure** in Kilopascal (kPa)
  Pressure Unit Conversion
- Measurement: **Energy** in Kilojoule (KJ)
  Energy Unit Conversion
- Measurement: **Molar Specific Heat Capacity at Constant Volume** in Joule Per Kelvin Per Mole (J/K*mol)
  Molar Specific Heat Capacity at Constant Volume Unit Conversion

Check other formula lists

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

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