

Important Thermal Efficiency Formulas PDF



Formulas Examples with Units

List of 17 Important Thermal Efficiency Formulas

1) Brake Thermal Efficiency Formula

Formula

$$\eta_{bth} = \frac{BP}{Q}$$

Example with Units

$$45.2381 = \frac{190 \text{ kW}}{4200 \text{ J}}$$

Evaluate Formula 

2) Brayton Cycle Efficiency Formula

Formula

$$BCE = 1 - \frac{1}{r_p^{\frac{\gamma-1}{\gamma}}}$$

Example

$$0.668 = 1 - \frac{1}{6^{\frac{2.6-1}{2.6}}}$$

Evaluate Formula 

3) Carnot Cycle Efficiency of Heat Engine using Temperature of Source and Sink Formula

Formula

$$n' = 1 - \frac{T_i}{T_f}$$

Example with Units

$$0.1159 = 1 - \frac{305 \text{ K}}{345 \text{ K}}$$

Evaluate Formula 

4) Compressor Efficiency Formula

Formula

$$CE = \frac{KE}{W}$$

Example with Units

$$0.3 = \frac{75 \text{ J}}{250 \text{ J}}$$

Evaluate Formula 

5) Cooled Compressor Efficiency Formula

Formula

$$CCE = \frac{KE}{W}$$

Example with Units

$$0.3 = \frac{75 \text{ J}}{250 \text{ J}}$$

Evaluate Formula 



6) Diesel Efficiency Formula

Formula

$$DE = 1 - \frac{1}{r^{\frac{1}{\gamma}} - 1} \cdot \left(Cr^{\frac{1}{\gamma}} - \frac{1}{\frac{1}{\gamma} \cdot (Cr - 1)} \right)$$

Evaluate Formula 

Example

$$1.0964 = 1 - \frac{1}{1.75^{\frac{1}{2.6}} - 1} \cdot \left(1.2^{\frac{1}{2.6}} - \frac{1}{2.6 \cdot (1.2 - 1)} \right)$$

7) Indicated Thermal Efficiency Formula

Formula

$$IDE = \frac{BP}{Q}$$

Example with Units

$$45.2381 = \frac{190_{kW}}{4200_J}$$

Evaluate Formula 

8) Nozzle Efficiency Formula

Formula

$$NE = \frac{\Delta KE}{KE}$$

Example with Units

$$1.2 = \frac{90_J}{75_J}$$

Evaluate Formula 

9) Otto Cycle Efficiency Formula

Formula

$$OTE = 1 - \frac{T_i}{T_f}$$

Example with Units

$$0.1159 = 1 - \frac{305_K}{345_K}$$

Evaluate Formula 

10) Overall Efficiency given Boiler, Cycle, Turbine, Generator, and Auxiliary Efficiency Formula

Formula

$$\eta_o = \eta_B \cdot \eta_C \cdot \eta_T \cdot \eta_G \cdot \eta_{Aux}$$

Example

$$0.1432 = 0.68 \cdot 0.54 \cdot 0.75 \cdot 0.65 \cdot 0.80$$

Evaluate Formula 

11) Ranking Cycle Efficiency Formula

Formula

$$RCE = 1 - q'$$

Example

$$0.75 = 1 - 0.25$$

Evaluate Formula 

12) Thermal Efficiency given Mechanical Energy Formula

Formula

$$\eta_{th\ m} = \frac{W_{net}}{Q_{in}}$$

Example with Units

$$0.5 = \frac{320_J}{640_J}$$

Evaluate Formula 



13) Thermal Efficiency given Waste Energy Formula

Formula

$$\eta_{th} = 1 - \frac{Q_{out}}{Q_{in}}$$

Example with Units

$$0.4688 = 1 - \frac{340_J}{640_J}$$

Evaluate Formula 

14) Thermal Efficiency of Carnot Engine Formula

Formula

$$\eta_{th\ c} = 1 - \frac{T_L}{T_H}$$

Example with Units

$$0.4918 = 1 - \frac{310_K}{610_K}$$

Evaluate Formula 

15) Thermal Efficiency of Heat Engine Formula

Formula

$$\eta = \frac{W}{Q}$$

Example with Units

$$0.0595 = \frac{250_J}{4200_J}$$

Evaluate Formula 

16) Turbine Efficiency Formula

Formula

$$\eta_T = \frac{W}{KE}$$

Example with Units

$$3.3333 = \frac{250_J}{75_J}$$

Evaluate Formula 

17) Volumetric Efficiency given Compression and Pressure Ratio Formula

Formula

$$\eta_v = 1 + r + r \cdot r_p^{\frac{1}{\gamma}}$$

Example

$$6.236 = 1 + 1.75 + 1.75 \cdot 6^{\frac{1}{2.6}}$$

Evaluate Formula 



Variables used in list of Thermal Efficiency Formulas above

- **BCE** Thermal Efficiency of Brayton Cycle
- **BP** Brake Power (*Kilowatt*)
- **CCE** Cooled Compressor Efficiency
- **CE** Compressor Efficiency
- **Cr** Cutoff Ratio
- **DE** Diesel Efficiency
- **IDE** Indicated Thermal Efficiency
- **KE** Kinetic Energy (*Joule*)
- **n'** Carnot Cycle Efficiency
- **NE** Nozzle Efficiency
- **OTE** OTE
- **q'** Heat Ratio
- **Q** Heat Energy (*Joule*)
- **Q_{in}** Thermal Energy (*Joule*)
- **Q_{out}** Waste Heat (*Joule*)
- **r** Compression Ratio
- **r_p** Pressure Ratio
- **RCE** Ranking Cycle
- **T_f** Final Temperature (*Kelvin*)
- **T_H** Absolute Temperature of Hot Reservoir (*Kelvin*)
- **T_i** Initial Temperature (*Kelvin*)
- **T_L** Absolute Temperature of Cold Reservoir (*Kelvin*)
- **W** Work (*Joule*)
- **W_{net}** Mechanical Energy (*Joule*)
- **Y** Gamma
- **ΔKE** Change in Kinetic Energy (*Joule*)
- **η** Thermal Efficiency of Heat Engine
- **η_{Aux}** Auxiliary Efficiency
- **η_B** Boiler Efficiency
- **η_{bth}** Brake Thermal Efficiency
- **η_C** Cycle Efficiency
- **η_G** Generator Efficiency

Constants, Functions, Measurements used in list of Thermal Efficiency Formulas above

- **Measurement: Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement: Energy** in Joule (J)
Energy Unit Conversion 
- **Measurement: Power** in Kilowatt (kW)
Power Unit Conversion 



- η_o Overall Efficiency
- η_T Turbine Efficiency
- $\eta_{th\ c}$ Thermal Efficiency of Carnot Engine
- $\eta_{th\ m}$ Thermal Efficiency given Mechanical energy
- η_{th} Thermal efficiency given Waste energy
- η_v Volumetric Efficiency



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