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Thermal Efficiency Formulas

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List of 17 Thermal Efficiency Formulas

Thermal Efficiency

1) Brake Thermal Efficiency

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

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b_img.jpg\)](#)

$$ex \quad 45.2381 = \frac{190kW}{4200J}$$

2) Brayton Cycle Efficiency

$$fx \quad BCE = 1 - \frac{1}{r_p^{\frac{Y-1}{Y}}}$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d_img.jpg\)](#)

$$ex \quad 0.668 = 1 - \frac{1}{(6)^{\frac{2.6-1}{2.6}}}$$

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

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

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d_img.jpg\)](#)

$$ex \quad 0.115942 = 1 - \frac{305K}{345K}$$



4) Compressor Efficiency

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

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

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

5) Cooled Compressor Efficiency

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

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

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

6) Diesel Efficiency

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

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

$$\text{ex } 1.096396 = 1 - \frac{1}{(1.75)^{2.6} - 1} \cdot \left((1.2)^{2.6} - \frac{1}{2.6 \cdot (1.2 - 1)} \right)$$

7) Indicated Thermal Efficiency

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

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

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



8) Nozzle Efficiency 

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

Open Calculator 

$$\text{ex } 1.2 = \frac{90J}{75J}$$

9) Otto Cycle Efficiency 

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

Open Calculator 

$$\text{ex } 0.115942 = 1 - \frac{305K}{345K}$$

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

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

Open Calculator 

$$\text{ex } 0.143208 = 0.68 \cdot 0.54 \cdot 0.75 \cdot 0.65 \cdot 0.80$$

11) Ranking Cycle Efficiency 

$$\text{fx } RCE = 1 - q'$$

Open Calculator 

$$\text{ex } 0.75 = 1 - 0.25$$



12) Thermal Efficiency given Mechanical Energy 

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

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 0.5 = \frac{320J}{640J}$$

13) Thermal Efficiency given Waste Energy 

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 0.46875 = 1 - \frac{340J}{640J}$$

14) Thermal Efficiency of Carnot Engine 

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

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.491803 = 1 - \frac{310K}{610K}$$

15) Thermal Efficiency of Heat Engine 

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

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 0.059524 = \frac{250J}{4200J}$$



16) Turbine Efficiency

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

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$\text{ex } 3.333333 = \frac{250J}{75J}$$

17) Volumetric Efficiency given Compression and Pressure Ratio

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

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$\text{ex } 6.235997 = 1 + 1.75 + 1.75 \cdot (6)^{\frac{1}{2.6}}$$



Variables Used

- **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)
- γ 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
- η_{o} Overall Efficiency
- η_{T} Turbine Efficiency
- $\eta_{\text{th c}}$ Thermal Efficiency of Carnot Engine
- $\eta_{\text{th m}}$ Thermal Efficiency given Mechanical energy
- η_{th} Thermal efficiency given Waste energy
- η_{v} Volumetric Efficiency



Constants, Functions, Measurements used

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



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