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# Compressor Formulas

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# List of 14 Compressor Formulas

## Compressor

### 1) Compressor work

$$fx \quad W_c = h_2 - h_1$$

[Open Calculator !\[\]\(a870788d6ed9b8fd294b7654a8c8526b\_img.jpg\)](#)

$$ex \quad 160.9KJ = 548.5KJ - 387.6KJ$$

### 2) Compressor Work in Gas Turbine given Temperature

$$fx \quad W_c = C_p \cdot (T_2 - T_1)$$

[Open Calculator !\[\]\(c50c8b7b2cc2cf9ff925edec0ee94c0d\_img.jpg\)](#)

$$ex \quad 152.0688KJ = 1.248kJ/kg \cdot K \cdot (420K - 298.15K)$$

### 3) Degree of Reaction for Compressor

$$fx \quad R = \frac{\Delta E_{\text{rotor increase}}}{\Delta E_{\text{stage increase}}}$$

[Open Calculator !\[\]\(f60b7a900783ac3fd531bfd9c111be6d\_img.jpg\)](#)

$$ex \quad 0.25 = \frac{3KJ}{12KJ}$$


### 4) Efficiency of Compressor given Enthalpy

$$fx \quad \eta_C = \frac{h_{2,\text{ideal}} - h_1}{h_{2,\text{actual}} - h_1}$$

[Open Calculator !\[\]\(83bbbd261710c59db0214aa27b2edc0d\_img.jpg\)](#)

$$ex \quad 0.920735 = \frac{547.9KJ - 387.6KJ}{561.7KJ - 387.6KJ}$$



5) Efficiency of compressor in actual gas turbine cycle 

$$fx \quad \eta_C = \frac{T_2 - T_1}{T_{2,actual} - T_1}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$ex \quad 0.924156 = \frac{420K - 298.15K}{430K - 298.15K}$$

6) Impeller Outlet Diameter 

$$fx \quad D_t = \frac{60 \cdot U_t}{\pi \cdot N}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$ex \quad 0.544872m = \frac{60 \cdot 485m/s}{\pi \cdot 17000}$$

7) Isentropic Efficiency of Compression Machine 

$$fx \quad \eta_C = \frac{W_{s,in}}{W_{in}}$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$ex \quad 0.927419 = \frac{230KJ}{248KJ}$$

8) Mean Diameter of Impeller 

$$fx \quad D_m = \sqrt{\frac{D_t^2 + D_h^2}{2}}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$ex \quad 0.536144m = \sqrt{\frac{(0.57m)^2 + (0.5m)^2}{2}}$$



## 9) Minimum Temperature Ratio

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5\_img.jpg\)](#)

$$\text{fx } T_r = \frac{P_r^{\frac{\gamma-1}{\gamma}}}{\eta_C \cdot \eta_T}$$

$$\text{ex } 1.533919 = \frac{(2.4)^{\frac{1.4-1}{1.4}}}{0.92 \cdot 0.91}$$

## 10) Shaft Work in Compressible Flow Machines

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d\_img.jpg\)](#)

$$\text{fx } W_s = \left( h_1 + \frac{C_1^2}{2} \right) - \left( h_2 + \frac{C_2^2}{2} \right)$$

$$\text{ex } -160.57018\text{KJ} = \left( 387.6\text{KJ} + \frac{(30.8\text{m/s})^2}{2} \right) - \left( 548.5\text{KJ} + \frac{(17\text{m/s})^2}{2} \right)$$

## 11) Shaft Work in Compressible Flow Machines neglecting Inlet and Exit Velocities

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32\_img.jpg\)](#)

$$\text{fx } W_s = h_1 - h_2$$


$$\text{ex } -160.9\text{KJ} = 387.6\text{KJ} - 548.5\text{KJ}$$



12) Tip Velocity of Impeller given Hub Diameter [Open Calculator](#) 

$$\text{fx } U_t = \pi \cdot \frac{N}{60} \cdot \sqrt{\frac{D_t^2 + D_h^2}{2}}$$

$$\text{ex } 477.2311\text{m/s} = \pi \cdot \frac{17000}{60} \cdot \sqrt{\frac{(0.57\text{m})^2 + (0.5\text{m})^2}{2}}$$

13) Tip Velocity of Impeller given Mean Diameter [Open Calculator](#) 

$$\text{fx } U_t = \pi \cdot (2 \cdot D_m^2 - D_h^2)^{0.5} \cdot \frac{N}{60}$$

$$\text{ex } 497.0334\text{m/s} = \pi \cdot (2 \cdot (0.53\text{m})^2 - (0.5\text{m})^2)^{0.5} \cdot \frac{17000}{60}$$

14) Work Required to Drive Compressor Including Mechanical Losses [Open Calculator](#) 

$$\text{fx } W_c = \left( \frac{1}{\eta_m} \right) \cdot C_p \cdot (T_2 - T_1)$$

$$\text{ex } 153.6048\text{KJ} = \left( \frac{1}{0.99} \right) \cdot 1.248\text{kJ/kg} \cdot \text{K} \cdot (420\text{K} - 298.15\text{K})$$



## Variables Used






- $C_1$  Compressor Inlet Velocity (Meter per Second)
- $C_2$  Compressor Exit Velocity (Meter per Second)
- $C_p$  Specific Heat Capacity at Constant Pressure (Kilojoule per Kilogram per K)
- $D_h$  Impeller Hub Diameter (Meter)
- $D_m$  Mean Diameter of Impeller (Meter)
- $D_t$  Impeller Tip Diameter (Meter)
- $h_1$  Enthalpy at Compressor Inlet (Kilojoule)
- $h_2$  Enthalpy at Exit of Compressor (Kilojoule)
- $h_{2,actual}$  Actual Enthalpy after Compression (Kilojoule)
- $h_{2,ideal}$  Ideal Enthalpy after Compression (Kilojoule)
- $N$  RPM
- $P_r$  Pressure Ratio
- $R$  Degree of Reaction
- $T_1$  Temperature at Compressor Inlet (Kelvin)
- $T_2$  Temperature at Compressor Exit (Kelvin)
- $T_{2,actual}$  Actual Temperature at Compressor Exit (Kelvin)
- $T_r$  Temperature Ratio
- $U_t$  Tip Velocity (Meter per Second)
- $W_c$  Compressor Work (Kilojoule)
- $W_{in}$  Actual Work Input (Kilojoule)



- $W_s$  Shaft Work (Kilojoule)
- $W_{s,in}$  Isentropic Work Input (Kilojoule)
- $\gamma$  Heat Capacity Ratio
- $\Delta E_{rotor\ increase}$  Enthalpy Increase in Rotor (Kilojoule)
- $\Delta E_{stage\ increase}$  Enthalpy Increase in Stage (Kilojoule)
- $\eta_C$  Isentropic Efficiency of Compressor
- $\eta_m$  Mechanical Efficiency
- $\eta_T$  Efficiency of Turbine



## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Function:** **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:** **Temperature** in Kelvin (K)  
*Temperature Unit Conversion* 
- **Measurement:** **Speed** in Meter per Second (m/s)  
*Speed Unit Conversion* 
- **Measurement:** **Energy** in Kilojoule (KJ)  
*Energy Unit Conversion* 
- **Measurement:** **Specific Heat Capacity** in Kilojoule per Kilogram per K (kJ/kg\*K)  
*Specific Heat Capacity Unit Conversion* 





## Check other formula lists

- [Compressor Formulas](#) 

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