# Important Compressor Formulas PDF

Formulas
Examples
with Units

**List of 14**
**Important Compressor Formulas**

## 1) Compressor work Formula

Evaluate Formula

Formula

$$W_c = h_2 - h_1$$

Example with Units

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

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

Evaluate Formula

Formula

$$W_c = C_p \cdot \left( T_2 - T_1 \right)$$

Example with Units

$$152.0688\,\text{KJ} = 1.248\,\text{KJ/kg*K} \cdot \left( 420\,\text{K} - 298.15\,\text{K} \right)$$

## 3) Degree of Reaction for Compressor Formula

Evaluate Formula

Formula

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

Example with Units

$$0.25 = \frac{3\,\text{KJ}}{12\,\text{KJ}}$$

## 4) Efficiency of Compressor given Enthalpy Formula

Evaluate Formula

Formula

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

Example with Units

$$0.9207 = \frac{547.9\,\text{KJ} - 387.6\,\text{KJ}}{561.7\,\text{KJ} - 387.6\,\text{KJ}}$$

## 5) Efficiency of compressor in actual gas turbine cycle Formula

Evaluate Formula

Formula

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

Example with Units

$$0.9242 = \frac{420\,\text{K} - 298.15\,\text{K}}{430\,\text{K} - 298.15\,\text{K}}$$

## 6) Impeller Outlet Diameter Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5449\,\text{m} = \frac{60 \cdot 485\,\text{m/s}}{3.1416 \cdot 17000}$$

## 7) Isentropic Efficiency of Compression Machine Formula

Evaluate Formula

Formula

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

Example with Units

$$0.9274 = \frac{230\,\text{KJ}}{248\,\text{KJ}}$$

## 8) Mean Diameter of Impeller Formula

Evaluate Formula

Formula

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

Example with Units

$$0.5361\,\text{m} = \sqrt{\frac{0.57\,\text{m}^2 + 0.5\,\text{m}^2}{2}}$$

## 9) Minimum Temperature Ratio Formula

Evaluate Formula

Formula

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

Example

$$1.5339 = \frac{2.4^{\frac{1.4 - 1}{1.4}}}{0.92 \cdot 0.91}$$

## 10) Shaft Work in Compressible Flow Machines Formula

Evaluate Formula

Formula

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

Example with Units

$$-160.5702\,\text{KJ} = \left(387.6\,\text{KJ} + \frac{30.8\,\text{m/s}^2}{2}\right) - \left(548.5\,\text{KJ} + \frac{17\,\text{m/s}^2}{2}\right)$$

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

Evaluate Formula

Formula

$$W_s = h_1 - h_2$$

Example with Units

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

## 12) Tip Velocity of Impeller given Hub Diameter Formula

Evaluate Formula

Formula

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

Example with Units

$$477.2311\,\text{m/s} = 3.1416 \cdot \frac{17000}{60} \cdot \sqrt{\frac{0.57\,\text{m}^2 + 0.5\,\text{m}^2}{2}}$$

## 13) Tip Velocity of Impeller given Mean Diameter Formula

Evaluate Formula

Formula

$$U_t = \pi \cdot \left(2 \cdot D_m^{\,2} - D_h^{\,2}\right)^{0.5} \cdot \frac{N}{60}$$

Example with Units

$$497.0334\,\text{m/s} = 3.1416 \cdot \left(2 \cdot 0.53\,\text{m}^{\,2} - 0.5\,\text{m}^{\,2}\right)^{0.5} \cdot \frac{17000}{60}$$

## 14) Work Required to Drive Compressor Including Mechanical Losses Formula

Evaluate Formula

Formula

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

Example with Units

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

## Variables used in list of Compressor Formulas above

- $C_1$ 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

## Constants, Functions, Measurements used in list of Compressor Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' 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: **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*

- $\eta_T$ Efficiency of Turbine

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