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Fundamentals of Rotating Machines Formulas

Calculators! Examples! Conversions!

List of 17 Fundamentals of Rotating Machines Formulas

Fundamentals of Rotating Machines

1) Degree of Reaction for Compressor

Open Calculator

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

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

2) Degree of Reaction for Turbine

Open Calculator

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

$$0.875 = \frac{14\text{KJ}}{16\text{KJ}}$$

3) Impeller Outlet Diameter

Open Calculator

$$D_2 = \frac{60 \cdot v}{\pi \cdot N}$$

$$19.5883\text{m} = \frac{60 \cdot 60\text{m/s}}{\pi \cdot 58.5}$$

4) Isentropic Efficiency of Compression Machine

Open Calculator

fx $$\eta_{\text{isen}} = \frac{W_{\text{isen in}}}{W_{\text{in}}}$$

ex $$0.5 = \frac{124\text{KJ}}{248\text{KJ}}$$

5) Isentropic Efficiency of Expansion Machine

Open Calculator

fx $$\eta_{\text{isen turbine}} = \frac{W_{\text{out}}}{W_{\text{isen out}}}$$

ex $$0.375 = \frac{45\text{KJ}}{120\text{KJ}}$$

6) Mean Diameter of Impeller

Open Calculator

fx $$D_m = \sqrt{\frac{D_1^2 + D_o^2}{2}}$$

ex $$2.829311\text{m} = \sqrt{\frac{(0.1\text{m})^2 + (4\text{m})^2}{2}}$$

7) Tip Velocity of Impeller given Hub Diameter

Open Calculator

fx $$v = \pi \cdot N \cdot \sqrt{\frac{D_1^2 + D_o^2}{2}}$$

ex $$519.9797\text{m/s} = \pi \cdot 58.5 \cdot \sqrt{\frac{(0.1\text{m})^2 + (4\text{m})^2}{2}}$$

8) Tip Velocity of Impeller given Mean Diameter

Open Calculator

fx $$v = \pi \cdot D_m \cdot N$$

ex $$2646.478\text{m/s} = \pi \cdot 14.4\text{m} \cdot 58.5$$

9) Work Done by Roots Blower

Open Calculator

fx $$w = 4 \cdot V_T \cdot (P_f - P_i)$$

ex $$3.38436\text{KJ} = 4 \cdot 63\text{m}^3 \cdot (18.43\text{Pa} - 5\text{Pa})$$

General Fluid Dynamics

10) Angular Moment of Momentum at Exit

Open Calculator

fx $$L = c_{t2} \cdot r_1$$

ex $$65.52\text{kg*m}^2\text{/s} = 8.19\text{m/s} \cdot 8\text{m}$$

11) Angular Moment of Momentum at Inlet

Open Calculator

fx $$L = c_{t1} \cdot r_1$$

ex $$112\text{kg*m²/s} = 14\text{m/s} \cdot 8\text{m}$$

12) Energy Transfer due to Centrifugal Effect

Open Calculator

fx $$E = \frac{u_1^2 - u_2^2}{2}$$

ex $$1.19\text{KJ} = \frac{(52\text{m/s})^2 - (18\text{m/s})^2}{2}$$

13) Energy Transfer due to Change of Absolute Kinetic Energy of Fluid

Open Calculator

fx $$E = \frac{c_1^2 - c_2^2}{2}$$

ex $$6.2445\text{KJ} = \frac{(125\text{m/s})^2 - (56\text{m/s})^2}{2}$$

14) Energy Transfer due to Change of Relative Kinetic Energy of Fluid

Open Calculator

fx $$E = \frac{w_2^2 - w_1^2}{2}$$

ex $$3.456\text{KJ} = \frac{(96\text{m/s})^2 - (48\text{m/s})^2}{2}$$

15) Peripheral Velocity of Blade at Entry corresponding to Diameter

Open Calculator

fx $$u_1 = \frac{\pi \cdot D \cdot N}{60}$$

ex $$30.63053\text{m/s} = \frac{\pi \cdot 10\text{m} \cdot 58.5}{60}$$

16) Peripheral Velocity of Blade at Exit corresponding to Diameter

Open Calculator

fx $$u_2 = \frac{\pi \cdot D \cdot N}{60}$$

ex $$30.63053\text{m/s} = \frac{\pi \cdot 10\text{m} \cdot 58.5}{60}$$

17) Torque Produced

Open Calculator

fx $$\tau = c_{t1} \cdot r_1 - c_{t2} \cdot r_2$$

ex $$5.53\text{N*m} = 14\text{m/s} \cdot 8\text{m} - 8.19\text{m/s} \cdot 13\text{m}$$

Variables Used

- c_1 Absolute Velocity at Inlet *(Meter per Second)*
- c_2 Absolute Velocity at Exit *(Meter per Second)*
- c_{t1} Tangential Velocity at Inlet *(Meter per Second)*
- c_{t2} Tangential Velocity at Exit *(Meter per Second)*
- D Diameter *(Meter)*
- D_1 Diameter of Impeller at Inlet *(Meter)*
- D_2 Diameter of Impeller at Outlet *(Meter)*
- D_m Mean Diameter of Impeller *(Meter)*
- D_o Hub Diameter of Impeller *(Meter)*
- E Energy Transfer *(Kilojoule)*
- L Angular Momentum *(Kilogram Square Meter per Second)*
- N Speed in RPM
- P_f Final Pressure of System *(Pascal)*
- P_i Initial Pressure of System *(Pascal)*
- R Degree of Reaction
- r_1 Radius 1 *(Meter)*
- r_2 Radius 2 *(Meter)*
- u_1 Peripheral Velocity at Inlet *(Meter per Second)*
- u_2 Peripheral Velocity at Exit *(Meter per Second)*
- v Velocity *(Meter per Second)*
- V_T Volume *(Cubic Meter)*

- **w** Work Done per Cycle *(Kilojoule)*
- **w_1** Relative Velocity at Inlet *(Meter per Second)*
- **w_2** Relative Velocity at Exit *(Meter per Second)*
- **W_{in}** Actual Work Input *(Kilojoule)*
- **$W_{isen\ in}$** Isentropic Work Input *(Kilojoule)*
- **$W_{isen\ out}$** Isentropic Work Output *(Kilojoule)*
- **W_{out}** Actual Work Output *(Kilojoule)*
- **$\Delta E_{rotor\ drop}$** Enthalpy Drop in Rotor *(Kilojoule)*
- **$\Delta E_{rotor\ increase}$** Enthalpy Increase in Rotor *(Kilojoule)*
- **$\Delta E_{stage\ drop}$** Enthalpy Drop in Stage *(Kilojoule)*
- **$\Delta E_{stage\ increase}$** Enthalpy Increase in Stage *(Kilojoule)*
- **$\eta_{isen\ turbine}$** Isentropic Efficiency of Turbine
- **η_{isen}** Isentropic Efficiency of Compressor
- **τ** Torque *(Newton Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Energy** in Kilojoule (KJ)
  Energy Unit Conversion
- Measurement: **Torque** in Newton Meter (N*m)
  Torque Unit Conversion
- Measurement: **Angular Momentum** in Kilogram Square Meter per Second ($kg*m^2/s$)
  Angular Momentum Unit Conversion

Check other formula lists

- **Basics of Gas Turbines Formulas**
- **Fundamentals of Rotating Machines Formulas**
- **Inlets and Nozzles Formulas**
- **Rocket Propulsion Formulas**

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