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Basics of Gas Turbines Formulas

Calculators! Examples! Conversions!

List of 17 Basics of Gas Turbines Formulas

Basics of Gas Turbines

1) Diffuser Efficiency

Open Calculator

fx $$\eta_d = \frac{\Delta P}{\Delta P'}$$

ex $$0.625 = \frac{25\text{Pa}}{40\text{Pa}}$$

2) Diffuser Efficiency given Inlet and Exit Velocities

Open Calculator

fx $$\eta_d = \frac{\Delta P}{\frac{\rho}{2} \cdot \left(C_1^2 - C_2^2\right)}$$

ex $$1.678375 = \frac{25\text{Pa}}{\frac{1.293\text{kg/m}^3}{2} \cdot \left((8\text{m/s})^2 - (6.4\text{m/s})^2\right)}$$

3) Enthalpy of Ideal Gas at given Temperature

Open Calculator

fx $$H = C_p \cdot T$$

ex $$301.5\text{KJ} = 1.005\text{kJ/kg*K} \cdot 300\text{K}$$

4) Heat Capacity Ratio

Open Calculator

fx $$\gamma = \frac{C_p}{C_v}$$

ex $$1.34 = \frac{1.005\text{kJ/kg*K}}{0.75\text{kJ/kg*K}}$$

5) Internal Energy of Perfect Gas at given Temperature

Open Calculator

fx $$U = C_v \cdot T$$

ex $$225\text{KJ} = 0.75\text{kJ/kg*K} \cdot 300\text{K}$$

6) Mach Angle

Open Calculator

fx $$\mu = a\sin\left(\frac{1}{M}\right)$$

ex $$30^\circ = a\sin\left(\frac{1}{2}\right)$$

7) Mach Number

Open Calculator

fx $$M = \frac{V_b}{a}$$

ex $$2.040816 = \frac{700\text{m/s}}{343\text{m/s}}$$

8) Mass Flow Rate of Exhaust Gases

Open Calculator

fx $$m = m_a + m_f$$

ex $$4.7\text{kg/s} = 3.5\text{kg/s} + 1.2\text{kg/s}$$

9) Mass Flow Rate of Exhaust Gases given Fuel Air Ratio

Open Calculator

fx $$m = m_a \cdot (1 + f)$$

ex $$9.45\text{kg/s} = 3.5\text{kg/s} \cdot (1 + 1.7)$$

10) Pressure Ratio

Open Calculator

fx $$r_p = \frac{P_f}{P_i}$$

ex $$0.283538 = \frac{18.43\text{Pa}}{65\text{Pa}}$$

11) Shaft Work in Compressible Flow Machines

Open Calculator

fx $$W_s = \left(h_1 + \frac{c_1^2}{2}\right) - \left(h_2 + \frac{c_2^2}{2}\right)$$

ex $$35.99836\text{KJ} = \left(48\text{KJ} + \frac{(0.85\text{m/s})^2}{2}\right) - \left(12\text{KJ} + \frac{(2\text{m/s})^2}{2}\right)$$

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

fx $W_s = h_1 - h_2$

Open Calculator

ex $36\text{KJ} = 48\text{KJ} - 12\text{KJ}$

13) Speed of Sound

fx $a = \sqrt{\gamma \cdot [\text{R-Dry-Air}] \cdot T_g}$

Open Calculator

ex $347.3856\text{m/s} = \sqrt{1.41 \cdot [\text{R-Dry-Air}] \cdot 298.15\text{K}}$

14) Stagnation Temperature

fx $T_0 = T_s + \frac{U_{fluid}^2}{2 \cdot C_p}$

Open Calculator

ex $300.9751\text{K} = 296\text{K} + \frac{(100\text{m/s})^2}{2 \cdot 1005\text{J/(kg*K)}}$

15) Stagnation Velocity of Sound

fx $a_o = \sqrt{\gamma \cdot [R] \cdot T_0}$

Open Calculator

ex $34.11781\text{m/s} = \sqrt{1.4 \cdot [R] \cdot 100\text{K}}$

16) Stagnation Velocity of Sound given Specific Heat at Constant Pressure

Open Calculator

fx $$a_o = \sqrt{(\gamma - 1) \cdot C_p \cdot T_0}$$

ex $$200.4994\text{m/s} = \sqrt{(1.4 - 1) \cdot 1.005\text{kJ/kg*K} \cdot 100\text{K}}$$

17) Stagnation Velocity of Sound given Stagnation Enthalpy

Open Calculator

fx $$a_o = \sqrt{(\gamma - 1) \cdot h_o}$$

ex $$6.957011\text{m/s} = \sqrt{(1.4 - 1) \cdot 121\text{J/kg}}$$

Variables Used

- **a** Speed of Sound *(Meter per Second)*
- **a_o** Stagnation Velocity of Sound *(Meter per Second)*
- **c_1** Inlet Velocity *(Meter per Second)*
- **C_1** Inlet Velocity to Diffuser *(Meter per Second)*
- **c_2** Exit Velocity *(Meter per Second)*
- **C_2** Exit Velocity To Diffuser *(Meter per Second)*
- **C_p** Specific Heat Capacity at Constant Pressure *(Kilojoule per Kilogram per K)*
- **C_p** Specific Heat Capacity at Constant Pressure *(Joule per Kilogram per K)*
- **C_v** Specific Heat Capacity at Constant Volume *(Kilojoule per Kilogram per K)*
- **f** Fuel Air Ratio
- **H** Enthalpy *(Kilojoule)*
- **h_1** Enthalpy at Inlet *(Kilojoule)*
- **h_2** Enthalpy at Exit *(Kilojoule)*
- **h_o** Stagnation Enthalpy *(Joule per Kilogram)*
- **m** Mass Flow Rate *(Kilogram per Second)*
- **M** Mach Number
- **m_a** Air Flow Rate *(Kilogram per Second)*
- **m_f** Fuel Flow Rate *(Kilogram per Second)*
- **P_f** Final Pressure of System *(Pascal)*
- **P_i** Initial Pressure of System *(Pascal)*

- r_p Pressure Ratio
- T Temperature for Gas Turbines *(Kelvin)*
- T_0 Stagnation Temperature *(Kelvin)*
- T_0 Stagnation Temperature *(Kelvin)*
- T_g Temperature of Gas *(Kelvin)*
- T_s Static Temperature *(Kelvin)*
- U Internal Energy *(Kilojoule)*
- U_{fluid} Velocity of Fluid Flow *(Meter per Second)*
- V_b Speed of Body *(Meter per Second)*
- W_s Shaft Work *(Kilojoule)*
- γ Heat Capacity Ratio
- γ Specific Heat Ratio
- ΔP Static Pressure Rise in Actual *(Pascal)*
- $\Delta P'$ Static Pressure Rise in Isentropic Process *(Pascal)*
- η_d Diffuser Efficiency
- μ Mach Angle *(Degree)*
- ρ Density of Air *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **[R-Dry-Air]**, 287.058 Joule / Kilogram * Kelvin
  Specific Gas Constant for Dry Air
- Constant: **[R]**, 8.31446261815324 Joule / Kelvin * Mole
  Universal gas constant
- Function: **asin**, asin(Number)
  Inverse trigonometric sine function
- Function: **sin**, sin(Angle)
  Trigonometric sine function
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Temperature** in Kelvin (K)
  Temperature 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: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Specific Heat Capacity** in Kilojoule per Kilogram per K (kJ/kg*K), Joule per Kilogram per K (J/(kg*K))
  Specific Heat Capacity Unit Conversion
- Measurement: **Mass Flow Rate** in Kilogram per Second (kg/s)
  Mass Flow Rate Unit Conversion

- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Specific Energy** in Joule per Kilogram (J/kg)
  Specific Energy Unit Conversion

Check other formula lists

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

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