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Compressible Flow Formulas

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List of 25 Compressible Flow Formulas

Compressible Flow

1) Bulk Modulus for Velocity of Sound Wave

Open Calculator

fx $$K = \rho_a \cdot C^2$$

ex $$140481\text{N/m}^2 = 1.29\text{kg/m}^3 \cdot (330\text{m/s})^2$$

2) Mach Angle for Compressible Fluid Flow

Open Calculator

fx $$\mu = a\sin\left(\frac{C}{V}\right)$$

ex $$53.59848^\circ = a\sin\left(\frac{330\text{m/s}}{410\text{m/s}}\right)$$

3) Mach Number for Compressible Fluid Flow

Open Calculator

fx $$M = \frac{V}{C}$$

ex $$1.242424 = \frac{410\text{m/s}}{330\text{m/s}}$$

4) Pressure Ratio for Maximum Flow Rate through Nozzle

Open Calculator

fx $$r_p = \left(\frac{2}{\gamma + 1}\right)^{\frac{\gamma}{\gamma - 1}}$$

ex $$0.528282 = \left(\frac{2}{1.4 + 1}\right)^{\frac{1.4}{1.4 - 1}}$$

5) Temperature of Fluid for Stagnation Temperature considering Compressible Fluid Flow

Open Calculator

fx $$T_1 = \frac{T_s}{1 + \frac{\gamma - 1}{2} \cdot M^2}$$

ex $$240.1493\text{K} = \frac{314\text{K}}{1 + \frac{1.4 - 1}{2} \cdot (1.24)^2}$$

6) Velocity at Outlet of Nozzle for Maximum Flow Rate of Fluid

Open Calculator

fx $$V_{f2} = \sqrt{\frac{2 \cdot \gamma \cdot P_1}{(\gamma + 1) \cdot \rho_a}}$$

ex $$251.6098\text{m/s} = \sqrt{\frac{2 \cdot 1.4 \cdot 70000\text{N/m}^2}{(1.4 + 1) \cdot 1.29\text{kg/m}^3}}$$

7) Velocity of Projectile of Mach Cone in Compressible Fluid Flow

Open Calculator

fx $$V = \frac{C}{\sin(\mu)}$$

ex $$409.992\text{m/s} = \frac{330\text{m/s}}{\sin(53.6^\circ)}$$

Absolute Temperature

8) Absolute Temperature for Velocity of Sound Wave in Isothermal Process

Open Calculator

fx $$T_{abs} = \frac{C^2}{R}$$

ex $$379.2575\text{K} = \frac{(330\text{m/s})^2}{287.14\text{J/(kg*K)}}$$

9) Absolute Temperature for Velocity of Sound Wave using Adiabatic Process

Open Calculator

fx $$T_{abs} = \frac{C^2}{\gamma \cdot R}$$

ex $$270.8982\text{K} = \frac{(330\text{m/s})^2}{1.4 \cdot 287.14\text{J/(kg*K)}}$$

Pressure and Density

10) Density of Fluid considering Velocity at Outlet of Orifice

Open Calculator

fx $$\rho_a = \frac{2 \cdot \gamma \cdot P_1}{V_{f2}^2 \cdot (\gamma + 1)}$$

ex $$1.296276\text{kg/m}^3 = \frac{2 \cdot 1.4 \cdot 70000\text{N/m}^2}{(251\text{m/s})^2 \cdot (1.4 + 1)}$$

11) Density of Fluid for Stagnation considering Compressible Fluid Flow

Open Calculator

fx $$\rho_a = \frac{\rho_s}{\left(1 + \frac{\gamma - 1}{2} \cdot M^2\right)^{\frac{1}{\gamma - 1}}}$$

ex $$1.289079\text{kg/m}^3 = \frac{2.52\text{kg/m}^3}{\left(1 + \frac{1.4 - 1}{2} \cdot (1.24)^2\right)^{\frac{1}{1.4 - 1}}}$$

12) Pressure at Inlet considering Maximum Flow Rate of Fluid

Open Calculator

fx $$P_1 = \frac{\gamma + 1}{2 \cdot \gamma} \cdot \rho_a \cdot V_{f2}^2$$

ex $$69661.11\text{N/m}^2 = \frac{1.4 + 1}{2 \cdot 1.4} \cdot 1.29\text{kg/m}^3 \cdot (251\text{m/s})^2$$

13) Pressure at Inlet of Tank or Vessel considering Compressible Fluid Flow

Open Calculator

$$P_a = \frac{p_s}{\left(1 + \frac{\gamma-1}{2} \cdot M^2\right)^{\frac{\gamma}{\gamma-1}}}$$

$$47729.91\text{N/m}^2 = \frac{1.22\text{E}5\text{N/m}^2}{\left(1 + \frac{1.4-1}{2} \cdot (1.24)^2\right)^{\frac{1.4}{1.4-1}}}$$

Stagnation Density

14) Stagnation Density considering other Stagnation Properties of Fluid

Open Calculator

$$\rho_s = \frac{p_s}{R \cdot T_s}$$

$$1.353121\text{kg/m}^3 = \frac{1.22\text{E}5\text{N/m}^2}{287.14\text{J/(kg*K)} \cdot 314\text{K}}$$

15) Stagnation Density given Compressible Fluid Flow

Open Calculator

$$\rho_s = \rho_a \cdot \left(1 + \frac{\gamma - 1}{2} \cdot M^2\right)^{\frac{1}{\gamma-1}}$$

$$2.5218\text{kg/m}^3 = 1.29\text{kg/m}^3 \cdot \left(1 + \frac{1.4 - 1}{2} \cdot (1.24)^2\right)^{\frac{1}{1.4-1}}$$

Stagnation Pressure

16) Stagnation Pressure considering other Stagnation Properties of Fluid

Open Calculator

fx $p_s = T_s \cdot R \cdot \rho_s$

ex $227208.1\text{N/m}^2 = 314\text{K} \cdot 287.14\text{J/(kg*K)} \cdot 2.52\text{kg/m}^3$

17) Stagnation Pressure for Compressible Fluid Flow

Open Calculator

fx $p_s = P_a \cdot \left(1 + \frac{\gamma - 1}{2} \cdot M^2\right)^{\frac{\gamma}{\gamma - 1}}$

ex $122179.1\text{N/m}^2 = 4.78\text{E4N/m}^2 \cdot \left(1 + \frac{1.4 - 1}{2} \cdot (1.24)^2\right)^{\frac{1.4}{1.4 - 1}}$

Stagnation Temperature

18) Stagnation Temperature considering Compressible Fluid Flow

Open Calculator

fx $T_s = T_1 \cdot \left(1 + \frac{\gamma - 1}{2} \cdot M^2\right)$

ex $313.8048\text{K} = 240\text{K} \cdot \left(1 + \frac{1.4 - 1}{2} \cdot (1.24)^2\right)$

19) Stagnation Temperature considering other Stagnation Properties of Fluid

Open Calculator

fx $$T_s = \frac{p_s}{R \cdot \rho_s}$$

ex $$168.6031\text{K} = \frac{1.22\text{E}5\text{N/m}^2}{287.14\text{J/(kg*K)} \cdot 2.52\text{kg/m}^3}$$

Velocity of Sound Wave

20) Sonic Velocity

Open Calculator

fx $$C = \sqrt{\frac{K}{\rho_a}}$$

ex $$332.9455\text{m/s} = \sqrt{\frac{1.43\text{E}5\text{N/m}^2}{1.29\text{kg/m}^3}}$$

21) Velocity of Sound Wave considering Mach Angle in Compressible Fluid Flow

Open Calculator

fx $$C = V \cdot \sin(\mu)$$

ex $$330.0065\text{m/s} = 410\text{m/s} \cdot \sin(53.6^\circ)$$

22) Velocity of Sound Wave given Bulk Modulus

Open Calculator

$$C = \sqrt{\frac{K}{\rho_a}}$$

$$332.9455\text{m/s} = \sqrt{\frac{1.43\text{E}5\text{N/m}^2}{1.29\text{kg/m}^3}}$$

23) Velocity of Sound Wave given Mach Number for Compressible Fluid Flow

Open Calculator

$$C = \frac{V}{M}$$

$$330.6452\text{m/s} = \frac{410\text{m/s}}{1.24}$$

24) Velocity of Sound Wave using Adiabatic Process

Open Calculator

$$C = \sqrt{\gamma \cdot R \cdot T_{abs}}$$

$$331.3687\text{m/s} = \sqrt{1.4 \cdot 287.14\text{J/(kg*K)} \cdot 273.15\text{K}}$$

25) Velocity of Sound Wave using Isothermal Process

Open Calculator

$$C = \sqrt{R \cdot T_{abs}}$$

$$280.0577\text{m/s} = \sqrt{287.14\text{J/(kg*K)} \cdot 273.15\text{K}}$$

Variables Used

- **C** Velocity of Sound in Medium *(Meter per Second)*
- **K** Bulk Modulus of Sound Medium *(Newton per Square Meter)*
- **M** Mach Number for Compressible Flow
- P_1 Pressure at Nozzle Inlet *(Newton per Square Meter)*
- P_a Pressure of Still Air *(Newton per Square Meter)*
- p_s Stagnation Pressure in Compressible Flow *(Newton per Square Meter)*
- **R** Gas Constant in Compressible Flow *(Joule per Kilogram per K)*
- r_p Pressure Ratio for Flow through Nozzle
- T_1 Temperature of Still Air *(Kelvin)*
- T_{abs} Absolute Temperature *(Kelvin)*
- T_s Stagnation Temperature in Compressible Flow *(Kelvin)*
- **V** Projectile Velocity of Mach Cone *(Meter per Second)*
- V_{f2} Velocity of Flow at Nozzle Outlet *(Meter per Second)*
- γ Specific Heat Ratio
- μ Mach Angle in Compressible Flow *(Degree)*
- ρ_a Density of Air Medium *(Kilogram per Cubic Meter)*
- ρ_s Stagnation Density in Compressible Flow *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- 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 Newton per Square Meter (N/m²)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Angle** in Degree (°)
  Angle Unit Conversion
- Measurement: **Specific Heat Capacity** in Joule per Kilogram per K (J/(kg*K))
  Specific Heat Capacity Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion

Check other formula lists

- Boundary Layer Flow Formulas
- Buoyancy Formulas
- Centrifugal pumps Formulas
- Compressible Flow Formulas
- Draft Tube Formulas
- Dynamics of Fluid Flow Formulas
- Flow in Open Channels Formulas
- Forces developed by moving fluid Formulas
- Forces on Submerged Bodies Formulas
- Francis Turbine Formulas
- Hydraulic Linear Actuators Formulas
- Hydraulic Motors Formulas
- Hydraulic Pumps Formulas
- Hydraulic Turbines Formulas
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- Kinematics of Flow Formulas
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- Orifices and Mouthpieces Formulas
- Pelton Turbine Formulas
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- Turbulent Flow Formulas
- Viscous Flow Formulas

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