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Fundamentals of Inviscid and Incompressible Flow Formulas

Calculators! Examples! Conversions!

List of 16 Fundamentals of Inviscid and Incompressible Flow Formulas

Fundamentals of Inviscid and Incompressible Flow

Aerodynamic Measurements and Wind Tunnel Testing

1) Airspeed Measurement by Pitot Tube

Open Calculator

fx $$V_1 = \sqrt{\frac{2 \cdot (P_0 - P_{1\ \text{static}})}{\rho_0}}$$

ex $$0.316703\text{m/s} = \sqrt{\frac{2 \cdot (61710\text{Pa} - 61660\text{Pa})}{997\text{kg/m}^3}}$$

2) Airspeed Measurement by Venturi

Open Calculator

fx $$V_1 = \sqrt{\frac{2 \cdot (P_1 - P_2)}{\rho_0 \cdot (A_{\text{lift}}^2 - 1)}}$$

ex $$0.315672\text{m/s} = \sqrt{\frac{2 \cdot (9800\text{Pa} - 9630.609\text{Pa})}{997\text{kg/m}^3 \cdot \left((2.1)^2 - 1\right)}}$$

3) Dynamic Pressure in Incompressible Flow

Open Calculator

fx $$q_1 = P_0 - P_{1\ \text{static}}$$

ex $$50\text{Pa} = 61710\text{Pa} - 61660\text{Pa}$$

4) Height Difference of Manometric Fluid for given Pressure Difference

Open Calculator

fx $$\Delta h = \frac{\delta P}{w}$$

ex $$0.1044\text{m} = \frac{0.2088\text{Pa}}{2\text{N/m}^3}$$

5) Surface Pressure on Body using Pressure Coefficient

Open Calculator

fx $$P = p_\infty + q_\infty \cdot C_p$$

ex $$61646\text{Pa} = 29900\text{Pa} + 39000\text{Pa} \cdot 0.814$$

6) Test Section Velocity by Manometric Height for Wind Tunnel

Open Calculator

fx $$V_T = \sqrt{\frac{2 \cdot w \cdot \Delta h}{\rho_0 \cdot \left(1 - \frac{1}{A_{\text{lift}}^2}\right)}}$$

ex $$0.022778\text{m/s} = \sqrt{\frac{2 \cdot 2\text{N/m}^3 \cdot 0.1\text{m}}{997\text{kg/m}^3 \cdot \left(1 - \frac{1}{(2.1)^2}\right)}}$$

7) Total Pressure in Incompressible Flow

Open Calculator

fx $$P_0 = P_{1\ static} + q_1$$

ex $$61710\text{Pa} = 61660\text{Pa} + 50\text{Pa}$$

8) Wind Tunnel Pressure Difference by Manometer

Open Calculator

fx $$\delta P = w \cdot \Delta h$$

ex $$0.2\text{Pa} = 2\text{N/m}^3 \cdot 0.1\text{m}$$

9) Wind Tunnel Pressure Difference with Test Speed

Open Calculator

fx $$\delta P = 0.5 \cdot \rho_{air} \cdot V_2^2 \cdot \left(1 - \frac{1}{A_{lift}^2}\right)$$

ex $$0.208813\text{Pa} = 0.5 \cdot 1.225\text{kg/m}^3 \cdot (0.664\text{m/s})^2 \cdot \left(1 - \frac{1}{(2.1)^2}\right)$$

10) Wind Tunnel Test Section Velocity

Open Calculator

fx $$V_2 = \sqrt{\frac{2 \cdot (P_1 - P_2)}{\rho_0 \cdot \left(1 - \frac{1}{A_{lift}^2}\right)}}$$

ex $$0.66291\text{m/s} = \sqrt{\frac{2 \cdot (9800\text{Pa} - 9630.609\text{Pa})}{997\text{kg/m}^3 \cdot \left(1 - \frac{1}{(2.1)^2}\right)}}$$

Bernoulli's Equation and Pressure Concepts

11) Pressure at Downstream Point by Bernoulli's Equation

Open Calculator

fx $$P_2 = P_1 + 0.5 \cdot \rho_0 \cdot \left(V_1^2 - V_2^2\right)$$

ex $$9630.212\text{Pa} = 9800\text{Pa} + 0.5 \cdot 997\text{kg/m}^3 \cdot \left((0.3167\text{m/s})^2 - (0.664\text{m/s})^2\right)$$

12) Pressure at Upstream Point by Bernoulli's Equation

Open Calculator

fx $$P_1 = P_2 - 0.5 \cdot \rho_0 \cdot \left(V_1^2 - V_2^2\right)$$

ex $$9800.397\text{Pa} = 9630.609\text{Pa} - 0.5 \cdot 997\text{kg/m}^3 \cdot \left((0.3167\text{m/s})^2 - (0.664\text{m/s})^2\right)$$

13) Pressure Coefficient

Open Calculator

fx $$C_p = \frac{P - p_\infty}{q_\infty}$$

ex $$0.814615 = \frac{61670\text{Pa} - 29900\text{Pa}}{39000\text{Pa}}$$

14) Pressure Coefficient using Velocity Ratio

Open Calculator

fx $$C_p = 1 - \left(\frac{V}{u_\infty}\right)^2$$

ex $$0.817438 = 1 - \left(\frac{47\text{m/s}}{110\text{m/s}}\right)^2$$

15) Static Pressure in Incompressible Flow

fx $$P_{1\ static} = P_0 - q_1$$

Open Calculator

ex $$61660\text{Pa} = 61710\text{Pa} - 50\text{Pa}$$

16) Velocity at Point on Airfoil for given Pressure Coefficient and Free-Stream Velocity

fx $$V = \sqrt{u_{\infty}^2 \cdot (1 - C_p)}$$

Open Calculator

ex $$47.44049\text{m/s} = \sqrt{(110\text{m/s})^2 \cdot (1 - 0.814)}$$

Variables Used

- A_{lift} Contraction Ratio
- C_p Pressure Coefficient
- P Surface Pressure at Point *(Pascal)*
- P_0 Total Pressure *(Pascal)*
- $P_{1\ static}$ Static Pressure at Point 1 *(Pascal)*
- P_1 Pressure at Point 1 *(Pascal)*
- P_2 Pressure at Point 2 *(Pascal)*
- p_∞ Freestream Pressure *(Pascal)*
- q_1 Dynamic Pressure *(Pascal)*
- q_∞ Freestream Dynamic Pressure *(Pascal)*
- u_∞ Freestream Velocity *(Meter per Second)*
- V Velocity at a Point *(Meter per Second)*
- V_1 Velocity at Point 1 *(Meter per Second)*
- V_2 Velocity at Point 2 *(Meter per Second)*
- V_T Test Section Velocity *(Meter per Second)*
- Δh Height Difference of Manometric Fluid *(Meter)*
- δP Pressure Difference *(Pascal)*
- ρ_0 Density *(Kilogram per Cubic Meter)*
- ρ_{air} Air Density *(Kilogram per Cubic Meter)*
- w Specific Weight of Manometric Fluid *(Newton per Cubic Meter)*

Constants, Functions, Measurements used

- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Specific Weight** in Newton per Cubic Meter (N/m³)
  Specific Weight Unit Conversion

Check other formula lists

- **Fundamentals of Inviscid and Incompressible Flow Formulas**

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