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Hypersonic Equivalence Principle and Blast-Wave Theory Formulas

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List of 16 Hypersonic Equivalence Principle and Blast-Wave Theory Formulas

Hypersonic Equivalence Principle and Blast-Wave Theory

Cylindrical Blast Wave

1) Boltzmann Constant for Cylindrical Blast Wave

Open Calculator

fx $$k_{b1} = \frac{2^{\cdot\frac{y_{sp}-1}{2-y_{sp}}}}{2^{\frac{4-y_{sp}}{2-y_{sp}}}}$$

ex $$0.417963 = \frac{(0.4)^{2\cdot\frac{0.4-1}{2-0.4}}}{2^{\frac{4-0.4}{2-0.4}}}$$

2) Modified Energy for Cylindrical Blast Wave

Open Calculator

fx $$E_{mod} = 0.5 \cdot \rho_{\infty} \cdot V_{\infty}^2 \cdot d \cdot C_D$$

ex $$14559.56\text{KJ} = 0.5 \cdot 412.2\text{kg/m}^3 \cdot (102\text{m/s})^2 \cdot 2.425\text{m} \cdot 2.8$$

3) Modified Pressure Equation for Cylindrical Blast Wave

Open Calculator

$$P = [BoltZ] \cdot \rho_{\infty} \cdot \sqrt{\frac{\pi}{8}} \cdot d \cdot \sqrt{C_D} \cdot \frac{U_{\infty\,bw}^2}{y}$$

ex

$$1.7E\hat{}\text{-}23Pa = [BoltZ] \cdot 412.2kg/m^3 \cdot \sqrt{\frac{\pi}{8}} \cdot 2.425m \cdot \sqrt{2.8} \cdot \frac{(0.0512m/s)^2}{2.2m}$$

4) Modified Radial Coordinate Equation for Cylindrical Blast Wave

Open Calculator

$$r = 0.792 \cdot d \cdot C_D^{\frac{1}{4}} \cdot \sqrt{\frac{y}{d}}$$

ex

$$2.366366m = 0.792 \cdot 2.425m \cdot (2.8)^{\frac{1}{4}} \cdot \sqrt{\frac{2.2m}{2.425m}}$$

5) Pressure for Cylindrical Blast Wave

Open Calculator

$$P_{cyl} = k_{b1} \cdot \rho_{\infty} \cdot \frac{\left(\frac{E}{\rho_{\infty}}\right)^{\frac{1}{2}}}{t_{sec}}$$

ex

$$2224.05Pa = 0.8 \cdot 412.2kg/m^3 \cdot \frac{\left(\frac{1200KJ}{412.2kg/m^3}\right)^{\frac{1}{2}}}{8s}$$

6) Pressure Ratio for Blunt Cylinder Blast Wave

Open Calculator

fx $$r_{bc} = 0.8773 \cdot [BoltZ] \cdot M^2 \cdot \sqrt{C_D} \cdot \left(\frac{y}{d}\right)^{-1}$$

ex $$6.8E\hat{}\text{-}22 = 0.8773 \cdot [BoltZ] \cdot (5.5)^2 \cdot \sqrt{2.8} \cdot \left(\frac{2.2m}{2.425m}\right)^{-1}$$

7) Radial Coordinate of Cylindrical Blast Wave

Open Calculator

fx $$r = \left(\frac{E}{\rho_\infty}\right)^{\frac{1}{4}} \cdot t_{sec}^{\frac{1}{2}}$$

ex $$20.77607m = \left(\frac{1200KJ}{412.2kg/m^3}\right)^{\frac{1}{4}} \cdot (8s)^{\frac{1}{2}}$$

8) Simplified Pressure Ratio for Blunt Cylinder Blast Wave

Open Calculator

fx $$r_p = 0.0681 \cdot M^2 \cdot \frac{\sqrt{C_D}}{\frac{y}{d}}$$

ex $$3.799624 = 0.0681 \cdot (5.5)^2 \cdot \frac{\sqrt{2.8}}{\frac{2.2m}{2.425m}}$$

Planar and Blunt Slab Blast Wave

9) Blunt-Nosed Flat Plate Pressure Ratio (First Approximation)

Open Calculator

fx $$r_p = 0.121 \cdot M^2 \cdot \left(\frac{C_D}{\frac{y}{d}} \right)^{\frac{2}{3}}$$

ex $$7.759055 = 0.121 \cdot (5.5)^2 \cdot \left(\frac{2.8}{\frac{2.2\text{m}}{2.425\text{m}}} \right)^{\frac{2}{3}}$$

10) Coefficient of Drag Equation using Energy Released from Blast Wave

Open Calculator

fx $$C_D = \frac{E}{0.5 \cdot \rho_\infty \cdot V_\infty^2 \cdot d}$$

ex $$0.230776 = \frac{1200\text{KJ}}{0.5 \cdot 412.2\text{kg/m}^3 \cdot (102\text{m/s})^2 \cdot 2.425\text{m}}$$

11) Creation Pressure for Planar Blast Wave

Open Calculator

fx $$P = [\text{BoltZ}] \cdot \rho_\infty \cdot \left(\frac{E}{\rho_\infty} \right)^{\frac{2}{3}} \cdot t_{sec}^{-\frac{2}{3}}$$

ex $$2.9\text{E}\hat{}\text{-}19\text{Pa} = [\text{BoltZ}] \cdot 412.2\text{kg/m}^3 \cdot \left(\frac{1200\text{KJ}}{412.2\text{kg/m}^3} \right)^{\frac{2}{3}} \cdot (8\text{s})^{-\frac{2}{3}}$$

12) Energy for Blast Wave

Open Calculator

$$E = 0.5 \cdot \rho_\infty \cdot V_\infty^2 \cdot C_D \cdot A$$

$$1200.788\text{KJ} = 0.5 \cdot 412.2\text{kg/m}^3 \cdot (102\text{m/s})^2 \cdot 2.8 \cdot 0.2\text{m}^2$$

13) Pressure Ratio for Blunt Slab Blast Wave

Open Calculator

$$r_p = 0.127 \cdot M^2 \cdot C_D^{\frac{2}{3}} \cdot \left(\frac{y}{d}\right)^{-\frac{2}{3}}$$

$$8.143801 = 0.127 \cdot (5.5)^2 \cdot (2.8)^{\frac{2}{3}} \cdot \left(\frac{2.2\text{m}}{2.425\text{m}}\right)^{-\frac{2}{3}}$$

14) Radial Coordinate for Planar Blast Wave

Open Calculator

$$r = \left(\frac{E}{\rho_\infty}\right)^{\frac{1}{3}} \cdot t_{sec}^{\frac{2}{3}}$$

$$57.11512\text{m} = \left(\frac{1200\text{KJ}}{412.2\text{kg/m}^3}\right)^{\frac{1}{3}} \cdot (8\text{s})^{\frac{2}{3}}$$

15) Radial Coordinate of Blunt Slab Blast Wave

Open Calculator

$$r = 0.794 \cdot d \cdot C_D^{\frac{1}{3}} \cdot \left(\frac{y}{d}\right)^{\frac{2}{3}}$$

$$2.543269\text{m} = 0.794 \cdot 2.425\text{m} \cdot (2.8)^{\frac{1}{3}} \cdot \left(\frac{2.2\text{m}}{2.425\text{m}}\right)^{\frac{2}{3}}$$

16) Time Required for Blast Wave

Open Calculator

fx $$t_{sec} = \frac{y}{U_{\infty\,bw}}$$

ex $$42.96875\text{s} = \frac{2.2\text{m}}{0.0512\text{m/s}}$$

Variables Used

- **A** Area for Blast Wave *(Square Meter)*
- **C_D** Drag Coefficient
- **d** Diameter *(Meter)*
- **E** Energy for Blast Wave *(Kilojoule)*
- **E_{mod}** Modified Energy for Blast Wave *(Kilojoule)*
- **k_{b1}** Boltzmann Constant
- **M** Mach Number
- **P** Pressure *(Pascal)*
- **P_{cyl}** Pressure for Blast Wave *(Pascal)*
- **r** Radial Coordinate *(Meter)*
- **r_{bc}** Pressure Ratio for Blunt Cylinder Blast Wave
- **r_p** Pressure Ratio
- **t_{sec}** Time Required for Blast Wave *(Second)*
- **$U_{\infty\ bw}$** Freestream Velocity for Blast Wave *(Meter per Second)*
- **V_∞** Freestream Velocity *(Meter per Second)*
- **y** Distance from X-Axis *(Meter)*
- **y_{sp}** Specific Heat Ratio
- **ρ_∞** Freestream Density *(Kilogram per Cubic Meter)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Constant: **[BoltZ]**, 1.38064852E-23 Joule/Kelvin
  Boltzmann constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area 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: **Density** in Kilogram per Cubic Meter (kg/m^3)
  Density Unit Conversion

Check other formula lists

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- Basic Aspects, Boundary Layer Results, and Aerodynamic Heating of Viscous Flow Formulas
- Blast Wave Part Theory Formulas
- Boundary Layer Equations for Hypersonic Flow Formulas
- Computational Fluid Dynamic Solutions Formulas
- Elements of Kinetic Theory Formulas
- Exact Methods of Hypersonic Inviscid Flowfields Formulas
- Hypersonic Equivalence Principle and Blast-Wave Theory Formulas
- Hypersonic Flight Paths Velocity of Altitude Map Formulas
- Hypersonic Small Disturbance Equations Formulas
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