Important Shock Dynamics and Aerodynamic Shape Formulas PDF

Formulas
Examples
with Units

List of 10
Important Shock Dynamics and Aerodynamic Shape Formulas

1) Detachment Distance of Cylinder Wedge Body Shape Formula

Evaluate Formula

Formula

$$\delta = r \cdot 0.386 \cdot \exp\left(\frac{4.67}{M^2}\right)$$

Example with Units

$$23.7505\,\text{mm} = 57.2\,\text{mm} \cdot 0.386 \cdot \exp\left(\frac{4.67}{8^2}\right)$$

2) Detachment Distance of Sphere Cone Body Shape Formula

Evaluate Formula

Formula

$$\delta' = r \cdot 0.143 \cdot \exp\left(\frac{3.24}{M^2}\right)$$

Example with Units

$$8.6044\,\text{mm} = 57.2\,\text{mm} \cdot 0.143 \cdot \exp\left(\frac{3.24}{8^2}\right)$$

3) Grid Point Calculation for Shock Waves Formula

Evaluate Formula

Formula

$$\zeta = \frac{y - b}{\delta}$$

Example with Units

$$89.9368 = \frac{2200\,\text{mm} - 64\,\text{mm}}{23.75\,\text{mm}}$$

4) Local Shock Velocity Equation Formula

Evaluate Formula

Formula

$$W = c_s \cdot \left(M - M_1\right)$$

Example with Units

$$2229.5\,\text{m/s} = 343\,\text{m/s} \cdot \left(8 - 1.5\right)$$

5) Mach Wave behind Shock Formula

Evaluate Formula

Formula

$$M_2 = \frac{V_\infty - W_m}{c_s}$$

Example with Units

$$0.0175 = \frac{98\,\text{m/s} - 92\,\text{m/s}}{343\,\text{m/s}}$$

6) Mach Wave behind Shock with Mach Infinity Formula

Evaluate Formula

Formula

$$M_1 = M - \frac{W}{c_s}$$

Example with Units

$$1.5 = 8 - \frac{2229.5\,\text{m/s}}{343\,\text{m/s}}$$

7) Nose Radius of Cylinder-Wedge Formula

Evaluate Formula

Formula

$$r = \frac{\delta}{0.386 \cdot \exp\left(\frac{4.67}{M^2}\right)}$$

Example with Units

$$57.1987\,\text{mm} = \frac{23.75\,\text{mm}}{0.386 \cdot \exp\left(\frac{4.67}{8^2}\right)}$$

8) Nose Radius of Sphere Cone Formula

Evaluate Formula

Formula

$$r_n = \frac{\delta}{0.143 \cdot \exp\left(\frac{3.24}{M^2}\right)}$$

Example with Units

$$157.8852\,\text{mm} = \frac{23.75\,\text{mm}}{0.143 \cdot \exp\left(\frac{3.24}{8^2}\right)}$$

9) Pressure Ratio for Unsteady Waves Formula

Evaluate Formula

Formula

$$r_p = \left(1 + \left(\frac{\gamma - 1}{2}\right) \cdot \frac{u'}{c_s}\right)^{2 \cdot \frac{\gamma}{\gamma - 1}}$$

Example with Units

$$1.0403 = \left(1 + \left(\frac{1.6 - 1}{2}\right) \cdot \frac{8.5\,\text{kg·m}^2}{343\,\text{m/s}}\right)^{2 \cdot \frac{1.6}{1.6 - 1}}$$

10) Ratio of New and Old Temperature Formula

Evaluate Formula

Formula

$$\text{Tshock}_{ratio} = \left(1 + \left(\frac{\gamma - 1}{2}\right) \cdot \frac{V_n}{c_{old}}\right)^2$$

Example with Units

$$3.5239 = \left(1 + \left(\frac{1.6 - 1}{2}\right) \cdot \frac{1000\,\text{m/s}}{342\,\text{m/s}}\right)^2$$

Variables used in list of Shock Dynamics and Aerodynamic Shape Formulas above

- **b** Body Shape in Hypersonic Flow *(Millimeter)*
- c_{old} Old Speed of Sound *(Meter per Second)*
- c_s Speed of Sound *(Meter per Second)*
- **M** Mach Number
- M_1 Mach Number ahead of Shock
- M_2 Mach Number behind Shock
- **r** Radius *(Millimeter)*
- r_n Nose Radius of Sphere Cone *(Millimeter)*
- r_p Pressure Ratio
- $Tshock_{ratio}$ Temperature Ratio across Shock
- **u'** Induced Mass Motion *(Kilogram Square Meter)*
- V_∞ Freestream Velocity *(Meter per Second)*
- V_n Normal Velocity *(Meter per Second)*
- **W** Local Shock Velocity *(Meter per Second)*
- W_m Local Shock Velocity for Mach Wave *(Meter per Second)*
- **y** Distance from X-Axis *(Millimeter)*
- **γ** Specific Heat Ratio
- **δ'** Detachment Distance of Sphere Cone Body Shape *(Millimeter)*
- **ζ** Grid Points
- δ Local Shock-Detachment Distance *(Millimeter)*

Constants, Functions, Measurements used in list of Shock Dynamics and Aerodynamic Shape Formulas above

- Functions: **exp**, exp(Number)
  n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.
- Measurement: **Length** in Millimeter (mm)
  Length Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Moment of Inertia** in Kilogram Square Meter (kg·m²)
  Moment of Inertia Unit Conversion

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