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Shock Dynamics and Aerodynamic Shape Formulas

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List of 10 Shock Dynamics and Aerodynamic Shape Formulas

Shock Dynamics and Aerodynamic Shape

1) Detachment Distance of Cylinder Wedge Body Shape

Open Calculator

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

ex $$23.75053\text{mm} = 57.2\text{mm} \cdot 0.386 \cdot \exp\left(\frac{4.67}{(8)^2}\right)$$

2) Detachment Distance of Sphere Cone Body Shape

Open Calculator

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

ex $$8.604353\text{mm} = 57.2\text{mm} \cdot 0.143 \cdot \exp\left(\frac{3.24}{(8)^2}\right)$$

3) Grid Point Calculation for Shock Waves

Open Calculator

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

ex $$89.93684 = \frac{2200\text{mm} - 64\text{mm}}{23.75\text{mm}}$$

4) Local Shock Velocity Equation

Open Calculator

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

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

5) Mach Wave behind Shock

Open Calculator

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

$$0.017493 = \frac{98\text{m/s} - 92\text{m/s}}{343\text{m/s}}$$

6) Mach Wave behind Shock with Mach Infinity

Open Calculator

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

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

7) Nose Radius of Cylinder-Wedge

Open Calculator

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

$$57.19873\text{mm} = \frac{23.75\text{mm}}{0.386 \cdot \exp\left(\frac{4.67}{(8)^2}\right)}$$

8) Nose Radius of Sphere Cone

Open Calculator

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

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

9) Pressure Ratio for Unsteady Waves

Open Calculator

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

ex $$1.040294 = \left(1 + \left(\frac{1.6 - 1}{2}\right) \cdot \frac{8.5\text{kg·m²}}{343\text{m/s}}\right)^{2 \cdot \frac{1.6}{1.6 - 1}}$$

10) Ratio of New and Old Temperature

Open Calculator

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

ex $$3.523853 = \left(1 + \left(\frac{1.6 - 1}{2}\right) \cdot \frac{1000\text{m/s}}{342\text{m/s}}\right)^2$$

Variables Used

- **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

- Function: **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

Check other formula lists

- **Shock Dynamics and Aerodynamic Shape Formulas**

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