Important Hypersonic Flow Parameters Formulas PDF

Formulas
Examples
with Units

List of 20
Important Hypersonic Flow Parameters Formulas

1) Axial Force Coefficient Formula

Evaluate Formula

Formula

$$\mu = \frac{F}{q \cdot A}$$

Example with Units

$$0.005 = \frac{2.51\,\text{N}}{10\,\text{Pa} \cdot 50\,\text{m}^2}$$

2) Coefficient of Drag Formula

Evaluate Formula

Formula

$$C_D = \frac{F_D}{q \cdot A}$$

Example with Units

$$0.16 = \frac{80\,\text{N}}{10\,\text{Pa} \cdot 50\,\text{m}^2}$$

3) Coefficient of Pressure with Similarity Parameters Formula

Evaluate Formula

Formula

$$C_p = 2 \cdot \theta^2 \cdot \left(\frac{Y + 1}{4} + \sqrt{\left(\frac{Y + 1}{4} \right)^2 + \frac{1}{K^2}} \right)$$

Example with Units

$$0.8259 = 2 \cdot 0.53\,\text{rad}^2 \cdot \left(\frac{1.6 + 1}{4} + \sqrt{\left(\frac{1.6 + 1}{4} \right)^2 + \frac{1}{2\,\text{rad}^2}} \right)$$

4) Deflection Angle Formula

Evaluate Formula

Formula

$$\theta_d = \frac{2}{Y - 1} \cdot \left(\frac{1}{M_1} - \frac{1}{M_2} \right)$$

Example with Units

$$-4.4444\,\text{rad} = \frac{2}{1.6 - 1} \cdot \left(\frac{1}{1.5} - \frac{1}{0.5} \right)$$

5) Drag Force Formula

Evaluate Formula

Formula

$$F_D = C_D \cdot q \cdot A$$

Example with Units

$$80\,\text{N} = 0.16 \cdot 10\,\text{Pa} \cdot 50\,\text{m}^2$$

6) Dynamic Pressure Formula

Evaluate Formula

Formula

$$q = \frac{F_D}{C_D \cdot A}$$

Example with Units

$$10\,\text{Pa} = \frac{80\,\text{N}}{0.16 \cdot 50\,\text{m}^2}$$

7) Dynamic Pressure given Coefficient of Lift Formula

Evaluate Formula

Formula

$$q = \frac{F_L}{C_L \cdot A}$$

Example with Units

$$10\,\text{Pa} = \frac{10.5\,\text{N}}{0.021 \cdot 50\,\text{m}^2}$$

8) Fourier's Law of Heat Conduction Formula

Evaluate Formula

Formula

$$q' = k \cdot \Delta T$$

Example with Units

$$407.2\,\text{W/m}^2 = 10.18\,\text{W/(m*K)} \cdot 40\,\text{K/m}$$

9) Hypersonic Similarity Parameter Formula

Evaluate Formula

Formula

$$K = M \cdot \theta$$

Example with Units

$$2.0034\,\text{rad} = 3.78 \cdot 0.53\,\text{rad}$$

10) Lift Coefficient Formula

Evaluate Formula

Formula

$$C_L = \frac{F_L}{q \cdot A}$$

Example with Units

$$0.021 = \frac{10.5\,\text{N}}{10\,\text{Pa} \cdot 50\,\text{m}^2}$$

11) Lift Force Formula

Evaluate Formula

Formula

$$F_L = C_L \cdot q \cdot A$$

Example with Units

$$10.5\,\text{N} = 0.021 \cdot 10\,\text{Pa} \cdot 50\,\text{m}^2$$

12) Mach Number with Fluids Formula

Evaluate Formula

Formula

$$M = \frac{u_f}{\sqrt{Y \cdot R \cdot T_f}}$$

Example with Units

$$3.7789 = \frac{256\,\text{m/s}}{\sqrt{1.6 \cdot 8.314 \cdot 345\,\text{K}}}$$

13) Mach Ratio at High Mach Number Formula

Evaluate Formula

Formula

$$Ma = 1 - K \cdot \left(\frac{Y - 1}{2}\right)$$

Example with Units

$$0.4 = 1 - 2\,\text{rad} \cdot \left(\frac{1.6 - 1}{2}\right)$$

14) Moment Coefficient Formula

Evaluate Formula

Formula

$$C_m = \frac{M_t}{q \cdot A \cdot L_c}$$

Example with Units

$$0.0311 = \frac{59\,\text{N*m}}{10\,\text{Pa} \cdot 50\,\text{m}^2 \cdot 3.8\,\text{m}}$$

15) Newtonian Sine Squared Law for Pressure Coefficient Formula

Evaluate Formula

Formula

$$C_p = 2 \cdot \sin\left(\theta_d\right)^2$$

Example with Units

$$1.8598 = 2 \cdot \sin\left(-4.444444\,\text{rad}\right)^2$$

16) Normal Force Coefficient Formula

Evaluate Formula

Formula

$$\mu = \frac{F_n}{q \cdot A}$$

Example with Units

$$0.005 = \frac{2.5\,\text{N}}{10\,\text{Pa} \cdot 50\,\text{m}^2}$$

17) Pressure Ratio for High Mach Number Formula

Evaluate Formula

Formula

$$r_p = \left(\frac{M_1}{M_2}\right)^{2 \cdot \frac{Y}{Y - 1}}$$

Example

$$350.4666 = \left(\frac{1.5}{0.5}\right)^{2 \cdot \frac{1.6}{1.6 - 1}}$$

18) Pressure Ratio having High Mach Number with Similarity Constant Formula

Evaluate Formula

Formula

$$r_p = \left(1 - \left(\frac{Y - 1}{2}\right) \cdot K\right)^{2 \cdot \frac{Y}{Y - 1}}$$

Example with Units

$$0.0075 = \left(1 - \left(\frac{1.6 - 1}{2}\right) \cdot 2\,\text{rad}\right)^{2 \cdot \frac{1.6}{1.6 - 1}}$$

19) Shear-Stress Distribution Formula

Evaluate Formula

Formula

$$\tau = \eta \cdot V_g$$

Example with Units

$$0.02\,\text{Pa} = 0.001\,\text{Pa*s} \cdot 20\,\text{m/s}$$

20) Supersonic Expression for Pressure Coefficient on Surface with Local Deflection Angle Formula

Evaluate Formula

Formula

$$C_p = \frac{2 \cdot \theta}{\sqrt{M^2 - 1}}$$

Example with Units

$$0.2908 = \frac{2 \cdot 0.53\,\text{rad}}{\sqrt{3.78^2 - 1}}$$

Variables used in list of Hypersonic Flow Parameters Formulas above

- **A** Area For Flow *(Square Meter)*
- C_D Drag Coefficient
- C_L Lift Coefficient
- C_m Moment Coefficient
- C_p Pressure Coefficient
- **F** Force *(Newton)*
- F_D Drag Force *(Newton)*
- F_L Lift Force *(Newton)*
- F_n Normal Force *(Newton)*
- **k** Thermal Conductivity *(Watt per Meter per K)*
- **K** Hypersonic Similarity Parameter *(Radian)*
- L_c Chord Length *(Meter)*
- **M** Mach Number
- M_1 Mach Number ahead of Shock
- M_2 Mach Number Behind Shock
- M_t Moment *(Newton Meter)*
- **Ma** Mach Ratio
- **q** Dynamic Pressure *(Pascal)*
- **q'** Heat Flux *(Watt per Square Meter)*
- **R** Universal Gas Constant
- r_p Pressure Ratio
- T_f Final Temperature *(Kelvin)*
- u_f Fluid Velocity *(Meter per Second)*
- V_g Velocity Gradient *(Meter per Second)*
- **Y** Specific Heat Ratio
- **ΔT** Temperature Gradient *(Kelvin Per Meter)*
- **η** Viscosity Coefficient *(Pascal Second)*
- **θ** Flow Deflection angle *(Radian)*
- θ_d Deflection Angle *(Radian)*
- **μ** Coefficient of Force
- τ Shear Stress *(Pascal)*

Constants, Functions, Measurements used in list of Hypersonic Flow Parameters Formulas above

- Functions: **sin**, sin(Angle)
  Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.
- Functions: **sqrt**, sqrt(Number)
  A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  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 Newton Meter (N*m)
  Energy Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion
- Measurement: **Thermal Conductivity** in Watt per Meter per K (W/(m*K))
  Thermal Conductivity Unit Conversion
- Measurement: **Heat Flux Density** in Watt per Square Meter (W/m²)
  Heat Flux Density Unit Conversion
- Measurement: **Dynamic Viscosity** in Pascal Second (Pa*s)
  Dynamic Viscosity Unit Conversion
- Measurement: **Temperature Gradient** in Kelvin Per Meter (K/m)
  Temperature Gradient Unit Conversion
- Measurement: **Stress** in Pascal (Pa)
  Stress Unit Conversion

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