AeroCalculator

A Portable Aerodynamic and Gas-Dynamic Calculator

Version 1.0 • Windows Portable Edition • 2026

User Guide and Engineering Reference

Portable release

This release is distributed as a portable Windows executable and this PDF manual. No installation or external package is required. Copy `AeroCalculator.exe` to a Windows computer, run it, enter the required inputs, and use the results.

Online access

Web version: https://iconclusions.com/aerocalculator/
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Supports English, Arabic, Chinese (Simplified), Japanese, French, Spanish, German, Russian

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1 Introduction

1.1 Purpose of the software

AeroCalculator is a desktop calculator for routine aerodynamic, compressible-flow, gas-dynamic, hypersonic, boundary-layer, and CFD pre-processing calculations. It is intended for fast preliminary analysis, teaching, design checking, and independent verification of larger CFD or propulsion workflows.

The application collects common relations that are usually taken from compressible-flow tables, gas-dynamics textbooks, online calculators, or private scripts. It gives the user a single interface for evaluating atmosphere properties, gas properties, viscosity, Reynolds number, isentropic ratios, area-Mach inversion, normal and oblique shocks, Prandtl-Meyer waves, conic shocks, first-cell height, turbulent inlet quantities, boundary-layer estimates, stagnation heating, detonation, Kantrowitz limit, direction cosines, and unit conversions. The final interface uses a grouped sidebar, unit selectors for selected fields, direct access to equations, and a copy-results function for reporting.

1.2 What is included in the release

The release package is deliberately simple:

- `AeroCalculator.exe`: the portable Windows application.
- **AeroCalculator_Manual.pdf**: this user guide and engineering reference.

There is no installer. No additional files are required by the user. The application is designed to be copied, opened, and used directly.

1.3 Module overview

The final interface organizes the modules in collapsible groups. This reduces sidebar clutter and makes the software easier to use during teaching, CFD setup, and preliminary design.

Sidebar group	Modules
Freestream / Properties	Atmosphere; Gas Property; Sutherland; Reynolds Number
Isentropic / Compressible Flow	Isentropic Flow; Mass Function; Corrected Mass; Area-Mach Solver
Shocks and Waves	Normal Shock; Oblique Shock; Prandtl-Meyer; Conic Shock
Boundary Layer / CFD Setup	Y+ / First Cell; BL Thicknesses; Turbulent Values
Hypersonic / Propulsion	Bluntness Heat; Kantrowitz Limit; Detonation (CJ)
Utilities	Flow Direction; Unit Conversion
Always available	About; Equations

The calculation modules are grouped by physical use rather than by formula type. For example, the Atmosphere module belongs to freestream setup, whereas Bluntness Heat and Kantrowitz Limit are grouped under hypersonic and propulsion applications.

1.4 Model assumptions

Most calculations assume a calorically perfect ideal gas with constant γ, constant c_p, constant c_v, and a user-specified or internally computed gas constant R. This assumption is appropriate for many preliminary air-breathing propulsion and high-speed aerodynamic estimates, but it is not a substitute for high-temperature real-gas modeling, finite-rate chemistry, reacting-flow simulation, or high-fidelity CFD.

Engineering limitation

Use AeroCalculator as a first estimate, a teaching tool, or an independent numerical check. For final design of hypersonic vehicles, inlets, combustors, nozzles, thermal protection systems, or detonative systems, verify the result using validated CFD or experiments.

2 Quick Start

2.1 Running the portable app

1. Copy `AeroCalculator.exe` to any convenient folder on a Windows 10 or Windows 11 computer.
2. Double-click `AeroCalculator.exe`.
3. Select the required module from the left sidebar.
4. Enter the input values using SI units unless the module states otherwise.
5. Press COMPUTE.
6. Read the outputs from the right panel.

No installation

The app is portable. It does not need to be installed and does not require a separate runtime, compiler, or external library on the target computer.

2.2 Windows security notice

Windows may show a SmartScreen or security warning for a portable executable downloaded from the internet or copied from another computer. This is normal for unsigned educational software. Run the application only if it was obtained from a trusted provider.

2.3 Interface layout

The main window has four functional regions.

Grouped sidebar.
The left panel contains collapsible module groups. Each group can be expanded or collapsed using the arrow marker. Active modules are highlighted in violet.

Top bar.
The top bar contains the application title, subtitle, and language selector. Changing the language updates the interface labels without changing the entered numerical values.

Input panel.
The middle panel contains editable numerical fields, dropdown selectors, and unit selectors where available. Use decimal notation such as `1.225` or scientific notation such as `1.225e0`.

Output panel.
The right panel displays computed quantities. Outputs are read-only and update after pressing COMPUTE. Selected outputs include unit selectors for direct engineering interpretation.

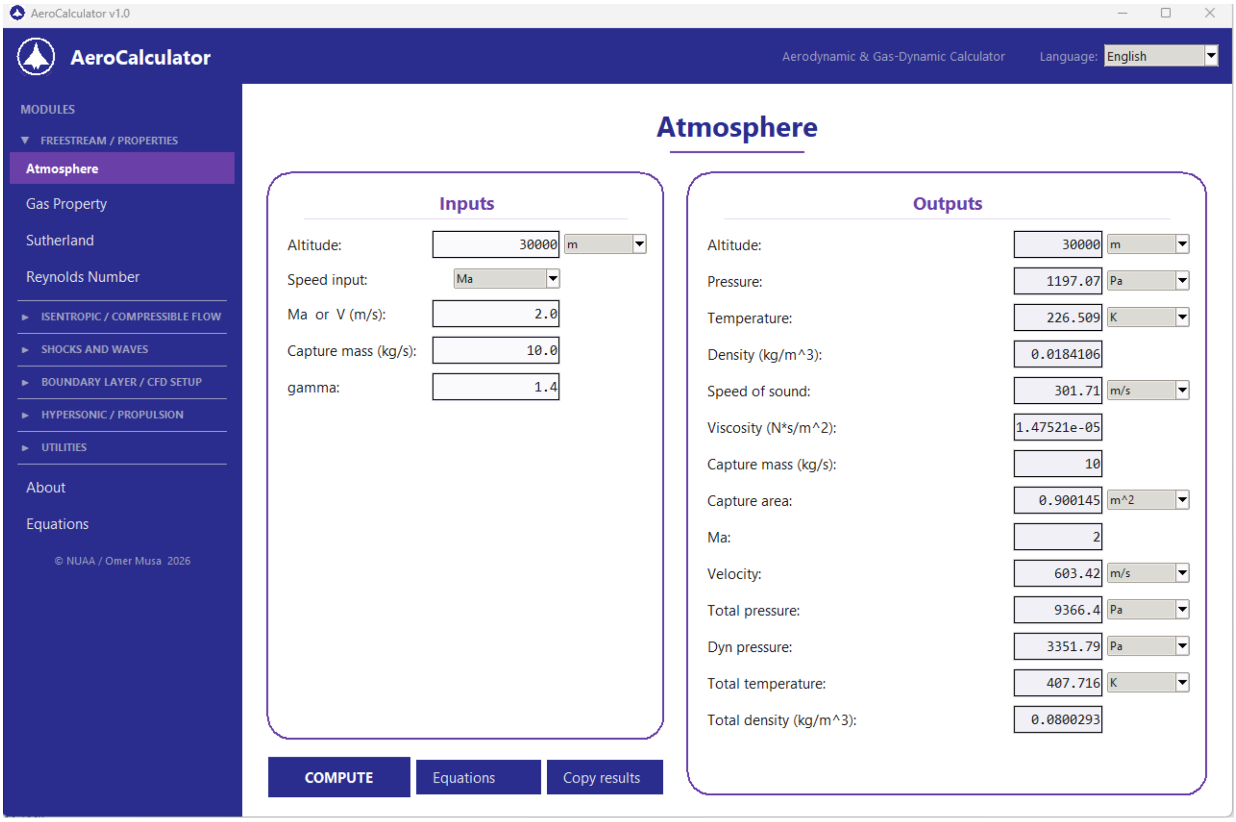
The bottom action buttons provide the normal calculation workflow:

- COMPUTE: evaluates the active module.
- EQUATIONS: opens the formula reference for the active module or the general equations panel.
- COPY RESULTS: copies the current inputs and outputs for reports, notes, or verification logs.

2.4 Recommended workflow

For reliable use, follow this sequence:

1. Identify the physical model: atmosphere, isentropic flow, shock, expansion, boundary layer, heating, or inlet startability.
2. Check the required assumptions: perfect gas, attached shock, inviscid relation, flat plate, empirical turbulent estimate, or one-dimensional detonation.
3. Enter SI-unit values carefully.
4. Compare the order of magnitude with physical expectation.
5. For reports or publications, record the inputs, outputs, formula, and assumptions.



Language: English

Atmosphere

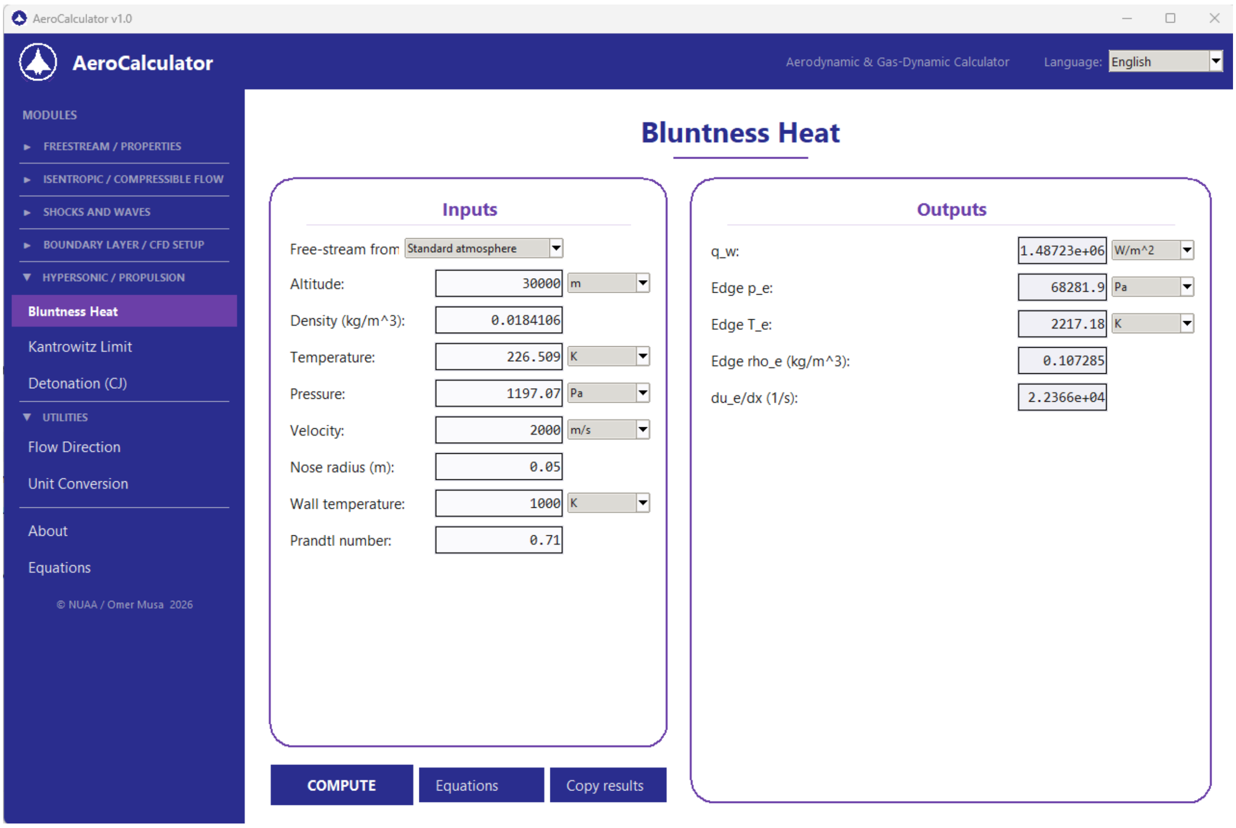
Inputs

Altitude: 30000 m
Speed input: Ma
Ma or V (m/s): 2.0
Capture mass (kg/s): 10.0
gamma: 1.4

Outputs

Altitude: 30000 m
Pressure: 1197.07 Pa
Temperature: 226.509 K
Density (kg/m^3): 0.0184106
Speed of sound: 301.71 m/s
Viscosity (N*s/m^2): 1.47521e-05
Capture mass (kg/s): 10
Capture area: 0.900145 m^2
Ma: 2
Velocity: 603.42 m/s
Total pressure: 9366.4 Pa
Dyn pressure: 3351.79 Pa
Total temperature: 407.716 K
Total density (kg/m^3): 0.0800293

Figure 1: Final grouped interface illustrated using the Atmosphere module. The sidebar is divided into physical groups, selected fields include unit selectors, and the bottom buttons provide computation, equations, and result-copying actions.



Language: English

Bluntness Heat

Inputs

Free-stream from Standard atmosphere
Altitude: 30000 m
Density (kg/m^3): 0.0184106
Temperature: 226.509 K
Pressure: 1197.07 Pa
Velocity: 2000 m/s
Nose radius (m): 0.05
Wall temperature: 1000 K
Prandtl number: 0.71

Outputs

q_w: 1.48723e+06 W/m^2
Edge p_e: 68281.9 Pa
Edge T_e: 2217.18 K
Edge rho_e (kg/m^3): 0.107285
du_e/dx (1/s): 2.2366e+04

Figure 2: Hypersonic / Propulsion group showing the Bluntness Heat module. This group contains Bluntness Heat, Kantrowitz Limit, and Detonation (CJ).

3 Module Reference

3.1 Fluid properties

3.1.1 Atmosphere

The Atmosphere module computes standard-atmosphere properties as a function of geometric altitude. It returns static pressure p, static temperature T, density ρ, speed of sound a, dynamic viscosity μ, velocity if Mach number is supplied, dynamic pressure, total temperature, total pressure, total density, and capture area if mass flow is supplied.

Key relations include

$$a = \sqrt{\gamma R T}, \qquad V = Ma,$$
$$q_\infty = \frac{1}{2}\rho V^2,$$
$$T_t = T\left(1 + \frac{\gamma - 1}{2}M^2\right),$$
$$p_t = p\left(1 + \frac{\gamma - 1}{2}M^2\right)^{\gamma/(\gamma-1)}.$$

The capture area for a specified mass flow rate is

$$A_c = \frac{\dot{m}}{\rho V}.$$

3.1.2 Reynolds Number

The Reynolds number module evaluates

$$\mathrm{Re}_L = \frac{\rho V L}{\mu} = \frac{VL}{\nu}, \qquad \nu = \frac{\mu}{\rho}.$$

It also reports Mach number when the speed of sound is available.

3.1.3 Sutherland

The Sutherland module computes air viscosity using

$$\mu(T) = \mu_{\mathrm{ref}}\left(\frac{T}{T_{\mathrm{ref}}}\right)^{3/2}\frac{T_{\mathrm{ref}} + S}{T + S}.$$

Default constants for air are $\mu_{\mathrm{ref}} = 1.716 \times 10^{-5}\,\mathrm{N\,s/m^2}$, $T_{\mathrm{ref}} = 273.15\,\mathrm{K}$, and $S = 110.4\,\mathrm{K}$.

3.1.4 Gas Property

The Gas Property module computes

$$R = \frac{R_u}{M_{\mathrm{mol}}}, \qquad c_v = \frac{R}{\gamma - 1}, \qquad c_p = \frac{\gamma R}{\gamma - 1}.$$

The molar mass field is in kg/kmol. For example, air has $M_{\mathrm{mol}} \approx 28.9647\,\mathrm{kg/kmol}$, equivalent to $28.9647\,\mathrm{g/mol}$.

3.2 Compressible flow

3.2.1 Isentropic Flow

For a perfect gas, the stagnation ratios are

$$\frac{T}{T_t} = \left(1 + \frac{\gamma - 1}{2}M^2\right)^{-1},$$

$$\frac{p}{p_t} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{-\gamma/(\gamma-1)},$$

$$\frac{\rho}{\rho_t} = \left(1 + \frac{\gamma - 1}{2} M^2\right)^{-1/(\gamma-1)}.$$

The area-Mach relation is

$$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1}\left(1 + \frac{\gamma - 1}{2} M^2\right)\right]^{(\gamma+1)/[2(\gamma-1)]}.$$

3.2.2 Mass Function

The velocity coefficient is

$$\lambda = M\sqrt{\frac{\gamma+1}{2 + (\gamma-1)M^2}}.$$

The normalized mass-flow function is

$$q(M) = M\left[\frac{2}{\gamma+1}\left(1 + \frac{\gamma - 1}{2} M^2\right)\right]^{-(\gamma+1)/[2(\gamma-1)]}.$$

3.2.3 Corrected Mass

The compressible mass-flow rate is

$$\dot{m} = A\frac{p_t}{\sqrt{T_t}}\sqrt{\frac{\gamma}{R}}\, M\left(1 + \frac{\gamma - 1}{2} M^2\right)^{-(\gamma+1)/[2(\gamma-1)]}.$$

Corrected mass flow is normally referenced to standard total conditions:

$$\dot{m}_{\mathrm{corr}} = \dot{m}\frac{\sqrt{T_t/T_{\mathrm{ref}}}}{p_t/p_{\mathrm{ref}}}.$$

If $T_t = T_{\mathrm{ref}}$ and $p_t = p_{\mathrm{ref}}$, then $\dot{m}_{\mathrm{corr}} = \dot{m}$.

3.2.4 Area-Mach Solver

The Area-Mach Solver performs the inverse of the standard isentropic area-Mach relation. Given A/A^* and γ, it returns the subsonic and supersonic Mach-number branches when both are physically possible:

$$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1}\left(1 + \frac{\gamma - 1}{2} M^2\right)\right]^{(\gamma+1)/[2(\gamma-1)]}.$$

For $A/A^* = 1$, both branches meet at $M = 1$. For $A/A^* > 1$, the equation has one subsonic solution and one supersonic solution. This module is useful for nozzle design, throat checking, and quick verification of isentropic duct calculations.

3.3 Shocks and expansion waves

3.3.1 Normal Shock

The normal shock module uses the Rankine-Hugoniot relations:

$$M_2^2 = \frac{1 + \frac{\gamma-1}{2}M_1^2}{\gamma M_1^2 - \frac{\gamma-1}{2}},$$

$$\frac{p_2}{p_1} = 1 + \frac{2\gamma}{\gamma+1}(M_1^2 - 1),$$

$$\frac{\rho_2}{\rho_1} = \frac{(\gamma+1)M_1^2}{(\gamma-1)M_1^2 + 2}, \qquad \frac{T_2}{T_1} = \frac{p_2/p_1}{\rho_2/\rho_1}.$$

3.3.2 Oblique Shock

For a wedge compression, the shock angle β satisfies the θ-β-M relation:

$$\tan\theta = 2\cot\beta \frac{M_1^2 \sin^2\beta - 1}{M_1^2(\gamma + \cos 2\beta) + 2}.$$

The normal component $M_{n1} = M_1 \sin\beta$ is then used in the normal-shock relations, and the downstream Mach number is recovered from

$$M_2 = \frac{M_{n2}}{\sin(\beta - \theta)}.$$

The weak solution is usually relevant for external aerodynamic compression. The strong solution is generally associated with severe compression and subsonic downstream flow.

3.3.3 Prandtl-Meyer

The Prandtl-Meyer function is

$$\nu(M) = \sqrt{\frac{\gamma+1}{\gamma-1}} \tan^{-1}\sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)} - \tan^{-1}\sqrt{M^2-1}.$$

For expansion,

$$\nu_2 = \nu_1 + \theta, \qquad M_2 > M_1.$$

For smooth isentropic compression,

$$\nu_2 = \nu_1 - \theta, \qquad M_2 < M_1.$$

Compression interpretation

Prandtl-Meyer compression is appropriate for smooth isentropic compression waves. A sharp compression corner or ramp normally produces an oblique shock, not a Prandtl-Meyer compression fan.

3.3.4 Conic Shock

The Conic Shock module solves the axisymmetric conical shock problem for a sharp circular cone at zero angle of attack. The calculation combines oblique-shock jump conditions behind the conical shock with downstream integration of the Taylor-Maccoll equation to the cone surface.

Outputs include the conical shock angle β_s, post-shock Mach number immediately behind the conical shock, cone-surface Mach number, and thermodynamic ratios.

Sensitive numerical module

Conic shock calculations are more sensitive than two-dimensional oblique shocks because the shock angle must be found iteratively and the post-shock flow must be integrated to the cone wall. Near detached-shock limits or at difficult Mach/cone-angle combinations, validate the result against a trusted reference table or independent solver. For $M_1 = 6$, $\theta_c = 15°$, and $\gamma = 1.4$, a useful reference value is $\beta_s \approx 19.01°$.

3.4 Boundary layer, CFD setup, and heat transfer

3.4.1 Y+ / First Cell

For a target wall coordinate y^+,

$$y = \frac{y^+\mu}{\rho u_\tau}, \qquad u_\tau = \sqrt{\frac{\tau_w}{\rho}},$$

where

$$\tau_w = \frac{1}{2}\rho V^2 C_f.$$

The module uses a turbulent flat-plate estimate such as

$$C_f = 0.026\mathrm{Re}_L^{-1/7}.$$

This is an initial mesh-sizing estimate. The actual CFD y^+ must still be checked after solving.

3.4.2 Turbulent Values

For RANS inlet conditions,

$$k = \frac{3}{2}(UI)^2,$$

$$\varepsilon = C_\mu^{3/4}\frac{k^{3/2}}{L_t}, \qquad \omega = \frac{\sqrt{k}}{C_\mu^{1/4}L_t},$$

$$\nu_t = \frac{C_\mu k^2}{\varepsilon}.$$

Turbulence intensity must be entered as a fraction. For 5 percent, use $I = 0.05$, not $I = 5$.

3.4.3 BL Thicknesses

The laminar incompressible flat-plate estimates are

$$\delta = \frac{5x}{\sqrt{\mathrm{Re}_x}}, \qquad \delta^* = \frac{1.7208x}{\sqrt{\mathrm{Re}_x}}, \qquad \theta = \frac{0.664x}{\sqrt{\mathrm{Re}_x}},$$

$$H = \frac{\delta^*}{\theta}, \qquad C_{f,x} = \frac{0.664}{\sqrt{\mathrm{Re}_x}}.$$

For turbulent 1/7-power estimates,

$$\delta = \frac{0.37x}{\mathrm{Re}_x^{1/5}}, \qquad \delta^* = \frac{\delta}{8}, \qquad \theta = \frac{7\delta}{72}, \qquad H = \frac{9}{7}.$$

3.4.4 Bluntness Heat

The Bluntness Heat module estimates stagnation-point convective heat flux for a spherical nose. Depending on the selected or implemented formulation, the result may correspond to a Fay-Riddell-type stagnation heating expression or a Sutton-Graves-type correlation.

A commonly used Sutton-Graves form is

$$\dot{q}_w = K\sqrt{\frac{\rho_\infty}{R_n}}V_\infty^3,$$

while modified forms may use edge or stagnation-region density and a wall-temperature correction. Because this choice can change the numerical heat flux significantly, always record which density and correction model are used.

Heating-model clarity

Do not report a heat-flux value without stating the correlation and whether the density is freestream density, edge density, or stagnation-region density.

3.5 Hypersonic inlet and detonation utilities

3.5.1 Detonation (CJ)

The Detonation (CJ) module estimates one-dimensional Chapman-Jouguet detonation speed and post-detonation ratios for an ideal gas with lumped heat release q. The reported CJ condition corresponds to sonic flow relative to the wave behind the detonation front.

Use this module as an ideal-gas estimate only. Real detonations may require detailed product thermodynamics, finite-rate chemistry, and different reactant/product gas properties.

3.5.2 Kantrowitz Limit

The Kantrowitz Limit module estimates the self-starting contraction constraint for a supersonic inlet. It compares two contraction ratios: the isentropic contraction reference and the Kantrowitz self-starting contraction limit.

For a freestream Mach number M_∞, the isentropic contraction reference is the area-Mach ratio evaluated on the freestream branch,

$$\mathrm{AR}_{\mathrm{isen}} = \left(\frac{A_{\mathrm{inlet}}}{A_{\mathrm{throat}}}\right)_{\mathrm{isen}} = \left.\frac{A}{A^*}\right|_{M_\infty}.$$

This value is a geometric isentropic reference. It is not, by itself, a self-starting limit.

The Kantrowitz limit assumes that a normal shock is swallowed at the inlet face. The Mach number immediately downstream of that normal shock is

$$M_2^2 = \frac{1 + \dfrac{\gamma-1}{2}M_\infty^2}{\gamma M_\infty^2 - \dfrac{\gamma-1}{2}}.$$

The corresponding Kantrowitz contraction ratio is then computed from the standard area-Mach relation evaluated at the post-shock Mach number,

$$\mathrm{AR}_K = \left(\frac{A_{\mathrm{inlet}}}{A_{\mathrm{throat}}}\right)_K = \left.\frac{A}{A^*}\right|_{M_2}.$$

Both area ratios use

$$\frac{A}{A^*} = \frac{1}{M}\left[\frac{2}{\gamma+1}\left(1 + \frac{\gamma-1}{2}M^2\right)\right]^{(\gamma+1)/[2(\gamma-1)]}.$$

The module also reports the self-starting margin,

$$\text{margin} = \frac{\mathrm{AR}_K}{\mathrm{AR}_{\mathrm{isen}}}.$$

For the ideal normal-shock Kantrowitz model, this margin is equal to the total-pressure ratio across the swallowed normal shock,

$$\frac{\mathrm{AR}_K}{\mathrm{AR}_{\mathrm{isen}}} = \frac{p_{t2}}{p_{t1}}.$$

Thus, an inlet with $\mathrm{AR} \le \mathrm{AR}_K$ is expected to self-start under the idealized criterion. If $\mathrm{AR}_K < \mathrm{AR} \le \mathrm{AR}_{\mathrm{isen}}$, the inlet may operate after starting but normally requires overspeed starting, bleed, variable geometry, or another start-assist mechanism. If $\mathrm{AR} > \mathrm{AR}_{\mathrm{isen}}$, steady inviscid supersonic operation is not possible under this one-dimensional model.

Interpretation

The Kantrowitz result is an inviscid, one-dimensional starting estimate. Real inlets are affected by boundary-layer growth, shock-boundary-layer interaction, bleed, spillage, cowl geometry, three-dimensional effects, and unstart dynamics. Treat AR_K as a conservative preliminary-design indicator, not as a final startability proof.

3.6 Utilities

3.6.1 Flow Direction

For angle of attack α and sideslip angle β, the direction cosines used by the module are

$$V_x = \cos\alpha\cos\beta,$$

$$V_y = \sin\beta,$$

$$V_z = \sin\alpha\cos\beta.$$

This gives a unit vector in the positive streamwise convention. Some CFD solvers require a sign change depending on how freestream direction is defined.

3.6.2 Unit Conversion

The Unit Conversion module provides quick conversion between common engineering units for length, pressure, temperature, velocity, mass flow rate, density, and force. Use it to avoid mixing SI and non-SI quantities in the calculation modules.

4 Validation and Example Values

This section gives useful benchmark values for checking the app outputs and for teaching. Values are rounded to the number of significant digits normally shown in the interface.

Module	**Input**	**Expected output**
Atmosphere	$h = 30$ km, $M = 7$, $\gamma = 1.4$	$p = 1197.0$ Pa, $T = 226.509$ K, $\rho = 0.0184106$ kg/m^3, $a = 301.71$ m/s, $V = 2111.96$ m/s
Reynolds Number	$h = 30$ km, $V = 300$ m/s, $L = 1$ m	$\nu = 8.0128 \times 10^{-4}$ m^2/s, $\mathrm{Re}_L = 3.7440 \times 10^5$, $M = 0.9943$
Sutherland	$T = 300$ K	$\mu = 1.84592 \times 10^{-5}$ N s/m^2
Gas Property	Air, $M_{\mathrm{mol}} = 28.9647$ kg/kmol, $\gamma = 1.4$	$R = 287.055$ J/(kg K), $c_p = 1004.69$ J/(kg K), $c_v = 717.638$ J/(kg K)
Isentropic Flow	$M = 2$, $\gamma = 1.4$	$p/p_t = 0.127805$, $T/T_t = 0.555556$, $\rho/\rho_t = 0.230048$, $A/A^* = 1.6875$
Area-Mach Solver	$A/A^* = 1.6875$, $\gamma = 1.4$	$M_{\mathrm{sub}} \approx 0.372$, $M_{\mathrm{sup}} = 2.000$
Mass Function	$M = 10$, $\gamma = 1.4$	$\lambda = 2.39046$, $q(M) = 0.00186589$
Corrected Mass	$p_t = 101325$ Pa, $T_t = 288.15$ K, $A = 0.01$ m^2, $M = 1$	$\dot{m} = 2.41238$ kg/s
Normal Shock	$M_1 = 2$, $\gamma = 1.4$	$M_2 = 0.57735$, $p_2/p_1 = 4.5$, $T_2/T_1 = 1.6875$, $\rho_2/\rho_1 = 2.66667$, $p_{t2}/p_{t1} = 0.720874$
Oblique Shock	$M_1 = 3$, $\theta = 10^\circ$, weak, $\gamma = 1.4$	$\beta = 27.3827^\circ$, $M_2 = 2.505$, $p_2/p_1 = 2.05447$, $T_2/T_1 = 1.24168$
Prandtl-Meyer expansion	$M_1 = 2$, $\theta = 5^\circ$, $\gamma = 1.4$	$M_2 = 2.18643$, $\nu_1 = 26.3798^\circ$, $\nu_2 = 31.3798^\circ$, $p_2/p_1 = 0.747464$
Prandtl-Meyer compression	$M_1 = 2$, $\theta = 5^\circ$, $\gamma = 1.4$	$M_2 = 1.8227$, $\nu_2 = 21.3798^\circ$, $p_2/p_1 = 1.31526$
Conic Shock	$M_1 = 7$, cone half-angle 15°, $\gamma = 1.4$	$\beta_s \approx 18.36^\circ$, $M_{\mathrm{post}} \approx 4.90$, $M_{\mathrm{wall}} \approx 4.82$, $p_2/p_1 \approx 5.51$
Y+ / First Cell	$h = 10$ km, $V = 250$ m/s, $L = 1$ m, $y^+ = 1$	$\mathrm{Re}_L = 7.0924 \times 10^6$, $C_f = 0.00273079$, $\tau_w = 35.288$ Pa, $y = 3.8158 \times 10^{-6}$ m
Turbulent Values	$U = 100$ m/s, $I = 0.05$, $L_t = 0.07$ m, $C_\mu = 0.09$	$k = 37.5$ m^2/s^2, $\varepsilon = 5.3905 \times 10^2$ m^2/s^3, $\omega = 1.5972 \times 10^2$ s^{-1}
Kantrowitz Limit	$M_\infty = 3$, $\gamma = 1.4$	$M_2 = 0.475191$, $\mathrm{AR}_K = 1.39039$, $\mathrm{AR}_{\mathrm{isen}} = 4.23457$

5 Common Mistakes and Remedies

Problem	Remedy
Entering Mach number where velocity is required	Check the label. Some modules require M, while others require V in m/s. At 30 km, $M = 7$ corresponds to about 2112 m/s, not 300 m/s.
Ignoring unit selectors	Several fields include unit dropdowns. Confirm the selected unit before comparing outputs or copying values into CFD software.
Using percent instead of fraction for turbulence intensity	Use $I = 0.05$ for 5 percent. Do not enter 5 unless the intended turbulence intensity is 500 percent.
Applying Prandtl-Meyer compression to a sharp ramp	Use Oblique Shock for a sharp compression corner. Use Prandtl-Meyer compression only for smooth isentropic compression.
Comparing conic shock with oblique shock	A cone is axisymmetric and generally has a smaller shock angle than a two-dimensional wedge of the same angle. Use the Conic Shock module for circular cones.
Using first-cell height as final mesh proof	The first-cell height is an initial estimate. Confirm actual y^+ after the CFD solution.
Reporting heat flux without correlation details	State the model, density definition, wall-temperature correction, nose radius, velocity, and units.
Forgetting gas-property assumptions	Most relations assume a perfect gas with constant γ. At very high temperature, real-gas effects may be important.

6 Recommended Engineering Use

6.1 For teaching

Use the app to demonstrate how Mach number, area ratio, pressure recovery, shock strength, expansion angle, and boundary-layer scale are connected. The validation table in this manual can be used as a classroom checklist.

6.2 For CFD pre-processing

Recommended uses include estimating freestream conditions, Reynolds number, turbulent inlet quantities, first-cell height, boundary-layer thickness, direction cosines, unit-converted inputs/outputs, and rough stagnation heating. These values are useful for setting up Fluent, CFX, SU2, OpenFOAM, or in-house solvers, but they must be checked after solution convergence.

6.3 For hypersonic intake analysis

Recommended uses include first estimates of shock compression, total-pressure loss, Prandtl-Meyer expansion, conical-shock behavior, capture area, corrected mass flow, and Kantrowitz startability. For inlet design, always combine these estimates with geometric constraints, viscous effects, shock-boundary-layer interaction analysis, and CFD validation.

7 About the Creator

Contact

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Dr. Omer Musa is Associate Professor of Aerospace Engineering at Nanjing University of Aeronautics and Astronautics, with research and teaching activity in compressible flow, hypersonic aerothermodynamics, computational fluid dynamics, and propulsion-system analysis. AEROCALCULATOR was developed to consolidate routine analytical calculations that recur in preliminary aerospace design, teaching, and verification of higher-fidelity simulations.

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