

Compressible Flow Intro

Lecture 21



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Outline

Motivation

Thermodynamics Review

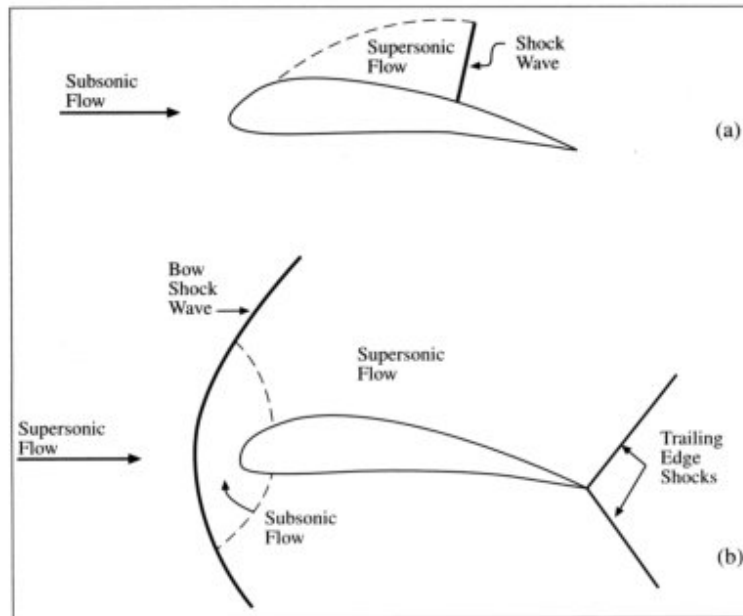
Isentropic Relations

Motivation

Example: hammer on a pipe

Mach Cone

[Supersonic Aircraft Video](#)



Source: Research in Supersonic Flight and the Breaking of the Sound Barrier, from <http://history.nasa.gov>

Thermodynamics Review

Thermodynamics Review

$v = 1/\rho$: specific volume

e : specific internal energy

$h = e + Pv$: specific enthalpy

s : specific entropy

Equations of State

Ideal Gas

Thermally Perfect Gas

Specific Heats

Calorically Perfect Gas

We can show that:

$$c_p - c_v = R$$

and

$$c_p = \frac{\gamma R}{\gamma - 1}$$

$$c_v = \frac{R}{\gamma - 1}$$

For air (at typical conditions)

$$\gamma = 1.4$$

$$R = 286.9 \frac{J}{kg \cdot K}$$

Isentropic Relations

Isentropic Relations

What is **isentropic**?

First and Second Laws of Thermodynamics

Isentropic Relationships

$$\frac{p_2}{p_1} = \left(\frac{\rho_2}{\rho_1}\right)^\gamma = \left(\frac{T_2}{T_1}\right)^{\gamma/(\gamma-1)}$$

Example problem with airplane sonic boom.