Compressible Flow: Energy

Lecture 22

ME EN 412
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Outline

Energy Equation

Speed of Sound

Stagnation Quantities

Energy Equation

Energy Equation

rate of accumulation $+$ rate of outflow
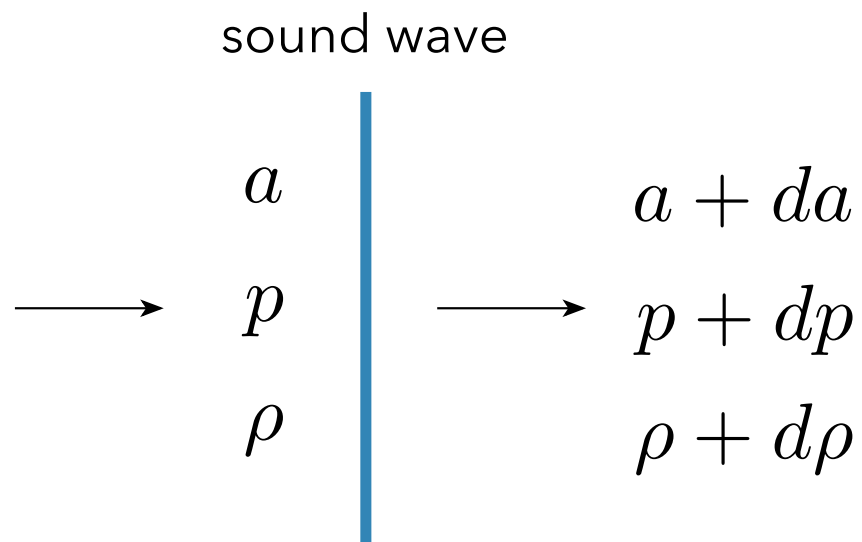
$-$ rate of inflow $=$ rate of production

Work

Differential form

along a streamline:

$$h_1 + \frac{V_1^2}{2} + gz_1 + q = h_2 + \frac{V_2^2}{2} + gz_2$$

Speed of Sound

Speed of Sound

sound wave

a

$\longrightarrow$ p

ρ

$a + da$

$\longrightarrow$ $p + dp$

$\rho + d\rho$

$$a = \sqrt{\left(\frac{\partial p}{\partial \rho}\right)_s}$$

Stagnation Quantities

$$\frac{T_0}{T} = 1 + \frac{\gamma - 1}{2}M^2$$

$$\frac{P_0}{P} = \left(1 + \frac{\gamma - 1}{2}M^2\right)^{\gamma/(\gamma-1)}$$

$$\frac{\rho_0}{\rho} = \left(1 + \frac{\gamma - 1}{2}M^2\right)^{1/(\gamma-1)}$$

Example problem with helium-filled balloon in car.