VIENNA UNIVERSITY OF TECHNOLOGY

INSTITUTE OF APPLIED PHYSICS

SURFACE SCIENCE

Bachelors Thesis

Title

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1 Theory

1.1 Formulary

Thermodynamics

Continuous one-dimensional flow

Thermal equation of state:

$$\frac{p}{\rho} = RT \quad \text{[term perf]} \tag{1}$$

Dynamic equation:

$$\frac{1}{\rho}dp + VdV = 0 \tag{2}$$

Speed of Sound:

$$a = \sqrt{\left(\frac{\partial p}{\partial \rho}\right)_s} = \sqrt{\gamma\left(\frac{\partial p}{\partial \rho}\right)_T} \tag{3}$$

$$a = \sqrt{\gamma\frac{p}{\rho}} = \sqrt{\gamma RT} \quad \text{[term perf]} \tag{36}$$

Mach Number:

$$M = \frac{V}{a} \tag{4}$$

Dynamic Pressure:

$$q = \frac{1}{2}\rho V^2 \tag{5}$$

$$q = \frac{\gamma}{2}pM^2 \tag{6}$$

From the dynamic equation and the speed of sound relation:

$$\frac{p}{\rho^\gamma} = \text{constant} = \frac{p_t}{\rho_t^\gamma} \quad \text{[isen, perf]} \tag{34}$$

From which:

$$\frac{p}{p_t} = \left(\frac{\rho}{\rho_t}\right)^\gamma = \left(\frac{T}{T_t}\right)^{\frac{\gamma}{\gamma-1}} = \left(\frac{a}{a_t}\right)^{\frac{2\gamma}{\gamma-1}} \quad \text{[isen, perf]} \tag{35}$$

Combining the above equations gives Bernoulli's equation for compressible flow:

$$\frac{\gamma}{\gamma-1}\left(\frac{p_t}{\rho_t}\right)^{\frac{\gamma-1}{\gamma}}\left(\frac{p}{p_t}\right)^{\frac{1}{\gamma}} + \frac{V^2}{2} = \frac{\gamma}{\gamma-1}\frac{p_t}{\rho_t} \quad \text{[isen, perf]} \tag{36}$$

Usefull Ratios

$$\frac{T}{T_t} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{-1} \quad \text{[adiab, perf]} \tag{43}$$

$$\frac{p}{p_t} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{-\frac{\gamma}{\gamma-1}} \quad \text{[isen, perf]} \tag{44}$$

$$\frac{\rho}{\rho_t} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{-\frac{1}{\gamma-1}} \quad \text{[isen, perf]} \tag{45}$$

$$\frac{a}{a_t} = \left(1 + \frac{\gamma-1}{2}M^2\right)^{-\frac{1}{2}} \quad \text{[adiab, perf]} \tag{46}$$

1.2 Foundational principles

Idealized flow regimes

Turbulence

Mach regimes

Dimensionality of the flow

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2.1 Scope and objectives

2.2 Framework for Analysis

Important assumptions

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Limits of the theory

2.3 Analytical Descriptions

Testing the waters. Lets do this.

3 Discussion

4 Conclusion

this is a test

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