

AEE 343 Compressible Flow
Problem set 1
Due date: 1/22/2015

Problem 1

A pressure vessel that has a volume of 10 m^3 is used to store high-pressure air for operating a supersonic wind tunnel. (a) If the air pressure and temperature inside the vessel are 20 atm and 300°K , respectively, what is the mass of air stored in the vessel? (b) Calculate the total internal energy of the gas stored in the vessel. (c) Let us now heat the gas in the vessel such that the temperature is raised to 600°K . Calculate the change in entropy of the air inside the vessel.

Problem 2

Consider a point in a flow where the velocity and temperature are $1,300 \text{ ft/s}$ and 480°R , respectively. Calculate the total enthalpy at this point.

Problem 3

In the reservoir of a supersonic wind tunnel, the velocity is negligible, and the temperature is $1,000^\circ\text{K}$. The temperature at the exit of the nozzle is 600°K . Assuming adiabatic flow through the nozzle, calculate the velocity at the exit.

Problem 4

An airfoil is in a freestream where $p_\infty = 0.61 \text{ atm}$, $\rho_\infty = 0.819 \text{ kg/m}^3$, and $V_\infty = 300 \text{ m/s}$. At a point on the airfoil surface, the pressure is 0.5 atm . Assuming isentropic flow, calculate the velocity at that point. Calculate the percentage error obtained if the problem is *incorrectly* solved using the incompressible Bernoulli equation.

Problem 5

Repeat Problem 4, considering a point on the airfoil surface where the pressure is 0.3 atm .