ME 510
Laboratory #2
Conducted in Building B-38
Nozzle Flow

Purpose: This experiment investigates converging nozzle and converging diverging flow of a gas. Measurements of pressure variations in the nozzle flows allow comparison to compressible flow theory.

Experimental Apparatus: A converging nozzle and a converging-diverging nozzle are used to study choked flow, shock waves, and pressure variations in real nozzles. Both nozzles can be connected to a vacuum pump downstream, and are exposed to atmospheric pressure upstream. The back pressure for each nozzle is regulated by valves in line to the vacuum pump. Pressures at several locations in both nozzles can be measured with a mercury manometer board located nearby. The converging nozzle inlet and exit diameters (throat) are 1.50 inches and 0.44 inches respectively. The converging diverging nozzle has seven pressure taps located along the axis of the nozzle. The diameters of the nozzle at the seven locations are 10.43 mm, 10.59 mm, 10.87 mm, 11.18 mm, 11.38 mm, 12.0 mm, and 12.37 mm. Also the throat diameter is 10.34 mm and the exit diameter is 12.51 mm. Note that the first measurement location is upstream from the throat and all other locations are downstream from the throat.

Experimental Procedures:

Using a barometer measure the atmospheric pressure

Converging Nozzle

1. Measure the pressure at the nozzle inlet, throat, and back pressure for a sufficient number of cases (9-10) to adequately represent both choked and unchoked flow. The back pressure is varied by adjusting the control valve.

Converging-Diverging Nozzle

1. Using the C-D nozzle, measure the pressure at the seven measurement locations for both subsonic and sonic throat conditions. Use 9-10 different back pressures and observe the behavior on the manometer board as the shock wave moves through the nozzle.

Note: As you take data listen for the change in sound as the flow becomes choked at the throat for both nozzles. Why is the sound different for the two?. Also you will be measuring vacuum in inches of Hg. To convert to absolute pressure you must subtract your measurements from atmospheric pressure.

Presentation of Data:

1. Plot the ratio of throat pressure over stagnation pressure for the converging nozzle and the ratio of the pressure at the first measurement location over upstream stagnation pressure, both vs. the ratio of back pressure over upstream stagnation pressure. On this same plot show the comparison with 1-D frictionless adiabatic compressible flow theory. Include this data in table form with a deviation from theory shown in a column

2. For the converging-diverging nozzle plot the ratio of measured pressure at each location over the upstream stagnation pressure vs. the ratio of area over throat area. On this same plot show the theoretical pressure distribution assuming 1-D frictionless adiabatic compressible flow. Include the back

pressure data at an area ratio of A/A_t=1.6. You may wish to present this data on two separate plots, each showing about half of the data. Include a table with your data, in addition to your theoretical predictions. If you are careful you may use the adiabatic flow chart in determining the theoretical values.

3. A summary report is expected for this laboratory. Most of your report should focus on the measurements and behavior observed. Your discussion should focus on what you learned from this lab, what the measurements mean, what physical phenomena cause the data to behave as measured, why the noise for the two nozzles is different, and a discussion of why there are deviations in your measurements and theory. Properly done your report need not be longer than 1 single spaced page of text in addition to your figures and tables. Be specific but do not include irrelevant material.

Data Sheet

Converging Nozzle Flow

ΔP at inlet	ΔP at throat	P Back pressure

Converging-Diverging Nozzle

ΔP1	ΔP2	ΔP3	ΔP4	ΔP5	ΔP6	ΔP7	ΔP8	Back Press.