ASE 162M
Fall 2024

Laboratory 1
Supersonic Flow Over Sphere
(September 30)

Instructions

Before You Start:
You will use the images acquired in this laboratory to complete the associated homework assignment. Create a folder with your lab name in the lab computer and store all your images. Please make sure that at least one member of your lab group brings a flash drive, or other suitable media to the lab for storing the images.

Procedure:
1. Your TA should explain the wind tunnel and Schlieren setup. It would be helpful for your report to make a detailed schematic of the tunnel and Schlieren setup including electronic and data acquisition components.

2. Install the sphere in the test section of the wind tunnel at a 0° angle of attack. Make sure that it is securely in place. Take a "wind off" image of the sphere without the wind tunnel running. This image will allow you to determine the location of the sphere free of distortions due to the shadowgraph or Schlieren effect.

3. Check that the pressure taps in the stagnation chamber and test section are properly connected to the pressure transducers. Check that the data acquisition system is properly connected.

4. Start LabVIEW and open the data acquisition VI. Check the settings to make sure you are recording the correct data. You need to configure the software to read the correct channels (for this lab you are going to use two channels). In the default configuration, the stagnation pressure of the tunnel should be measured by Channel 0 and the freestream static pressure is Channel 1. Verify these connections. Adjust the max/min of the range of expected values (make sure you do this for each channel you will be using) in order to optimize your resolution. Note the acquisition rate. What is the uncertainty in your pressure measurements?

5. Conduct runs at Mach numbers of 1.63 (or lowest possible), 1.75, 2, 2.25, 2.5, 2.75, 3, and 3.25. Be sure to collect pressure data for all runs, and save **3 images** for each run. You will need these to calculate the uncertainty in shock standoff location. One run should be shadowgraph, while the others should be Schlieren. The knife edge orientation will be important. Which orientation should you use to make data processing easiest when you are completing your assignment?

Apparatus:

Aerolab Variable Mach Number Wind Tunnel: The test section is nominally 3"×3". The Mach number is varied by sliding the lower block of the nozzle with a hand crank according to the calibration table provided by the manufacturer. The nominal operating range is $1.4 \leq M \leq 3.5$. The wind tunnel is equipped with stagnation and test section pressure gages.

Schlieren System: We use a folded Schlieren system that uses a pulsed xenon arc lamp as the light source and spherical mirrors to collimate and focus the light. The image is projected onto a Pulnix color CCD camera. XCAP for Windows is the acquisition software.

Data Acquisition System: The pressure measurements are made using a series of pressure transducers. A pressure transducer is directly mounted on the tunnel to measure the stagnation pressure, whereas the others are placed in the pressure transducer and data acquisition box (it should be underneath the front optical table). The signals from the pressure transducers are recorded using an NI data acquisition card interfaced with the pressure transducers through a BNC NI adapter. The NI data acquisition card is mounted in the laboratory computer. Finally, the voltage outputs from the pressure transducers are acquired using a LabVIEW VI and are then saved in a data file. Note that the outputs are in Volts, so you need to convert them to pressure units using the following calibration constants (note that the readings are gage pressures):

1. Stagnation pressure: 60 psi/0.1 V
2. Surface/Static pressure: 15 psi/0.1 V