19 November 2012

EA204 Wind Tunnel Procedures and Data Reduction

Follow all instructions in this exercise to predict and measure the Drag of your Estes® Alpha Rocket and determine the rocket drag coefficient.

1. **This test is conducted in one of the small, demonstration tunnels built by AeroLab:**

   a. Install the model in the wind tunnel and adjust so that it is horizontal. Use the digital protractor to set the angle to 0º.

   b. Record the room temperature and atmospheric pressure.

   c. Measure the body tube diameter.

   d. Position the pointer on the Zero Preset button on the control panel <u>with the wind off</u> and press the left mouse button. The computer display should read accordingly:

Airspeed	0 ± 0.2 mph
Angle	0 ± 0.00 deg
Normal Force	0 ± 0.03 lb
Axial Force	0 ± 0.03 lb
Pitching Moment	0 ± 0.03 ft-lb

   e. Turn on the fan in the manual mode to 50% speed. Type in an airspeed of 60 mph on the computer displace and set the controls to Auto Mode. . If you see excessive model vibration, **SHUT DOWN**.

   f. Hit the Take Data button to record the Normal (Lift) and Axial (Drag) forces. You will only need the drag, but you should verify that the lift does not increase significantly.

   g. Increment the speed by 10 mph and repeat up to the tunnel maximum speed.

   h. Save your data to a file before you shut down the wind tunnel.

   i. To shut down, use the mouse button to turn the Fan Speed Control knob all the way to the left and shut off the fan.

2. Data reduction procedure:

a. Calculate the air density in the room, ρ (kg/m³).

b. Calculate the cross-sectional area of the rocket body tube, A (m²).

c. Tabulate the velocity, V (m/sec); V² (m²/sec²); and the drag, D (N).

d. Plot D vs. V² in Matlab or Excel. Using least-squares fit a straight line through your data points (you can use polyfit). The slope of this line will be $C_D \cdot A \cdot \rho / 2$. Calculate the drag coefficient from this value.

e. Calculate the 'r-squared' value for your data and the fit in order to ascertain the accuracy of your results.

f. Properly label all plots.