Module #2 - Airflow Visualization

Arvin N. Gastardo, AeE
Holy Angel University, Angeles City, Pampanga
agastardo@hau.edu.ph/agastardo@gmail.com

I. OVERVIEW

Aerodynamicists use wind tunnels to test models of proposed aircraft and engine components. In this lesson we will operate our subsonic wind tunnel to visualize the airflow inside the wind tunnel.

During a test, the model is placed in the test section of the tunnel and air is made to flow past the model. In some wind tunnel tests, the aerodynamic forces on the model are measured. In some wind tunnel tests, the model is instrumented to provide diagnostic information about the flow of air around the model. In some wind tunnel tests, flow visualization techniques are used to provide diagnostic information about the flow around the model. Two of the oldest flow visualization techniques are the use of smoke and tufting.

II. LEARNING OUTCOMES

➢ Understand the characteristics of air when it meets certain objects.

➢ Conceptualize the movement of air with respect to the difference in air pressure.

III. DISCUSSION

Smoke is used to visualize the flow that is away from the surface of the model. Smoke can be used to detect vortices and regions of separated flow. On the figure, smoke has been introduced at the corner of the fuselage and leading-edge extension (LEX) to visualize the vortex generated by the LEX at angle of attack. In the picture we see that vortex is well established until the flow encounters the vertical stabilizer of the aircraft.

Smoke has the advantage that is relatively inexpensive to produce. Smoke can be injected from the surface or dispersed with a hollow wand that can be moved through the flow field. The disadvantage of smoke is that it does not work well at higher speeds (greater than ~300 mph), the smoke must be introduced at the proper location without altering the flow, and the smoke can leave a residue in the tunnel or on the model, depending on the type of smoke employed.

Chemical methods for producing smoke include **titanium tetrachloride and tin tetrachloride** which re-act with damp air. However, both materials are corrosive. **Anhydrous ammonia and hydrogen sulfide** produce smoke, but they also produce odors and, with damp air, sulfuric acid. **Steam and liquid nitrogen** produce dense smoke with no ill effects. Light oils can also be burned to produce smoke with some residue.

*Shutting down the wind tunnel.

Here are some pictures that shows the airflow around different test subjects.

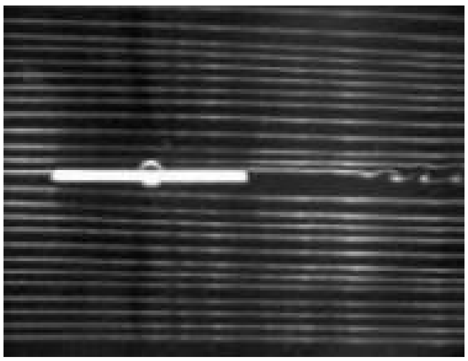

Figure 2. Flow Around Flat Plate

This figure shows the flow around flat plate parallel to the flow, the drag is due entirely to friction drag.

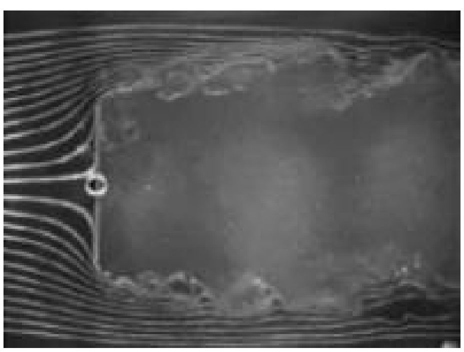

Figure 3. Wake Flow Behind Flat Plate Body

In this figure the flow around a flat plate, shows an appreciable wake behind the body and the pressure.

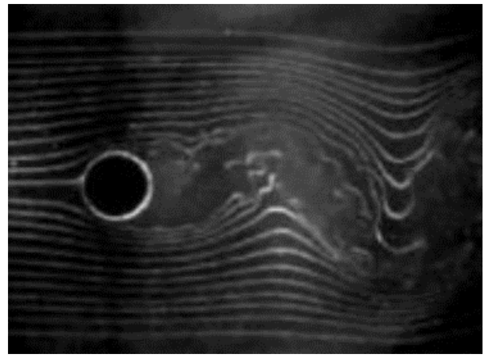

Figure 4. Flow Around Cylinder

In this figure the flow around a cylinder and a streamlined strut in the same stream shows practically no wake for the streamlined strut section the pressure drag is very small.

CONCLUSION:

The importance of the air flow visualization is to understand the different characteristics of the airflow passing to the test subject. With this, different traits will be seen once the angle knob is adjusted and modified. Air flow visualization helps us to properly design and control prevents turbulence and stagnant air in the critical area. Once relevant parameters are established, it is crucial that airflow patterns be evaluated for turbulence