Module #1 - Laboratory Safety Orientation and Wind Tunnel Familiarization

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I. OVERVIEW

What is a Wind Tunnel?

A wind tunnel is a machine used to fly aircraft's, missiles, engines, and rockets on the ground under pre-set conditions. With a wind tunnel you can chose the air speed, pressure, altitude and temperature to name a few things. A wind tunnel usually has a tube-like appearance with which wind is produced by a large fan to flow over what they are testing (plane, missiles, rockets, etc.) or a model of it.

II. LEARNING OUTCOMES

➢ To learn safety protocols inside the laboratory.

➢ Identify and familiarize the parts and use of a subsonic wind tunnel.

III. DISCUSSION

Here are the safety protocols inside the laboratory classrooms

1.1. The students under any circumstances, cannot work in the lab without the supervision and/or endorsement of the faculty-in-charge. When the faculty-in-charge cannot be physically present to supervise the students, he/she is still accountable for any untoward incident that may happened.

1.2. Wear Protective Gears such as goggles, gloves, ear muffs/earplugs and etc. as necessary when conducting experiments and tests. WEAR YOUR FACE MASK AND FACE SHIELD AT ALL TIMES.

1.3. Do Not Operate the equipment without supervision from instructors and/or professors.

1.4. During activities, Carefully Follow the Instructions given to you by your instructors and/or professors before attempting any operation on the equipment.

1.5. DO NOT TOUCH ANY ELECTRICAL WIRES/CIRCUITS, BRAKERS, MOTORS, AND/OR ANYTHING THAT MAY POTENTIALLY PUT YOU AND/OR THE INDIVIDUALS INSIDE THE LABORATORY AT RISK. IT'S ALWAYS GOOD TO ASK FOR HELP WHENEVER YOU'RE NOT SURE IF THE ACTION YOU'RE ABOUT TO MAKE IS RIGHT. SAFETY FIRST!

1.6. High voltage electrical connections are present for the operation of the equipment therefore Foods and Drinks Are Strictly Prohibited inside the laboratory.

1.7. Person/s present with foods and/or drinks shall not be allowed to enter the laboratory

1.8. ALWAYS MAINTAIN SOCIAL DISTANCING

1.9. Maintain the Cleanliness of the room whenever you use it to avoid incident/accident.

2.0. If any, collect pieces of papers, garbage, wastes, or any of the likes you see on the floor and throw them out on the bin outside of the laboratory to avoid future injuries.

Type of Wind Tunnel There are four basic types of wind tunnels.

Which are low subsonic, transonic, supersonic, and hypersonic. The wind tunnels are classified by the amount of speed they can produce.

For Subsonic – Speed is lower than the speed of sound or $M<1$,

Transonic - Speed which is equal to the speed of sound or $M=1$,

Supersonic - Speed which is greater than the speed of sound but only up to 5 times the speed of sound or $M\leqq 5$,

Hypersonic - The fastest of them all it is classified as speed greater than 5 times the Mach number or $M>5$,

Classification of Wind Tunnel

1. **Open Wind Tunnel** - This type of tunnel is also called an Eiffel tunnel, after the French engineer, or an NPL tunnel, after the National Physical Laboratory in England, where the tunnel was first used. The Eiffel tunnel has an open test section, while the NPL tunnel has a closed test section as shown in the figure. The original Wright Brother's wind tunnel was an open return design. In the open return tunnel, the air that passes through the test section is gathered from the room in which the tunnel is located. The arrows on the figure denote the flow of air through the wind tunnel and around the room.

Finally, you should know the five basic parts of the wind tunnel (Open wind tunnel). From front to back, they are: **1. The Settling Chamber, 2. the Contraction Cone, 3. the Test Section, 4. the Diffuser, and the 5. Drive Section. Please see figure 1.**

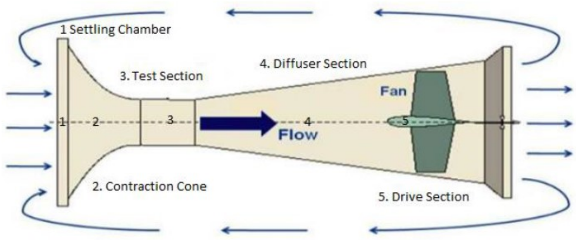


Figure 1. Flow of Air on Wind Tunnel

The **Settling Chamber** is at the very front of the wind tunnel, and is made up of screens and honeycomb-shaped mesh, which straighten out the air and reduce turbulence.

The **Contraction Cone** is a large volume of air through a small opening in order to increase the wind velocity in the tunnel (for more on this, study the continuity equation).

The **Test Section** is the place where a model is mounted on sensors.

The **Diffuser** is at the end of the Test Section, and keeps the air running smoothly as it goes toward the back. It also increases in volume in order to slow the air down as it exits the tunnel.

Finally, the **Drive Section** is at the very back of the wind tunnel, and it is where the fan is housed.

Advantages of the Open Return Tunnel

• Low construction cost.

• Superior design for propulsion and smoke visualization. There is no accumulation of exhaust products in an open tunnel.

Disadvantages of the Open Return Tunnel

• Poor flow quality possible in the test section. Flow turning the corner into the bellmouth may require extensive screens or flow straighteners. The tunnel should also be kept away from objects in the room (walls, desks, people.) that produce asymmetries to the bellmouth. Tunnels open to the atmosphere are also affected by winds and weather.

• High operating costs. The fan must continually accelerate flow through the tunnel.

• Noisy operation. Loud noise from the fan may limit times of operation.

Closed Wind Tunnel - This type of tunnel is also called a Prandtl tunnel, after the German engineer, or a Gottingen tunnel, after the research laboratory in Germany where the tunnel was first used. Many of the large research wind tunnels of NASA are closed return tunnels. In the closed return tunnel, air is conducted from the exit of the test section back to the fan by a series of turning vanes. Exiting the fan, the air is returned to the contraction section and back through the test section. Air is continuously circulated through the duct work of the closed return tunnel. The arrows on the figure denote the flow of air through the wind tunnel.

Parts of a Closed Wind Tunnel

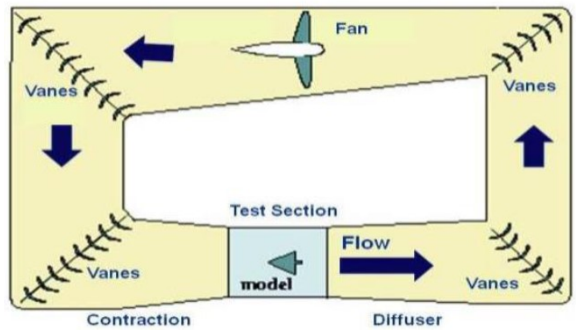
It also has the Contraction Section, the Test Section, the Diffuser, the 5. Drive Section and an additional part the Turning vanes/ Guide vane.

Turning vanes/ Guide vanes - The turning vanes are a cascade of airfoils which minimize the total pressure loss through the corners. Leaving the corner at the upper left of the figure, the air passes through some flow straighteners before entering the test section. The purpose of the flow straighteners is to make the flow in the test section as uniform as possible.

Advantages of the Closed Return Tunnel

• Superior flow quality in the test section. Flow turning vanes in the corner and flow straighteners near the test section insure relatively uniform flow in the test section.

• Low operating costs. Once the air is circulating



in the tunnel, the fan and motor only needs to overcome losses along the wall and through the turning vanes. The fan does not have to constantly accelerate the air.

• Quiet operation relative to an open return tunnel.

Disadvantages of the Closed Return Tunnel

• Higher construction cost because of the added vanes and ducting.

• Inferior design for propulsion and smoke visualization. The tunnel must be designed to purge exhaust products that accumulate in the tunnel.

• Hotter running conditions than an open return tunnel. Tunnel may have to employ heat exchangers or active cooling.

CONCLUSION:

In order to participate in the lab activities, it is important to know how to properly demonstrate all of the safety precautions needed. If safety precautions are not taken seriously major injuries may occur, especially in experiments involving hazardous materials. Other than learning from experiments, it is crucial to understand how to correctly conduct any and all safety steps before, during and after experiments. The wind tunnel is a tool by which air flow phenomena occurring in nature may be reproduced to a smaller scale in such a manner that observations made in the tunnel can be interpreted in terms of full scale.