

A REVIEW PAPER ON DEVELOPMENT AND FABRICATION OF LOW SPEED WIND TUNNEL

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ABSTRACT: In today's industries, where most of the aircraft, automobiles are designed using different software's and the same time attention is paid on reducing the cost of the system so it becomes very necessarily to examine them with preliminary results. Scientists and engineers used various small models of automobiles and air-crafts so as to study the effect of air which is placed in the test section of sub-sonic or low speed wind tunnel.

The wind tunnel design in this case is capable of generating laminar flow. In test section, to analyse the internal flow manual analysis was used. This paper primarily focuses on development and fabrication of low speed wind tunnel, flow visualization of various objects and calculation of drag coefficient of an object. Our design includes convergent section, test section and divergent section. Convergent section frontal area measures 81cm*81cm*61cm, test section area measures 30cm*30cm*61cm and divergent section measures 43cm*43cm*122cm. Divergent section is equipped with exhaust fan for suction purpose.

KEYWORDS: Open Circuit Low Speed Wind Tunnel, Test Section, Exhaust Fan.

I. INTRODUCTION:

Wind tunnel is an instrument to study the flow around the body and calculate forces and pressure values which are acting on the model which is placed in the test section of low speed wind tunnel. It is a basic instrument to analyse drag characteristics and separation of boundary layer over the model or object which is placed in the test section of wind tunnel.

Wind tunnels are categorized into two types viz. Open circuit and Closed circuit.

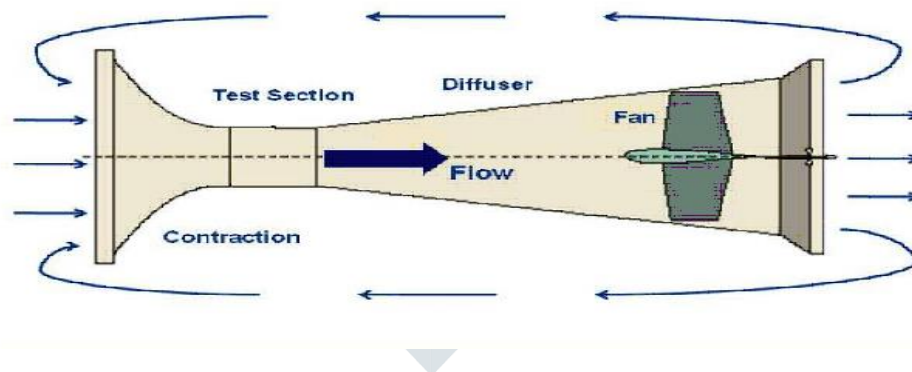


Fig.1: Open circuit wind tunnel

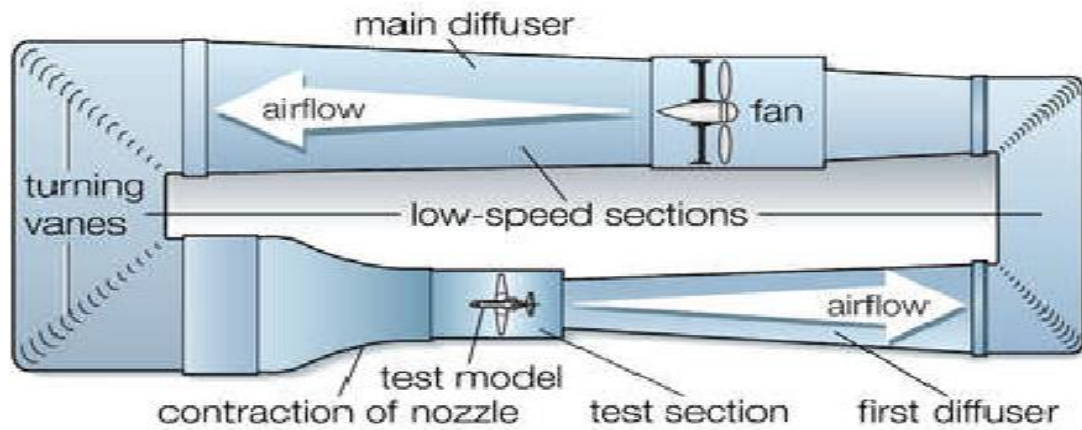


Fig.2: Closed Circuit Wind tunnel

The concept of wind tunnel was firstly introduced by Leonardo Da Vinci about 400 years ago when he realized that air flow around the object was same as that of the object moving through the air. The first wind tunnel was constructed by Francis Wenham in Great Britain in 1871. After Great Britain wind tunnel was developed by many countries like Austria, Russia, U.S.A., etc.

II. LITERATURE SURVEY:

Francis Herbert Wenham a member of council of aeronautical society of Great Britain discovered the idea of design and development of first enclosed wind tunnel. Further, wind tunnel testing was applied to automobile models, to examine aerodynamic forces as well as other ways to reduce power required to move the automobile on roads. In 1960, at Washington Navy Yard, a large wind tunnel was built with an inlet of 11 feet in diameter and discharge of 7 feet in diameter.

Osbourne Reynolds from the university of Manchester examined the stream line flow over a same model, that will be similar for the full-scale vehicle, if the required flow constraint is similar in both the cases. This parameter is known as Reynolds number which is the basic constraint in describing various fluid flow situations, like the shape of stream line flow patterns and the ease with which heat is getting diffused. This makes the basic scientific solution for the use of small-scale models in wind tunnels to analyze real life phenomena

Pankhurst and Holder had justified the concept of relative motion, "It has been shown that the stream line flow pattern around the body is dependent on the relative motion and it is equivalent if the body is moving through a fluid at rest or even if it is in stationary relative to the moving stream" This statement of relative motion was the integral part of wind tunnel testing as it describes that in order to test the aerodynamic parameters of the model, the model does not have to move in the air, instead the air may be moved around the model. Since the test parameters could be adjusted using a wind tunnel, test operators can increase and adopt some new design to simulate the yawing and driving conditions.

Wilbur Wright and Orville Wright made their first attempt to build first flying machine in August 1899 with unpowered manned glider. The glider with due course of time generated less lift compared to the drag force that was larger in number. A normal experiment using natural winds was carried out to compare the relative lift force of flat and cambered profile. However, after the experimental work they came to a point that without generating well equipped wind tunnel they could not further carry on their work. Hence, they generated a wind tunnel in a real sense which can be used for obtaining flight.

III. METHODOLOGY:

Following are the components of the wind tunnel:

Convergent Section:

Convergent section located in front of testing section and is used to improved air flow speed in testing section as well as to change the consistency in the non-uniformity of air flow. It has a dimension of 81cm*81cm*61cm. As the power loss occurs when air travels from convergent section to honeycomb therefore the convergent section wall should be straight without any curve in order to achieve the balance between size test section and contraction ratio.

Honey-comb Structure:

The honey-comb structure is columnar or hexagonal in shape. The dimension of honeycomb structure is 30cm*30cm*10cm. It is situated in between converging cone and testing section and is used to improve the uniformity in the air flow.

Testing Section:

Testing section is visible section. The shape and size of the testing section depends on testing object requirements. It has a dimension of 30cm*30cm*61cm. The testing section should be long so that air flow disturbance caused by contraction section should be dampened before reaching the test object should not be too large because it may cause boundary layer separation in diffusing section and can eventually lead to power loss.

Diffusing Section:

Placed at the exit of the testing section through which the air exists. Dimension of diffusing section is 43cm*43cm*122cm. It gradually expands along its length, allowing air fluid pressure to increase up to the outside atmospheric pressure while decreasing fluid flow velocity. Diffusing angle greater than 5 degrees can cause increase in air flow pressure which eventually leads to boundary layer separation.

Exhaust Fan:

Situated in diffusing section. Consists of one or multiple fans utilized to move air flow past the object. The diffuser section consists of fan with a regulator to control the flow speed of the air.

Wind tunnel testing is applied to aerodynamic study of automobiles to determine different methods to reduce the power required to move the vehicle. Wind tunnels for wind turbine testing as well as its mechanical aspects are important. Many issues such as anemometer selection, exhaust fan and their placement involve electrical and instrumentation engineering with precision.

IV. EXPERIMENTAL SETUP:

The wind tunnel having close tubular passage with an object placed in the middle of test section for visual inspection. The diffuser section which consists of powerful fan system with one or multiple fans moves air past the object. Generally, wind tunnels comprised of a convergent section, a test section having honeycomb structure, a diffuser section with exhaust fan.



Fig.3: Actual Setup

V. CONCLUSION:

It is evident from the above literature survey that only some developed countries have wind tunnels as they have very high cost associated with them. This has limited the research and development in the Automobile related fields. Also, research activities cannot be carried out at college level since the Institutes cannot afford such costly equipment. So, all the research and development work is done in Industries. As computer modelling is economical and less time consuming compared to building and testing models on wind tunnel, therefore many organizations are switching to computer modelling. This paper thus evaluates the basics of wind tunnel and the need for its cost-effective construction.

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