Experiment- 1

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FLOW VISUALIZATION IN FLUID DYNAMICS

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04 November,2022

1. Aim:

- To understand the flow of air around different bodies.

2. Apparatus:

- Flow visualisation wind tunnel
- Smoke generators :- To generate smoke required to view the flow.
- Models :- Different models for us to visualise the flow.

3. Theory:

3.1 Streamlines:

Streamlines are a family of curves whose tangent vectors constitute the velocity vector field of the flow. These show the direction in which a massless fluid element will travel at any point in time.

Figure 1: Caption

3.2 Pathlines:

Pathlines are the trajectories that are followed by individual fluid particles.They are also known as recordings of the path of a fluid element in a flow over a period.

3.3 Streaklines:

Streaklines are the loci of points of all fluid particles which have passed through a particular path. An agent inducted in a fluid will create a streakline. In a steady flow, all of the 3 lines will superimpose each other and will appear the same.

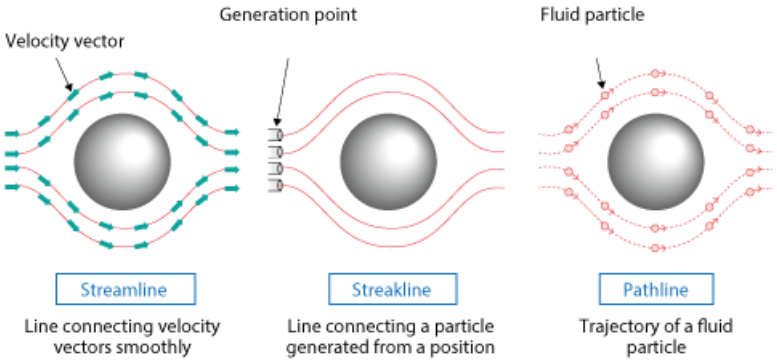

Figure 2: Different types of lines

4. Procedure:

- Fix the object in the test-section.
- Release the smoke.
- Release the CO2.
- Observe the flow across the object.
- Stop the smoke and CO2 release.
- Remove the object and place the next one.
- Repeat the steps for an airfoil, a cylinder and a car model.

5. Inference:

When a Body moves in a fluid, It created a region of turbulent flow behind it. It is known as Wake. It heavily depends on the aerodynamics of the body and also on the cross section of the body.

Figure 3: Aerodynamics of a Cylinder

5.1 Solid Cylinder:

- We can see that the area behind the solid cylinder is turbulent which is proportional to its cross section. It is indicated by the warping of the streaklines produced by the oil.
- The air flows along a streamline(we can see the velocity of the smoke in the pathline tangential to the curved formed by the smoke)close to the cylinder.

5.2 Different models of car:

- The van has a greater area of cross section as well as an un-aerodynamic body and a car with less area of cross section and more aerodynamic body.We can see that van creates a more turbulent flow as compared to the car.
- In the streamlined car,one can observe that the airflow is not forced to suddenly bend its path,unlike in the van.This causes less drag to the car which formed as a reaction force.

5.3 Airfoil (Zero angle of attack):

The airfoil is a very aerodynamic structure so the turbulent flow behind it is very low.The air flows along a streamline(we can see the velocity of the smoke in the pathline tangential to the curve formed by the smoke) close to the airfoil.

5.4 Airfoil (Non zero angle of attack):

The side which receives the attack has pretty stable air flow. But the side opposite to it has a pressure drop and thus creating a turbulent flow in that area.

Figure 4: Aerodynamics of cars

Figure 5: Straight airfoil(Zero angle of attack)

Figure 6: Slanted airfoil

6. Sources of Error:

- Human error in observation.
- Interference of external atmosphere with the airflow generated may make the airflow turbulent.

7. Conclusion

Airflow across different objects varies with object geometry, nature of the flow set up and angle of attack among various parameters.
More aerodynamic body produce less turbulence and hence less drag on the body.
We can conclude that more aerodynamic body produce less turbulence and hence less drag on the body.
This flow visualization technique gives us the means to observe the flow across objects and determine where the airflow gets detached. It is useful to make, modify and test our designs.