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Experiment 9

Flow Visualization

Group A

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Objectives

To make the student familiar with the flow patterns and to see the stream lines when different shapes of objects are inserted in the flow path.

Introduction

Generally speaking, flow visualization is an experimental method of analyzing the flow pattern over or around a body.

Since most liquids and gases are transparent materials, it is impossible to directly observe the motion of a fluid with the human eye. To show how fluids move and flow around various forms so that we can measure and see this movement, several ways are applied. One of these approaches uses hot oil, by atomizing heated mineral oil in an air stream, the oil mist is created.

The resulting "vapor," which is primarily a suspension of tiny liquid droplets, creates a "smoke" that is quite visible and has contrast qualities that make it especially useful for visual inspection. An electrically heated Pyrex vaporizing tube receives oil by gravity from an oil reservoir. The vapor is transported to a flexible smoke storage to smooth the flow and dampen density differences after being entrained in an air stream produced by a double diaphragm pump. (It additionally makes it easier to remove accumulated oil from the output tubes.) A valve next to the vaporizing tube offers precise control over smoke production.

The smoke rake that comes with the equipment receives the contents of the smoke reservoir through an outlet pipe.

Smoke circuit oscillations can be controlled with a throttle clamp. Then, we will introduce various forms into the flow channel in order to track how the flow reacts to various surfaces and identify its direction.

Stagnation point

The stagnation point is a point on the surface of a body submerged in a fluid flow where the fluid velocity is zero. The Bernoulli equation shows that the static pressure is highest when the velocity is zero. The velocity is zero at stagnation points so the pressure around the submerged body is highest at the stagnation points. This pressure is called the stagnation pressure.

The stagnation pressure is equal to the sum of the dynamic and static pressures, according to the Bernoulli equation for incompressible flow. In incompressible flows, stagnation pressure is equivalent to total pressure since total pressure is also equal to dynamic pressure + static pressure (In compressible flows, stagnation pressure is also equal to total pressure providing the fluid entering the stagnation point is brought to rest is entropically).

Discussion

The flow in this experiment is ether laminar or turbulent. We can decide which type of flow it is using Reynolds number

$$\mathrm{Re} = \frac{\rho V D}{\mu}.$$

Laminar flow is a uniform, highly ordered flow, whereas turbulent flow is a disorganized, extremely unpredictable flow. Laminar flow exists at Re 2300, but turbulent flow occurs when Re > 4000. We can see from the equation above that the velocity and the dynamic viscosity can have an impact on the flow. Because of the fluid's viscosity, a fluid particle on a solid surface will go past it at the same speed as the surface when a real fluid is present. The no-slip condition at the boundary is how this fact is typically referred to (see Figure 1). The fluid particle at the boundary will have zero velocity if the boundary is static. The fluid speed decreases as you get closer to the boundary.

When a fluid is further from a boundary, its fluid velocity progressively increases. Large shear stresses are generated at the boundary as a result. These variables may alter the type of flow we experienced in our experiment.

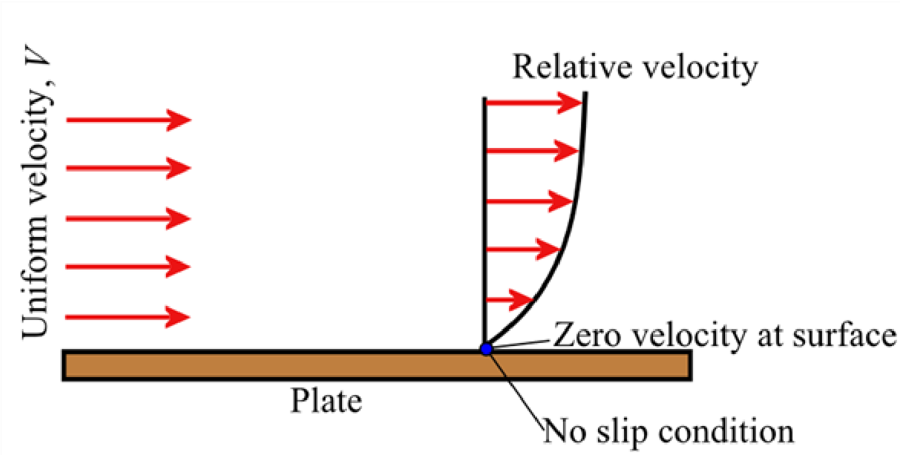

***Figure 1**:The no-slip condition*

These factors will cause changes in the streamline, which is tangent to the velocity vector, by creating forces in the flow and between the flow and the body's boundary.

Conclusion

In this experiment, we examine the flow of fluids and find that the key factor influencing the flow is viscosity, which is dependent on the sheer stress that the body's boundary can produce. Additionally, the no-slip condition may have an impact on the fluid's velocity. These elements may influence the flow type (laminar or turbulent). Additionally, we learn that a body with a 0 degree can produce a smooth laminar flow and can lessen the forces between the fluid (in this example, air) and the body. A body at a 30-degree angle can produce laminar flow on one side and turbulent flow on the other. A 90-degree body will finally change the flow from laminar to a turbulent flow.

Application

The sea buckthorn plant has a flexible dam that makes use of the principles of fluid dynamics that the pressure head going through the spaces between the main branches of sea buckthorn creates a drag reduced flow formed by flow obstacle preventing water, flow rate reduction and silt settlement caused by flood sediment retardation, and flow rate reduction caused by flood sediment accumulation. When sea buckthorn is planted in a valley between mountains, the silt that the flood brings will be held in the upper or middle reaches of the sea buckthorn cluster, controlling water and soil loss of gullies and intercepting silt.