Lab report: Fluid Visualization

Abstract

Visualization of fluid flow is one of the most crucial experiments to understand the general patterns of fluid flow when it collides with several other objectives. We use the scientific model to predict mechanical data of fluid flow, such as force and velocity. Drag force is one of the experience forces. The drag force is the summation of friction drag and pressure drag where the direction of these forces is parallel to the flow. In a lift, force helps find an optimal amount of lift force related to Bernoulli's principle.

Introduction

For an open channel, the passage of the fluids leaves the upper part more exposed while the velocity distribution is straight. The velocity reduces while approaching the sides and bases of the fluids due to more friction. The velocity of the flow is maximum at the topmost point where the vertical centerline is but due to the effect of surface tension and friction resistance from the air. The velocity is reduced at the free fluid surface. The vertical velocity is the velocity measured along a vertical line on the channel cross-section.

The Reynold number is the ratio of the inertial forces to the viscous forces acting in any flow phenomena. It helps predict if the flow is laminar or turbulent and find the friction coefficient to determine the frictional loss of head accurately. The Reynold number has much application. It provides engineers with timely information about the flow state, helping to solve the problem at hand. It is also used in dimension analysis and similitude.

For lamina flow, the liquid moves in layers, which occurs when the velocity of the flow is small and viscous forces are predominant. for the case of streamline flow velocity at a point that is constant in magnitude and direction and turbulent flow, the velocity reaches a maximum in a specific point on the fluid, meaning the magnitude of the velocity varies with time

On the concept of the body layers, when a specific fluid passes past a solid. the fluid particles on the surface will have the velocity of the surface because of the viscosity of the fluid

Objectives

The purpose of this experiment is to finger the instability of an interface between two fluids of different density, which occurs when the lighter fluid is pushing the heavy fluid, and attempt to understand these phenomena qualitatively

Experiment and discussion

The demonstration was set at a room temperature of 25 degrees. On the top of the light wooden table, I placed a clear and visible 100ml beaker above a white tile, and I also put a white tile behind the beaker. This was to help me to see the motion of the fluid motion. I placed a black tea to a level of 50 ml; I then poured a yellow yoghurt into the black tea slowly and steadily while observing the behavior of the two fluids. The yellow yoghurt was observed flowing to the bottom of the beaker with constant acceleration. After reaching the bottom, it started spreading out with constant acceleration till it was uniformly mixed with the black tea. The observed flow is due to the force of gravity and the acceleration of the yoghurt particles due to gravitational pull and differences in both fluids. In science, this behavior observed is due to the Rayleigh-Taylor instability, where gravity forces the poured fluid to find stability. The image was taken at a frequency of every 4 seconds.

Now assuming that the viscosity of the liquid is the same as the standard water, we can approximate thus

Re=ud/v= (0.42*0.13)/100*^-6=500

I used the cooked black tea of density 1.1mole/ml and a brown yogurt of density 5mole/ml, and the pictures were taken in the daytime. I wanted to view it from the aerial. Sideways, I set the camera 2 m above the table and 3 m away from the beaker. This enabled me to capture a wide field of view. The lenses of both cameras had a diameter of 60mm, and the small distance was favored. I later changed the camera and used the iPhone 11 pro max camera, which got the accurate focus of image 4500by 3000. the image was not cropped but was located to get a clear image. The image can quantitively explain the Rayleigh –Taylor instability of fluids. The visibility can be increased by using a camera of large diameter and good lighting to increase the field of view. The lower part of the beaker was not captured in the camera, hence difficult to fully explain the effect qualitatively.

Conclusion

The boundary layer is visible, and the flow is around the object. In the separation point, the boundary is retarded due to an adverse pressure gradient. The emerged body experiences both drag and lift forces. The liquid flows in the upper point of the material undisturbed due to gravity, and this is the Rayleigh-Taylor effect

References

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