Flow Visualization

Fall 2019

Team Third Report

Saud Alobaidan

12/14/19

For this final team assignment, Austin Ramirez, Jon Cohen, Julian Cruz and I decided to make an image of a colored water being injected into a glass having corn syrup. Our team's purpose initially was to demonstrate an interesting fluid phenomenon. We had different ideas where we wanted to use various of liquids with different densities. Ultimately, we decided to stick with water and corn syrup because it was easier and convenient for our team. For the remaining of the report, we will examine the physics behind the experiment, the setup of the experiment, the camera features, and conclusion.

The Rayleigh-Taylor instability takes place when colored water pushes it way through a corn syrup. This is because corn syrup is considerably denser than colored water and therefore offers greater resistance to the mixing of the colored water. Moreover, at the junction of mixing both the fluids attempt to reduce their total potential energy. When the mixed color water fluid is introduced to the corn syrup it can be observed that the blue color is the first one to push through and form a dominant vertical column compared to the other colors such as the green and red colors which appear in water mix as observed in the picture below in figure 1. This is because blue weighs more than red and green color as it weighs more so it makes a vertical column and begins to sink to the bottom. The blue color is followed by green and red colors; eventually, all the colors will stack themselves one on top the other such that the heavier i.e. denser is at the bottom and the lightest color water mix is at the top. Hence, the corn syrup will be at the bottom, the blue water mix will be on it, the green color will rest on blue color water mix and the red color will be at the top. Each color will enter in a vertical channel and its density will govern the respective width of channel. The principles of laws of conservation of energy, linear stability theory and self-similarity conditions are followed during this process of Rayleigh-Taylor instability. The formation of vertical column and grain size perturbation will depend on the rate of diffusion, viscosity, surface tension and compressibility of each fluid (Cook & Youngs). Whereas, in some case an idealized condition of self-similarity is achieved in which both the fluid forget their original forms and attain self-similar growth stage. Figure 1 below shows the picture without the final editing.

Figure 1. Team Third Image Without Editing

In terms of the setup of the experiment, we used three glasses of water, and we added into each glass a different color dye (food coloring), like blue, red and green. We used a big glass filled with corn syrup. Another important item that we used was pipettes. Lastly, we used a white background for the image to be clear and to avoid distractions.

Canon EOS Rebel T6 from the camera maker Canon was used to capture the image as it was under manual mode with an aperture of F/5, a shutter speed of 1/320 sec, a focal length of 37 mm, and an ISO setting of 6400. The use of a flash was not necessary during the time. The distance between the camera and the desired object was approximately about 7 inches. The pixel dimension for the image was 5184 x 3456 and reduced to 790 x 812. The image was edited using Gimp as a photo editor. It was used because I wanted the picture to be cropped and adjusted in exposure and saturation. Figure 2 displayed below illustrates the original image after the editing using Gimp.

Figure 2. Team Third Final Image

All in all, the image we captured as a group shows an important aspect of fluid flow. A statement of meaning for the image is it reminds me of an alien or a creature forming. What I love about the image is the editing, I think I did a great job zooming into the flow as it shows and gives a whole different flow perspective as the flow is enjoyable. What I wish I could change is having one food coloring instead of three because in my opinion, the image is a little crowded with all the colors flowing around, but that gave a whole other different view when having all three colors. Overall, the image is amazing to observe.

References

Cook, A. W., & Youngs, D. (n.d.). Rayleigh-Taylor Instability and Mixing. Retrieved December 14, 2019, from http://www.scholarpedia.org/article/Rayleigh-Taylor_instability_and_mixing.