Get Wet Image Report

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Purpose

The purpose of the get wet assignment was to learn the basics of flow visualization, explore fluid in both a physical form and an art form, and to capture the beauty of a fluid image. Because fluid accounts for the majority of substances in the world, the assignment was very open ended and offered a lot of room for creativity. I had very limited resources, which lead me to experiment with household items. I have always been very intrigued with fluid at the micro scale, so I knew I was interested in capturing a close up image of a fluid phenomenon.

For my image, I chose to experiment with water and oil because oil is such a unique fluid that is essential in many aspects of daily life. The way oil behaved when mixing with water was very interesting, as the different densities collided and the oil shot to the surface of the water, forming very distinct bubbles. This experiment provided both a beautiful image, as well as a demonstration of the physics behind nucleation and surface tension.

Physical Phenomenon

The formation of bubbles is due to a phenomenon known as nucleation. Nucleation is the process in which ions, atoms, or molecules arrange in a crystalline solid pattern, forming a site in which additional particles deposit as the crystal grows. Bubbles generally keep their shape as they rise to the surface of the immersive fluid and are kept in tact due to surface tension. Surface tension provides pressure at the surface of the fluid and the tendency for the immersive fluid to minimize the tension creates the spherical shape of the bubble. The shape is maintained by a pressure difference between the inside and the outside of the bubble, which is determined by the following equation:

$$P_i - P_o = \frac{4T}{r}$$

Where

P_i is the internal pressure inside the bubble
P_o is the external pressure applied to the outside of the bubble
r is the radius of the spherical bubble
T is the force of the surface tension acting on the fluid

Because the bubble was contained in a pot that was open to the atmosphere, P_o becomes the atmospheric pressure.

Visualization Technique

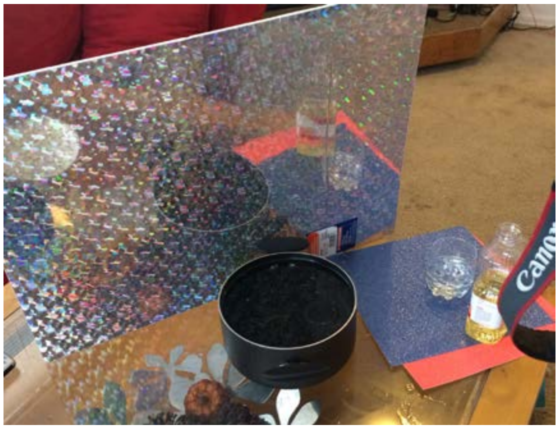

Figure 1: Experimental Apparatus

The test set up, as seen in figure 1 above, consisted of the following list of materials:

- Medium sized aluminum pot
- Water
- Cooking oil
- Colored and glittered poster board

The pot was filled to the top with water and a blue, glittery poster board was placed behind the pot in order to reflect the color in the fluid when the image was captured. I had a volunteer slowly pour in the oil into the pot of water, in attempt for me to capture the formation of the bubbles created as the oil rushed to the surface of the water. The lighting in the room was due to natural sunlight coming from a large window in my apartment.

Photographic Technique

In order to capture fluid physics at a close up scale, the macro setting on my Canon EOS 20D camera was used with an F-number of 5.6, an ISO of 400, and a focal length of 53. The camera was held only inches from the surface of the water. It was very difficult to achieve a full resolution photo that was in focus. In order to accomplish a focused image, the shutter speed used had to be high. The speed of the oil dropping into the water is determined from the following equation:

$$V = \sqrt{2gh} = \sqrt{2 * 32.2\frac{ft}{s} * 0.5ft} = 5.67\frac{ft}{s}$$

Where

g is the acceleration of gravity
h is the height at which the fluid was dropped

If the fluid is moving at this velocity, and I approximate the image being in focus at $\frac{1}{10th}$ of its size with the shutter open, the shutter speed should approximately be:

$$\frac{1s}{5.67ft} * \frac{1ft}{12in} * \frac{1in}{10} = 0.0015s$$

This is an extremely fast shutter speed. The shutter speed used, based on the capabilities of my camera, was 0.016 seconds ($\frac{1}{60}s$), over ten times larger than the theoretical shutter speed needed. Based on the high resolution of my image, I found that the shutter speed used was sufficient. There was a small amount of motion blur toward the front of the image, however it was not enough to deplete the beauty of the photograph.

Conclusion

There wasn't a large amount of editing done to the original image. I increased the contrast to sharpen and define the boundaries of the bubbles and I also changed the tint of the image to get a darker blue effect. The original image was 2713 x 1829 pixels. I cropped the original image in order to shift the central focus of the photo to be some of the smaller bubbles that are in really good focus. One of my favorite features of my photo is the visibility of the small bubbles through the center of the larger bubble on the left side of the photo. This adds a unique aspect because it is visually appealing and also provides a more intriguing demonstration of the physics of nucleation. In the future, I would repeat this experiment taking more time for the set up of the image. I would have liked to have a cleaner, darker surface to place the water and oil in because some of the defects of the pot I was using are visible in my image. Overall, I am very pleased with the result of the get wet experiment.

Figure 2: Original Image

Works Referenced

[1] http://hyperphysics.phy-astr.gsu.edu/hbase/surten2.html
[2] http://en.wikipedia.org/wiki/Nucleation