Team Second 2015

MCEN4151

University of Colorado
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11/13/15

This image is a submission for the second team assignment in MCEN4151 Flow Visualization at the University of Colorado, Boulder. The intent of this attempt was to capture the formation of large bubbles. The image considered in this report shows a soap film bubble with fog inside of it. The following report describes the physics regarding the formation of bubbles as well as how fog machines create the fog captured in this image. This report also describes how the experiment was set up, the camera settings, as well as the techniques used to capture this flow.

Fog machines are used in many applications. Theatre productions, party decorations, and as with this case, photography experiments. These are just a few applications of fog machines. The fog machine uses a mixture of propylene glycol, triethylene glycol, and water.[2] The machine heats the mixture to create smoke. A fan within the machine then blows the smoke into the surrounding atmosphere. We put the soap film directly in front of the fog machine. This allowed for the bubble to fill with fog as it formed. The fog machine was used in this setup because it allowed for a better image to be captured in that light was able to reflect off of the fog particles and allowed the camera to focus on the subject of the photo. The fog also allowed for the image to have a nice contrast between the whites of the fog and the darkness of the background. Without the fog the distracting background was visible through the soap film bubble.

The pressure within the bubble relies on the following equation:

Equation (1):

$$P_i - P_o = 4T/R$$

Where P_i is the pressure inside the bubble, P_o is the pressure outside the bubble (atmospheric pressure ~ 100,000 Pa), T is the surface tension of the soap film bubble (approximately 0.025 N/m for a soapy water), and R is the approximate radius of the bubble (0.33m).[3,1] Plugging these values in shows that the pressure inside the bubble is 100,000.3 Pa. This says that the pressure within the bubble is virtually equal to atmospheric pressure. This makes sense because if the pressure difference were substantial and positive the bubble radius would increase. If the pressure difference were negative the bubble radius would decrease. This would occur because the soap film would react to a pressure gradient to keep the system at its lowest energy state. During the life of the bubble, the radius remained approximately the same, which agrees with the minuscule pressure difference between the inner pressure and outer pressure of the system.

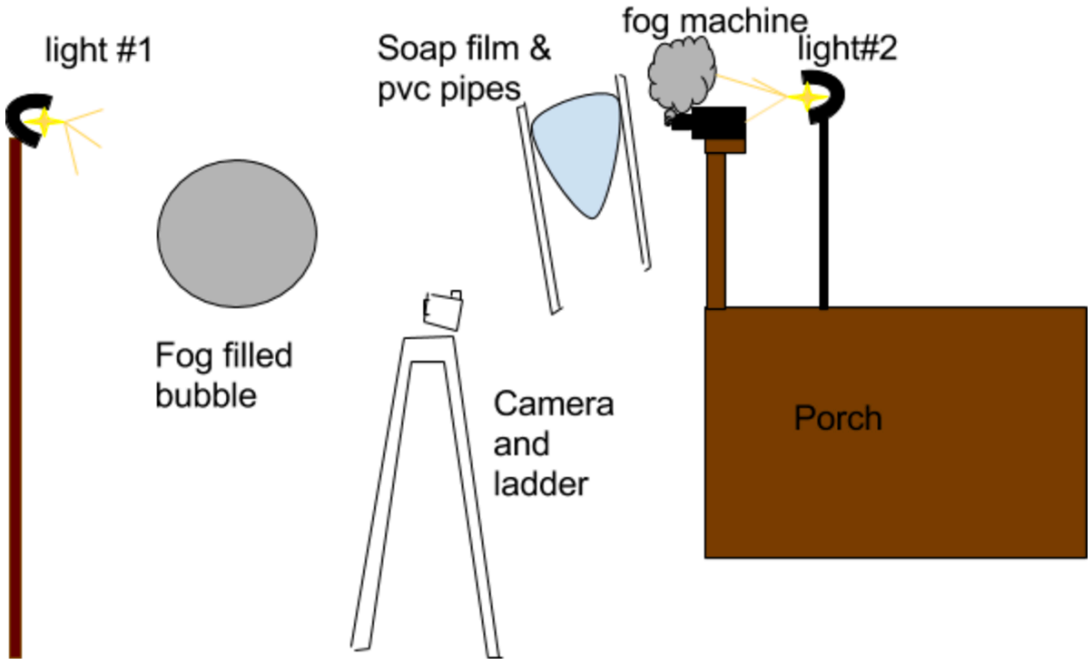

Figure 1: Setup

The image was taken at night. This said, light was at a premium when the image was captured. Two floodlights were used in the set up of this image: the first was above and to the left of the bubble in the moment this frame was captured. The second was to the right of the frame pointing in the direction of the motion of the bubble. Both lights are depicted in Figure 1. The ITLL at the University of Colorado was a great resource in collecting items necessary for this experiment. Two PVC pipes and a cotton rope were used to create the soap film suspension device. The rope was tied into a half ellipse shape with each end tied to an end of one of the PVC pipes. The solution was a mix of 12 cups of water, 1 cup of cornstarch, 1 cup of dish liquid, and 2 tablespoons of baking powder.[4] The forum instructions also called for a few ounces of lubricant containing glycerin. This aids in the stability of the bubble. Approximately ½ cup of sugar was used instead of glycerin.

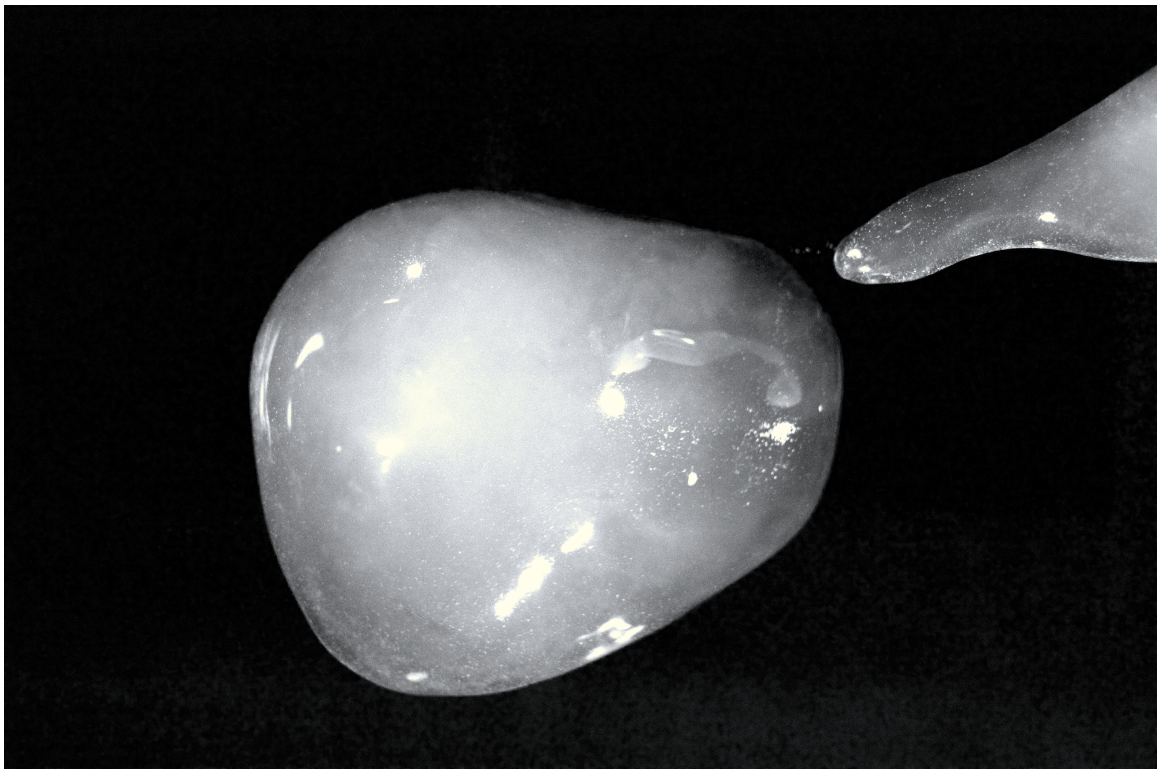

Figure 2: Final Photograph

The smoke machine was filled with the recommended solution level and allowed to heat up before producing smoke. The setup was created on my back porch. The temperature outside was approximately 65˚ F.

The lens used is a Nikon 50mm manual lens accompanied with an aps-c sensor. The camera used is a Nikon D5100. This is a DSLR camera. The height and width of the picture is 4918 x 3264 pixels. The exposure specs are as follows: aperture 1.4 2 split, ISO 800, shutter speed 1/800. Photoshop was used to manipulate the photo. The only edits done to produce this image were increased contrast and decreased saturation.

I like the contrast in this photo. The background of the picture is very black while the light reflecting off the fog within the soap film as well as the soap film itself is very white. I like too that the bubble on the right of the frame is very in focus. The main bubble broke away from the bubble on the right and the photo gives the feel that the main subject is escaping. The flow physics was captured very well in this photo and allowed for a scientific discussion. I like that the bubbles is directly in the center of the photo.

One aspect of this photo that I do not like is that the main bubble is not as in focus as the bubble on the right. I would like to have captured everything in focus. The lens I was using has a 2mm focal range. This means any adjustment at all significantly changed the focus. In conclusion I learned a lot about imaging bubbles. An automatic focusing lens may have been helpful. In future images I will consider using different equipment. I would also like to capture an image of a large bubble in daylight. My next experiment will incorporate some of those things mentioned above.

Works Cited

1. Beat, Andrew. *Team 2 Report*. University of Colorado, Boulder, 2011. Web. 15 Nov. 2015.

2. Brain, Marshall. “Entertainment: How Stuff Works.” Web. 15 Nov. 2015.

3. “Hyperphysics.” Web. 15 Nov. 2015.

4. Tackett, D. “Huge Bubble Maker.” *instructables*. Web. 11 Nov. 2015.