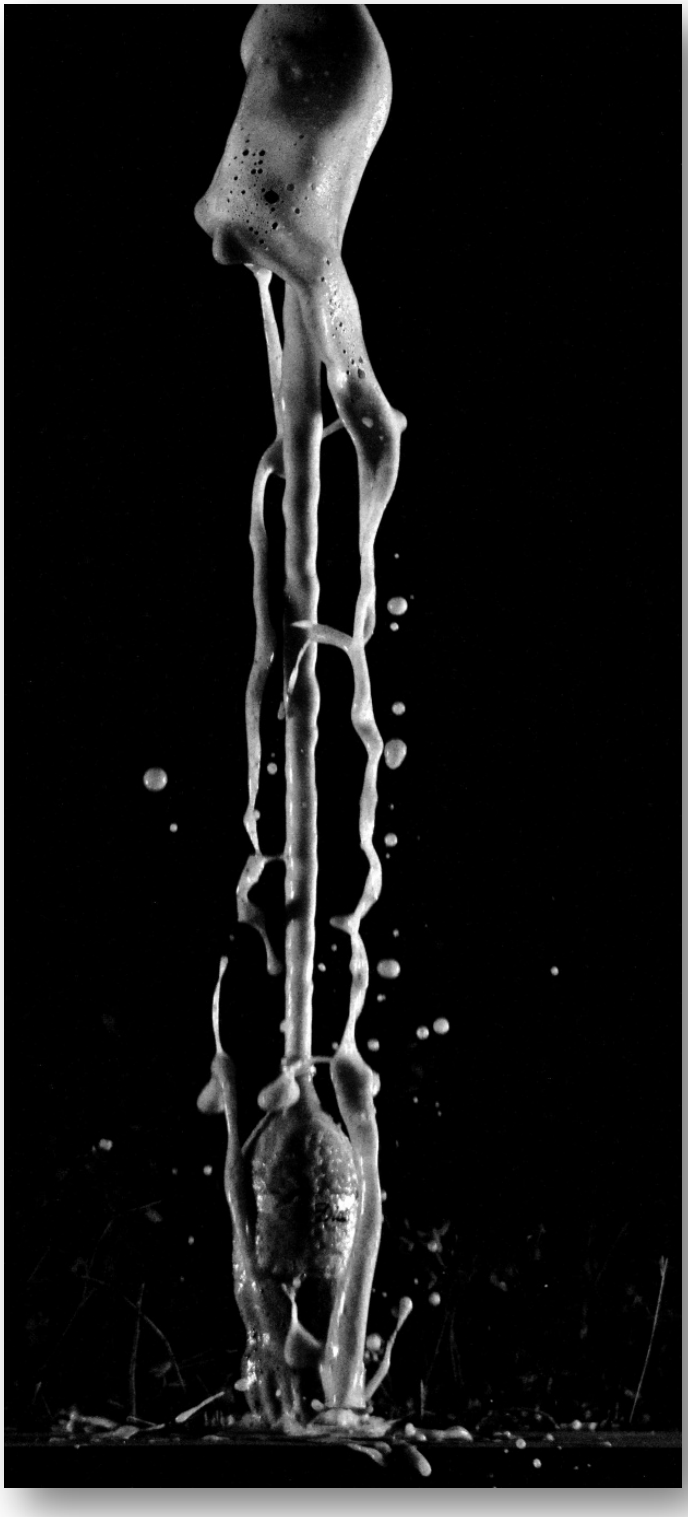
MCEN 4151: Flow Visualization



Mentos and Coke

Second Team Image

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The fourth assignment for the Flow Visualization course is the second team image. For this assignment, each student is expected to work in their groups of five to take a photo of a fluids phenomenon that both demonstrates the situation and is artistically sound, just as was expected for the first team image. This is similar to the first "Get Wet" assignment except that by working in groups, the students are expected to put their resources and expertise together to create even more brilliant images than were done initially. My group chose to work with candy, Mentos, and soda, Diet Coke, which when combined creates an explosion out of the top of soda bottle. Through multiple trials, this resulting fountain of soda was captured.

This experiment used three 2-liter bottles of Diet Coke and a packet of Mint Mentos. The experiment was repeated three times, with more Mentos being added each time. For each experiment, a bottle of Diet Coke was set on the ground, the Mentos were dropped into the bottle from directly above the lid by a person who then ran away from the bottle, and the bottle was left on the ground until all reactions were finished. Two work lights were used to light the scene, and these lights were pointed directly at the bottle of Diet Coke. This set up can be seen in Figure 1.

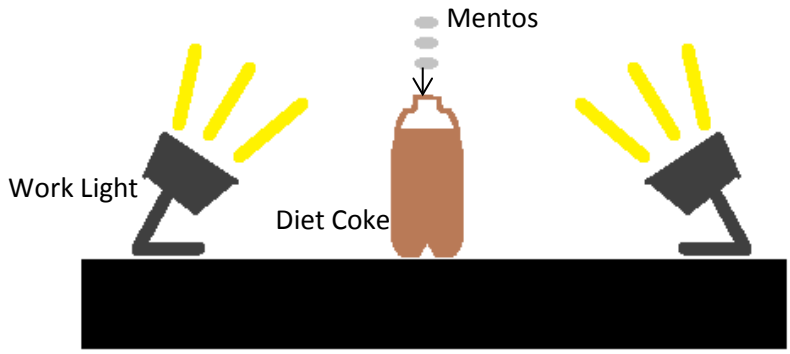

Figure 1: Mentos and Coke Set-Up

The final image used was taken during the second experiment, where three Mentos were used. It was quickly noticed that as more Mentos were used, the explosion of Diet Coke occurred more rapidly, and the explosion was larger. The final image is also at the point when the fountain was near its maximum height.

Although one might think that this fountain of soda is created by some sort of chemical reaction, as there are many chemicals in Diet Coke, it is actually due to a physical reaction of the addition of nucleation sites from the Mentos and the super saturation of the Diet Coke with carbon dioxide.[1] The mint Mentos were chosen especially due to the fact that they are uncoated and the surface is very rough. The roughness of the surface of the Mentos is what allows the nucleation, which causes the carbon dioxide to be released very quickly. The fruit Mentos, which are also sold, are coated which makes that candy smoother, so there are less nucleation sites, so the reaction would not be as explosive. The Diet Coke was also chosen very specifically due to its chemical makeup. Although the fountains are not due to a chemical reaction, the chemicals in the soda allow the carbon dioxide to be

released more quickly. This is largely due to the aspartame, or sugar substitute in Diet Coke, which reduces the work to form bubbles as compared to regular Coke, which contains corn syrup.[2]

As the Mentos fall down through the soda, more and more carbon dioxide bubbles grow in the nucleation sites of the Mentos and are released. The soda is supersaturated with carbon dioxide, so this initial release causes more carbon dioxide to be released. This all happens very quickly and comes with an increase in pressure, so all of the carbon dioxide bubbles are forces out very quickly through the lid of the bottle, which causes the fountain to grow very tall. This is why dropping multiple Mentos caused a larger fountain than a single Mentos.

Figure 2: Sequential shots

Knowing that a 2 liter bottle is approximately 1 foot tall, the height of the coke fountain can be estimated to be 3 feet by looking at the picture. I can also determine the approximate speed at which bulk of the fountain travels upwards by comparing two sequential pictures of the fountain. These two sequential pictures are shown in Figure 2. Again, knowing the height of the bottle, 1 foot, the change in height of the fountain between the two frames is about 1 foot. The camera was in burst mode and raw capture when the photo was taken, with a Canon Rebel T2i, which can capture photos at a rate of 3.7 frames per second. Assuming the camera was taking the pictures at its maximum speed, than the fountain traveled 1 foot in 3.7 seconds, or was traveling at an average velocity of 0.27 feet/second.

The Reynolds number can be found for this velocity using Equation 1.

$$Re = \rho u L / v \qquad \text{Eq } 1^{3}$$

By using the diameter of the bottle lid, L=0.083ft, and constants for the liquid, ρ = 1g/cm^3 and v = 9.58x10^-6 ft^2/s, and the value for velocity found earlier of u=0.27 ft/s. This gives a Reynolds number of 2339. This means that the flow is turbulent as it is coming out of the water.

This picture is spatially resolved, which can be seen by comparing the magnitude of the flow to the magnitude of the photo. The smallest point of interest in the photo is the small separated bits of soda, which can be seen around the main flow. These are estimated to be around 1/4 in. The largest part of the flow is all that is included in the frame. This is estimated to be approximately 4 feet on the long side. Comparing these two figures, there is a separation of 3 decades. The picture is approximately 5000 pixels in size, which is equivalent to 3 decades. As the flow requires 3 decades to be spatially

resolved, and the picture has 3 decades of information, the photo is spatially resolved. This means that all parts of the photo pertinent to understanding the flow in the picture can be seen.

The visualization technique used here is the fountain of soda. The flume was lit in two directions by work lights on either side of the soda bottle as shown in Figure 1. This photo was taken at night outside, so there was very little ambient light. The background was simply a hill covered in debris, and as this was not desired to be shown in the photo, the lights were pointed so that the hill was not lit, leaving the background black. The work lights were also far enough back that they would not be splashed with falling soda, but still close so as to provide as much light as possible.

The size of the field of view was 4 feet by 2 feet, which was large enough to include the entire flow. The bottle was approximately 10 feet from the camera lens. The camera settings were defined by the shutter speed and ISO, which were set in such a way as to freeze the motion of the fountain, while keeping the picture bright enough to capture the details. The camera specifications and settings are shown in Table 1.

Table 1: Camera Specs and Settings

Camera Body	Canon Rebel T2i
Lens Focal Length	75mm
Aperture	6
Shutter Speed	1/640
ISO	800

The photo was digitally altered in Photoshop. The brightness and contrast were increased to bring out the detail in the flow. The picture was changed to black and white, as the brown color of the soda did not add anything to the photo. The picture was cropped to bring the focus to the soda fountain. The initial pixel size of the photo was 3456 x 5184, and the final pixel size of the photo after cropping is 2285 x 4997.

I feel that this image reveals the complex way in which a fluid fountain will move vertically into the air, and the beauty which can result from the oddest combinations, which in this case are Diet Coke and Mentos. I like that the image freezes the motion almost completely, but I dislike that the top of the fountain was cut off. If I were to improve the image, I would use a wider angle lens, so that I could capture the entirety of the fountain.

References

[1]Senese, Fred. "Why Do Mentos Mints Foam When You Drop Them into Soda Pop?" General Chemistry Online, 1997. Web. 3 Apr. 2012.

[2] Coffey, Tonya S. "Diet Coke and Mentos: What Is Really behind the Physical Reaction?" *American Journal of Physics* 76.6 (2008): 551-58. Print.

[3]"Reynolds Number." *Reynolds Number*. Engineering Toolbox. Web. 07 May 2012. <http://www.engineeringtoolbox.com/reynolds-number-d_237.html>.