Diet Coke and Mentos Eruption

Colin Stewart
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INTRODUCTION

The intent of this photographic experiment was to image an interesting fluid phenomenon that was worth photographing. The submitted photograph was the fourth image assignment called "Team Assignment 2" for a class called Flow Visualization. Specifically, the objective of this particular image was to capture the movement of a reaction of Diet Coke and Mentos. The Mentos used here are the original flavor and they were dropped into a two-liter bottle of soda. The main driving force of this phenomenon is the formation of carbon dioxide and subsequent pressure build-up within the soda bottle. As the pressure builds the fluids and gas above it are forced out of the small opening of the two-liter bottle. The mouth acts as a jet shooting the fluid into the air. Many different phenomena could have been photographed for this second team image; it was the task of the photographer to create a flow worth submitting. The idea for this image came from seeing the phenomena shown in class. After being tasked with creating a team image this explosion immediately came to mind.

FLOW APPARATUS

Creating this flow was very easy. A normal two-liter bottle of Diet Coke was used with four Mentos. The number of Mentos inserted into the soda changed on each run of the apparatus. Starting with three Mentos the team worked their way up to using five Mentos. The difference was apparent when using more Mentos as it created a taller jet of the fluid.

The actual insertion of the Mentos into the Diet Coke was the only complicated part of the setup. It required that one of the team members dropped the candy into the soda, while keeping a safe distance to not affect the flow or the photographs. After deliberation it was decided that the Mentos would be stacked on top of one another and dropped in all at once by only one team member. This system worked well and the team members took turns being the catalyst to the reaction. An image showing this is below.

Figure 1: Team Member Inserting Mentos

The reaction followed the insertion of the Mentos almost immediately. The apparatus was located outside on a flat surface to allow the jet of fluid to rise straight up. This also meant that the fluid was allowed to fall back onto itself after reaching the maximum height.

FLOW & REACTION ANALYSES

This fluid jet is caused by a mass release of carbon dioxide within the Diet Coke. When soda is sealed it has a finite amount of carbon dioxide within it, which exits upon opening the lid [2]. This is why when you open a soda it sounds like pressure is being released. Carbon dioxide is a soluble component of the Diet Coke [4], but when it is allowed to exit bubbles form within the bottle at any impurity. These nucleation sites exist at the walls of bottles, which is why bubbles are seen on the sides of glasses containing carbonated beverages [3].

The amount of carbon dioxide that is allowed to release by the soda is extremely limited due to a lack of bubble formation sites. This hurdle is overcome when Mentos are inserted. Potassium benzoate and aspartame within the candy reduce the amount of energy required for the bubbles to form making it easier for the carbon dioxide to separate from the liquid. The most important part of inserting the Mentos however is that its rough surface provides bubble formation sites [1].

After the carbon dioxide bubbles form around the candy they rise to the top of the bottle because they are a gas and are much lighter than the dense liquid surrounding them. This collection of bubbles pushes the liquid above it up with the gas. They exit the bottle together as a frothy mixture of Diet Coke and carbon dioxide flying into the air.

The flow in this particular picture, which can be seen in the appendix, occurs just after the fluid has reached its maximum height. Judging by the height of the soda bottle, which is approximately 0.3 meters, the flow height appears to be nearly 1.05 meters from the mouth of the bottle. Some of the fluid is falling back down onto the jet causing the mushroom effect at the top. A good amount of the fluid is falling back down around the original jet, which can be seen, on the left and right side of the fluid stream. Unfortunately the blurred droplets of fluid are falling down making it difficult to tell from the photo exactly how fast the fluid is travelling upwards.

IMAGING TECHNIQUE

The Mentos and Diet Coke were purchased from a King Soopers close to campus. The photo was taken at night to allow the background to be easily removed. For this particular picture there were four Mentos inserted into the Diet Coke bottle.

The lighting used in this photograph is a strong pair of 500W work lights. They were situated opposite each other on either side of the soda bottle. They were approximately one meter away from the bottle. The photograph was taken about three meters away from the bottle, perpendicular to the line formed by the two lights. There was no flash from the camera when the photo was taken.

PHOTOGRAPHIC TECHNIQUE

As previously stated, the photo was taken from approximately three meters away and the flow is nearly 1.05 meters above the bottle mouth.

This photo was taken with a digital Nikon D3000. It provided a (3872x2592) pixel resolution that, after editing, resulted in a (437×1753) pixel resolution. The D3000 is a digital single lens reflex camera (DSLR). When the image was taken the ISO was set to 1800 due to the bright sunlight, the lens focal length to 29mm to get a wide view, shutter speed to 1s/30 for a slightly sharp image, and aperture set at f/4.5.

After importing the original raw image it was clear what the center of the picture should have been. By cropping out the sides and bottom of the picture the true subject stood out. Besides the cropping job the image was also edited to make the color of the fluid appear as though it was a chocolate mix exiting the bottle. This really brought out the definition of the fluid and gave the image the feel of chocolate milk commercial.

CONCLUSION

This image shows a great flow visualization. The reaction occurring here has swept the nation through YouTube videos and this is a great image of the phenomenon. As cliché as it is I feel as though this image tackles this event in a different way, giving a new feel to a well known reaction.

The physics of this reaction are very clearly shown. The jet rises up right in the middle of the frame and the fluid falling can be seen as well. It is obvious what is going on and where the fluid is coming from.

One question that lingers post assignment is what other factors could increase the fluid height. I am curious if the ambient heat of the atmosphere has a large affect on the fluid height as well. My main interest in this project was how fun it was to create the actual explosion. It would be really fun to make this a larger reaction with greater fluid height.

My intent for this project was not only to capture an interesting flow that showed physics at work, but also to make it look stunning. This photograph encompasses both of those goals well and I am very proud of the picture.

To improve on this image I would like to have a high-speed camera to take a high definition video of this event. This would be to really focus in on the explosion. I feel as though some of the image is clearly out of focus and a video would contribute to the understanding of this a lot. Overall I feel accomplished with this photograph.

REFERENCES

1. Coffey, Tonya Shea. "Diet Coke and Mentos: What Is Really behind This Physical Reaction?" *American Journal of Physics* 76.6 (2008): 551. Print.
2. Kagan, David. "The Shaken-Soda Syndrome." *The Physics Teacher* 39.5 (2001): 290. Print.
3. Kappes, S.M., S.J. Schmidt, and S.-Y. Lee. "Relationship between Physical Properties and Sensory Attributes of Carbonated Beverages." *Journal of Food Science* 72.1 (2007): S001-011. Print.
4. Markham, Aaron, and Kenneth A. Kobe. "The Solubility of Gases in Liquids." *Chemical Reviews* 28.3 (1941): 519-88. Print.

APPENDIX

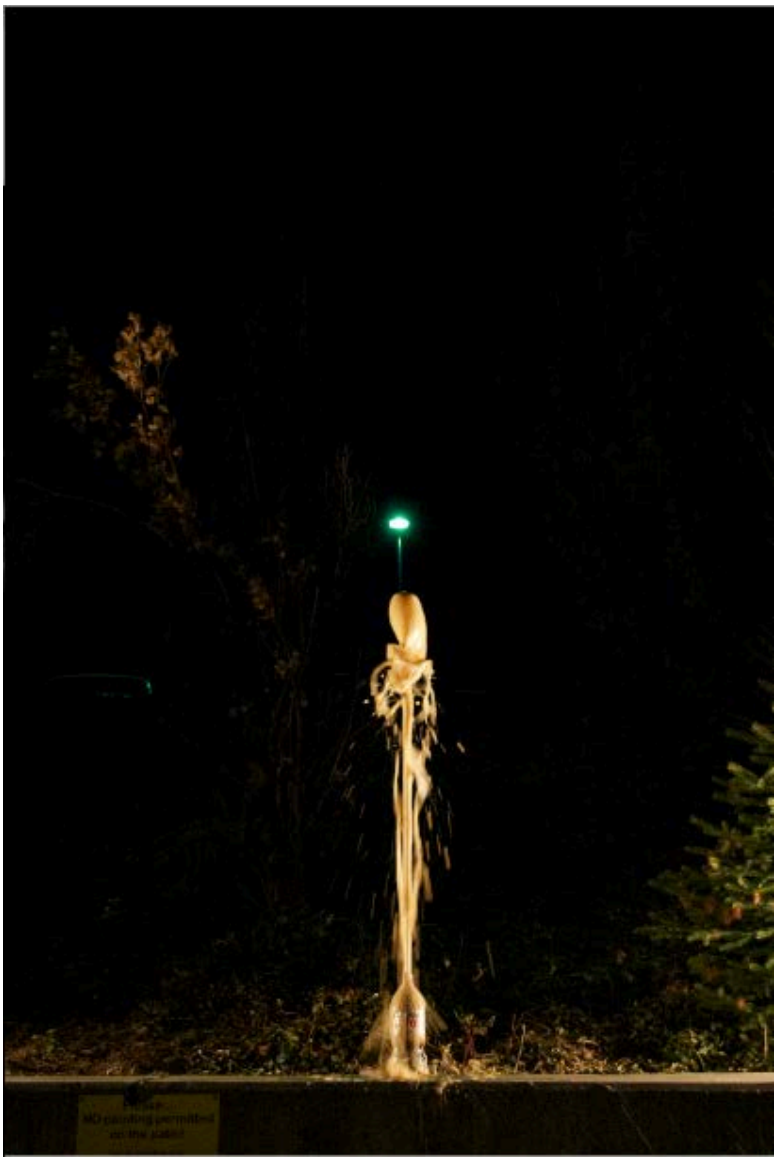

Figure A 1: Unedited Image (2592 × 3872) Pixels

Figure A 2: Edited Image (437 × 1753) Pixels