

MCEN 4151: Flow Visualization

Section 001

Team Third Report

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The Team Third Assignment gave our team the opportunity to experiment and visualize any fluid physics phenomena of our choice. Our original idea was to use *Schlieren Imaging* to capture how a flame from a lighter would distort the surrounding air. However, due to logistical reasons, half the team (Nebiyu Tadesse and I) were unable to meet up and perform the Schlieren Imaging experiment so instead we decided to run the *Black Snake Experiment*. This experiment shows how using household items such as sugar, baking soda, and fire can be mixed to create an interesting chemical reaction that produces a snake-like creature.

In order to capture this effect, Nebiyu and I gathered all the appropriate materials which are listed in **Table 1**.

Materials	Quantity
Baking Soda	1 box
Sugar	1 bag
Sand	1 bag
Zippo Lighter Fluid	1 container
Lighter	1
Ceramic Bowl	1
Solo Cup (for mixing)	1
Spoon	1

Table 1. List of materials used to create the Black Snake Experiment

In order to capture this effect, we went through the following procedure:

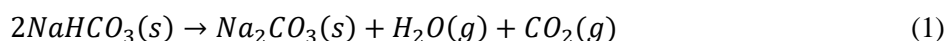
- Step 1:** Measure out 4 Tbs of sugar and place in mixing cup
- Step 2:** Measure out 1 Tbs of baking soda and place in mixing cup
- Step 3:** Fill up half of the ceramic bowl with sand
- Step 4:** Make a pit with the spoon as a place to pour the sugar and baking soda mixture
- Step 5:** Fill the pit and surrounding area with lighter fluid (not too much—just get the sand wet)
- Step 6:** Pour the sugar + baking soda mixture in the sand pit creating a mound-like structure
- Step 7:** Ignite the lighter fluid with the lighter

The experimental setup can be visualized in **Figure 1**.



Figure 1. The mound of sugar and baking soda seconds after igniting the lighter fluid

By following this procedure, we were hoping to create a large snake-like creature. As the mixture of baking soda heats up and decomposes, carbon dioxide gas is released. Carbonate and water vapor is created by the lack of oxygen in the sugar. The carbon dioxide gas pushes the carbonate out because of the innate pressure differential and in turn a black snake is formed. The chemical equation Eq(1) can be used to further understand this reaction.



We were expecting to see something similar to the black snake shown in **Figure 2**.



Figure 2. Black Snake experiment from https://www.youtube.com/watch?v=Hibxz9_ZW18

After many failed attempts at trying to achieve a black snake of such high caliber, we decided that something with our materials, procedure, or set up were incorrect. I believe the fire was not hot enough to ignite such

a reaction, but we were still able to capture a beautiful image of the fire with small remnants of miniature black snakes slowly growing. The image was taken with only the natural lighting produced by the flame at about six inches away from the bowl at a focal length of 50mm, an exposure time of 1/250s, a maximum aperture of 5, and an f-stop f/8. A Nikon d3500 DSLR camera was used to capture this 4,000 x 6,000-pixel image. I decided to take my picture up close and zoomed in to the bowl because I liked how it clearly it captured both the fire and black snake tendrils. The darkness of the background was also intentional as the flame highlights the inner wall of the bowl, but the background is very dark which creates abstract aesthetic. During the post-production phase, I used Nikon ViewNX-i photo editing software to decrease the contrast and add a color booster which helped lower the intense orange of the flame while keeping the background dark and ambiguous. The difference after post-production can be visualized in **Figure 3**.

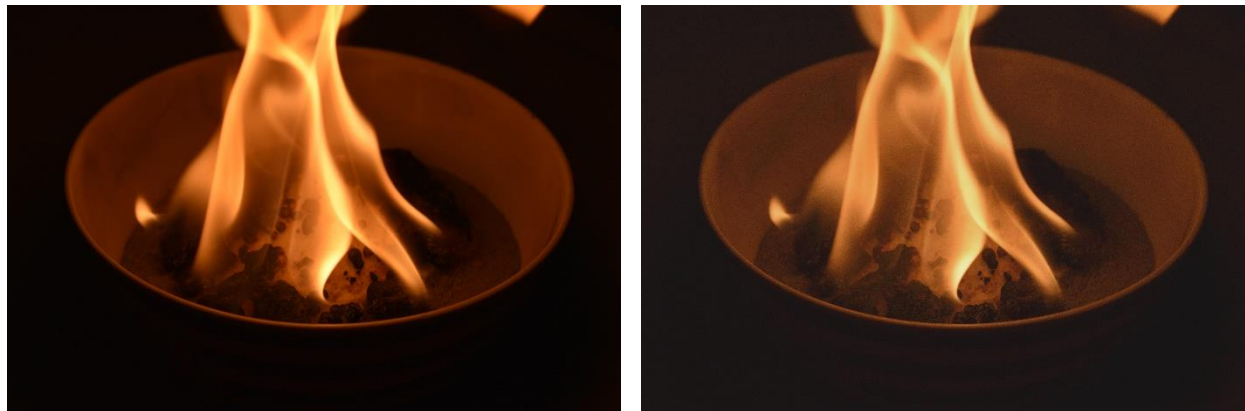


Figure 3. Side by side comparison between non-edited image (left) and edited image (right)

Overall, I am very pleased with the outcome of my photo, even though it was not what I initially expected. I believe I was able to capture an authentic natural flow of the flame while also still including the subtle aspects of the black snake. I also think the post-production enhanced the image as it is less intense but equally as abstract as the original image. The original intent of my photo was not fulfilled as the black snake experiment was unsuccessful, however the image I was able to capture exceeded my expectations. This was my first experiment dealing with combustion and I thought it was an overall success. Next time I would try to perfect the *Black Snake Experiment* by using more lighter fluid and in turn generating a larger, hotter flame.

References

“Black Snake (Firework).” *Wikipedia*, Wikimedia Foundation, 26 Nov. 2019, [en.wikipedia.org/wiki/Black_snake_\(firework\)](https://en.wikipedia.org/wiki/Black_snake_(firework)).

Maric, Vladimir, et al. “How to Make a Fire Snake from Sugar & Baking Soda.” *WonderHowTo*, WonderHowTo, 18 Oct. 2017, food-hacks.wonderhowto.com/how-to/make-fire-snake-from-sugar-baking-soda-0164401/.