



---

# FLY FISHIE FLY

Nebiyu Tadesse | MCEN 4151 - 001 | December 14, 2019  
Helped By: Jared Moya.

---

For the team third project, my team and I decided to use Schlieren Imaging to capture very interesting videos of heat from a lighter. However, due to logistical error Jared and I were not able to make it to our team's session and thus decided to do the black snake experiment, also known as the Carbon Sugar Snake, due to that being our second interest. My intent with this experiment was to capture the flow of the black snake that is generated from the chemical reaction in a video. However, due to technical difficulty we were not able to achieve a black snake worth submitting but had great pictures of the flames formed when first lighting the mixture. The final image submitted was thus a mesmerizing flame captured.

To setup this experiment, no special flow apparatus was utilized. The first things necessary are the ingredients specified in **Table.1**.

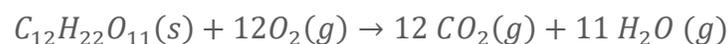
<b>Ingredient Name</b>	<b>Measurement</b>
Powdered Sugar	4 tablespoons
Sand	1 bowl
Zippo Lighter Fluid	1 can
Lighter	1 lighter
Baking Soda	1 tablespoon

**Table.1:** Ingredients and measurements for the black snake experiment

The following steps are then used to setup the experiment:

1. Combine the powdered sugar with the baking soda in a cup.
2. Take the bowl of sand, create a small mound in the middle with the center indented, just like a volcano.
3. Soak the mound and surrounding area with the Zippo lighter fluid
4. Pour the sugar and baking soda mixture in the indent
5. Put the bowl in a safe place for flame to be in and is well ventilated.
6. Light the sand near the sugar mixture and step back as the snake grows out.

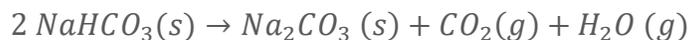
Cane Sugar has the chemical composition of  $C_{12}H_{22}O_{11}$ . When it is burned in the presence of Oxygen,  $O_2$ , it creates Carbon Dioxide,  $CO_2$ , and Water,  $H_2O$ . This is depicted in the chemical reaction below,



Some of the sugar don't have access to enough oxygen due to the reaction from above displacing the oxygen and being trapped in the mixture and thus thermally decomposes which produces solid carbon and water vapor as depicted in the following reaction.



The baking soda,  $NaHCO_3$ , also decomposes thermally forming solid sodium carbonate,  $Na_2CO_3$ , carbon dioxide, and water vapor as shown in the reaction equation below.



The solid carbon and sodium carbonate, when combined with the carbon dioxide and water vapor hot gases, expand and inflate up and out of the sand bowl. The purpose of the sand is to distribute the flame or in other words, the burning lighter fluid, to the mixture of sand and baking soda evenly to help ensure a proper steady burn. This allows the growth of long Black Snake as shown in **Figure.1**.



**Figure.1:** Black Snake Experiment result from reference [2].

It can be noted that it may take a couple of tries to achieve properly. If too much lighter fluid was put, the flame may be visibly large for a short period of time and if the mixture was not setup properly the black snake might not grow to great heights nor for long. This is beautifully depicted in the original image of my edited picture, shown in the cover page. The original image is shown in **Figure.2** below.



**Figure.2:** Large flame produced when first lighting up the sand due to large amount of burning fluid availability.

We tried this experiment multiple times, but we were not able to achieve the snake we were expecting. However, as stated previously, the flame may be visibly large when first lighting the mixture and thus can be captured with high frame rate, which is exactly what we did.

To visualize the flame properly, the images were captured in a completely dark room with the windows behind our shades open and fan on for proper ventilation. The dark room was chosen because the flame emission wouldn't be captured sharply if there were any other sources of light present around.

The camera that was used to capture this image is a Nikon D3500. The camera was setup with dimensions of 6000 pixels x 4000 pixels, a F-stop of f/4.5, exposure time of 1/500 sec, ISO of 360, focal length of 24 mm, max aperture of 3.9 and at 2 feet from the bowl.

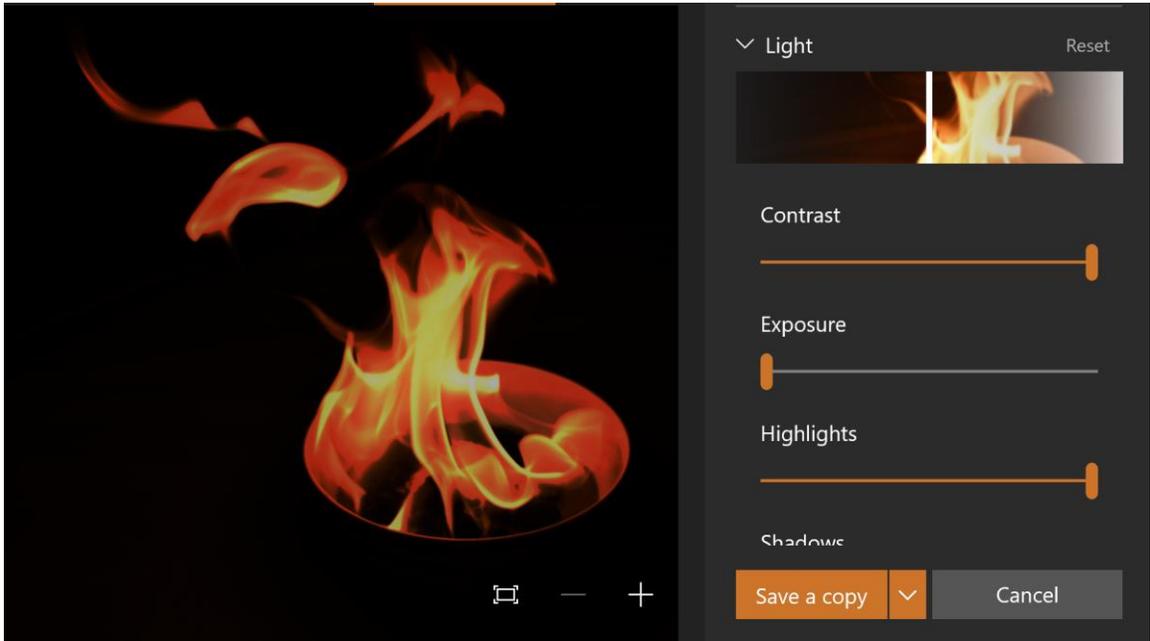
Throughout our multiple trials, I was able to capture great flame images, but one stood out to me and that this the one shown in **Figure.1**. As I looked closely, the flame had somehow formed a flying bird with a body that resembles a fish. This gave me great joy and decided to make this the image I use for my final product. It also gave me the idea of the title, Fly Fishie Fly.

To get the image to the feelings I was getting when looking at it, I used the Windows 10 default app, Photos, to do the necessary edits. The first thing done was cropping out the unnecessary background. The following edits is shown below:

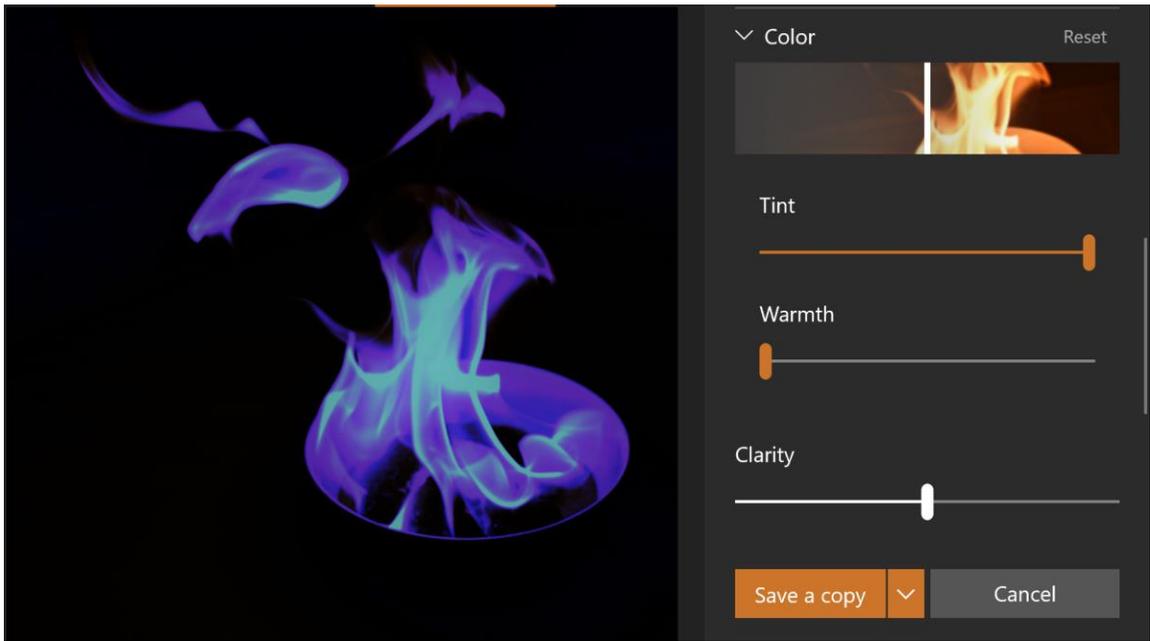
1. Start with the Original Image



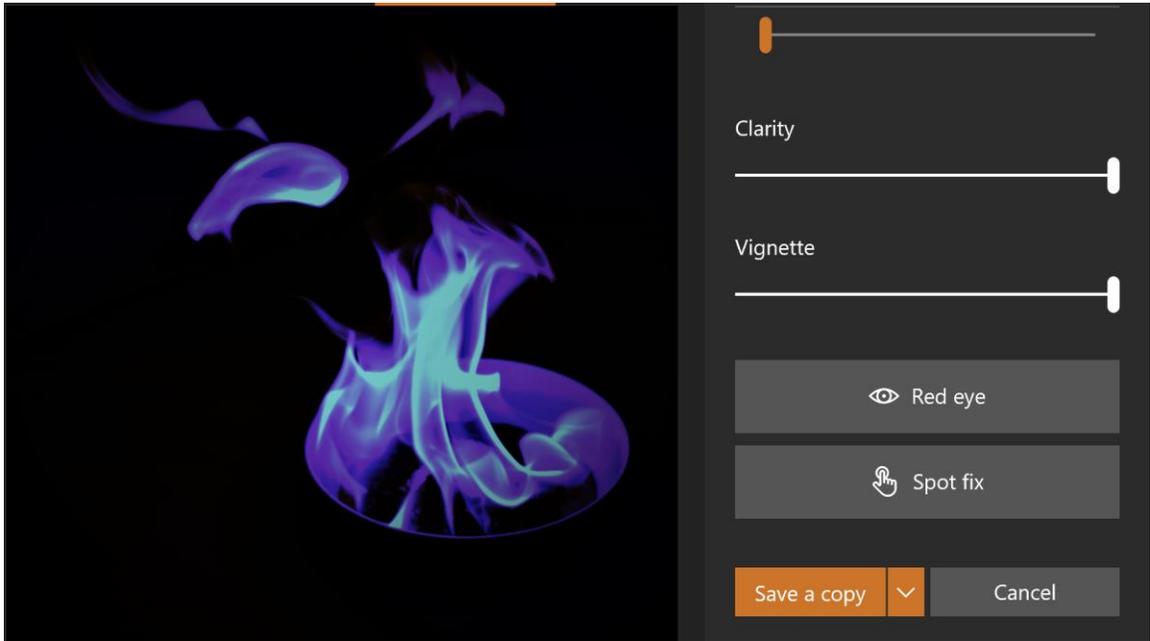
2. Crop Image, Set contrast to 100, Exposure to -100 and Highlight to 100



3. Set tint to 100, and warmth to -100



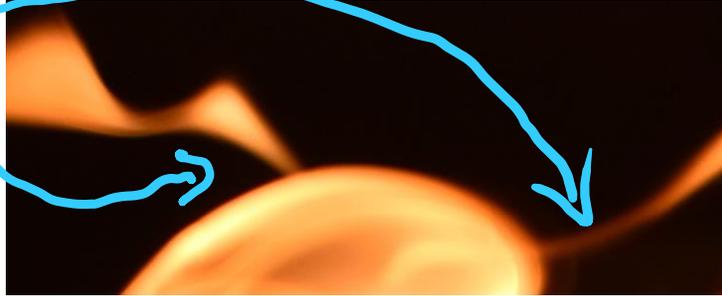
4. Set clarity to 100 and Vignette to 100,.



5. We then finally land on our final image.



The image reveals something mystical to me. It resembles a fish growing wings about to jump in a magical flame pool. I really like the image and how it turns out because I was able to extract exactly what I was feeling from my edits. The original fluid flow intended is not shown, however, the flame has a beautiful fluid flow of its own that was not described in this report due to not being the goal but can be searched later if interested. One thing I would've liked to improve my final picture with was somehow keeping the body and wing connecting flames shown in the image below in my final edits.



Outside of that, I am very happy with how everything came out.

---

#### Citations:

[1] “Carbon Sugar Snake.” *KiwiCo*, <https://www.kiwico.com/diy/Science-Projects-for-Kids/3/project/Carbon-Sugar-Snake/2784>

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