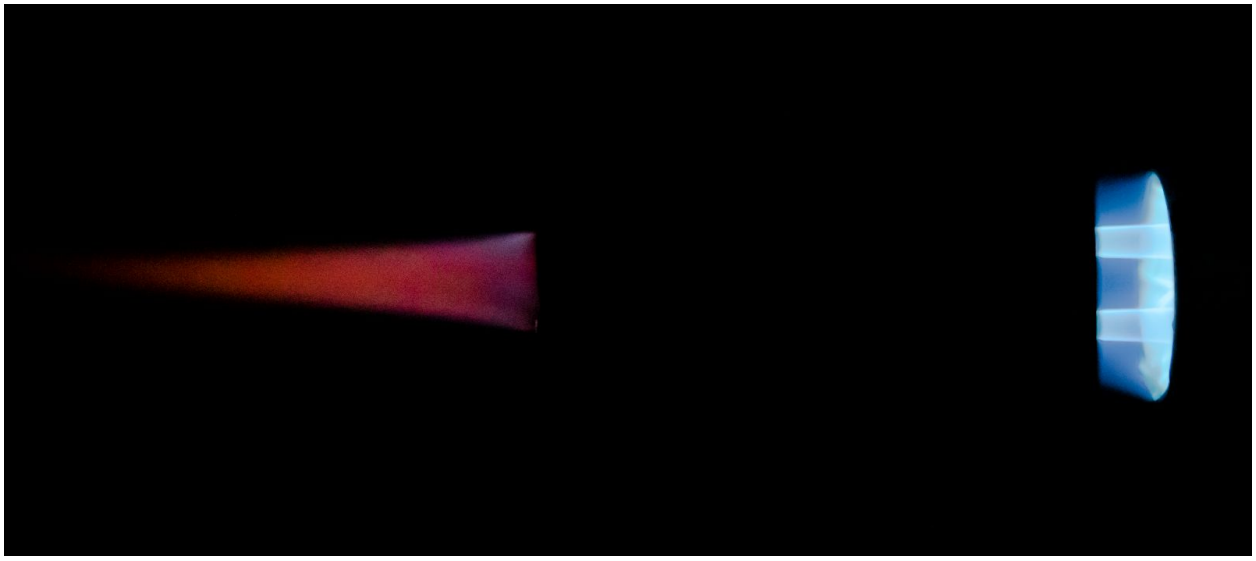
ATLS 4151 Flow Vis - Team First

10/13/2019 Peter Rosenthal



Torch and Funnel

For the “team first” assignment, my team decided we wanted to do something with fire. We weren’t exactly too sure what we wanted to do with the fire, other than we knew we had a torch that could provide the flame. I decided I wanted to direct the flame in a meaningful way, and ended up with a funnel that could converge the two flames from the blowtorch into one single flame. The whole team: Alejandro Barron Toriello, Jennifer Kracha, Conan McHugh, Mary Rahjes, and I (Peter Rosenthal), worked together to create the team photos. In my photo, Alejandro was holding the torch while I was taking the picture.

Apparatus and Science

An illustration of the whole scientific apparatus and setup is included in figure 1. The team searched for a location to host the experiment apparatus that was both far away from anything flammable (as per the the FlowVis combustion experiment), and also far away from any artificial lighting. We then placed a brick up against a concrete wall to provide an elevated but still protected and safe area to perform fire experiments. The team also had a filled fire extinguisher on hand as seen in figure 2 for safety reasons. The set up for my experiment in particular involved clamping the aluminum funnel in a pair of pliers that could then be rested on the edge of the brick. This suspended the funnel in the air with just enough room off the ground to fit the blowtorch in firing horizontally. The horizontal positioning of this setup can be seen in the top down view in figure 1.

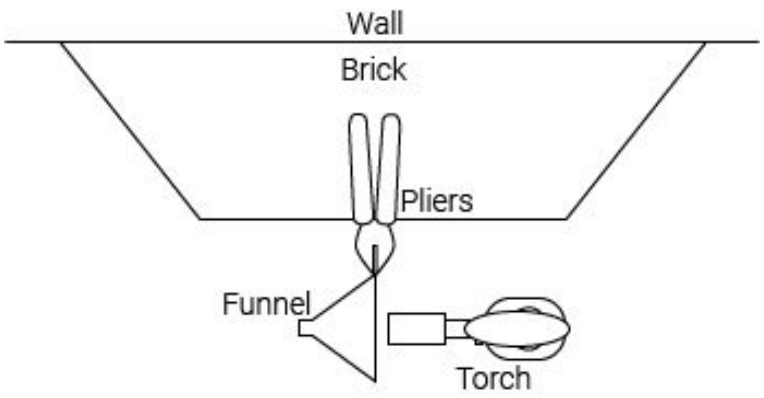


Figure 1: A top down illustration of the experiment apparatus. The funnel and torch opening are to scale, but the torch handle, pliers, and brick are not illustrated to scale as they aren't crucial to reproducing the flow.

Figure 2: The fire extinguisher used to keep the team safe while experimenting with fire.

When the flame is coming out of the torch initially, it is a premixed flame. In a premixed flame, the fuel, in this case butane, and oxygen, are mixed together before ignition (Kondratiev 2018). The blue color of the flame shown in figure 3 indicates that the mixture was oxygen rich. When the flame encounters the funnel about 15% of the way from the end, the flame interacts with the metal and changes color. The metal is most likely aluminum, which will be discussed in the next section. I am personally not 100% sure where the color change exactly comes from, but it seems to only start at the very end of the funnel, where the aluminum has a rough edge from being cut there. Burning powdered aluminum reveals a small amount of the purple and orange colors that we are looking for amongst a lot of bright yellow and white (Astral 2019). So there is a chance that the color in the flame comes from the aluminum on the rough cut end burning and changing the flame color. But it is unclear if solid aluminum can burn enough in a butane flame

to produce as much color as seen in the experiment. Figure 4 shows how a premixed flame in a very fuel rich environment can burn with the vibrant oranges and pinks seen in the experiment (Fijalkowski 2005). Perhaps inside the funnel the flame uses up the oxygen in the mixture, and without the environmental oxygen surrounding the flame, it starts burning fuel rich to produce the colors.

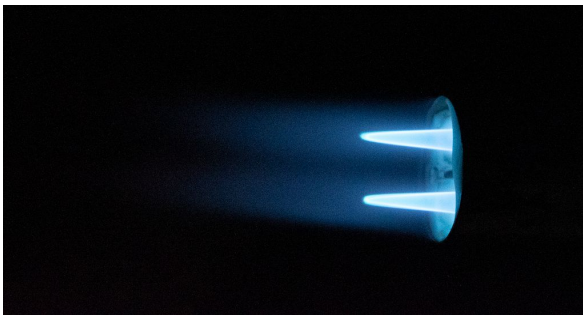


Figure 3: The torch burning with no obstructions in the way. The blue flame indicates an oxygen rich premixed flame.

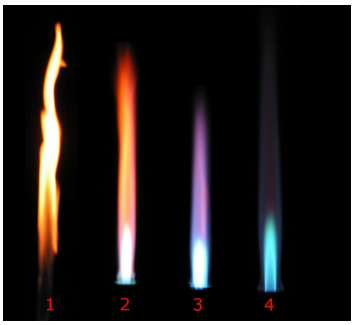


Figure 4: A Bunsen burner with 1. the air all the way closed (very fuel rich burning), 2. the air slightly open (slightly fuel rich burning), 3. the air almost all the way open (slightly oxygen rich), and 4. the air completely open (oxygen rich burning). Source: Artur Jan Fijalkowski uploaded original work to Wikimedia Commons on August 18th, 2005.

Visualization Technique

The first piece of equipment needed to reproduce this image is the blowtorch with two flames. I unfortunately cannot say where to get this exact blowtorch, because it was a hand-me-down from a previous roommate, but several similar torches can be found online with the key words “double flame torch.” This torch is 23mm across at the front, this can be used as a vertical reference for the height of the blue flame all the way to the right of the photo. A picture of the two torch nozzles is in figure 5. The funnel is 70mm across at the widest and 10mm across at the lowest, meaning that the widest part of the funnel is clipped out of the image (even though

the funnel is exposed to black), and that the height of the exit flame in the image is also 10mm at the start.

Figure 5: a picture of the torch's dual nozzles and the igniter in the center.

Photographic Technique

The 6000x4000 photo was taken with my Nikon D5500 with the standard kit lens, about one to two feet away from the subject. For this picture, the focal length was at its maximum 55mm, and the aperture was the widest at that focal length which was f/5.6. The scene was very dark with the only light coming from the torch, so my ISO was all the way up at 10000, and my shutter speed was 1/100th of a second for a compromise between motion blur and letting enough light hit the sensor. The photo was edited in the Camera RAW plugin for Adobe Photoshop with the goal of balancing the amount of light coming from the brighter initial flame versus the darker exiting flame. The lighting editing can be seen in figure 6, while the color editing done is featured in figure 7, and the original photo without any editing is in figure 8.

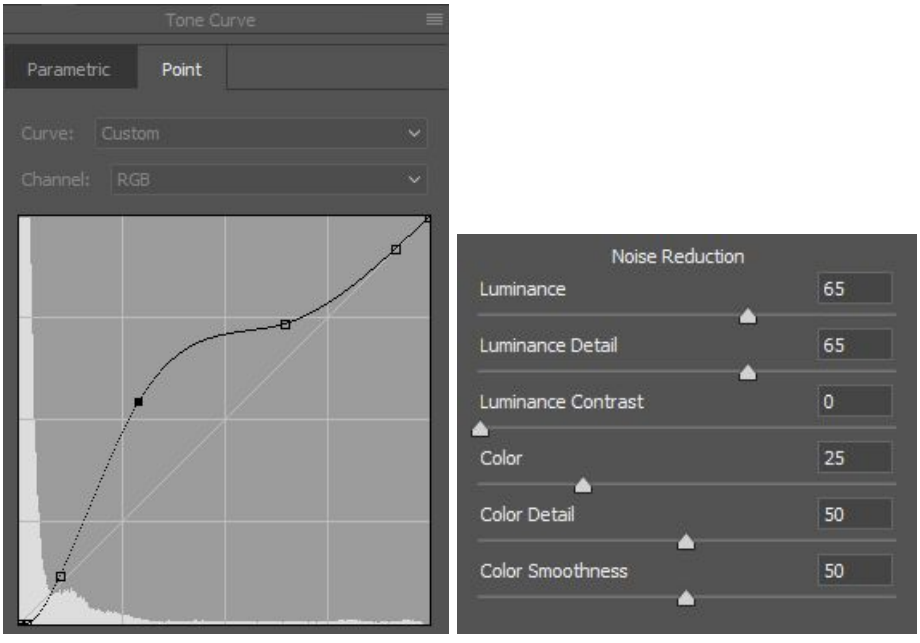


Figure 6: Tone Curves on the left showing increased contrast for the lower half of the spectrum with a return to normal for high values. Noise reduction editing shown on the left done to offset the increase in noise caused by excessive lighting editing and the very high ISO of the photo.

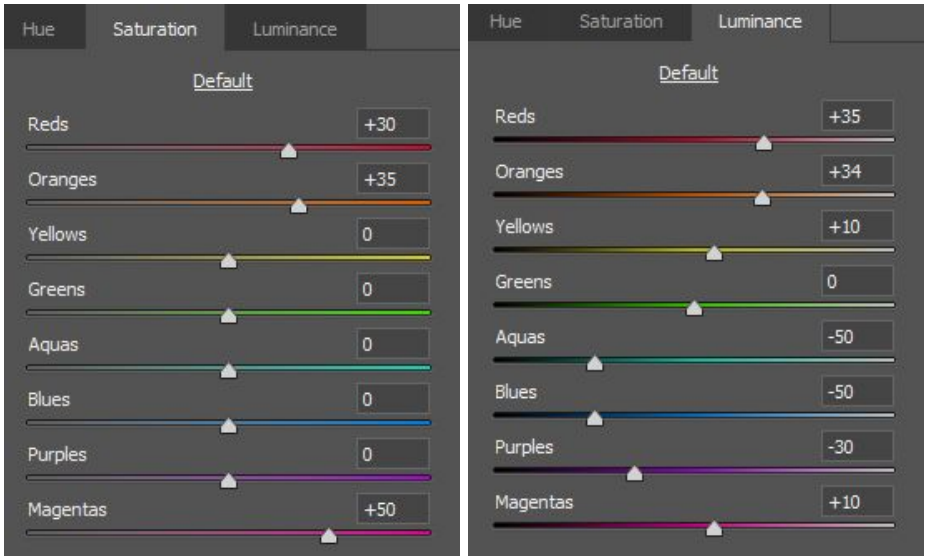


Figure 7: Color editing done to the photo to bring out and reinforce the colors in the exiting flame. Saturation on the left, and Luminance on the right.

Figure 8: A scaled down version (1/10th the resolution) of the original photo with no cropping or editing of color or lighting.

Conclusions

This report for the “team first” assignment went way over length, but I think that’s because of how many figures were included, and how poorly formatted they are. Overall the picture achieved my goal of directing the flame of the torch in a meaningful way, and even revealed more with the color change of the flame. I think this experiment could be taken further with funnels of different sizes and possibly even different shapes.

References

Astral Chemistry. (2016). *Burning Metal Powders (Zn, Al, Mg, Fe) + Thermochromism.* YouTube - Astral Chemistry. [Web, Video] https://youtu.be/GWGIjd0cHUk

Fijalkowski, Artur J. (2005). *Bunsen burner flame types.*Wikimedia Commons. [Image] https://commons.wikimedia.org/wiki/File:Bunsen_burner_flame_types.jpg

Kondratiev, Victor N. (2018). *Combustion.* Encyclopaedia Britannica. [Web] https://www.britannica.com/science/combustion/Combustion-phenomena-and-classification