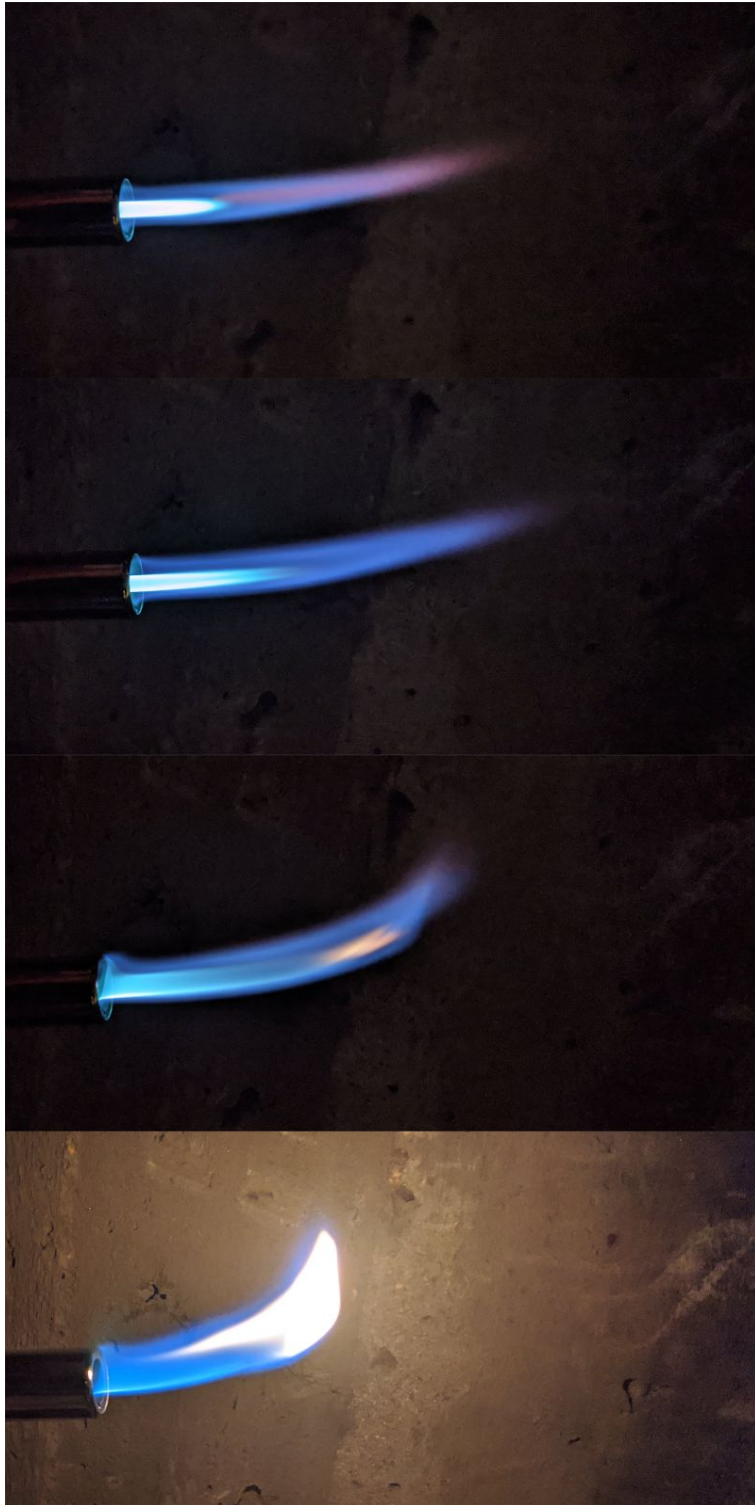


Oxidation States of a Butane Torch

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We initially wanted to visualize aerosolized orange essential oils from squeezing an orange peel. The goal was just to light up the particles with an array of camera flashes, but we were very unsuccessful, so instead grabbed some fire that we could light the orange oil on fire with. Some team members did that, but instead I just messed around with the torch that we were getting our fire from. The team member that helped directly with this photo was Mary Rahjes who took the pictures while I controlled the apparatus.

Apparatus and Science

The apparatus for this experiment ended up being really simple. This is because we just used a concrete background (the same exact one as in the Team First assignment), and used our hands to cover the oxygen intake ports of the torch. This will be expanded on later in the Visualization Technique section. We also used the same fire extinguisher as our Team First assignment, as seen in figure 2. Figure 1 shows a top down illustration of the experiment, the camera was about 18 inches away from the torch.

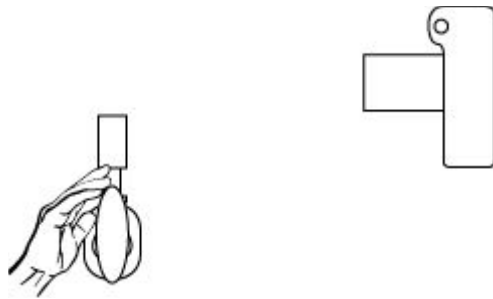


Figure 1: An illustration of a top-down view of the experimental setup. The torch on the left is kept on while I manually cover up the oxygen intake with my fingers. Meanwhile Mary Rahjes took pictures from the side.



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

Visualization Technique

The idea for this visualization technique and experiment came when I was investigating oxygen-fuel ratios in premixed flames for my Team First assignment (Rosenthal 2019). I found a picture of a Bunsen burner that was burning with different amounts of oxygen premixed into the fuel (Fijalkowski 2005). This picture can be seen in figure 3.

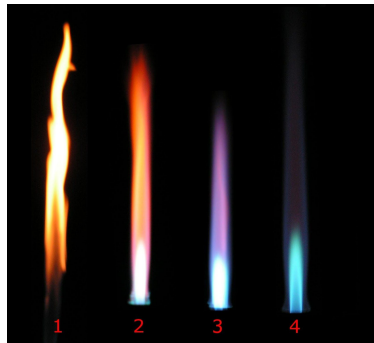


Figure 3: A Bunsen burner with 1. the air all the way closed (very fuel rich burning), 2. the air slightly open (slightly fuel rich burning), 3. the air almost all the way open (slightly oxygen rich), and 4. the air completely open (oxygen rich burning). Source: Artur Jan Fijalkowski uploaded original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

Now that I had a torch that allowed me to easily adjust my oxygen to butane mixture, I wanted to recreate this experiment. Figure 4(a) shows the single nozzle of my torch (in contrast to the double nozzle torch featured in the Team First assignment), and figure 4(b) shows the easily accessible oxygen intakes of this torch that are safely behind the flame. I was able to cover these ports to varying degrees with my fingers. In the top picture of my submitted image, all ports were left open, and in the second picture half of the ports are closed. In the third picture 3 out of 4 ports were completely covered, and the remaining port was barely “feathered” open to barely allow oxygen into the mixture. In the final bottom picture, all oxygen intakes were completely covered up to show a completely unmixed flame. The flame in the final picture was magnitudes brighter than the other flames, and it completely illuminated the background with no hope of properly exposing my shot to compensate for it (see the Photographic Technique section). This is the first major problem with my picture compared to Fijalkowski’s. The other problem is that my photo featured a horizontally burning flame with a headwind causing it to burn sideways first and then upwards instead of directly up.

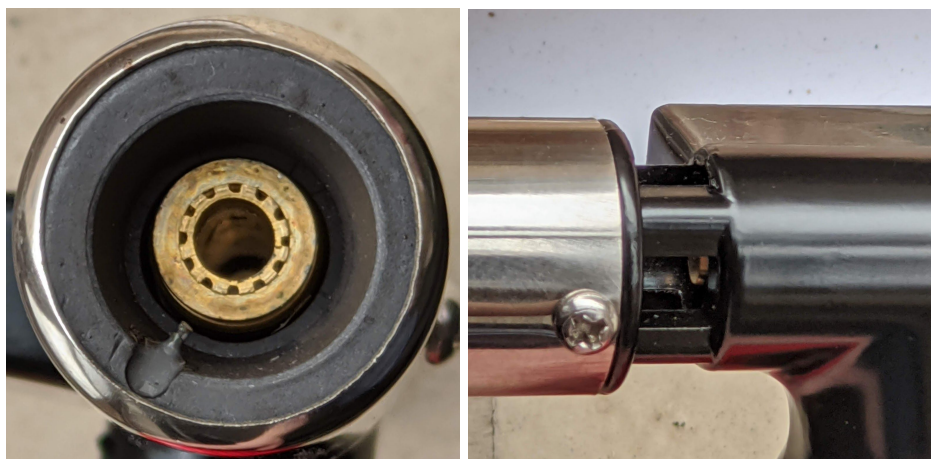


Figure 4: Pictures of the torch used. (a) on the left, the single nozzle with the piezoelectric igniter in the bottom left. (b) on the right, the oxygen intake holes that I covered up with my fingers.

Photographic Technique

This picture also used my phone, a Google Pixel 4, instead of my DSLR, because my phone weighs less than a percent of my DSLR which couldn't fit in my backpack space or weight wise the night of this photo. The aperture, ISO, shutter speed, focal length, and pixel dimensions of each photo are featured in table 1.

Image	Aperture	ISO	Shutter Speed	Focal Length	Dimensions
Top	f/1.73	432	1/23 s	4.38 mm	4032x3024
Second	f/1.73	433	1/23 s	4.38 mm	4032x3024
Third	f/1.73	527	1/27 s	4.38 mm	4032x3024
Bottom	f/1.73	382	1/36 s	4.38 mm	4032x3024

I just left my phone on auto because while I was very familiar with manual controls on a camera, I wasn't familiar with the manual controls of my phone, and it was resulting in much worse looking pictures. I decided not to edit the photos at all other than cropping and rearranging into a line. Figure 5 shows the uncropped version of the bottom picture in the sequence, I'm not including the rest because they are all very similar, and I can't let this document get too long. Figure 5 also helps showcase the apparatus and visualization technique with context as well.



Figure 5: The uncropped version of the final bottom photo (the case with no oxygen present). This photo was the brightest because of how bright the unmixed flame was, so it shows the scientific apparatus the best.

References

- Fijalkowski, Artur J. (2005). *Bunsen burner flame types*. Wikimedia Commons. [Image]
https://commons.wikimedia.org/wiki/File:Bunsen_burner_flame_types.jpg
- Rosenthal, Peter. (2019). *TeamFirst Report*. Flow Visualization. [Web]
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