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MCEN 4151
Team First Report
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Team First Report

Context

This was for the first team project and my team decided we wanted to visualize the phenomenon of isopropyl alcohol ignition. We wanted to capture the blue flames that occur when isopropyl alcohol is added into a large jar, coating the inside, and ignited with a match. We discovered that the jar needed to dry out in open air after each ignition attempt, so in between attempts we chose to pour the alcohol into different dishes and light it to see what other kinds of flows we could achieve. This image was created during one of these in between attempts. We created an aluminum foil dish, added the isopropyl alcohol, ignited it, and took pictures as it burned. This image captures the flow of diffusion flames. This image was created with the help of my team, Lara Buri, Michael Guenther, Michael Johnson, and Cara Medd. Lara did a lot of the camera work, Cara took videos, Michael G. was in charge of ignition, Michael J. was blocking as much light as possible, and I helped with the setup and supplies.

Apparatus and Flow

In order to capture this image, our group created a dark room out of one of our house's garages. We blocked all windows and doors with towels to reduce the light and make the only light come from the flame. The aluminum foil dish was around the size of a person's palm, and it sat on top of two tables. One table was covered in a black cloth for the base of the image and the background was a black poster board taped to the wall. We poured around 2 tablespoons of the alcohol into the dish and then set it on fire using a lighter. The setup is shown in Figure 1.

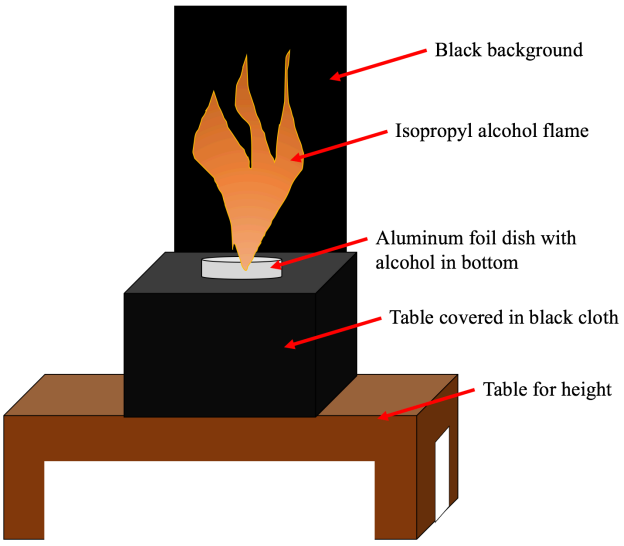

Figure 1: Image setup.

The burning isopropyl alcohol created a diffusion flame[1], which was captured very well on camera. The diffusion flame comes from the oxidizer combining with the fuel by diffusion. This combustion occurs and emits heat and light. The light in this case is orange-yellow, which means it is a fuel rich flame that produces more soot[2]. The flame itself is difficult to give an exact Reynolds number. The flame is not propagating downwards as if it were in a jar, so the velocity is difficult to determine. However, we can assign a definition to the flow by just looking at the image. The flame nearer to the aluminum foil is much smoother, demonstrating laminar flow, which is indicative of low flow velocity. The middle and top portion of the flame appear to be in transitional to turbulent flow based on the more dynamic motion in the captured flame. This indicates the air flow in this region is faster and increasing. Based on this, we can determine the Reynolds number ranges between 10^3 and larger as the flame ranges from the base to the flame tip.

Visualization Technique

This image was made by pouring 91% isopropyl alcohol into a homemade aluminum foil dish. The alcohol was the generic store brand and it was standard aluminum foil. The room was darkened and we lit the isopropyl alcohol immediately after pouring it into the dish. The light was entirely supplied by the flame. We actually had to go to some decent efforts to make the room dark. We had to block all windows and doors and cover up cracks where light was sneaking through. We chose the aluminum foil in the hopes that it would reflect all the light from the flame upwards.

Photographic Technique

The original image is shown in Figure 2 and was 3744 by 5616 pixels.

Figure 2: Raw original form of image.

It was taken with a Canon EOS 5D Mark II camera. The focal length was 28 and the F number was 2.8. The lens was about 18 inches from the flame. The exposure time was 1/1600. After post processing, the image (shown in Figure 3) was 2333 by 3501 pixels.

Figure 3: Final image after post processing.

I altered the curves of the image in order to get a brighter orange color and I cropped the image to really emphasize the flame and the aluminum foil. The curves alteration is shown in Figure 4.

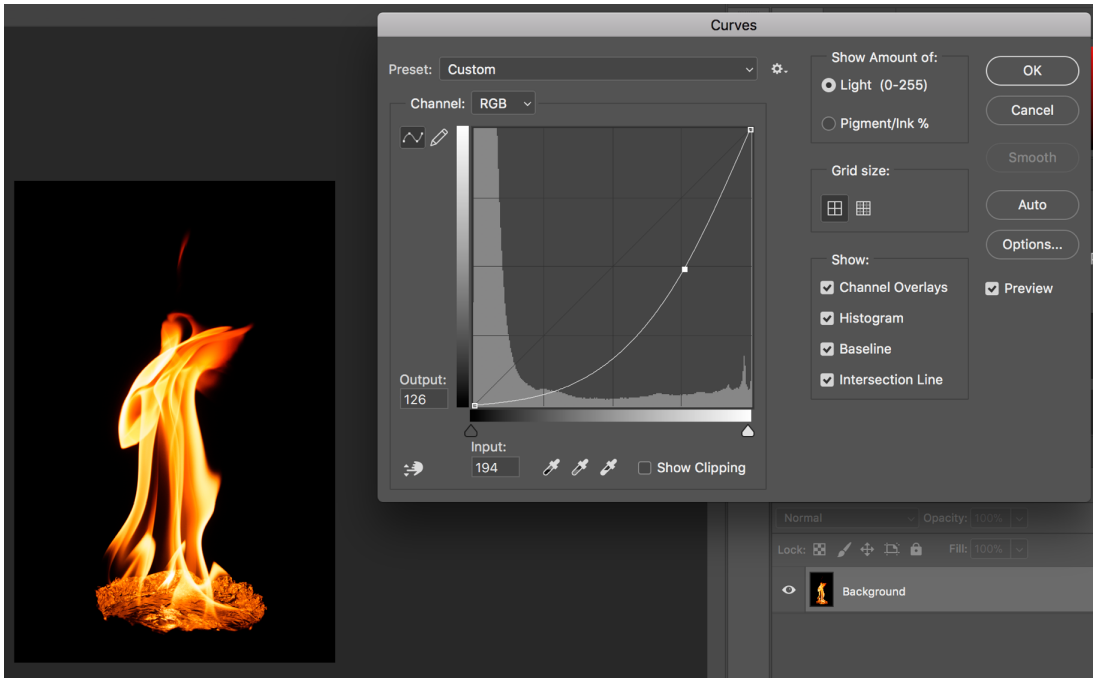

Figure 4: Screenshot of curves during post processing.

I chose to only alter the size of the image and the curves because I really wanted to keep the focus on the flame and the light. I also really liked the contrast of the texture of the foil with the smooth flame. The adjustment of the curves decreased the brightness of the flame while allowing the orange of the flame to really stand out. The cropping framed the flame nicely.

What the Image Reveals

The image does a great job revealing the flow associated with a diffusion flame. I really like the contrasting components of the image. The black background and the bright flame are beautiful to look at and the colors are stunning. The texture of the foil and the and smooth flames are also really satisfying and great additions to the image. The image also captures the fluid physics nicely. I am really pleased with how this image turned out. If I were to improve anything, I would want to try burning different kinds of salts or alcohol to produce varying colors in the flames. This might require more materials, research into material properties, and more setup and coordination on the ignition timing.

Citations

[1] Diffusion flame. (2018, February 28). Retrieved February 28, 2018, from https://en.wikipedia.org/wiki/Diffusion_flame

[2] FLAMES. (n.d.). Retrieved February 28, 2018, from http://www.thermopedia.com/content/766/