Unstable Flames

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The image below, in *Figure 1*, is a submission for the assignment "Group Image 2" for the Flow Visualization course. The intent of this image is to capture and display the instability in the flame of a welding torch. The image in Figure 1 was captured due to a group effort in which the following people were involved: Faith Batrack, Chris Francklyn, David Gagne and Jiffer Harriman.

Figure 1: Unstable Flame Image

The apparatus setup was located indoors. Since it was located indoors, there was little to no air movement in the room during the image taking process. An oxy-acetylene gas welding[1] torch was used for the image. The fuel gas used was Acetylene. On the right side of the image, the torch is visible. A schematic of the torch can be seen in *Figure 2*.

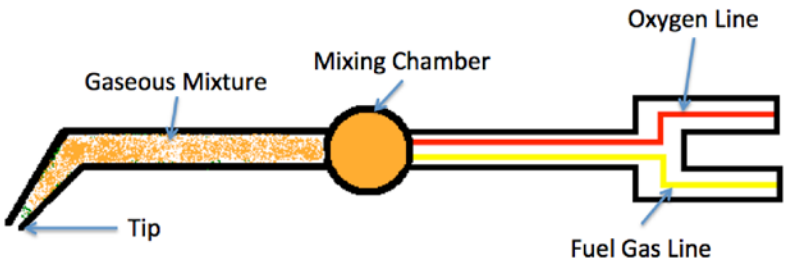

Figure 2: Schematic of a typical oxyfuel-gas welding torch

In Figure 2, it can be seen that two lines feed into the torch; an oxygen line and a fuel gas line. Both gas lines can be controlled by the user; this is not shown in *Figure 2*. Once the two lines combine in the mixing chamber, if both are on, the gas mixture coming out of the tip will have both oxygen and fuel gas in it. At the time of this particular image, the oxygen line was turned off, so only acetylene gas was burning. Once oxygen got introduced, the flame became stronger and hotter because oxygen is a highly combustible gas[2].

Since the flame provides a lot of light, the lights in the room during the image taking process were turned off. Due to the large amounts of light that the flame emits, some details in the flame that is visible to the human eye was not captured with the camera. Regardless, the image still demonstrates the flame's behavior when it is no longer laminar. This image was

taken with no oxygen gas (from the torch tip), and solely with acetylene gas. In order for this image to be re-created, a lot of photos would need to be taken. Fire is always moving and ever changing, so it would be difficult, but not impossible. The original image can be seen in *Figure 3*.

Figure 3: Original Welding Torch Flame Image

Photographic Technique

The following are the parameters used in the creation of the image.

- Field of view: 9.5 inches x 4 inches (= 38 square inches)
- Distance from object to lens: 4.5 feet
- Lens focal length: 50 millimeters
- Type of camera: Nikon D40
- Final image size: 2670 x 1564 pixels
- Original image size: 3008 x 2000 pixels
- Aperture: f/2.8
- Shutter speed: 1/2500s
- I.S.O.: 800

A high shutter speed was used because the flame edges were whipping out at a fast rate. Any slower of a shutter speed would result in more motion blur. Since the shutter speed was high, the aperture was low because the two variables are inversely related to one another. The ISO on the camera was set at a higher value because the room was dark and the group wanted to make sure the camera picked on the light. There was minimal post processing of the original image. It was cropped and the contrast was turned up slightly.

The image reveals the erratic behavior of flames. I like the composition of the image; it has an industrial feel to it with the torch tip and sparker in the background. I dislike that the camera wasn't focused on the flame, but rather on the table's edge. The fluid physics could be shown in better detail, but the silhouette of the flame along with the details in the edges show the fluid physics adequately. The intent of the image was fulfilled. I would like to improve upon the image by making the details inside the flame more visible. This idea could go in the direction of seeing and interpreting the different shades of orange, red and yellow to determine the temperature at different places in the flame.

Sources:

[1] DeGarmo, E. Paul, J. Temple. Black, Ronald A. Kohser, and E. Paul DeGarmo.*DeGarmo's Materials and Processes in Manufacturing*. Chichester: Wiley, 2008. Print.

[2] Carey, Leo. "19900118 The Use of Combination Oxygen and Combustible Gas Detectors." *The Use of Combination Oxygen and Combustible Gas Detectors*. United States Department of Labor, 18 Jan. 1990. Web. Mar. 2013. <http://www.osha.gov/dts/hib/hib_data/hib19900118.html>.