Get Wet Report

My image of a flame on a reflective glass plane was inspired by the shear power a flame can have. Following the combustion guidelines presented in class, I was able to attain great images which showed the progression of a gasoline flame. Not knowing much about photography allowed me to experiment with different camera settings. Speeding up the shutter speed allowed me to cut down on the motion blur produced by the flame. Many of the images appeared to tell a story as the flame danced on the table but the one chosen showed unique ridgelines that draws your eyes from the rest of the image.

To create the flames associated with the image, a minor setup was involved and many safety cautions were executed. The flames were created on a ¼ inch black tempered glass desk in an open garage. The glass was used for its smooth and dark surface. Tempered glass was used because other glass can be known to crack with that high of temperatures on its surface. The garage needed to be dark to create a large focus on the flame. The fuel used in the combustion was about a fluid ounce of 16:1 ratio of gasoline and 2-stroke motor oil with a diameter of around 6 inches. The oil is slower burning than the gasoline so it helped create a deeper burning look. See figures below for a detailed setup of the experiment.

Figure 1: Isometric View
(Gas tank is only there for representation)

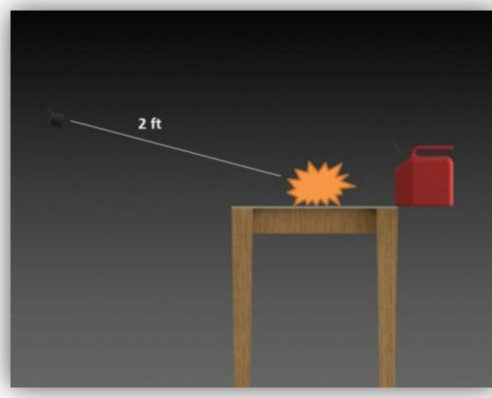

Figure 2: Side View
(Gas tank is only there for representation)

The photos taken are called a pool flame, described as an upward facing combusting fluid.[1] Radiation and convective heat from the flame vaporizes the gas and spreads it to the rest of the fuel igniting it till the whole pool is engulfed.[2] Pool flames depend on the surface area of the flame and have a few different burning modes based off the diameter of the fluid used in the burn. Since the diameter of fuel used was below 8 inches, we can estimate the burning mode as convective and turbulent. Knowing the amount of fuel used, the area of the fire, and the type of fuel used will allow us to calculate many quantitative values of the fire. These include the estimate for burning duration and flame height. Additional data is required to calculate these including: flame regression rate (m/sec), mass burning rate per fuel area (kg/m^2-s), heat of combustion (kJ/kg), density (kg/m^3). Assuming that the only constants come from the gasoline burning, the following are the necessary numbers needed to solve for burning duration and max flame height:

Table 1 Gasoline constants[1]

Fuel	Mass Burning Rate (kg/m^2-sec)	Heat of Combustion (kJ/kg)	Density (kg/m^3)	Fuel Volume m^3	Fuel Area m^3
Gasoline	0.055	43700	740	0.00002957	0.01824

To determine the pool burning duration, the flame regression rate must be found first.[1]

$$Flame\ regression\ \ rate = \frac{Mass\ burning\ rate\ per\ fuel\ area}{Density}$$

$$Flame\ regression\ rate = \ 0.000074\ m/s$$

With the Flame regression rate equation, the burning duration estimate can be calculated.[1]

$$Burning\ duration = \frac{Volume}{Fuel\ area * Flame\ regression\ rate}$$

$$Burning\ duration = 21.9\ \text{sec}$$

This estimate is very close to the actual time the flame was lit, unfortunately data was not taken during the experiment. Calculating the max height of the flame can be estimated by two methods; Method of Heskestad and the Method of Thomas. The Method of Thomas will be used for its simplicity, and is as follows:[1]

$$Flame\ height = 42 * Diameter * \left(\frac{Mass\ burning\ rate}{Air\ density} * \sqrt{Gravity * Diameter}\right)^{.61}$$

$$Flame\ Height = .87\ m\ or\ 2.86\ ft$$

This value is quite possible for the max height when the fuel was first ignited, but as a safety concern no one was next to the flame measuring it. This information would have been interesting had it been conducted before the experiment.

To reproduce this image many photographs would need to be taken to catch the fire in the exact right location. The gasoline and two stroke motor oil can be purchased at any gas station and mixed in any sort of vessel. The image has to be taken in a dark area in order to eliminate any backgrounds. The flame will be bright enough to light the room. The photo was taken on shutter priority mode, which allowed the adjusting of shutter based on the amount of blur. Having a moderately fast shutter speed is necessary to capture the flame without much blur. This is because the flame is flickering very fast.

Photographic Technique:

- Size of the field view: 12 inches x 20 inches = 240in^2
- Distance from object to lens: 24 inches
- Lens focal length: 27 mm
- Type of camera: 6.3 megapixel Canon EOS Digital Rebel
  Original (3072 x 2048)
  Edited (1976 x 2048)
- Exposure Specs: Aperture: f/5.6
  Shutter Speed: 1/1000
  ISO 800
- Photoshop processing:
  The image was cropped on the sides to center the flame. The curves were adjusted to reduce the amount of reflection on the glass and bring out more darkness in the photo.

This image caught my eye out of the rest of the ones I took because it has such dramatic lines in the flame. I've always enjoyed contrast in images and I believe my image greatly shows that. After seeing all the other photos during the class presentation I wish I could resubmit my photo because I feel my image does not show all the creativity that I possess. Some of my other images have better reflections off the glass and are somewhat more interesting. More editing could also make most of these images really pop off the page. Overall I am content with my image but I am very excited to see what else this semester will allow me to explore with fluids.

References:

1) Weerakkody, Sunil (2004). Fire Dynamics Tools (FDTs): Quantitative Fire Hazard Analysis Methods for the U.S. Nuclear Regulatory Commission Fire Protection Inspection Program. (pp: 1-16) NRC publications <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1805/final-report/ch3-6.pdf>

2) Nolan, Dennis P. (1996). Handbook of Fire and Explosion Protection Engineering Principles for Oil, Gas, Chemical, and Related Facilities. (pp: 47). William Andrew Publishing/Noyes.