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Image-Video Report 3
MCEN 4151
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Image-Video 3 Report: Colorful Flames

This video was taken of burning 2x4s for the third Image-Video project. A product called “Funky Flames” was added to the fire, causing a change in the emitted light of the combustion. The video was taken in slow motion in order to capture the flickering of the flames and their vibrant colors. No visual editing was done to the colors.

The apparatuses that were used in this image include a fire pit (approximately 2.5 feet in diameter), wooden 2x4 planks, and the Funky Flames chemicals. The chemicals in the Funky Flames product include potassium chloride, sodium chloride, and copper sulfate. See the visual below for a representation of the flow set-up. The firepit has star and moon cut-outs around the sides. These cutouts allowed the perspective of the camera to be closer to the flame, and more level with the bottom, without getting too hot. The image was taken outside on a cool clear night.

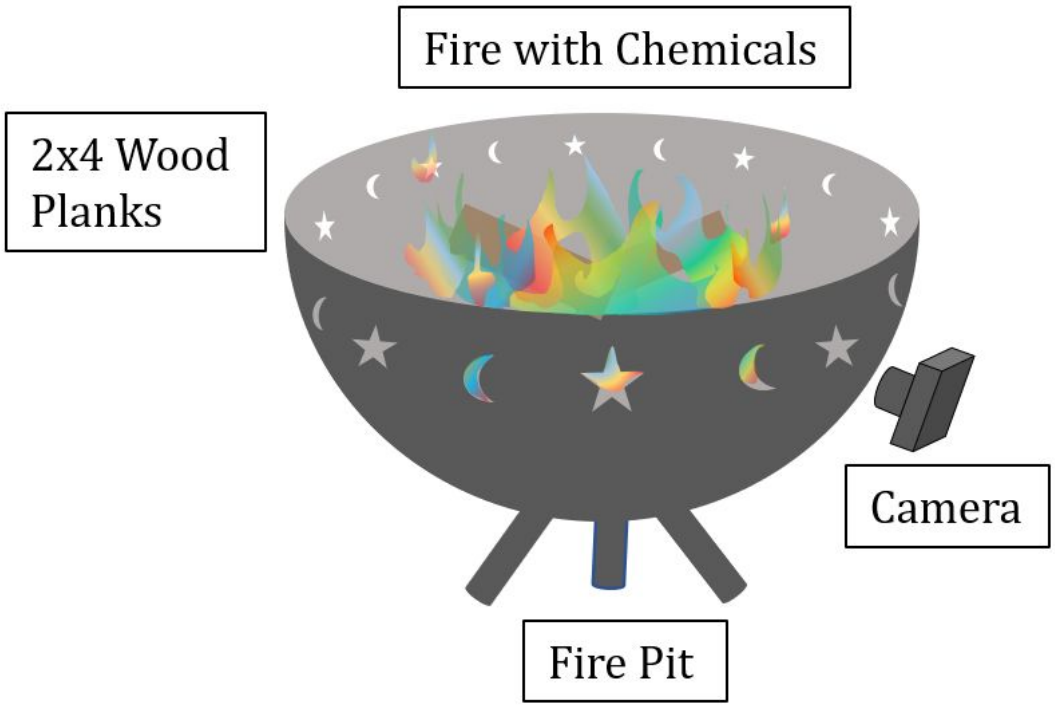

Figure 1: A diagram of the flow set-up. Note the camera perspective through the fire pit cut-outs.

The flame gives off light due to the black body radiation of the soot from the fuel. As the carbon particles heat up, and the wood is vaporized, the gas-state fuel will mix with the oxygen in the surrounding atmosphere. This reaction will result in carbon dioxide, water, and other byproducts

of hydrocarbon combustion. Below is an example of stoichiometric combustion of a hydrocarbon in air, with an approximation of the ratio of oxygen and nitrogen in air.

$$C_xH_y + (x+y/4)\,(O_2 + 3.76\,N_2) \rightarrow x\,CO_2 + (y/2)\,H_2O + 3.76(x+y/4)\,N_2$$

The exothermic combustion reaction releases heat and light. The light is a result of thermal electromagnetic radiation emitted from the burning particles, called blackbody radiation. This light ranges from red, orange, and yellow to blue, depending on the temperature of the flame at that point (as seen commonly in candles and wood fires). Unburned particles, volatile gases, and byproducts are released as smoke. Since hydrocarbons are not the only type of fuel in the flames, the colors have a wider range based on the chemical reaction of the combustion. The inclusion of potassium chloride, sodium chloride, and copper sulfate allow for a wider range of naturally occurring colors at the given temperature. The potassium chloride gives off a purple color. The sodium chloride gives off a yellow color. The copper sulfate gives off a green color. Altogether, the flames take on a myriad of rainbow colors, making an attractive display. This information was informed by MCEN 4152, Introduction to Combustion.

As previously mentioned, the materials that were relevant to creating the flow visualization phenomena included wooden 2x4s of an unknown wood type, and the product “Funky Flames” by the brand Winlow. Newspapers and dry sticks were used to initiate the flames, but did not sustain the fire for the period when the recording was taken. The video was taken outside, after the sun had set. Minimal ambient light was present due to the moon, and a nearby streetlight.

An iPhone 6s Plus was used to take the video. The aperture was f/2.2, the ISO 40, shutter speed 1/120, and lens of 4.15 mm. The focal length was 53 mm. The video size was 1,280 x 720 pixels, and was not cropped. The perspective of the video was chosen since the camera was placed up to the star cut-out in the side of the fire pit (see Figure 1 for a diagram illustrating this). This allowed for a more level view into the flame, albeit forcing the vertical profile and the cropping of the flame. This was chosen to be preferable to an aerial view. No visual editing was required. The video was taken using the slow motion feature on the iPhone. Editing in Windows’ Photos app was used, and the video was played at 0.12x speed.

To me, this slow-motion video reveals the beautiful dancing of the flames that one cannot see with the human eye. It also captures the incredible colors that are emitted from the fire, which are both beautiful and unnatural to see. I think that this video fulfils my original intent fully, and shows the fluid physics very well. I wish I could have improved the cropping of the video, but that was a necessary downfall in order to get the perspective I wanted. To develop this idea further, I think that other chemicals could be explored, or other perspectives of the flames.