Campfire

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Image/Video 3 Assignment

December 3rd, 2021

MCEN 4151-001

I. Introduction

The purpose of this video was to capture a flow for the Flow Visualization course image/video 3 assignment. The intent of this video was to show the motion of the flames around the central log. Also, to show the motion created by having a cylindrical metal casing that encases the fire pit. The image was taken on a camping trip so various videos were taken of the flame but the one selected shows the motion the best.

II. Flow

Seen in Figure 1 below the set up of the flow was a metal cylindrical fire pit with dirt on the bottom. There were slits along the base of the metal to allow for air intake. Logs were placed centrally in the pit and eventually caught on fire. The height of the metal pit is roughly three feet tall and three feet in diameter.

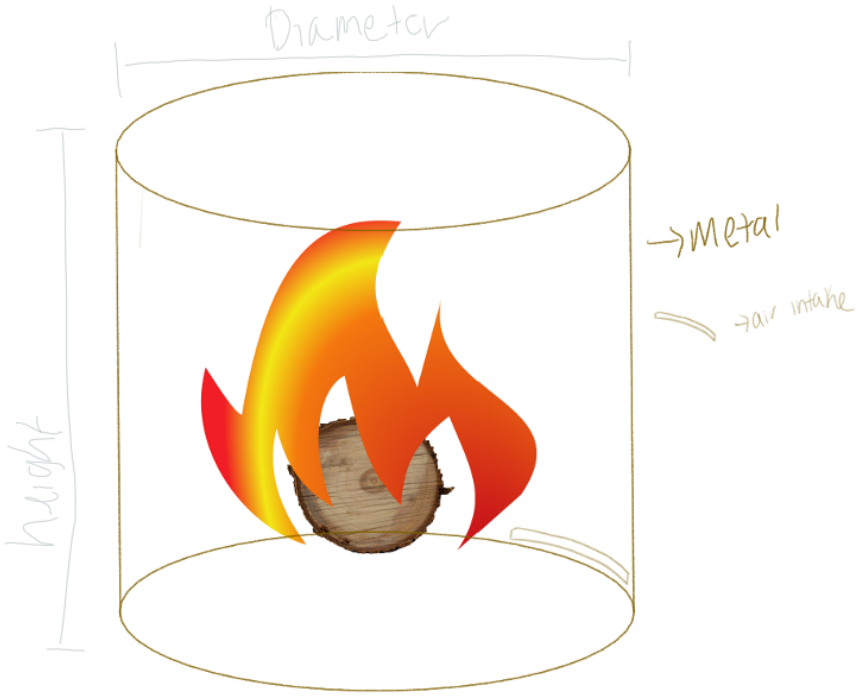

Figure 1. Flow apparatus set up.

Combustion can be described through a chemical reaction, Equation 1. As seen in Figure 2 below the wood from the campfire as well as the oxygen from the intake areas are the reactants, and the products are water and carbon dioxide. Forces acting on the flames are gravity as well as pressure from air flow. This airflow is coming from underneath the flames at the intake as well as from wind outside of the pit that enters the top of the pit cylinder.

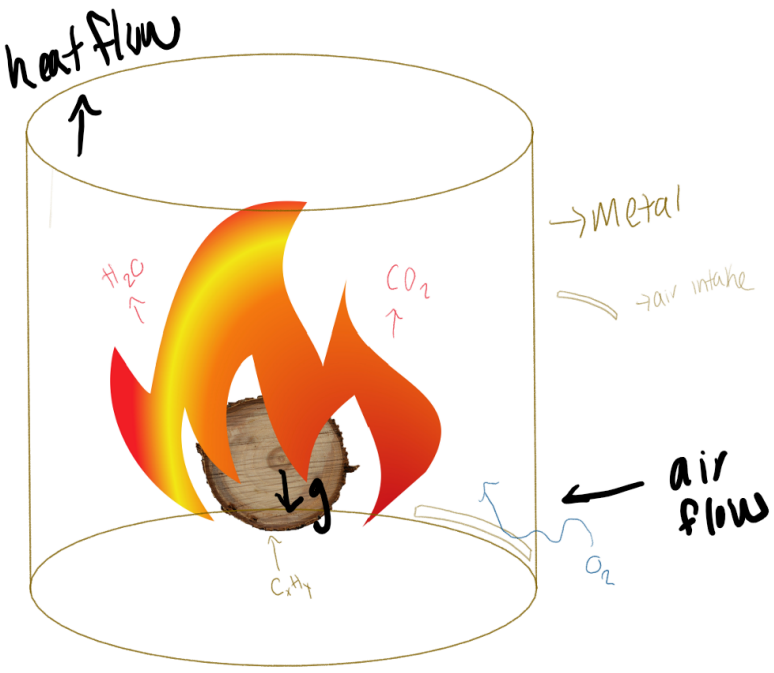

Figure 2. Free body diagram.

Combustion Reaction [1] $C_XH_Y + O_2 -> CO_2 + H_2O + \Delta H$ Eq. 1

Looking at Table 1 we can see that the density of fire is about one third that of air, and so the flame will be moved quickly by the force of the air. Wind patterns can be seen throughout the video making the flames move back and forth and sometimes even in a circular pattern. The forces from the outside wind change with time, and the air intake also changes with time varying the forces acting on the flames themselves.

Property	Value	Units	Reference
Density (ρ)	0.3	kg/m^3	[2]

Table 1. Properties of Everyday Fire.

III. Visualization Technique

The environment was outside in the woods in the mountains. The background of the video was aimed to be relatively solid so that the metal pit enclosure was most of the background to enhance the focus on the fire. Firewood was found near the campsite and a regular lighter was used to start the fire. There was no flash used on the video, and the only light source was the fire since the video was taken in the evening/night time.

IV. Photographic Technique

The camera used was an iPhone 11 Pro with default settings at 1x zoom in an horizontal orientation. The size of the field was approximately 2 feet tall and 3 feet wide. The distance from the camera lens to the flames was approximately 2 feet. Concerning post processing the only edit made to the original video was trimming the length of the video to cut out a section where the camera moved on accident, as well as adding nice background music to make the video calming to go along with the aesthetically pleasing content. (Therefore there will be no 'before' image shown since major edits were made audibly)

V. Final Thoughts

The image reveals the uncalculated and unpredictable movement and flow of a campfire flame. The resolution is slightly lower than I would like. To see the flow in greater detail it would have been beneficial to have taken the video on a DSLR camera, but the iPhone was the best camera option available at that time. This would have helped show the fluid physics better. Also, if the video was more planned I could have controlled more of the background to decrease the distracting features even more. To develop the idea further I would video fires in different shapes of metal pits to see how that impacts the air flow forces that act on the flames. Also, it would be interesting to compare various experiments where wind was made artificially and put onto the flames in different patterns and orientations to visualize the effects wind has on fires.

VI. Works Cited

[1] Inkoly. "Combustion Reaction - Wood Burning at Fire Camp. Stock Vector - Illustration of Complete, Molecule: 93920564." *Dreamstime*, 7 June 2017, https://www.dreamstime.com/stock-illustration-combustion-reaction-wood-burning-fire-camp-types-chemical-reactions-part-educational-chemistry-kids-cartoon-vector-image93920564.

[2] "Q: How Much Does Fire Weigh?" *Ask a Mathematician / Ask a Physicist*, 19 July 2017, https://www.askamathematician.com/2012/04/q-how-much-does-fire-weigh/#:~:text=For%20most%20%E2%80%9Ceveryday%E2%80%9D%20fires%2C%20the%20density%20of%20the,a%20cube%20about%201.2%20meters%20to%20a%20side.