

Get Wet

Fire has always been extremely fascinating to me and is an excellent way to visualize fluid flow. In addition, fire is probably the most common and easily accessible means of observing fluid flow in everyday life. For the first "Get Wet" project, I decided to play with a cheap handheld lighter. The lighter was modified by removing the top metal cover and increasing the gas flow many times past its intended maximum. With the flame size so large, the flames only lasted about a second or so before they died out. The objective of this image was to capture the large but short burst of flame that is projected from the modified lighter. I was especially interested in the flame's transition from laminar to turbulent flow.

The setup for this image was extremely simple but it took many tries to capture the desired shot. The setup consisted of my tripod-mounted camera a few feet from a simple black backdrop. Previously, I was photographing the flow of smoke rising from incense and decided to leave it in the shot to add another element of interest. The lighter was held slightly off camera at a comfortable angle and ignited by hand while I tried to capture the shot with the shutter release cable in the other hand. The flow of the flame begins extremely tight and laminar and continues until some of the fluid begins to separate and actually recirculate very similar to a mushroom cloud. Based on the elevation and temperature, I estimated the kinematic velocity of the gaseous flame to be approximately $1.8 \text{ E-4 m}^3/\text{s}$. The size of my observation frame was approximately .3 m. Using these two values in addition the gas velocity, the Reynolds number can be calculated. However, I am unable to estimate the gas velocity without a high-speed video camera and was unable to find any type of book values. I do know the

Reynolds number must be less than approximately 2000 due to its mostly laminar flow, meaning the velocity of the gas must be less than approximately 1.2 m/s.

For this photograph, there were no special visualization techniques employed. The image was captured indoors behind a black cloth backdrop. While the image appears almost pitch black, there was quite a bit of light being used: all room lights (fluorescent) were turned on in addition to a 60 watt-equivalent fluorescent desk lamp that was utilized as a spotlight. The on-camera flash was omitted to allow fast continuous shooting.

Due to the small amount of available light and fast shutter speed of 1/320, an extremely large aperture was required. For this photograph, a 50mm prime lens with an f-stop of 1.7 was used. The ISO was set to 400 to further reduce the amount of light required to get the shot while keeping digital noise to a minimum. The approximate field of view is 30 degrees. While typically a 35mm film camera with a 50mm lens results in 40 degrees field of view, the smaller APS-C sized CCD of my Sony Alpha 100 DSLR creates a 1.5x crop factor which yields an equivalent focal length of 75mm. With a 30 degrees field of view, the shot was taken approximately 18 inches from the flame which seemed to produce a good balance of flame detail and frame composition and resulted in an approximate 70 in² field of view. Finally, the image was left uncropped at its original resolution of 3872 x 2592.