“Flame Jet”

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Context and Purpose

Fire has always been a point of interest and awe to humans. The unpredictability and spontaneity gives flame the qualities that attract humans. The photographical intention for this image was to capture fire or flames uncommon to what is generally observed by the public. Often times in highly decorated hotels, such as the Bellagio in Las Vegas, jet water fountains are common to the surrounding decorative ponds. The motivation behind this image comes from the curiosity of whether those finely grouped water jets could be on fire through there journey through the air.

Apparatus and Theory

The apparatus used to capture the image consisted of the following and can be seen in Figure 1:

- Cannon Camera and Tripod
- Syringe
- Isopropyl Alcohol
- Black Cloth
- Candle and Candle stand
- Fire Extinguisher

The lit candle was mounted into position above the point of view of the camera horizontal to the ground. The flame was required to jet out horizontally to allow for the alcohol to pass through the flame without saturating the candle. The syringe with the alcohol was held 2 feet above the lit candle to insure the flame would not ignite the syringe. The camera was placed 4 feet away to one side. All images took place inside a ceramic tiled bathtub to help prevent unnecessary fires.

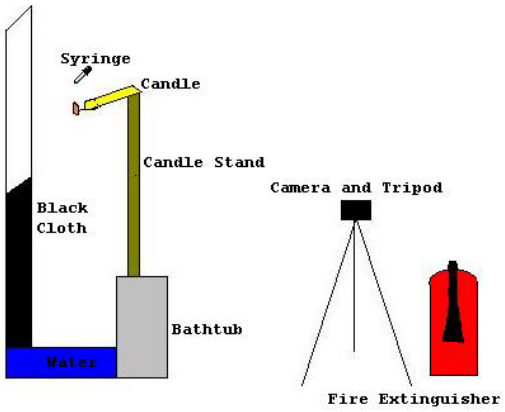

Figure 1: Apparatus

The flow imaged is that of a mostly solid stream of alcohol with the outer layer on fire. The flame may be compared to imaging the boundary layer of the alcohol; however the flow has no Reynolds number because it is not flowing around an object. Dimensionally the stream is a 32^{nd} of an inch in diameter at the start and expands to about $1/8^{th}$ inch. The flames are about 1 inch from side to side at the widest portion of

the flame. The field of view of the image is about 18 X 22 inches, width by height respectively. The speed of the flow through the field of view was that created by gravity. Starting at 2 feet above the field of view the flow accelerated to 11.35 ft/s as in entered the frame and 15.018 ft/s as it left the field of view. At this speed the maximum shutter speed of $1/400^{th}$ of a second was chosen to take the photograph. The fluid traveled 60 pixels in the time the image was taken which suggests a noticeable amount of motion blur, but still acceptable for the purposes of the image.

Visualization Technique

Isopropyl Alcohol was extracted from its container using a 10 ml syringe. The background was reflective white tile so a black t-shirt was draped over the tiles to create a dark background. The alcohol was poured using the syringe two feet above the flame to prevent the flame running back up to the source. Two people were required to take the image: one to pour the fluid and the other to take the picture. Each picture taken required about 2-3 ml of alcohol. The photograph required no extra lighting because the flame supplied ample amounts.

Photographic Technique

The technique used was a simple two person timing system. The photographer took a queue from the alcohol pourer and then the picture was taken. This process was done 25-30 times until an acceptable photograph was taken. The camera was held on a tripod to eliminate operator induced motion blur. The camera was placed on the tripod and then rotated 90 degrees to capture the flame in the longest axis of the camera. Camera statistics are given below:

- Field of view: 18 x 22 inches
- Distance from object to lens: 4 feet
- Lens: 7.4-22.2 mm
- Camera: Digital, Canon PowerShot Digital Elph S400
- Exposure: Aperture 2.8, Exposure $1/400^{th}$ sec
- Resolution: 2272 X 1704

Image Context and Conclusion

The jet when not lit is almost entirely invisible to the naked eye. Even when the jet was lit with artificial light, the fluid was clear and hard to make out when photographed in front of the dark background. Under a close inspection of the photograph the different flames at there different temperatures make the appearance of a solid stream flowing through the middle, even though it is not visible. What I really like about this image is this false representation of the stream through the middle. The motion blur, though not originally intended gives a spiraling effect around the center shaft which is quite beautiful. The time clarity of the image needs to be improved, but was not for this image because of camera restrictions. The image was also cropped within Photoshop to make the image stand out.

The fluid physics are not incredibly original. The main idea is the surface tension of the alcohol keeping itself in a solid stream and not spraying outwards, creating the apparent shaft through the middle of

the flames. The other physical concept behind the image is the effect of gravity on a fluid with a constant mass flow rate.

The intent of the image was to photograph fluid flow similar to water jets often seen in expensive Las Vegas hotels, but on fire. However, it was hard to mimic the types of fountains without getting a fair amount of spraying and that became an extreme fire hazard. The technique was then reduced to pouring the liquid into a fire safe receptacle to prevent spraying and fires. Knowing exactly how the water jets work would help further photographic idea. However, the general idea of the water jet on fire was realized.

For the next go around I would like to try horizontal motion instead of vertical motion as long as the spraying effects are minimized. I would also like to have access to a camera with a faster shutter speed so that there is no motion blur within the photograph.