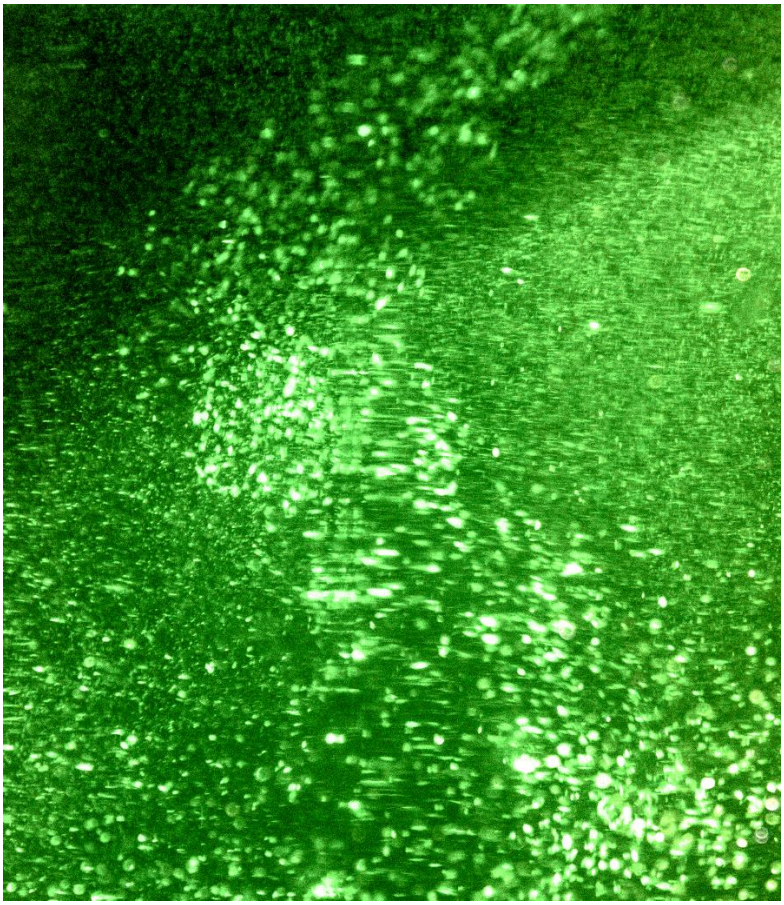
William Norris

Team Third

MCEN 4151

12/04/24



1. **Introduction**

   The image above shows an attempt at capturing a vortex created in a cylindrical glass. Water, green food coloring, dish soap and glitter were mixed into a glass container. The container was then moved vigorously in a circular motion to create a vortex in the center. In the picture above, one can see the remnants of that current running through the center of the frame. The picture is reminiscent of a night sky when you are in a place free of light pollution. Additionally, the picture shows a significant motion blur which will allow us to calculate the speed at which the particles in the mixture were moving. The vortex was also captured in video which can be found at this link: https://youtu.be/hQK3nGkc8eM

2. **Set up**

The set up for this experiment started by combining all materials into a glass cylinder. The container was sealed and then was vigorously moved in a circular motion. The result was the creation of a vortex in the center of the glass that was captured in a video. From the video and images, we are able to calculate the speed of the particles at a given point in time. In the still image we can determine that the 6.5cm diameter of the container takes up 3912 pixels in the frame. The images clearly show particles in motion described as “motion blur.” We select a streak and can determine that it is approximately 110 pixels long in the direction of the motion of the liquid. So, the equation below gives us the total distance that the particle traveled

$$3912 \text{ pixels}/110 \text{ pixels} = 0.065\text{m}/\text{Distance(m)}$$

Distance traveled is approximately 1.8cm. The frame rate was 1/40 second, so we can determine velocity of the fluid from the equation below.

$$\text{Velocity(m/s)} = \text{Distance(m)}/\text{Frame Rate(s)}$$

The velocity is approximately .73m/s. Using this velocity and knowing that the density of water at room temperature is ρ=1g/mL and the viscosity of water at room temperature is μ=1.0016mPA.s [1]we can use the following equation to determine the Reynolds number.

$$Re = \mu u L/\rho^{[1]}$$

Observationally the flow appears to be laminar at the time of the picture and the low Reynolds number (Re = .73L) would support that assessment. This image was captured after the vortex had begun to settle. As such, it is possible that with a sufficiently high velocity, particularly at the center of the container, we could have possibly seen more turbulent flow.

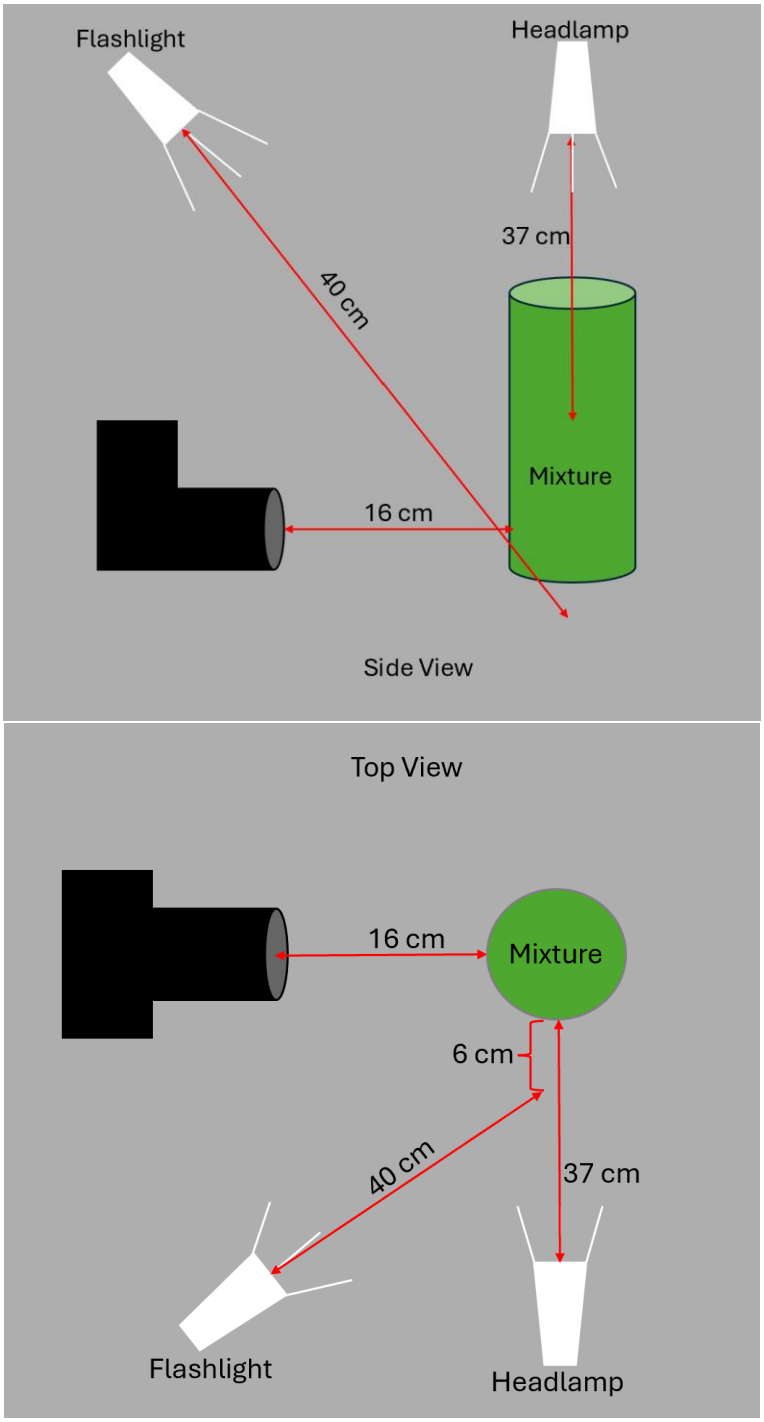
3. **Visualization Technique**

The experiment was conducted at room temperature using a glass cylinder, 6.5cm in diameter and 11cm tall and filling it approximately ¾ with room temperature tap water. Then, two drops of Dawn dish soap and 5 drops of Great Value brand green food coloring were added. Lastly ½ Tbsp of Sulyn Extra Fine Sterling Glitter and the solution was mixed.

4. **Photographic Technique**

The camera (Canon Rebel T7) was held approximately 16cm from the closest part of the flow. A Black Diamond headlamp was held 37cm above and looking down at the container perpendicular to the camera. The headlamp was an LED light emmiting 400 Lumens [3]. Additionally, a Surefire Fury Tactical flashlight was held 40cm away from the container and aimed so the center beam was hitting 6cm from the base of the container.

This flashlight emits 1500 lumens [4] and ensured the camera was able to effectively capture the vortex. Diagrams of the set up can be seen below.

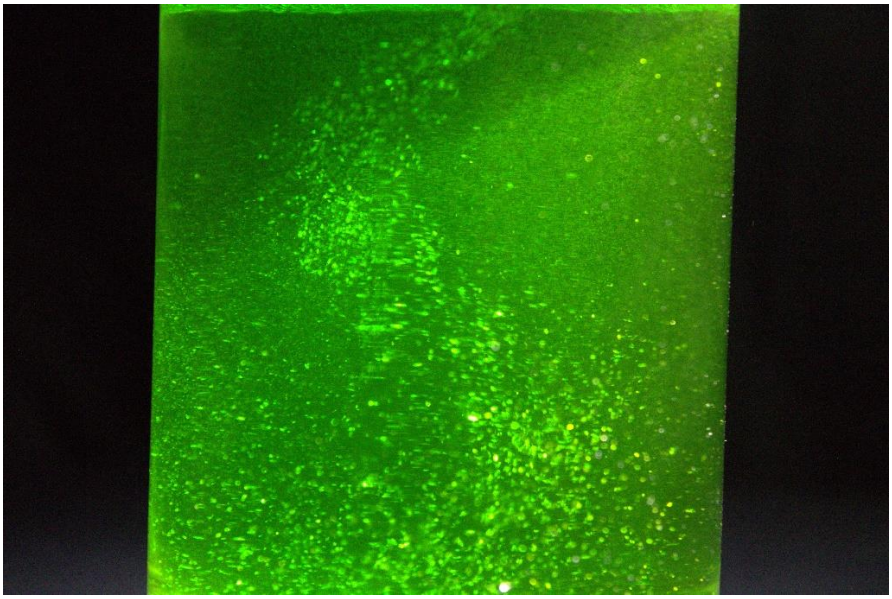


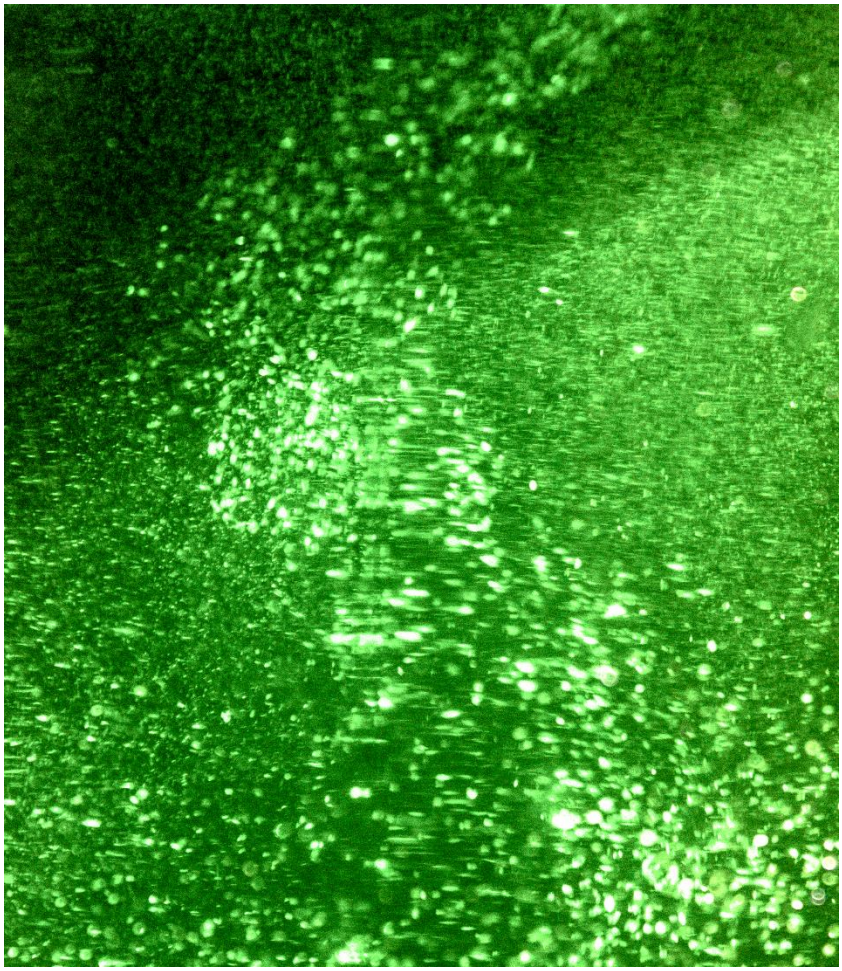
The field of view of the camera was approximately 10 cm. The aperture was f/5.6, exposure time was 1/40 sec and ISO speed was 1600. The focal length was 55mm

which gave the original photo dimensions of 6020x4015. The photo was edited using the program Darktable.

To edit the image, first extra space on each side was cropped out. Then the local contrast detail was increased to 176%. The white relative exposure was decreased to

2.07 EV and the black relative exposure was increased to -3.00 EV. The final image dimensions were 2794x3223. The original and edited images are shown below.





5. Conclusion

The experiment was an overall success but could have been improved in a variety of ways. The vortext was able to be captured in a video however there was a struggle capturing it in still images. Better understanding of manipulation of the camera could have probably improved this. Additionally, possibly changing the size of the container could have helped create a vortex that was more easily captured on camera. Additionally having a more professional lighting system would have helped improve the visual of the video. The current video becomes slightly washed out at times which detracts from the overall experience of the viewer.

6. References

[1] Anton Paar (n.d.). *Viscosity of Flower Honey (Blended)*. Retrieved September 18, 2024, from https://wiki.anton-paar.com/us-en/flower-honey-blended/

[2] The Engineering ToolBox (2003). *Reynolds Number*. [online] Available at: https://www.engineeringtoolbox.com/reynolds-number-d_237.html [Accessed 18 Sep 2024]

[3] The ZaneRay Group. (n.d.). *Spot 400 Headlamp | Black Diamond Equipment*. Black Diamond. https://www.blackdiamondequipment.com/en_US/product/spot-400/

[4] SureFire. (n.d.). *FURY Dual Fuel Tactical*. https://www.surefire.com/fury-dual-fuel-tactical/